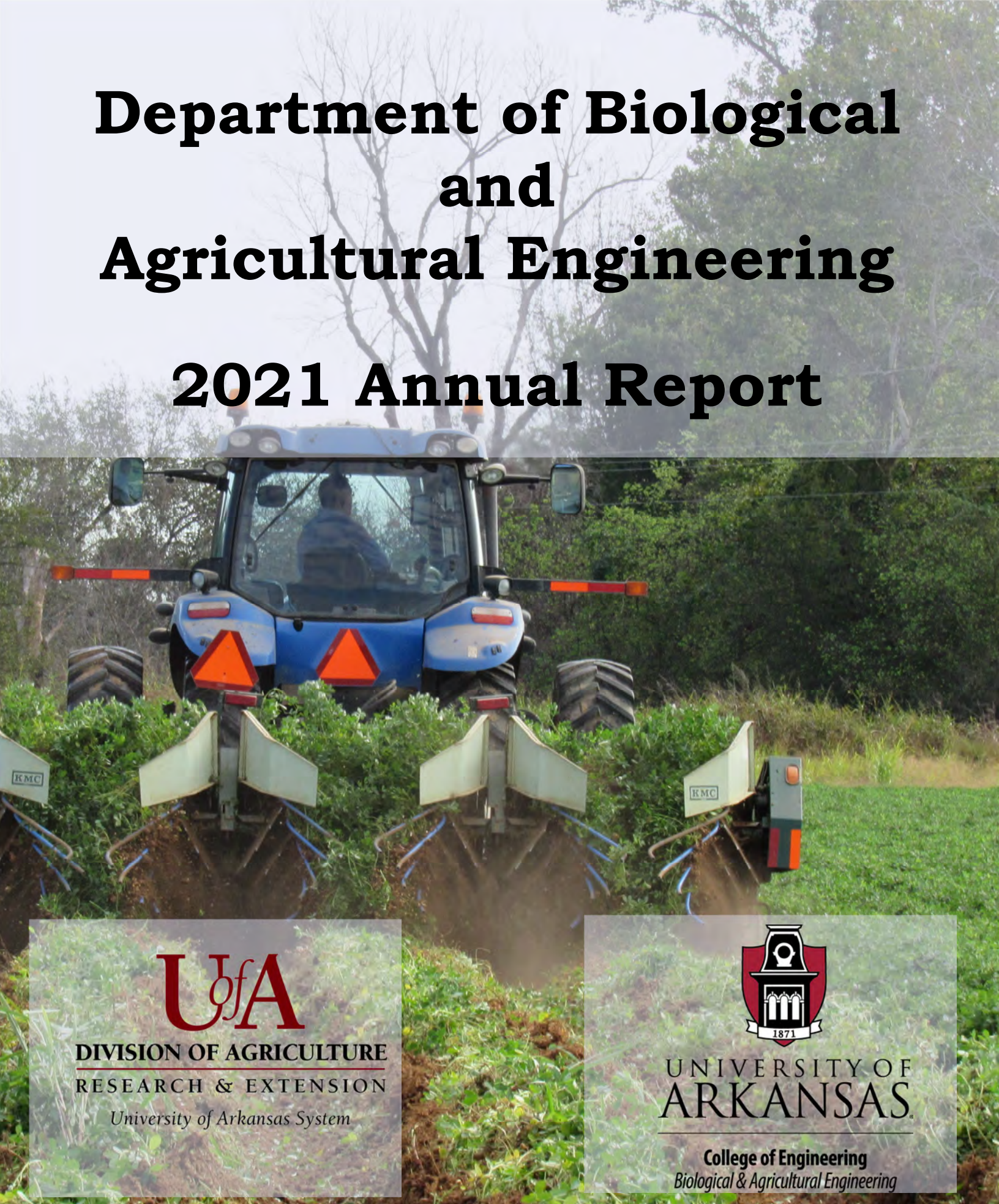
2021

Annual Report, 2021

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

Department of Biological and Agricultural Engineering

2021 Annual Report



DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

1871
UNIVERSITY OF ARKANSAS
College of Engineering
Biological & Agricultural Engineering

2021 Annual Report
Department of Biological and Agricultural Engineering

Lalit R. Verma
Department Head

University of Arkansas System
Division of Agriculture
Chuck Culver
Interim Vice President for Agriculture

Arkansas Agricultural Experiment Station
Jean-Francois Meullenet
Senior Associate Vice President for Agriculture Research

Cooperative Extension Service

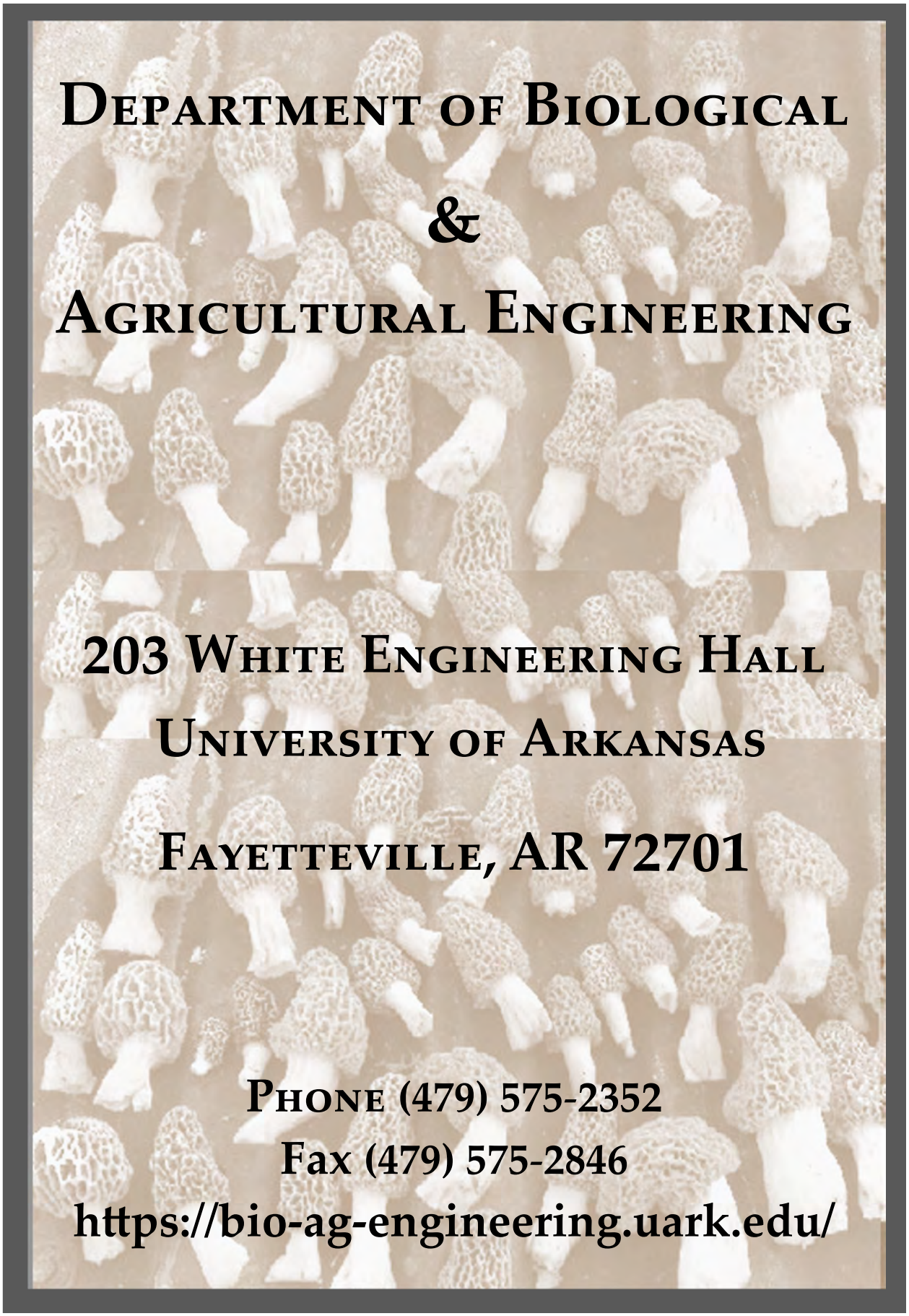
Bob Scott
Senior Associate Vice President - Agriculture Extension

College of Engineering

Kim LaScola Needy
Dean

University of Arkansas
Charles Robinson
Interim Chancellor

Terry Martin
Interim Provost and Executive Vice Chancellor for Academic and Student Affairs



Department of Biological & Agricultural Engineering

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University of Arkansas
Fayetteville, AR 72701

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FOREWORD

FROM THE DEPARTMENT HEAD

I am pleased to share highlights of our departmental programs and personnel in 2021, the second year of the lingering pandemic. Our faculty and staff continued to contribute to the departmental mission through education, research and extension programs in 2021.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 is well aligned with the land-grant mission delivering our programs to the students and clientele we exist to serve.

We are addressing the challenges facing our society – from climate change to global food insecurity. Our academic programs in Biological Engineering prepare engineers to solve problems in sustainable water, food and energy systems. Our graduates go on to engage in designing sustainable engineering solutions for in light of complex challenges including societal issues and are prepared to pursue successful careers supporting "Green Engineering." These programs contribute to the goals of both UA System's Division of Agriculture's agricultural research and extension programs, and the UA College of Engineering. Our offices are in White Engineering College and lab space is at the Milo J. Shult Agricultural Research and Extension Center off the main campus. 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 and emerging challenges in Agriculture for our state and nation.

The Accreditation Board for Engineering and Technology provided their official report confirming regular 6-year accreditation without any concerns or weakness. Thirty-six undergraduates completed their degrees with all those seeking employment being successful. Dr. Dongyi Wang joined us in the Food Engineering program jointly with the Department of Food Science and Dr. Ahmed Mahmoud came on board as a Teaching Assistant professor. Ms. Haley Ellis was honored as a College of Engineering Outstanding Senior Finalist and the Biological Engineering Outstanding Senior. Ms. Alexis Barber, one of our undergrads was selected as a 2021 Udall Scholar. Dr. Brian Haggard was awarded the College of Engineering Dean's Award of Excellence for Outstanding Public Service. Drs. Ben Runkle, Jun Zhu and Scott Osborn were the recipients of department's outstanding teaching, research and "service to students" awards, respectively and Ms. Leslie Reinhart was named the outstanding staff. Dr. Chris Henry was recognized as the "Outstanding Engineer" at the ASABE Arkansas State section virtual meeting in October. Dr. Ben Runkle was honored with the UA Alumni Association's "Rising Teaching Faculty Award" and was also honored with the "Distinguished faculty teaching and research award" from the UA Honors College. Dr. Marty Matlock is serving as Senior Advisor for Food Systems Resiliency with Marketing and Regulatory Programs in the USDA. Dr. Ebenezer Kwofie was named a Distinguished Ag. Alumnus at McGill University. The Induction Banquet of Arkansas Academy of Biological and Agricultural Engineering (AABAE) was postponed.

We look forward to a healthier and safe 2022 with continued growth and progress in all our programs.

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

- Jin-Woo Kim was given Adjunct Professorship in the Department of Electrical Engineering at Pohang University of Science & Technology, Korea, (this is a continuation since 2014).
- Jin-Woo Kim was featured in Who's Who in America, Marquis Who's Who, 2021.
- Jin-Woo Kim was nominated to be a Fellow in IEEE Leadership International 2021 (Note: Received a notification of the elevation to IEEE Fellow (effective January 1, 2022) on November 22, 2021).
- Ebenezer Miezah Kwofie was awarded the Macdonald Distinguished Young Alumni Award from McGill University, Montreal, Quebec, Canada.
- Scott Osborn was awarded the Outstanding Service to Students by the Biological and Agricultural Engineering Department.
- Benjamin Runkle received the Departmental Teaching Award from the Biological & Agricultural Engineering Department
- Benjamin Runkle received the Distinguished Faculty Teaching and Research Award (Honors College)
- Benjamin Runkle received the Rising Teaching Award from the University of Arkansas Alumni Association
- Sammy Sadaka received the Outstanding Researcher of the Year from the Arkansas Association of Cooperate Extension Service.
- Sammy Sadaka was recognized as Associate Editor for Contributions by ASABE.
- Jun Zhu honored by ASABE as "Exemplifying Best Practices" as an Associate Editor for ASABE Publications.
- Jun Zhu received Long-Term "Outstanding Service Recognition" as an Associate Editor by ASABE for the Plant, Animal, and Facility Systems Community.
- Brian Haggard received the Engineering Dean's Faculty Award of Excellence for Outstanding Public Service.
- Brian Haggard received the John W. White Outstanding Team Award, University of Arkansas Division of Agriculture, 2021

Significant Accomplishments in 2021

Students

- Courtney Austin, Tatianna Castillo Hernandez, Christian Hitt, Olivia Liedel design team won 2nd Place at the National Student Design Competition at the pen Format – Gunlogson Environmental Design Student Competition at the ASABE 2021 Annual International Meeting. They were mentored by Thomas Costello, Chris Henry and Yi Liang.

- Abbie Lasater Ph.D. graduate student won for her poster presentation at the Virtual Student Poster Competition, Oklahoma Clean Lakes and Watershed Association 2021 annual meeting.

- Lillie Haddock M.S. graduate student won for her poster presentation at the Virtual Student Poster Competition, Oklahoma Clean Lakes and Watershed Association 2021 annual meeting.

- Xinge Xi, PhD student received the ASABE 2021 Superior Paper Award, as the 1st author for the article "A portable biosensing device with magnetic separation and quantum dot bead labeling for simple, rapid and quantitative detection of Salmonella Typhimurium" published in Transaction of the ASABE 63(6):1947-1955, 2020

- Alexis Barber, a U of A honors junior from West Plains, Missouri, was named a Morris K. and Stewart L. Udall Scholar. Recognized by the Morris K. and Stewart L. Udall Scholarship Foundation for their commitment to environmental sustainability as well as demonstrated leadership connected to the environment on campus and in their communities

- The U of A student chapter of the American Society of Agricultural and Biological Engineers was voted the outstanding school by participants of the southeast region during 2020-21 annual rally, held virtually March 27 and hosted by the University of Tennessee at Knoxville. The Southeast Region is made up of 14 schools.

- Ellie Kuhn won 2nd place undergraduate poster presentation at the 23rd Annual Arkansas Soil & Water Education virtual Conference.

- Marguerita Leavitt masters student won 2nd place graduate poster presentation at the 23rd Annual Arkansas Soil & Water Education virtual Conference.

- Marguerita Leavitt, masters student received the Top 5 Outstanding Student Presentation Award at the 7th North America Carbon Program Open Science Meeting.

- 3rd place in Undergraduate Research Poster Competition, Engineering category, Kristen Trinh, University of Arkansas. University. Primary mentor. (2021).
- Ellie Kuhn won 1st place at the Students of Agronomy, Soils, and Environmental Sciences, 2021 Research Symposium, Triple Societies Conference.

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, and 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.

Ebenezer Kwofie, Ph.D.
Assistant Professor
B.Sc. Chemical Engineering (20006) Kwame Nkrumah University of Science and Technology
M.Sc. Industrial Engineering (2010) University of Boras, Sweden
Ph.D. Bioresouce Engineering (2016) McGill University, Canada
Research Areas: Industrial eco-friendly analysis (food and bio-products, Nutrition-sensitive agriculture programming and food value chain analysis, food quality and nutrition dynamics for sustainability

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.

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.

Ahmed Mahmoud, Ph.D.
Assistant Professor
B.S. Biology (2007) Ain Shams University, Cairo, Egypt
M.S. Environmental Engineering (2014) Texas A&M University
Ph.D. Environmental Engineering (2018) Texas A&M University
Research Areas: Urban Pollutant Fate and Transport, Green Infrastructure, Low Impact Development, Stormwater Runoff Effects on Human and Ecological Health

Departmental Resources

Faculty

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

Sydney Jones
Administrative Specialist III; Extension

Beatriz Moreno Garcia
Post-Doctoral Fellow

Fei Jia
Research Scientist

Sandhya Karki
Post-Doctoral Associate

Gurshagan Kandhola
Post-Doctoral Fellow

Bonan Li
Post-Doctoral Fellow

Linda Pate
Department Administrative Manager

Leslie Reinhart
Administrative Specialist III

Lee Schrader
Program Technician

Eric Simon
Program Associate

Abdus Sobhan
Post-Doctoral Fellow

Elahe Tajfar
Post-Doctoral Associate

BAEG Advisory Board
2021 Members

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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

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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

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)

Nupra Bhise
B.S. ('07), Ph.D. ('13)

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)

Mark Christie Childress
B. S. ('85), Ph.D. (18)

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)

Catherine Erickson
B.S. ('07)

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

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

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

Dennis R. Gardisser
B.S. ('79), M.S. ('81), Ph.D. ('92)

Thomas Garrison
B.S. ('05), M.S. ('07), Ph.D. ('13)

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)

Adam Jokerst
B.S. ('02), M.S. ('06)

AJ Kaufman
B.S. ('07)

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)

Leslie Massey
B.S. ('06), M.S. ('08)

Stanley A. Mathis
B.S. ('84)

James McCarty
B.S. ('06), M.S. ('15), Ph.D. ('20)

Katherine McCoy
B.S. ('09), M.S. ('12)

Toni McCrory
B.S. ('07)

Drake McGruder
B.S. ('06)

James McNeal
B.S. ('86)

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

Amber Meisner
B.S. ('02)

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

Rebecca Muenich
B.S. ('09), M.S. ('11), Ph.D. ('15)

Bruce Netherton
B.S. ('60)

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)

Shelly Thomas
B.S. ('05)

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

Wesley Busheled

FRED G. FOWLKES
B.S. ('68), M.S. ('77)

CARL L. GRIFFIS
B.S. ('63), M.S. ('65), Ph.D. ('68)

ALBERT H. MILLER
Posthumously

ROBERT W. NEWELL
B.S. ('54)

STANLEY E. REED
B.S. ('73) Posthumously

HAROLD S. STANTON
B.S. ('50) M.S. ('53)

FREDDIE C. STRINGER
B.S. ('70)

ALBERT E. "GENE" SULLIVAN
B.S. ('59)

H. FRANKLIN WATERS
B.S. ('55) Posthumously

2021 Academy Inductees

Nupura Bhise

Catherine Erickson

James McCarty

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 fund-raising efforts by a U.S. public university, while focusing on the university's future goals.

