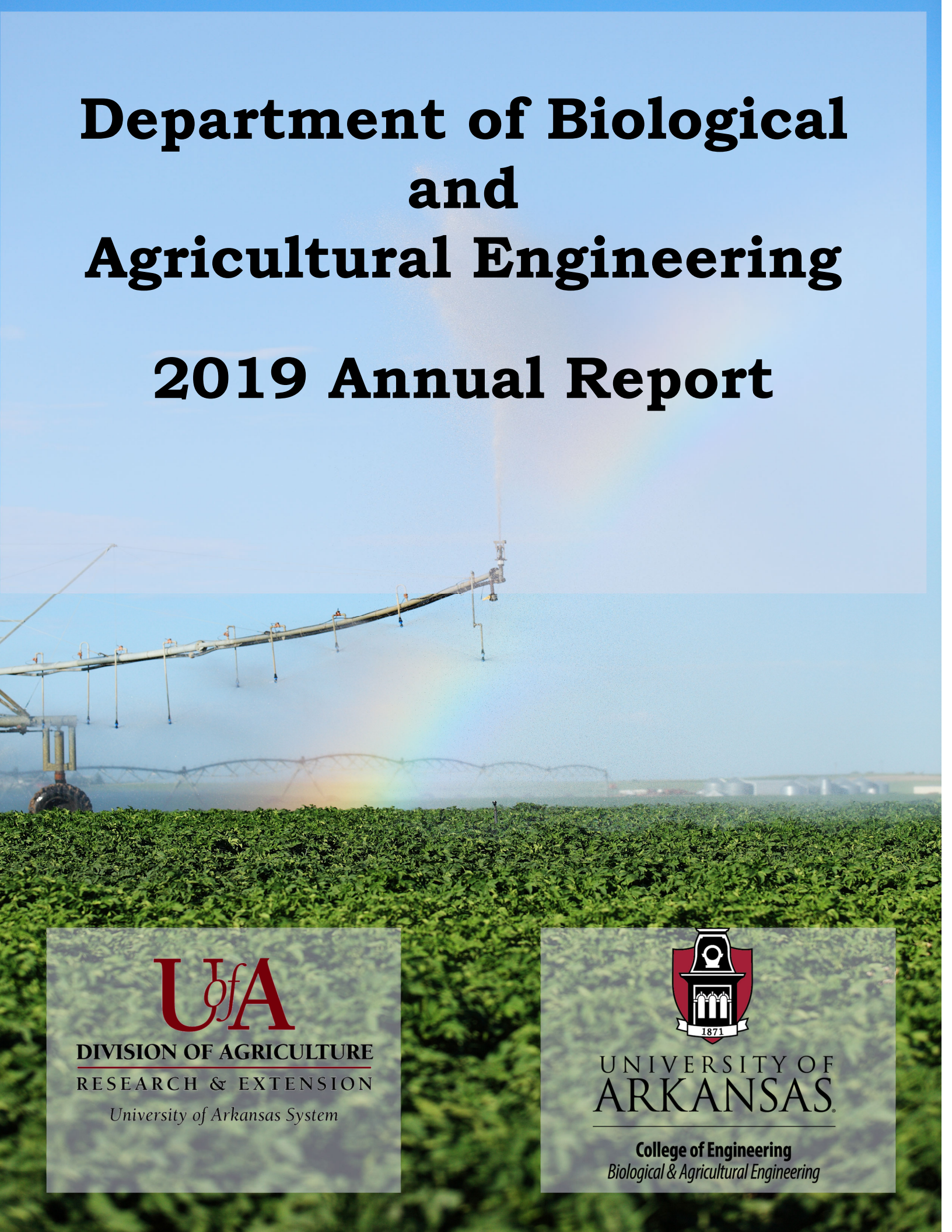
# Department of Biological and Agricultural Engineering

# 2019 Annual Report



DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

UNIVERSITY OF ARKANSAS
College of Engineering
Biological & Agricultural Engineering

# 2019 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**
Jean-Francois Meullenet
*Associate Vice President for Agriculture Research*

**Cooperative Extension Service**
Rick Cartwright
*Associate Vice President for Agriculture Extension*

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

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

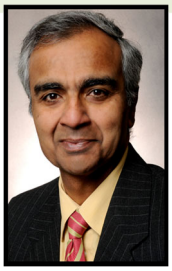
Jim Coleman
*Provost and Vice Chancellor for Academic Affairs*


Department of Biological
&
Agricultural Engineering
203 White Engineering Hall
University of Arkansas
Fayetteville, AR 72701
Phone (479) 575-2352
Fax (479) 575-2846
https://bio-ag-engineering.uark.edu/

# Table of Contents

# FOREWORD

## FROM THE DEPARTMENT HEAD



Lalit R. Verma,
Professor and Department Head

It is a pleasure to share the news and highlights of 2018. The mission of our department is "*to develop and disseminate engineering knowledge to address problems dealing with sustainable food, water and energy systems*." This mission supports the mission of our land-grant university and aligns well in addressing the grand challenges facing our society. Our Biological Engineering curriculum prepares engineers to solve problems in sustainable water, food and energy systems. A common thread noticed in the career goals of our students is their desire to "make a difference" and the program gives them the opportunity to do so by working to design engineering solutions for water, food and energy systems. The program continues to have a steady growth and attracts incoming engineering freshmen wishing to pursue careers closely aligned with sustainable systems. Our department has the opportunity to contribute to the programs of both the UA System's Division of Agriculture's research and extension programs, and the UA College of Engineering. We are housed in the engineering college and our departmental support budget is provided by the Arkansas Agricultural Experiment Station and the Cooperative Extension Service, while our academic programs are funded by the College of Engineering. Some of our faculty are located 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. Our team is 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.

Seven outstanding alumni were inducted in the Arkansas Academy of Biological and Agricultural Engineering (AABAE) in 2018 on April 20th. They are Mr. John Chris Brock, Dr. Dylan Carpenter, M.D., Mr. Zach Dalmut, Mr. Kyle Kruger, Ms. Toni McCrory, Ms. Katherine Merriman-Hoehne and Ms. Shelly Thomas. AABAE provides valuable support annually through scholarships, student membership in ASABE, travel for student competitions and student club activities. Mr. Gregory Baltz (BSAGE 1980) of Running Lake Farms in Pocahantas, AR was honored as a "*Distinguished Alumnus*" and Mr. Drake McGrudder (BSBE 2006) of Kraft Heinz Co. in Ft. Smith, AR was recognized as an "*Early Career Alumnus*" of the College of Engineering.

A successful industry tour for 43 undergraduates was coordinated by Dr. Tom Costello in the fall semester. Our enrollment is strong and required two sections of the sophomore level "Design Studio" course this semester. We had 117 undergraduate Biological Engineering students with sophomore, junior or senior standings, and 19 graduate students. Several faculty participated in the 2018 Annual International Meeting of the American Society of Agricultural and Biological Engineers (ASABE) in Detroit in July. Twenty four students in seven teams showcased their senior design projects on May 3rd. Ms. Ali Ezell, one of our 23 graduating seniors was selected as the "*Most Outstanding Graduating Senior*" in Biological Engineering and was recognized at the College of Engineering student recognition reception and graduation ceremony on May 12th. Three of our graduating seniors, Ali Ezell, Casey Gibson and Kendrick Hardaway were honored as "Seniors of Significance" with their mentor Dr. Scott Osborn by the Arkansas Alumni Association. Dr. Osborn, student club advisor organized and accompanied 16 students to the ASABE Southeast Student Rally in Lexington, KY during April 5 to 8.

Distinguished Professor Yanbin Li was inducted as a 2018 ***Fellow*** of the Institute of Biological Engineering in Norfolk, VA on April 7, 2018. He received a $2.3 million grant from the Walmart Foundation to conduct research for improving food safety in poultry supply chain in China. The project focuses on innovative biosensing technology to rapidly detect pathogenic bacteria and antibiotic residues in poultry supply chain and advanced dynamic risk-assessment models integrated with supply chain management to help the industry and regulators make better decisions for ensuring food safety in poultry. He was also awarded a College of Engineering "*Excellence in External Research Award*."

Dr. Ben Runkle is the recipient of the prestigious NSF CAREER Award. This *Faculty Early Career Development* award from the National Science Foundation is to expand his research on sustainable rice production. The NSF award will enable Dr. Runkle to quantify the climate impact of water-saving irrigation strategies. He was also recognized with the "*Rising Teaching Award*" in the College of Engineering.

In March it was announced in Washington, D.C. that Dr. Marty Matlock is the winner of the prestigious "*2018 Borlaug CAST Communication Award*." Drs. Tom Costello, Jin-Woo Kim and Brian Haggard were recognized for excellence in teaching, research and service to students in our department, respectively. Mr. Julian Abram was awarded the Division of Agriculture Non-Classified Support Personnel Award in January for his superior service. I had the opportunity to make a keynote address at the inaugural conference of the Pan-African Society for Agricultural Engineering in Nairobi, Kenya.

The Arkansas Section of ASABE held its 55th meeting on October 5th in Fayetteville in the Don Tyson Center for Agricultural Sciences. Ms. Laura Gray was named the "Outstanding Senior" and Dr. Sammy Sadaka was recognized as the "Outstanding Engineer" at this event. We have made good progress in raising funds to endow the ***Carl Griffis Memorial Scholarship*** but have not yet reached our goal. Support of our alumni and friends in endowing this scholarship is needed so we may honor the dedicated service of Professor Griffis to our students and our stakeholders.

Preparations are underway for an external departmental review of our research, extension and graduate education programs in 2019. I hope this annual report provides an overview of the programs, contributions and accomplishments of our faculty, students and staff in 2018.

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

- Dr. Ji-Woo Kim received the Arkansas Biosciences Institute "Established Investigator of the Year Award", 2019
- Dr. Yanbin Li received the "International Food Engineering Award", ASABE (American Society of Agricultural and Biological Engineers)
- Dr. Marty Matlock received the "WAF Award for Education"- Future Project: Shortlisted, World Architecture Festival
- Dr. Marty Matlock received the "The Plan Award: Urban Planning Finalist", The Plan Magazine
- Dr. Marty Matlock – "AN Best of Design Award for Unbuilt Urban", The Architect's Newspaper
- Dr. Benjamin Runkle – ASEE BAE Division "Early Achievement in Education Award"
- Dr. Thomas Costello – ASABE – AR Section "Outstanding Ag. Engineer" - 2019
- Dr. Scott Osborn received the College Outstanding Teaching award for Biological and Agricultural Engineering.
- Dr. Thomas Costello received the College Outstanding Service to students award for Biological and Agricultural Engineering.
- Dr. Yanbin Li received the College Outstanding Research award for Biological and Agricultural Engineering.
-

ALUMNI ACCOMPLISHMENTS

- Mr. Cory Scott, Ms. Jessica Temple, Mr. Rusty Tatewere inducted into the Arkansas Academy of Biological and Agricultural Engineering.
- Mr. Steve Danforth, (BSAGE 1980) of Little Rock, was recognized as a "Distinguished Alumnus" and Mr. Kyle Kruger P.E., BSBE 2005, MSEnE 2009, Oklahoma Plant Team Leader, Garver, was recognized as an "Early Career Alumnus" of the College of Engineering.

# Significant Accomplishments in 2019

## Students

- Lydia Huck recognized on cover of Resource Magazine (professional society magazine) for her work on water sustainability in Senior Design.
- Natalie Von Tress recognized as Outstanding Senior in BENG.
- Sarah Gould named UA Senior of Significance.
- Lillie Haddock named UA Senior of Significance.
- Laura Gray named UA Senior of Significance.
- Libby Topping named ASABE State Section Outstanding senior
- Laura Gray named 2019 Razorback Classic by Alumni Association.
- Senior design team Lillie Haddock, Mary Lawson, Kristen Connelly, and Trent Woessner placed 2nd in the Gunlogson Environmental Student Design Competition, ASABE Annual Meeting, Boston, MA, in July 2019.

**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.**
*Associate 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 considerations; develop and maintain positive working relationships with other government agencies and industries.*

**Jin-Woo Kim, Ph.D.**
*Professor*
B.S. Ch.E. (1986) Seoul National University, Korea
B.S. Microbiology (1991) University of Iowa
M.S. Biology (1994) University of Wisconsin
Ph.D. Ag.E. (1998) Texas A&M University

*Research Areas: Biotechnology engineering, biomedical engineering, bionanotechnology, and bio-abio interfacing technology.*

**Kieu Ngoc Le, Ph.D.**
*Instructor*
B.S. Education and Foreign language (English), Cantho University (2006) , Vietnam
B.S. Hydraulic Engineering, Cantho University (2007) , Vietnam
M.S. Plant Soil and Environmental Science (2011) North Carolina Agricultural and Technical State University
Ph.D. (2017) North Carolina Agricultural and Technical State University
*Research Areas: Field- and watershed-scale modeling to evaluate the impacts of land use, on-farm management decisions on soil organic carbon sequestration, soil properties, crop productivity and water quality. Life cycle assessment on the impact of conservation agriculture versus different tillage systems*

**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 Rural Sustainability
B.S. Soil Chemistry (1984) Oklahoma State University
M.S. Plant Physiology (1989) Oklahoma State University
Ph.D. Biosystems Engineering (1996) Oklahoma State University
*Research Areas: Ecological engineering, ecological watershed modeling, biological assessment and monitoring, ecosystem design and management.*

**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.**
*Associate 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 and agro ecosystems, surface water nutrient fluxes and source partitioning. Land-atmosphere exchange of carbon dioxide, methane, and water vapor.*

**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*

Dawn Adamson
*Fiscal Manager*

Randy Andress
*Program Associate*

Eric Cummings
*Program Associate*

Sydney Jones
*Administrative Specialist III; Extension*

Beatriz Moreno Garcia
*Post Doctoral Fellow*

Sandhya Karki
*Post Doctoral Associate*

Janelle Mott
*Fiscal Manager*

Linda Pate
*Department Administrative Manager*

William Benjamin Putnam V
*Research Associate*

Leslie Reinhart
*Administrative Specialist III*

Lee Schrader
*Program Assistant*

Kosana Suvočarev
*Post Doctoral Associate*

Anthony Taylor
*Administrative Specialist III*

Ronghui Wang
*Post Doctoral Associate*

### BAEG Advisory Board
### 2019 Members

Mark Christie
*Manufacturing Services*
*Tyson Foods*

Alan Fortenberry
*Chief Executive Officer*
*Beaver Water District*

Tyler Gipson
*Hydraulic Engineer*
*Southwestern Power Administration*

Kevin J. Igli
*SVP and Chief EHS Officer*
*Tyson Foods*

Kyle Kruger
*Garver Engineering*

Jeff Madden
*Director of Engineering*
*Riceland Foods, Inc.*

Toni Peacock McCrory
*Director*
*Water Compliance*
*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
### 2019 Members

Bill HagenBurger
*Beaver Water District*

Jeff Madden
*Riceland*

Don Mosley
*Entegrity*

Katherine Yarberry
*Wal-Mart*

Thomas Costello
*BAEG Faculty*

Scott Osborn
*BAEG Faculty*

Lydia Huck
*Undergraduate student*

Katharine Campbell
*Undergraduate Student*

## 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)*

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

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)*

John Chris Brock
B.S. ('85) M.S. ('00)

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

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

Dylan Carpenter
B.S. ('05) M.S. ('07)

Indrajeet Chaubey
*M.S. ('94)*

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)*

Zach Dalmut
B.S. ('06)

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

Glenn Davis
*B.S. ('67)*

Anthony Doss
*B.S. ('94)*

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)*

Kyle Kruger
B.S. ('86)

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)*

Kate MerrimanAmber Meisner
B.S. ('02)

Drake McGruder
*B.S. ('06)*

Katie Migliaccio, Ph.D.
Ph.D. ('05)

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)*

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

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*

Corey Scott
*B.S. (2005)*

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)*

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

Rusty Tate
*B.S. (2008)*

Jessica Temple
*B.S. (2007)*

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*

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

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

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

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

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

Albert E. "Gene" Sullivan
B.S. ('59)

John Chris Brock
B.S. ('85) M.S. ('00)

Dylan Carpenter
B.S. ('05) M.S. ('07)

Zach Dalmut
B.S. ('06)

Kyle Kruger
B.S. ('86)

Kate Merriman-Hoehne
B.S. ('02)

Shelly West
B.S. ('05)

Toni McCrory
B.S. ('07)

## 2019 Academy Inductees

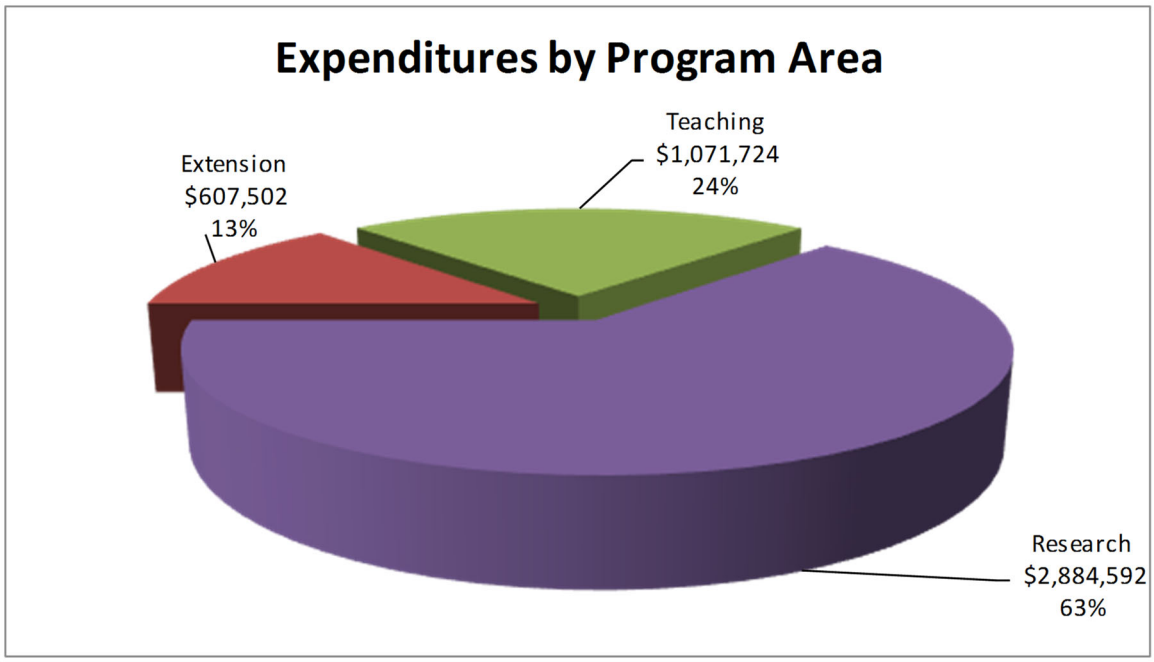
Corey Scott
B.S. ('05)

