Department of Biological and Agricultural Engineering

2020 Annual Report

U of A
DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

UNIVERSITY OF ARKANSAS
1871
College of Engineering
Biological & Agricultural Engineering

2020 Annual Report
Department of Biological and Agricultural Engineering

Lalit R. Verma
Department Head

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Department of Biological & Agricultural Engineering

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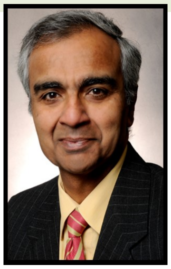
Foreword

From the Department Head



I am pleased to share highlights of our departmental programs and personnel in 2020, a year unlike any other due to the pandemic. It is very gratifying to have faculty and staff committed to our mission in spite of unprecedented obstacles and delivering our programs to the students and clientele we exist to serve. The mission of our department is "*to develop and disseminate engineering knowledge to address problems dealing with sustainable food, water and energy systems.*" This mission supports the land-grant mission of our land-grant university and strives to address the grand challenges facing our society. 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 water, food and energy systems in light of complex challenges due to climate change and ever changing societal issues. Our graduates are prepared to pursue successful careers closely aligned with sustainable systems. The 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.

Eleanor Henson was selected as the "Outstanding Graduating Senior" in Biological Engineering and was also selected as the "College of Engineering Outstanding Graduating Senior" for her extraordinary accomplishments. She also won the Fulbright Award to study in Canada. Two graduating seniors, Eleanor Henson and Kira Simonson, were named "Seniors of Significance" by the UA Alumni Association. Drs. Tom Costello, Jun Zhu and Kieu Le were recipients of department's outstanding teaching, research and service to students awards, respectively. Ms. Linda Pate was honored as our outstanding staff member.

Four outstanding alumni were inducted virtually into the Arkansas Academy of Biological and Agricultural Engineering (AABAE). Mr. Richard Penn, Past-president of our Academy was honored as a "Distinguished Alumnus" and Mr. Rusty Tate was recognized as "Early Career Alumnus" of the UA College of Engineering. We successfully wrapped up the search for food systems engineering faculty who will begin in May. Dr. Ebenezer Kwofie from McGill University is our newest faculty who will work across our department, chemical engineering and the food science department as a sustainability food engineer.

The ABET accreditation virtual visit and review were successfully completed in the fall under the guidance of Dr. Tom Costello. The annual industry tour was canceled and the Arkansas Section meeting of the American Society of Agricultural and Biological Engineers (ASABE) was held virtually. Dr. Tim Burcham was named the "Outstanding Engineer" and Ms. Kristen Trinh was named the "Outstanding Senior." We raised over $32,000 for the "50 for the Future" fundraising campaign to assist students with unprecedented needs due to the pandemic. A fall virtual event organized by AABAE titled "Brave Blue World: Racing to Solve Our Water Crisis" featured presentations by Dr. Benjamin Runkle, of our department, Mr. Kyle Kruger of Garver and Mr. Steve Danforth, AP Innovations.

Student team members Brynn Bodwell, Kanaan Hardaway, Kira Simonson and Clare Yurchak took home the top prize in the Gunlogson Environmental Student Design Open Competition hosted by ASABE. The team was co-advised by Drs. Benjamin Runkle and Kieu Le. Doctoral student Xinge Xi, advised by Distinguished Professor Yanbin Li, Tyson Endowed Chair in Biosensing Engineering, earned first place in the ASABE 2020 Boyd-Scott Graduate Research competition.

I hope that 2021 will let us get back to our normal mode of operation and continue to deliver impactful programs for our stakeholders.

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

- Benjamin Runkle received the Dean's Award of Excellence- Collaborative Research Faculty Award, Scholarship/Research, College, 2020

- Benjamin Runkle received the Faculty Rising Teaching Award, University of Arkansas Alumni Association, Teaching, University, 2020

- Benjamin Runkle received the Group Achievement Award: Recognition as part of ACT-America team (Atmospheric Carbon and Transport – America), "Exceptional Scientific Achievements of the ACT-America Earth Venture Suborbital Mission", NASA Langley Research Center, Scholarship/ Research, National, 2020

- Benjamin Runkle received the Mentoring award, The Provost's Office and the Office of Nationally Competitive Awards, Advising/Mentoring, 2020

- Marty Matlock received the College of Arts and Sciences Distinguished Alumni, 2020, Oklahoma State University Department of Plant Biology, Ecology, and Evolution.

- Marty Matlock received the Green GOOD DESIGN Award from the European Centre for Architecture Art Design and Urban Studies & The Chicago Athenaeum: Museum of Architecture and Design for the Wahiawa Value-Added Product Development Center.

- Marty Matlock received the Best of Design Awards 2020: Education Unbuilt category by the Architect's Newspaper, for the Wahiawa Value-Added Agricultural Product Development Center.

- Scott Osborn was named Fellow in UA Teaching Academy

- Sammy Sadaka received Paper Named Editor's Pick - Rebecca Bruce, Cereal Chemistry, Advising/ Mentoring, National, 2020

- Karl VanDevender John W. White Outstanding Team Award. 2020. To be awarded January 2021. Big Creek Research & Extension Team. Berry, L., Burke, J., Glover, T., Purtle, J., Sharpley, A., Smith, B., VanDevender, K., Webb, P., Willis, Adam.

ALUMNI ACCOMPLISHMENTS

- Mr. A.J. Kaufman, Ms. Kathryn McCoy, Ms. Leslie Massey and Dr. Rebeca Muenich were inducted into the Arkansas Academy of Biological and Agricultural Engineering.

- Mr. Richard Penn, BSAGE 1982, MSE 1992 City Engineer, City of Sherwood, was recognized as a "Distinguished Alumnus" and Mr. Rusty Tate P.E., BSBE 2008, MSEnE 2010, Water Design Center, Process Team Leader, Garver, LLC, was recognized as an "Early Career Alumnus" of the College of Engineering.

Significant Accomplishments in 2020

Students

- FEP Honors Symposium, Kendele Kramer, University of Arkansas College of Engineering, College, FEP Honors Symposium – Best Overall Project, Evaluating Dose Response Curves to Determine Optimal Doses of EarthTec™, Hydrogen Peroxide, and $CuSO_4$ on Mixed Algal Samples from Lake Fayetteville; Kendele Kramer, BENG Student, 2020

- 2020 Competition Winners! 1st Place - Gunlogson Environmental Design Student Competition, Brynn Bodwell, Kanaan Hardaway, Kira Simonson, and Clare Yurchak, ASABE, National, Co-advising the team, 2020

- First Place Elevator Pitch, Gurshagan Kandhola and Joseph Batta-Mpouma, 2020 Heartland Challenge Startup Competition, Regional, 2020

- First Place Innovation Division, Gurshagan Kandhola and Joseph Batta-Mpouma, 2020 Arkansas Governor's Cup, State, 2020

- First Place Winner in Graduate Division, Gurshagan Kandhola and Joseph Batta-Mpouma, 2020 Arkansas Governor's Cub, State, 2020

- Semi-Finalist, Gurshagan Kandhola and Joseph Batta-Mpouma, 2020 Brown-Forman Cardinal Challenge, International, 2020

- Semi-Finalist, Gurshagan Kandhola and Joseph Batta-Mpouma, 2020 Rice Business Plan Competition, National, 2020

- Third Place Winner Overall, Gurshagan Kandhola and Joseph Batta-Mpouma, 2020 Heartland Challenge Startup Competition, Regional, 2020

- Professional Member Coordinator, Gurshagan Kandhola, Graduate Society of Women Engineers at the University of Arkansas, University, 2020

- The 1st place of IAFP-CAFPNA 2020 Student Presentation Competition, Wenqian Wang, International Association for Food Protection, International, I am the advisor for Wenqian Wang's PhD research., 2020

- The 1st place of ASABE 2020 Boyed-Scott Graduate Research Award (PhD Category), Xinge Xi, American Society of Agricultural and Biological Engineers, International, I am the advisor for Xinge Xi's PhD research., 2020

- Eleanor Henson recognized as Outstanding Senior in BENG. Ms. Henson was named the outstanding senior for the College of Engineering.

- Kristen Trinh named ASABE State Section Outstanding senior

- 1st place, Gunlogson Environmental Student Design Open Competition, American Society of Agricultural and Biological Engineers, Creative Scholarship, National, 2020

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

Brian E. Haggard, Ph.D.
Professor
Director, Arkansas Water Resources Center
B.S. Life Sciences (1994) University of Missouri
M.S. Environmental Soil & Water Science (1997)
University of Arkansas Ph.D. Biosystems Eng. (2000) Oklahoma State University
Research Areas: Ecological engineering, environmental soil and water sciences, water quality chemistry, algal nutrient limitation, pollutant transport in aquatic systems, water quality monitoring and modeling.

Christopher Henry, Ph.D., P.E.
Associate Professor, Extension
B.S. (1996) Kansas State University
M.S. (1998) Kansas State University
Ph.D. (2009) University of Nebraska
Research Areas: Development and implementation of statewide integrated research and extension programs in irrigation water management and water quality; improve irrigation efficiency practices, novel irrigation system design, and improved energy efficiency and alternative energy sources for irrigation; develop alternative irrigation systems for rice; water policy research; solar power; pumping plant telematics; improve irrigation systems using embedded systems and mobile apps; develop curricula and training materials for educational programs in irrigation water management for cropping systems, performance and energetics, irrigation systems, and water quality impacts; investigate and develop solutions for reduction of pollutant loads with respect to gulf hypoxia; work with other UA personnel to develop and demonstrate irrigation and farming practices that address environmental, production, and economic considerations; develop and maintain positive working relationships with other government agencies and industries.