Department of Biological & Agricultural Engineering

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

The first Bachelor of Science 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 2021

Names listed in Italic are spring 2021 scholar - ship Recipients the others listed are fall 2021 scholarship

Arkansas Academy of Biological & Agricultural Engineering Scholarship
Issac Bertels
William Franke
Ellie Kuhn

Biological & Agricultural Engineering Departmental Scholarship
Juan Arguijo
Clarissa Fuller
Jake Krier
Daisy Mota
Megan Doty

Mildred V. And Billy B Bryan Scholarship
Megan Doty
Halley Ellis
Hayden Engelbrecht
Sophia Gomez
Angel Meneses
Holland Morton
Shawn Pearson
Dharma Shepard
Amanda Bogart
Craigon Bradley
Hope Dwyer

Division of Agriculture Scholarship
Issac Bertels
Megan Doty
Annette Benbrook

J.A. Riggs Tractor Company Scholarship
Kaden Belcher
Shawn Pearson
Juan Arguijo
Sophie Gomez
Kyson Hardaway

Xzin McNeal Scholarship
Alexis Barber
Amanda Bogart
Megan Doty
William Franke
Feranda Novoa
Christopher Pryor

Xzin McNeal Scholarship Cont.
Dharma Shepard
Harrison Davis
Hayden Engelbrecht
Katherine Skiles
Christopher Pryor
Sarah Flannery
Maloree Morris
Iana Lara Ruheta Wase
Hope Dwyer
Hailey Roye
Ava Hatch

Joel Steel & Hardy Croxton Beaver Water District
Jake Krier
Jacqueline Steinauer

John W & Trannye Odom White Scholarship
Harrison Davis
Hailey Roye
Spencer Warrick

Carl L. Griffis Endowed Memorial Award
Lille Bolton
Feranda Novoa

Alfred B. Rhode Scholarship
Tatiana Castillo
Katherine Skiles
Hunter Dowell
Clarissa Fuller
Tarah Inena
Holland Morton
Emily Tappana
Olivia Torres

Graduates for 2021

Bachelor of Science in Biological Engineering

Spring 2021
Alexander M. Anderson
Courtney Jane Austin
Kaden Scott Belcher
Isaac Nolan Bertels
Hunter Ross Brown
Evan Ryan Byrd
Jordan Matthew Cocanower
Maxwell C. Criswell
Haley Shannon Ellis
Mike Gasasu
Christian Oliver Hitt
Lukes James Huffman
Spencer Lawrence Johnson
Ian James Klein
Rachael Rose Koehler
Jake Conrad Krier
Olivia S. Liedel
Marret Christian Lineberry
Charis Joy Lykins
Zane Thomas Mallicote
Angel Damiro Meneses
Brent Byron Miller
Daisy Aranda Mota
Joshua David Pierce
Alexie K. Pope
Clay Michael Schuler
Lara Morgan Tarr
Gil Edward Thomas
Kristen Khanh Ngoc Trinh
Chandler Nicole Trotter
Charles Austin Don Weeks
Rebecca Hannah Widdowson
Caroline Grace Wilson
Anthony Robert Zadoorian

Summer 2021
Jesse E. Morrison

Fall 2021
Jason Deoin Angel
Karina Arellano
Juan Alberto Arguijo

Biological Engineering Student Club

Mandy Bogart- *President*
Ellie Kuhn– *Vice President*
Jacob Miller- *Treasurer*
Immaculin Joe- *Treasurer in Training*
Juniper Matlock- *Secretary*
Hayden Engelbrecht- *Social Media/PR*
Dawson Oakley- *Co Outdoor Coordinator*
Noah Geels- *Co Outdoor Coordinator*

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 2021-2022 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

Freshman Year	
First Semester **1** GNEG 1111 Introduction to Engineering I **3** ENGL 1013 Composition I **3** CHEM 1103 University Chemistry I **4** MATH 2554 Calculus I **3** U.S. History or Government Elective - Choose one course from the following: HIST 2003 History of the American People to 1877 or HIST 2013 History of the American People, 1877 to Present or PLSC 2003 American National Government **(14 Semester hours)**	**Second Semester** 1 GNEG 1121 Introduction to Engineering II 3 ENGL 1033 Technical Composition II 4 First-Year Engineering Science Electives: CHEM 1123 University Chemistry II & CHEM 1121L University Chemistry II Laboratory or BIOL 1543 and BIOL 1541L 4 MATH 2564 Calculus II 4 PHYS 2054 University Physics I **(16 Semester hours)**
Sophomore Year	
First Semester 2 BENG 2632 Biological Engr Design Studio 4 MATH 2574 Calculus III (ACTS Equivalency = MATH 2603) 4 Sophomore Science Electives ** 4 PHYS 2074 (ACTS Equivalency = PHYS 2044 Lecture) 3 MEEG 2003 Statics **(17 Semester hours)**	**Second Semester** 2 BENG 2632 Biological Engineering Design Studio 4 MATH 2574 Calculus III 4 Sophomore Science Elective (whichever has not been taken) : CHEM 1123 University Chemistry II & CHEM 1121L University Chemistry II Lab or BIOL 1543 and BIOL 1541L 3 MEEG 2003 Statics PHYS 2074 University Physics II **(17 Semester hours)**
Junior Year	
First Semester 3 BENG 3653 Global Bio-Energy Engineering 3 BENG 3663 Biological Engineering Methods II 3 BENG 3733 Transport Phenomena in Biological Systems 4 **Choose one:** CHEM 3603 Organic Chemistry I & CHEM 3601L Organic Chemistry I Laboratory or CHEM 2613 Organic Physiological Chemistry & CHEM 2611L Organic Physiological Chemistry Laboratory 3 CVEG 3213 Hydraulics (or MEEG 3503 Mechanics of Fluids or CHEG 2133 Fluid Mechanics) **(16 Semester hours)**	**Second Semester** 3 BENG 3723 Unit Operations in Biological Engr 3 BENG 3113 Measurements and Controls for Biological Systems 3 BIOL 3863 General Ecology 3 CVEG 3223 Hydrology 3 Technical Elective **(15 Semester hours)**
Senior Year	
First Semester 2 BENG 4812 Senior Biological Engineering Design I 1 BENG 4831 Biological Engineering Professionalism 3 BENG 4743 Food and Bio-Product Systems Engineering 3 BENG 4933 Sustainable Watershed Engineering 3 Humanities Elective - Choose one course from the list below 3 Social Science Elective-choose any course listed on the State Minimum Core. **(15 Semester hours)**	**Second Semester** 2 BENG 4812 Senior Biological Engineering Design I 1 BENG 4831 Biological Engineering Professionalism 3 BENG 4743 Food and Bio-Product Systems Engineering 3 BENG 4933 Sustainable Watershed Engineering 3 Humanities Elective - Choose one course from the list below 3 Social Science Elective-choose any course listed on the State Minimum Core. **(18 Semester hours)**

This Social Science Elective should be selected from the following courses in order to meet State Minimum Core:
ANTH 1023, COMM 1023, GEOS 2003, GEOS 2003H, HDFS 1403, HDFS 2413, HDFS 2603, HIST 1113, HIST 1113H, HIST 1123, HIST 1123H, HIST 2093, HUMN 1114H, HUMN 2114H, PLSC 2013, or RESM 2853.
The Humanities Elective should be selected from the following courses in order to meet State Minimum Core: CLST 1003, CLST 1013, PHIL 2003, PHIL 2003H, PHIL 2003C, PHIL 2103, or PHIL 2103C.
The Fine Arts Elective should be selected from the following courses in order to meet State Minimum Core: ARHS 1003, COMM 1003, DANC 1003, MLIT 1003, MLIT 1003H, MLIT 1013, MLIT 1013H, MLIT 1333, THTR 1003, or THTR 1013.

BIOLOGICAL ENGINEERING B.S.B.E. ENVIRONMENTAL CONCENTRATION, EIGHT-SEMESTER DEGREE PROGRAM 2021-2022 COURSE CATALOG

Freshman Year

First Semester
1 GNEG 1111 Introduction to Engineering I**3** ENGL 1013 Composition I (ACTS Equivalency = ENGL 1013) (Satisfies General Education Outcome 1.1)
3 CHEM 1103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture)
4 MATH 2554 Calculus I (ACTS Equivalency = MATH 2405) (Satisfies General Education Outcome 2.1)
4 PHYS 2054 University Physics I (ACTS Equivalency = PHYS 2034)
(15 Semester hours)

Second Semester
1 GNEG 1121 Introduction to Engineering II
3 ENGL 1033 Technical Composition II
4 First-Year Engineering Science Electives: CHEM 1123 University Chemistry II & CHEM 1121L University Chemistry II Laboratory or PHYS 2074 University Physics II
4 MATH 2564 Calculus II
3 U.S. History or Government Elective - Choose one course from the following: HIST 2003 History of the American People to 1877 or HIST 2013 History of the American People, 1877 to Present or PLSC 2003 American National Government
(15 Semester hours)

Sophomore Year

First Semester
2 BENG 2632 Biological Engineering Design Studio
4 MATH 2574 Calculus III
4 Sophomore Science Elective (whichever has not been taken) :
CHEM 1123 University Chemistry II
& CHEM 1121L University Chemistry II Lab or PHYS 2074 University Physics II
4 BIOL 1543 Principles of Biology & BIOL 1541L Principles of Biology Laboratory
3 MEEG 2003 Statics
(17 Semester hours)

Second Semester
3 BENG 2643 Biological Engineering Methods I
4 MATH 2584 Elementary Differential Equations
4 BIOL 2013 General Microbiology & BIOL 2011L General Microbiology Laboratory
3 MEEG 2403 Thermodynamics or CHEG 2313 Thermodynamics of Single-Component Systems
3 Social Science Elective - Choose one course from the list below.

(17 Semester hours)

Junior Year

First Semester
3 BENG 3653 Global Bio-Energy Engineering
3 BENG 3663 Biological Engineering Methods II
3 BENG 3733 Transport Phenomena in Biological Systems
4 Choose one: CHEM 3603 Organic Chemistry I
& CHEM 3601L Organic Chemistry I Laboratory or CHEM 2613 Organic Physiological Chemistry (ACTS Equivalency = CHEM 1224 Lecture)
& CHEM 2611L Organic Physiological Chemistry Laboratory
3 CVEG 3213 Hydraulics or MEEG 3503 Mechanics of Fluids
or CHEG 2133 Fluid Mechanics
(16 Semester hours)

Second Semester
3 BENG 3723 Unit Operations in Biological Engineering
3 BENG 3113 Measurement and Control for Biological Systems
3 CVEG 3223 Hydrology
3 Biological Elective
3 Technical Elective
(15 Semester hours)

Senior Year

First Semester
2 BENG 4812 Senior Biological Engineering Design I
1 BENG 4831 Biological Engineering Professionalism
3 BENG 4743 Food and Bio-Product Systems Engineering
3 BENG 4933 Sustainable Watershed Engineering
3 Social Science Elective-choose any course listed on the State Minimum Core.
Technical Elective
3 CVEG 4243 Environmental Engineering Design
(15 Semester hours)

Second Semester
3 BENG 4823 Senior Biological Engineering Design II (Satisfies General Education Outcome 6.1)
3 BENG 4663 Sustainable Biosystems Designs
3 Fine Arts Elective - Choose one course from the list below (Satisfies General Education Outcome 3.1)[3]
3 Social Science Elective - choose any course listed on the State Minimum Core.
3 Technical Elective (choose a course from the Technical Electives list maintained by the department.)
(18 Semester hours)

Total Units in Sequence: **128**

This Social Science Elective should be selected from the following courses in order to meet State Minimum Core:
ANTH 1023, COMM 1023, GEOS 2003, GEOS 2003H, HDFS 1403, HDFS 2413, HDFS 2603, HIST 1113, HIST 1113H, HIST 1123, HIST 1123H, HIST 2093, HUMN 1114H, HUMN 2114H, PL SC 2013, or RESM 2853.
The Humanities Elective should be selected from the following courses in order to meet State Minimum Core: CLST 1003, CLST 1013, PHIL 2003, PHIL 2003H, PHIL 2003C, PHIL 2103, or PHIL 2103C.
The Fine Arts Elective should be selected from the following courses in order to meet State Minimum Core: ARHS 1003, COMM 1003, DANC 1003, MLIT 1003, MLIT 1003H, MLIT 1013, MLIT 1013H, MLIT 1333, THTR 1003, or THTR 1013.

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.

Teaching Program

Graduate Program

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
Prince Agyemang	Dr. Ebenezer Kwofie
Lillie Haddock	Dr. Brain Haggard
Lydia Huck	Dr. Scott Osborn
Vinay Kumar Kalyankar	Dr. Sammy Sadaka
Matthew Kelly	Dr. Thomas Costello
Patrick Kuczwara	Dr. Jin-Woo Kim
Kyle Lawrence	Dr. Marty Matlock
Marguerita Leavitt	Dr. Benjamin Runkle
Helena Tchoungang Nkeumen	Dr. Jin-Woo Kim
Yiting Xiao	Dr. Jun Zhu
Winfred Yeboah	Dr. Ebenezer Kwofie

Doctor of Philosophy in Biological Engineering

Student	Advisor
Prathamesh Bandekar	Dr. Marty Matlock
Eric Cummings	Dr. Marty Matlock
Jaspreet Kaur	Dr. Jin-Woo Kim
Abbie Lasater	Dr. Brian Haggard
Kaushik Luthra	Dr. Sammy Sadaka
Colby Reavis	Dr. Benjamin Runkle
Xinge Xi	Dr. Yanbin Li
Yiting Xiao	Dr. Jun Zhu
Yuanhang Zhan	Dr. Jun Zhu

Doctor of Philosophy in Chemical Engineering

Student	Advisor
Derrick Allotey	Dr. Ebenezer Kwofie

Master of Science in Crop Soil Environmental Science

Student	Advisor
Alyssa Ferri	Dr. Brian Haggard

Doctor of Philosophy in Materials Science and Engineering

Student	Advisor
Joseph N. Batta-Mpouma	Dr. Jin-Woo Kim

Doctor of Philosophy in In Cell and Molecular Biology

Student	Advisor
Cody Chivers	Dr. Jin-Woo Kim

Doctor of Philosophy in Poultry Science

Student	Advisor
Wenqian Wang	Dr. Yanbin Li

MASTER SCIENCE IN ENVIRONMENTAL DYNAMICS

STUDENT	ADVISOR
Brittany McIntyre	Dr. Brian Haggard
Jeferson Pimental	Dr. Christopher Henry

DOCTOR OF PHILOSOPHY IN ENVIRONMENTAL DYNAMICS

STUDENT	ADVISOR
Riasad Bin Mahbub	Dr. Benjamin Runkle

GRADUATE DEGREES EARNED

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

Spring 2021
Deanna L. Mantooth M. S.
Helena Tchoungang Nkeumen M. S.

Summer 2021
Abbie LaNell Lasater Ph.D.
Kaushik Luthra Ph.D.
Xinge Xi Ph.D.

Fall 2021
Colby Wade Reavis Ph.D.
Yiting Xiao M.S.

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
Prashant Borhade	Master Science Computer Science/Computer Engineering	Dr. Christopher Henry
Isabelle Niyonshuti	Master Science	Dr. Yanbin Li
Deborah Okyere	Master Science Materials Science & Engineering	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 software techniques for the graphical and geo-spatial representation of processes, structures, devices, landscapes and watersheds in biological engineering. Process layout and process flow diagrams. Two-dimensional and three-dimensional scale drawings and models. Elements of engineering drawings and plans. Mapping and introduction to geographic information systems. Surface topography, digital elevation modeling, spatial land use, soils and other GIS data sources. Stream networks, watershed delineation, grade planning and introductory runoff modeling. Introductory land surveying. Geo-referencing and integrating designed hydrologic structures with GIS-based site maps. Communicating complex designed systems. Two hours of lecture plus one 3-hour lab per week.
Corequisite: Lab component. Prerequisite: PHYS 2054

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: PHYS 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: (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).