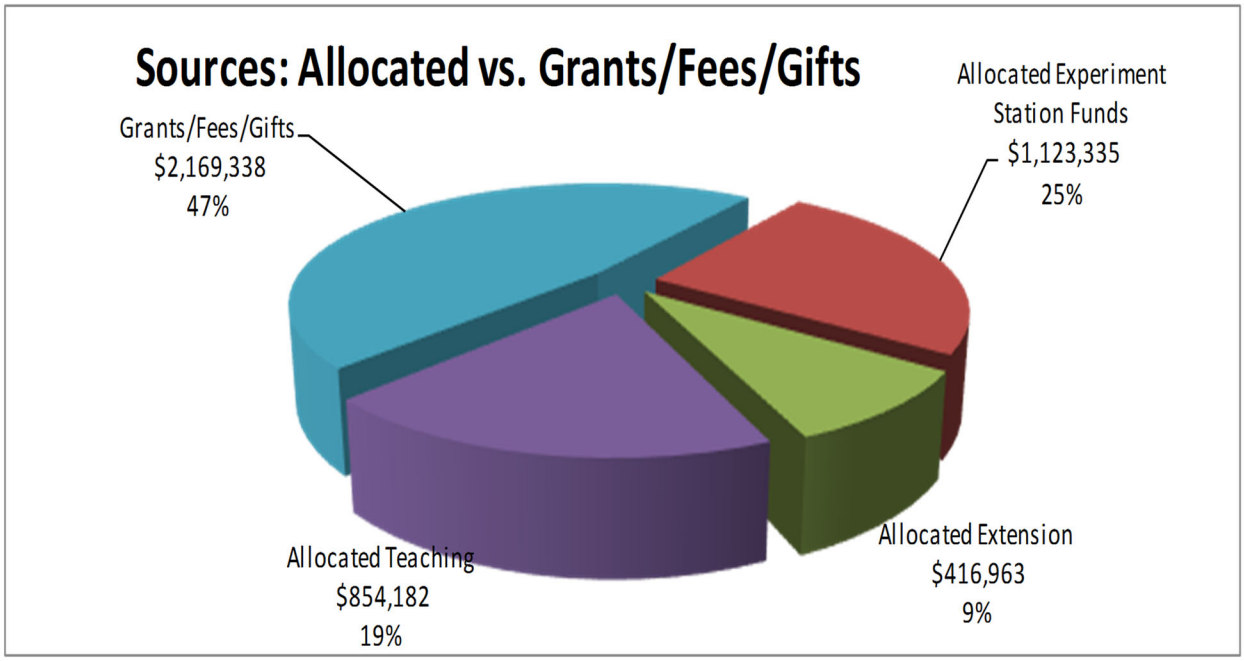
Rusty Tate
B.S. ('05) M.S. ('08)

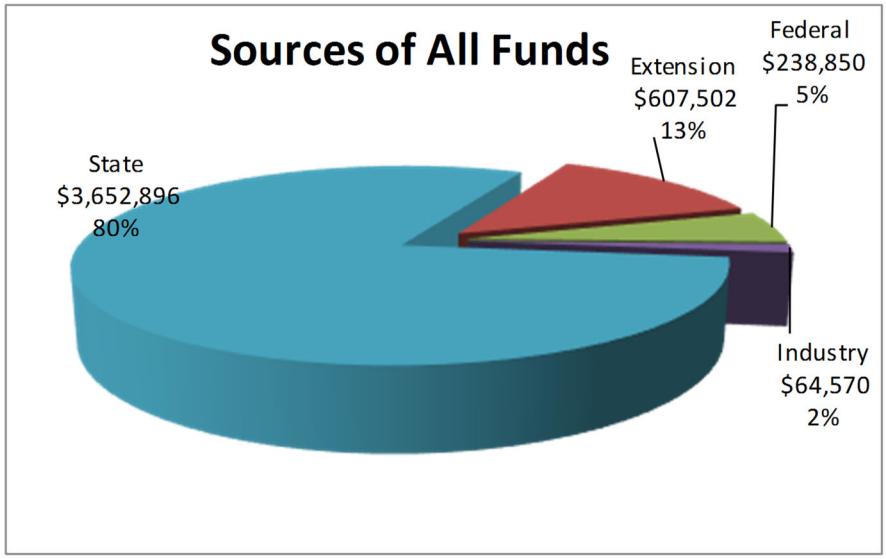
Jesscia Temple
B.S. ('07)


Arkansas Academy of Biological and Agricultural Engineering
Induction Ceremony

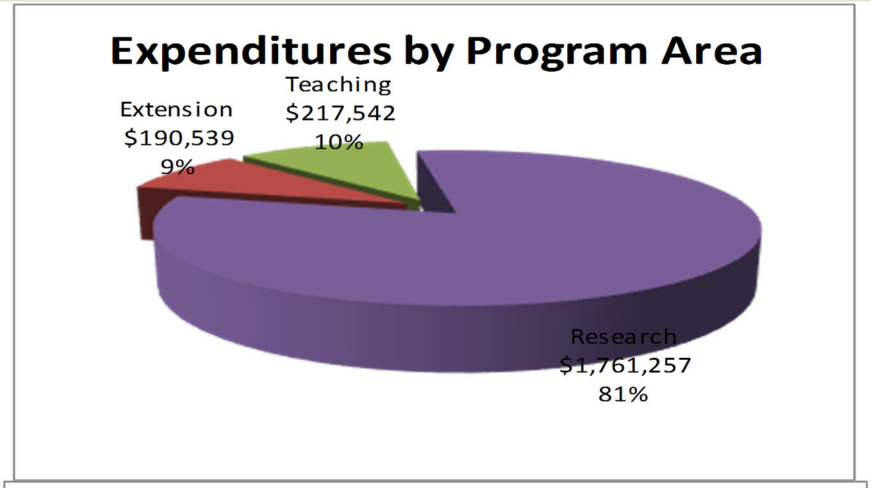
# TOTAL EXPENDITURES, JULY 1, 2017 TO JUNE 30, 2018
# $4,563,818

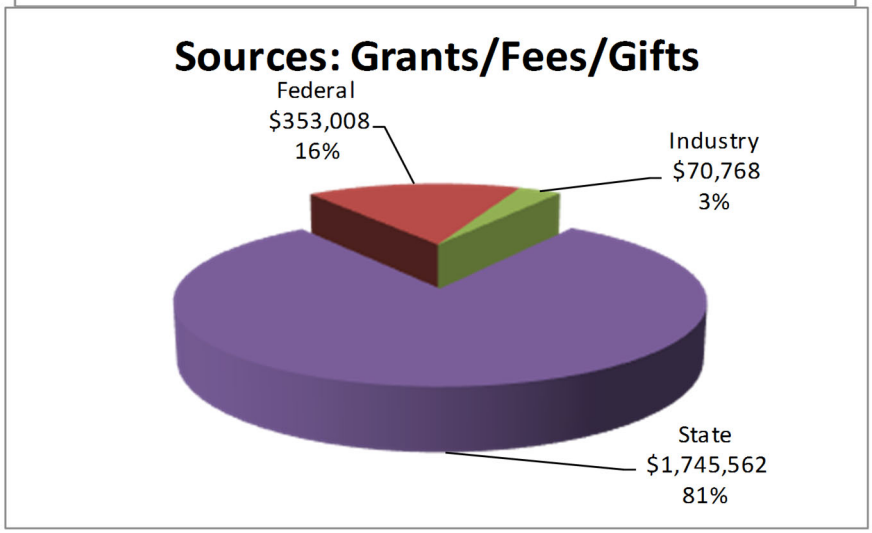





## GRANTS/FEES/GIFTS
## $2,169,338



## 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 band 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

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

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

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

## DEPARTMENT OF BIOLOGICAL & AGRICULTURAL ENGINEERING

In 2012, the Biomedical Engineering program was separated and the revised curriculum in Biological 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 2018 census, Fayetteville has a population of 86,751 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 2019

Names listed in Italic are spring 2018 scholar ship Recipients the others listed are fall 2018 scholarship recipients.

**Arkansas Academy of Biological & Agricultural Engineering Scholarship**
*Thomas Helvick*
*Bailey Keller*
Laura Gray
Megan O'Hare

**Biological & Agricultural Engineering Departmental Scholarship**
*Kendrick Hardaway*
Natalie VonTress

**Billy B. and Mildred V. Bryan Scholarship**
*McKenna Belcher*
Kaden Belcher
Katharine Campbell
Lillie Haddock
Bailey Keller
Daisy Mota

**Division of Agriculture Scholarship**
*Ryan Clark*
*Trent Woessner*
Isabel Arrocha Cordovez
Issac Bertels
Kanaan Hardaway
Cady Puckett

**J.A. Riggs Tractor Company Scholarship**
*Lillian Glaeser*
*Nicholas Cross*
Sarah Gould
Lydia Huck
Marilyn Pharr

**Xzin McNeal Scholarship**
*McKenna Blecher*
*Laura Gray*
*Trent Woessner*
*Brooke Benham*
*Megan Woodsworth*
*Gavin Heller*
*Wesley Jones*
*Michael Leppold*
*Mary Lawson*
*Taylor Butler*
*Juan Arguijo*
*Jennifer Bravo*
*Evan Byrd*
*Nicole Duncan*
*Wesley Jones*
*Mary Lawson*
*Angel Meneses Castillo*
*Thania Ramos*
*(David) His-Cheng Su*
*Chandler Trotter*
*Trent Woessner*
*Clare Yurchak*
*Jacob Askey*
*McKenzie Gillit*

***Joel Steel & Hardy Croxton Beaver Water District***
*Trent Woessner*

**John W & Trannye Odom White Scholarship**
*Natalie Von Tress*
Jacob Askey

**Mike & Yvonne Jones Scholarship**
*Lillian Glasser*
*Natalie VonTress*
*Kendrick Hardaway*
McKenzie Gillit
Clare Yurchak

### Graduates for 2019

**Bachelor of Science in Biological Engineering**

**Spring 2018**
Mckenna L. Belcher
Brooke Anne Benham
Seth Edward Boles
Colton E. Bryant
Linden Kay Cheek
Ryan James Clark
Ali K. Ezell
Casey Ann Gibson
Kendrick Clay Hardaway
Thomas Helvick
Rose Elizabeth Hendley
Merrisa Kendrick Jennings
Samuel Stone Lahodny
Madeline Jane Ludwig
Madison Taylor Rain McMillen
Kami A. Parmenter
Alexander Wayne Parr
Mason Christopher Puckett
Will Pape Richardson
Rachel Christine Schlais
Allison A. Sites
Jacob Alan Stanosheck
Megan Faith Woodworth

**Fall 2018**
Zachary Morgan Johnson
Pablo Andres Pena Cabezas

### Biological Engineering Student Club

**2019-2020 Officers**

David Su—*President*
Kat Campbell—*Vice President*
Mason Jewell—*Treasurer*
Kira Simonson—*Secretary*
Priscila Morales —*Social Outreach Coordinator*
Wesley Wahls– *Outdoor Event Coordinator*
*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 2017-2018 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 1033 Technical Composition or 1023 Technical Composition II<br>4 First-Year 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<br>**(17 Semester hours)** | **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>**(15 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>3 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 First-Year 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 First-Year 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 B.S. 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 2018. 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 |
|---|---|
| Josef Dalaeli | Dr. G. Scott Osborn |
| Christian Heymsfield | Dr. Yi Liang |
| Jacob Hickman | Dr. Marty Matlock |
| Vaishali Kandapal | Dr. Chris Henry |
| Deanna Mantooth | Dr. Marty Matlock |
| Angelica Makuch | Dr. Marty Matlock |
| Dominic A. Romero | Dr. Jin-Woo Kim |
| Andrew Shaw | Dr. Marty Matlock |
| Slater Smith | Dr. Brain Haggard |
| America Sotero | Dr. Yanbin Li |
| Brandon Taylor | Dr. Marty Matlock |
| Summer Wilkie | Dr. Marty Matlock |

### Master of Science in Microelectronics –Photonics

| Student | Advisor |
|---|---|
| Mahshid Imiparast | Dr. Jin-Woo Kim |

### Doctor of Philosophy in Biological Engineering

| Student | Advisor |
|---|---|
| Prathamesh Bandekar | Dr. Marty Matlock |
| Zachary Callaway | Dr. Yanbin Li |
| Eric Cummings | Dr. Marty Matlock |
| Gurshagan Kandhola | Jin-Woo Kim |

### Doctor of Philosophy in Biological Engineering

| Student | Advisor |
|---|---|
| Abbie Lasater | Dr. Brian Haggard |
| Kaushik Luthra | Dr. Sammy Sadaka |
| James McCarty | Dr. Marty Matlock |
| Colby Reavis | Dr. Benjamin Runkle |
| Sepideh Tavakoli | Dr. Jin-Woo Kim |
| Xinge Xi | Dr. Yanbin Li |

### Doctor of Philosophy in Cell and Molecular Biology

| Student | Advisor |
|---|---|
| Joseph N. Batta-Mpouma | Dr. Jin-Woo Kim |
| Cody Chivers | Dr. Jin-Woo Kim |
| Xiaofan Yu | Dr. Yanbin Li |

### Doctor of Philosophy in Poultry Science

| Student | Advisor |
|---|---|
| Wenqian Wang | 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 2018
Christian Heymsfield MSBE
Jay Mishra MSBE

SUMMER 2018
Vaishali Kandpal 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 |
|---|---|---|
| Jacob Alberti | Master Science Engineering | Dr. Otto J. Loewer |
| Joshua Blackstock | PhD Geosciences | Dr. Benjamin Runkle |
| Lulu Cao | Master Science Zhejiang University | Dr. Yanbin Li |
| Christopher Carr | Maters Science Engineering | Dr. Otto J. Loewer |
| Huang Dai | PhD Zhejiang University | Dr. Yanbin Li |
| John Deurpinghaus | Masters Industrial Engineering | Dr. Benjamin Runkle |
| Luke Dinkledine | Master Science Engineering | Dr. Otto J. Loewer |
| Dean Dronen | Master Science Engineering | Dr. Otto J. Loewer |
| Tyler Fochtman | Master Science Computer Science | Dr. Jin-Woo Kim |
| William Garrahan | Master Science Engineering | Dr. Otto J. Loewer |
| Yawen He | Master Science Zhejiang University | Dr. Yanbin Li |
| Jeffrey Henson | Master Science Biomedical Engineering | Dr. Jin-Woo Kim |
| Jacob Hickman | Master Science Environmental Engineering | Dr. Marty Matlock |
| Josh Humphreys | PhD Crop Soil & Environmental Sciences | Dr. Benjamin Runkle |
| Zhishang Li | PhD Zhejiang University | Dr. Yanbin Li |
| Aoming Liang | Masters of Science Zhejiang University | Dr. Yanbin Li |
| Bo Ma | PhD Microelectronics-Phontonics | Dr. Jin-Woo Kim |
| Shelly Maddox | PhD Mechanical Engineering | Dr. Jin-Woo Kim |
| Jacob Marsh | Master Science Engineering | Dr. Otto J. Loewer |
| Sangeeta Mukhopadhyay | PhD Food Science | Dr. Scott Osborn |
| Haiying Pang | Master Of Science Zhejiang University | Dr. Yanbin Li |
| Leigh Parette | PhD Poultry Science | Dr. Yanbin Li |
| Joseph Parker | Master Science Engineering | Dr. Otto J. Loewer |
| Alexander Plumb | Master Science Engineering | Dr. Otto J. Loewer |
| Zahohui Qiao | PhD Zhejiang University | Dr. Yanbin Li |
| Francia Ravelombola | PhD Crop, Soil and Environmental Sciences | Dr. Chris Henry |
| Jacob Reed | Master Science Engineering | Dr. Otto J. Loewer |
| Trent Rodgers | PhD Computer Science and Computer Engineering | Dr. Jin-Woo Kim |
| Savanna Royals | Master Science Engineering | Dr. Otto J. Loewer |
| Bradley Silfies | Master Science Engineering | Dr. Oto J. Loewer |
| Yafang Shen | PhD Zhejiang University | Dr. Yanbin Li |
| Xiangning Xiao | PhD Zhejiang University | Dr. Yanbin Li |
| Xiaofan Yu | PhD Cell and Molecular Biology | Dr. Yanbin Li |
| Qi Zhang | PhD Zhejiang University | 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.*

**BENG 2632 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).

**BENG 2643 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.

**BENG 3113 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.

**BENG 3113H 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. Corequiste: Lab component: Prerequistie: PHYS 2074 and honors candidacy.