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

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

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

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

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

Otto J. Loewer, Ph.D., P.E.
Professor
ASABE Fellow
B.S. Ag.E. (1968) Louisiana State University
M.S. Ag.E. (1970) Louisiana State University
M.S. Ag. Econ (1980) Michigan State University
Ph.D. Ag.E. (1973) Purdue University
Research Areas: Computer simulation of biological systems; linkages among technology, economics and societal values.

Marty D. Matlock, Ph.D., P.E., B.C.E.E.
Professor
Area Director, Center for Agricultural and Rural Sustainability
B.S. Soil Chemistry (1984) Oklahoma State University
M.S. Plant Physiology (1989) Oklahoma State University
Ph.D. Biosystems Engineering (1996) Oklahoma State University
Research Areas: Ecological engineering, ecological watershed modeling, biological assessment and monitoring, ecosystem design and management.

Scott Osborn, Ph.D., P.E.
Associate Professor
B.S. Ag.E. (1984) University of Kentucky
M.S. Ag.E. (1987) University of Kentucky
Ph.D. Bio & Ag.E. (1994) North Carolina State University
Research Areas: Grain and Food Processing, dissolved oxygen and ozone technologies for water and wastewater treatment.

Sammy Sadaka, Ph.D., P.E., P.Eng.
Associate Professor, Extension
B.S. (1982) Alexandria University, Egypt
M.S. (1988) Alexandria University, Egypt
Ph.D. (1995) Dalhousie University, Nova Scotia, Canada and Alexandria University, Egypt
Research Areas: Bioenergy and energy conservation, grain drying and storage; gasification, pyrolysis, biodrying, energy con-servation.

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

Karl VanDevender, Ph.D., P.E.
Professor, Extension Engineer
B.S. Ag.E. (1985) Mississippi State University
M.S. Ag.E. (1987) Mississippi State University
Ph.D. Engineering (1992) University of Arkansas
Research Areas: Development and implementation of statewide extension programs in livestock and poultry waste management, liquid and dry; develop curricula and training materials for educational programs in collection, storage, and land application of waste to prevent contamination of surface and groundwater; work with other UA personnel to develop and demonstrate manure storage, treatment, and utilization practices that address environmental, production, and economic considerations; develop and maintain positive working relationships with other government agencies and industries.

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

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

Julian Abram
Program Technician

Dawn Adamson
Fiscal Manager

Randy Andress
Program Associate

Eric Cummings
Program Associate

Sydney Jones
Administrative Specialist III; Extension

Beatriz Moreno Garcia
Post Doctoral Fellow

Sandhya Karki
Post Doctoral Associate

Gurshagan Kandhola
Post Doctoral Fellow

Linda Pate
Department Administrative Manager

Leslie Reinhart
Administrative Specialist III

Lee Schrader
Program Technician

Eric Simon
Program Associate

Elahe Tajfar
Post Doctoral Associate

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Tyson Foods

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Beaver Water District

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Hydraulic Engineer
Southwestern Power Administration

KEVIN J. IGLI
SVP and Chief EHS Officer
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Garver Engineering

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Riceland Foods, Inc.

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Director-Water Compliance
Wal-Mart

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Manager of Environmental Quality
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VP of Operations
Pacific Vet Group-USA

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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

Active Academy Members

David Anderson
B.S. ('70)

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

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

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B.S. ('80)

Pat Bass
B.S. ('76)

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

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B.S. ('76), M.S. ('78)

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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)

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B.S. ('71)

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B. S. ('85)

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

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

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

Zach Dalmut
B.S. ('06)

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

Glenn Davis
B.S. ('67)

Anthony Doss
B.S. ('94)

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

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

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

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

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

Floyd R. Gunsaulis
B.S. (88), M.S. (90)
COE Young Alumni 2006

Kevin Henry
B.S. ('99)
COE Young Alumni 2008

Darrell Holmes
B.S. ('81)

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

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

Jeff Keeter
B.S. ('84)

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

Kyle Kruger
B.S. ('86)

John L. Langston
B.S. ('71), M.S. ('73)

Otto J. Loewer
B.S. ('68), M.S. ('70), Ph.D. ('73)

Jeffery D. Madden
B.S. ('88)

Ralph A. Mashburn
B.S. ('58)

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

Toni McCrory
B.S. ('07)

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

Amber Meisner
B.S. ('02)

Drake McGruder
B.S. ('06)

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

Bruce Netherton
B.S. ('60)

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

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

Carl Peters
B.S. ('58), M.S. ('61)

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

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

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

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

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

Corey Scott
B.S. (2005)

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

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

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

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

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

Rusty Tate
B.S. (2008)

Jessica Temple
B.S. (2007)

Marcus Tilly
B.S. ('00)

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

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

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

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

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B.S. ('05)

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B.S. ('90)
COE Young Alumni 2005
COE Distinguished Alumni 2012

John Westerman
B.S. ('94)

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

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

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

Honorary Academy Members

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

Albert H. Miller
Posthumously

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

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

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

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

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

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

2020 ACADEMY INDUCTEES

Adrian J. Kauf-

Kathryn L. McCoy

Leslie B. Massey

Rebecca Logsdon Muen-

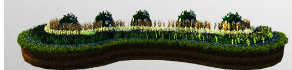
Design of a Bio-Retention Cell for Walker Park

The City of Fayetteville has identified the northern parking lot of Walker Park as requiring low-impact development to retain and treat storm water runoff before it drains into the adjacent Spout Spring Branch Creek. This group designed a bio-retention cell at the southwestern corner of the parking lot to have a significant impact on storm water infiltration. They recommended a Level 1 bio-retention cell design with a focus on bringing aesthetic quality to the parking lot. Further projects could address additional parking lot outlets that directly drain into the creek.

Student Team: Brynn Bodwell, Kanaan Hardaway, Kira Simonson, Clare Yurchak
Faculty Mentors :Dr. Kieu Le and Dr. Benjamin Runkle, P.E.

West-Side Wastewater Treatment Plant: LID System Design

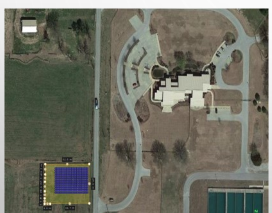
The City of Fayetteville's West-Side Wastewater Treatment Plant (WWTP) Facility, operated and managed by Jacobs Engineering, serves as a client. This facility aims to reduce all storm water runoff from the property to ensure operators do not have to worry about non-point source storm water regulations and can instead focus on the point-source regulations from a WWTP. The current rain gardens and bio-swales at the WWTP were designed without disturbing the existing soil. The team decided that any proposed LID structures would function more efficiently if the design included added layers of engineered soil to the bio-swale design. The team's designed bio-swale is situated on the northwest edge of the property, near to the plant's discharge into Goose Creek.



Student Team: Garrett Lampson, Isabel Arrocha, Julie Halveland, and Eleanor Henson
Faculty Mentors: Dr. Kieu Le and Dr. Benjamin Runkle, P.E.

Design of Photovoltaic Power System for the Beaver Water District's Headquarters Building

Besides providing high quality drinking water, Beaver Water District (BWD) is interested in stepping up their stewardship by adding renewable energy generation capacity to their headquarter buildings. The team evaluated several renewable energy alternatives and designed a 185 kW stationary PV array system with net metering capability to the power grid. If implemented, the proposed solar array system would allow BWD headquarter be completely powered by renewable energy.



Student Team: Patrick Comer, Wesley Jones and Elizabeth Topping
Faculty Mentor: Dr. Yi Liang

Carbon Footprint Reduction for a Cidery

The team worked with Black Apple Crossing, a local cidery in Springdale, Arkansas, to design methods for reducing their carbon dioxide emissions produced through the fermentation process of their cider. The goal was to model a system that would capture the fermentation gas emissions and store them for later uses. These uses include recycling the carbon dioxide to utilize in the carbonation of the cider and selling the collected carbon dioxide to third parties.

Student Team: David Ferber, Mei Pentecost,Cady Rosenbaum and Tony Siebenmorgen
Faculty Mentor: Dr. G. Scott Osborn, P.E.

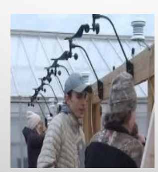
Design of Hydroponic Plant Growth Chamber as a Recruiting Demonstration for Biological Engineering

The Biological Engineering program at the University of Arkansas has requested the design of an interactive plant growth demonstration display to help inform visitors about the skills and subject matter of the biological engineer. The team focused on the design of the basic life support systems needed to grow herbs in an enclosed hydroponic system. This included systems for ventilation, lighting and nutrient/water management. Design decisions were partially based on the desire to make the unit hands-on, interactive and dynamic.

Student Team: Samuel Carroll, Nicholas Cross and Mike Gasasu
Faculty Mentor: Dr. Thomas Costello, P.E.

Design of On-Farm Surface Water Storage Options for Irrigating A Commercial Rice Seed Research Farm

RiceTec, Inc. is a leading source of high-yielding, hybrid rice seeds that farmers utilize all over the world. Their research farm, near Houston, has a history of relying on irrigation water supplied by a local water district. Suburban sprawl has created a demand to meet the growing needs for municipal drinking water systems. This challenge is threatening to eliminate the irrigation water supply that RiceTec depends upon. The team explored options for on-farm storage of surface water (runoff from rainfall) to see if this would be a viable and sustainable source to irrigate the research plots into the future.



