Department of Biological and Agricultural Engineering

2014 Annual Report

UofA
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

COOPERATIVE EXTENSION
1914-2014
100
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EXTENDING KNOWLEDGE CHANGING LIVES

UNIVERSITY OF ARKANSAS

2014 Annual Report
Department of Biological and Agricultural Engineering

Lalit R. Verma
Department Head

University of Arkansas
Division of Agriculture
Mark Cochran
Vice President for Agriculture

Arkansas Agricultural Experiment Station
Clarence Watson Jr.
Associate Vice President for Agriculture Research

Cooperative Extension Service
Tony Windham
Associate Vice President for Agriculture Extension

College of Engineering
John English
Dean

University of Arkansas
G. David Gearhart
Chancellor

Sharon Gaber
Provost and Vice Chancellor for Academic Affairs

Department of Biological & Agricultural Engineering

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FOREWORD

FROM THE DEPARTMENT HEAD

Lalit R. Verma,
Professor and Department Head

It is with sadness we share that two long-time and dedicated members of our departmental family, Drs. Carl Griffis and Ivan Berry passed away in late 2014. Dr. Griffis was a 43-year faculty at UA and served as department head during 1992-97 and 2008-2010. Dr. Ivan Berry was a Professor in the department for 14 years, retiring in 1999. He served as Interim Department Head during 1997-1999. They will both be greatly missed.

I am delighted to share the accomplishments of our faculty, students and staff during 2014. There were 75 undergraduates (sophomores to seniors) and 33 graduate students in 2014. Our departmental academic programs are now in the College of Engineering, with research and extension functions continuing in the UA Division of Agriculture's Agricultural Experiment Station and Cooperative Extension Service, respectively. One outstanding alumnus, Mr. Glenn Davis, was inducted in the Arkansas Academy of Biological and Agricultural Engineering on April 4. The Senior Design Expo, under Dr. Tom Costello's leadership, was held on April 30 with eight senior design students in three teams showcasing their projects.

On May 9, at the College of Engineering Spring Faculty meeting, Drs. Scott Osborn, Julie Carrier, and Yi Liang were recognized with the departmental faculty awards for teaching, research, and service to students, respectively. Ms. Linda Pate, Departmental Administrative Manager was recognized with the Employee of the Semester and also the Employee of the Year awards. One of our senior design teams, mentored by Dr. Tom Costello, won the second prize in the G.B. Gunlogson "*Open*" Student Competition at the 2014 Annual International Meeting of the American Society of Agricultural and Biological Engineers (ASABE) in Montreal, Canada. We were visited for ABET accreditation of our undergraduate program in Biological Engineering in October. The Arkansas Section of ASABE held its 51st Annual meeting in Fayetteville on October 3 with technical presentations and a field tour. Ms. Shelby Paschal and Katie Smith were recognized as our Outstanding Seniors at this event.

BAE research and teaching faculty on the U of A campus, extension colleagues in the state office of the UA System Division of Agriculture's Cooperative Extension Service, and our colleagues at the Rice Research and Education Center in Stuttgart are engaged in addressing problems important and relevant to our state and nation, dealing with challenges in sustainable food, agriculture, water and energy systems in support of the Arkansas agriculture enterprise. These are very much in line with the grand challenges being faced by society in general and our profession is critically important to addressing these challenges.

Dr. Benjamin Runkle joined us as an Assistant Professor and is engaged in *Climate Change* research with emphasis on wetland ecohydrology, and land-atmosphere exchange of CO_2, methane, and water vapor. I had the honor of representing ASABE at the 2014 EuroAgEng Conference in Zurich, followed by concluding my term as President at the 2014 ASABE Annual International Meeting in Montreal in July. Participation in September in the 2014 CIGR Congress in Beijing, China was very enlightening. These forums have provided invaluable global exposure and relationships with individuals related to our profession.

I hope you find this annual report informative and take some time to review our programs (www.baeg.uark.edu). Please continue to support our efforts and feel free to contact us with any suggestions or questions you may have.

Thank you

Lalit R. Verma, Ph.D., P.E.
Professor and Department Head

SIGNIFICANT ACCOMPLISHMENTS IN 2014

PROFESSIONAL AND ADMINISTRATIVE STAFF

- Julie Carrier presents at the 48th Annual Convention of Indian Society of Agricultural Engineers (ISAE).
- Julie Carrier serves as Scientific panel manager for the Quebec Government.
- Julie Carrier receives College of Engineering Outstanding Researcher
- Jin-Woo Kim receives the John W. White Outstanding Research Award
- Jin-Woo Kim presented at 2014 Fall i-bio Seminar by the School of Interdisciplinary Bioscience and Bioengineering, Pohang University of Science and Technology (POSTECH)
- Yanbin Li patented his project "a Capillary– Column– Based Bioseparator/Bioreactor with an Optical/ Electrochemical Detector for Detection of Microbial Pathogens."
- Yanbin Li presented at Shenyang Agricultural University and at the 2nd International Summit on Precision Agriculture.
- Yi Liang receives College of Engineering Outstanding Service to Students
- Scott Osborn receives the Dale Bumpers College Alumni Society Advising Award
- Scott Osborn and Marty Matlock patented their project "System and Method for Dissolving Gases in Fluids and for Delivery of Dissolved Gases"
- Scott Osborn receives College of Engineering Outstanding Teacher
- Benjamin Runkle presented at the 3rd General Assembly of the PAGE21 project
- Sammy Sadaka receives Outstanding Researcher Award 2014
- Dharmendra Saraswat receives the John W. White Outstanding Extension State Faculty Award
- Dharmendra Saraswat was named 2014 Fellow of Indian Society of Agricultural Engineers.
- Lalit Verma receives Biological Systems Engineering Hall of Fame Inductee
- Lalit Verma receives James R. and Karen A. Gilley Academic Leadership Award
- Lalit Verma was named a 2014 Fellow of Indian Society of Agricultural Engineers

ALUMNI ACCOMPLISHMENTS

- Glen Davis were inducted into the Arkansas Academy of Biological and Agricultural Engineering

Significant Accomplishments in 2014

Students

- Russell Bair was recognized as a First Ranked Senior Scholar from College of Engineering.
- Zach Callaway won 1st Place in PhD posters in Gamma Sigma Delta 2014 Students Competition. His advisor was Dr. Yanbin Li
- Kalavathy Rajan won first place in the A2C Graduate Student Research Competition. Her advisor is Dr. Danielle Julie Carrier.
- Grace Richardson named New Face of Engineering for DiscoverE (Engineers Week)
- Gurdeep Singh won second place in the A2C Graduate Student Research Competition. His advisor is Dr. Dharmendra Saraswat.
- R. Bair, T. M. McVey , C. Reavis, D. Smith. 2014. "Design an Anaerobic Digester to Produce Fuel from Food Wastes to Power Campus Transit Buses". Second place, G.B. Gunlogson National Student Design Competition, held at the 2014 annual international conference of the American Society of Agricultural and Biological Engineers (ASABE), Montreal, Canada, July 13-17, 2014. Faculty mentor: T. A. Costello.
- The freshman engineering program honors symposium award best paper, presentation and poster in various categories at the annual event – Dr .Haggard's team won best presentation in the environment and energy category in 2014
- Rossetti, M.S. and N.K. Ownby. The potential release of phosphorus in floodplains. Best Presentation, Environment and Energy Section, FEP Honors Symposium, Spring 2014. This research was also published in the journal, Discovery – The Undergraduate Research Journal of the Dale Bumpers College of Agricultural, Food and Life Sciences. The advisor is Dr. Brian Haggard.
- Sardar Abdullah, Ph.D. Student in Cell and Molecular Biology won the 3rd place of the 2014 Ph.D. Student Oral Presentation Competition sponsored by the Arkansas Chapter of Gamma Sigma Delta (***GSD***), March 12, 2014, Fayetteville, AR. His presentation title is "Aptamer and mmicroelectrode based impedance assay for detection of H5N1 influenza virus". His advisor is Dr. Yanbin Li.
- Lizhou Xu, Ph.D. Student in Biosystems Engineering won the 2nd place of AOCABFE 2014 Graduate Research Papers Competition, July 13-16, 2014, Montreal, Canada. His paper title is "A fluorescent aptasensor coupled with nanobeads-based immunomagnetic separation for simultaneous detection of four foodborne pathogens". Hi advisor is Dr. Yanbin Li.
- Zach Callaway, Ph.D. student in Biological Engineering won the SFC Intervention Honorable Mention Poster Award in AAFP 2014 Research Poster Competition, September 11-13, 2014, Fayetteville, AR. His paper title is "Modeling the electromagnetic properties of bacterial cells with different materials immobilized on microelectrodes in impedance biosensors". His advisor is Dr. Yanbin Li.
- Lizhou Xu, Ph.D. student in Biosystems Engineering won the Vivione Biosciences Rapid Detection Methods Poster Award in AAFP 2014 Research Poster Competition, September 11-13, 2014, Fayetteville, AR. His paper title is "A fluorescent aptasensor coupled with nanobeads-based immunomagnetic separation for simultaneous detection of four foodborne pathogens". His advisor is Dr. Li.
- Sardar Abdullah, Ph.D. student in Cell and Molecular Biology won the J.B. Hunt Honorable Mention Poster Award in AAFP 2014 Research Poster Competition, September 11-13, 2014, Fayetteville, AR. His presentation title is "Aptamer and microelectrode based impedance assay for detection of H5N1 influenza virus". His advisor is Dr. Yanbin Li
- Meng Xu, Ph.D. student in Biological Engineering, won the 2nd Place of Graduate Research in Food Science in University of Arkansas 2014 Graduate Student Research Poster Competition, November 14, 2014, Fayetteville, AR. His paper title is "Screen-printed electrode based aptasensor for rapid detection of E. coli O157:H7 in foods". His advisor is Dr. Yanbin Li.
- Freshman Honors Research team, Indran Kamalanathan and Isabelle Pumford won best paper award for College of Engineering Freshman Honors Colloquium Environment Section. Their advisor is Dr. Scott Osborn.