**BENG 3653 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.

**BENG 3723 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).

**BENG 3733 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.

**BENG 4123 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.

**BENG 450V 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.

**BENG 451VH Honors Thesis (Sp, Su, Fa)** Prerequisite: Honors candidacy.

**BENG 452V 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.

**BENG 4663 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.

**BENG 4703 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.

**BENG 4743 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.

**BENG 4753L 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.

**BENG 4753M 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.

**BENG 4812 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.

**BENG 4823 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.

**BENG 4933 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

**BENG 500V 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.

**BENG 5103 Advanced Instrumentation in Biological Engineering (Even years, Sp)** Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies,dataacquisition and analytical instruments. Lecture 2 hours, lab 3 hours per week. Corequisite: Lab component. Prerequisite: BENG 3113.

**BENG 5253 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)

**BENG 5303 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.

**BENG 5313 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.

**BENG 5323 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.

**BENG 5333 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.

**BENG 5343 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.

**BENG 5351 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.

**BENG 5613 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.

**BENG 5623 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.

**BENG 5633 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)

**BENG 5703 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.

**BENG 5723 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).

**BENG 5733 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.

**BENG 5743 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 bio-

logically 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.

**BENG 5801 Graduate Seminar (Sp)** Reports presented by graduate students on topics dealing with current research in biological engineering. Prerequisite: Graduate standing.

**BENG 5923 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.

**BENG 5933 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.

**BENG 5953 Ecological Engineering Design (Fa)** Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bio-swales, retention basins, filter strips. Design of sustainable ecological processes for the treatment and utilization of wastes/residues. Techniques may include: direct land application to soils/crops, composting systems, lagoons and constructed wetlands. Design goals include optimization of ecological services to maintain designated uses of land, water and air; including enhancement of habitat for wildlife and recreation, and the discovery of economically viable methods for co-existence of urban and agricultural land uses. Lecture 3 hours per week. Students may not earn credit for both BENG 5953 and BENG 4923. Prerequisite: BENG 4903 or equivalent.

**BENG 600V Master's Thesis (Sp, Su, Fa) (1-6)** Graduate standing required for enrollment.

**BENG 700V Doctoral Dissertation (Sp, Su, Fa) (1-18)** Candidacy is required for enrollment.

# Student Field Industry Tour FALL 2018


Tour of Greg Baltz farm Pocahontas AR

Fourche Creek Wastewater Treatment Facility, Little Rock, AR


ASU Campus for Arkansas Section of ASABE meeting, Jonesboro , AR

The Gathering Place (park) in Tulsa, Ok

Bergey Windpower, Norman, OK

# 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 water, food and energy systems.

- 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.
- 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.
- 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, and energy effectiveness analysis.

**Research areas of the Biological and Agricultural Engineering Department**

- **Agricultural and Food Engineering**: Faculty in this area are developing more efficient and sustainable ways to produce food for a growing population. They are investigating ways to improve practices in several agricultural industries, including on-farm grain drying for transportation costs reduction, on-farm utilization of agricultural residues for biofuel and bioenergy production, space-heating poultry houses using renewable fuels, aerial emissions and mitigation from poultry housing, indoor air quality and environmental control, risk assessment of microbial hazards in poultry and food processing, predictive models of pathogenic bacteria in food products, value-added products production from agricultural renewable resources for bio-energy and chemicals, production of algae as a biofuel feedstock, livestock and poultry manure management, and applications of site-specific and geospatial technologies in food production systems.

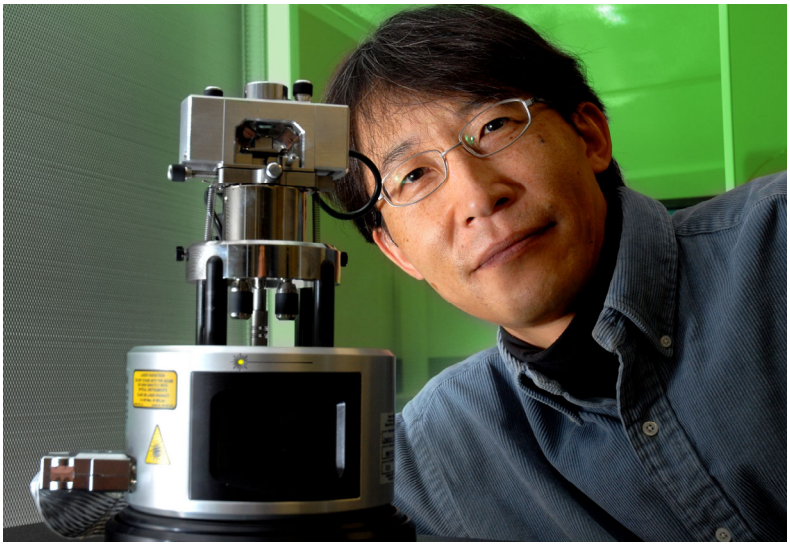
- **Biotechnology Engineering**: Faculty in this area design systems utilizing engineering tools with life sciences. Examples of biotechnology engineering include biosensors and bioinstrumentation for foodborne pathogens, avian influenza in poultry and food safety. Bio-nanotechnology for DNA-computing, nano-building block toolboxes (nano-toolboxes) for multifunctional nanocomposites with "customizable" shapes and functions, nano-therapeutics and diagnostics (nanotheranostics) with nanoparticles and nanocomposites, multimodal, multiplex, multicolor bio-detection platform for agriculture, food safety and biosecurity, bio-driven nanostructure self-assembly, nanoscale bio/abio interfacing technology, and nucleic acid technology for molecular computation, genomics and proteomics.

- **Ecological Engineering and Water Resources**: Faculty in this area combine the science of ecology with the practice of engineering to solve complex ecosystem problems. These solutions include designing systems to restore lakes, disinfect water, remove nutrients and contaminants, repair eutrophic reservoirs, and monitor water quality. Studies are conducted on agricultural and urban Best Management Practices and efficiencies, water quality management and trends, stream restoration, eco-hydrology, ecological risk assessment, designing water risk protocols for governments and industries under climate change scenarios, non-point source pollution engineering, water quality impacts of row crop irrigated agriculture in Arkansas, irrigation scheduling, water resource development, irrigation system technology development and alternative irrigation systems, crop water use, chemigation, irrigation scheduling, pumping plant performance and irrigation energy use.

- **Sustainability and Green Engineering**: Sustainability concerns inform all the areas of biological and agricultural engineering. Researchers in this department are using lifecycle assessment of agricultural, urban and supply chain systems, designing sustainable global food supply systems, devising corporate strategies for risk reduction and management, and reducing environmental impacts. Impacts of climate change are being studied by evaluating evapotranspiration, surface water nutrient fluxes and source partitioning, land-atmosphere exchange of carbon-dioxide, methane and water vapor, and wetlands eco-hydrology in agricultural practices. Researchers are also collaborating with national and international organizations to develop industry standards and contribute to the global conversation about sustainability.

**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; farm safety, grain drying, storage and handling, web and mobile-device information delivery, modeling of watersheds, climate-change variables, and biomass resources; irrigation, water use efficiency, 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.

Dr. Benjamin Runkle at Chris Isbell's rice field, three miles south of Bayou Meto conducting research on reducing Rice's Carbon Footprint. The tower, 12-feet tall and supported by tripod sticks, measures everything – the basic, such as air temperature, rainfall, wind speed and relative humidity, and the advanced, including soil nutrients and acidity, water vapor concentration, water evaporation rate, soil moisture and temperature, and, perhaps most importantly, carbon emissions in form of methane and carbon dioxide.



Jin-Woo Kim, a biological engineering researcher at the University of Arkansas, is part of a cutting-edge nanotechnology research group that has discovered a way to capture tumor cells in the bloodstream. The work could dramatically improve early cancer diagnosis and prevent deadly metastasis.

Dr. Yanbin Li, a biological engineering researcher project has two main focuses: biosensing technology to more rapidly and easily detect pathogenic bacteria and antibiotic residues in the poultry supply chain and dynamic risk-assessment models integrated with supply chain management to help the industry and regulators make better decisions for ensuring food safety.

## Educating Engineers on Energy Management in Agricultural Production Systems

Thomas Costello, Associate Professor

**ISSUE:**
Agricultural producers and the food processing industry are faced with continuing challenges to decrease operating costs associated with the consumption of utility-provided energy (electricity and gas) and mobile fuels (diesel, gasoline). Many sub-systems in row crop production, horticultural production, forage production and livestock and poultry production routinely consume large amounts of fuels or energy supply, at significant costs that impact sometimes low margins for profit. Furthermore, much of these energy sources that are consumed are so-called fossil fuels whose consumption contributes to the emissions of global-warming potential (GWP) gases. To reduce these emissions and to minimize operating expenses, it is necessary to invest in improvements that will decrease energy consumption, while still allowing the production activities to continue as needed.

**ACTION:**
The Biological and Agricultural Engineering Department at the University of Arkansas prepares engineers for careers assisting clients in the agricultural sector. The B.S. degree in biological engineering brings science and engineering expertise to bear on problems in agriculture. As part of the educational program, we have developed a course on bio-energy (BENG 3653, Global Bio-Energy Engineering) that has a strong focus on energy management in the major food production unit processes (e.g.,space-heating of livestock and poultry structures, irrigation pumping, fuel consumption by tractor and combines associated with field operations, and grain drying); and in major food processing unit processes (e.g., water heating, motor and other loads and task/work lighting). For each process, mathematical models are employed to represent the fuel/energy consumption as a function of the primary physical and biological parameters that control behavior of the system in each scenario. Engineers are tasked to seek updated or optimized systems that get the job done with less energy. Engineering students are trained to estimate reduced operating costs associated with a proposed upgrade to assist the client in determining the economic return, and whether an option makes good sense.

**IMPACT:**
Many of our young engineering students are interested in agriculture as the enterprise that feeds the world. They are motivated to seek sustainable solutions within a world that they see as clearly resource-constrained with environmental challenges on a global scale. The majority of these students do not have a farm background; nevertheless, they are passionate about agricultural challenges. Through Global Bio-Energy Engineering, they learn about global biological systems including the hydrologic cycle (of course) but also the carbon and nitrogen cycles and the biological nature of these transformations that have such a major impact on ecological services. They also learn about, and are able to mathematically model, our travels about the sun and the dynamics of energy flux from the sun to earth, a delivery of free energy every day, energy that powers every living organism on our planet. They also learn the mechanisms that control the terrestrial energy balance, the science behind anthropogenic impacts on global climate change. We also look at renewable energy (all sources based upon the sun) including solar, wind, hydro and biomass. Students develop mathematical skills that allow them to understand and quantify, as needed to design systems that employ these renewable energy sources. They are exposed to key processes that use a lot of energy in agriculture and are challenged to learn and understand agricultural production practices, including the ability to parse a realistic problem scenario, using industry terminology, to acquire the key operating parameters that determine energy usage. With these skills, they can not only estimate the energy use at present, but they can also propose changes and predict the net change in energy consumption if these changes are implemented. These graduates are taking jobs in the food industry—manufacturing through retail grocery, and public agencies. These graduates have the skills to analyze and encourage energy conservation through energy audits and specialized design. They can predict cost savings and GWP emissions reductions associated with proposed system upgrades. They are alert to opportunities to phase in the use of renewable energy in those niche situations where it benefits the client and society. These graduates are passionate about the impacts that can be made, benefits to growers and ranchers and to industry--reduced costs, decreased carbon footprint, and improved economic return. It is in society's interest to insure that the good actors who participate in sustainable food production can continue to thrive and to feed the world into a sustainable future.

**CONTACT:**
Thomas Costello
Associate Professor
tac@uark.edu

## Risk Indicators for Identifying Critical Sources Areas in Arkansas Watersheds

Brian Haggard, Professor

**ISSUE:**

Where should we implement best management practices to improve water quality? This is the question 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 continues to monitor water quality in streams in Northwest Arkansas to answer this question.

**ACTION:**

The Arkansas Water Resources Center, funded by the 319 Nonpoint Source Program of the Arkansas Natural Resources Commission, collects water samples from streams in the Upper Illinois River Watershed, Upper White River Basin and the Poteau River Watershed, as well as other watersheds across the state. 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 with watershed land use was evaluated using cool statistical techniques.

**IMPACT:**

The Arkansas Water Resources Center suggests that source water protection programs could potentially focus best management practices inn areas that meet these four criteria:

- Watersheds that have less than 50% forested area within the drainage area.
- Watersheds that have less than 50% forested area within the riparian buffer zone.
- Watersheds that have more than 0.9 poultry houses $km^{-2}$.
- Watersheds with a stream density that exceeds 50 m $ha^{-1}$.

Watershed that met this criteria tended have greater nutrient concentrations, suggesting this might be where we want to invest resources to improve water quality. The data collected by the Center is critical to our understanding of how we influence water quality with what we do in our watersheds.

**CONTACTS:**

Brian E. Haggard, PhD
Professor, Department of Biological Engineering
Director, Arkansas Water Resources Center
Division of Agriculture
University of Arkansas
203 Engineering Hall
Fayetteville, AR 72701
haggard@uark.edu

**COLLABORATORS:**

Marty Matlock, Professor, Biological and Agricultural Engineering, University of Arkansas, Fayetteville, AR
James McCarty, Environmental Manager, Beaver Water District, Lowell, AR
J. Thad Scott, Professor, Biology Department, Baylor University, Waco, TX

**Row Rice Roundtable 2019**

Chris Henry, Associate Professor

**ISSUE:**

Row rice is an emerging production practice for rice that is increasing adoption, but agronomic practices for successful and reliable production are not well understood. The purpose of the roundtable meetings was to share information and experiences from growers about row rice production in the Arkansas Delta.

**ACTION:**

The roundtable meetings took place at the University of Arkansas Rice Research & Extension Center in Stuttgart and at the Food Bank of Northeast Arkansas in Jonesboro. A combined total of 164 attendees participated between the two meetings. Attendees were primarily rice farmers and crop consultants. Fourteen panel members consisting of University of Arkansas faculty and USDA scientists, and crop consultants participated as panelists to help direct discussion. Audience members were polled using turning point response devices immediately after each panel session.

**RESULTS:**

Nearly 60% of the participants did not grow row rice in 2018. About 60,000 acres of rice was represented by growers and 133,000 acres by consultants. About 13% of the rice acres being reported were in the furrow irrigation production system. 35% reported that furrow irrigated rice uses slightly less water on the farm as opposed to the 17% of producers that indicated that it uses more water. The main motivation behind growing furrow irrigated rice (40% of respondents) was tillage and levee construction and labor costs of flooded rice production. 65% of respondents reported using between 160 and 180 units of nitrogen on row rice. 70% of respondents expected to pay $20--$40 more in herbicide expense for row rice fields than flooded ones. 75-86% of the rice used in furrow irrigated rice fields were hybrids. Grape Colaspis and Billbugs were the greatest entomology concern, with between 80-93% observing less than 10% yield loss from infestation. 42% of respondents in the Grand Prairie reported using experiencing Sheath Blight at a level necessary for treatment. 40% of attendees believe there is no difference in profit margin between furrow and flooded rice production. About half of the respondents reported that they were willing to accept a 6-10 bushel per acre yield reduction for furrow rice over flooded rice.

**IMPACT:**

Respondents rated the value of the roundtable on a scale from 0-5 as a 3.8. When asked if the attendees would make a change as a result of what they learned from the roundtable, 69% responded as planning to make a significant or moderate change in their approach to furrow irrigated rice. The respondents reported a financial benefit from what they learned of approximately $4,839,300.

**CONTACTS:**

Chris Henry, University of Arkansas
(cghenry@uark.edu) 870-673-2661

**Collaborators:**

Jarred Hardke, Trent Roberts, Nick Bateman, Yeshi Wamishi, Tom Barber, Wendel Monson, Bob Scott, Brad Watkins, Ranjit Mane, Joe Massey, Lee Atwill, Marc Cummings, Rob Dedman, Dustin Pickelmann, Jacob Rix, Greg Simpson, Phil Horton, Grant Beckwith, Branon Thiesse, Chris Grimes, Brian Otis, Matt Snow.

**FUNDING SOURCES:**

Ricetec

## Adoption of Multiple Inlet Rice Irrigation using a Mobile App

Chris Henry, Associate Professor

**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. One of the Irrigation Water Management Practices that has demonstrated a water savings of 25% is Multiple Inlet Rice Irrigation (MIRI). However, one of the challenges has been that the implementation and planning of MIRI is challenging, because there are no tools available and to successfully implement MIRI. The area of levees must be known, information which is difficult for irrigators to obtain. Another water saving technology, Alternate Wetting and Drying (AWD) aka Intermittent Flooding of rice requires the proper implementation of MIRI on precision grade or contour levees to implement AWD.

**ACTION**:

A mobile app, "Rice Irrigation" has been under development since 2012 for Android operating systems and was made available in 2016. An iOS version for apple products was released in January of 2017 they are available on google play and the apple app store for phones and tablets. Most growers have or use Apple products as almost no usage was observed between 2016 and 2017. Awareness of the app has been mostly by word of mouth and twitter, and brief mention at industry meetings. In 2019 an education effort was started to train end users on the app, twenty people attended the two schools.

**RESULTS:**

To date there are over 452 registered users, up 150 from 2018 of the app that have set up 1443 individual fields. Over 13,184 levees were created by users compromising 143,730 acres of MIRI rice. Over 2.05 million feet of lay flat pipe poly pipe have been planned using the app.

**IMPACT**:

The 143,730 acres of planned MIRI represents 10% of the 1.4 million rice acres grown in Arkansas. The impact of this implementation is an annual savings of 31 Billion gallons of water for an Extension program that has only conducted a handful of small trainings.

**CONTACT**:

Chris Henry, University of Arkansas
cghenry@uark.edu
870-673-2661

**COLLABORATORS:**

Shruti Vaman, Greg Simpson

**COUNTY AGENT COLLABORATORS:**

Rick Wimberly, Grant Beckwith, Phil Horton, Chuck Capps, Russel Parker, Stewart Runsick, Dave Freeze, Keith Perkins, Brett Gordon, Stan Baker, Chris Grimes Cody Griffin, Kevin Norton, Brent Griffin, Shawn Payne, Van Banks, Matthew Davis, Ralph Mazzani, Robert Goodson.