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 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 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, data acquisition 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 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 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 5963. Modeling Environmental Biophysics. Interactions between the biosphere and the atmosphere. Connecting the physical environment of solar energy, wind, soil, and hydrology to the biosphere through plant ecophysiology. Boundary layer meteorology, photosynthesis and boundary layer modeling strategies, and the soil-plant-atmosphere continuum. Instrumentation, measurement and modeling strategies for understanding leaf-, landscape- and regional behaviors; and, the transfer, kinetics, and balance of momentum, energy, water vapor, CO2, and other atmospheric trace gases between the landscape (vegetation and soil) and the atmosphere. Applications in sustainable agriculture, irrigation, land and water resources, and modeling plant water use and carbon uptake strategies. A working knowledge of calculus and a discipline related to the course is expected. Three hours of lecture per week. Students may not earn degree credit for both BENG 4963 and BENG 5963. Prerequisite: Instructor consent. (Typically offered: Spring Even Years)

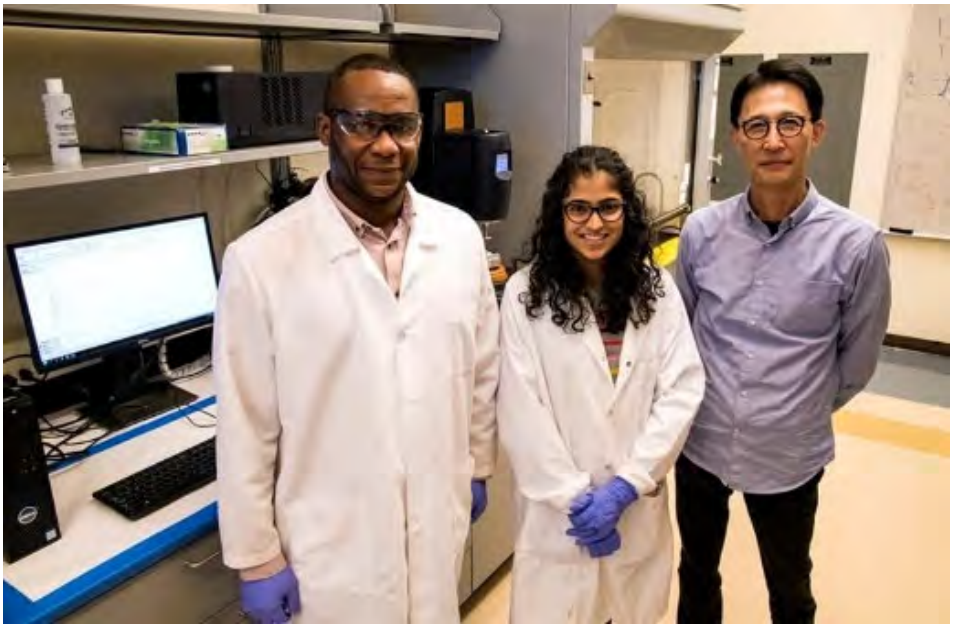
BENG 5973. Advanced Practice in Water Quality Monitoring and Analysis. Application of water quality principles to a real world problem. Team project experience leading and developing quality assurance project plans, designing monitoring systems, selecting chemical analysis methods, estimating loads, performing trend analysis, basic model calibration and validation, team management, and technical report writing and oral presentations. Working with various clientele to analyze water quality data in the context of evaluating real-world problems and issues. Three hours of lecture per week. Prerequisite: Graduate standing. (Typically offered: Spring Odd Years)

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.

Cellulosic Nanomaterial May Help Solve Problem of Herbicide Drift

May 24, 2021



Fred Miller, Division of Agriculture

Doctoral candidate Joseph Batta-Mpouma and post-doctoral researcher Gurshagan Kandhola created a company to commercialize cellulosic nanomaterials for agricultural use. They developed the particles in their graduate research working with Arkansas Agricultural Experiment Station researcher Jin-Woo Kim. Batta-Mpouma developed their business plan in a Walton College entrepreneur class. (UA System Division of Agriculture photo by Fred Miller)

Marty Matlock Appointed Senior Advisor for Food Systems Resiliency

Sep. 14, 2021

Marty Matlock, a University of Arkansas professor and center director, has been appointed to serve as senior advisor for food systems resiliency with Marketing and Regulatory Programs at the U.S. Department of Agriculture.

U of A Students Launch the People, Planet and Profit Project

An interdisciplinary group of M.B.A. and doctoral-level graduate students in the University of Arkansas' Graduate Net Impact chapter have completed a student-run pilot social and environmental impact consultancy project with Markham & Fitz, a Bentonville-based craft sustainable chocolate maker.

The project is under the umbrella of Graduate Net Impact's People, Planet, and Profit Project, or P4 and is an Arkansas Global Changemakers initiative. This initiative aims to place pressing social issues into global context and bring communities together to enhance local solutions to global challenges.

Members of the pilot project include:

- Mark Howard, P4 Project lead, Graduate Net Impact director of operations – Ph.D. Fellow, Department of Computer Science and Computer Engineering
- Gurshagan Kandhola, PhD, P4 consultant – Post-Doctoral Fellow, Department of Biological and Agricultural Engineering
- Prathamesh Bandekar, P4 consultant – Ph.D. Fellow, Department of Biological and Agricultural Engineering
- Caroline Wilson, P4 consultant – M.B.A. candidate
- Clay Schuler, P4 consultant – M.B.A. candidate
- Megan Reavis, PhD, P4 consultant – Department of Biology
- Ralph Bray, P4 graduate assistant – M.B.A. candidate
- Alana Collins, president, Graduate Net Impact – M.B.A. candidate

Rogelio Garcia Contreras, advisor – Director of Social Innovation and faculty in the Department of Strategy, Entrepreneurship, and Venture Innovation at Sam M. Walton College of Business and co-founder, Arkansas Global Changemakers Initiative (RGarciaContreras@walton.uark.edu)

Meredith Adkins, advisor – Director for Northwest Arkansas Industry and Community Engagement, Ph.D. candidate, Public Policy-Community Development Program, University of Arkansas (mmckee@uark.edu)

Lindsey Steiger-Muck, advisor – Corporate outreach manager, Sam M. Walton College of Business (lsteiger-muck@walton.uark.edu)

U of A Student Named 2021 Udall Scholar

May 26, 2021

Alexis Barber, a U of A honors junior from West Plains, Missouri, was named a Morris K. and Stewart L. Udall Scholar. Recognized by the Morris K. and Stewart L. Udall Scholarship Foundation for their commitment to environmental sustainability as well as demonstrated leadership connected to the environment on campus and in their communities

ALEXIS BARBER

Majoring in biological engineering with a sustainability minor, Barber has actively engaged in the Biological Engineering Student Club, the Volunteer Action Center and an ecological restoration project. Off-campus, she has interned with several engineering firms, including most recently as an environmental engineering intern at Perennial Energy in Pennsylvania.

"I am extremely grateful and honored to be a part of the Udall Scholar Family," Barber said. "It is a great privilege to represent the University of Arkansas, and I am looking forward to connecting with Udall Scholars from across the country to learn and share ideas."

Barber's professional aspirations are to build a career around utilizing the emissions from landfills in the United States as a means to make clean energy from the methane being released. Upon graduation, Barber plans on entering the renewable energy industry and hopes to start her own business designing methane-reducing technologies for landfills that are trying to reduce their emission rates.

Barber said, "I want to start my own business to ensure the profits I generate can be used to fund environmental restoration efforts."

"Alexis is incredibly smart, getting things done because she is organized, proactive and engaged," said Scott Osborn, associate professor of biological and agricultural engineering and Barber's mentor. "Throughout her future career, she will be a leader addressing problems with both the environment and environmental justice. Alexis' potential is so great because she has the rare combination of intellect, work ethic, devotion to this cause and a deep respect and empathy for her fellow humans as both individuals and communities."

Three Minute Thesis Competition

Kaushik Luthra is the College of Engineering winner for his presentation *Feeding lives: vital role of grains in ensuring world food security*. He is a biological engineering doctoral student advised by Sammy Sadaka.

Biological and Agricultural Engineering Chapter Wins Best School Award for Southeast Region

April 19, 2021

The U of A student chapter of the American Society of Agricultural and Biological Engineers was voted the outstanding school by participants of the southeast region during 2020-21 annual rally, held virtually March 27 and hosted by the University of Tennessee at Knoxville. The Southeast Region is made up of 14 schools.

Each school was invited to create a video describing their activities over the academic year. The U of A's winning video was created by Hayden Engelbrecht, a junior from Decatur, Illinois. Engelbrecht serves as social chair for the club.

"While this year was unlike any other, my goal for this video was to highlight the relationships within the club and the initiative we took to maintain engagement even with COVID-19 restrictions," Engelbrecht said. "I'm really proud of all the small things we were able to accomplish this year, and I'm especially excited to see what we can accomplish when we return next fall."

The club is led by President Kristen Trinh, a graduating senior from Fort Smith.

"We are ecstatic that we won this award during this very challenging year," Trinh said. "Thank you, Hayden, for accurately capturing how we all felt and showing how we successfully made the best out of a very difficult situation."

Lalit Verma, head of the Biological and Agricultural Engineering Department, added, "We are very proud of our student club and the leadership provided by club officers under the guidance of club adviser Dr. Scott Osborn. This club has done an amazing job even during the pandemic and made us proud by their outstanding performance at the virtual Student Rally."

The focus of this year's rally was transitioning from school to employment and career paths for biological engineering students. Participants were also given a virtual tour of the Tennessee Valley Authority River Forecast Center that manages a 49-dam, integrated river system to provide flood-damage reduction, navigation, hydroelectric power, water quality, water supply and recreation.

Teaching Academy Inducts New Fellows

Scott Osborn is an associate professor in the Department of Biological and Agricultural Engineering. He received his B.S. in 1984 and M.S. in 1988 in agricultural engineering from the University of Kentucky. He earned his Ph.D. in 1994 in biological and agricultural engineering from North Carolina State University. Scott worked as a design engineer for GSI in the grain-drying industry as well as for Kellogg's in the food processing industry, and is a licensed professional engineer in Arkansas and Texas. Osborn joined the University of Arkansas as an assistant professor in 2001. He teaches courses in engineering design, processing and heat/mass transfer. His expertise is technology to dissolve gas into liquid for water treatment and craft beer carbonation/nitrogentation. Osborn is the co-founder of BlueInGreen LLC, a company that sells equipment to dissolve oxygen, ozone and carbon dioxide into water for treatment. He holds 13 patents related
to dissolved gas technology.

Scott Osborn

DISTINGUISHED FACULTY TEACHING AND RESEARCH AWARDS (Honors College)

Benjamin Runkle, associate professor, biological and agricultural engineering, College of Engineering. Benjamin Runkle leads a research group that aims to enhance our understanding of globally relevant landscapes through connections between the carbon and water cycles. His research on rice irrigation practices has helped quantify a water-saving technique that significantly reduces the greenhouse gas production of these food-providing landscapes.

Runkle's honors students have examined questions related to irrigation water use, rice plant growth dynamics, and modeling agricultural systems. One of these theses was published in peer-reviewed literature. In 2018, Runkle helped initiate a team research grant focused on the campus's green roof on Hillside Auditorium that also supported several individual honors research theses. He has also advised honors theses in sustainable urban and rural topic areas and he co-leads a study abroad course to Ghent, Belgium, that attracts many honors students. He is planning to offer an Honors College Forum, Nature-based Climate Solutions, in 2022.

Runkle has been recognized as an outstanding teacher by the University of Arkansas Alumni Association, the American Society of Engineering Education, the College of Engineering, and the Department of Biological and Agricultural Engineering. In research, he has received recognition from the Rice Technical Working Group, the College of Engineering, and the National Science Foundation, which awarded him a CAREER grant on climate-smart irrigation strategies for rice agriculture. In service, Runkle has co-advised the LGBTQ+ affinity group, oSTEM at the University of Arkansas, since its inception in 2018.

Runkle's research group uses a micro-meteorological station to measure evaporation over a rice field in central Arkansas.

Benjamin Runkle confers with students that developed and studied Hillside Auditorium's green roof.
Photo Russell Cothren

Alumni and Faculty Honored at 76th Annual Alumni Awards Celebration Thursday, Oct. 14, at the Fayetteville Town Center.

DISTINGUISHED FACULTY ACHIEVEMENT AWARDS

The Distinguished Faculty Achievement Award recognizes exceptional faculty members for teaching, research and service.

- The rising teaching award, **Benjamin Runkle**, associate professor of Biological and Agricultural Engineering in the College of Engineering.

Community Design Center Collaborative 'Wood City' Project Wins Green Good Design Award

May 28, 2021

The Community Design Center is an outreach program of the Fay Jones School of Architecture and Design at the U of A led by Stephen Luoni. Luoni is also a Distinguished Professor and the Steven L. Anderson Chair in Architecture and Urban Studies.

The project was a collaborative effort between the Community Design Center and the U of A Resiliency Center, an interdisciplinary sustainability initiative hosted by the Fay Jones School and led by executive director Marty Matlock. Matlock is also a professor in the Department of Biological and Agricultural Engineering in the College of Engineering at the university.

Fay Jones School architecture students Matthew Scott, Mary Grace Corrao, Wenjie Zhu, Keturah Bethel and Jacob Alford also worked on the "Wood City" project through a studio conducted at the Community Design Center.

This is the fifth time that a collaborative project by the Community Design Center and Resiliency Center has received a Green Good Design Award. The Wood City project was sponsored by the Weyerhaeuser Giving Fund.

NASA Awards $1 Million for Research on Sustainable Rice Production

July 21, 2021

A new $1 million grant from NASA's Carbon Monitoring Program will go towards a study headed up by associate professor of biological engineering at the U of A, Benjamin Runkle, on greenhouse gases and its implications of rice cultivation.

The grant, titled "A national quantification of methane emissions from rice cultivation in the U.S.: integrating multi-source satellite data and process-based modeling," will support the hiring of a postdoctoral scientist, graduate students and undergraduates to work on the project from 2021 to 2024.

The team project includes colleagues at the University of Illinois, Urbana-Champaign, where professor Kaiyu Guan will lead the detection of field inundation dynamics and advanced application of satellite imagery to help understand agricultural carbon and water dynamics.

Courtesy of Beatriz Moreno Garcia

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 engineer's 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)
- Water Quality Lab
- Resiliency Center
- 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

- **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.

Fine tune chicken sprinkler technology to maintain production performance

Yi Liang, Associate Professor

What was addressed?

Water is a crucial component for poultry production, not only for chicken consumption but also to alleviate heat stress in tunnel-ventilated broiler houses. Heat stress is one of the most challenging stressors to poultry production. Evaporative cooling cell pad systems and other moisture-rich systems saturate a barn air with relative humidity greater than 70 percent. For a chicken, this is counterproductive to cooling itself by breathing.

Sprinkler systems drop a relatively small amount of water directly on the chickens to produce a wind-chill effect when exhaust fans pull air through the building. The sprinkler systems can save an average of 67 percent in water for cooling birds in poultry houses during the hot summer months.

What was accomplished?

Our study in 2021 focused on proper management of the cooling-cell temperature set points in houses with low-pressure sprinkler systems at two commercial broiler houses measuring about 40-by-400 feet at the Applied Broiler Research Unit in Savoy.

Tests showed that sprinklers should be activated before the poultry house temperature approaches 90 degrees Fahrenheit. The set point of a cooling-cell system should be about 21 degrees above the house set point to allow sprinkler activation under a drier thermal condition. Results of production of the hear-stress-prone summer flock were compared with a spring flock. The feed conversion rate was 1.78 in the spring flock and 1.83 in the summer flock with a "livability percentage" at 94.7 percent in the spring flock and 95.3 percent in the summer flock.

Live market weights were comparable in the 2021 study with 9.24 pounds at 55 days in the spring flock and 9.37 pounds at 57 days in the summer flock.

Anticipated Impact

Sprinkler systems offer cooling water conservation of over 50 percent compared to a cool-cell system while maintaining production without sacrificing flock performance. As poultry industry combat climate change and heat stress, management of sprinkler systems will be crucial in meeting sustainability goals, including water conservation.

Low-Cost Solar Collectors to Pre-heat Ventilation Air in Broiler Buildings

Yi Liang, Associate Professor

What was addressed?

Commercial meat bird production requires large amount of fossil fuel energy such as natural gas or propane in order to maintain target temperatures when brooding young chickens. Solar collectors installed on the façade of buildings collect heat by solar radiation and provide preheated ventilation air. The objective of this study is to evaluate whether a low-cost solar collector can be integrated into commercial broiler buildings in order to reduce ventilation heat loss, reduce fuel energy consumption and potentially improve air quality.

What was accomplished?

Black, fabric-based solar collectors were installed on the rooftop of a commercial-scale broiler house. The solar collectors were operated under either heating or minimum ventilation modes by introducing preheated air under the collectors into the buildings. When in use, the solar collectors were able to raise 20°C above the ambient temperature, reducing fuel usage of 7% in the fall and winter flocks. Daily utilization of solar collectors averaged 25% during the 9-hour daytime periods of the first 18 days of a fall flock, and the first 33 days of a winter flock. Even though temperature under the solar collectors were high enough to allow them operated as solar space heaters for a few days, the additional ventilation provided by solar collectors as heaters did not make a substantial difference in air quality between the Test and Control houses.

Anticipated Impact

Incorporating renewable energy into poultry production is critical in lowering energy use and reducing greenhouse gas emissions, and low-cost solar collector is a promising technology. This study reported the potential use, challenges and limitation of implementing rooftop solar collectors in broiler operations. Future research is needed on improving plumbing between collectors and ventilation inlets as well as the control algorithm to increase the utilization.

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

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. A couple of years ago a version was posted to *www.uada.edu/manure* . This posting has been advertised via email to key personnel within the agencies listed above with a request to forward to their appropriate internal and external personnel. In addition the required online Nutrient Planner Certification course provides training on the tool and directs students to the web site for current versions.

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 training 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, *kvandevender@uada.edu*, UA Division of Agriculture, 501-671-2244

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

Funding Sources: Various general base state and federal funds.

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#: OIIA-1457888 and ECCS-1810014) and National Institute of Health (NIH; award#: 1R21HG010055)

Understanding Cyanobacterial Harmful Algal Blooms in Arkansas

Brian Haggard, Professor

Issue:
The occurrence of Harmful Algal Blooms (HABs) across the United States is becoming more prevalent with anthropogenic eutrophication and climate change, and this issue is local too; we have HABs from cyanobacteria (i.e., cyanoHABs) in our own Lake Fayetteville.