Danielle Julie Carrier, Ph.D.
Professor
B.S.(1984) McGill University, Canada
M.S. (1986) McGill University, Canada
Ph.D. (1992) McGill University, Canada
Research Areas: Processing of biological materials, biomass saccharification, inhibitory product characterization, compound fractionation and purification and biorefinery co -products development.

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

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

Christopher Henry, Ph.D., P.E.
Assistant Professor, Extension
B.S. (1996) Kansas State University
M.S. (1998) Kansas State University
Ph.D. (2009) University of Nebraska
Research Areas: Development and implementation of statewide integrated research and Extension programs in irrigation water management and water quality; develop curricula and training materials for educational programs in water management for cropping systems, performance and energetics, irrigation systems, and water quality impacts; investigate and develop solutions for reduction of pollutant loads with respect to gulf hypoxia; work with other UA personnel to develop and demonstrate irrigation and farming practices that address environmental, production, and economic considerations; develop and maintain positive working relationships with other government agencies and industries.

Jin-Woo Kim, Ph.D.
Professor
B.S. Ch.E. (1986) Seoul National University, Korea
B.S. Microbiology (1991) University of Iowa
M.S. Biology (1994) University of Wisconsin
Ph.D. Ag.E. (1998) Texas A&M University
Research Areas: Biotechnology engineering, biomedical engineering, biocatalysis technology, environmental biotechnology, nucleic acid technology, and nano-biotechnology.

Mansoor Leh, Ph.D.
Instructor
B.S. Civil Engineering (2001) Kwame Nkrumah University of Science & Technology, Ghana
M.S. Biological Engineering (2006) University of Arkansas
Ph.D. Biological Engineering (2011) University of Arkansas

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
Ph.D. Ag.E. (1989) Pennsylvania State University
Research Areas: Biotechnology engineering, biomedical engineering, biosensor technologies, microbial predictive modeling, quantitative risk assessment, and antimicrobial technologies.

Yi Liang, Ph.D.
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; grain drying, handling, and storage systems; linkages among technology, economics and societal values.

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

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

Scott Osborn, Ph.D., P.E.
Associate Professor
B.S. Ag.E. (1984) University of Kentucky
M.S. Ag.E. (1987) University of Kentucky
Ph.D. Bio & Ag.E. (1994) North Carolina State University
Research Areas: Biotechnology engineering, ecological engineering, dissolved oxygen and ozone technologies, Biological Modeling, drying and energy processes.

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

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

Dharmendra Saraswat, Ph.D.
Associate Professor / Extension Engineer—Geospatial
B.S. Ag.E. (1988) Allahabad University, India
M.S. Ag.E. (1990) Indian Agricultural Research Institute, India
Ph.D.(2007) Ohio State University
Research Areas: Geospatial analysis, mobile-, web-, and cloud-based system design and development, precision agriculture for nursery plants and row crops, bio-Energy, and watershed modeling.

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

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

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

JULIAN ABRAM
Program Technician

RANDY ANDRESS
Program Associate

PRATHAMESH BANDEKAR
Research Associate

HOLLY BEASON
Administrative Support Supervisor, Extension

ERIC CUMMINGS
Program Associate

STACI HUDSPETH
Department Fiscal Manager

JERRY JACKSON
Skilled Tradesman

MANSOOR LEH
Instructor

JAMES MCCARTY
Research Associate

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RIFATI RAINDRIATI
Administrative Specialist III

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JIACHENG SHEN
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ARVIND SINHA
Post Doctoral Associate

ERIN SCOTT
Program Associate

KAREN WITHERS
Administrative Office Supervisor, Extension

RONGHUI WANG
Post Doctoral Associate

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US Army Corps of Engineers

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Garver Engineering

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Manager of Environmental Quality
Beaver Water District

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Randy Young
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Stormwater Project Manager, Walmart

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VP of Operations
Pacific Vet Group-USA

Rusty Tate
Garver Engineering

Active Academy Members

David Anderson
B.S. ('70)

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

Howard B. Austin
B.S. ('56)

Greg Baltz
B.S. ('80)

Pat Bass
B.S. ('76)

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

John L. Bocksnick
B.S. ('76), M.S. ('78)

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

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

Robert Chatman
B.S. ('71)

Randy Childress
B. S. ('85)

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

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

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

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

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

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

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

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

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

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

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

Darrell Holmes
B.S. ('81)

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

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

Jeff Keeter
B.S. ('84)

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

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

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

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

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

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

Bruce Netherton
B.S. ('60)

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

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

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

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

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

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

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

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

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

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

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

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

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

Marcus Tilly
B.S. ('00)

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

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

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

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

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

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

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

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

Honorary Academy Members

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

Albert H. Miller
Posthumously

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

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

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

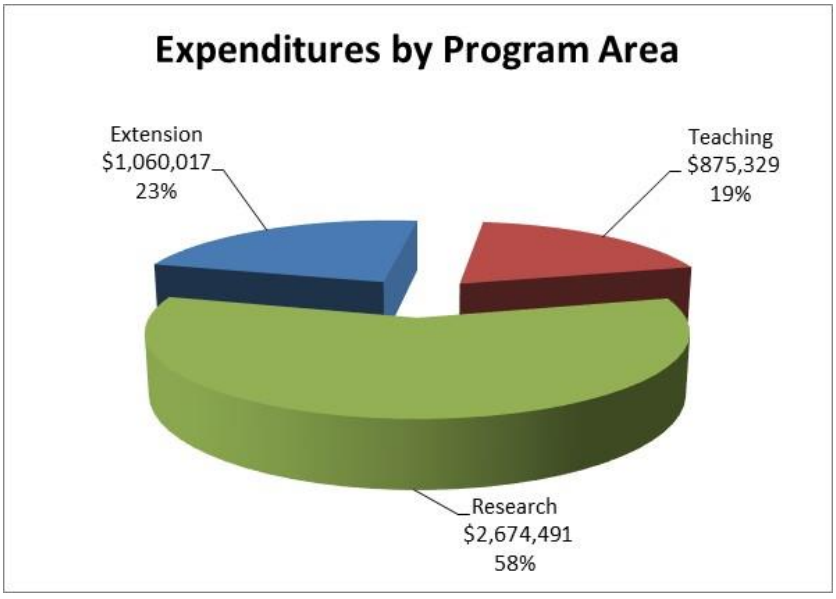
Carl L. Griffis
B.S. ('63), M.S. ('65), Ph.D. ('68)

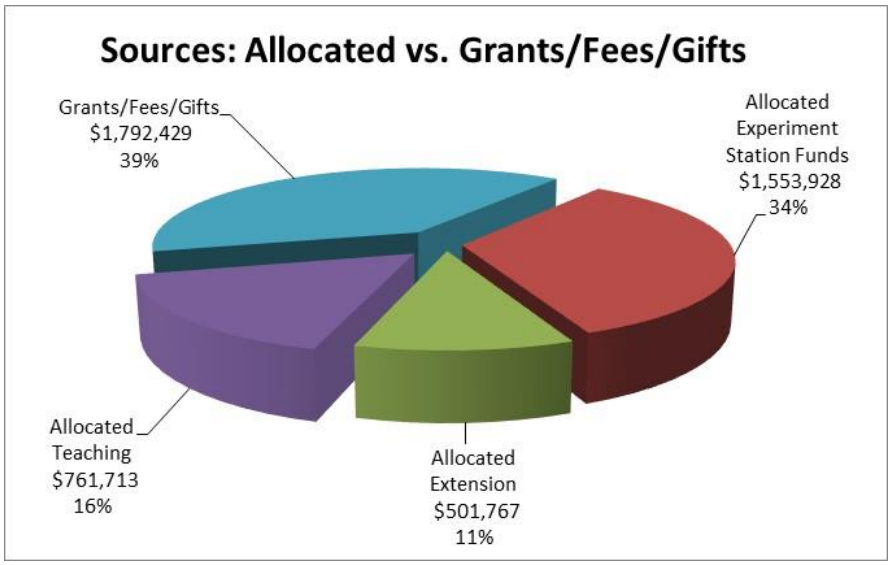
Freddie C. Stringer
B.S. ('70)