**FUNDING SOURCES**:

USDA NRCS. Supported in part by the Arkansas Rice Research and Promotion Board. Previous support was provided by the US Forest Service.

**Irrigation Schools Improve Water Management**

Chris Henry, Associate Professor

**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. Without sustainable irrigation practices, yields could be 30-50% less in the future if water becomes limited in the region. Aquifer overdrafts in this region pose a real concern about the future of row crop production in the region. For example in Arkansas 3.8 Million acres are expected to have limited or no water resources by 2050 according to a recent study, which is about the annual soybean acres currently grown in Arkansas.

**ACTION:**

Considerable adoption of Computerized Hole Selection has occurred in Arkansas from industry and Extension efforts. Those that attended our schools reported using CHS on 41% of their acres but only used surge irrigation on 3% and soil moisture sensors on 12% of their acres. However Irrigation Water Management (IWM) requires more than just CHS to improve the long term sustainability of irrigated agriculture in Arkansas. On-farm demonstration has proven that the combined implementation of CHS, surge irrigation and soil moisture sensors can reduce water and energy use by 27%. To accomplish this a series of full day schools were delivered to irrigators, a series of trainings for irrigators was held, one was a surge irrigation school and the other a soil moisture sensor school. 74 participants attended the surge school and 81 attended the soil moisture schools for a total of 472 contact hours. Schools are limited to 20 people per school and these are designed as intense learning environments, with an average of 2-5 contact hours. A program was initialed in 2018 to promote IWM through an irrigation yield contest. Participants acquire a portable flow meter, where the installation is verified and sealed to prevent tampering. Rain was predicted for each site. Yield was measured on 3 acres for a minimum sized 30 acre field. Contests were established for three commodities, corn, soybeans, and rice. Financial support was provided by commodity boards and industry

**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% and adoption is wide spread. Efforts since 2012 have successfully increased the adoption of CHS to 41% where previously it was very low (< 5%). Adoption of surge irrigation and soil moisture sensors is still very low, and these tools are the next step to improving water management practices in the region. The schools resulted in high degrees of learning, but participants only reported modest behavior change of 12% increase in surge acres and 5% acre increase in sensor adoption. However they reported that the tools could be applied to large portions of their production (35% for surge and 60% for sensors). No capital investment is required to implement CHS. Likely the capital investment for surge and sensors is hindering rapid adoption, but that they recognize the tools are applicable to their farms indicates that they will adopt these practices in the future as a result of the schools. These and other efforts have resulted in water savings of over 21 billion gallons annually in Arkansas. Wide-spread adoption of IWM practices will have a dramatic impact on the overdraft of Arkansas aquifers and improve the profitability and sustainability of row crop production

**CONTACT:**

Chris Henry, University of Arkansas cghenry@uark.edu 870-673-2661

**COLLABORATORS:**

Dustin Pickelmann, Greg Simpson, Paul Francis, Leo Espinoza, Mukhammadzakhrab Ismanov.

**COUNTY AGENT COLLABORATORS:**

Phil Horton, Rick Wimberly, Grant Beckwith, Chuck Capps, Russel Parker, Stewart Runsick, Herb Ginn, Mike Andrews, Dave Freeze, Craig Allen, Keith Perkins, Brett Gordon, Stan Baker, Kevin Norton, Shawn Payne, Branon Thiesse, Steve Kelly, Allen Davis, Chris Grimes, Matthew Davis, Robert Goodson and Ray Benson. All other county agents not listed who have done irrigation programming.

**FUNDING:**

USDA Natural Resource Conservation Service, Arkansas Soybean Promotion Board, Arkansas Corn and Grain Sorghum Promotion Board, US Forest Service

**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.

**CONTACT:**

Jin-Woo Kim, Biological and Agricultural Engineering, jwkim@uark.edu.

**COLLABORATORS:**

Steve Tung, UA Mechanical Engineering Dept., Joshua Sakon, UA Chemistry and Biochemistry Dept., Vladimir Zharov, UA for Medical Sciences, Russell Deaton, University of Memphis, and Haewook Han, Pohang University of Science and Technology, Korea.

**FUNDING:**

National Science Foundation (NSF; award#: CMMI-1235100, OIIA-1457888 and ECCS-1810014) and National Institute of Health (NIH; award#: 1R21HG010055)

## Portable Biosensors for In-field Screening of Pathogenic Bacteria in Poultry Supply Chain

Yanbin Li, Distinguished Professor, Tyson Endowed Chair Biosening Engineering

**ISSUES:**

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 to detect foodborne pathogens in the field in poultry supply chain

**ACTION:**

The objective of this project is to develop portable, automated, nanomaterials-based biosensors for rapid detection of foodborne bacterial pathogens in poultry. The biosensor system consists of a magnetic nanobeads bioseparator for separation of target bacteria from a poultry sample and an impedance or fluorescent detector for detection of target bacteria. The portable biosensor system has been designed, fabricated and evaluated for screening of *Salmonella* Typhimurium in samples from poultry on farm, processed chicken carcasses in plants and poultry products in market. The biosensors are able to provide the required specificity (strain level), sensitivity (10-100 cfu/ml or cfu/g) and time (less than 1 h). The testing data can be directly transmitted to the network through a smart phone without delay.

**IMPACT:**

The poultry 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 nanotechnology-based biosensors would also enable the poultry industry to be benefited economically in terms of prevention of product recalls with the microbial contamination of poultry products.

**CONTACTS:**

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

**COLLABORATORS:**

Steve Tung (Mechanical Engineering Dept.), Zhong Chen (Electrical Engineering Dept.), Ronghui Wang (Bio & Ag Engineering Dept.), Maohua Wang (China Agricultural University), Jianping Wang (Zhejiang University), and Jianhan Lin (China Agricultural University)

**FUNDING:**

Walmart Foundation, ABI

## Evaluating Low-Cost Solar Collectors as Heaters in Broiler Buildings

Yi Liang, Associate Professor

**ISSUES:**

Commercial meat bird production requires large amount of fossil fuel such as natural gas or propane in order to maintain target temperatures when brooding young chickens. The objective of this study is to evaluate whether a low-cost solar collector can be economically integrated into commercial broiler buildings in order to reduce ventilation heat loss and potentially improve air quality.

**ACTION:**

Black fabric-based solar collectors were installed on roof tops of two commercial-scale broiler houses. The solar collectors were operated under either heating or minimum ventilation mode to introduce warm air under the collectors into the buildings. Heating mode, a mode impossible without solar collectors, allowed additional air exchange using fresh air that's warmer than indoor target temperature. Temperatures at multiple locations and the cumulative amount of airflow from the collectors were monitored continuously to compute the energy saving. Building ventilation rates and carbon dioxide levels were also monitored to assess the air quality status.

**IMPACT:**

Incorporating renewable energy into poultry production is critical in lowering energy use and reducing greenhouse gas emissions. Low-cost solar collector is a promising technology that not only could reduce the production cost, but also could improve air quality during brooding. Better air quality can reduce mortality and improve growth performance. The expected project outcomes are to assess operational performance of the solar collectors, and to demonstrate improved systems for commercial poultry producers to achieve increased production efficiency.

**CONTACT:**

Liang, Yi, yliang@uark.edu
Department of Biological and Agricultural Engineering

## Improving the Competitiveness of Arkansas Small Business in Food Processing: Craft Brewing

Scott Osborn, Associate Professor

**ISSUE:**

The craft brewing industry is focused on high quality products (for which consumers have shown a willingness to pay premium prices) created using traditional, small-batch techniques rather than large-scale, highly engineered techniques of national breweries. The scale of craft breweries does not allow the purchase of typical large-scale food manufacturing equipment because of the high capital costs relative to throughput. However, craft breweries are businesses with owners and operators that want to maximize their profits within the goals of creating their craft beer. There is a need for applying engineering to craft beer production to bridge the gap between home brewing and large breweries to allow an economically sustainable scale of beer to be produced while maintaining high quality and time honored, traditional methods. Creating innovative technologies for more cost effectively producing craft beer can help a burgeoning Arkansas industry grow more quickly, which will produce more jobs and help improve the overall innovation and technology ecosystem in the food processing industry in the state.

**ACTION:**

The research being conducted with in the University of Arkansas Division of Agriculture has focused on improving the force carbonation process. This process dissolves carbon dioxide gas into beer immediately before packaging and can result in 50% of the gas being wasted. Carbonation is a critical step for producing the desired flavor, mouthfeel and aroma of beer. A new process was created to reduce carbon dioxide waste to nearly zero while allowing the brew master to have more precise control over carbonation to assure quality. One US patent has been issued for the process and another related to use of the process for the effective addition of other gases such as nitrogen (think Guinness) is pending. A prototype was constructed and is currently being tested in a local craft brewery to compare the new technology to what they are currently using. If these tests prove successful, the brewery that is testing the device has expressed interest in purchasing a beta unit for use in their process and larger scale testing. The brewery will also provide feedback on how to scale the unit for commercial use including how to fit it into the existing control scheme. Another advantage of the invention is that it may allow replacement of a costly meter currently used to measure carbonation in beer. Previous prototype was reworked twice by incorporating new ideas to improve carbonation rate and reduce energy input thereby reducing capital cost recovery period.

Prototype was moved to Core Brewing in Springdale, AR for tests using donated beer. Core donated space, utilities, beer, and operator expertise to the project (an estimated value of $3000). Four senior biological engineering students used this project for BENG 4823, a required capstone design class. The students redesigned and constructed a prototype and tested the unit at Core Brewing using donated beer. This project provided the students valuable experience in the food processing industry to make them much more competitive for entry level engineering jobs. Data is currently being collected for publication of the invention testing results in a beverage industry journal. Planning is underway for testing the prototype for nitrogenation of beer for a potential new product. ION:

**IMPACT:**

To this point, testing has shown that beer can be carbonated with no wasted carbon dioxide gas. The invention also has the ability to precisely control dissolved $CO_2$ and appears to be an improvement over the existing method. The prototype is at approximately 1/15 of full scale. By reducing wasted $CO_2$, the brewery will save substantial costs as well as reduce their carbon footprint by reducing the amount of a greenhouse gas released into the atmosphere. All of this will help the bottom line of brewers and allow them to advertise their "green" approach to creating beer that is highly desirable among craft beer consumers. Cost projections indicate that the payback period for the capital investment of the equipment will be 2 years or less.

**CONTACT:**

Scott Osborn, Biological and Agricultural Engineering, gsosborn@uark.edu.

**FUNDING:**

Core Brewing Company, and UA System Division of Agriculture.

## A global $CH_4$ flux initiative to better understand terrestrial contributions to the carbon cycle

Benjamin Runkle, Assistant Professor

**ISSUE:**

Terrestrial emissions of the powerful greenhouse gas, $CH_4$, to the atmosphere, are difficult to model and characterize due to the many controlling factors on its cycling. Direct, ground-based measurements are therefore important to characterize and quantify the response of $CH_4$ fluxes to environmental factors across different spatial landscapes and temporal periods. While databases of $CO_2$ fluxes via the eddy covariance method are common (e.g., AmeriFlux, EuroFlux), $CH_4$ measurements have been less synthesized. Because rice cultivation contributes 11% of the global 308 Tg $CH_4$ anthropogenic emissions, and Arkansas generates about half of the U.S.'s total rice production, $CH_4$ emission measurements over rice fields are particularly important in understanding global $CH_4$ dynamics. The eddy covariance method provides continuous, direct observations over a larger footprint than in previous studies. This synthesis work is necessary to connect the carbon and water cycles in terrestrial systems, and to test methods to model and predict their behavior.

**ACTION:**

Runkle joined a synthesis project that is a Global Carbon Project methane budget activity funded by the Moore Foundation and supported by a USGS Powell Center Synthesis Grant. This group is organizing the aggregation and collection of global $CH_4$ flux data in coordination with the regional networks such as AmeriFlux and FLUXNET. This group aims to provide novel insights into the controls and timing of wetland and related landscape $CH_4$ emissions, including in how they are modeled and treated on a global scale. By including rice agriculture, management options will be pursued and contextualized in a global setting. The group's first paper[1] lays out the initiative's aims and describes the wide range of $CH_4$ emissions by landscape class; it also characterizes the important roles of temperature and water level in governing a site's potential $CH_4$ emissions. The paper lays the groundwork for further synthesis, machine learning approaches to modeling, and site classification studies.

**Selected Collaborators:**

Michele Reba, Hydrologist, USDA-ARS, Delta Water Man. Res., Jonesboro, AR
Sara Knox, University of British Columbia
Robert Jackson, Stanford University

**FUNDING:**

This work was funded through the USDA-NRCS under Cooperative Agreement 68-7103-17-119 and the NSF under its flagship CAREER program award CBET:1752083.

**WORKS CITED:**

(1) Knox, S. H.; Jackson, R. B.; Poulter, B.; McNicol, G.; Fluet-Chouinard, E.; Zhang, Z.; Hugelius, G.; Bousquet, P.; Canadell, J. G.; Saunois, M.; et al. FLUXNET-CH4 Synthesis Activity: Objectives, Observations, and Future Directions. *Bull. Am. Meteorol. Soc.* **2019**. https://doi.org/10.1175/BAMS-D-18-0268.1.

(2) Runkle, B. R. K.; Suvočarev, K.; Reba, M. L.; Reavis, C. W.; Smith, S. F.; Chiu, Y.-L.; Fong, B. Methane Emission Reductions from the Alternate Wetting and Drying of Rice Fields Detected Using the Eddy Covariance Method. *Environ. Sci. Technol.* **2019**, *53* (2), 671–681. https://doi.org/10.1021/acs.est.8b05535.

(3) Runkle, B.; Ward, E.; Windham-Myers, L.; Ryu, Y.; Kang, M.; Bansal, S.; Jackson, R.; McNicol, G.; Knox, S.; Riley, W.; et al. How drying and wetting events impact landscape methane fluxes, poster B13J-2421, AGU Fall Meeting, San Francisco, 2019 https://agu.confex.com/agu/fm19/meetingapp.cgi/Home/0 (accessed Dec 20, 2019).

## Avoid Grain Dust Explosion

Sammy Sadaka, Associate Professor

**ISSUE:**

Combustible dust explosion hazards are prevalent in various industries, including but not limited to agriculture, grain, food, chemicals, fertilizer, tobacco, and pesticides. The total number of reported agricultural dust explosion incidents in the U.S. reached 84 cases between 2009 and 2018. Unfortunately, these explosions resulted in 16 fatalities and 96 injuries cases, respectively. The dust explosion incidents increased from 5 to 7 and then to 12 during the last three years. Dust explosions in grain elevators corresponded to 51% of the total U.S. agricultural dust explosion incidents, with many of these occuring in grain milling faciltiies.

**ACTION:**

I developed an article that presents an overview to help prevent dust explosions in both industrial mill facilities and producer-owned facilities. The article (peer reviewed fact sheet) showed that the critical requirements for a dust explosion are fuel, oxidizer, ignition source, dispersion of dust and Confinement. It explored the methods, techniques and actions to avoid grain dust explosion. The fact sheet was distributed to Arkansas county agents. It is available on the Cooperative Extension Web Site.

**IMPACT:**

The implementation and utilization of the information included in this fact sheet would prevent or minimize grain dust explosion related to grain handling.

**CONTACT:**
Sammy Sadaka: ssadaka@uaex.edu, UA Division of Agriculture, 501-671-2298

**Collaborating Scientists:**
Kingsly Ambrose, Ph.D., Associate Professor
Purdue University

**FUNDING:**
This extension activity was supported by the University of Arkansas System – Division of Agriculture

**Assisting Arkansas Agricultural and Environmental Sustainability Efforts via Development and Maintenance of a P Index Calculator and Nutrient Management Planning Tool**

Karl VanDevender, Professor

**ISSUE:**

The production of animal derived food and products generates manure 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 byproducts must adhere too. Central to most of these is the development of farm specific Nutrient Management Plans based on farm conditions, phosphorus and nitrogen runoff risk, and crop agronomic requirements.

**ACTION:**

In keeping with the land grant mission of dispersal of research based information and service, a Microsoft Excel workbook based nutrient management planning tool (ARNMP) has been developed and refined over a number years. In the past the tool has been provided to nutrient management planners to facilitate and expedite their plan writing process. Over time, both the Arkansas Department of Environmental Quality, the Arkansas Natural Resources Commission, and the Natural Resources Conservation Services have come to expect plans be written using ARNMP. In the past ARNMP was distributed via email. This year the latest version was posted to www.uaex.edu/manure. This posting was advertised via email to key personnel within the agencies listed above with a request to forward to their appropriate internal and external personnel.

**IMPACT:**

The results of this long term and continuing efforts is a nutrient management tool that is focused at Arkansas landowner and nutrient planner needs. The tool is provided at no charge to potential users. This provides Arkansas's limited number of certified planners a tool targeted at the writing of nutrient management plans that meet certification requirements. In addition the tool coupled with Extension's planner certification train helps to ensure that written plans are structurally uniform which facilitates agency review. Both of which helps to reduce the development/approval time of a plan as well as increase the number of plans that can be written/revised. A benefit to Arkansas' landowners and their downstream neighbors

**CONTACT:**

Karl VanDevender Ph.D., PE
Professor - Extension Engineer
Biological and Agricultural Engineering
University of Arkansas System
Division of Agriculture
2301 S. University Avenue
Little Rock, AR 72204-4940
E-mail: kvandevender@uaex.edu
Phone: 501-671-2244
Cell: 501-944-1016

**COOPERATING SCIENTISTS OR INSTITUTIONS:**

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.