Response:
The Arkansas Water Resources Center shifted its research focus to study cyanHABs, where we established long-term water quality monitoring sites at Lake Fayetteville, designed bioassays to understand how nutrients influence algal growth and cyanotoxins (i.e., microcystin), and statistically evaluated microcystin thresholds and hierarchical structure with nutrients, algal parameters, and general physico-chemical properties.

Impact:
We have found that nutrient limitation and cyanotoxins concentration vary temporally, and the toxin of interest, microcystin, shows thresholds and structure with water temperature, nutrients, and algae which might help guidance advisories for cyanoHABs in local lakes.

Contacts:
Brian E. Haggard, PhD, Director, Arkansas Water Resources Center, and Professor, Biological and Agricultural Engineering, University of Arkansas System Division of Agriculture

Funding Sources:

Funding for this research was provided in part by the AWRC through the USGS WRRI 104B Program, the USDA NIFA Hatch Program Project 2660, and the University of Arkansas System Division of Agriculture.

Arkansas Irrigation Yield Contest: A Novel Extension Approach to Promoting Irrigation Conservation Chris Henry, Associate Professor

Collaborators:
Russ Parker, Shruti Vaman, Nathan Blankenship, Jeferson Pimental and Travis Clark County Agent Collaborators Jan Yingling, 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, Brent Griffen and Ray Benson. All other county agents not listed who have done irrigation programming.

Summary Statement 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.

What Was Done A program was initialed in 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 using a computer-based tracking system. Yield was measured on 3 acres for a minimum sized 30 acre field. Participant made their own irrigation decisions. County Agents served as advisors for irrigation management and judges for the yield measurement. Some contestants used the tools they learned about in Irrigation Schools to improve their irrigation management. Contests were established for three commodities, corn, soybeans, and rice. Financial support was provided by commodity boards and industry. All corn and soybean fields were furrow irrigated. Research was conducted between 2012 and 2021 to develop a new production system for furrow irrigated rice that improved irrigation efficiency. The system was patented in 2019 and on-farm tests have been installed and conducted on 5 Arkansas farms. One farm received the system in 2021 and used it in the irrigation contest.
Results There were 20 soybean, 10 corn, 10 rice entries from south to northeast Arkansas. The most notable result was the rice winner who achieved 240 bpa on 13 inches of rice resulting in the highest ever recorded WUE for rice of 9.77 bushels per inch. This entry used the novel tailwater recovery system. In the soybean category, 7 contestants achieved over 4 bushels per inch, in 2019 there were 3, and in 2018 there were none. Participants are improving their WUE as a result of the contest program. In corn and soybeans especially there is a clear and defined trend of increasing WUE over time. In rice it is mixed, but few are using IWM practices in furrow irrigated rice. Participants are increasing their adoption of IWM practices, in 2018 only 50% of the participants used soil moisture sensors, in 2021 87% used them. Computerized hole selection adoption has increased from 43% to 97%. This winner used only 23% of the anticipated irrigation needs for soybeans. WUE increased, in previous years only one person had achieved 4 bu/in, in 2020 seven contestants achieved this high WUE.
Impact This program is providing key data on water use, yields, and water use efficiency. The participants are demonstrating extremely high yields, low water use and high water use efficacies. Most importantly the contest demonstrates the full effect and results that can be achieved when irrigators apply highly managed crop production and irrigation management practices. The program is demonstrating how a comprehensive approach to IWM can achieve sustainability. In summary the yields, water use efficiency and extremely low irrigation depths participants were able to achieve are nothing but short of amazing. The program has also demonstrated how research developments can be transferred to clientele to achieve the desired outcome and create awareness. Irrigation application rates were nearly half or more than half of the long term average water demand assumed and reported. This program demonstrates that through management and the use of off the shelf irrigation and new technology, large gains are possible to attaining a sustainable yield from the aquifer.

Contacts: Chris Henry, University of Arkansas (cghenry@uark.edu) 870-673-2661 Funding Sources: Arkansas Soybean Promotion Board, Arkansas Corn and Grain Sorghum Promotion Board, Ricetec, Irrometer, Delta Plastics, Trellis, McCrometer, USDA NRCS, Seametrics, Trellis, and Agse

Portable Biosensors for In-field Detection of Pathogenic Bacteria in Food

Yanbin Li, Distinguished Professor

Issue Contaminated food, mainly by pathogenic microorganisms, is estimated to cause 76 million illnesses, 325,000 serious illnesses resulting in hospitalization, and 5,000 deaths in the US each year. USDA/ERS estimates the medical costs and productivity losses associated with E. coli O157, Salmonella, Listeria monocytogenes and Campylobacter alone amount to at least $6.9 billion annually. Current methods for the detection of foodborne pathogens rely upon culture plating, PCR and ELISA. However, these methods are time consuming, expensive, and require trained operators with laboratory facilities. Therefore, rapid methods are needed to detect foodborne pathogens in-field or on-site in agricultural and food supply systems.

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 bioseparator for separation of target bacteria from a poultry sample, a 3D-printed detection chamber for holding and mixing a sample, and a fluorescent detector for measuring the signal generated by the presence of target bacteria. Magnetic nanobeads are immobilized with specific antibodies or aptamers to capture target bacterial cells and then separate the cells from a food sample. Quantum dots are coated with specific antibodies or aptamers to attach to the bacterial cells captured on the magnetic nanobeads. After the nanobead-cell-quantum dot complexes are isolated, the intensity of fluorescence emitted by the excited quantum dots is proportional to the concentration of target bacteria. The portable, automatic biosensor system has been designed, fabricated, and evaluated for screening of Salmonella in samples from poultry on farm, processed chicken carcasses in plants and poultry products in market. The biosensor can provide the necessary specificity (strain level), sensitivity (10-100 cfu/ml or cfu/g) and time (less than 1 h). The testing data can then be directly transmitted to the network or a cloud platform through a smart phone without delay. The biosensor can be modified to detect different foodborne pathogens in different food products.

Impact The poultry industry and federal regulatory agencies could adopt this novel biosensing method in food inspection and quality control to ensure food safety. Society could benefit from this technology in terms of reducing foodborne diseases and related medical costs. Applications of the portable biosensors would also enable the poultry industry to benefit economically in terms of prevention of product recalls due to microbial contamination of poultry products.

Contact Yanbin Li, Distinguished Professor, Department of Biological & Agricultural Engineering, Center of Excellence for Poultry Science, yanbinli@uark.edu / 479-575-2881 Cooperators Steve Tung (Mechanical Engineering Dept.), Zhong Chen (Electrical Engineering Dept.), John Marcy (Poultry Science Dept.), Jingyi Chen (Chemistry and Biochemistry Dept.)

Funding Walmart Foundation, ABI, USDA-NIFA

Development of Intelligent Monitoring and Autonomous Solutions for Food Manufacturing Challenges

Dongyi Wang, Assistant Professor

Current Project: Illumination robust computer vision algorithm developments for ag/food product monitoring.

Problems:

In the recent decade, significant advances of deep learning and artificial intelligence have pushed the agricultural and food research onto a new track. The global market value of precision agriculture area is expected to increase from $6 billion in 2020 to $23 billion in 2030. Specifically, imaging-based solutions have attracted great attention in precision agriculture and food manufacturing applications. However, current computer vision algorithms rely on reliable environmental illumination or illumination system. Various illumination conditions will not only affect human perception but also the performance of artificial intelligence algorithms and machine vision systems. Therefore, there's a need to evaluate how the illumination variations affect computer vision algorithms and develop illumination robust algorithms for ag/food product monitoring.

Methods:

We will use consumer acceptability prediction from food appearances as an example to investigate how illumination will affect the image understanding models and develop a new illumination-robust model to predict consumer acceptability reliably. Firstly, taking fresh lettuce as an example, a dataset will be built to describe the relationship between food appearance and consumer acceptances under different illumination conditions (light intensity/light temperature). Secondly, under given illumination condition (e.g., 5000 Kelvin, 1050 Lumens), a specific deep learning-based regression model will be built to predict consumer preferences from input lettuce images. Finally, an illumination-robust customer preference prediction model will be trained and validated. The model simultaneously predicts illumination parameters and customer preferences. Even the lettuce images are captured under different illumination conditions, the well-trained model is expected to predict human preferences as the food samples are placed under a fixed lighting condition.

Impacts:

The research will broadly benefit precision agriculture and smart food engineering applications, which can make computer vision and artificial intelligence algorithms more widely used in real-world conditions. Meanwhile, it will help consumers to understand how illumination conditions will affect their perceptions on food products which can minimize potential impulsive purchasing of consumers.

Collaborators:

Han-Seok Seo (FDSC), Shengfan Zhang (INEG)

Funding:

NSF RII Track 1: Data Analytics that are Robust and Trusted (DART) seed grant

Utilization of Ozone Gas to Decontaminate Corn and Suppress Insects

Sammy Sadaka, Associate Professor

Issue:

Unsuitable management of freshly harvested and stored corn, particularly in warmer climates, can lead to significant fungal contamination that profoundly reduces corn quality. It is responsible for US producers' income losses annually. Toxigenic fungi infect crops both in the field and in storage. Preventing fungi contamination is technically extremely challenging, giving rise to decontamination strategies. Various chemical, physical, and biological treatments have been tested for their ability to reduce or eliminate the fungal level in contaminated grains and foods. However, several of these methods are costly and environmentally unfriendly. More recently, exposure to ozone has been tried to decontaminate corn successfully. Ozone gas is considered a Generally Recognized Safe Substance (GRSS) by the US Food and Drug Administration. It can be used to eliminate bacteria, viruses, and odors.

Action:

A lab-scale corn drying, aflatoxin decontamination, and insect suppression system was designed, developed, and tested. The system consisted of a drying column that held freshly harvested corn, ozone generators, and electric heaters. The effects of corn moisture content, ozone concentration, and application duration on corn decontamination and insect suppression are ongoing experiments.

Impact:

Corn decontamination and insect suppression positively and significantly affect corn quality. It enhances the corn's value and marketability. In addition, ozone gas as a safe substance will be an eco-friendly substance to treat contaminated corn and suppress insects.

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

Collaborating Scientists:
Griffiths Atungulu, and Neelendra Joshi

Funding Sources: Arkansas Corn and Grain Sorghum Board.

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

Scott Osborn, Associate Professor

In its 2018 rankings of Top States for Business, CNBC (https://www.cnbc.com/2018/07/10/americas-top-states-for-business-2018.html) ranked Arkansas 40th overall and 47th in technology and innovation. This ranking is based on each state's support for innovation and number of patents issued to their residents. Arkansas's greatest economic strength is agriculture, which includes food production. It would seem reasonable that a place to focus efforts to improve Arkansas' performance in technology and innovation to improve its business ecosystem would be to amplify an existing strength by combining innovation with food processing. One of the fastest growing and highest value business sectors across the US is in craft beer production. The volume of beer produced from microbreweries has grown at a rate of 28% per year between 2010 and 2016 (brewersassociation.org). Currently, there are 35 craft breweries in Arkansas, which ranks 41st per capita indicating room for growth. The economic impact of this industry in Arkansas is $406 million per year (https://www.brewersassociation.org/statistics/by-state/). For comparison, this value was similar to or exceeded that of each of the following Arkansas crops: pork ($100 million), corn and grain sorghum ($296 million), aquaculture ($61 million), dairy ($22 million), tomatoes ($10 million), vegetables ($450 million), and fruit ($180 million) (https://www.arfb.com/pages/arkansas-agriculture/).

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. Another advantage of the invention is that it may allow replacement of a costly meter currently used to measure carbonation in beer and improve beer flavor. 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 commercial, food-grade unit was constructed and tested in a local craft brewery and cidery to compare the new technology to what they are currently using. Core Brewing, Springdale, AR and Black Apple Crossing, Springdale, AR have both agreed to purchase units for their carbonation process. The design for their equipment was completed by Osborn, Lydia Huck (MS student) and Kira Simonson (undergraduate Honors Student). Funding has been acquired from the Walton Family Foundation's support of economic development of UA research results via the Chancellor's Fund to improve the design for commercial sales and to conduct research to determine if the carbonation method of the invention improves beer flavor compared with conventional methods. The brewery and cidery will provide feedback on how to improve the unit for commercial use including how to fit it into the existing control scheme.

Impact:
Commercial scale testing using a prototype has shown that beer can be carbonated with no wasted carbon dioxide gas. The invention also has the ability to precisely control dissolved CO2. Test of the commercial unit were able to carbonate a 120 barrel batch of spiked seltzer water in 5 hours compared to the 72 hours required using the previous method. More than 50% gas savings were realized. By reducing wasted CO2, 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.

Accomplishments for 2021:
Commercial, food-grade unit was designed and constructed.
Commercial unit was operated in production line in Core Brewing on Scarlett Letter and beer. Products passed tests for safety and quality and sold to the public.
Eight batches of beverage were carbonated. Results showed carbonation time was cut from 72 hours to 5 hours for 120 barrel batch and 12 hours to 1.5 hours for 40 barrel beer batch. CO2 losses were reduced from greater than 50% to near zero.
Lydia Huck, MS Biological Engineering student, is researching methods and models to improve operational efficiency and reduce operating cost of the commercial unit in cooperation with Core Brewing.
Kira Simonson, undergraduate Honors Biological Engineering student, completed her honors thesis modeling traditional bubble force carbonation for economic comparisons to the commercial unit. Her studies indicated an 18 month payback for the equipment and that any potential flavor improvements that could support a $0.50 price increase per can to the product could reduce the payback period to a few weeks.

Contact: Scott Osborn, Ph.D., PE, Dept. Biological and Agricultural Engineering, 203 White Engineering Hall, University of Arkansas, Fayetteville, AR.72701. 479-575-2877, gsosborn@uark.edu.

Funding: Core Brewing Company, Springdale, AR, Black Apple Crossing, Springdale, AR, Chancellors Commercialization Fund Walton Family Charitable Support Foundation.

Publications:
Osborn, G.S. 2018. System and Method for Controlling the Concentration of Single and Multiple Dissolved Gases in Beverages. US Patent Application 20180362906. Pending (received 2 office actions with some claims allowed and other in process).

Environmental sustainability assessment of rice management practices using decision support tools

Benjamin Runkle, Associate Professor

Issue:

Rice has a large water demand and its cultivation is responsible for 8 % of global anthropogenic methane (CH_4) emissions. In this context, on-farm practices to increase water use efficiency and decrease greenhouse gas (GHG) emissions are increasingly being considered by rice producers. In the Mid-South, rice farmers have recently implemented new water-saving practices, such as furrow irrigation (FIR), alternate wetting and drying (AWD), multiple inlet rice irrigation (MIRI) and zero grading fields. To evaluate these new water-saving practices and other management practices, it is necessary to take a holistic approach that accounts for different environmental metrics, since some of the practices might decrease the environmental impact on one metric but produce an increase in another metric.

While Life Cycle Assessment is complex and inaccessible for farmers, several farm-level decision support tools (DSTs) have been recently developed to guide the farmers on the implementation of new practices offering farm assessment from a holistic perspective. There has been little work on the use of the application of these tools to rice production to evaluate water-saving practices and there are no works specifically in Arkansas. The application of these tools to evaluate these water-saving practices is needed since they can help farmers make tailored, best-practice decision-making that accounts for each farm's unique conditions.

Action:

Runkle is researching the use of DSTs to assess rice farm practices including irrigation practices. The work consists on monitoring fields across 10 farms in central-eastern AR and the input of the management practices in DSTs. His recently published paper[1], led by postdoctoral scientist Beatriz Moreno-García, shows that FIR and AWD are the best irrigation practices to decrease CH_4 emissions. Other practices such as burning the post-harvest residue or other straw removal practices when practicing a rice-rice rotation, or making decisions about crop planting based on differences in soil type inside the farm, should also be encouraged to decrease CH_4 emissions. This work also shows that energy cost of agrochemical production represents the majority (74%) of total farm energy use, therefore even 10-20 % reductions in application rates can significantly reduce the energy use.

Runkle's group is doing additional research in a pair of adjacent, production-sized rice fields under conventional irrigation practice and AWD irrigation since 2015, where eddy covariance towers are installed. His group's paper[2], led by graduate student Colby Reavis, shows there were no significant differences in cumulative evapotranspiration (ET) or yield when comparing AWD to the conventional irrigation practice. Furthermore, AWD elicited no change in ET during periods of drying when compared to the conventional practice. By this metric, AWD did not induce drought stress within the plants. This research shows that not only AWD can decrease CH_4 emissions, it also maintains yield and avoids stress. Follow-up work will investigate impacts on "ecosystem water use efficiency" and test how space-borne datasets can assist farmers in estimating irrigation needs.

Collaborators:

Michele Reba, Hydrologist, USDA-ARS, Delta Water Man. Res., Jonesboro, AR
Eric Coronel, Field to Market: The Alliance for Sustainable Agriculture, Washington, DC.
Kosana Suvočarev, University of California, Davis, Dept. of Land Air and Water Resources

Funding:

These studies were funded by Unilever and the Knorr Sustainability Partnership Fund (Project: Water sustainability in Arkansas rice fields), the USDA-NRCS (Cooperative Agreement 68-7103-17-119), the USGS under Cooperative Agreements G11AP20066 and G16AP00040 as administered by the Arkansas Water Resources Center at the University of Arkansas, and the NSF under CBET CAREER Award 1752083.

Works cited and produced:

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Reavis, C. W., Suvočarev, K., Reba, M. L., and Runkle, B. R., 2021, Impacts of Alternate Wetting and Drying and Delayed Flood Rice Irrigation on Growing Season Evapotranspiration: Journal of Hydrology, p. 126080.