Student Team: Emily Cumiskey, Joseph Mathis, Cade Prince and Seth Smith
Faculty Mentor: Dr. Thomas Costello, P.E.

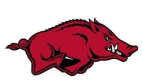
University of Arkansas

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

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

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

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



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

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

Department of Biological & Agricultural Engineering

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

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

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

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

Department of Biological & Agricultural Engineering

In 2012, the Biomedical Engineering program was separated and the revised curriculum in Biological Engineering of *"Healthy Planet Healthy People"* was designed to address the challenges in sustainable food, water and energy systems.

The Biological and Agricultural Engineering Department is housed on the second floor of the John A. White Jr. Engineering Hall. The main department office and all the faculty offices are located on the second floor. The department has use of two classrooms, two conference rooms, one computer lab, one student lab, and a study lounge.

The department also has offices and labs at the Biological and Agricultural Lab, located on North Garland Avenue, and at the Institute for Nanoscience and Engineering , located at 731 W. Dickson St.

City of Fayetteville and Northwest Arkansas

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

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

According to the 2018 census, Fayetteville has a population of 86,751 and is the third most populous city in Arkansas. It boasts a proud history, with several notable residents including authors Ellen Gilchrist (*In the Land of Dreamy Dreams*, 1981) and Donald Harrington (*The Cherry Pit*, 1965), Arkansas U.S. Senators J. William Fulbright and David Pryor, poet Miller Williams and his Grammy Award-winning songwriter daughter Lucinda, and noted architect E. Fay Jones.

The city of Fayetteville has many highlights, including the town square, where a farmer's market is held from April through November. Dickson Street is a main thoroughfare leading to the University of Arkansas and is lined with shops and restaurants. The Walton Arts Center is a professional performing arts center and hosts many national and international fine art events throughout the year.

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

SCHOLARSHIP RECIPIENTS FOR 2020

Names listed in Italic are spring 2019 scholar - ship Recipients the others listed are fall 2019 scholarship recipients.

ARKANSAS ACADEMY OF BIOLOGICAL & AGRICULTURAL ENGINEERING SCHOLARSHIP

Issac Bertels
Brynn Bodwell
Cady Puckett

BIOLOGICAL & AGRICULTURAL ENGINEERING DEPARTMENTAL SCHOLARSHIP

Juan Arguijo
Clarissa Fuller
Jake Krier
Daisy Mota
Clare Yurchak
Wesley Jones

MILDRED V. AND BILLY B BRYAN SCHOLARSHIP

Isabel Arrocha
Kanaan Hardaway
Lillian Glaeser
Megan Doty
Halley Ellis
Hayden Engelbrecht
Sophia Gomez
Angel Meneses
Holland Morton
Shawn Pearson
Dharma Shepard

Division of Agriculture Scholarship

Issac Bertels
Kanaan Hardaway
Megan Doty

J.A. RIGGS TRACTOR COMPANY SCHOLARSHIP

Kaden Belcher
Shawn Pearson
Isaac Bertels
Tatiana Castillo

XZIN MCNEAL SCHOLARSHIP

Juan Arguijo
Evan Byrd
McKenzie Gillit
Thania Ramos
Brynn Bodwell
Lillian Glaeser
Alexie Pope
Alexis Barber
Megan Doty
William Franke
Feranda Novoa
Christopher Pryor
Dharma Shepard
Cady Puckett
Anthony Siebenmorgen
Kaden Belcher
Daisy Mota
Amanda Bogart
Haley Ellis
Tatiana Castillo
Hannah Vickmark
Harrison Davis
Charles Whitten

Joel Steel & Hardy Croxton Beaver Water District

Jake Krier

JOHN W & TRANNYE ODOM WHITE SCHOLARSHIP

Harrison Davis
Amanda Bogart

Carl L. Griffis Endowed Memorial Award

Lille Bolton

Alfred B. Rhode Scholarship

Tatiana Castillo
Katherine Skiles

GRADUATES FOR 2020

BACHELOR OF SCIENCE IN BIOLOGICAL ENGINEERING

Spring 2020

Isabel Arrocha Cordoves
Brynn Bodwell
Samuel Carroll
Patrick Comer
Emily Cuminsky
Conlee Hale
Julie Halveland
Kanaan Hardaway
Eleanor Henson
Wesley Jones
John Lampson
Joseph Mathis
Alex Pentecost
Cady Rosenbaum
Anthony Siebenmorgen
Kira Simonson
Seth Smith
Elizabeth Topping
Clare Yurchak
Lillian Glaeser
Zachary Morgan
Nicholas Cross
Andrew McDaniel
Cade Prince

BIOLOGICAL ENGINEERING STUDENT CLUB

2020-2021 OFFICERS

Kristen Trinh—*President*
Janeth Jaen—*Vice President*
Mandy Bogart—*Treasurer*
Harper Williams– Dow—*Secretary*
Ellie Kuhn & Hayden Engelbrecht —*Outreach Coordinators*
Olivia Torres– *Outdoor Event Coordinators*

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 2018-2019 Course Catalog

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

Freshman Year	
First Semester 1 GNEG 1111 Introduction to Engineering I 3 ENGL 1013 Composition I 3 CHEM 1103 University Chemistry I (ACTS Equivalency = CHEM 1414 Lecture 4 MATH 2554 Calculus I (ACTS Equivalency = MATH 2405) 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 or 1023 Technical Composition II 4 First-Year Engineering Science Electives * 4 MATH 2564 Calculus II (ACTS Equivalency = MATH 2505) 3 U.S. History Requirement **(15 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 BIOL 1543/1541L Principles of Biology and Lab 3 MEEG 2003 Statics **(17 Semester hours)**	**Second Semester** 3 BENG 2643 Biological Engineering Design Methods 4 MATH 2584 Differential Equations 4 BIOL 2013/2011L General Microbiology w/Lab 3 MEEG 2403 Thermodynamics (OR CHEG 2313) 3 Humanities/Social Science Electives **(17 Semester hours)**
Junior Year	
First Semester 3 BENG 3653 Global Bio-Energy Engineering 3 BENG 3663 Biological Engineering Methods II 3 BENG 3733 Transport Phenomena in Biological Systems 4 CHEM 3603/3601L Organic Chemistry I w/Lab or CHEM 2613/2611L Organic Physiological Chemistry w/Lab 3 CVEG 3213, Hydraulics (OR MEEG 3503 OR CHEG 2133) **(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/Social Science Electives 3 Humanities/Social Science Electives **(15 Semester hours)**	**Second Semester** 3 BENG 4823 Senior Biological Engineering Design II 3 BENG 4663 Sustainable Biosystems Design 3 Engineering Electives 3 Fine Arts Electives (from University/State core list) 3 Humanities/Social Science Electives 3 Technical Electives **(18 Semester hours)**

* The First-Year Engineering Science Elective must be chosen from either CHEM 1123/1121L or PHYS 2074.

** The Sophomore Science Elective must be: PHYS 2074 if CHEM 1123/1121L was chosen as the First-Year Engineering Elective; or CHEM

Master of Science and Doctor of Philosophy in Biological Engineering

Foreword

The Department of Biological and Agricultural Engineering desires that each graduate student receives a broad and comprehensive educational experience. This experience includes social as well as intellectual development to lead students to an increased level of maturity. Certainly, coursework is primary, but social activities—the exploration of the unknown and the exchange of ideas with fellow students and faculty—are also part of the total educational experience.

An additional part of this development process occurs through service to others. Students are encouraged to become involved in all departmental functions including teaching, research, extension, and social activities so that they may obtain the best possible education.

The core of graduate education lies in obtaining technical expertise in an area of specialization. Specifically, the objectives of the Master's and Ph.D. engineering graduate program are for students to:

- Develop the ability to comprehend and apply engineering principles in order to solve problems in research, development and design.
- Obtain sufficient understanding of the mathematical, physical and biological sciences for comprehension of literature in these and related fields.
- Acquire the skills required to use appropriate equipment, including instruments and computers, in solving problems in their areas of interest.
- Achieve the technical competence necessary to teach college-level courses and conduct an adult education program (such as in Cooperative Extension).

In the attainment of the above objectives, graduate students will combine biological or biomedical engineering courses with other engineering fields, the physical sciences, mathematics, statistics and the biological sciences in developing their program of study. The advanced degrees are primarily research degrees awarded for significant creative research or design accomplishment, and not for the completion of a specified number of courses. Therefore, a student's program concentration is on a significant thesis or dissertation problem completed under the supervision of members of the graduate faculty. This complements a program of strong course support to properly address the thesis or dissertation problem.

Admission Requirements

In general, admission to the Department of Biological and Agricultural Engineering graduate program is a three-step process. First, the prospective student must be admitted to graduate standing by the University of Arkansas Graduate School. Second, the student must be accepted into the department's program, which depends on transcripts, recommendations, a statement of purpose, and the following GPA and test scores.