## Poultry production wastes treatment for Arkansas producers

Jun Zhu, Professor

**ISSUE:**

Given the fact that Arkansas is ranked #2 in poultry production in the nation with about 4.1 million metric tons of litter generated annually, lack of cost-effective techniques to treat this waste stream environmentally and resourcefully has been an pending issue because conventional land application of poultry litter as fertilizer at the agronomic rate for nitrogen (N) has long been proved to always lead to excessive amounts of plant extractable phosphorus (P) in the soil due to the high concentration of P relative to N in the litter. Reviewing literature indicates that several techniques were investigated in the past in treating poultry litter including compost, direct combustion, palletization, and anaerobic digestion. The first three methods were developed predicated upon the dry nature of poultry litter; however, they have inherent problems. For instance, composting can lead to loss of N, carbon, and other nutrients during the process, high equipment cost and labor, odor emissions, and large land acreage for establishing the composting site. Direct combustion of poultry litter can release particulate matter, dioxins, arsenic, bio-aerosols, and other toxins into the atmosphere, the various components of which are associated with cardiovascular disease, cancer, respiratory illness, and other diseases for humans. Although palletization of poultry litter can produce a sellable fertilizer product, both pelleting and granulation are costly processing methods at roughly $50 per ton, which makes the litter pellets an expensive product but with low fertilizer density compared to commercial fertilizers. The last technology, anaerobic digestion, has been around for at least over a century, and wastes to which this technology has been applied run the gamut including industrial, agricultural, and municipal sources. However, the only requirement for using technology is that the substrate must be a liquid, while poultry litter is a solid. To overcome this issue, one option is to add water to the litter to make a liquid, leading to a large quantity of water wasted and increasing the difficulty and workload to handle the digested effluent, which is not a palatable option to the producers. The other option is to recycle the effluent from the digester to the front to dilute the incoming litter. Certainly, the second option requires treating the effluent to meet the minimum water standards, so the fresh water usage can be minimized in digestion operation. This is a challenge requiring us to conduct in-depth and translational research to develop novel systems and technologies and make these technologies available to poultry producers in a timely manner.

**ACTION:**

In order to understand the basics of anaerobic digestion of poultry, research experiments were first developed and designed to investigate co-digestion of poultry litter with another liquid waste stream, and also with another carbon source such as crop residues to improve the carbon to nitrogen ratio to determine the optimal operating conditions for the digestion process. Based on the data, models were developed to simulate the digestion process using data from batch experiments of anaerobic co-digestions of poultry litter and wheat straw at 2% total solids level, which consisted of 100, 75, and 50% VS of poultry litter. The maximum specific methane volumes were obtained to be 207, 134, 5.18 mL $(gVS)^{-1}$ for 50, 75, and 100% VS co-digestion, respectively. The developed model for bio-products was successfully applied to cumulative methane volumes produced from anaerobic co-digestion. The data from these experiments will pave the way for further studying a treatment system consisting a digester, a precipitator or an electrical reactor to produce struvite, and a water cleaning unit to remove nutrients and other substances for water recycling. This step-wise research plan will provide us knowledge about the feasibility and practicality of using liquid anaerobic digestion technology to treat poultry litter, a dry solid, and help develop new, cost effective, and applicable treatment systems for on-farm use.

**IMPACT:**

The long-term impact of this research rests with the successful development of an applicable anaerobic digestion system for poultry litter treatment. As said early, a cost-effective technology to treat poultry litter and recycle nutrients for the Arkansas poultry industry is not currently available, and thus highly needed to support the growth of the industry while still protecting the environment. The ongoing research that produces key information for technology development over time will eventually lead to a long-term technical solution to the poultry litter issue facing the producers in Arkansas. It is expected that as the research moves forward, an advanced, cost-effective system to handle and treat a large quantity of poultry production waste to not only recover the value of the waste but also reduce the environmental footprint of poultry production in Arkansas will come to fruition. In the due course, several manuscripts are published annually in high-impact refereed journals based on the continuous research outcomes on the topic, which contributes to the scientific literature. This has a global impact, with a large number of audiences, on the advancement of science and engineering in new technology development in the agricultural production realm.

**CONTACT:**

Jun Zhu, Biological and Agricultural Engineering, junzhu@ujark.edu

**COLLABORATORS:**

Amanda Ashworth (USDA/ARS), Sammy Sadaka (BAEG), Thomas Costello (BAEG), Wen Zhang (CE), Mike Popp (Ag. Econ.), Sarah Wu (Univ. of Idaho), Zhiwu Wang (Virginia Tech)

**FUNDING:**

UA System Division of Agriculture

## Air Dehumidification as a Drying Agent

Sammy Sadaka, Associate Professor

**ISSUE:**

Rice is one of the principal crops produced in Arkansas, which accounts for more than 40% of U.S. production. Farmers use ambient air for drying rice to safe storage moisture content. Arkansas is prone to experience high temperatures and high relative humidity during the harvest and drying season. Therefore, a significant problem of rewetting the stored rice during the period of high ambient humidity could occur and daunts the farmers. Rewetting of rice creates fluctuations in the final moisture content of rice that leads to variable milled rice quality. Increase of airflow rate by increasing the horsepower of the blower and heating the ambient air can be two possible solutions. However, both management practices are costly for farmers to be included in their drying system. Bins equipped with programmed and controlled fans were introduced to the farmers that can stop the airflow during humid conditions and save the rice from rewetting. However, bins with wet rice without airflow even for a few hours can decrease the shelf life of rice tremendously. Accordingly, the high humidity of ambient air could be reduced by desiccant to achieve continuous drying.

**ACTION:**

An air dehumidification system was designed and tested. The air dehumidification system consisted of a desiccant pipe that holds silica gel packets. The desiccant pipe is a 4 inch in diameter with top end connected to a duct pipe that sucks the humid ambient air (70-80% RH) from top of an industrial humidifier.

**IMPACT:**

Air dehumidification had a positive and significant effect on moisture reduction. It improved the head rice yield for the experimental runs. Utilization of air dehumidification helped in reducing the energy consumption per unit mass of water removal for rough rice drying.

.

**CONTACT:**

Sammy Sadaka: ssadaka@uaex.edu, UA Division of Agriculture, 501-671-2298

**COLLABORATING SCIENTISTS:**

Griffiths Atungulu, Scott Osborn, and Thomas Costello

**FUNDING SOURCES:**

These extension and research activities were supported by the University of Arkansas System - Division of Agriculture.

# Biological Engineering Class 2019

## Congratulations to the Class of 2019!

Undergraduate:

Mckenna L. Belcher
Brooke Anne Benham
Seth Edward Boles
Colton E. Bryant
Linden Kay Cheek
Ryan James Clark
Ali K. Ezell
Casey Ann Gibson
Kendrick Clay Hardaway
Thomas Helvick
Rose Elizabeth Hendley
Merrisa Kendrick Jennings
Samuel Stone Lahodny
Madeline Jane Ludwig
Madison Taylor Rain McMillen
Kami A Parmenter
Alexander Wayne Parr
Mason Christopher Puckett
Will Pape Richardson
Rachel Christine Schlais
Allison A. Sites
Jacob Alan Stanosheck
Megan Faith Woodworth
Zachary Morgan Johnson
Pablo Andres Pena Cabezas
Andreas Gustav Kleveland

# Research Grants

*The following active grants during 2018 fund research in specific areas.*

**AWRC Program Administration**
*Dr. Brian Haggard*
USGS 104B
2018
$30,985

**AWRC Information Transfer**
*Dr. Brian Haggard*
USGS 104B
2018
$8,757

**Sediment Phosphorus Release**
*Dr. Brian Haggard*
Beaver Water District
2018
$50,000

**Water Quality Monitoring**
*Dr. Brian Haggard*
Beaver Water District
2018
$24,000

**Water Shed Investigative Support**
*Dr. Brain Haggard*
Poteau Valley Improvement Authority
$40,000

**USGS Internship Program**
*Dr. Brian Haggard*
USGS
$20,408

**Improving Yield and Yield Stability for Irrigated Soybeans**
*Dr. Chris Henry*
Soybean Promotion Board
2018
$80,424

**Improving Irrigation Scheduling and Efficiency in Corn and Grain Sorghum**
*Dr. Chris Henry*
Arkansas Corn and Grain Sorghum Promotion Board
2018
$159,424

**Promoting the use of Multiple Inlet in Arkansas Rice Production**
*Dr. Chris Henry*
Arkansas Rice Promotion Board
2018
$75,000

**Analysis of Irrigation Survey**
*Dr. Chris Henry*
Mid-South Soybean Promotion Board
2018
$38,803

**Improving Furrow Irrigated Rice**
Dr. Chris Henry
Arkansas Rice Promotion Board
$75,500

**Economics of Irrigation Technologies and Practices**
*Dr. Chris Henry*
Arkansas Soybean Promotion Board
2018
$1000

**Economics of Multiple Water– Saving Technologies across the Arkansas Delta Region**
*Dr. Chris Henry*
Arkansas Rice Research Promotion Board
2018
$1000

**Implementing Irrigation water Management as a Holistic Approach to Water Management for Arkansas Irrigators**
*Dr. Chris Henry*
USDA NRCS
2018
$500,000

**Center for Advanced Surface Engineering**
*Dr. Jin-Woo Kim*
NSF-OIA
2018
$327,827

**Engineering Nano-Building Block Toolboxes for Programmable Self Assembly of Nanostructures with Arbitrary Shapes and Functions**
*Dr. Jin-Woo Kim*
NSF
2018
$50,000

**Poultry Excellence in China-Improving Food Safety in Poultry Supply Chain**
*Dr. Yanbin Li*
Walmart Foundation
2018
$208,300

**Bio-nanogate based Aptasensor for Rapid Detection of Avian Influenza Viruses (renew)**
*Dr. Yanbin Li*
ABI
2018
$24,000

**Highly Integrated Optofluidic Biosensor for Portable Bacteria Detection**
*Dr. Yanbin Li*
ABI
2018
$4,000

**Optofluidic Biosensor for Portable Bacteria Detection**
*Dr. Yanbin Li*
ERSIF
2018
$4,000

**Managing Crop Residues to Reduce Particulate Matter Emissions**
*Dr. Yi Liang*
AR Department of Environment Quality
2018
$64,000

**In-vessel Mortality Composter Management Guidelines Refinement and Educational Material Development**
*Dr. Yi Liang*
NRCS-AR CIG
2018
$67,730

**CAREER: Developing Climate- Smart Irrigation Informing post-disaster Restoration through Modeling Interdependent Agric. & Transportation Networks**
*Dr. Benjamin Runkle*
MarTREC
2018
$40,000

**Reducing Arsenic and Methylmercury Intake from Rice**
*Dr. Benjamin Runkle*
USDA-NIFA
2019
$500,000

**INFEWS/T2: Enhanced Spatiotemporal Imaging of Resource Availability, Utilization, & Efficiency in Agric. Systems**
*Dr. Benjamin Runkle*
2018
$2,500,000

**Improving Root Zone Soil Water and Nutrient Availability, Farm Economics, and Regional Policy for Sustainable Crop Production in Gulf Coast States**
*Dr. Benjamin Runkle*
USDA-NIFA
2019
$10,000,000

**Development of On-line Instructional Program for Nutrient Management Training Required by ANRC Titles XX, XXI and XXII**
*Dr. Karl VanDevender*
ANRC
2018
$184,198

**UA Sustainable Nutrient Management**
*Dr. Karl VanDevender*
CES Subcontract of UA AES grant from NRCS
2018
$18,333

**In-Vessel Mortality Composter Management**
*Dr. Karl VanDevender*
AR NRCS
2018
$33,865

## *Books, Book Chapters*

Sivaraman, S., Sinha, A., Lim, K.-T., **Kim, J.-W.**, Rao, R. & Jensen, H. 2019. Nanotechnology-based stem cell tissue engineering. *In:* Characterization Tools for Nanotechnology-Based Tissue Engineering. K. Challa (ed). Springer.

Sinha, A., Sakon, J., Roper, D.K., Li, W.J., Ghosh, A., Han, H., Zharov, V.P. & **Kim, J.-W.** Nanoscale particles and multifunctional hybrid soft nanomaterials in bio/nano medicine. *In:* Nanoscale Materials in Nano/Bio Medicine. J.-W. Kim, et al. (ed). World Scientific Publishing Company/Imperial College Press (*in press*).

Singaravelu, I., Kotagiri, N. & **Kim, J.-W.** Cell-derived biomimetic nanostructures for biomedical applications. *In:* Nanoscale Materials in Nano/Bio Medicine. J.-W. Kim, et al. (ed). World Scientific Publishing Company/Imperial College Press (*in press*).

Henson, J.C., Jensen, H., Balachandran, K., Rao, R., **Kim, J.-W.** & Jensen, M. Cues from the nano-environment: the role of nanomaterials in stem cell differentiation and stem cell tissue engineering. *In:* Nanoscale Materials in Nano/Bio Medicine. J.-W. Kim, et al. (ed). World Scientific Publishing Company/Imperial College

**Matlock, M.D.,** 2019. Scaling From Local to Global for Environmental Impacts From Agriculture. In Agroecosystem Diversity (pp. 415-423). Academic Press.

**Sadaka, S.** 2019. Soybean Farm Safety. Arkansas Soybean Production Handbook. Chapter 18. University of Arkansas – Division of Agriculture, Cooperative Extension Service. Submitted.

**Sadaka, S.** and K. Luthra. 2019. Principles of On-Farm Soybean Drying and Storage. Arkansas Soybean Production Handbook. Chapter 15. University of Arkansas – Division of Agriculture, Cooperative Extension Service. Submitted.

**Sadaka, S.** and K. Rosentrater. 2019. Significance of Grain Moisture and Their Measurement. In: Storage of Cereal Grains and Their Products. 5th Ed. AACCE International Publisher. Submitted.

**Sadaka, S.** and D. Jayas. 2019. Cereal Grains Drying. In: Storage of Cereal Grains and Their Products. 5th Ed. AACCE International Publisher. Submitted.

Atungulu, G. and **S. Sadaka.** 2019. Postharvest Technology: Rice Drying. In: Rice Chemistry and Technology. 4th Ed. AACCE International and WP Publisher. Chapter 15. PP: 473-515.

Atungulu, G**.,** G Olatunde and **S. Sadaka.** 2019. Rice Aeration: Fundamental and Principles. In: Advances in Science & Engineering of Rice. DEStech Publications, Inc. Chapter 5. Pp: 143-167. Book Chapter

## *Peer-Reviewed Journal Articles*

Austin, B.J., V. Eagle, M.A. Evans-White, J. T. Scott, and **B.E. Haggard**. 2019. Sediment phosphorus release sustains nuisance periphyton growth when nitrogen is not limiting. Journal of Limnology (Reviewed 3 December 2019)

Henson, E., A. Lasater, and **B.E. Haggard**. 2019. Reducing dissolved phosphorus in stream water may not influence estimation of sediment equilibrium phosphorus concentrations. Agrosystems, Geosciences and Environment 2:190037

McDowell, R., A. Noble, P Pletnyakov, **B. Haggard**, and L. Mosely. 2019. Global mapping of freshwater nutrient enrichment and periphyton growth potential. Nature Scientific Reports (Submitted 4 December 2019)

G.D. Spencer, L.J. Krutz, L.L. Falconer, W.B. **Henry, C.G**. Henry, E.J. Larson, H.C. Pringle III,C.J. Bryant, R.L. Atwill. 2019. Irrigation Water Management Technologies for Furrow Irrigated Corn that Decrease Water Use and Improve Yield and On-Farm Profitability. Agronomy Journal 5(1). doi:10.2134/cftm2018.12.0100

McClung, A. M., J. S. Rohila, **C.G. Henry**, A. Lorence. In press. Genetic Variation in the water-deficit response among US rice cultivars. Accepted for publication in the Agronomy Journal.

Moon, K., Do, Y., Park, H., Kim, J., Kang, H., Lee, G., Lim, J.-H., **Kim, J.-W**. & Han, H. Computed terahertz near-field mapping of molecular resonances of lactose stereo-isomer impurities with sub-attomole sensitivity. Sci. Rep. 9: 16915 (2019). DOI: 10.1038/s41598-019-53366-0 [JIF: 4.525]

Dachavaram, S.S., Moore, J.P.II, Bommagani, S., Penthala, N.R., Calahan, J.L., Delaney, S.P., Munson, E., Batta-Mpouma, J., **Kim, J.-W**., Hestekin, J.A. & Crooks, P.A. A facile microwave assisted TEMPO/NAOCl/Oxone® (KHSO5) mediated micron cellulose oxidation procedure: preparation of two nano TEMPO-cellulose forms. Starch 1900213 (2019). DOI: 10.1002/star.201900213 [JIF: 1.795]

Dutta, S.D., Patel, D., Seo, Y.-R., Park, C.-W., Lee, S.-H., **Kim, J.-W**., Kim, J., Seonwoo, H. & Lim, K.-T. In vitro biocompatibility of electrospun poly(◎-caprolactone)/cellulose nanocrystals nanofibers for tissue engineering. J. Nanomater. 2019, 2061545 (2019). DOI: 10.1155/2019/2061545 [JIF: 2.233]

Kim, H.-B., Jin, B., Patel, D., **Kim, J.-W**., Kim, J., Seonwoo, H. & Lim, K.-T. Enhanced osteogenesis of human mesenchymal stem cells in presence of single-walled carbon nanotubes. IEEE Transactions on Nanobioscience 18, 463-468 (2019). DOI: 10.1109/TNB.2019.2914127 [JIF: 2.771]

# PUBLICATIONS

## PEER-REVIEWED JOURNAL ARTICLES

Minh, H.V.T., Kurasaki , M., Van Ty, T., Tran, D.Q., **Le, K.N**., Avtar, R., Rahman, M.M., Osaki, M., 2019. Effects of Multi-Dike Protection Systems on Surface Water Quality in the Vietnamese Mekong Delta. Water 11, 1010.