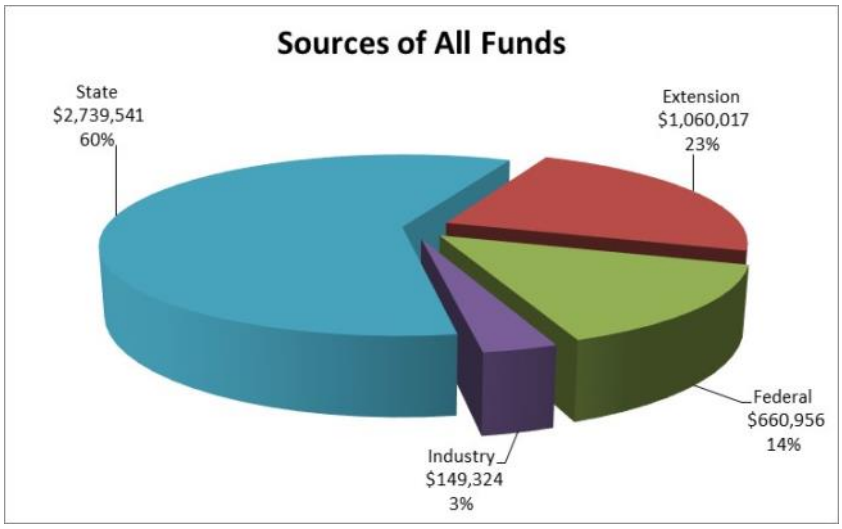
2015 Academy Inductees

Glenn Davis
B.S. ('67)

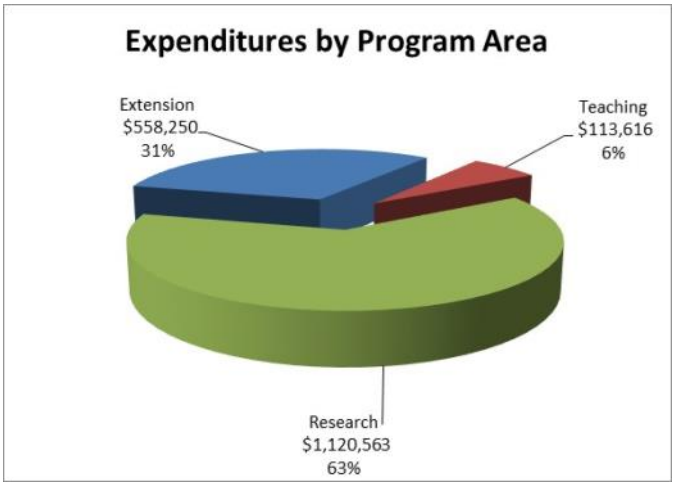
Total Expenditures, July 1, 2014 to June 30, 2015
$4,609,837

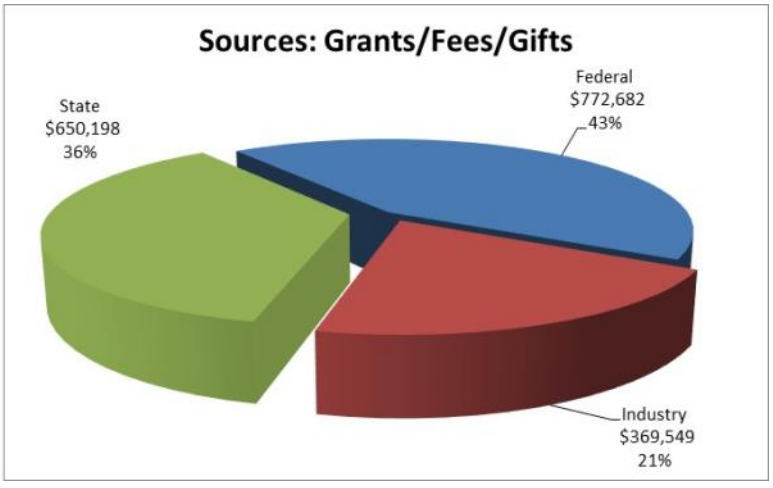






GRANTS/FEES/GIFTS
$1,792,429





University of Arkansas

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

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

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

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

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

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

Department of Biological & Agricultural Engineering

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

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

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

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

DEPARTMENT OF BIOLOGICAL & AGRICULTURAL ENGINEERING

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

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

CITY OF FAYETTEVILLE AND NORTHWEST ARKANSAS

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

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

According to the 2010 census, Fayetteville has a population of 73,580 and is the third most populous city in Arkansas. It boasts a proud history, with several notable residents including authors Ellen Gilchrist (*In the Land of Dreamy Dreams*, 1981) and Donald Harrington (*The Cherry Pit*, 1965), Arkansas U.S. Senators J. William Fulbright and David Pryor, poet Miller Williams and his Grammy Award-winning songwriter daughter Lucinda, and noted architect E. Fay Jones.

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

Many industry giants consider Northwest Arkansas home. Bentonville based Wal-Mart, is the world's largest public corporation by revenue, according to the 2008 Fortune Global 500. Founded by Sam M. Walton in 1962, it is the largest private employer in the world and the fourth largest utility or commercial employer. Lowell is the home for J.B. Hunt Transport Services, Inc., one of the largest truckload transportation companies in the United States, with annual revenues of over $2 billion. Tyson Foods, Inc. is based out of Springdale and is the world's largest processor and marketer of chicken, beef, and pork. With 2005 sales of $26 billion, Tyson Foods is the second-largest food production company in the Fortune 500, the largest meat producer in the world, and according to Forbes one of the 100 largest companies in the United States.

Teaching Program

Undergraduate Program

Scholarship Recipients for 2014

Arkansas Academy of Biological & Agricultural Engineering Scholarship

Russell Bair
Jacob Hickman
Paul Naegle
Khoa Thai
Arlena Tran
Sarah Witrz

Biological & Agricultural Engineering Departmental Scholarship

Kyle Lawrence
Lee Nosal
Khoa Thai

Billy Bryan Scholarship

Kelli Barker
Benjamin Matthews
Arlena Tran

J.A. Riggs Tractor Company Scholarship

Colby Reavis
Jacob Allen Hickman
Thomas Matthew McVey
Sarah Elizabeth Wirtz

Xzin McNeal Scholarship

Kelli Barker
Barrett Knutson
Lee Nosal
Jared Schenebelen
Lyndsey Nicole Copley
Aya El-Khouly
Clayton Dean Shook
Sarah Elizabeth Wirtz

John W & Trannye Odom White Scholarship

Kyle Lawrence
Sarah Elizabeth Wirtz

Mike & Yvonne Jones Scholarship

Shelby Owens

Beaver Water District

Andrew Stephens

Graduates for 2014

Bachelor of Science in Biological Engineering

Spring 2014

Justin Angel
Russell Bair
Matthew Martin
Colby Reavis
Zach Simpson
Deandrae Smith

Summer 2014

Megan Acord
Rian Eddins
Nicholas Lombardo

Fall 2014

Thomas McVey

Biological Engineering Student Club

2014-2015 Officers

Shelby Paschal—*President*

Katie Smith—*Vice President*

Arlena Tran—*Treasurer*

Andrew Dugan—*Secretary*

Trent McKenzie—*Public Relations*

Advisor: Dr. Scott Osborn

MASTER OF SCIENCE AND DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

FOREWORD

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

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

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

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

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

ADMISSION REQUIREMENTS

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

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

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

Teaching Program

Undergraduate Program

The department's mission is: *Healthy Planet, Healthy People*. Biological Engineers improve people's lives today and help assure a sustainable quality of life for tomorrow. They create solutions to problems by coupling living systems (human, plant, animal, environmental, food, and microbial) with the tools of engineering and biotechnology. Biological engineers improve human health; ensure a safe, nutritious food supply; and secure a healthy and safe environment. The department focuses on engineering design that promotes sustainable production, processing and management of food water and energy. A Bachelor of Science degree in biological engineering is a job-ready degree with opportunities in many industries, government agencies, and consulting firms. It is also excellent preparation for medical, veterinary, dental or other health science professional school as well as M.S. and Ph.D. studies in engineering in other areas.

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

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

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

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

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

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

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

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

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

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

accredited program or equivalent.