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

- Students to a M.S. program from a B.S. degree in engineering or to a Ph.D. program from a B.S. degree in engineering and a M.S. degree:
    1. A score of 301 (1100 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the Graduate Record Examination (GRE).
    2. A TOEFL score of at least 550 (paper-based) or 213 (computer-based) or 80 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. GPA of 3.00 or higher on the last 60 hours of a B.S. degree or B.S. and/or M.S. degrees.
    4. B.S. degree in engineering from an ABET (Accreditation Board for Engineering and Technology) accredited or equivalent.
- Students to Ph.D. program directly from a B.S. degree in engineering:
    1. A score of 307 (1200 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the GRE.
    2. A TOEFL score of at least 550 (paper-based) or 213 (computer-based) or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. A cumulative GPA of 3.5 or above for undergraduate work.
    4. B.S. degree in engineering from an ABET accredited program or equivalent.

- Students to a M.S. program from a non-engineering B.S. degree:

    1. A score of 301 (1100 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the GRE.
    2. A TOEFL score of at least 550 (paper-based) or 2013 (computer-based) or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. GPA of 3.00 or higher on the last 60 hours of a B.S. degree.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Master of Science in Biological Engineering.

- Students to a Ph.D. program from non-engineering B.S. plus M.S. degrees:

    1. A score of 301 (1100 for the tests taken prior to August 1 , 2011 or above (verbal and quantitative) on the GRE.
    2. A TOEFL score of at least 550 (paper-based) or 213 (computer-based) or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. GPA of 3.00 or higher on the last 60 hours of B.S. and/or M.S. degrees.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Doctor of Philosophy in Biological Engineering.

- Students to a Ph.D. program directly from a non-engineering B.S. degree:

    1. A score of 307 (1200 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) with 155 (700 for the tests taken prior to August 1, 2011) and 4.5 or above in writing on the GRE
    2. A TOEFL score of at least 580 (paper-based) or 237 (computer-based) or 92 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. A cumulative GPA of 3.5 or above for undergraduate work.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Doctor of Philosophy in Biological Engineering.

Finally, a member of the faculty who is eligible (graduate status of group II or higher) must agree to serve as major advisor to the prospective student.

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

GRADUATE STUDENTS

The following students were part of the Graduate program during 2018. Several students cannot be listed due to limitations of the Family Educational Rights and Privacy Act (FERPA). Faculty advisors provided support and planning to the students throughout their career in the Department of Biological and Agricultural Engineering.

MASTER OF SCIENCE IN BIOLOGICAL ENGINEERING

STUDENT	ADVISOR
Morgan Broadbent	Dr. Brian Haggard
Jacob Hickman	Dr. Marty Matlock
Lydia Huck	Dr. Scott Osborn
Patrick Kuczwara	Dr. Jin-Woo Kim
Deanna Mantooth	Dr. Marty Matlock
Andrew Shaw	Dr. Marty Matlock
Lillie Haddock	Dr. Brain Haggard
America Sotero	Dr. Yanbin Li
Brandon Taylor	Dr. Marty Matlock
Vinay Kumar Kalyankar	Dr. Sammy Sadaka
Kyle Lawrence	Dr. Marty Matlock
Marguerita Leavitt	Dr. Benjamin Runkle
Helena Tchoungang Nkeumen	Dr. Jin-Woo Kim
Summer Wilkie	Dr. Marty Matlock
Yiting Xiao	Dr. Jun Zhu

DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

STUDENT	ADVISOR
Prathamesh Bandekar	Dr. Marty Matlock
Bennett Barr	Dr. Benjamin Runkle
Eric Cummings	Dr. Marty Matlock
Jacob Hickman	Dr. Marty Matlock
Jaspreet Kaur	Dr. Jin-Woo Kim

DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

STUDENT	ADVISOR
Abbie Lasater	Dr. Brian Haggard
Kaushik Luthra	Dr. Sammy Sadaka
Colby Reavis	Dr. Benjamin Runkle
Yuanhang Zhan	Dr. Jun Zhu
Xinge Xi	Dr. Yanbin Li

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

GRADUATE DEGREES EARNED

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

Spring 2020
McCarty, James Ph.D.

Fall 2020
Shaw, Andrew MS
Sotero, America MS

Graduate Student Advisees in Other Areas

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

Student	Program	Advisor
Jacob Alberti	Master Science Engineering	Dr. Otto J. Loewer
Joshua Blackstock	Ph.D. Geosciences	Dr. Benjamin Runkle
Christopher Carr	Maters Science Engineering	Dr. Otto J. Loewer
Huang Dai	Ph.D. Zhejiang University	Dr. Yanbin Li
Luke Dinkledine	Master Science Engineering	Dr. Otto J. Loewer
Yawen He	Master Science Zhejiang University	Dr. Yanbin Li
Zhishang Li	Ph.D. Zhejiang University	Dr. Yanbin Li
Aoming Liang	Masters of Science Zhejiang University	Dr. Yanbin Li
Shelly Maddox	Ph.D. Mechanical Engineering	Dr. Jin-Woo Kim
Jacob Marsh	Master Science Engineering	Dr. Otto J. Loewer
Leigh Parette	Ph.D. Poultry Science	Dr. Yanbin Li
Francia Ravelomboia	Ph.D. Crop, Soil and Environmental Sciences	Dr. Chris Henry
Yafang Shen	Ph.D. Zhejiang University	Dr. Yanbin Li
Qi Zhang	Ph.D. Zhejiang University	Dr. Yanbin Li

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

BENG 2632 Biological Engineering Design Studio (Fa) Application of the engineering design process to projects involving living systems. Projects are team-based open-ended design with hands-on construction and testing of design prototypes. Emphasis is placed on understanding, quantifying and controlling complex interacting living systems involving humans, animals, plants and microbes with the goal of creating economically and ecologically sustainable systems. 4 hours of design studio per week. Pre- or Corequisite: PHYS 2054 and BIOL 1543/1541L, and (GNEG 1111 or GNEG 1103).

BENG 2643 Biological Engineering Methods (Sp) Introduction to the tools needed to perform biological engineering design, integrated through projects in the food, energy and/or water area. The tools covered include structured programming language for modeling, statistical analysis, geographic information systems, engineering graphics, and engineering economics. Two hours of lecture and three hours of lab per week. Corequisite: Lab component. Prerequisite: BENG 2632.

BENG 3113 Measurement and Control for Biological Systems (Sp) Principles of sensors, instruments, measurements, controls, and data acquisition systems, with emphasis on applications for biological systems; including basic circuit analysis, sensor calibration and hardware selection. Basic process monitoring and control methods, including hardware and software. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: 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: BENG 2643 and (MEEG 2403 or CHEG 2313).

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

BENG 3723 Unit Operations in Biological Engineering (Sp) Design of basic unit operations typical of biological engineering practice; unit operations include pump-pipe, fan-duct, moist air (psychrometric) processes (cool/heater/humidifier/dryer), air mixing, aeration, and refrigeration; unit operations design will account for unique constraints imposed by biological systems. Lecture 2 hours and lab 3 hours per week. Corequisite: Lab component. Prerequisite: (MEEG 2403 or CHEG 2313) and (CVEG 3213 or CHEG 2133 or MEEG 3503).

BENG 3733 Transport Phenomena in Biological Systems (Fa) Basic principles governing transport of energy and mass. Estimating transfer of energy (heat) through solid bodies and liquid/gas boundary layers through conduction, convection, and radiation. Modeling the rates at which biological reactions occur (kinetics). Estimating the transfer of diffusing mass (gas or liquid) through solid bodies and liquid/gas boundary layers, including processes such as drying and oxygen diffusion. Three hours lecture per week. Pre- or Corequisite: (CVEG 3213 or MEEG 3503 or CHEG 2133.) Prerequisite: (MEEG 2403 or CHEG 2313) and MATH 2584.

BENG 4123 Biosensors & Bioinstrumentation (Odd years, Sp) Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in bioinstrumentation. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component. Prerequisite: BIOL 2013 or BIOL 2533 and BENG 3113.

BENG 450V Special Problems (Sp, Su, Fa) Selected problems in biological engineering are pursued in detail. Prerequisite: senior standing. May be repeated for up to 4 hours of degree credit.

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

BENG 452V Special Topics in Biological Engineering (Irregular) Special topics in biological engineering not covered in other courses. May be repeated for up to 8 hours of degree credit.

BENG 4663 Sustainable Biosystems Designs (Fa) Process and methodologies associated with measuring, assessing, and designing sustainable systems in water, energy and food. Quantitatively rigorous methodology for life cycle analysis (LCA) for inventory, assessment and impact analyses. Use of other systems analyses and process control theory to evaluate and design sustainable systems. Application of the methods to a project to gain experience in defining, quantifying and utilizing sustainable metrics. Three hours of lecture per week. Prerequisite: BENG 3653.

BENG 4703 Biotechnology Engineering (Fa) Introduction to biotechnology topics ranging from principles of microbial growth, mas balances, bioprocess engineering as well as emerging principles in the design of biologically based microbial and enzymatic production systems. Application areas such as biofuels, and fine and bulk chemical production. Lecture 2 hours, laboratory 3 hours per week. Prerequisite: BENG 2632. Corequisite: Lab component.

BENG 4743 Food and Bio-Product Systems Engineering (Fa) Sustainable bio-product engineering through biosystem design, analysis, modeling, control, and optimization. Life cycle phases for bio-products (food, fiber, feed, and fuel). System analysis of inputs and outputs of energy, water and mass for the purpose of producing and processing biomass for human uses. Advanced bioprocess design topics to utilize enzymes, cells, tissues and organisms to create bio-products and methods for deactivating biological agents to preserve the quality and safety of food and other bio-products. Three hours lecture per week. Prerequisite: BENG 3723 and BENG 3733.