Cai, G.Z., L.Y. Zheng, M. Liao, **Y. Li**, M.H. Wang, N. Liu, J.H. Lin. 2019. A microfluidic immunosensor for visual detection of foodborne bacteria using immunomagnetic separation, enzymatic catalysis and distance indication. Microchimica Acta, 186(12), DOI:10.1007/s00604-019-3883-x

Guo, R.Y., S.Y. Wang, F.C. Huang, Q. Chen, **Y. Li**, M. Liao, and J.H. Lin. 2019. Rapid detection of *Salmonella* Typhimurium using magnetic nanoparticle immunoseparation, nanocluster signal amplification and smartphone image analysis. Sensors & Actuators: B. Chemical 284:134-139. doi.org/10.1016/j.snb.2018.12.110

He, K.Y., Z.S. L. Wang, Y.C. Fu, H.R. Quan, **Y. Li***; X.Q. Wang, S. Gunasekaran, and X.H. Xu. 2019. A water-stable luminescent metal-organic framework for rapid and visible ssensing of organophosphorus pesticides. ACS Applied Materials & Interfaces 11(29): 26250-26260. doi.org/10.1021/acsami.9b06151

Li, Y.Q., J. Liu, Y.C. Fu, Q.J. Xie, and **Y. Li**. 2019. Magnetic-core@dual-functional-shell nanocomposites with peroxidase mimicking properties for use in colorimetric and electrochemical sensing of hydrogen peroxide. Microchimica Acta 186:20. doi.org/10.1007/s00604-018-3116-8

Li, Z.S., X.H. Xu, Y.C. Fu, Y.N. Guo, Q.Y. Zhang, H. Yang, and **Y. Li***. 2019. A water-stable luminescent metal-organic framework for effective detection of Aflatoxin B1 in walnut and almond beverages. RCS Advances 9:620-625. DOI: 10.1039/c8ra07804a

Wang, S.Y., L.Y. Zheng, G.Z. Cai, N. Liu, M. Liao, **Y. Li**, X.B. Zhang, and L.J. Han. 2019. A microfluidic biosensor for online and sensitive detection of *Salmonella* typhimurium using fluorescence labeling and smartphone video processing. Biosensors and Bioelectronics 140:111333. doi.org/10.1016/j.bios.2019.111333

Xiao, X.N., W. Wang, X.B. Zhang, J.M. Zhang, M. Liao, H. Yang, Q.Y. Zhang, C. Rainwater, and **Y. Li***. 2019. Modeling the reduction of *Salmonella* spp. on chicken breasts and wingettes during scalding for QMRA of the poultry supply chain in China. Microorganisms 7:165. doi:10.3390/microorganisms7060165

Xiao, X.N., W. Wang, J.M. Zhang, M. Liao, H. Yang, W.H. Fang, and **Y. Li***. 2019. Modeling the reduction and cross-contamination of *Salmonella* in poultry chilling process in China. Microorganisms 7:448. doi:10.3390/microorganisms7100448

Yao, P., R.H. Wang, X.G. Xi, **Y. Li**, and S. Tung. 2019. 3D-printed pneumatic microfluidic mixer for colorimetric detection of *Listeria Monocytogenes*. Transactions of the ASABE, 62(3):841-850. doi: 10.13031/trans.13245

Yu, N.X., X.Y. Wang, F.J. Ning, C.J. Jiang, **Y. Li**, H.L. Peng, and H. Xiong. 2019. Development of antibacterial pectin from Akebia trifoliata var. australis waste for accelerated wound healing. Carbohydrate Polymers 217:58-68.

## PEER-REVIEWED JOURNAL ARTICLES

Yu, N.X., X.Y. Wang, L. Qiu, T.M. Cai, C.J. Jiang, Y. Sun, **Y. Li**, H.L. Peng, and H. Xiong. 2020. Bacteria-triggered hyaluronan/AgNPs/gentamicin nanocarrier for synergistic bacteria disinfection and wound healing application. Chemical Engineering Journal 380:122582. doi.org/10.1016/j.cej.2019.122582

Yu, N.X., H.L. Peng, L. Qiu, R.H. Wang, C.J. Jiang, T.M. Cai, Y. Sun, **Y. Li***, and H. Xiong. 2019. New pectin-induced green fabrication of Ag@AgCl/ZnO nanocomposites for visible-light triggered antibacterial activity. International Journal of Biological Macromolecules 141:207-217. doi.org/10.1016/j.ijbiomac.2019.08.257

Zhang, L., W.Y. Zhu, Z. Liu, S.J. Zha, G.X. Liu, Q.J. Xie, **Y. Li**, Y. Ying, Y.C. Fu. 2019. Bio-/nano-immobilization platform based on bio-inspired fibrin-bone@polydopamine -shell adhesive composites for biosensing. ACS Applied Materials & Interfaces 11(50): 47311-47319. Doi.org/10.1021/acsami.9b15376

Zhang, L., Q.J. Xie, **Y. Li**, Y. Ying, Z.Y. Liu, and Y.C. Fu. 2019. One-pot facile integration of functional materials in bionanocomposite by mimicking blood coagulation for electrochemical biosensing. Chemical Engineering Journal (accepted November 11, 2019; available online)

Zhang, L., **Y. Li**, Y.B. Ying, and Y.C. Fu. 2019. Recent advances in fabrication strategies and protein preservation application of protein-nanomaterial hybrids: Integration and synergy. TrAC Trends in Analytical Chemistry 118: 434-443. doi.org/10.1016/j.trac.2019.06.002

Zhang, L., Z.Y. Liu, Q.J. Xie, **Y. Li**, Y.B. Ying, and Y.C. Fu. 2019. Bioinspired assembly of reduced graphene oxide by fibrin fiber to prepare multi-functional conductive bionanocomposites as versatile electrochemical platforms. Carbon 153:504-521. doi.org/10.1016/j.carbon.2019.06.101

Zheng, L.Y., G.Z. Cai, S.Y. Wang, M. Liao, **Y. Li**, and J.H. Lin. 2019. A microfluidic colorimetric biosensor for rapid detection of *Escherichia coli* O157:H7 using gold nanoparticle aggregation and smart phone imaging. Biosensors & Bioelectronics 124-125: 143-149. doi.org/10.1016/j.bios.2018.10.006

Zhu, W.Y., Y. Chen, Y.W. He, W.H. Fang, Y.B. Ying, **Y. Li**, Y.C. Fu. 2019. Cooperation mode of outer surface and inner space of nanochannel: Separation-detection system based on integrated nanochannel electrode for rapid and facile detection of *Salmonella*. Analytical Chemistry (accepted November 18, 2019) doi:10.1021/acs.analchem.9b03644

Heymsfield, C. L, **Liang, Y**. and Costello, T.A. 2019. Computational fluid dynamics model of air velocity through a poultry transport trailer in a holding shed. Applied Eng. in Agric. Submitted.

Aldridge, D., K. Luthra, **Y. Liang**, S.E. Watkins, K. Christensen, C. Scanes. 2019. Thermal micro-Environment during Poultry Transportation in South Central United States. Animals. 9(1):31

## PEER-REVIEWED JOURNAL ARTICLES

Thomson, A., Ehiemere, C., Carlson, J., **Matlock, M.**, Barnes, E., Moody, L. and DeGeus, D., 2020. Defining Sustainability as Measurable Improvement in the Environment: Lessons from a Supply Chain Program for Agriculture in the United States. In Sustainability Perspectives: Science, Policy and Practice (pp. 133-153). Springer, Cham.

Parajuli, R., Thoma, G. and **Matlock, M.D.,** 2019. Environmental sustainability of fruit and vegetable production supply chains in the face of climate change: A review. Science of The Total Environment, 650, pp.2863-2879.

**Suvočarev K**, Castellví F, Reba ML, **Runkle BRK** (2019) Surface renewal measurements of H, LE and CO2 fluxes over two different agricultural systems, Agricultural and Forest Meteorology, 279, 107763, https://www.sciencedirect.com/science/article/pii/S016819231930379X.

Simpson G, **Runkle BRK**, Eckhardt T, Kutzbach L. (2019) Evaluating closed chamber evapotranspiration estimates against eddy covariance measurements in an arctic wetland, Journal of Hydrology, 578, 124030, https://www.sciencedirect.com/science/article/pii/S0022169419307577.

Knox SH, Jackson RB, Poulter B, McNicol G, Fluet-Chouinard E, Zhang Z, Hugelius G, Bousquet P, Canadell JG, Saunois M, Papale D, Chu H, Keenan TF, Baldocchi DD, Torn MS, Trotta C, Mammarella I, Aurela M, Bohrer G, Campbell D, Cescatti A, Chamberlain S, Chen J, Chen W, Dengel S, Desai AR, Euskirchen E, Friborg T, Gasbarra D, Goded I, Goeckede M, Heimann M, Helbig M, Hirano T, Hollinger D, Iwata H, Kang M, Klatt J, Krauss KW, Kutzbach L, Lohila A, Mitra B, Morin TH, Nilsson MB, Niu S, Noormets A, Oechel WC, Peichl M, Peltola O, Reba ML, **Runkle BRK**, Richardson A, Ryu Y, Sachs T, Schaefer KVR, Schmid HP, Shurpali N, Sonnentag O, Tang ACI, Ueyama M, Vargas R, Vesala T, Ward EJ, Windham-Myers L, Wohlfahrt G, Zona D. (2019) FLUXNET-$CH_4$ Synthesis Activity: Objectives, Observations, and Future Directions, Bulletin of the American Meteorological Society, https://doi.org/10.1175/BAMS-D-18-0268.1.

Liang L, **Runkle BRK**, Sapkota BB, Reba ML, (2019), Automated mapping of rice fields using multi-year training sample normalization, International Journal of Remote Sensing, 40:18, 7252-7271, https://doi.org/10.1080/01431161.2019.1601286.

**Runkle BRK**, **Suvočarev K**, Reba ML, **Reavis CW**, **Smith SF**, Chiu Y-L, Fong B, (2019), Methane emissions reductions from alternate wetting and drying of rice fields detected using the eddy covariance method, Environmental Science & Technology, 53(2), 671-681, DOI**:** 10.1021/acs.est.8b05535.

## PEER-REVIEWED JOURNAL ARTICLES

Holl D, Wille C, Sachs T, Schreiber P, **Runkle BRK**, Beckebanze L, Langer M, Boike J, Pfeiffer EM, Fedorova I, Bolshianov DY, Grigoriev MN, Kutzbach L, (2019), A long-term (2002 to 2017) record of closed-path and open-path eddy covariance $CO_2$ net ecosystem exchange fluxes from the Siberian Arctic, Earth Syst. Sci. Data, 11, 221-240, 2019.

Luthra**, K., S. Shafiekhani*, **S. Sadaka** and G. Atungulu. 2019. Determination of the Impacts of Dockage on the Rough Rice Moisture Sorption Isotherms. Applied Engineering in Agriculture. Under Review. Manuscript

Luthra**, K. and **S. Sadaka**. 2019. Opportunities and Challenges Associated with Drying Rough Rice in Fluidized Bed Dryers: A Review. Transactions of the ASABE. Under Review Manuscript

Luthra**, K. and **S. Sadaka**. 2019. Investigation of Rough Rice Drying in Fixed and Fluidized Bed Dryers Utilizing Dehumidified Air as A Drying Agent. Drying Technology. Under Review. Manuscript

Bruce*, R. G. Atungulu and **S. Sadaka**. 2019. Impacts of Size Fractionation, Comingling and Drying Temperature on Physical and Pasting Properties of Broken Rice Kernels. Chemical Chemistry. 2019;00: 1-14. https://doi.org/10.1002/cche.10241. Manuscript

Sharara, M., D. Kim, **S. Sadaka** and G. Thoma. 2019. Consequential Life Cycle Assessment of Swine Manure Management within a Thermal Gasification Scenario. Energies, 12, 4081; doi:10.3390/en12214081 Manuscript

Zhang, Y., A. Ghaly, **S. Sadaka**, & B. Li, .2019. Determination of Energy and Exergy of Syngas Produced from Air-steam Gasification of Wheat Straw in a Dual Distributer Fluidized Bed Gasifier. Journal of Energy Research and Reviews, 1-24. Manuscript

Luthra**, K., S. Shafiekhani, B. Stephens, **S. Sadaka** & G. Atungulu. 2019. Evaluation Of The Performance Of A Newly Developed Wireless Temperature And Moisture Sensor For Rice Under Various Levels Of Temperature, Moisture Content And Dockage. Applied Engineering in Agriculture. Applied Engineering in Agriculture. Vol. 35(3): 311-318. Manuscript

Fox, G. A., K. R. Douglas-Mankin, K. Muthukumarappan, **J. Zhu**, J. C. Walker. 2019. Navigating the publication process: an ASABE Journals' perspective. *Trans. ASABE* 62(5): 1147-1153.

Xu, S., **J. Zhu**, Z. Meng, W. Li, S Ren, T. Wang. 2019. Hydrogen and methane production by co-digesting liquid swine manure and brewery wastewater in a two-phase system. Bioresource Technology 293: In press.

# Publications

## Peer-Reviewed Journal Articles

Wu, S., S. Deng, **J. Zhu**, H. Hsieh, F. Izuno. 2019. Optimization of a novel liquid-phase plasma discharge process for continuous production of biodiesel. J. Cleaner Production 228: 405-417. https://doi.org/10.1016/j.jclepro.2019.04.311.

Ding, Y., J. Xiong, B. Zhou, J. Wei, A. Qian, H. Zhang, W. Zhu, **J. Zhu**. 2019. Odor removal by and microbial community in the enhanced landfill cover materials containing biochar-added sludge compost under different operating parameters. Waste Management 87(15): 679-690.

**Zhu, J**., S. Wu, J. Shen. 2019. Anaerobic co-digestion of poultry litter and wheat straw affected by solids composition, free ammonia, and carbon/nitrogen ratio. J. Environ. Sci. Health Part A 54(3): 231-237.

## Other Peer-Reviewed Publications

Pickelmann, D. M., **C.G. Henry**, V. Kandpal and G. Simpson. 2019. Grain Yield Response of Furrow-Irrigated Clearfield Hybrid RT 7311 to different Nitrogen Sources. In B.R. Wells Arkansas Rice Research Series 2018 editors R.J. Norman and K.A.K. Moldenhauer. University of Arkansas, August 2019, Research Series 659. Pp 343-352

## Other Peer-Reviewed Publications

Mozzoni, L., F. Ravelombola, L. Purcell, A. Kaler, **C. Henry**, A. Acuna-Galindo, L. lorez-Palacios, C. Wu, M. Da Silva, D. Rogers, S. Yarnell, M. de Oliveira, and D. Harrison. 2019. Genomic selection for seed yield and drought traits under various water regimes.Soybean Research Series. University of Arkansas. In press.

Ismanov, M**. C.G. Henry**, L. Espinoza, P.B. Francis. 2019. Sap flow and moisture use by soybean during late reproductive growth: Implications for Improved Irrigation Management. Soybean Research Series. In press.

Watkins, K.B., **C.G. Henry**, J.T. Hardke, R.U. Mane, R. Mazzanti and R. Baker. 2019. Efficiency Measurement of Irrigation water and Other Inputs in Arkansas Rice Production using Data from the Rice Research Verification Program. In B.R. Wells Arkansas Rice Research Series 2018 editors R.J. Norman and K.A.K. Moldenhauer. University of Arkansas, August 2019, Research Series 659. pp 412-430.

Watkins, K.B., **C.G. Henry**, J.T. Hardke, R. U. Mane, R. Mazzanti and R. Baker. 2019. In B.R. Wells Arkansas Rice Research Series 2018 editors R.J. Norman and K.A.K. Moldenhauer. University of Arkansas, August 2019, Research Series 659. Pp 431-438.

Lunga, D.D., K.R. Brye, **C.G. Henry** and J.J. Humphreys. 2019. Chamber Effects on Soil Moisture and Plant Productivity in Furrow-Irrigated Rice on an Silt-Loam Soil. Universityof Arkansas. In B.R. Wells Arkansas Rice Research Series 2018 editors R.J. Norman and K.A.K. Moldenhauer. University of Arkansas, August 2019, Research Series 659. Pp260-268.

Nian, Y., Q. Huang, K.F. Kovacs, **C. G. Henry** and J. Kurtz. 2019. The use of Pattern
Irrigation Practices by Arkansas Producers. In B.R. Wells Arkansas Rice Research Series
2018 editors R.J. Norman and K.A.K. Moldenhauer. University of Arkansas, August 2019, Research Series 659. Pp321-323

## Non-Refereed Publications and Articles

Scott, E.E., and **B.E. Haggard**. 2019. Constituent loads and trends in the Upper Illinois River Watershed and Upper White River Basin: 2015 October through 2018 September. AWRC Publication MSC 387. 79 pp.

E.E. Scott, and **B.E. Haggard**. 2019. Turbidity and ion concentrations vary with land use and underlying geology at the West Fork of the White River. AWRC Publication MSC 388. 15 pp.

Irrigation Leader Magazine. Most Crop per Drop: The Arkansas Irrigation Yield Contest. (**Henry, Chris**) pp 12-15. May/June 2019.