B. **Students without an Engineering Degree**

- Students to a M.S. program from a non-engineering BS degree:
    1. A score of 301 (1100 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) on the GRE
    2. A TOEFL score of at least 550 (paper-based) or 2013 (computer-based) or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. GPA of 3.00 or higher on the last 60 hours of a B.S. degree.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Master of Science in Biological Engineering.
- Students to a Ph.D. program from non-engineering B.S. plus M.S. degrees:
    1. A score of 301 (1100 for the tests taken prior to August 1 , 2011 or above (verbal and quantitative) on the GRE.
    2. A TOEFL score of at least 550 (paper-based) or 213 (computer-based) or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. GPA of 3.00 or higher on the last 60 hours of B.S. and/or M.S. degrees.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Doctor of Philosophy in Biological Engineering.
- Students to a Ph.D. program directly from a non-engineering B.S. degree:
    1. A score of 307 (1200 for the tests taken prior to August 1, 2011) or above (verbal and quantitative) with 155 (700 for the tests taken prior to August 1, 2011) and 4.5 or above in writing on the GRE
    2. A TOEFL score of at least 580 (paper-based) or 237 (computer-based) or 92 (Internet-based). This requirement is waived for applicants whose native language is English or who earn a Bachelor's or Master's degree from a U.S. institution.
    3. A cumulative GPA of 3.5 or above for undergraduate work.
    4. Completion of 18 hours of engineering course work (listed below under Degree Requirements). Also see additional information below under the Admission Requirements for Doctor of Philosophy in Biological Engineering.

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

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

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

GRADUATE STUDENTS

The following students were part of the Graduate program during 2014. Several students cannot be listed due to limitations of the Family Educational Rights and Privacy Act (FERPA). Faculty advisors provided support and planning to the students throughout their career in the Department of Biological and Agricultural Engineering.

MASTER OF SCIENCE IN BIOLOGICAL ENGINEERING

STUDENT	ADVISOR
Adrian Beirise	Dr. G. Scott Osborn
Jason Corral	Dr. Brian Haggard
Noaa Frederick	Dr. Julie Carrier
Jaime Gile	Dr. Brian Haggard
Nathan Holeman	Dr. Thomas Costello
Eeshan Kumar	Dr. Dharmendra Saraswat
James McCarty	Dr. Marty Matlock
William Merritt McDougall	Dr. Chris Henry
Colt Oade	Dr. Chris Henry
Sakura Phansiri	Dr. G. Scott Osborn
William Putman	Dr. Marty Matlock
Grace Richardson	Dr. G. Scott Osborn
George Sakhel	Dr. Jin-Woo Kim
Richard Sakul	Dr. Julie Carrier
Zachary Simpson	Dr. Brian Haggard
Yixiang Wang	Dr. Yanbin Li
William Morgan Welch	Dr. Brian Haggard

MASTER OF SCIENCE IN CELL AND MOLECULAR BIOLOGY

STUDENT	ADVISOR
Charles Armistead	Dr. Jin-Woo Kim

DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

STUDENT	ADVISOR
Zachary Callaway	Dr. Yanbin Li
Eric Cummings	Dr. Marty Matlock
Angele Mezindjou Djioleu	Dr. Julie Carrier
John Judkins	Dr. Jin-Woo Kim
Mahmoud Sharara	Dr. Sammy Sadaka
Gurdeep Singh	Dr. Dharmendra Saraswat
Gagandeep Singh Ubhi	Dr. Sammy Sadaka
Meng Xu	Dr. Yanbin Li

DOCTOR OF PHILOSOPHY IN CELL AND MOLECULAR BIOLOGY

STUDENT	ADVISOR
Sardar Abdullah	Dr. Yanbin Li
Xiaofan Yu	Dr. Yanbin Li

GRADUATE DEGREES EARNED

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

SPRING 2014
Eric Boles MSBE

SUMMER 2014
Grace Richardson MSBE
George Sakhel MSBE

FALL 2014
Yixiang Wang MSBE
William Morgan Welch MSBE

Teaching Program

Graduate Program

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
Chase Armistead	Master Science Cell and Molecular Biology	Dr. Jin-Woo Kim
Jacob Anderson	Master Science Horticulture	Dr. Brian Haggard
Winfred Akoetey	Master Science Food Science	Dr. Danielle Julie Carrier
Joseph N. Batta-Mpouma	Master Science Microelectronics-Photonics	Dr. Jin-Woo Kim
Bryant Baker	Master Science Environmental Soil and Water Science	Dr. Brian Haggard
Nick Booth	Master Science Engineering	Dr. Marty Matlockj
Tara Lynn Johnson	Master Science Agriculture Economic	Dr. Brian Haggard
Mouli Koppolu	Master Science Computer Science Computer Engineering	Dr. Dharmendra Saraswat
Dhivya Kumar	Master Science Computer Science Computer Engineering	Dr. Dharmendra Saraswat
Austin Lewis	Medical Doctor ASU University	Dr. Chris Henry
Zhishang Li	Master Science Zhejiang University	Dr. Yanbin Li
Margaret Rawls-Lombarno	Master Science Engineering	Dr. Marty Matlock
Josue Nahun Leiva Lopez	Master Science Horticulture	Dr. Dharmendra Saraswat
Jeffery Purdy	Master Science Engineering	Dr. Marty Matlock
Kamil Rosales Rodriguez	Master Science Crop Soil Environmental Sciences	Dr. Dharmendra Saraswat
Nathaniel Sheehan	Master Science Engineering	Dr. Marty Matlock
Nikhil Thomas	Master Science Computer Science Computer Engineering	Dr. Dharmendra Saraswat
Joseph Wyatt	Master Science Biomedical Engineering	Dr. Thomas Costello
Xiangning Xiao	Master Science Zhejiang Univeristy	Dr. Yanbin Li
Hou Min Zhong	Master Science Food Science	Dr. Scott Osborn
Zeina Al-Dolami	PhD Microelectronics-Photonics	Dr. Jin-Woo Kim
Maryam Asharour	PhD Chemical Engineering	Dr. Thomas Costello
Alex Aviram	PhD Chemical Engineering	Dr. Danielle Julie Carrier
Hua Bai	PhD Crop, Soil & Environmental Science	Dr. Chris Henry
Sandeep Chalamalasetty	PhD Mechanical Engineering	Dr. Yanbin Li
Huang Dai	PhD Zhejiang University	Dr. Yanbin Li
Lamine Diop	PhD Ohio State University	Dr. Chris Henry
Rebecca Gill	PhD Cell and Molecular Biology	Dr. Yanbin Li
Qinqin Hu	PhD Zhejiang University	Dr. Yanbin Li
Zhanming LI	PhD Zhejiang University	Dr. Yanbin Li
Dustin Lynch	PhD Biology	Dr. Brian Haggard
Alex Lopez	PhD Chemical Engineering	Dr. Danielle Julie Carrier
Laryna Masniuk	PhD in Biomedical Engineering	Dr. Yanbin Li
Abdollah Mosleh	PhD Microelectronics-Photonics	Dr. Jin-Woo Kim
Sangeeta Mukhopadhyay	PhD Food Science	Dr. Scott Osborn
Leigh Parette	PhD Poultry Science	Dr. Yanbin Li
Zahohui Qian	PhD Zhejiang University	Dr. Yanbin Li
Kalavathy Rajan	PhD Food Science	Dr. Julie Carrier & Dr. Thomas Costello
Ling Wang	PhD Zhejiang University	Dr. Yanbin Li
Amie West	PhD Environmental Dynamics	Dr. Brian Haggard
Lizhou Xu	PhD Zhejiang University	Dr. Yanbin Li

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

BENG4933 Sustainable Watershed Engineering (Sp) Provides students with expertise in using advanced tools in watershed monitoring, assessment, and design. Builds on core competencies in hydrology and hydraulics to allow student to evaluate water used by sector in water management regions; evaluate and quantify water demands by sector with emphasis on irrigation; develop risk-based simulations of hydrologic processes, including precipitation, evapo-transportation, infiltra-

tion, runoff, and stream flow; quantify and simulate constituent loading to watersheds using GIS-based models, and understand the applications of these methods in water resource management policy. Three hours lecture per week. Prerequisite: CVEG 3223 or BENG 4903.

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

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

BENG5253 Bio-Mems (Irregular) Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hour per week. Prerequisite: MEEG 3503 or CVEG 3213 or CHEG 2133. (Same as MEEG 5253)

BENG5303 Fundamentals of Biomass Conversion (Fa) Web-based overview of the technology involved in the conversion of biomass to energy, including associated sustainability issues. Overview of biomass structure and chemical composition; biochemical and thermochemical conversion platforms; issues, such as energy crop production related to water consumption and soil conservation. Further topics include: biomass chemistry, logistics and resources; biological processes; and thermochemical processes. Two web-based lectures/meetings per week. Prerequisite: Graduate standing or instructor consent.

BENG5313 Fundamentals of Bioprocessing (Sp) This course covers the fundamentals of mass and energy balances, fluid dynamics, heat and mass transfer, as applied to Bioprocessing. The microbial growth, kinetics and fermenter operation as applicable to Bioprocessing will be covered in this course. Industrial Bioprocessing case studies that involve the integration of the course contents will be discussed. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non -UA faculty member at a participating university. Prerequisite: MATH 2554, CHEM 3813, and PHYS 2054.