Poultry production wastes treatment for Arkansas producers

Jun Zhu, Professor

ISSUES:

A large volume of poultry litter is generated in Arkansas annually (about 1.5 million metric tons), and the stickiest problem associated with it is that most of the litter is concentrated in the northwest region of the State, which makes it extremely difficult to dispose of the wastes onsite due to the excessive volumes. Poultry litter consists of the bedding material used during the poultry production cycle and the birds' excreta. Multiple materials are normally used to make the beddings including straw, sawdust, wood shavings, shredded paper, and peanut or rice hulls. Upon completing the production cycle, the litter containing both manure and beddings is removed from the poultry house for disposal. Since poultry litter contains rich essential plant nutrients such as nitrogen (N), phosphorous (P), and potassium (K), land application as fertilizer is a traditional practice for many years. However, in the last two decades, due to the growth of the poultry industry leading to an increased production of litter, application of litter at the agronomic rate for N has been proved to always lead to excessive amounts of plant extractable P in the soil due to the high concentration of P relative to N in the litter. Especially in the two counties (Benton and Washington) in northwest Arkansas where over half of all broilers in the State are raised, the excess of poultry litter generated exceeds the land capacity to absorb it. Apparently, continuing land application of poultry litter is not an option and is posing a dire threat of pollution to the natural water resources in the region. To cope with the litter surplus issue, new technologies must be developed to treat litter on farm at affordable costs. Therefore, our paramount task is to conduct cutting-edge research to develop new, or significantly improve the current, animal waste treatment technologies with the goal to support the growth of our poultry industry in Arkansas while minimizing or eliminating the negative environmental impact on the natural ecosystems.

To date, there are few effective technologies available for poultry farmers to use to handle litter. Several techniques were investigated in the past in treating poultry litter including composting, direct combustion, pelletization, and anaerobic digestion. These technologies all have pros and cons given the dry nature of poultry litter. The problems with combustion, pelletization, and composting include air pollution, cost inefficiency, and high operating and maintenance requirements such as large land surface areas and special equipment. Therefore, in our study, we focus on anaerobic digestion. Admittedly, anaerobic digestion is a technology for treating liquid waste streams. Technical bottlenecks exist in applying this technology for a largely dry waste material, which makes research to overcome the technical barriers more intriguing and challenging. However, considering the benefits associated with anaerobic digestion such as producing a more stable product, removal of nuisance odors, maintaining the fertilizer value of the manure, and the production of a renewable fuel, i.e., methane, it is worth the effort to pursue scientific and technical breakthroughs in using this technology for poultry litter treatment. Another great benefit of anaerobic digestion is the reduction in pathogens in the digested effluent. Salmonellae, fecal coliforms, oocysts (*Eimeria tenella*), and fungal spores are all either significantly destroyed or inactivated in the anaerobic process. To garner all the benefits for applying the digestion technology to poultry litter treatment, innovative research has been vigorously conducted with funding from the Division and a project funded by USDA/NIFA/ AFRI Foundational and Applied Science Program to develop an anaerobic digestion system for treating poultry litter with value recovery that can be eventually developed into a cost-effective technique for individual poultry farms to solve the poultry litter issue.

ACTION:

With the continued support from AAES and the funding from the USDA/NIFA/AFRI, anaerobic digestion experiments are underway after two graduate students came on board in the last year (one MS starting fall 2019 and one PhD starting spring 2020). Experimental apparatuses have been established with experiments started. Research in the partner institutions (U of ID and Virginia Tech) are also in full swing, although all work in the three participating universities is delayed to some extent by the covid-19 pandemic. After making adjustments to the timelines, we are confident that by the end of this project, a sustainable treatment system consisting of an anaerobic digester, an electrolytic reactor with a magnesium plate, and a forward osmosis membrane reactor for poultry litter will be developed, tested, and demonstrated. It is expected that the outcomes of this research project will provide valuable technical information for scaling up the treatment system for commercial applications.

IMPACT:

The success of this project will have a long-term impact on poultry litter handling and treatment in not only Arkansas, but other major poultry states in the US. The industry has long been plagued by the lack of a cost-effective technology to treat poultry litter and recycle nutrients. Therefore, the ongoing and planned research is timely and will eventually lead to a technical solution to the poultry litter issue facing the producers in the nation. In the meantime, the findings of this project will be converted to publications that can be accessed by poultry producers and other professionals worldwide to advance the science and engineering in poultry waste management and protect the environment at a global scale.

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2. Cai, Y., Z. †Han, X. Lin, Y. Duan, J. Du, Z. Ye, **J. Zhu**. 2020. Study on removal of phosphorus as struvite from synthetic wastewater using a pilot-scale electrodialysis system with magnesium anode. Science of The Total Environment 726:138221. DOI: https://doi.org/10.1016/j.scitotenv.2020.138221.

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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; USDA/NIFA/AFRI Foundational and Applied Science Program

Instrumentation Lab Implemented in Hybrid Mode

Thomas Costello, Associate Professor

Issue

In Spring, 2021, the campus was operating mostly with remote class meetings. The instrumentation course: BENG 3113/3113H (Measurements and Controls for Biological Engineering) has an important hands-on lab component that is key to attaining the learning objectives. Under normal conditions, students work in groups of 4 on hands-on lab activities. We have an equipped lab space (Room 104, White Hall) with 12 stations (maximum enrollment 48 students). Two sections of the lab were normally offered so that only 6 teams (24 students) would be meeting at one time. The lab space is relatively small and cannot accommodate 48 students at one time due to crowding. Under conditions of the pandemic, the existing lab layout would not allow the required social distancing. Cancelling the lab portion of the course would have severely impacted the students.

Action

To achieve a 6 ft spacing between students, a drastic re-design of the lab facility was required. A second lab space was assigned to the course at the Biological and Agricultural Engineering Lab Building, located off campus at the Milo J. Shult Agricultural Research and Extension Center. The second lab space was furnished and equipped to handle 6 of the 12 lab stations for BENG 3113. The furniture and equipment were placed so that two students could work at each station, maintaining 6-ft spacing, but only if a maximum of 3 teams were present at one time. The number of sections was doubled so that 3 teams (2 students each) were present in either lab space, at any time.

At each lab period, three teams of 4 students would participate. But only two students on each team could attend in-person. The other two members of the team were able to join their team remotely, in real-time. Tablets on tripods were used so each team could login to MS-Teams software, and share audio and video with the remote students. It took a concentrated effort to maintain continuous dialog and engagement between the hands-on, in-person students and those joining remotely. In this way, only 6 students were present in the lab space at any time, rather than the normal occupancy of 24 students. The spacing allowed all of the hands-on lab activities to be implemented as per the original plan.

Further changes were made by putting together kits so that the first two lab exercises could be done individually at home. Video demonstrations were developed to help students perform the activities on their own. We populated 48 kits with multi-meters, hand tools, breadboards, connectors, wire, switches, batteries, power supplies, fans, LEDs, relays and resistors. These two exercises involved wiring and testing of circuits--resistor networks or powered devices--with power supplies and various switch gear. Measurements of voltage, current and power were made using the multi-meter. Every student was able to complete these two foundational labs on their own at home.

Impact

Students were able to complete all of the 14 lab activities and gain the experiences and learning opportunities that are normally implemented. The fact that each student was only able to attend in-person for half of the time, although the remote connections were made, made it difficult for students to become as comfortable with the equipment, techniques and concepts as we normally expected. Some lab activities were extended beyond the normal allotted time period due to the need to individually coach students on the material from previous labs that they missed, as needed to continue to build their capabilities. Final student projects progressed and were completed successfully. Students were allowed to access the lab outside their regular lab time so they could work on their individual contributions. It was at the end of the project that many students commented that their frustration was relieved and they felt that the concepts were finally mastered.

The students, faculty and teaching assistants worked diligently under the circumstances to maximize learning. Students were witnesses to the potential achievements made when a group of people truly commit to a shared goal. This is something that they will take with them into their careers.

Contact

Dr. Thomas A. Costello, P.E.
Associate Professor
Department of Biological and Agricultural Engineering
UA Division of Agriculture

Congratulations to the Class of 2021!

Undergraduate:

Spring 2021

Alexander M. Anderson
Courtney Jane Austin
Kaden Scott Belcher
Isaac Nolan Bertels
Hunter Ross Brown
Evan Ryan Byrd
Jordan Matthew Cocanower
Maxwell C. Criswell
Haley Shannon Ellis
Mike Gasasu
Christian Oliver Hitt
Lukes James Huffman
Spencer Lawrence Johnson
Ian James Klein
Rachael Rose Koehler
Jake Conrad Krier
Olivia S. Liedel
Marret Christian Lineberry
Charis Joy Lykins
Zane Thomas Mallicote
Angel Damiro Meneses
Brent Byron Miller
Daisy Aranda Mota
Joshua David Pierce
Alexie K. Pope
Clay Michael Schuler
Lara Morgan Tarr
Gil Edward Thomas
Kristen Khanh Ngoc Trinh
Chandler Nicole Trotter
Charles Austin Don Weeks
Rebecca Hannah Widdowson
Caroline Grace Wilson
Anthony Robert Zadoorian

Undergraduate:

Summer 2021

Jesse E. Morrison

Fall 2021

Jason Deoin Angel
Karina Arellano
Juan Alberto Arguijo
Sydney Rosslyn Bowman
Tatiana Cristal Castillo Hernandez
Kelsea Drew Crabb
Jacob Christopher Fisher
Ryan Alexander Sklar

Graduate:

Spring 2021

Deanna L. Mantooth M. S.
Helena Tchoungang Nkeumen M. S.

Summer 2021

Abbie LaNell Lasater Ph.D.
Kaushik Luthra Ph.D.
Xinge Xi Ph.D.

Fall 2021

Colby Wade Reavis Ph.D.
Yiting Xiao M.

Research Grants

The following active grants during 2021 fund research in specific areas.

Subcontract Scope of Services– SWAT Modeling
Dr. Brian Haggard
Poteau River Watershed, GBMc Associates
$41,000

Development of metrics for the Beaver Watershed Alliance
Dr. Brian Haggard
BWA
$28,000

Water sampling, analysis, and load estimation at the Brush and Roberts Creek
Dr. Brian Haggard
NRCS
$170,001

Arkansas Nutrient Reduction Strategy
Dr. Brian Haggard
Continued work ANRC-EPA
$100,000

Pump Station Dam Project
Dr. Brian Haggard
City of Fayetteville, Arkansas
$37,631

ROUTINE WATER QUALITY MONITORING IN BEAVER LAKE WATERSHED, ARKANSAS
Dr. Brian Haggard
Beaver Water District
2020
$32,494

Improving Irrigation Scheduling and Irrigation Efficiency for Corn Production in Arkansas
Dr. Chris Henry
Arkansas Corn and Grain Sorghum Promotion Board
2020
$174,500

Arkansas Irrigation Yield Contest
Dr. Chris Henry
Arkansas Corn and Grain Sorghum Promotion Board
2020
$10,000

Developing and Improving Irrigation Tools for Rice
Dr. Chris Henry
Arkansas Rice Research and Promotion Board
2020
$90,000

Promoting Irrigation Water Management for Soybeans
Dr. Chris Henry
Arkansas Soybean Promotion Board
2021
$148.500

Arkansas Irrigation Yield Contest
Dr. Chris Henry
Arkansas Soybean Promotion Board
2021
$10,000

Maximizing Spatial Resolution of DNA Sequencing Using Single Carbon Chain
Dr. Jin-Woo Kim
NIH
2020
$99,000

A Microscale Power Generator Driven by Tethered Bacterial Flagellar Motors
Dr. Jin-Woo Kim
NSF
2020
$52,000

Acquisition of PA 800 Plus Capillary Electrophoresis System for Expanding Biomedical Research
Dr. Jin-Woo Kim
Arkansas Biosciences Institute
2020
156,107

RII Track-1: Arkansas ASSET Initiative III (Cellulosic)
Dr. Jin-Woo Kim
NSF/Arkansas Economic Development Commission
2020
$403,408

Nanocellulose based Hydrogel Nano-delivery Systems for Controlled Release of Anti-cancer Drugs
Dr. Jin-Woo Kim
Arkansas Biosciences Institute
$49,737

Nanocellulose based Formulation for Reducing Herbicide Drift
Dr. Jin-Woo Kim
UA Chancellors Fund: Commercialization Fund
$49,964

Nanocellulose Based Adjuvant for Reducing Herbicide Drift
Dr. Jin–Woo Kim
NSF SBIR-CelluDot Inc,
$79,360

Techno-eco-environmental Optimization of Pea-Protein Processing and Starch
Dr. Miezah Kwofie
McGill University/National Research Council of Canada
$30,000

Poultry Excellence in China-Improving Food Safety in Poultry Supply Chain
Dr. Yanbin Li
Walmart Foundation
2020
$233,333

Poultry Excellence in China-Improving Food Safety in Pork Supply Chain
Dr. Yanbin Li
Walmart Foundation
2020
$145,000

A Portable Biosensor based on Aptamer-capped and Dye-loaded Nanocages to Generate Mass and Fluorescence Dual Signals for Rapid Detection of Viruses
Dr. Yanbin Li
ABI
2020-2021
$25,000

A Portable Biosensor based on Aptamer-capped and Dye-loaded Nanocages to Generate Mass and Fluorescence Dual Signals for Rapid Detection of Viruses
Dr. Yanbin Li
ABI
2021-2022
$25,000

Acquisition of PA 800 Plus Capillary Electrophoresis System for Expanding Biomedical Research
Dr. Yanbin Li
ABI
2020
$156,107

Fully Printed Electronics and Energy Devices via Low-Dimensional
Dr. Yanbin Li
USDA-NIF A
2020
$119,217

Empowering US Poultry Farmer Sustainability through Innovative Genetic Selection, Environmentally Responsible Production and Animal Wellbeing
Dr. Yi Liang
USDA-NIFA
$3,000

Optimizing Carbon Footprint and Economic Implications of Modifying Poultry Ventilation Systems using Solar Energy
Dr. Yi Liang
USDA-ERS
$5,000

Artificial Intelligence System for Poultry Behavior Monitoring
Dr. Yi Liang
University of Arkansas Chancellor Innovation Fund
$16,853

Commercializing a Beer Carbonator for the Craft Brewing Market
Dr. Scott Osborn
UA Chancellors Commercialization Fund
2020
$49,796

Enhancing Teaching and Learning in Ecological Engineering
Dr. Scott Osborn
USDA NIFA Capacity Building
2020
$50,000

Research Grants

Commercializing the Carbo Rock-It: A beverage carbonator for the craft brewing market
Dr. Scott Osborn
UA Chancellors fund Commercialization Grant
$49,830

Utilization of Ozone gas to suppress rough rice insects and increase head rice yield
Dr. Sammy Sadaka
Arkansas Rice Board
2021
$46,000

A national quantification of methane emissions from Rice cultivation in the U.S.; integrating multi -source satellite data and process-based modeling
Dr. Benjamin Runkle
NASA– Washington, Federal
$1,069,563

REU SITE: Assessment and sustainable management of ecosystem at the nexus of food, energy, and water systems
Dr. Benjamin Runkle
NSF, Federal
$403,166

A network of evapotranspiration observation sites to constrain ET estimation methods and water availability models in the Mississippi Alluvial Plain
Dr. Benjamin Runkle
U.S Geological Survey, Federal
$379,000

Quantify Changes in Water Quality and Greenhouse Gas Emissions Due to Innovative Rice Production Practices
Dr. Benjamin Runkle
U.S. Department of Agriculture, Federal
$147,510.44

CAREER: Developing climate-smart irrigation strategies for rice Agriculture in Arkansas
Dr. Benjamin Runkle
National Science Foundation, Federal
$500,199

Conservation Water Management Practice for Reducing Greenhouse Gas Emissions and Sustaining Productivity in Irrigated Rice Systems
Dr. Benjamin Runkle
USDA-ARS, Federal
$141,062

Energy partitioning, evapotranpiration, and CO2 exchange of the forage component of a silvopasture system
Dr. Benjamin Runkle
U.S. Department of Agriculture, Federal
$44,154

Comparing three water-saving irrigation strategies in production-scale rice fields
Dr. Benjamin Runkle
U.S. Department of Agriculture
$331,415

Ground Observations of CO2 flux dynamics to support the ACT– America Project
Dr. Benjamin Runkle
NASA-Washington
$87,633

Development of On-line Instructional Program for Nutrient Management Training Required by ANRC Titles XX, XXI and XXII
Dr. Karl VanDevender
ANRC
2020
$184,198

On-line Comprehensive Nutrient Management Plan) CNMP) Training: Educational Materials and Planning and Record Keeping
Dr. Karl VanDevender
AR NRCS
$242,303

In-Vessel Mortality Composter Management Guidelines Refinement and Educational Materials Development Project
Dr. Karl VanDevender
AR NRCS
2019
$33,865

LP: Toward fair and reliable consumer acceptability prediction from food appearances
Dr. Dongyi Wang
NSF
$99,921

Development of a sustainable treatment system for poultry litter with maximum value recovery
Dr. Jun Zhu
USDA/NIFA/AFRI Foundational Program
$70,330

PUBLICATIONS

BOOKS, BOOK CHAPTERS

Book Chapter

Elis, E., **Kwofie, E. M.**, Ngadi, M. (2021). A consumer-food security nexus framework analysis for resilient agri-food value chains.

PEER-REVIEWED JOURNAL ARTICLES

Scott, E. E. *, **Haggard, B. E.** (2021). Natural characteristics and human activity influence turbidity and ion concentrations in streams. Journal of Contemporary Water Research and Education, 172, 43-49. 10.1111/j.1936-704X.2021.3353.x

Wagner, N. D., Quach, E., Buscho, S., Ricciardelli, A., Kannan, A., Naung, S. W., Phillip, G., Sheppard, B., Ferguson, L., Allen, A., Sharon, C., Duke, J. R., Taylor, R. B., Austin, B. J. #, Stovall, J. K., **Haggard, B. E.,** Chambliss, C. K., Brooks, B. W., Scott, J. T. (2021). Nitrogen form, concentration, and micronutrient availability affect microcystin production in cyanobacterial blooms. Harmful Algae, 103 (102002). https://doi.org/10.1016/j.hal.2021.102002 https://doi.org/10.1016/j.hal.2021.102002

Della Lunga, D., K. R. Brye, J. M. Slayden, **C. G. Henry**, & L. S. Wood. 2021.