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

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

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

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

BENG 4812 Senior Biological Engineering Design I (Fa) Initiation of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Practice in following the design process, including the definition of design objectives and constraints, establishing functions and performance criteria, generating alternatives and evaluating alternatives through analysis, modeling and prototype testing; exploring relevant design considerations including performance, efficiency, costs, environmental impacts, sustainability and stewardship, safety and ethics. Developing analytic capability; and practicing design optimization to find best alternative for the client. Lecture 1 hour, laboratory 3 hours per week. Prerequisite: Instructor consent. Corequisite: Lab component.

BENG 4823 Senior Biological Engineering Design II (Sp) Completion of comprehensive two-semester team-design projects to design processes, devices and systems to meet needs of clients in sustainable water, food and energy. Focus on building of prototypes or models, system optimization, evaluation and improvement. Final design details packaged to meet the needs of the client. Interaction with appropriate persons from other disciplines.Written and oral reporting. Communications with peers, supervisor, clients and the public. Lecture 1 hour per week, two 2-hour lab periods per week. Prerequisite: BENG 4812. Corequisite: Lab component.

BENG 4831. Biological Engineering Professionalism (Fa). Preparation to be job-ready, employable and successful in transition to a professional career and further study in Biological Engineering. Introduction to job and graduate study searches. Professional and ethical responsibilities; professional registration. Conflict, change and project management. Effective communications and interactions with supervisors, peers, clients, and stakeholders. Two hour discussion section per week. Prerequisite: Senior standing.

BENG 4933 Sustainable Watershed Engineering (Sp) Provides students with expertise in using advanced tools in watershed monitoring, assessment, and design. Builds on core competencies in hydrology and hydraulics to allow student to evaluate water used by sector in water management regions; evaluate and quantify water demands by sector with emphasis on irrigation; develop risk-based simulations of hydrologic processes, including precipitation, evapo-transportation, infiltration, runoff, and stream flow; quantify and simulate constituent loading to watersheds using GIS-based models, and understand the applications of these methods in water resource management policy. Three hours lecture per week. Prerequisite: CVEG 3223

BENG 500V Advanced Topics in Biological Engineering (Irregular) (1-6) Special problems in fundamental and applied research. Prerequisite: Graduate standing. May be repeated for up to 6 hours of degree credit.

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

BENG 5253 Bio-Mems (Irregular) Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hour per week. Prerequisite: MEEG 3503 or CVEG 3213 or CHEG 2133. (Same as MEEG 5253)

BENG 5303 Fundamentals of Biomass Conversion (Fa) Web-based overview of the technology involved in the conversion of biomass to energy, including associated sustainability issues. Overview of biomass structure and chemical composition; biochemical and thermochemical conversion platforms; issues, such as energy crop production related to water consumption and soil conservation. Further topics include: biomass chemistry, logistics and resources; biological processes; and thermochemical processes. Two web-based lectures/meetings per week. Prerequisite: Graduate standing or instructor consent.

BENG 5313 Fundamentals of Bioprocessing (Sp) This course covers the fundamentals of mass and energy balances, fluid dynamics, heat and mass transfer, as applied to Bioprocessing. The microbial growth, kinetics and fermenter operation as applicable to Bioprocessing will be covered in this course. Industrial Bioprocessing case studies that involve the integration of the course contents will be discussed. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: MATH 2554, CHEM 3813, and PHYS 2054.

BENG 5323 Bioseparations (Even years, Sp) Study of separations important in food and biochemical engineering such as leaching, extraction, expression, absorption, ion exchange, filtration, centrifugation, membrane separation, and chromatographic separations. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

BENG 5333 Biochemical Engineering (Odd years, Sp) The analysis and design of biochemical processing systems with emphasis on fermentation kinetics, continuous fermentations, aeration, agitation, scale up, sterilization, and control. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent Required.

BENG 5343 Advanced Biomass Thermochemical Conversion (Odd years, Fa) Advanced study, evaluation, and application of thermochemical conversion pathways in biofuel production. Specific topics include biomass gasification, pyrolysis, liquefaction, and heterogeneous catalysts. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

BENG 5351 Sustainability Seminar (Su) Topics in environmental sustainability, green engineering, life cycle analysis, sustainable development and sustainability science. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non -UA faculty member at a participating university. Prerequisite: CHEM 1123.

BENG 5613 Simulation Modeling of Biological Systems (Irregular) Application of computer modeling and simulation of discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 4023 or STAT 4003 or INEG 2313.

BENG 5623 Life Cycle Assessment (Sp) This course will examine the process and methodologies associated with life cycle analysis (LCA). The course will explore the quantitatively rigorous methodology for life cycle inventory (LCI), LCA and life cycle impact assessment (LCIA). This course is offered on-line. The principal instructor will be a UA faculty member.

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

BENG 5703 Design and Analysis of Experiments for Engineering Research (Irregular) Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Students must have an introductory background in statistics. Lecture 2 hours, laboratory 3 hours per week. Corequisite: Lab component.

BENG 5723 Food Safety Engineering (Even years, Fa) Principles of engineering methods applied to food and safety and sanitation. Principles of engineering methods applied to food safety and security. Discussion of thermal, chemical and electrical pasteurization or sterilization in food processing. Demonstration of monitoring and detecting techniques for food safety, including image analysis, biosensors and modeling. Lecture 3 hours per week. Prerequisite: BENG 4103 and FDSC 4123 (or equivalent).

BENG 5733 Advanced Biotechnology Engineering (Odd years, Fa) Applications of the principles of bioprocess/biochemical engineering to microbiological and biomedical problems. Topics include applied enzymology, metabolic engineering, molecular genetics and control, and bioinformatics and nanobiotechnology in addition to classical applied enzyme and cell-growth kinetics and advanced bioreactor design. Prerequisite: BENG 3733 or BENG 4703 or BENG 5743 or equivalent.

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

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

BENG 5923 Nonpoint Source Pollution Control and Modeling (Irregular) Control of hydrologic, meteorologic, and land use factors on nonpoint source (NPS) pollution in urban and agricultural watersheds. Discussion of water quality models to develop NPS pollution control plans and total maximum daily loads (TMDLs), with consideration of model calibration, validation, and uncertainty analysis. Prerequisite: BENG 4903 or CVEG 3223.

BENG 5933 Environmental and Ecological Risk Assessment (Sp) Process and methodologies associated with human-environmental and ecological risk assessments. Environmental risk assessments based on human receptors as endpoints, addressing predominantly abiotic processes. Ecological risk assessments based on non-human receptors as endpoints. Approach using hazard definition, effects assessment, risk estimation, and risk management. Application of methods to student projects to gain experience in defining and quantifying uncertainty associated with human perturbation, management and restoration of environmental and ecological processes.

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

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

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

Eleanor Henson named 2020 Outstanding senior for BENG and College of Engineering

Sammy Sadaka received Paper Named Editor's Pick—Rebecca Bruce, Cereal Chemistry, Advising/Mentoring, National, 2020

Dr. Scott Osborn named fellow in UA teaching Academy

Karl VanDevender John W. White Outstanding Team Award. 2020. To be awarded January 2021. Big Creek Research & Extension Team. Berry, L., Burke, J., Glover, T., Purtle, J., Sharpley, A., Smith, B., VanDevender, K., Webb, P., Willis, Adam.

Faculty Research & Extension Projects

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

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

- Water Resources Center
- Office of Sustainability
- Center for Agricultural and Rural Sustainability
- Watershed Research and Education Center
- Society of Women Engineers (SWE)
- Advancement of Women in Academic Science and Engineering Careers (ADVANCE)
- 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.

Benjamin Runkle 2020 honoree for the rising teaching award, Benjamin Runkle, associate professor of Biological and Agricultural Engineering in the College of Engineering

Runkle joined the U of A's department of biological and agricultural engineering in 2014. He teaches courses in sustainable watershed engineering and modeling environmental biophysics — both senior-level courses in biological engineering. Runkle has:

- Been honored with mentoring awards in 2018, 2019 and 2020 from the Provost's Office and the Office of Nationally Competitive Awards.
- Mentored 2019 Razorback Classic Laura Gray and 2020 Razorback Classic Eleanor Henson

Earned the 2019 Early Achievement in Engineering Education Award from the Biological and Agricultural Engineering Division of ASEE.

He received the CAREER award from the National Science Foundation in 2018 and has been acknowledged with departmental and college teaching and research awards.

- Marty Matlock has been elected to chair the Leaders' Alliance of the National Council for Science and the Environment.
- Marty Matlock, executive director of the University of Arkansas Resiliency Center, has been appointed chair of the Racial Justice Committee for the National Council for Science and the Environment.

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,
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Cooperators:

Steve Tung (Mechanical Engineering Dept.), Zhong Chen (Electrical Engineering Dept.), John Marcy (Poultry Science Dept.), Jingyi Chen (Chemistry and Biochemistry Dept.)

Evaluating Timing of Pure7 Application on Windrowed Litter for Ammonia Mitigation

Yi Liang, Associate Professor

ISSUE:

One of the commonly used litter amendment, aluminum sulfate (Alum), acidifies litter and inhibits ammonia production during the brooding period of broiler growout. It takes about 5 to 7 days for aluminum sulfate to take effect in binding ammonia. A newer product, Pure7, is liquid aluminum sulfate with 7% sulfuric acid. With sulfuric acid in the mix, the hypothesis is that immediate ammonia control could compliment the delayed ammonia control provided by aluminum sulfate. The application time option window and dosage remain to be evaluated to provide a guideline for this Pure7 product.