BENG5323 Bioseparations (Even years, Sp) Study of separations important in food and biochemical engineering such as leaching, extraction, expression, absorption, ion exchange, filtration, centrifugation, membrane separation, and chromatographic separations. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

BENG5333 Biochemical Engineering (Odd years, Sp) The analysis and design of biochemical processing systems with emphasis on fermentation kinetics, continuous fermentations, aeration, agitation, scale up, sterilization, and control. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent Required.

BENG5343 Advanced Biomass Thermochemical Conversion (Odd years, Fa) Advanced study, evaluation, and application of thermochemical conversion pathways in biofuel production. Specific topics include biomass gasification, pyrolysis, liquefaction, and heterogeneous catalysts. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: Instructor Consent.

BENG5351 Sustainability Seminar (Su) Topics in environmental sustainability, green engineering, life cycle analysis, sustainable development and sustainability science. This course is offered on-line in collaboration with the AG*IDEA consortium of land grant universities. The principal instructor will be a non-UA faculty member at a participating university. Prerequisite: CHEM 1123.

BENG5613 Simulation Modeling of Biological Systems (Irregular) Application of computer modeling and simulation of discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing com-

plex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 4023 or STAT 4003 or INEG 2313.

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

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

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

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

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

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

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

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

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

BENG5953 Ecological Engineering Design (Fa) Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bioswales, retention basins, filter strips. Design of sustainable ecological processes for the treatment and utilization of wastes/residues. Techniques may include: direct land application to soils/crops, composting systems, lagoons and constructed wetlands. Design goals include optimization of ecological services to maintain designated uses of land, water and air; including enhancement of habitat for wildlife and recreation, and the discovery of economically viable methods for co-existence of urban and agricultural land uses. Lecture 3 hours per week. Students may not earn credit for both BENG 5953 and BENG 4923. Prerequisite: BENG 4903 or equivalent.

BENG600V Master's Thesis (Sp, Su, Fa) (1-6) Prerequisite: Graduate standing.

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

FACULTY RESEARCH & EXTENSION PROJECTS

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

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

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

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

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

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

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

DANIELLE JULIE CARRIER, PROFESSOR

ISSUE:
Although horizontal drilling can provide oil and gas supplies, sustainable energy still needs to be developed from a long-term perspective, especially due to the volatility of oil markets that are currently experienced. One pathway for sustainable energy production is the biochemical deconstruction of feedstocks into sugars, which can then be fermented to biobased fuels or chemicals. This approach requires pretreatment of biomass prior to enzymatic hydrolysis. Our laboratory is working on two main themes related to this subject. Firstly, plant secondary metabolites are extracted prior to pretreatment and tested for antimicrobial and antioxidant properties. In addition of providing a value-added slipstream, the extraction of secondary metabolites could decrease the toxicity of pretreatment hydrolyzates. The second theme is devoted to understanding biomass pretreatment, specifically, determining which of the pretreated-generated compound(s) inhibit enzymatic hydrolysis. These inhibitory compounds include, but are not limited to, furfural, acetic acid and formic acid, and lignin-derived phenolic compounds, and oligomers. The listed inhibitory compounds inhibit the sugar release step, which, in turn, impedes the conversion of biomass into biofuels or other biobased products. Understanding how to release the sugars from biomass, without producing the plethora of inhibitory compounds, is critical for maximizing biofuel and biobased production yields.

ACTION:
Plants currently tested for antimicrobial and antioxidant properties are sweetgum and loblolly pine, which are tested for inhibitory activity of food safety related microorganisms and inhibition of low density lipoprotein oxidation. Our long-term goal is to develop extraction procedures that enable the production of value-added slipstreams. In terms of pretreatment hydrolyzate characterization, our group is studying herbaceous (switchgrass), agricultural residue (rice straw), and wood (poplar, pine and sweetgum) biomass. We pretreat in dilute acid or hot water and enzymatically hydrolyze the biomass, calculate the sugar recovery, and track the release of inhibitory compounds. We are determining the effect of these inhibitory compounds on the enzymatic hydrolysis system, namely, endo-cellulase, exo-cellulase and β-glucosidase. Our long-term goal is to determine which compounds are key players in causing inhibition to the enzymatic system, and through pretreatment processing conditions minimize their release.
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IMPACT:
The payoff is quite important in the sense, that the creation of value-added slip streams, the increase of sugar release and a the decrease of inhibitory compound concentration(s) will set the stage for better use of our biomass resources. In other words, more biobased fuels or chemicals will be produced from a said amount of feedstock.

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FUNDING SOURCES:
NSF EPSCoR – P3, ASTA, and DOT.

Algal Biomass Production Using Swine Wastewater to Irrigate and Fertilize

Thomas Costello, Associate Professor

ISSUE:

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

ACTION:

The UA Biological and Agricultural Engineering Department is continuing to investigate systems to produce algae using wastewater from swine production to yield biomass feedstock for biofuel production. The system grows attached periphytic algae in an open flow way with a continual stream of the inlet swine effluent. Experiments were conducted at Algae Flow Way facility adjacent to the UA Swine Grower Unit near Savoy Arkansas. Tests of the system using undiluted swine effluent were conducted at varied flow rates and surging modes in an attempt to identify optimal growth conditions.

IMPACT:

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

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Charles Maxwell, Department of Animal Sciences
Greg Thoma, Department of Chemical Engineering

FUNDING SOURCES:

USDA, NIFA/AFRI
University of Arkansas Division of Agriculture, Dale Bumpers College of Agricultural, Food and Life Sciences
University of Arkansas College of Engineering

Deriving an Assessment Methodology for Effects-based Water Quality Criteria for Beaver Lake

Brian Haggard, Professor

ISSUE:

The State of Arkansas adopted effects-based water quality standards in 2012 to protect Beaver Lake from accelerated eutrophication. The standards state that the growing season geometric mean chlorophyll-a (chl-a) concentration shall not be greater than 8 μg/L and that the annual average secchi transparency (ST) shall not be less than 1.1 m in Beaver Lake near Hickory Creek. These standards were adopted based on the recommendation of a working group that used a weight of evidence approach to derive the standard recommendations. However, an important missing component of the standard development process, and the adopted numeric standards, was the frequency and duration at which these standards must be met in Beaver Lake at Hickory Creek.

ACTION:

In collaboration with Dr. Thad Scott of the University of Arkansas System's Division of Agriculture, we developed a single recommendation and list of separate considerations that could be used by the State of Arkansas in developing an assessment plan for the eutrophication standards in Beaver Lake. We utilized the methodology from the original standard development to re-create their analysis and quantify the risk of exceeding the water quality standards in Beaver Lake at Hickory Creek. The final report outlined this specific recommendation and other considerations in detail.

IMPACT:

The Beaver Watershed Alliance, who funded the study, forwarded our final report to the Arkansas Department of Environmental Quality (ADEQ). ADEQ is considering our recommendation in the development of the official state assessment methodology for the eutrophication standards on Beaver Lake and will be proposing this to the US Environmental Protection Agency for final approval.

CONTACTS:

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FUNDING SOURCES:

Beaver Watershed Alliance

IRRIGATING SMART: CONSERVES WATER, SAVES MONEY, REDUCES ENERGY

CHRISTOPHER HENRY, ASSISTANT PROFESSOR, EXTENSION

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

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

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

Some comments about the workshops included:

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

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

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Bill Branch, Louisiana State University
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FUNDING SOURCES:
Southern Region Water Quality Initiative
Arkansas Soybean Promotion Board

MICRO/NANOSCALE BIO/ABIO INTERFACING TECHNOLOGY

JIN-WOO KIM, PROFESSOR

ISSUE:
The biomaterials, including DNA, proteins, and cells, are well optimized through evolution, exhibiting unique recog-nition, transport, catalytic, and replication properties. In stead of reinventing the wheels, the integration of such pre-engineered biomaterials into nano systems would lead to the realization of the next generation bio/abio hybrid engineered systems for applications ranging from MEMS/NEMS to bio-sensing and nanomedicine. However, the major challenges for making this merger feasible are integration and interfac-ing of the micro- and nano-scale biological and abiological materials at similar scales. The successful development of interfacing techniques for their integration is imperative to overcome the challenges.

ACTION:
Currently, we are in the process of developing technical plat-forms for 'controllable' interfaces between biological materi-als, such as nucleotides, proteins, cells, and abiological mate-rials, such as MEMS/NEMS channels and nanoparticles, at the micro/nanoscale. Also a series of nano hybrid devices are being developed through the stable and controllable inter-facing technology: (a) a nano flagellar motor based AC dyna-mo (nFMD), (b) a nano flagellar motor based TNT detection system (nFMTNT), (c) an electron tunneling based nanochan-nel system for DNA sequencing, and (d) a photoacoustic and photothermal biosensing as well as diagnostic systems.

IMPACT:
These projects are important steps towards realization of the bio/nano nanotechnology that bridges the sciences of biology, medicine, nano-materials, and MEMS/NEMS by pairing their advantages. The research has generated 3 journal article pub-lished or in press and 1 provisional patent pending during the year 2013.