Relationships among soil, plant, and environmental variables and greenhouse gas emissions from furrow-irrigated rice on a silt-loam soil. Geoderma Regional, 24, e00365.

Della Lunga, D., K. R. Brye, **C. G. Henry**, & J. M. Slayden. 2021. Plant productivity and nutrient uptake as affected by tillage and site-position in furrow-irrigated rice. Agronomy Journal, 113, 2374-2386

Shew, A. M. L. L. Nalley, A. Durand-Morat, K. Meredith, R. Parajuli, G. Thoma, **C.G. Henry**. 2021. Holistically valuing public investments in agricultural water conservation. Agricultural Water Management. Vol 252, 30 June 2021 106900. https://doi.org/10.1016/j.agwat.2021.106900

Koh, H., Lee, J. G., Lee, J. Y., Kim, R., Tabata, O., **Kim, J.-W**., Kim, D.-N. (2021). Design approaches and computational tools for DNA nanostructures. IEEE Open Journal of Nanotechnology, 2, 86-100. 10.1109/OJNANO.2021.3119913

Patel, D.K., Dutta, S.D., Ganguly, K., **Kim, J.-W.**, Lim, K.-T. (2021). Enhanced osteogenic potential of unzipped carbon nanotubes for tissue engineering. *Journal of Biomedical Materials Research Part A, 109*, 1869-1880. 10.1002/jbm.a.37179

Sakamaki, Y., Ozdemir, J., Hendrick, Z., Azzun, A., Watson, O., Tsuji, M., Sinha, A., Batta-Mpouma, J., McConnell, Z., Fugitt, D., Du, Y., **Kim, J.-W**., Beyzavi, M. H. (2021). A bioconjugated chlorin-based metal-organic framework for targeted photodynamic therapy of triple negative breast and pancreatic cancers. *ACS Applied Bio Materials, 4*, 1432-1440. 10.1021/acsabm.0c01324

Okonkwo, V. C., Mba, O., **Kwofie, E. M.**, Ngadi, M. (2021). Rheological Properties of Meat Sauces as Influenced by Temperature. *Food and Bioprocess Technology, 14*, 2146–2160. https://doi.org/10.1007/s11947-021-02709-9 Rheological Properties of meat Sauces as influenced by temperature-1.pdf

Agyemang, P., **Kwofie, E. M**. (2021). Response-to-Failure Analysis of Global Food System Initiatives: A Resilience Perspective. *Frontiers in Sustainable Food Systems, 5*, 1-19. https://www.frontiersin.org/articles/10.3389/fsufs.2021.676997/full https://doi.org/10.3389/fsufs.2021.676997

Peer-Reviewed Journal Articles

Okonkwo, V. C., **Kwofie, E. M.,** Mba, O. I., Ngadi, M. O. (2021). Impact of thermo -sonication on quality indices of starch-based sauces. *Ultrasonics Sonochemistry, 73*, 105473.
Impact of thermo-sonication on quality indices of starch-based sauces-1.pdf

Qi, W.Z., Wang, L., Na, R., Huo, X.T., **Li, Y.**, Liao, M., Lin, J. (2021). A lab-on-a-tube biosensor for automatic detection of foodborne bacteria using rotated halbach magnetic separation and raspberry Pi imaging. *Talanta, 239*(3), 123095. doi.org/10.1016/j.talanta.2021.123095

Peng, Y., He, Y., Shen, Y., Liang, A., Zhang, X.B., Liu, Y.J., Lin, J., Wang, J., **Li, Y**., Fu, Y. (2021). Fluorescence nanobiosensor for simultaneous detection of multiple veterinary drugs in chicken samples. *Journal of Analysis and Testing*. https://doi.org/10.1007/s41664-021-00199-4

Xi, X., Niyonshuti, I.I., Yu, N.X., Yao, L., Fu, Y., Yao, P., Chen, J., **Li, Y.** (2021). A label-free QCM biosensor based on target-triggered release of cargo molecules in gold nanocages capped with aptamers for thrombin detection. *ACS Applied Nano Materials, 6*(8). DOI: 10.1021/acsanm.1c01350

Xue, L., Jin, N., Guo, R., Wang, S., **Li, Y.**, Qi, W., Liu, Y., Lin, J. (2021). Microfluidic colorimetric biosensors based on MnO2 nanozymes and convergence-divergence spiral micromixers for rapid and sensitive detection of Salmonella. *ACS Sensors, 6*, 2883-2892. doi.org/10.1021/acssensors.1c00292

Jia, F., Bai, X.J., Zhang, X.W., Fu, Y.C., **Li, Y.**, Li, X.M., Kokini, J. (2021). A low-field magnetic resonance imaging aptasensor for the rapid and visual sensing of Pseudomonas aeruginosa in food, juice and water. *Analytical Chemistry, 93*(24), 8631-8637.

Peer-Reviewed Journal Articles

Wang, W., Wang, R., Liao, M., Kidd, M., **Li, Y.** (2021). Rapid detection of enrofloxacin using a localized surface plasmon resonance sensor based on polydopamine molecular imprinted recognition polymer. *Journal of Food Measurement and Characterization, 15*(4), 3376-3386. DOI:10.1007/s11694-021-00913-x

Shen, Y., Xu, L., **Li, Y.** (2021). Biosensors for rapid detection of Salmonella in food: A review. Comprehensive Reviews in Food Science and Food Safety. *Comprehensive Reviews in Food Science and Food Safety, 20*, 149-197. DOI: 10.1111/1541-4337.12662

Liang, A., Shen, Y., He, Y., Wang, J., **Li, Y.** (2021). An automated magnetic separation device coupled with a fluorescent biosensor for the detection of antibiotics residues. *Transactions of the ASABE, 64*(1), 23-30. doi: 10.13031/trans.14076

Li, Z., Xu, X., Quan, H. R., Zhang, J., Zhang, Q., Fu, Y., Ying, Y., **Li, Y.** (2021). Adsorptive and responsive hybrid sponge of melamine foam and metal organic frameworks for rapid collection/removal and detection of mycotoxins. *Chemical Engineering Journal, 410*, 128268. doi.org/10.1016/j.cej.202

McLamore, E.S., Alcocilja, E., Gomes, C., **Li, Y.** et al. (2021). FEAST of biosensors: Food, environmental and agricultural sensing technologies (FEAST) in North America. *Biosensors and Bioelectronics, 178*, 113011. doi.org/10.1016/j.bios.2021.113011

Xiao, X., Wang, W., Zhang, J., Liao, M., Rainwater, C., Yang, H., **Li, Y.** (2021). A quantitative risk assessment model of Salmonella contamination for the yellow-feathered broiler chicken supply chain in China. *Food Control, 121*(6), 107612. doi.org/10.1016/j.foodcont.2020.107612

Navarro, L., **MAHMOUD, A.,** Ernest, A., Oubeidillah, A., Johnstone, J., Chavez, I. R. S., Fuller, C. (2021). Development of a Cyberinfrastructure for Assessment of the Lower Rio Grande Valley North and Central Watersheds Characteristics. *Sustainability, 13*(20), 11186.

PUBLICATIONS

PEER REVIEWED JOURNAL ARTICLES

Alam, T., Bezares-Cruz, J. C., **MAHMOUD, A.,** Jones, K. D. (2021). Modeling transport, fate, and removal kinetics of nitrate and orthophosphate using recycled adsorbents for high and low-flow stormwater runoff treatment. *Chemosphere, 287* (0045-6535/2021). https://doi.org/10.1016/j.chemosphere.2021.132152

Liang, L., Meyarian, A., Yuan, X., **Runkle, B. R.**, Mihaila, G., Qin, Y., Daniels, J., Reba, M., Rigby, J. (2021). The first fine-resolution mapping of contour-levee irrigation using deep Bi-Stream convolutional neural networks. *International Journal of Applied Earth Observations and Geoinformation*. https://doi.org/10.1016/j.jag.2021.102631

Hemes, K. S., **Runkle, B. R.**, Novick, K. A., Baldocchi, D. D., Field, C. B. (2021). An Ecosystem-Scale Flux Measurement Strategy to Assess Natural Climate Solutions. *ENVIRONMENTAL SCIENCE & TECHNOLOGY, 55*(6), 3494-3504.

Knox, S. H., Bansal, S., McNicol, G., Schafer, K., Sturtevant, C., Ueyama, M., Valach, A. C., Baldocchi, D., Delwiche, K., Desai, A. R., Euskirchen, E., Liu, J., Lohila, A., Malhotra, A., Melling, L., Riley, W., **Runkle, B. R.**, Turner, J., Vargas, R., Zhu, Q., Alto, T., Fluet-Chouinard, E., Goeckede, M., Melton, J. R., Sonnentag, O., Vesala, T., Ward, E., Zhang, Z., Feron, S., Ouyang, Z., Alekseychik, P., Aurela, M., Bohrer, G., Campbell, David, I, Chen, J., Chu, H., Dalmagro, H. J., Goodrich, J. P., Gottschalk, P., Hirano, T., Iwata, H., Jurasinski, G., Kang, M., Koebsch, F., Mammarella, I., Nilsson, M. B., Ono, K., Peichl, M., Peltola, O., Ryu, Y., Sachs, T., Sakabe, A., Sparks, J. P., Tuittila, E.-S., Vourlitis, G. L., Wong, G. X., Windham-Myers, L., Poulter, B., Jackson, R. B. (2021). Identifying dominant environmental predictors of freshwater wetland methane fluxes across diurnal to seasonal time scales. *Global Change Biology, 27*(15), 3582-3604. https://onlinelibrary.wiley.com/doi/10.1111/gcb.15661

Huang, X., **Runkle, B. R.**, Isbell, M., Moreno-Garcia, B., McNairn, H., Reba, M. L., Torbick, N. (2021). Rice Inundation Assessment Using Polarimetric UAVSAR Data. *EARTH AND SPACE SCIENCE, 8*(3). https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020EA001554

Chang, K.-Y., Riley, W. J., Knox, S. H., Jackson, R. B., McNicol, G., Poulter, B., Aurela, M., Baldocchi, D., Bansal, S., Bohrer, G., Campbell, David, I, Cescatti, A., Chu, H., Delwiche, K. B., Desai, A. R., Euskirchen, E., Friborg, T., Goeckede, M., Helbig, M., Hemes, K. S., Hirano, T., Iwata, H., Kang, M., Keenan, T., Krauss, K. W., Lohila, A., Mammarella, I., Mitra, B., Miyata, A., Nilsson, M. B., Noormets, A., Oechel, W. C., Papale, D., Peichl, M., Reba, M. L., Rinne, J., **Runkle, B. R.**, Ryu, Y., Sachs, T., Schaefer, Karina V. R., Schmid, H. P., Shurpali, N., Sonnentag, O., Tang, Angela C., I, Torn, M. S., Trotta, C., Tuittila, E.-S., Ueyama, M., Vargas, R., Vesala, T., Windham-Myers, L., Zhang, Z., Zona, D. (2021). Substantial hysteresis in emergent temperature sensitivity of global wetland CH4 emissions. *Nature Communications, 12*(1). https://www.nature.com/articles/s41467-021-1

Parazoo, N. C., Bowman, K. W., Baier, B. C., Liu, J., Lee, M., Kuai, L., Shiga, Y., Baker, I., Whelan, M., Feng, S., M., Sweeney, C., **Runkle, B. R.**, Tajfar, E., Davis, K. J. (2021). Covariation of Airborne Biogenic Tracers (CO2, COS, and CO) Supports Stronger Than Expected Growing Season Photosynthetic Uptake in the Southeastern US. *Global Biogeochemical Cycles, 35*(10), e2021GB006956. https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GB006956

22452-1

Publications

Peer Reviewed Journal Articles

Irvin, J., Zhou, S., McNicol, G., Lu, F., Liu, V., Fluet-Chouinard, E., Ouyang, Z., Knox, S. H., Lucas-Moffat, A., Trotta, C., Papale, D., Vitale, D., Mammarella, I., Alekseychik, P., Aurela, M., Avati, A., Baldocchi, D., Bansal, S., Bohrer, G., Campbell, D. I., Chen, J., Chu, H., Dalmagro, H. J., Delwiche, K. B., Desai, A. R., Euskirchen, E., Feron, S., Goeckede, M., Heimann, M., Helbig, M., Helfter, C., Hemes, K. S., Hirano, T., Iwata, H., Jurasinski, G., Kalhori, A., Kondrich, A., Lai, D. Y., Lohila, A., Malhotra, A., Merbold, L., Mitra, B., Ng, A., Nilsson, M. B., Noormets, A., Peichl, M., Rey-Sanchez, A. C., Richardson, A. D., **Runkle, B. R.**, Schäfer, K. V., Sonnentag, O., Stuart-Haëntjens, E., Sturtevant, C., Ueyama, M., Valach, A. C., Vargas, R., Vourlitis, G. L., Ward, E. J., Wong, G. X., Zona, D., Alberto, M. C. R., Billesbach, D. P., Celis, G., Dolman, H., Friborg, T., Fuchs, K., Gogo, S., Gondwe, M. J., Goodrich, J. P., Gottschalk, P., Hörtnagl, L., Jacotot, A., Koebsch, F., Kasak, K., Maier, R., Morin, T. H., Nemitz, E., Oechel, W. C., Oikawa, P. Y., Ono, K., Sachs, T., Sakabe, A., Schuur, E. A., Shortt, R., Sullivan, R. C., Szutu, D. J., Tuittila, E.-S., Varlagin, A., Verfaillie, J. G., Wille, C., Windham-Myers, L., Poulter, B., Jackson, R. B. (2021). Gap-filling eddy covariance methane fluxes: Comparison of machine learning model predictions and uncertainties at FLUXNET-CH4 wetlands. *Agricultural and Forest Meteorology, 308-309*, 108528. https://www.sciencedirect.com/science/article/pii/S0168192321002124

Runkle, B. R., Seyfferth, A. L., Reid, M. C., Limmer, M. A., Moreno-García, B., Reavis, C. W., Peña, J., Reba, M. L., Adviento-Borbe, M. A. A., Pinson, S. R. M., Isbell, C. (2021). Socio-Technical Changes for Sustainable Rice Production: Rice Husk Amendment, Conservation Irrigation, and System Changes. *Frontiers in Agronomy, 3*, 81. https://www.frontiersin.org/article/10.3389/fagro.2021.741557

Peer-reviewed Journal Articles

Moreno-Garcia, B., Coronel, E., Reavis, C., Suvocarev, K., **Runkle, B. R.** (2021). Sustainability assessment of conservation rice management practices using decision support tools. *Journal of Cleaner Production, 315*, 128135. https://www.sciencedirect.com/science/article/pii/S0959652621023532

Delwiche, K. B., Knox, S. H., Malhotra, A., Fluet-Chouinard, E., McNicol, G., Feron, S., Ouyang, Z., Papale, D., Trotta, C., Canfora, E., Cheah, Y.-W., Christianson, D., Alberto, M. C. R., Alekseychik, P., Aurela, M., Baldocchi, D., Bansal, S., Billesbach, D. P., Bohrer, G., Bracho, R., Buchmann, N., Campbell, D. I., Celis, G., Chen, J., Chen, W., Chu, H., Dalmagro, H. J., Dengel, S., Desai, A. R., Detto, M., Dolman, H., Eichelmann, E., Euskirchen, E., Famulari, D., Fuchs, K., Goeckede, M., Gogo, S., Gondwe, M. J., Goodrich, J. P., Gottschalk, P., Graham, S. L., Heimann, M., Helbig, M., Helfter, C., Hemes, K. S., Hirano, T., Hollinger, D., Hörtnagl, L., Iwata, H., Jacotot, A., Jurasinski, G., Kang, M., Kasak, K., King, J., Klatt, J., Koebsch, F., Krauss, K. W., Lai, D. Y. F., Lohila, A., Mammarella, I., Belelli Marchesini, L., Manca, G., Matthes, J. H., Maximov, T., Merbold, L., Mitra, B., Morin, T. H., Nemitz, E., Nilsson, M. B., Niu, S., Oechel, W. C., Oikawa, P. Y., Ono, K., Peichl, M., Peltola, O., Reba, M. L., Richardson, A. D., Riley, W., **Runkle, B. R.**, Ryu, Y., Sachs, T., Sakabe, A., Sanchez, C. R., Schuur, E. A., Schäfer, K. V. R., Sonnentag, O., Sparks, J. P., Stuart-Haëntjens, E., Sturtevant, C., Sullivan, R. C., Szutu, D. J., Thom, J. E., Torn, M. S., Tuittila, E.-S., Turner, J., Ueyama, M., Valach, A.