What Has Been Done:

A field experiment of litter amendments was conducted in six production houses with built-up, windrowed litter on a commercial broiler farm during a winter flock. Two different chemical products (liquid aluminum sulfate versus granular sodium bisulfate) at their different target times for application were used in six houses with windrowed litter. Acidified aluminum sulfate, called Pure 7, was applied at either 30 (two houses) or 25 (one house) gallons/1000 sq. ft. three days prior to chick placement, while sodium bisulfate product, PLT, was applied one day prior to chick placement at either 120 (one house) or 125 (two houses) pounds/1000 sq. ft. Ammonia and carbon dioxide concentrations were continuously monitored over the grow-out period. Litter samples were analyzed for moisture contents and pH values. Ammonia levels dropped sharply immediately after litter amendment application. The higher rate of Pure7 (P7_30+) was able to prevent ammonia from reaching 25 ppm about 3 days longer than the lower rate of Pure7 (P7_25), but did not maintain ammonia below 25 ppm beyond 10 days during the brooding period. pH values of litter sampled two days after Pure 7 applications ranged from 7.9 to 8.0. The result indicated that ammonia mitigation after litter windrowing can be challenging. Gowers should either operate higher ventilation after flattening litter piles for at least four days or employ a level of Pure 7 or PLT higher than the recommended rates in order to maintain a low litter pH to gain the benefits of keeping ammonia level sufficient low when brooding broilers.

Overall Values to Your Clients

With quick and extended ammonia control, Pure7 product provides flexibility to growers thus a greater time option window for application before finishing set-up for chick placement. Results of the study are reported in factsheet and disseminated with agribusiness personnel. The application rates of litter amendment should be high enough to maintain a low litter pH and lower aerial ammonia concentration when managing windrowed litter.

Nanotoolbox Technology for Programmable Self-Assembly of Multifunctional Hierarchical Structures for Biomimetic Advanced Materials and Devices

Jin 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.

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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:
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Sediment Phosphorus Release Sustains Nuisance Algal Blooms

Brian Haggard, Professor

Issue:

If phosphorus supply is low, how is the nuisance algal bloom sustained? This is the question that was asked about one local lake, Partner's Lake in Cave Springs, Arkansas; this lake has nuisance blooms of filamentous algae, while dissolved phosphorus is the water is low. The Arkansas Water Resources Center continues to monitor water quality in lakes in Northwest Arkansas to understand nuisance and harmful algal blooms.

Action:

The Arkansas Water Resources Center, funded by the University of Arkansas System Division of Agriculture, NSF EcoREU Program, and USGS 104B Program, collected water and sediment samples from the local lake. These water samples were analyzed for dissolved and total nutrients plus sestonic chlorophyll-a at its water quality lab, which is certified by the Arkansas Department of Environmental Quality; the sediment cores were used in phosphorus flux experiments and algal growth bioassays. The data was organized, and then sediment phosphorus release and algal growth bioassays showed interesting results.

Impacts:

The Arkansas Water Resources Center showed that sediment phosphorus release rates from the shoreline and deeper lake were significant, despite water samples have negligible dissolved phosphorus. The algae in our experiments reached maximum growth potential with lake sediments, suggesting the dissolved phosphorus from sediments sustained algal growth. This information shows that even when dissolved phosphorus is low in the water that sediment phosphorus release is an important factor in algal growth. Thus, management strategies to improve water quality need to sediments as a potential phosphorus source.

Collaborators:

Bradley J. Austin, Arkansas Water Resources Center, University of Arkansas System Division of Agriculture, Fayetteville, AR
Michelle A. Evans-White, Biology Department, University of Arkansas, Fayetteville, AR
J. Thad Scott, Professor, Biology Department, Baylor University, Waco, TX

Funding:

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Contacts:

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Publications:

Austin, B.J., V. Eagle, M.A. Evans-White, J.T. Scott, and B.E. Haggard. 2020. Sediment phosphorus release sustains nuisance periphyton growth when nitrogen is not limiting. Journal of Limnology 79(3):210–220.

Arkansas Irrigation Yield Contest: A Novel Extension Approach to Promoting Irrigation Conservation

Chris Henry, Associate Professor

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.

Results:

There were 18 soybean, 14 corn, 22 rice entries from south to northeast Arkansas. For the soybean contest, the average effective rainfall was 13.4 inches and the average depth of irrigation applied was 10.2 inches for a total water use of 23.7 ac-in/ac which resulted in an average water use efficiency of 3.48 bu/ac-in. The average yield was 80 bpa for the soybean contest. The winner achieved 64 bpa and 4.34 bu/ac-in using 3.8 inches of irrigation. For reference irrigators report to the Arkansas Natural Resource Commission using 16.3 ac-in/ac of water to soybeans. 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. The corn contest averaged 211 bpa, with an average water use efficiency of 8.07 bu/ac-in and irrigation application depths of 10.4 ac-in/ac. The winner of the contest achieved a yield of 227 bpa, a water use efficiency of 11.59 bu/ac-in using 2.8 ac-in/ac of irrigation. He achieved a high water use efficiency, a high yield and low irrigation application depth. For reference irrigators report to the Arkansas Natural Resource Commission using 18.1 ac-in/ac of water to corn. The winner used a fraction of the expected irrigation needs for corn. The rice contest consisted of a mix of AWD, MIRI, Cascade and furrow irrigated fields, although the most popular system was furrow (16 using furrow). The average yield attained by contestants was 196 bpa with a water use efficiency of 4.6 bu/ac-in using 33.1 ac-in/ac of irrigation. The winner achieved a yield of 240 bpa with a water use efficiency of 8.72 bu/ac-in using only 14.9 ac-in/ac of irrigation. For reference the average yield in the Rice Research and verification program was 186 bpa and the average depth of irrigation applied was 24.6 ac-in/ac. Irrigators report to the Arkansas Natural Resource Commission using an average of 37.0 ac-in/ac of water to rice. This winner achieved a very good rice crop on 60% less water than the expected irrigation needs for rice. Also interesting is that he did this using a cascade flooded levee field, demonstrating what can be accomplished when management is the only IWM tool.

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. 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 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 Agsense.

Irrigation Schools Improve Water Management

Chris Henry, Associate Professor

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:

in 2020 On-farm demonstration has proven that the combined implementation of CHS, surge irrigation and soil moisture sensors can reduce water and energy use by 27%. To accomplish this a series of full day schools were delivered to irrigators, a series of trainings for irrigators was held, one was a surge irrigation school and the other a soil moisture sensor school. Since 2018, 205 participants have attended the surge school and 230 have attended the soil moisture schools for a total of 1025 contact hours. Schools are limited to 20 people per school and these are designed as intense learning environments, with an average of 2-5 contact hours. Four schools were delivered in 2020 for a total of 84 attendees; however, two schools were canceled due to the pandemic. Attendees were represented by 25 counties in Arkansas.

Results:

Evaluations were used to assess the degree of learning, they reported the degree of learning using four categories of none, little, moderate and substantial. Surge irrigation respondents reported moderate to substantial learning of how a valve works (99%) and how to adjust the advance time (99%), the critical skill to effectively use a surge valve. Respondents reported that 40% of their irrigated acres are using CHS and 42% of their acres could use surge irrigation and they planned to use it on 19% of their acres. This is a very high adoption rate because unlike CHS surge valves have a high capital cost ($3500 per 80 acres). Those that attended our schools reported using CHS on 41% of their acres in 2018 but in 2020 adoption increased to 65%. In 2018 attendees used surge irrigation on 3% of their acres but in 2020 participants reported they use surge irrigation on 3.4% of their acres. Soil moisture sensors were used on 12% of their acres in 2018 and participants reported usage on 19% of their acreage in 2020. Soil moisture sensor schools resulted in substantial learning, 87% reported moderate to substantial learning on how to assemble and install soil moisture sensors. Using the mobile app to interpret sensors resulted in 89% of respondents reporting substantial learning about this key skill. Participants were using sensors on 15% of their acres before the workshop and indicated that they could be used on over 32% of their acres. Since most have rice in a rotation this could be interpreted to mean a good portion all of their corn, cotton and soybean acres in 2019. They planned to use soil moisture sensors on 13% of their acres. To supplement the interpretation of soil moisture sensors, a mobile app was developed. Over 374 irrigators are using this app to interpret soil moisture sensor readings and manage their irrigation. A 100% increase in app downloads in 2020.

Impact :

County agent-led Computerized Hole Selection (CHS) programming and Irrigation Water Management (IWM) demonstrations have improved the adoption of Computerized Hole Selection by 83% and adoption is wide spread. Efforts since 2012 have successfully increased the adoption of CHS to 40% where previously it was very low (< 5%). Adoption of surge irrigation and soil moisture sensors is still very low, and these tools are the next step to improving water management practices in the region. The schools resulted in high degrees of learning, but participants only reported modest behavior change of 3% increase in surge acres and 15% acre increase in sensor adoption. However, they reported that the tools could be applied to large portions of their operations. No capital investment is required to implement CHS. Likely the capital investment for surge and sensors is hindering rapid adoption, but that they recognize the tools are applicable to their farms indicates that they will adopt these practices in the future as a result of the schools. These and other efforts have resulted in water savings of over 21 billion gallons annually in Arkansas. Wide-spread adoption of IWM practices will have a dramatic impact on the overdraft of Arkansas aquifers and improve the profitability and sustainability of row crop production.