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

NANO-TOOLBOX TECHNOLOGY FOR PROGRAMMABLE SELF-ASSEMBLY OF MULTIFUNCTIONAL HIERARCHICAL STRUCTURES FOR BIOMIMETIC ADVANCED MATERIALS AND DEVICES

JIN-WOO KIM, PROFESSOR

ISSUE:
Engineering multiple nanoscale materials into single multifunctional structure with predefined biophysicochemical characteristics has much promise for advanced materials and devices. Geometric factors, such as shape, size, and material compositions, influence the biophysicochemical properties of materials. Hence, the assembly of various nanoparticles (NPs) of different sizes and shapes 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, our group focuses on a transformative research to develop a nano-building block toolbox ("nano-toolbox") 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. 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.

IMPACT:
The ultimate significance of the nano-toolbox technology is that it addresses the urgent need in the field of nanotechnology for functional, reliable and scalable techniques for more complicated and controlled multifunctional hierarchical structures that incorporate diverse nanocomponents for specific applications. Thus, this technology offers a clever way of alleviating the current challenges of NP structure self-assembly and provides an effective and efficient route to nanomanufacturing a "second-generation" multifunctional nano-architecture at all scales and in all three dimensions with properties that are "programmable and customizable" on the basis of the target applications. The research has generated 3 journal articles published or *in press*, 1 book chapter, and 4 invited lectures, and 1 pending patent during the year 2014.

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

PORTABLE BIOSENSEO FOR IN-FIELD DETECTION OF AVIAN INFLUENZA

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

ISSUE:

Avian influenza (AI) virus H5N1 was discovered in the late 1990s, and it has been reported by WHO in more than 46 countries for animal cases and in 16 countries for human cases with 676 people infected and 398 died since 2003. In the US, a recent outbreak of low pathogenic AI in 2001 and 2002 resulted in the depopulation of over 4.5 million chickens and turkeys and had cost the poultry industry approximately $125 million. World Bank estimated that more than 140 million birds had died or been destroyed due to AI H5N1 and losses to the poultry industry are in excess of $10 billion worldwide. A key in controlling the spread of AI is to rapidly detect the disease, and then eradicate infected animals, quarantine and vaccinate animals. The technology for detection of AI H5N1 is mature, but many tests are complex, some are liable to error, and some can be performed safely only in BSL3 facilities. A simple, rapid, robust and reliable AI test, suitable for use in the field, is urgently needed.

ACTION:

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

IMPACT:

Since currently there is no any in-field AI test instrument available, this biosensor would provide the poultry industry with a very needed technology for rapid, sensitive and specific screening of AI H5N1 in poultry. This will help the poultry industry be better prepared for AI H5N1, ensure poultry product safety and security and minimize the testing cost. Further, this will help our society in surveillance and control of avian influenza infections with animal and human. The biosensor technology developed in this research can also be applied to the detection of other poultry and animal diseases.

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MICROPLATE-BASED BIOSENSING SYSTEM FOR RAPID DETECTION OF MULTIPLE VIRUSES

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

Issue

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

Action

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

Impact

This biosensing system would provide the poultry industry with a very needed technology for rapid, sensitive and specific screening of AI H5N1, H7N9 and other viruses in poultry. This will help the poultry industry be better prepared for AI, ensure poultry product safety and security and minimize the testing cost. Further, this will help our society in surveillance and control of avian influenza infections with animals and human. The biosensing system developed in this research can also be applied to the detection of other animal diseases.

Contact

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Funding

ABI

ENGINEERED B-CELL BASED BIOSENSOR FOR DETECTION OF FOODBORNE PATHOGENS

YANBIN LI, PROFESSOR, TYSON ENDOWED CHAIR IN BIOSENSING ENGINEERING

ISSUE:

Contaminated food, mainly by pathogenic microorganisms, is estimated to cause 76 million illnesses, 325,000 serious illnesses resulting in hospitalization, and 5,000 deaths in the US each year. USDA/ERS estimates the medical costs and productivity losses associated with *E. coli* O157, *Salmonella*, *Listeria monocytogenes* and *Campylobacter* alone amount to at least $6.9 billion annually. Current methods for detection of bacteria rely upon culture plating, ELISA and PCR. However, these methods are time consuming, expensive, or not specific, and require trained operators with laboratory facilities. There is an urgent need for rapid methods in detection of major foodborne pathogens.

ACTION:

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

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

IMPACT:

The food industry and federal regulatory agencies may apply this novel biosensing method to food safety inspection and quality control to ensure food safety and security. Our society could be benefited from this technology in terms of reducing foodborne diseases and consequently related medical costs. Application of the new nanotechnology-based biosensor would enable the food industry to be benefited economically in terms of prevention of product recalls and international embargo associated with the microbial contamination of food products.

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FUNDING:

ABI, ZJU

POULTRY PROCESSING PLANT

YI LIANG, ASSOCIATE PROFESSOR, EXTENSION

ISSUES:

Food-related energy use increased steadily at an annual average rate of 8.3%, accounting for approximately 16% of energy consumption in the United States. Poultry production has experienced tremendous growth and efficiency improvement, characterized with large, highly automated processing facilities. Despite the production efficiency, the broader implication of the material and energetic intensity of US broiler production from a supply chain perspective is largely unaddressed, with data of three decades old.

ACTION:

The energy users in a typical modern broiler processing facility were measured and documented on an annual basis. Natural gas consumption for steam generation by boilers was higher than electricity used for refrigeration, lighting, air conditioning, compressed air and other mechanical drives. Electrical energy consumption in this study was 20% lower than those reported three decades ago, despite a greater amount of plant automation. Modern processing plants added more electrical equipment that could have partially increased electrical energy usage per unit of product, likely offsetting reduction by adopting energy efficiency standards and measures over the past years. Specific measures to reduce utility costs were identified, with many having guaranteed payback periods of two years.

IMPACT:

Growing concern for resource management and climate change has led to focus on energy use and conservation in energy-intensive industries. Results from this project demonstrated that cost-effective energy saving opportunities exists in poultry processing plants. If the identified energy saving measures were adopted, the annual fuel and electricity consumption can be reduced 13% and 4%, respectively, with additional electrical demand saving. Energy efficiency improvement of poultry industry will contribute toward natural resource conservation and supply chain sustainability.

CONTACTS:

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COOPERATORS:

Darin Nutter, Mechanical Engineering

FUNDING:

U.S. Poultry & Egg Association; Division of Agriculture, University of Arkansas

Sustainable Metrics for Agriculture

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

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

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

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

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

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

IMPROVING DRINKING WATER QUALITY AND AVAILABILITY

G. SCOTT OSBORN, ASSOCIATE PROFESSOR

ISSUE:

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

ACTION:

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

IMPACT:

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

CONTACT:
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INFLUENCE OF PYROLYSIS CONDITIONS ON SWITCHGRASS BIOCHAR FOR USE AS A SOIL AMENDMENT

SAMMY SADAKA, ASSISTANT PROFESSOR, EXTENSION

ISSUE:

Land application of biochar promotes a 'closed-loop' system, considering that the feedstock co-product is re-applied the following season. Biochar composition and nutrient concentration level is dependent on the feedstock as well as operating conditions. Therefore, chars are not equivalent, and little research has been performed to characterize biochar, to determine optimal production settings, and to validate the agronomic benefits of utilizing switch grass-based biochar as a soil amendment. Herein we aim at (i) characterizing switch grass biochar, (ii) estimating water-holding capacity under increasing ratios of char: soil; as a function of pyrolysis conversion methodologies (*i.e.* continuous, externally-heated auger versus carbonized batch systems) for terminal use as a soil amendment.

ACTION:

We utilized carbonization technology to produce biochar. An externally heated auger system was used to continuously produce biochar from switch grass at 400, 500 and 600°C. We also produced biochar using a batch reactor at 400ºC and under residence times of 1, 2, and 3 hrs. Lab water-holding capacity experiments were conducted with switch grass biochars produced via the batch and continuous systems and mixed under various char: soil ratios. Soil samples were mixed with 5, 10, or 20% switchgrass biochar by volume. Biochar produced in the auger system at 400°C was mixed to the aforementioned volume with composite soil samples and constituted 'experiment 1.' Biochar utilized in 'experiment 2' was produced using the carbonized batch system at 400°C and 2 hours of residence time. Samples were then prepared and analyzed for water-holding capacity. Gravimetric and volumetric soil water content at both saturated and field capacity conditions were determined, as well as bulk density.

IMPACT:

Biochars form recalcitrant carbon and increase water and nutrient retention in soils; however, the magnitude is contingent upon production conditions and thermochemical conversion processes. Increase in switchgrass-biochar application rates of >2Mt per hectare increased soil water retention and decreased soil bulk density. Continuous application of biochars may have the potential to increase soil water-holding capacity, as biochar is highly absorbent due to a high particle surface charge, which reacts with soil colloids. Such increases in exchange sites may sustain biomass yields under extended drought periods. Switchgrass biochar produced via carbonization technology could be used as a soil amendment.