1-23-19 Clay Co Times Democrat – UAEX to offer irrigation school (**Chris Henry**)

1-17 Pocahontas Star Herald – Irrigation/water management schools planned for 2019 (**Chris Henry**)

1-10-19 Salem News – Irrigation/water management schools planned for 2019 (**Chris Henry**)

1-9-19 England Democrat – Irrigation/Water management schools planned for 2019 (**Chris Henry**)

1-9-19 Charleston Express – Irrigation/Water management schools planned for 2019 (**Chris Henry**)

1-9-19 (Cherokee Village) Villager Journal – Irrigation/water management schools planned for 2019 (**Chris Henry**)

1-8-19 AgFax – 3 upcoming irrigation/water management schools planned (**Chris Henry**)

2-14-19 Pine Bluff Commercial – Row rice roundtables seek to reach consensus on production methods (**Chris Henry**)

2-13-19 High Plains Journal – Row Rice Roundtables seek to reach consensus on production methods (**Chris Henry**)

2-8-19 AgFax – 2 upcoming row rice roundtables (**Chris Henry**)

## NON-REFEREED PUBLICATIONS AND ARTICLES

5-7-19 Pine Bluff Commercial – 2019 Arkansas Irrigation Yield Contest now open to entries (**Chris Henry**, Greg Simpson)
5-3-19 AgFax -- 2019 irrigation yield contest now open to entries (**Chris Henry**, Greg Simpson)
Zou, Q.Y., R. Wang and **Y. Li***. 2019. A minireview on electrochemical biosensors for the detection of heavy metal ions in water. ASABE Paper No. 1901797. ASABE 2019 Annual International Meeting, July 7-10, 2019, Boston, MA. doi.org/10.13031/aim.201901797
**Liang**, Y. 2019. When it comes to broiler cooling: sprinklers deliver results and save water. Avian Advice newsletter, June 2019. University of Arkansas. Online https://poultry-science.uark.edu/_resources/PDFs/JUNE-2019_AvianAdvice.pdf
DeMoss, N, T. Costello, **G.S. Osborn**. 2019. Brewing Up a Sustainable Future. Resource. September/October 2019, p. 14. ASABE, St. Joseph, MI.
**Dataset:** Seyednasrollah, B., A.M. Young, K. Hufkens, T. Milliman, M.A. Friedl, S. Frolking, A.D. Richardson, M. Abraha, D.W. Allen, M. Apple, M.A. Arain, J. Baker, J.M. Baker, C.J. Bernacchi, J. Bhattacharjee, P. Blanken, D.D. Bosch, R. Boughton, E.H. Boughton, R.F. Brown, D.M. Browning, N. Brunsell, S.P. Burns, M. Cavagna, H. Chu, P.E. Clark, B.J. Conrad, E. Cremonese, D. Debinski, A.R. Desai, R. Diaz-Delgado, L. Duchesne, A.L. Dunn, D.M. Eissenstat, T. El-Madany, D.S.S. Ellum, S.M. Ernest, A. Esposito, L. Fenstermaker, L.B. Flanagan, B. Forsythe, J. Gallagher, D. Gianelle, T. Griffis, P. Groffman, L. Gu, J. Guillemot, M. Halpin, P.J. Hanson, D. Hemming, A.A. Hove, E.R. Humphreys, A. Jaimes-Hernandez, A.A. Jaradat, J. Johnson, E. Keel, V.R. Kelly, J.W. Kirchner, P.B. Kirchner, M. Knapp, M. Krassovski, O. Langvall, G. Lanthier, G.l. Maire, E. Magliulo, T.A. Martin, B. McNeil, G.A. Meyer, M. Migliavacca, B.P. Mohanty, C.E. Moore, R. Mudd, J.W. Munger, Z.E. Murrell, Z. Nesic, H.S. Neufeld, T.L. O'Halloran, W. Oechel, A.C. Oishi, W.W. Oswald, T.D. Perkins, M.L. Reba, B. Rundquist, **B.R. Runkle**, E.S. Russell, E.J. Sadler, A. Saha, N.Z. Saliendra, L. Schmalbeck, M.D. Schwartz, R.L. Scott, E.M. Smith, O. Sonnentag, P. Stoy, S. Strachan, **K. Suvocarev**, J.E. Thom, R.Q. Thomas, A.K. Van den berg, R. Vargas, C.S. Vogel, J.J. Walker, N. Webb, P. Wetzel, S. Weyers, A.V. Whipple, T.G. Whitham, G. Wohlfahrt, J.D. Wood, S. Wolf, J. Yang, X. Yang, G. Yenni, Y. Zhang, Q. Zhang, and D. Zona. 2019. PhenoCam Dataset v2.0: Vegetation Phenology from Digital Camera Imagery, 2000-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1674

## NON-REFEREED PUBLICATIONS AND ARTICLES

**Dataset** :Milliman, T., B. Seyednasrollah, A.M. Young, K. Hufkens, M.A. Friedl, S. Frolking, A.D. Richardson, M. Abraha, D.W. Allen, M. Apple, M.A. Arain, J. Baker, J.M. Baker, C.J. Bernacchi, J. Bhattacharjee, P. Blanken, D.D. Bosch, R. Boughton, E.H. Boughton, R.F. Brown, D.M. Browning, N. Brunsell, S.P. Burns, M. Cavagna, H. Chu, P.E. Clark, B.J. Conrad, E. Cremonese, D. Debinski, A.R. Desai, R. Diaz-Delgado, L. Duchesne, A.L. Dunn, D.M. Eissenstat, T. El-Madany, D.S.S. Ellum, S.M. Ernest, A. Esposito, L. Fenstermaker, L.B. Flanagan, B. Forsythe, J. Gallagher, D. Gianelle, T. Griffis, P. Groffman, L. Gu, J. Guillemot, M. Halpin, P.J. Hanson, D. Hemming, A.A. Hove, E.R. Humphreys, A. Jaimes-Hernandez, A.A. Jaradat, J. Johnson, E. Keel, V.R. Kelly, J.W. Kirchner, P.B. Kirchner, M. Knapp, M. Krassovski, O. Langvall, G. Lanthier, G.l. Maire, E. Magliulo, T.A. Martin, B. McNeil, G.A. Meyer, M. Migliavacca, B.P. Mohanty, C.E. Moore, R. Mudd, J.W. Munger, Z.E. Murrell, Z. Nesic, H.S. Neufeld, W. O echel, A.C. Oishi, W.W. Oswald, T.D. Perkins, M.L. Reba, B. Rundquist, **B.R. Runkle**, E.S. Russell, E.J. Sadler, A. Saha, N.Z. Saliendra, L. Schmalbeck, M.D. Schwartz, R.L. Scott, E.M. Smith, O. Sonnentag, P. Stoy, S. Strachan, **K. Suvocarev**, J.E. Thom, R.Q. Thomas, A.K. Van den berg, R. Vargas, C.S. Vogel, J.J. Walker, N. Webb, P. Wetzel, S. Weyers, A.V. Whipple, T.G. Whitham, G. Wohlfahrt, J.D. Wood, J. Yang, X. Yang, G. Yenni, Y. Zhang, Q. Zhang, and D. Zona. 2019. PhenoCam Dataset v2.0: Digital Camera Imagery from the PhenoCam Network, 2000-2018. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1689

***(Non-refereed websites) Sadaka, Sammy***
**Farm and Home Safety Tips for Arkansans** https://www.uaex.edu/farm-ranch/special-programs/safety-services/default.aspx
**Farm Equipment Safety** https://www.uaex.edu/farm-ranch/special-programs/safety-services/farm-equipment-safety.aspx
Agricultural Equipment Safety Guidelines
On-Farm Hazards and Accident Prevention
Tractor Safety
Safe Use of Tractors in the Woods
Power Take-Off (PTO) Safety
Large Farm Equipment Safety
Trailer Use Safety
Attachment Safety
Falls from Tractors and Trailing Equipment
Safe Use of Harvesting Equipment
Skid-Steer Safety
**Home and Small Equipment Safety** https://www.uaex.edu/farm-ranch/special-programs/safety-services/home-and-small-equipment-safety.aspx
Safety First
**Farm Shop Safety** https://www.uaex.edu/farm-ranch/special-programs/safety-services/farm-shop-safety.aspx

## *Non-Refereed Publications and Articles*

Personal Protective Equipment
Safety First
Farm Shop Safety
Safe Use of Hand Tools
On-Farm Chemical and Fuel Safe Storage and Handling
Electrical Hazards on the Farm
**Grain Handling Safety** https://www.uaex.edu/farm-ranch/special-programs/safety-services/grain-handling-safety.aspx
Grain Storage Structures and Handling Equipment Safety
Grain Bin Safety
Safe Operation of On-Farm Augers
**Outdoor Farming Safety** https://www.uaex.edu/farm-ranch/special-programs/safety-services/outdoor-farming-safety.aspx

Sun and Heat Exposure
Protecting Your Sight
**Livestock Handling Safety** https://www.uaex.edu/farm-ranch/special-programs/safety-services/livestock-handling-safety.aspx
Livestock Handling
**AgrAbility Purpose**
AgrAbility
https://www.uaex.edu/farm-ranch/special-programs/agrability.aspx

Luthra, K. and **S. Sadaka**. 2019. Effects of dehumidification on the Performance of a fluidized Bed Dryer and the Rice Quality. ASABE Annual International Meeting, Boston, Massachusetts. July 7-10, 2019. Paper No. 1900322. Paper

## *Published Abstracts of Conference Presentations*

J. Batta-Mpouma, C. Chivers, G. Huffstutler, H.K. Jensen, M.O. Jensen, J. Kim, and **J.-W. Kim**. 2019. Hybrid Composites of Cellulose Nanocrystal and Polycaprolactone as Scaffold Materials for Cardiomyocyte Regeneration. 13th IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), November 21-24, Gwangju, Korea.

J. Cook, **J.-W. Kim**, G. Kandhola, J. Batta-Mpouma, and B. Babst. Investigation of Woody Feedstocks for Cellulosic Nanocrystals. 2019. SAF (Society of American Foresters) National Convention. October 30-November 3, Louisville, KY.

G. Kandhola, A. Djioleu, K. Rajan, J. Batta-Mpouma, H. Nkeumen, M.O. Lisunova, B.A. Babst, W.L. Headlee, D.J. Carrier, and **J.-W. Kim**. 2019. Extraction of nanocrystals from different wood species: evaluation of yields and properties. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

J. Batta-Mpouma, G. Kandhola, M.O. Lisunova, J. Sakon, and **J.-W. Kim**. 2019. Physico-Mechanical Properties of Crosslinked Cellulose Nanocrystals. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

## *Published Abstracts of Conference Presentations*

M. Iraniparast, J. Batta-Mpouma, M.O. Lisunova, S. Tavakoki, J. Sakon, V.P. Zharov, and **J.-W. Kim.** 2019. Synthesis of Cellulose Nanocrystal-Gold Nanoparticle Hybrid System for Surface Plasmon Resonance-Enhanced Property. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

J.C. Henson, J. Batta-Mpouma, C. Chivers, G. Huffstutler, W. Kim, J. Kim, H. Jensen, M. Jensen, and **J.-W. Kim**. 2019. Nanopatterned Polycaprolactone/Cellulose Nanocrystal Films for Cardiomyocyte Regeneration. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

M.S. Pharr, G. Kandhola, and **J.-W. Kim**. 2019. Assessing Commonly Used Methods in Measuring Yield of Cellulose Nanocrystals. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

Nut, N., Reyes, M. R., Sigua, G. C., Doro, L., Worqlul, A. W., Jeong, J., Srinivasan, R., **Le, K. N**., Ly, S., Tivet, F., Leng, V., Lor, L., Chan, S., & Sous, V. (2019). Evaluation of soil carbon sequestration in conservation agriculture production and tillage systems in Cambodia using SWAT. ASABE Annual International Meeting, Jul. 7–10, 2019, Boston, MA.

Nut, N., Reyes, M. R., Sigua, G. C., Doro, L., Worqlul, A. W.,

## *Extension Publications and Literature*

Brian Haggard https://watercurrents.uark.edu/
Brain Haggard https://arkansas-water-center.uark.edu/publications/newsletters.php
Brian Haggard https://arkansas-water-center.uark.edu/publications/arkansasbulletin/index.php
Brian Haggard https://arkansas-water-center.uark.edu/publications/water-data-reports.php
Brian Haggard https://arkansas-water-center.uark.edu/publications/annual-summary.php
Brian Haggard https://arkansas-water-center.uark.edu/publications/factsheets.php
Brian Haggard The AWRC also provides the USGS annual reports on 104B projects and activities; see: https://arkansas-water-center.uark.edu/publications/annual-reports-104b.php
**Henry, C. G**. 2019. Irrigation and Drainage. Corn Production Handbook. In press.
**Henry, C.G**. and D.M. Pickelmann. 2019. How to Prepare, Test, and Install Watermark Sensors. Irrigation Information Factsheet. http://www.uaex.edu/irrigation
**Henry, C.G**., P.B. Francis, L. Espinoza. 2019. How to use Watermark Soil Moisture Sensor for Irrigation. Irrigation Information Factsheet. http://www.uaex.edu/irrigation
**Henry, C.G**., P.B. Francis, L. Espinoza, and M. Ismanov. 2019. Timing the Final Irrigation Using Watermark Sensors. Irrigation Information Factsheet. http://www.uaex.edu/irrigation

## *Extension Publications and Literature*

**Liang**, Y. and K. **VanDevender**. 2019. Managing a livestock facility to minimize odors. University of Arkansas Division of Agriculture FSA3007. Major revision.
Tabler, T., **Liang**, Y. and Wells, J. 2019. Sprinklers offer flock cooling benefits and water conservation opportunities. Mississippi State University Extension Poultry Science, Publication 3351.
Tabler, T., **Liang**, Y., Moon., J. and Wells, J. 2019. Importance of water quality to NAE production. Mississippi State University Extension Poultry Science, Publication 3400.

***Smartphone Apps and Interactive Spread Sheets***

**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Equilibrium Moisture Content. 2016 & Updated 2019. Equilibrium Moisture Content Web Based Calculator Chung Pfost Eq.; Equilibrium Moisture Content Excel Sheet Chung Pfost Eq.
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Equilibrium Moisture Content. 2016 & Updated 2019. Equilibrium Moisture Content Web Based Calculator Henderson Eq.; Equilibrium Moisture Content Excel Sheet Henderson Eq.
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Grain Bin Capacity. 2016 & Updated 2019. Grain Bin Capacity Web Based Calculator; Grain Bin Capacity Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Grain Blending Calculator. 2016 & Updated 2019. Grain Blending Calculator Web Based Calculator; Grain Blending Calculator Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Semi-trailer Capacity. 2016 & Updated 2019. Semi-trailer Capacity Web Based Calculator; Semi-trailer Capacity Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Grain Shrinkage Table.2016 & Updated 2019. Grain Shrinkage Table Web Based Calculator ; Grain Shrinkage Table Excel Sheet
**Sadaka, S**. Grain Drying and Storage at Your Fingertips: Will Natural Air-drying Occur. 2016 & Updated 2019. Will Natural Air-drying Occur Web Based Calculator ; Will Natural Air-drying Occur Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Grain Shrinkage Determination (Pound Based). 2016 & Updated 2019. Grain Shrinkage Determination (Pound Based) Web Based Calculator; Grain Shrinkage Determination (Pound Based) Excel Sheet.
**Sadaka, S**. Grain Drying and Storage at Your Fingertips: Grain Shrinkage Determination (Bushel Based). 2016 & Updated 2019. Grain Shrinkage Determination (Bushel Based) Web Based Calculator; Grain Shrinkage Determination (Bushel Based) Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Grain Drying Time Calculator. 2016 & Updated 2019. Grain Drying Time Calculator Web Based Calculator; Grain Drying Time Calculator Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Grain Drying Cost (Diesel Powered Fan System). 2016 & Updated 2019. Grain Drying Cost (Diesel Powered Fan System) Web Based Calculator; Grain Drying Cost (Diesel Powered Fan System) Excel Sheet

## *Extension Publications and Literature*

**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Cost for Grain Drying and Storage with a pass Dryer/Bin Fueled with Liquid Propane. 2016 & Updated 2019. Cost for Grain Drying Fueled with Liquid Propane Web Based Calculator ; Cost for Grain Drying Fueled with Liquid Propane Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Cost for Grain Drying and Storage with a pass Dryer/Bin Fueled with Natural Gas. 2016 & Updated 2019. Cost for Grain Drying Fueled with Natural Gas Web Based Calculator; Cost for Grain Drying Fueled with Natural Gas Excel Sheet
**Sadaka, S.** Grain Drying and Storage at Your Fingertips: Conversion between Moisture Content Wet Basis and Moisture Content Dry Basis. 2019. Conversion between MC wb and MC db Web Based Calculator; Conversion between MC wb and MC db Excel Sheet
**VanDevender, Karl**, It's not too early To Start Thinking About Summer Heat Stress, UA Animal Science Dairy E-Newsletter, December submission

## *Professional Presentations*

### Invited Presentations

**Haggard, B.E.** Microcystin is highly variable in Lake Fayetteville. North Carolina State University, Biological and Agricultural Engineering Department Visit, Raleigh, NC. December 2019.
**Haggard, B.E**. Microcystin is highly variable in Lake Fayetteville. Northwest Arkansas District American Water Works and Water Environment Annual Meeting, Eureka Spring, AR. October 2019.
**Haggard, B.E**. Microcystin is highly variable in Lake Fayetteville. Lake Fayetteville Partnership Special Meeting, Fayetteville, AR. August 2019.
**Haggard, B.E**. Big Creek Research and Extension Team: Monitoring to date. Buffalo National River Symposium, National Park Service, Harrison, AR. April 2019.
**Henry, C.G**. 2019. Ten years of lessons learned from Vegetative Treatment Systems. Presented to NRCS and NDEQ agency meeting, Lincoln, Nebraska. August 20, 2019.
**Henry C.G**. 2019. The value an applied irrigation engineer can bring to the new Mississippi Water Center. Presented to the Delta Council, February 11, 2019. Lehland, MS.
**Henry, C.G**. 2019. Technology and the Irrigation Contest. Presented to the Mid- south Water Stewardship Program and Sustainable Rice 2025 Initiative, June 17, 2019.