Contacts:

Chris Henry, University of Arkansas (cghenry@uark.edu) 870-673-2661 Funding Sources: USDA Natural Resource Conservation Service, Arkansas Soybean Promotion Board, Arkansas Corn and Grain Sorghum Promotion Board, US Forest Service and the Arkansas Rice Research and Promotion Board

Collaborators:

Greg Simpson, Paul Francis, Leo Espinoza, Mukhammadzakhrab Ismanov, Philip Gahr

County Agent Collaborators:

Danielle Kurz, Clay Gibson, Mike Andrews, Dave Freeze, Lance Blythe, Steven Stone, Kurt Beaty, John Farabaugh, Phil Horton, Rick Wimberly, Grant Beckwith, Chuck Capps, Russel Parker, Stewart Runsick, Bryce Baldridge, Mike Andrews, Dave Freeze, Cortney Sisk, Jeffrey Works Craig Allen, Keith Perkins,

Adoption of Multiple Inlet Rice Irrigation using a Mobile App

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

What Was Done:
A mobile app, "Rice Irrigation" has been under development since 2012 for Android operating systems and was made available in 2016. An iOS version for apple products was released in January of 2017 and again updated in 2020, they are available on google play and the apple app store for phones and tablets. Most growers have or use Apple products as almost no usage was observed between 2016 and 2017. Awareness of the app has been mostly by word of mouth and twitter, and brief mention at industry meetings. In 2019 an education effort was started to train end users on the app, twenty people attended the two schools. No educational programs were delivered in 2020.

Results:
Previously, evaluations were done to indicated learning outcomes, for all of the skills needed to use the app, respondents indicated between 85% to 100% full understanding of how to complete tasks using the app. About 6% were using MIRI, but respondents indicated that 35% of their acres could use MIRI and that they planned to use the app to plan MIRI on 6% of their acres. Only 7% of MIRI acres use Delta Plastics Pipe Planner, the private sector tool for planning MIRI. To date there are over 506 registered users, up 204 from the 2018 release of the app that have set up 1814 individual fields. Over 16,733 levees were created by users compromising 165,850 acres of MIRI rice. Over 2.6 million feet of lay flat pipe poly pipe have been planned using the app. Impact The 143,730 acres of planned MIRI represents 12% of the 1.4 million rice acres grown in Arkansas. The impact of this implementation is an annual savings of 340 billion gallons of water for an Extension program that has only conducted a handful of small trainings.

Contacts:
Chris Henry, University of Arkansas (cghenry@uark.edu) 870-673-2661 Funding Sources: USDA NRCS. Supported in part by the Arkansas Rice Research and Promotion Board. Previous support was provided by the US Forest Service.

Collaborators:
Shruti Vaman, Greg Simpson

County Agent Collaborators:
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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.uaex.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.

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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.

Best Practice of Rough Rice Drying: Layer Drying

Sammy Sadaka, Associate Professor

Issue:

Numerous on-farm grain drying and storage facilities have been constructed during the past decades. Many of these facilities have more than one-grain bins equipped with high capacity aeration fans that can generate an airflow rate of more than one cubic foot per min per bushel (cfm/bu). Most producers currently use the management technique of filling a single grain bin to the eave. Following, they start the drying process. Subsequently, they begin to fill other bins. There are two possible hazards associated with this technique: the possibility of overdrying the bottom layers and the spoilage occurring at the top due to the excessive moisture content of the grains. Over drying of grain can occur if too much heat is used. If the grain placed in the bin is too wet, spoilage can occur before the drying front reaches the top. Additionally, this technique could be considered the least efficient in energy consumption, and it takes the longest time to dry grain. Accordingly, grain producers who harvest low grain rates (200 to 500 bu/day) or low annual harvest volumes (up to 10,000 bu/year) are looking for alternative drying techniques, such as layer drying.

Action:

The layer drying technique is very comparable to natural air/low-temperature drying, except that the grain bin is filled in layers approximately 4 to 5 feet deep. The first layer of grain is placed in the bin, and drying is started. The drying air temperature should be limited to no more than a 20°F rise above ambient conditions to prevent excessive overdrying. A drying front is initiated, and the grain layer's drying continues until the grain moisture content is reduced to an acceptable moisture level. Other layers of the grains are intermittently added to maintain the wet grain depth on top of the dried grain.

Impact:

The main impact of grain drying in layers is to limit the grain depth and to increase the airflow rate per bushel, which allows drying higher moisture content grains than the system can handle on a full-bin basis. For simplification, in a bin designed for one cfm/bu on a full-bin basis, the airflow rate is estimated to be about four cfm/bu if the bin is one-fourth full.

This technique would help producers maintain grain quality at their highest levels, improve grain drying efficiency, and reduce grain drying and storage cost.

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Collaborating Scientists:

Griffiths Atungulu, and Scott Osborn.

Funding Sources:

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

Utilization of Dehumidified Air as a Drying Agent for Non-Interrupted Drying

Sammy Sadaka, Associate Professor

Issue:

Several midsouth farmers use ambient air for drying rough rice to safe storage moisture content. Accordingly, a significant amount of rough rice grown is dried and aerated in the storage bins using natural air. Arkansas is prone to experience high temperatures and high relative humidity during the harvest and drying season. There has been a considerable problem of rewetting the stored rice and its quality changes in beds during high ambient humidity that could occur and daunts the farmers. Aerating with cold, humid air may cause grain rewetting, especially in the layers near the bin's bottom. Rewetting of rice creates fluctuations in rice's final moisture content that leads to undesirable milled rice quality. It also may lead to storage problems such as spontaneous heating, mold development, and insect infestation. Increased airflow rate by increasing the blower's horsepower and heating the ambient air can be two possible solutions. However, both management practices are costly for farmers to be included in their drying system. Consequently, the high humidity of ambient air could be reduced by dehumidification to achieve continuous drying.

Action:

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

Impact:

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

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Collaborating Scientists:

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Funding Sources:

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

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

Scott Osborn

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 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 2020:
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.

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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).

An alternative approach to measuring turbulent scalar exchange over agricultural landscapes

Benjamin Runkle, Associate Professor

Issue:

Direct measurements of the turbulent exchange of energy, water, carbon, and other scalars are used to test the impact of changes in agricultural practices on adjacent fields. While the eddy covariance (EC) method and large weighing lysimeters are preferred for scientific studies in agricultural landscapes, the required instrumentation and maintenance are expensive. Meanwhile there is increased interest in the sustainable intensification of our agricultural landscapes, and a shift toward new practices must be ground in research on the holistic effects of change on the surface carbon, energy, and water balance.

The surface renewal method of measuring turbulent scalar exchange may offer a cheaper solution via reduced instrumentation and maintenance complexity. The analysis is based on the assumption that coherent structures in the lower atmosphere continuously renew macro-parcels of air that remain, for a characteristic period of time, in contact with the surface. The regular ejection of these parcels after contact represents an exchange of scalars within the atmospheric surface sub-layer. The method assumes these events explain most of the mean turbulent flux of the scalar. However, details of the implementation are still uncertain, particularly in their ability to extend to scalars beyond temperature (such as water vapor or carbon dioxide; CO_2).

Action:

Runkle's research group initiated a series of papers to investigate and extend the surface renewal with special attention to its performance in agricultural landscapes. The method was tested in both cotton and rice crop sites in Arkansas, building on research in these fields using the eddy covariance method[1,2]. The surface renewal work benefited from hosting Spanish scientist Francesc Castellví in Oct-Nov 2017 for a 10 day visit to the University of Arkansas. Together, the group established several approaches: (1) testing the surface renewal technique for its performance measuring temperature, water vapor, and CO_2 dynamics over both of these crop types, including in cases without high frequency wind measurements[3]; (2) testing a new approach to SR for its ability to derive the critical friction velocity term from scalars beyond the tradition wind speed approach[4]; (3) an application of that new approach to flux estimation without the need for wind speed measurements[5]. These methods showed strong promise in their comparison to the eddy covariance standard, and were verified by a comparison of energy balance closure as a quality control metric of reliability.

Outcome:

These papers lays the groundwork for further agricultural experimentation, where each experimental field is measured by cheaper instrumentation, anchored to a single set of eddy covariance instrumentation. Thus the net outcome is a simplified but still robust measurement technique that will enable new forms of field-scale agricultural experimentation to be investigated with a quantitative method.

Selected Collaborators:

Michele Reba, Hydrologist, USDA-ARS, Delta Water Management Research, Jonesboro, AR

Francesc Castellví, Department of Environment and Soil Sciences, University of Lleida

Kosana Suvočarev, formerly a postdoctoral scientist in Runkle's lab, now an Extension Specialist, University of California, Davis

Funding: Data collection and analysis was partially funded through the US Geological Survey (USGS) under Cooperative Agreements G11AP20066 and G16AP00040 administered by the Arkansas Water Resources Center at the University of Arkansas; the US Department of Agriculture, Natural Resources Conservation Service under Cooperative Agreement 68-7103-17-119, and the National Science Foundation (NSF) under Award 1752083. Catellví's visit was supported by projects CGL2015-65627-C3-1-R from the Spanish State Research Agency (AgenciaEstatal de Investigación; AEI) and European Regional Development Fund (FondoEuropeo de Desarrollo Regional; FEDER) of the European Union/ Unión Europea (AEI/FEDER, UE) and RTI2018-098693-B-C31 from the Ministry of Economy and Competitiveness (Ministerio de Economía y Competitividad) of Spain.

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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.