CONTACT:

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Collaborating Scientists:
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Fred Allen, Dept. of Plant Sciences, University of Tennessee.
Mahmoud Sharara, Dept. of Bio. & Ag. Eng., University of Arkansas.
Patrick Keyser, Dept. of Forestry, Wildlife & Fisheries, University of Tennessee.

FUNDING SOURCES:

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

FLAG THE TECHNOLOGY CLOUD TOOL (FITCLOUD)

DHARMENDRA SARASWAT, ASSOCIATE PROFESSOR / EXTENSION ENGINEER—GEOSPATIAL

ISSUE:

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

ACTION:

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

IMPACT:

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

CONTACTS:

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COLLABORATORS:

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

APPS FOR INFORMATION DISSEMINATION

DHARMENDRA SARASWAT, ASSOCIATE PROFESSOR / EXTENSION ENGINEER—GEOSPATIAL

ISSUE:

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

ACTION:

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

IMPACT:

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

CONTACTS:

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COLLABORATORS:

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Leo Espinoza, Ph.D., Associate Professor, Crop, Soil, and Environmental Sciences, UACES.
Jason Kelley, Ph.D., Associate Professor, Crop, Soil, and Environmental Sciences, UACES.
Christopher Henry, Ph.D., Assistant Professor, Biological and Agricultural Engineering, U of A.

FUNDING SOURCE:

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

SWAT2009_LUC: Evaluating land Use Land Cover Categorical Uncertainty

Dharmendra Saraswat, Associate Professor / Extension Engineer—GeoSpatial

ISSUE:

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

ACTION:

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

IMPACT:

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

CONTACTS:

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FUNDING SOURCE:

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

MANURE VALUATOR APP AUTOMATES CALCULATING MANURE VALUE

KARL VANDEVENDER, PROFESSOR, EXTENSION

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

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

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

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

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

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

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

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

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

Research Grants

The following active grants during 2014 fund research in specific areas.

The Plant Powered Production (P3) Center is funded through the RII: Arkansas ASSET Initiatives (AR EPSCoR) I (EPS-0701890) and II (EPS-1003970)
Dr. Julie Carrier
National Science Foundation Arkansas Science & Technology Authority's ASSET
2014
$10,416

Decreasing severity of switch grass pretreatment through biological pretreatment Sun Grant
Dr. Julie Carrier
Sun Grant
2014
$27,000

Midsouth Energy Consortium
Dr. Julie Carrier
Department of Education
2014
$74,000

Seasonal and tree size-related effects on biological activity of loblolly pine and sweetgum
Dr. Julie Carrier
Arkansas Science & Technology Authority's ASSET
2014
$28,638

Reduced Carbon Footprint for Swine Production
Dr. Thomas Costello and others
USDA NIFA/AFRI
2014
$89,300

AWRC Program Administration
Dr. Brian Haggard and others
USGS
2014
$3131

AWRC Information Transfer Program
Dr. Brian Haggard
U.S. Geological Survey
2014
$2,000

Relation of Chlorine Demand to Water Quality
Dr. Brian Haggard
Beaver Water District
2014
$25,000

West Fork Water Quality Monitoring
Dr. Brian Haggard
Beaver Watershed Alliance
2014
$9,794

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

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

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

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

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

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

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

Economics of Multiple Water-saving Technologies across the Arkansas Delta Region
Dr. Chris Henry and others
Arkansas Soybean Promotion Board
$29,936
2014

Irrigation Water Management for Southern Region Soybean Growers
Dr. Chris Henry and others
United Soybean Board
$455,000
2014

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

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

Engineered B-cell Biosensor for Detection of Foodborne Pathogens
Dr. Yanbin Li and others
ABI
2013-2014
$50,000

Engineered B-cell Biosensor for Detection of Foodborne Pathogens
Dr. Yanbin Li and others
ABI
2014-2015
$50,000

Microelectrode-based Impedance Microarray Sensor for Detection of Avian Influenza Virus
Dr. Yanbin Li
ABI
2013-2014
$50,000

Impedance biosensor for screening of avian influenza
Dr. Yanbin Li
China Agricultural University
2013-2014
$12,000

Managing Crop Residues to Reduce Particulate Matter Emissions
Dr. Yi Liang and others
AR Department of Environment Quality
2014-2016
$888.012

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

Greenhouse Gas Management for Great Lakes Dairy Industry
Dr. Marty Matlock with Matt Ruark, UWisc
USDA-AFRI
2012-2018
$10,000,000

Development of a Life Cycle Inventory for Agriculture
Dr. Marty Matlock and Dr. G. Thoma
USDA
$500,000

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

Research Grants

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

Measuring and Managing the Land Use Footprint of US Swine
Dr. Marty Matlock and Dr. G. Thoma
NPB
2013-2015
$350,000

REWARD: Rice Evapotranspiration and Water use in the Arkansas Delta
Dr. Benjamin Runkle
AWRC/104B
$25,000
2015-2016

SWS 2015 Annual Meeting
Dr. Benjamin Runkle
UA Office for Faculty Development and enhancement/Travel Assistance Program
2015
$500

Prevention of Mycotoxin Development and Quality Degradation in Rice during On-Farm, In-Bin Drying and Storage
Dr. Sammy Sadaka and others
Rice Promotion Board
2014
$45,250

Development of Effective Strategies for Simultaneously Drying and Decontamination of Corn to Maintain
Dr. Sammy Sadaka and others
Corn and Grain Sorghum Promotion Board
$45,250

Smartphone Apps for Information Dissemination to Corn Producers
Dr. Dharmendra Saraswat and others
AR Corn and Grain Sorghum Board
2014-2015
$32,000

Flag the Technology GPS/GIS Support
Dr. Dharmendra Saraswat and Dr. Bob Scott
AR Soybean Promotion Board
2014-2015
$78,000

Improving Yield and Yield Stability for Irrigated Soy beans
Dr. Dharmendra Saraswat and others
Arkansas Soybean Promotion Board
2014-2015
$13,000

Technological Aids for Information Dissemination to Soybean Producers
Dr. Dharmendra Saraswat
AR Soybean Promotion Board
2014-2015
$13,000

Development of NAWF Monitor app for Enhanced Cotton Crop Management
Dr. Dharmendra Saraswat and others
Cotton Inc
2014
$21,482

Mid-south soybean promotion
Dr. Dharmendra Saraswat and Multi-state team
USB
2014-2018
$455,870

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

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

PUBLICATIONS

BOOKS AND BOOK CHAPTERS

Matlock, M. 2014. Intensifying agricultural production: Measuring the key performance indicators for a sustainable future. World Nutrition Forum 2014, Biomin, Munich, GE

Sundsbo AO, **Runkle BRK**, McMonagle S, Jantke J, Lottermoser F, Gottschick M, Haeseler S, Rodriguez-Lopez JM, Scheele M (2014) One metaphor – several meanings: An interdisciplinary approach to sustainable development, in: Integrating Sustainability Thinking in Science and Engineering Curricula, World Sustainability Series, Ed. W Leal Filho, U Azeiteiro, F Alves, S Caeiro, Springer Publishing, Germany. doi:10.1007/978-3-319-09474-8_15

Runkle BRK, Kutzbach L (2014) Peatland Characterization, In: Guidebook: Towards climate responsible peatland management, ed. Biancalani R. & Avagyan A., Mitigation of Climate Change in Agriculture (MICCA) Series 9, FAO, Rome, pp 6-11. (http://www.fao.org/documents/card/en/c/ed3a3b92-de47-4825-a417-f0daad81efb5/

Pai, N., and **D. Saraswat**. Integrating Land Use Change Influences in Watershed Models. In *GIS Applications in Agriculture, Volume 4: Conservation Planning*, xxx-xxx. T. Muller and G.F. Sassenrath, ed., CRC Press (in print).

Yao, W., **J. Zhu**, B. Sun. 2014. One-step purification of glutamate decarboxylase from E. coli using aqueous two phase system. In Series: Methods in Molecular Biology, Editor: John M. Walker. Volume Title: "Protein Downstream Processing" edited by Nikolaos E. Labrou. Pp: 539-546. Springer Humana Press, New York, NY, USA. ISBN: 978-1-62703-976-5.

PEER-REVIEWED JOURNAL ARTICLES

Adams J, Martin E, Almeida G, Ricke S, Gibson K, Frederick **N** and **Carrier DJ.** (2014). "Characterization and variation of essential oil from *Pinus taeda* L. and antimicrobial effects against antibiotic resistant and susceptible *Staphylococcus aureus*. " *Forest Products Research* 64:161-165.

Frederick N, Zhang N, Ge X, Xu J, Pelkki M, Martin E and Carrier DJ. (2014). "Poplar (*Populus deltoides* L.): The effect of washing pretreated biomass on enzymatic hydrolysis and fermentation to ethanol." *Sustainable Chemistry and Engineering* 2: 1835–1842.