C., Vargas, R., Varlagin, A., Vazquez-Lule, A., Verfaillie, J. G., Vesala, T., Vourlitis, G. L., Ward, E. J., Wille, C., Wohlfahrt, G., Wong, G. X., Zhang, Z., Zona, D., Windham-Myers, L., Poulter, B., Jackson, R. B. (2021). FLUXNET-CH4: a global, multi-ecosystem dataset and analysis of methane seasonality from freshwater wetlands. *Earth System Science Data, 13*(7), 3607--3689. https://essd.copernicus.org/articles/13/3607/2021/i/S0959652621023532

PUBLICATIONS

Peer Reviewed Journal Articles

Reavis, C. W., Suvocarev, K., Reba, M. L., **Runkle, B. R.** (2021). Impacts of alternate wetting and drying and delayed flood rice irrigation on growing season evapotranspiration. *Journal of Hydrology, 596*. https://www.sciencedirect.com/science/article/pii/S002216942100127X

Huang, X., Reba, M., Coffin, A., **Runkle, B. R.,** Huang, Y., Chapman, B., Ziniti, B., Skakun, S., Kraatz, S., Siqueira, P., Torbick, N. (2021). Cropland mapping with L-band UAVSAR and development of NISAR products. *Remote Sensing of Environment*, 112180. http://www.sciencedirect.com/science/article/pii/S0034425720305538

Fisher, J. B., Keenan, T. F., Buechner, C., Shirkey, G., Perez-Quezada, J. F., Knox, S. H., Frank, J. M., **Runkle, B. R.,** Bohrer, G. (2021). Once upon a time, in AmeriFlux. *Journal of Geophysical Research: Biogeosciences, 126*(1), e2020JG006148. https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2020JG006148

sd.copernicus.org/articles/13/3607/2021/

Luthra, K., **Sadaka, S. S.**, Atungulu, G. (2021). Effects of ambient air dehumidification, air temperature, and drying duration on rough rice quality and pasting properties using fluidized bed and fixed bed dryers. *Cereal Chemistry*. 10.1002/cche.10438

Luthra, K., **Sadaka, S. S.** (2021). Energy and exergy efficiencies of fluidized bed and fixed bed drying. *Transactions of the ASABE, 46*(6). https://doi.org/10.13031/trans.14670

Bruce, R., Atungulu, G., **Sadaka, S. S.**, Smith, D. (2021). Impact of specific energy input of a 915 MHz microwave dryer on quality, func properties of different rice cultivarstional, and physicochemical. *Cereal Chemistry, 2021* (98), 557-570.

Peer Reviewed Journal Articles

Luthra, K., **Sadaka, S. S.** (2021). Mathematical modeling of rough rice. *Applied Engineering in Agriculture*.https://doi.org/10.13031/aea.14641

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Yuyan Cai, Zhiying Han, Xiaochang Lin, Jianghui Du, Zeyu Lei, Zhangying Ye, **Jun Zhu**. 2021 Mechanisms of releasing magnesium ions from a magnesium anode in an electrolysis reactor with struvite precipitation. Journal of Environmental Chemical Engineering 9(6): 106661.

M. A. Bashir, S. Wu, **J. Zhu**, A. Krosuri, M. U. Khan, N. A. Robinson Jr. 2021. Recent development of advanced processing technologies for biodiesel production: A critical review. *Fuel Processing Technology* 224: 107120.

Conference Proceeding

Kaur, Kandhola, G., Batta-Mpouma, J., Chen, J., Sakon, J., **Kim, J.-W.** (2021). Enhanced Localized Surface Plasmon Resonance of Gold Nanoparticles on Cellulose Nanocrystals Proceedings of 15th IEEE International Conference on Nano/Molecular Medicine and Engineering. IEEE.

Batta-Mpouma, J., Kandhola, G., Kuczwara, P., Chivers, C., Kim, W., Jensen, H. K., Kim, J., Jensen, M. O., **Kim, J.-W**. (2021). Preparation and Characterization of Nanopatterned Polycaprolactone/Cellulose Nanocrystal Composite Membranes for Cardiovascular Tissue Engineering Proceedings of 15th IEEE International *Conference on Nano/Molecular Medicine and Engineering*. IEEE.

Conference Proceeding

Liang, Y., Janorschke, M., Hayes, C. Low-Cost Solar Collectors to Pre-heat Ventilation Air in Broiler Buildings (Paper number: 2100619). St. Joseph, MI: ASABE.

Luthra, K., **Sadaka, S. S.,** Atungulu, G. (2021). Effects of fluidized bed dryer operating parameters on the pasting properties of rough rice. (doi: 10.13031/aim.202100692

Luthra, K., **Sadaka, S. S.** (2021). Energy and Exergy Analysis of Rough Rice Drying in a Fluidized Bed and Fixed Bed with Ambient Air Dehumidification.

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Wang, C.-y.[1], Hevaganinge, A.[1], **Wang, D.[1]**, Ali, M., Maurizio, C., Tao, Y. (2021). Prediction of Aqueous Glucose Concentration Using Hyperspectral Imaging (pp. 3237-3240). IEEE EMBC.

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Other peer-reviewed publications

Henry, C.G., J. P. Pimentel, P. N. Ghar, M. Ismanov, P. Francis, L. Espinoza and T. Clark. 2020. Irrigation Timing, Intercropping, and Tillage Effects on Corn Yield. Arkansas Corn and Grain Sorghum Research Series 2020 editors V. Ford, J. Kelley and Nathan McKinney II Research Series 677. July 2021. Pp 30-33.

Other peer-reviewed publications

Henry, C.G., T. Clark, G. D. Simpson, P. N. Ghar and J. P. Pimentel. 2020. Results from three years of the University of Arkansas System Division of Agriculture Corn Irrigation Yield contest. Arkansas Corn and Grain Sorghum Research Series 2020 editors V. Ford, J. Kelley and Nathan McKinney II. Research Series 677. July 2021. Pp 34-36. leid=2773461

Ismanov, M., **C. G. Henry**, L. Espinoza, and P.B. Francis. 2020. Soybean Plant's Sap Flow and Crop Yield Relations. In Soybean Research Series 2020. Arkansas Soybean Research Series 2020. Jeremy Ross editor. Research Series 680. December 2021. pp 185-189

Henry, C. G., T. Clark, G. D. Simpson, P.N. Ghar, and J. P. Pimentel. 2020. Results from Three Years of the University of Arkansas System Division of Agriculture Soybean Irrigation Yield Contest. In Soybean Research Series 2020. Jeremy Ross editor. Research Series 680. December 2021. Pp 190-192.

Henry, C.G., G. D. Simpson, R. Mane, J. P. Pimentel, and T. Clark. 2020. Water Use and Yield Differences in Farmer-Managed Furrow Irrigated and Multiple Inlet Rice Irrigation Levee Flooded Fields. In B.R. Wells Arkansas Rice Research Series 2020 editors J. Hardke, X. Sha, and N. Bateman. University of Arkansas, August 2021, Research Series 676. pp 247-248.

Henry, C.G., J. P. Pimentel, P.N. Ghar, and T. Clark. 2020. Grain Yield Response of Furrow-Irrigated Hybrid RT 7521 FP to Environmentally Smart Nitrogen (ESN) and Fertigation using Water Soluble Fertilizers. In B.R. Wells Arkansas Rice Research Series 2020 editors J. Hardke, X. Sha, and N. Bateman. University of Arkansas, August 2021, Research Series 676. Pp 250-254.

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Henry, C. G., T. Clark, G. D. Simpson, P.N. Ghar and J. P. Pimental. Results from Three Years of the University of Arkansas System Division of Agriculture's Rice Irrigation Yield Contest. In B.R. Wells Arkansas Rice Research Series 2020 editors J. Hardke, X. Sha, and N. Bateman. University of Arkansas, August 2021, Research Series 676. Pp 259-261.

Henry, C.G., D.M. Pickelmann, J.P. Rix, and G. D. Simpson. 2020. Grain Yield Response of Furrow Irrigated RiceTec Gemini 214L CL to Different Nitrogen Sources, Irrigation Timing and Tillage. In B.R. Wells Arkansas Rice Research Series 2019 editors K.A.K. Moldenhauer, B. Scott and J. Hardke. University of Arkansas, August 2020, Research Series 667. pp 223-227.

Henry, C.G., M. Ismanov and L. Espinoza. 2020. Irrigation Timing, Fertigation, and Tillage Effects on Corn Yield. In Arkansas Corn and Grain Sorghum Research Studies 2019 editors J. Kelley and N. McKinney. University of Arkansas, July 2020, Research Series 669. pp 48-51.

Mozzoni, L., F. Ravelombola, L. Purcell, A. Kaler, **C. Henry**, A. Acuna-Galindo, L. Florez-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. In Arkansas Soybean Research Series 2019 editor Jeremy Ross, University of Arkansas, December 2019, Research Series 663. pp15-17.

Extension publications and literature.

Henry, C. G. 2021. Irrigation and Drainage. Corn Production Handbook. MP 437. University of Arkansas Division of Agriculture. Little Rock, Arkansas.

Henry, C.G. M. Daniels, M. Hamilton, and J. T. Hardke. Water Management. In Hardke, J. (ed). 2021. Rice Production Handbook. MP192. University of Arkansas Division of Agriculture.

Extension Publications and Literature

Tabler, T., **Liang**, Y., Moon, J., Wells, J. (2021). Manure Management on Commercial Layer Operations: Environmental Concerns. Publication 3724. Mississippi State University.

Tabler, T., **Liang**, Y., Moon, J., Well, J. (2021). Manure production and Challenges. Publication 3719. Mississippi State University Extension.

Sadaka, S. S., Kalyankar, V. (2021). Effects of Ozone Gas Concentration and Application Duration on Corn Decontamination in a Lab scale Fixed Bed.

Sadaka, S. S., Atungulu, G., Kelley, J. (2021). Corn drying, storage and aflatoxin levels.

Sadaka, S. S. (2021). Capacity of a Semi-Trailer. Grain Management. https://grainmgmt.uada.edu/pages/semi-trailer-capacity.html

Sadaka, S. S. (2021). Conversion Between Moisture Content Wet Basis & Dry Basis. Grain Management. https://grainmgmt.uada.edu/pages/wet_dry_conversion.html

Sadaka, S. S. (2021). Cost for Grain Drying and Storage with a Pass Dryer/Bin System. Grain Management. https://grainmgmt.uada.edu/pages/grain-drying-propane.html

Sadaka, S. S. (2021). Cost for Grain Drying and Storage with Nat. Gas. Grain Management. https://grainmgmt.uada.edu/pages/grain-drying-natural-gas.html

Sadaka, S. S. (2021). Determine Grain Shrinkage. Grain Management. https://grainmgmt.uada.edu/pages/grain-shrinkage-bushel.html

Sadaka, S. S. (2021). Equilibrium Moisture Content. Grain Management. https://grainmgmt.uada.edu/pages/emc.html

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Sadaka, S. S. (2021). Grain Drying with Diesel Powered Fan System. Grain Management. https://grainmgmt.uada.edu/pages/grain-drying-diesel.html
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Sadaka, S. S. (2021). In-Bin Grain Drying Time Calculator. Grain Management. https://grainmgmt.uada.edu/pages/grain_drying_time_calculator.html
Sadaka, S. S. (2021). Will Natural Air-Drying Occur? Grain Management. https://grainmgmt.uada.edu/pages/air-drying.html
J.M. Burke, **K.W. VanDevender,** A.N. Sharpley, L.G. Berry, and M.B. Daniels. Assessment of Phosphorus Migration by Soil Tests at an Arkansas Discovery Farms Dairy Operation. : 2021 Wayne E. Sabbe Arkansas Soil Fertility Studies

Magazine/Trade Publication

Osborn, G. S. (2021). New carbonation method could save time and money for craft brewers *Resource Magazine ASABE* (November/December 2021 ed., pp. 24-25). ASABE.

Invited presentations

Costello, T. A., Climate Change: Protecting and Sustaining Mother Earth for the Future, "Outlook for Renewable Energy," Phi Alpha Omega Chapter, Alpha Kappa Alpha Sorority, Inc., Virtual, Fayetteville, AR, United States. (October 12, 2021).

Henry, C.G. T. 2021. How to grow 200+ BPA Row Rice without NBPT Urea and only a foot of water, virtual, Delta States Irrigation Conference, Virtual, February 10th, 2021.

Henry, C.G. and D. Gholson. 2021. Soil Moisture Roundtable. Delta States Irrigation Conference, virtual, Delta States Irrigation Conference, Virtual, February 10th, 2021.

Invited presentations

Henry, C.G. 2021. Irrigation Contest Winners. Arkansas Soil and Water Conference, virtual, January 27, 2021.
Henry, C.G., G. Simpson, T. 2021. The Arkansas "Most Crop per Drop" Contest: An Innovative Extension Method to Improve Irrigation Water Management Adoption. ASABE 6th Decennial Irrigation Conference, December 6-8, 2021.
Kim, J.-W., 15th IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), "Multifunctional Biohybrid Nanoscale Materials: Design and Assembly," IEEE, Virtual. (November 16, 2021). [Keynote talk]
Kim, J.-W., Innovation Frontiers 2021, "Nanoscale Materials in Bio/Nano Medicine: Design and Assembly," Society of HealthCare Innovation (SHCI), Virtual. (October 26, 2021). [Featured talk]
Kwofie, E. M., Ellis, E., Ngadi, M., Regional Strategic Analysis and Knowledge Support System (ReSAKSS), "A consumer-food security nexus framework analysis for resilient agrifood value chains," AKADEMIYA 2063 and African Union, Virtual. (November 16, 2021).
Li, Y., International Forum on Food Safety of Pork Products, "A monitoring and risk analysis system for improving food safety of pork supply chain", Chongqing, China (October 20, 2021).
Liang, Y., Hayes, C., USDA SAS Project meeting, "Enhance Water Use Efficiency by Sprinkling to Cool Broilers," Virtual. (October 2021).
MAHMOUD, A. (Presenter), 23rd Annual EPA Region 6 Stormwater Conference, "Development of a Cyberinfrastructure for Assessment of the Lower Rio Grande Valley North and Central Watersheds Characteristics," The US Environmental Protection Agency, Online, New Orleans, LA, United States. (August 10, 2021). 2021-Conference-Program_-8-4-21 (1)-1.pdf

Publications

Invited presentations

MAHMOUD, A., Bioretention Cell Green Infrastructure Virtual Workshop, "Evaluation of field-scale stormwater bioretention structure flow and pollutant load reductions in South Texas," Research, Applied Technology, Education and Service, Inc. – Rio Grande Valley, Online, Kingsville, TX, United States. (November 5, 2021). Bioretention Workshop_agenda-1.pdf

Osborn, G. S., Seltzerfest, "Carbo Rock-It: An improved way to carbonate beer," Core Brewing, Core Brewing, Springdale, AR, United States. (July 2021).

Runkle, B. R., "Climate-smart solutions for the rice agro-ecosystem," University of California, Berkeley, Biomet Research Group, Berkeley, CA, United States. (November 2021).

Runkle, B. R., "Climate-smart solutions for the rice agro-ecosystem," University of California, Davis, Department of Land Air and Water Resources, Davis, CA, United States. (November 2021).

Runkle, B. R., Natural Resources and the Environment Seminar Series, "Climate-smart management of the rice agro-ecosystem," Indiana University, (zoom), Bloomington, IN, United States. (February 18, 2021).

Runkle, B. R., Earth Sciences Colloquium, "Carbon and water cycling in the rice agro-ecosystem," Memphis University, (zoom), Memphis, TN, United States. (February 12, 2021).

Xiao, Y., **J. Zhu**, M. Vanotti. 2021. Evaluation of Nitrifying, Anammox and Heterotrophic bacteria in a One-Stage Reactor During Direct Treatment of Poultry Litter. ASABE Annual International Meeting paper#: 2100634. July 11 -14. Virtual.

Bashir, MA., S. Wu., S. Deng, **J. Zhu**, A. Krosuri, 2021. Continuous Production of Ethyl Ester from Corn Oil by Liquid Plasma Catalysis. 2021 ASABE Annual International Meeting. Paper#: 2100285. July 11-14, 2021. Virtual.

Submitted/selected oral or poster presentations

Haggard, B. E., BENG 4933 Sustainable Watershed Engineering, "Monitoring harmful algal blooms and microcystin at Lake Fayetteville: what are we learning?," Virtual. (December 2021).

Haggard, B. E., AGU Annual Meeting, "Understanding Nutrient Dynamics Through Mesocosm Experiments Could Influence Management Strategies in Hypereutrophic Urban Lakes," American Geophysical Union, Convention Center, New Orleans, LA, United States. (December 2021).

Ferri, A., **Haggard, B. E.,** NALMS Annual Virtual Meeting, "Monitoring of variable cyanobacterial harmful algal blooms in Lake Fayetteville, Arkansas," North American Lake Management Society, Virtual. (November 2021).

Haddock, L., **Haggard, B. E.,** NALMS Annual Virtual Meeting, "Nutrient addition affects harmful algal blooms biomass and cyanotoxin production," North American Lake Management Society, Virtual. (November 2021).

Haggard, B. E., GNEG 1111H FEP Honors Research, "Monitoring harmful algal blooms and microcystin at Lake Fayetteville: what are we learning?," First-Year Engineering Program, Classroom. (September 2021).

Fritsch, I., Nicholson, A. G., Rathke, N. R., Magness, M. L., Khan, F. Z., Stewart, A., Muldoon, T. J., **Haggard, B. E.,** 239th ECS Meeting with the 18th International Meeting on Chemical Sensors, "Manipulating microvolumes of fluids by redox-magnetohydrodyanmics for applications of chemical analysis," The Electrochemical Society, Virtual. (June 2021).

Lasater, A., **Haggard, B. E.,** OCLWA Virtual Student Poster Competition, "Magnitude of external phosphorus loading likely reduces effectiveness of aluminum sulfate treatments for management of sediment phosphorus flux," Oklahoma Clean Lakes and Watershed Association, Virtual. (May 2021).

Ferri, A., **Haggard, B. E.,** OCLWA Virtual Student Poster Competition, "Monitoring of variable cyanobacterial harmful algal blooms in Lake Fayetteville, AR," Oklahoma Clean Lakes and Watershed Association, Virtual. (May 2021).

Submitted/selected oral or poster presentations

Haddock, L., **Haggard, B. E.,** OCLWA Virtual Student Poster Competition, "Nutrient addition may affect harmful algal bloom biomass and cyanotoxin production," Oklahoma Clean Lakes and Watershed Association, Virtual. (May 2021).