3. †Wu, S. M. Bashir, **J. Zhu**. 2020. Optimize a novel liquid-phase plasma discharge process for biodiesel synthesis from pure oleic acid. Fuel Processing Technology 202: 106368. DOI: https://doi.org/10.1016/j.fuproc.2020.106368.

4. †Cheng, J., C. Zhu, **J. Zhu**, X. Jing, F. Kong, C. Zhang. 2020. Effects of waste rusted iron shavings on enhancing anaerobic digestion of food wastes and municipal sludge. J. Cleaner Production 242: 118195. DOI: https://doi.org/10.1016/j.jclepro.2019.118195.

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

Students Continue Group Projects through the Pandemic

Thomas Costello, Associate Professor

Issue

When the pandemic closed all in-person classes on the UA campus in March 2020, many biological engineering students were in the middle of important team projects. Seniors in BENG 4823 (Senior Design II) were finishing up their two-semester capstone team design projects. Juniors in BENG 3113 (Measurements and Controls) were just beginning a 3-week module in which teams built model biological habitats and implemented monitoring and control hardware and software. The team activities usually require close collaboration with faculty and often utilize hands-on fabrication and testing with prototype systems. With short notice, regular group meetings on campus and direct access to the lab and fabrication shop were curtailed.

Action

Through a rapid response, with support from the UA administration, the faculty, staff and students developed new modalities to keep the work flowing. We often think of engineering design applied to structures and devices, but this scenario provided us with a chance to be creative in developing tactics to continue our work and study, while retaining as much of the hands-on activity as possible, maximizing the educational benefits for students, under the severe constraints of the pandemic. This was a challenge that required a lot of extra effort from the whole team—administration, faculty, staff and students.

Everyone had to learn how to use software platforms to continue to meet remotely, on-line, with live video. The university made immediate technical help (phone, email, on-line chat) available for faculty and students all day, into the evening and on weekends. This was necessary because the work required us to go beyond the traditional work day. Class lectures were streamed live with interactive capability. All students were required to join virtually and the university was able to help students obtain the computer and internet access that they needed. Extra video tutorials, recording of lectures and virtual office hours helped the traditional classroom activities to keep on track.There were particular challenges for teams involved in projects, especially those that included work with physical prototyping, fabrication and testing; as well as project work that required special software only available in our labs. Teams were kept in-tact by regular, frequent scheduled meetings with live video. Faculty and students got comfortable with the new format very quickly and with a commitment to keep up with these connections, teams found that they were able to collaborate, brain-storm, share their findings, spreadsheets and ideas very effectively. spreadsheets and ideas very effectively. Teams, made up of people who are used to face-to-face contact, were now isolated and the scheduled meetings were enthusiastically and faithfully attended. With small groups, the software brings the video images of each person to near life size and participants interacted as if they were in the same room. Meetings were productive. What we missed was sharing a cup of coffee or getting lunch together.

With help from our IT support people, special arrangements were made for students to acquire remote access to specialty software. In BENG 3113 (Measurements and Controls) students were able to access lab computers where limited-seat software (for programmable logics controllers) was installed. This was done with some frustration but students who persisted were able to gain access to the software from home and they were able to do their work. Some prototyping and testing in BENG 4823 (Senior Design II) was completed by students at home after having arranged for the loan of sub-systems and test instruments.

Unfortunately, some routine, hands-on tasks that were planned were not completed in the usual way. In some ways, these conditions provided unexpected educational benefits. Students were forced to visualize their hardware and software systems with more detail and they were required to consider and identify alternate modes of failure, and then to test and improve their designs using their modeling and logical skills. The crutch of trial and error was not so easily available while at home in lock-down.

Impact

Student projects progressed and were completed successfully. One of the senior design teams placed first in a national student design competition hosted by our professional society ASABE. The students did indeed learn and they gained valuable experience. Progress toward degrees was maintained. We gained an enhanced appreciation and affection for our missed colleagues and friends. Personal connections were maintained from a distance and they were valued like an oasis in the desert. Students were witnesses to the potential achievements made when a group of people truly commit to a shared goal.

The UA should be proud of the education provided to these hard-working students. The year 2020 was not typical, there were some losses to grieve, but the graduates from this time will not be hindered. They are ready for the upcoming challenges of 2021 and beyond.

Contact

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

2020 started with great promise for our department then in March 2020 the campus was shut down due to Covid19 concerns. If we had been able to honor our graduates with a reception there would have been a great cake for them. The cake below shows we just had to roll with it.

Congratulations to the Class of 2020!

Undergraduate:

Isablel Arrocha Cordovez
Brynn Bodwell
Samuel Carroll
Patrick Comer
Emily Cuminskey
Conlee Hale
Julie Halveland
Kanaan Hardaway
Eleanor Henson
Wesley Jones
John Lampson
Joseph Mathis
Alex Pentecost
Cady Rosenbaum
Anthony Siebenmorgen
Kira Simonson
Seth Smith
Elizabeth Topping
Clare Yurchak
Lillian Glaeser
Zachary Morgan
Nicholas Cross
Andrew McDaniel
Cade Prince

Graduate:

James McCarty Ph.D.
Andrew Shaw MS
America Sotero MS

Research Grants

The following active grants during 2020 fund research in specific areas.

Arkansas Natural Resources Commission
Dr. Brian Haggard
Water quality monitoring in the Upper Illinois River Watershed and Upper White River Basin
2020
$524,768

U.S. Geological Survey
Dr. Brian Haggard
US Geological Survey 104B Program Grant
2020
$250,000

Water Sampling and Analysis at the West Fork White River
Dr. Brian Haggard
Beaver Water District
2020
$90,778

104B State Water Resources Research Institute Program
Dr. Brian Haggard
U.S. Geological Survey
2020
$678,994

WATER QUALITY TRENDS AND LOGISTICAL SUPPORT
Dr. Brain Haggard
Arkansas Natural Resources Commission
2020
$200,000

USGS 104B FY2019
Dr. Brian Haggard
U.S. Geological Survey
2020
$184,670

Water Quality Monitoring in the Upper Poteau River Watershed
Dr. Brian Haggard
Arkansas Natural Resources Commission
2020
$830,830

ROUTINE WATER QUALITY MONITORING IN BEAVER LAKE WATERSHED, ARKANSAS
Dr. Brian Haggard
Beaver Water District
2020
$18,000

Improving Irrigation Scheduling and Irrigation Efficiency for Corn Production in Arkanss
Dr. Chris Henry
Arkansas Corn and Grain Sorghum Promotion Board
2020
$163,000

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
$80,000

Arkansas Irrigation Yield Contest
Dr. Chris Henry
Arkansas Soybean Promotion Board
2020
$10,000

Maximizing Spatial Resolution of DNA Sequencing Using Single Carbon Chain
Dr. Jin-Woo Kim
NIH
2020
$397,036

A Microscale Power Generator Driven by Tethered Bacterial Flagellar Motors
Dr. Jin-Woo Kim
NSF
2020
$315,000

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
2,317,737

CASE Research Acceleration
Dr. Jin-Woo Kim
Arkansas Economic Development Commission
2020
28,000

Healthy People Healthy Planet, a Food Desert Program at the University of Arkansas at Pine Bluff and Fayetteville, AR
Dr. Kieu Le
USDA-NIFA-CBGP-0073732019
$99,957

Poultry Excellence in China-Improving Food Safety in Poultry Supply Chain
Dr. Yanbin Li
Walmart Foundation
2020
$1,750,000

Poultry Excellence in China-Improving Food Safety in Poultry Supply Chain
Dr. Yanbin Li
Walmart Foundation
2020
$1,600,000

A Portable Biosensor based on Aptamer-cappe d and Dye-loaded Nanocages to Generate Mass and Fluorescence Dual Signals for Rapid Detection of Viruses
Dr. Yanbin Li
ABI
2020
$50,000

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

Managing Crop Residues to Reduce Particulate Matter Emissions
Dr. Yi Liang
AR Department of Environment Quality
2020
$60,000

Effect of Pure7 as Litter Amendment on Ammonia Volatilization in Broiler Production
Dr. Yi Liang
Clear View Enterprises
2020
$10,000

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

Establishing Grain Drying and Storage in Ghana
Dr. Sammy Sadaka
2020
$10,000

Utilization of Ozone Fumigation to Reduce Aflatoxin and Mycotoxins Contamination from Corn
Dr. Sammy Sadaka
Arkansas Corn Board
2020
$138,000

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

2020
$210,000

Extension of: Quantify Changes in Water Quality and Greenhouse Gas Emissions Due to Innovative Rice Production Practices
Dr. Benjamin Runkle
U.S. Department of Agriculture
2020
$67,510

Ground observations of CO2 flux dynamics to support the ACT-America project
Dr. Benjamin Runkle
NASA - Washington
2020
$87,633

Energy Partitioning, Evapotranspiration, and CO2 Exchange of the Forage Component of a Silvopasture System
Dr. Benjamin Runkle
U.S. Department of Agriculture
2020
$12,415

Platform for Multi-modal, Multi-scale Data Integration for Sustainable Agriculture
Dr. Benjamin Runkle
Lawrence Berkeley Lab
2020
$19,819

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

UA Sustainable Nutrient Management
Dr. Karl VanDevender
CES Subcontract of UA AES grant from NRCS
2020
$18,333

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

Combing poultry litter with woody biomass for bioenergy production – method, opportunities, and economic impacts
Dr. Jun Zhu
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2020
$113,418

BOOKS, BOOK CHAPTERS

Books

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