## PROFESSIONAL PRESENTATIONS

### Invited Presentations continued

**J.-W. Kim**. 2019. Programmable Molecular/Nanoscale Building Blocks for Nano/Bio-Hybrid Materials in Bio/Nano Medicine. IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), November 21-24, Gwangju, Korea. (Invited Talk)

**J.-W. Kim** and H. Han. 2019. Multifunctional Hybrid Soft Nanomaterials: Design and Assembly. IEEE International Conference on Nanotechnology (IEEE-NANO), July 22-26, Macau, China. (Invited Talk)

**J.-W. Kim** and H. Han. 2019. Hybrid Nanocomposites in Bio/Nano medicine. IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), April 11-14, Bangkok, Thailand. (Invited Talk)

H. Han and **J.-W. Kim.** 2019. THz Spectroscopy for Bio/Nano Molecular Analyses. IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), April 11-14, Bangkok, Thailand. (Invited Talk)

**J.-W. Kim**. 2019. Programmable Molecular/Nanoscale Building Blocks and Development Strategies for Multifunctional Hybrid Soft Nanomaterials in Bio/Nano Medicine. 2019 Fall CiTE Seminar, November 20, Department of Creative IT Engineering (CiTE), Pohang University of Science and Technology (POSTECH), Pohang, Korea. (Invited Talk)

S. Tung and **J.-W. Kim**. 2019. Maximizing Spatial Resolution of DNA Sequencing Using Single Carbon Chain: Updates. May 29-31, Advanced Genomic Technology Development Meeting, Northeastern University, Boston, MA. (Invited Talk)

**K. N. Le**, The teaching panel discussion in the Biological Engineering Graduate Seminar Class on March 11 , 2019

**Li, Y.** 2019. Poultry excellence in China: Improving food safety of poultry supply chain (II). An invited presentation at the 2nd Global Food Safety Governance Forum (organized by Walmart Food Safety Collaboration Center), November 20, 2019, Beijing, China.

**Li, Y.** 2019. Application of biosensors and risk assessment for pathogen detection and early warning in food supply chain. An invited presentation at the 1st Symposium on Plant & Animal Health and Quality & Safety of Agro-Products, November 17-18, 2019, Ningbo, China.

**Li, Y.** 2019. Biosensors for intelligent agriculture and food systems. An invited presentation at International Forum on Agriculture Artificial Intelligence, November 2-3, 2019, Guangzhou, China.

## PROFESSIONAL PRESENTATIONS

**Li, Y.** 2019. Nanomaterials-based biosensors for rapid detection of pathogenic bacteria and viruses. An invited presentation at International Forum on Advances in Biomedical Engineering at Zhejiang University, June 24, 2019, Hangzhou, Zhejiang Province, China.

**Li, Y.** 2019. Biosensors for smart agriculture. An invited presentation at the 2nd China Forum on Biosensors, Biochips and Nanobiotech (BBN China 2019, organized by Chinese Society of Biotechnology), May 24-25, 2019, Jinan, Shandong Province, China.

**Li, Y.** 2019. Poultry excellence in China: Improving food safety of poultry supply chain. An invited presentation at the 1st Global Food Safety Governance Forum (organized by Walmart Food Safety Collaboration Center), April 18, 2019, Beijing, China.

**Li, Y.** 2019. Microbial risk assessment and control for poultry supply chain. An invited presentation at Food Safety Workshop on Microbial Risk Management of Poultry and Meat Supply Chain (organized by Walmart Food Safety Collaboration Center), April 17, 2019, Beijing, China.

**Liang**, Y. 2019. Characterizing Thermal Microenvironment During Poultry Transportation. Invited Speaker at "Current Poultry Research and Findings: Information You Need to Know to Help Your Business" at Poultry Expo, Atlanta, GA. Feb 14th 2019

**Matlock, M**, Dairy Sustainability Institute, 2019. Dairy Sustainability Framework: Annual Review 2017-2018. UN Secretary General Climate Action Summit.

Rajagopalan, K., Sulser, T., Stockle, C., Gustafson, D., Thoma, G.J., Kruse, J., Intarapapong, P., **Matlock, M**., Hoogenboom, G. and Asseng, S., 2019, December. Capturing the effect of human influence in downscaling irrigating water availability estimates: an evaluation in the western US. In AGU Fall Meeting 2019. AGU.

Runkle, BRK "Carbon cycling and management in the rice agro-ecosystem", University of Oklahoma Eco-Munch seminar series, April 3, 2019.

Runkle, BRK "Sustainability in rice production systems: carbon, water, and harvest", University of Oklahoma Earth Observation and Modeling Facility (EOMF) meeting, April 2, 2019.

Runkle, BRK "Toward water resources sustainability in the Lower Mississippi River Basin", Texas A&M University Civil Engineering Seminar, Jan. 14, 2019

### Submitted/selected oral or poster presentations

Shults, M., B.J. Austin, and **B.E. Haggard**. Variability in microcystin concentrations in a recreational lake. Arkansas Water Resources Center Annual Conference, Fayetteville, AR. July 2019.

## *Professional Presentations*

**Haggard, B.E**., B.J. Austin, and D. Lee. Occurrence of microcystin (or lack there of) across a nutrient gradient in Ozark streams. University Council on Water Resources Annual Meeting, Snow Bird, UT. June 2019.

Austin, B.J., D. Lee and **B.E. Haggard**. Occurrence of microcystin in Ozark streams across a nutrient gradient in northwest Arkansas. National Water Quality Monitoring Conference, Denver, CO. March 2019.

Henson, E. A. Lasater, and **B.E. Haggard**. Reducing dissolved phosphorus in stream water may not influence estimation of sediment equilibrium phosphorus concentration. National Water Quality Monitoring Conference, Denver, CO. March 2019.

Lasater, A., B.J. Austin, and **B.E. Haggard**. Stream discharge monitoring and load estimation for small scale watersheds. National Water Quality Monitoring Conference, Denver, CO. March 2019.

Scott, E.E., and **B.E. Haggard**. Water quality changes in the West Fork of the White River from upstream to downstream: what could this mean for resource managers? National Water Quality Monitoring Conference, Denver, CO. March 2019.

**Henry, C.G.** 2019. Irrigation Advancement in Furrow Irrigated Rice. Presented at the Annual ASABE International Meeting, Boston, MA, July 9-11, 2019.

**Henry, C.G**. 2019. Arkansas Irrigation Yield Contest. Presented at the Annual ASABE International Meeting, Boston, MA, July 9-11, 2019.

J. Batta-Mpouma, C. Chivers, G. Huffstutler, H.K. Jensen, M.O. Jensen, J. Kim, and **J.-W. Kim**. 2019. Hybrid Composites of Cellulose Nanocrystal and Polycaprolactone as Scaffold Materials for Cardiomyocyte Regeneration. 13th IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), November 21-24, Gwangju, Korea.

J. Cook, **J.-W. Kim**, G. Kandhola, J. Batta-Mpouma, and B. Babst. Investigation of Woody Feedstocks for Cellulosic Nanocrystals. 2019. SAF (Society of American Foresters) National Convention. October 30-November 3, Louisville, KY.

G. Kandhola, A. Djioleu, K. Rajan, J. Batta-Mpouma, H. Nkeumen, M.O. Lisunova, B.A. Babst, W.L. Headlee, D.J. Carrier, and **J.-W. Kim.** 2019. Extraction of nanocrystals from different wood species: evaluation of yields and properties. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

J. Batta-Mpouma, G. Kandhola, M.O. Lisunova, J. Sakon, and **J.-W. Kim**. 2019. Physico-Mechanical Properties of Crosslinked Cellulose Nanocrystals. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

## *Professional Presentations*

M. Iraniparast, J. Batta-Mpouma, M.O. Lisunova, S. Tavakoki, J. Sakon, V.P. Zharov, and **J.-W. Kim**. 2019. Synthesis of Cellulose Nanocrystal-Gold Nanoparticle Hybrid System for Surface Plasmon Resonance-Enhanced Property. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

J.C. Henson, J. Batta-Mpouma, C. Chivers, G. Huffstutler, W. Kim, J. Kim, H. Jensen, M. Jensen, and **J.-W. Kim**. 2019. Nanopatterned Polycaprolactone/Cellulose Nanocrystal Films for Cardiomyocyte Regeneration. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

M.S. Pharr, G. Kandhola, and **J.-W. Kim**. 2019. Assessing Commonly Used Methods in Measuring Yield of Cellulose Nanocrystals. Arkansas NSF EPSCoR Annual Conference, May 15-16, Little Rock, AR.

J. Batta-Mpouma, J. Sakon, and **J.-W. Kim**. 2020. Physicochemical Properties of Multifunctional Crosslinked Cellulose Nanocrystals. 15th IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), April 20-24, San Diego, CA.

G. Kandhola, K. Rajan, A. Djioleu, J. Batta-Mpouma, N. Labbe, J. Sakon, D.J. Carrier, and **J.-W. Kim**. 2020. Assessing Cellulose Nanocrystals from Different Wood Species as Engineering Materials. 15th IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), April 20-24, San Diego, CA.

M. Iraniparast, J. Batta-Mpouma, G. Kandhola, M. Kim, J. Sakon, J. Chen, and **J.-W. Kim.** 2020. Hybrid Cellulose Nanocrystal / Gold Nanoparticle Nanocomposites for Surface Plasmon Enhanced Property. 15th IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), April 20-24, San Diego, CA.

G. Kandhola, K. Rajan, B. Babst, N. Labbe, D.J. Carrier, and **J.-W. Kim**. 2020. Cellulose Nanocrystals from Different Wood Species: Evaluation of Yields and Properties. 42nd Symposium on Biomaterials, Fuels & Chemicals (SBFC), April 26-29, New Orleans, LA

Wang, R.H., X.F. Yu, T.S. Jiang, Y.M. Kwon, J.C. Zhao, M. Ivey, and **Y. Li***. 2019. A label-free QCM biosensor for sensitive and rapid detection of E. coli O157:H7 based on a multivalent aptamer system. Oral presentation at the IAFP 2019 Annual Meeting, July 21-24, 2019, Louisville, KY. Paper No. T5-05.

Wang, W.Q., R.H. Wang, M. Liao, and **Y. Li***. 2019. Rapid detection of enrofloxacin in poultry using a localized surface plasmon resonance sensor based on polydopamine surface imprinted recognition polymer. Oral presentation at the IAFP 2019 Annual Meeting, July 21-24, 2019, Louisville, KY. Paper No. T5-09.

# PUBLICATIONS

## PROFESSIONAL PRESENTATIONS

### Submitted/selected oral or poster presentations continued

Xiao, X.N., W. Wang, J.M. Zhang, M. Liao, H. Yang, Q. Wang, and **Y. Li***. 2019. A predictive model for cross-contamination of Salmonella in the poultry chilling process. Poster presentation at the IAFP 2019 Annual Meeting, July 21-24, 2019, Louisville, KY. Paper No. P1 -166.

Xi, X.G., R.H. Wang, P. Yao, J.H. Lin, M. Liao, and **Y. Li***. 2019. A portable sensing device with magnetic separation and quantum dot labeling for simple, rapid and quantitative detection of Salmonella Typhimurium. ASABE Paper No. 1900564. An oral presentation at ASABE 2019 Annual International Meeting, July 7-10, 2019, Boston, MA.

Zhu, W.Y., Y.Q. Li, Y.C. Fu, and **Y. Li**. 2019. A nanobiosensor based on integrated nanochannel-electrode system for rapid detection of Salmonella in chicken products. ASABE Paper No. 1900995. An oral presentation at ASABE 2019 Annual International Meeting, July 7-10, 2019, Boston, MA.

Zou, Q.Y., R.H. Wang, and **Y. Li**. 2019. A mini-review on research progress on the detection of heavy metal ions by electrochemical biosensors. ASABE Paper No. 1901797. An oral presentation at ASABE 2019 Annual International Meeting, July 7-10, 2019, Boston, MA.

Yao, L., L. Wang, N. Liu, S. Wang, **Y. Li**, J.H. Lin. 2019. Direct detection of Salmonella using inertial microfluidics-based separation and enzymatic catalysis-based colorimetry. Poster presentation at 6th International Conference on Biosensing Technology (ICBT), June 16-19, 2019, Kuala Lumpur, Malaysia. Paper # P2.68.

Lu, Z., Y.F. Shen, C.J. Li, **Y. Li**, Y.C. Fu, Z.Z. Ye, and J.P. Wang. 2019. Micro-optical components and quantum dots based handheld instrument system for in-field detection in poultry supply chain. Presented it at Pittcon 2018, March 17-21, 2019, Philadelphia, PA.

Wang, W.Q., R.H. Wang, M. Liao, M.T. Kidd, and **Y. Li***. 2019. Rapid detection of enrofloxacin in poultry using a localized surface plasmon resonance sensor based on polydopamine surface imprinted recognition polymer. Poster presentation at AAFP 2019 Annual Conference, September 17-18, 2019, Fayetteville, AR.

Xi, X.G., R.H. Wang, P. Yao, S. Tung, and **Y. Li***. 2019. A semi-automated portable sensing device with magnetic separation and quantum dot beads labeling for simple, rapid and quantitative detection of *Salmonella* Typhimurium. Poster presentation at AAFP 2019 Annual Conference, September 17-18, 2019, Fayetteville, AR.

McCain, H. and **Liang**, Y. 2019. Ambient and laboratory evaluation of two low-cost particulate matter sensors. Annual International Meeting of ASABE. Poster #72, Boston, MA, July 2019

## PROFESSIONAL PRESENTATIONS

**Osborn, G.S.,** 2019. Practice: Designing, Modeling, and Building a Small Grain Dryer; Theory: Fluids, Psychrometrics, and Thermodynamics. ASABE Annual International Meeting, Boston, MA.

**Runkle BRK**, Reba M, Fong B, Teague T, Suvočarev K, Dynamics of $CO_2$ exchange in US Mid-South cotton production, oral presentation at the Beltwide Cotton Conference, New Orleans, LA, 1/9/19

Wofford Z, LaSalle E, Oxner M, Hardaway K, Henson E, **Runkle BRK**, Measuring Hydrologic Benefits of a Green Roof: A University of Arkansas Honors College Project, Poster presentation at the Arkansas Soil and Water Education Conference and Expo, Jonesboro, AR, 1/30/19, **Awarded** *3rd place prize, undergraduate poster competition.*

O'Halloran T, Kaminski R, Motallebi M, **Runkle B**, Beyond waterfowl habitat: Valuing multiple ecosystem services in managed wetlands to inform conservation, 2019 North American Duck Symposium, Winnipeg, Canada, 28 August 2019.

Suvočarev K, Snyder RL, Marino G, Zaccaria D, **Reavis CW**, Reba ML, **Runkle BRK**, Simplified evapotranspiration measurements using the surface renewal method over different agricultural crops, presentation at X International Agriculture Symposium "AGROSYM 2019" Jahorina, 3-6 October 2019, Bosnia and Herzegovina.

**Runkle BRK**, Reba ML, Suvocarev K, Reavis C, Moreno-Garcia B, Methane emissions in rice production systems in the US Mid-South, presentation at Ameriflux Annual Meeting, Boulder, CO, Sept 2019.

Moreno-García B, Reavis CW, Suvočarev K, **Runkle BRK**, Sustainability tools to assess water-saving irrigation practices in rice fields in Arkansas, Triple Societies (ASA, CSSA, SSSA) International Meeting, San Antonio, 10-13 Nov, 2019.

Helbig M, Waddington JM, and >50 co-authors, including **Runkle B**, Peatland-dominated boreal ecoregions at risk of drying in a warmer climate, Presentation at AGU Fall Meeting, San Francisco, CA, December 2019.

Fong B, Reba ML, Reavis C, **Runkle BRK**, Suvocarev K, Adviento-Borbe A, Massey JH, Identifying relationships between vegetative indices and gross primary productivity (GPP) in rice agriculture sites, Presentation at AGU Fall Meeting, San Francisco, CA, December 2019.

**Runkle BRK**, Reba ML, Suvocarev K, Reavis CW, Moreno-García B, Heuschele J, Adviento-Borbe A, Isbell C, Williams M, How can we significantly reduce the methane impact of rice production? Presentation at AGU Fall Meeting, San Francisco, CA, December 2019

**Runkle BRK**, Ward E, Windham-Myers L, Ryu Y, Kang M, Bansal S, Jackson RB, McNicol G, Knox SH, Riley WJ, Lohila A, Schafer KV, Vargas R, Reba ML. How drying and wetting events impact landscape methane fluxes, Presentation at AGU Fall Meeting, San Francisco, CA, December, 2019

## Professional Presentations

Reba ML, Fong B, Reavis C, **Runkle BRK**, Suvocarev K, Adviento-Borbe A, Massey JH, Comparison of methane reductions with alternate irrigation techniques in US mid-south rice production, Presentation at AGU Fall Meeting, San Francisco, CA, December, 2019

Reba ML, Fong BN, Teague TG, Adviento-Borbe MAA, **Runkle BRK**, US Mid-South Cotton Ecosystem Respiration Measurements, Upcoming presentation at the Cotton Agronomy, Physiology & Soil Conference of the 2020 Belt-wide Cotton Conferences, Austin TX, January, 2020.

Moreno-García B, Reavis CW, Suvočarev K, **Runkle BRK**, Comparison of water-saving irrigation practices in rice production in Arkansas using two farm sustainability tools, Upcoming presentation at the Rice Technical Working Group meeting, Orange Beach, AL, February, 2020.

**Zhu, J**., S. Wu, J. Shen. 2019. Anaerobic co-digestion of poultry litter and wheat straw affected by solids, free ammonia, and carbon/nitrogen ratio with response surface analysis. ASABE Annual International Meeting paper#: 1900026. Boston, MA. July 7-10, 2019.

## Other Creative Endeavors

**Chris Henry** UA Irrigation Water Management Team. 2016. Rice Irrigation. Mobile Application Software. https://play.google.com/store/apps/details?id=org.uark.riceirrigation

Chris Henry UA Irrigation Water Management Team. 2017. Rice Irrigation. Mobile Application Software. http://itunes.apple.com

**Chris Henry** UA Irrigation Water Management Team. 2017. Arkansas Watermark Tool. http://itunes.apple.com

**Chris Henry** UA Irrigation Water Management Team. 2019. Arkansas Watermark Tool. https://play.google.com/store.

**Chris Henry** UA Irrigation Water Management Team. 2019. Poly Printer and CHS Planning App. Unpublished.

*The University of Arkansas is committed to the policy of providing educational opportunities to all qualified students regardless of their economic or social status, and will not discriminate on the basis of handicaps, race, color, sex, or creed.*



***A nationally competitive student-centered research university serving Arkansas and the world.***