Shuler, C., **Haggard, B. E.,** Arkansas Governor's STEM Virtual Poster Presentation and Contest, "Quantifying potential urban heat islands in Fayetteville, Arkansas," Virtual. (March 2021).

Haggard, B.E. 2021. Microcystin is highly variable in Lake Fayetteville. Northwest Arkansas Rotary Club, Virtual Seminar (April 2021)

Batta-Mpouma, J., Sakon, J., **Kim, J.-W.**, 2021 MRS Fall Meeting & Exhibit, "Characterization of Covalently Crosslinked Cellulose Nanocrystals for Multifunctional Materials with Tun-able Physicochemical Properties," MRS, Virtual. (November 30, 2021).

Kandhola, G., Batta-Mpouma, J., **Kim, J.-W.**, 2021 MRS Fall Meeting & Exhibit, "Surfactant-like Cellulose Nanocrystals to Stabilize Pickering Emulsions for Use in Agricultural Applications," MRS, Virtual. (November 30, 2021).

Kaur, J., Kandhola, G., Batta-Mpouma, J., Iraniparast, M., Chen, J., Sakon, **Kim, J.-W.**, 15th IEEE International Conference on Nano/ Molecular Medicine and Engineering (IEEE-NANOMED), "Enhanced Localized Surface Plasmon Resonance of Gold Nanoparticles on Cellulose Nanocrystals," IEEE, Virtual. (November 17, 2021).

Batta-Mpouma, J., Kandhola, G., Kuczwara, P., Chivers, C., Kim, W., Jensen, H. K., Kim, J., Jensen, M. O., **Kim, J.-W.**, 15th IEEE International Conference on Nano/Molecular Medicine and Engineering (IEEE-NANOMED), "Preparation and Characterization of Nanopatterned Polycaprolactone/Cellulose Nanocrystal Composite Membranes for Cardiovascular Tissue Engineering," IEEE, Virtual. (November 17, 2021).

Kwofie, E. M., Departmental Seminar - Cornell University, "Sustainable Healthy Diets: Examining the trade-offs of processing, nutrition and environmental sustainability," Cornell University, Virtual. (October 19, 2021).

Submitted/selected oral or poster presentations

Kwofie, E. M., ASABE Seminar Series - Transforming Food and Agriculture to Circular Systems, "When circularity becomes central to our global food security agenda: Concepts to implementation readiness in rice value chain," ASABE, Virtual. (September 30, 2021).

Wang, W., Kidd, M., **Li, Y.**, IAFP 2021 Annual Meeting, "Localized surface plasmon resonance biosensor based on polydopamine molecular imprinted polymer for detection of multi-antibiotics in chicken meat," IAFP, Phoenix, AZ. (July 19, 2021).

Xi, X., Yu, N., Niyonshuti, I., Yao, L., Fu, Y., Chen, J., **Li, Y.**, ASABE 2021 Annual International meeting, "An ultrasensitive and label-free quartz crystal microbalance biosensor based on gold nanocagescapped with aptamers for rapid detection of thrombin," ASABE, virtual. (July 13, 2021).

Jia, F., Wang, J.P., **Li, Y.**, Li, J.M., Biosensors 2021, "A square wave voltammetric (SWV) nanosensorbased on AuNFs/AuNRs composite for the reliable and sensitive detection of pyocyanin", Biosensors, virtual. (July 27, 2021).

Liang, Y., Janorschke, M., Hayes, C. 2021. ASABE Annual Meeting, "Low-Cost Solar Collectors to Pre-heat Ventilation Air in Broiler Buildings." American Society of Biological & Agricultural Engineers, Virtual. (July 14, 2021).

Osborn, G. S., Come as you Arkansas, "Carbo Rock-It," University of Arkansas Technology Ventures, Student Union for 150 year Celebration of UA, Fayetteville, AR. (September 2021).

Osborn, G. S., Advisor Board Meeting - UA Technology Ventures, "Commercializing the Carbo Rock-It," UA Technology Ventures, Fayetteville, AR. (May 2021).

Submitted/selected oral or poster presentations

Novick, K., Metzger, S., Hemes, K., Anderegg, W., Barnes, M., Cala, D., Guan, K., Hollinger, D., Kumar, J., Litvak, M., Lombardozzi, D., Normile, C., Oikawa, P., **Runkle, B. R.**, Wiesner, S., Torn, M., American Geophysical Union Fall Meeting, "Informing Nature-based Climate Solutions with the best-available science: a research agenda for the land-atmosphere flux community," New Orleans, LA. (December 2021).

Richardson, W., Reba, M., **Runkle, B. R.**, American Geophysical Union Fall Meeting, "Temporal Variation in Rice Field Ebullitive Methane Fluxes as Derived from Violations of Scalar Similarity Using a Modified Wavelet Method for Eddy Covariance Observations," New Orleans, LA. (December 2021).

Kuhn, E., Moreno-Garcia, B., Reba, M., **Runkle, B. R.**, Tri-societies meeting, "Modeling Leaf Area Index and Canopy Height Using Growing Degree Days," Salt Lake City, UT. (November 2021).

Richardson, W., Reba, M., **Runkle, B. R.**, 34th Conference on Agricultural and Forest Meteorology, "Determining the Ebullition Fraction of Methane Fluxes from an Irrigated Rice Production System: Application of a Wavelet-Based Method for Eddy Covariance Observations," Virtual. (June 2021).

Bansal, S., Valach, A., Kasak, K., McNicols, G., Malhotra, A., Goeckede, M., **Runkle, B. R.**, Noormets, A., Knox, S., Society of Wetland Scientists Annual Meeting, "Diurnal variation in wetland methane fluxes: Global patterns," Virtual. (May 2021).

Meyarian, A., Yuan, X., Liang, L., **Runkle, B. R.**, Qiao, Z., Guo, X., International Conference on Urban Intelligence and Applications, "Contour-Net: A gradient-based network for classification of contour levees,"

Submitted/selected oral or poster presentations

Runkle, B. R., Seyfferth, A., Reid, M., Limmer, M., Moreno-Garcia, B., Reavis, C., Reba, M., Adviento-Borbe, A., Pena, J., Pinson, S., Circular Food Systems network meeting, "Rice husk soil amendments as a GHG-mitigating piece of the circular rice production system," Global Research Alliance. (June 2021

Tajfar, E., **Runkle, B. R.**, Reba, M., Fong, B., Reavis, C., American Geophysical Union Fall Meeting, "Estimating Crop Coefficients for Rice Fields in the U.S. Mid-South using Eddy Covariance Measurements and the gridMET Dataset," New Orleans, LA. (December 2021).

Moreno-Garcia, B., Limmer, M., Seyfferth, A., Reba, M., **Runkle, B. R.**, Tri-societies meeting, "Rice grain metal(loid) concentration as affected by management practices," Salt Lake City, UT. (November 2021).

Leavitt, M., Moreno-Garcia, B., Reavis, C., Reba, M., **Runkle, B. R.**, Tri-societies meeting, "The Effect of Water Management and Ratoon Rice Cropping on Methane Emissions and Harvest Yield in Arkansas," Salt Lake City, UT. (November 2021).

Tajfar, E., Reba, M., Fong, B., Novick, K., White, P., Bhattacharjee, J., **Runkle, B. R.**, Ameriflux Community meeting, "Evapotranspiration in the Mid-South US: Estimating crop coefficients with gridMet and eddy covariance observations across 32 field-seasons," Virtual. (September 2021).

Trinh, K., Moreno-Garcia, B., **Runkle, B. R.**, STEM Posters @ the Capitol, "Estimating Irrigation Inputs from Changes in Water Table Level Using Water Balance Approach," Virtual, Little Rock, AR. (March 2021).

Leavitt, M., Moreno-Garcia, B., Reavis, C., Reba, M., **Runkle, B. R.**, North America Carbon Program Open Science Meeting, "The effect of ratoon rice cropping on greenhouse gas emissions and harvest yield in Arkansas," Virtual. (March 2021).

Kuhn, E., Moreno-Garcia, B., Reba, M., **Runkle, B. R.**, Arkansas Soil and Water Conference, "Modeling Leaf Area Index and Canopy Height Using Growing Degree Days," Virtual, Jonesboro, AR, United States. (January 2021).

Submitted/selected oral or poster presentations

Torbick, N., Huang, X., Chapman, B., Coffin, A., Cosh, M., Huang, Y., Justice, C., Kraatz, S., McNairn, H., Moreno-Garcia, B., Robertson, L., **Runkle, B. R.**, Reba, M., Skakun, S., Siqueira, P., Wang, J., Ziniti, B., JAXA PI Meeting, "Scaling agricultural management metrics with multi-source EO." (January 2021).

Leavitt, M., Moreno-Garcia, B., Reavis, C., Reba, M., **Runkle, B. R.**, Arkansas Soil and Water Conference, "The effect of ratoon rice cropping on greenhouse gas emissions and harvest yield in Arkansas," Virtual, Jonesboro, AR, United States. (January 2021).

Sadaka, S. S., ASABE Annual International Meeting, "Estimation of the Performance of an Electrically Heated Allothermal Auger System," ASABE.

Luthra, K., **Sadaka, S. S.**, ASABE Annual International Meeting, "Modeling of the rice drying process in a custom-made lab-scale fluidized bed dryer," ASABE.

Sadaka, S. S., ASABE Annual International Meeting, "Reanalyze Previous Data to Develop a Universal Kinetic Model for Grain Sorghum Drying Process," ASABE.

Sun, C., Chen, V., Wang, D. (Mentor), Saeedi, O., UMB Student Research Forum, "The Effect of Aging on Vasomotion and Microvascular Autoregulation," Baltimore, MD, United States.

Wang, D., Ali, M., Cobau, J., Tao, Y., ASABE Annual Meeting, "Designs of a customized active 3D scanning system for food processing applications." ASABE. (July 2021).

Hevaganinge, A., **Wang, D.**, Ali, M., Wang, C.-Y., Tao, Y., National Institute for Innovation in Manufacturing Biopharmaceuticals Annual Meeting, "Non-Contact pH and Glucose Sensing using Short Wavelength Infrared Hyperspectral Imaging," NIIMBL. (July 2021).

Le, C., **Wang, D.**, Villanueva, R., Liu, Z., Hammer, D., Saeedi, O., ARVO annual meeting, "Automated Vessel Segmentation in Adaptive Optics–Optical Coherence Tomography Images," ARVO. (May 2021).

Wang, D., Pottenburgh, J., Lai, W. C., Simon, C., Tao, Y., Saeedi, O., ARVO Annual Meeting, "Deep learning aided erythrocyte stasis characterization based on erythrocyte mediated angiography.," ARVO. (May 2021).

Other Creative Endeavors

Chris Henry

Mobile App Development. I have developed a mobile application for Multiple Inlet for Rice Irrigation. It is available on Google Play for android devices. The application provides a map for the user to draw field boundaries, levee boundaries, and pipe location. The user enters in the flow rate for the well and the application determines the pipe size, length, number of rolls required and provides a gate punch and setting plan for the field. Multiple fields can be entered and saved and the user can have the plan emailed to them and saved as a pdf.

The iOS version of this application was released in 2017 and updated in 2021. Currently there are 548 users that have planned 1059 farms, 1,978 fields, 18,070 individual levees, 2.8M feet of pipe and 2,520 pipe designs. Over 174,084 acres are planned using the app, which on average reduce irrigation water use by 8 ac-in/ac. These planned acres using the mobile app represent about 13% of the rice acres in Arkansas, and is estimated to conserve 34 billion gallons of irrigation water annually.

UA Irrigation Water Management Team. 2021. Rice Irrigation. Mobile Application Software.http://itunes.apple.com

UA Irrigation Water Management Team. 2021. Rice Irrigation. Mobile ApplicationSoftware. https://play.google.com/store/apps/details?id=org.uark.riceirrigation

A second app, Arkansas Watermark Tool, is a mobile app that interprets soil moisture sensor readings. The app is available for iOS and Android devices. This app has been installed 374 times and the average usage is 4.3 sessions per month. This is fairly high usage rate because the app is only used for 2-3 months during the year. This app is a good example of integrating research and

Other Creative Endeavors

Extension, soybean sap flow experiments being conducted and soil water retention curves are integrated into the algorithms in the app to provide Arkansas specific soil moisture sensor recommendations. This approach immediately integrates commodity board funded research with an Extension outreach tool,putting complex research results into an easy to use product. The app allows for easy implantation of research and puts it "in the hands" of my clientele using their smartphone.

UA Irrigation Water Management Team. 2020. Arkansas Watermark Tool.https://play.google.com/store.

UA Irrigation Water Management Team. 2020. Arkansas Watermark Tool.http://itunes.apple.com.

Another app is a simple soils mapping app that will be integrated into the soil moisture sensor calculator app. The app reports soils information from the SSURGO database managed by NRCS for a user's given location.

UA Irrigation Water Management Team. 2021. The Soils Map App. Not yet released on Google Play.

Considerable effort has been made to develop a tool to help farmers implement Computerized Hole Selection. Currently many farmers (40% in the region) use a program developed by Delta Plastics, the manufacture of lay flat irrigation pipe, called Pipe Planner (pipeplanner.com). One challenge with CHS is that plans can be difficult to implement because many plans have many hole size changes. This project is developing a tool to increase adoption of CHS by automating this process as the pipe is installed. First the app is used to download Computerize Hole

Other Creative Endeavors

Selection plans developed using Delta Plastics Pipe Planner (pipeplanner.com). The app imports the CHS plans and then communicates with a GPS receiver and an embedded printer system to print the CHS plan hole on pipe as it is installed on a tractor and pipe installation machine. The second part of this app, allows for the user to create their own CHS plan rather than import the one from Pipe Planner. Since the app only works with the embedded system it is not published on Google Play. However, the app is very robust and functional and has been extensively tested in the field. The CHS feature has just been added and is nearly ready to be released. It is also being coded in iOS, once finished, the app will be ready for extensive testing by end users and release.

UA Irrigation Water Management Team. 2021. Poly Printer and CHS Planning App.Unpublished.

Mid-South Irrigation Survey Products. L.J. Krutz and I led a regional project to survey irrigators in the mid-south encompassing Missouri, Louisiana, Mississippi and Arkansas. I have led the analysis of the survey data since it was collected in 2016. Dr. Henggeler (retired at the time) and I composed the data into a final report (200 pp), series of factsheets and several presentations for a variety of meetings. Several colleagues have worked with and published work using this dataset and other colleagues are working on additional publications. The survey is likely the most detailed irrigation survey ever conducted in a region. The survey provides a benchmark for Extension impacts and helps establish research priorities for the many professionals that work in this region

Other Creative Endeavors

Novel Tail-water Pump Technology Transfer. During 2019 and 2021, I have installed four of the novel pit-less tailwater recovery systems on farmer fields in Arkansas. These systems are the first technology transfer of the IP for the patented "Irrigation System:

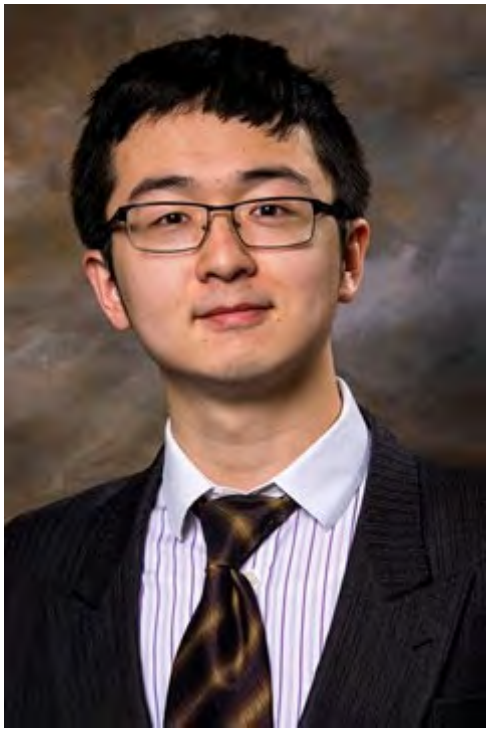
20190307083A1 (See Henry, C. G. et al., 2019 in IP section). These four systems are demonstrating the pit-less technology for furrow irrigated rice. The results have been very successful and the farmers are promoting the technology among their peers. This project will allow the technology to be adopted as an incentive payment within the Environmental Quality Incentives Program, which allows for farmers to receive government funding to install the technology on their farms. One farmer's installation will be the front cover story of the 2021 fall issue of the "Rice" magazine trade publication.

Additionally, in 2021 we were successful in testing in 2021 a fully automated irrigation system centered around the pit-less tailwater recovery system, demonstrating the full application of the patented system.

Master Irrigator National Initiative. I have been leading a group that applied for a National Conservation Innovation Grant application that was not funded. I have led the group to apply for additional funding from the International Irrigation Consortium. I have formed a committee and created awareness for the initiative nationally gathering critical mass. The group is coming together when it is possible to meet in person to begin the development of a national curriculum and standards for a program on December 16, 2021.

NEW FACULTY

Ebenezer Miezah Kwofie, assistant professor of food systems sustainability and resilience, joined the Biological and Agricultural Engineering Department January 6, 2021 Dr. Kwofie holds a joint appointment in Biological and Agricultural Engineering, Chemical Engineering and Food Science departments at the U of A .



Dongyi Wang, assistant professor of Artificial Intelligence; Machine vision systems; Imaging systems (color, 3D, spectral); Smart food manufacturing; Robotics joined the Biological and Agricultural Engineering Department on May 28, 2021. Dr. Wang holds a joint appointment in Biological and Agricultural Engineering and Food Science departments at the U of A.

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.

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