Lau C, Clausen E, Thomas G and Carrier DJ (2014). "Kinetic modeling of xylose oligomer degradation during pretreatment in dilute acid or in water." *Industrial Research Engineering Chemistry* 53:2219-2228.

Djioleu A, Sverzut C, Martin E, Childres E, Johnson C, West C and Carrier DJ. (2014). "Effect of harvest and storage of switchgrass on the recovery of carbohydrates during dilute acid pretreatment and enzymatic hydrolysis." *Forage and Grazinglands* 12:1. doi:10.2134/FG-2013-0016-RS

Djioleu A, Martin E, Pelkki M and **Carrier DJ.** (2014). "Mixtures of sweetgum wood with sweetgum bark, oak wood and oak bark: Effects on xylose and glucose yields from dilute acid pretreatment and enzymatic hydrolysis. " *Transactions of* ASABE 57: 1175-1185.

Sandefur, H. N. , R. Z. Johnston, , M. D. Matlock, T**. A. Costello,** W. H. Adey, and H. D. Laughinghouse IV. 2014. "Hydrodynamic regime considerations for the cultivation of periphytic biofilms in two tertiary wastewater treatment systems". Ecol. Engr. 71: 527-532.

Liang, Y., G. T. Tabler, **T. A. Costello**, I. L. Berry, S. E. Watkins and Y. V. Thaxton. 2014. "Cooling broiler chickens by surface wetting: indoor thermal environment, water usage and bird performance". Applied Engr. in Agric. 30(2): 249-258.

Grantz, E.M., **B.E. Haggard**, and J.T. Scott. 2014. Stoichiometric imbalance in rates of nitrogen and phosphorus retention, storage, and recycling can perpetuate nitrogen deficiency in highly productive reservoirs. Limnology and Oceanography 59(6): 2203-2216

Jarvie, H.P.,A.N. Sharpley, J.V. Brahana, T. Simmons, A. Price, C. Neal, A. Lawlor, D. Sleep, S. Thacker, and **B.E. Haggard**. 2014. Phosphorus retention and remobilization along hydrological pathways in karst terrain. Environmental Science and Technology 48(9): 4860-4868

Toland, D.C., M.E. Boyer, G.V. McDonald, C.P. West, and **B.E. Haggard**. 2013. Plants influenced by growing media and compost addition on mock green roofs within the Ozark Highlands. Journal of Green Building 9(1): 130-144

White, M.J., D.E. Storm, A. Mittelstet, P.R. Busteed, **B.E. Haggard**, and C. Rossi. 2013. Development and testing of an in-stream phosphorus cycling model for the Soil and Water Assessment Tool. Journal of Environmental Quality 43:215-223

Galvin, G., **C. G. Henry**, D. B. Parker, R. Omerod, P. D'Abreton, M. Rhoades. August 2014. Efficacy of a Lagrangian and a Gaussian Model for Back Calculating Emission Rates from Feedyard Area Sources. *Air Quality and Climate Change Journal* 48(3):39-45.

PUBLICATIONS

Clean Air Society of Australia and New Zealand. Olinda, Victoria, Australia.

Kotagiri, K. & **Kim, J.-W**. REVIEW: Stealth theranostic agents: strategies of shielding carbon nanotubes and their hybrids to evade opsonization and improve biodistribution. International Journal of Nanomedicine 9, 85-105 (2014). Invited paper for a special issue: Emerging nanotechnology approaches in tissue engineering & regenerative medicine

Kim, J.-W. & Tung, S. REVIEW: Bio-hybrid micro/nanodevices powered by flagellar motor: challenges and strategies. Medical & Biological Engineering & Computing (in press). Invited paper for a special issue: Biological engineering

Lee, J.S., Chen, J., Deaton, R. & **Kim, J.-W.** A DNA-based pattern classifier with in vitro learning and associative recall for genomic characterization and biosensing without explicit sequence knowledge. Journal of Biological Engineering 8, 25 (2014).

Lim, K.-T., Baik, S.J., Kim, S.W., Kim, J.H., Seonwoo, H., **Kim, J.-W.,** Choung, P.-H., Choung, Y.-H. & Chung, J.H. Development and characterization of fast-hardening composite cements composed of natural ceramics originated from horse bones and chitosan solution. Tissue Eng. Regen. Med. 11(5), 1-10 (2014).

Lim, K.-T., **Kim, J.-W**., Kim, J. & Chung, J.H. Development and evaluation of natural hydroxyapatite ceramics produced by the heat treatment of pig bones. J. Biosystems Eng. 39, 227-234 (2014).

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Huang, X.L., Z.D. Xu, Y. Mao, Y.W. Ji, H.Y. Xu, Y.H. Xiong, and **Y. Li**. 2015. Gold nanoparticle-based dynamic light scattering immunoassay for ultrasensitive detection of *Listeria monocytogenes* in lettuces. Biosensors & Bioelectronics 66:184-190.

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label-free detection of bisphenol A in milk samples. Food Chemistry 162:34-40.

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Avagyan A, **Runkle BRK**, Hartmann J, Kutzbach L, (2014) Spatial variations in pore-water biogeochemistry greatly exceed temporal changes during baseflow conditions in a boreal river valley mire complex, Northwest Russia. Wetlands, 34(6), 1171-1182 (http://link.springer.com/article/10.1007/s13157-014-0576-4).

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Lin, H., X. Wu, B. Hu and **J. Zhu**. 2014. Microbial electrochemical systems for agro-industrial wastewater remediation and renewable products generation: a review. *Arc. Micro. Biotech.* 1(1): 1-20.

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Simpson, Z.P. B. Smith, D.A. Zaharoff, and **B.E. Haggard**. 2014. Reducing water extractable phosphorus in poultry litter using chitosan treatment. Discovery – The Undergraduate Research Journal of the Dale Bumpers College of Agricultural, Food and Life Sciences. 15: 84-92

Rossetti, M.S., N.K. Ownby, E. Scott, and **B.E. Haggard**. 2014. The potential release of phosphorus in floodplains. Discovery – The Undergraduate Research Journal of the Dale Bumpers College of Agricultural, Food and Life Sciences. 15: 68-75.

Kotagiri, K. & **Kim, J.-W.** REVIEW: Stealth theranostic agents: strategies of shielding carbon nanotubes and their hybrids to evade opsonization and improve biodistribution. International Journal of Nanomedicine 9, 85-105 (2014). Invited paper for a special issue: Emerging nanotechnology approaches in tissue engineering & regenerative medicine

Kim, J.-W. & Tung, S. REVIEW: Bio-hybrid micro/nanodevices powered by flagellar motor: challenges and strategies. Medical & Biological Engineering & Computing (*in press*). *Invited paper for a special issue: Biological engineering*

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Callaway, Z., R. Wang, and **Y. Li***. 2014. Modeling the electromagnetic properties of E. coli cells with different components of biological immobilization components on a screen-printed interdigitated microelectrode using Comsol. ASABE 2014 Annual International Meeting, July 13-16, 2014, Montreal, Canada. ASABE Paper No. 1897698. American Society of Agricultural Engineering, St. Joseph, MI.

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Xu, L.Z., Z. Callaway, R. Wang, and **Y. Li***. 2014. A fluorescent aptasensor coupled with nanobeads-based immunomagnetic separation for simultaneous detection of four foodborne pathogens. ASABE 2014 Annual International Meeting, July 13-16, 2014, Montreal, Canada. ASABE Paper No. 1895935. American Society of Agricultural Engineering, St. Joseph, MI.

Sammy Sadaka and Rusty Bautista. Grain Drying Tools: Equilibrium Moisture Content Tables and Psychrometric Charts. Fact Sheet. http://uaex.edu/publications/pdf/FSA-1074.pdf.

Sammy Sadaka. Selection, Performance and Maintenance of Grain Bin Fans. Fact Sheet. http://uaex.edu/publications/pdf/FSA-1075.pdf.

Amanda J. Ashworth, Patrick D. Keyser, Fred L. Allen, **Sammy S. Sadaka and** Mahmoud **A.** Sharara**.** Use of biochar in Switchgrass Production. Fact Sheet. https://extension.tennessee.edu/publications/Documents/D8.pdf.

Sammy Sadaka. Lawn Mower Safety. Fact Sheet. http://uaex.edu/publications/PDF/FSA-1005.pdf

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Leiva, J.N., J. Robbins, Y. She, **D. Saraswat**, R. Ehsani. 2014. Effect of Plant Canopy Shape on Plant Count Accuracy Using Aerial Imagery. Proc. SNA Rsch. Conf. 59: 298-301. Available at: http://www.sna.org/Resources/Documents/14resprosec12.pdf Accessed 16 December 2014. (the paper has gone through editorial oversight but not peer reviewed).

Liang, Y., R. Bautista, G. Dabhadka, T.A. **Costello**.

NON-REFEREED PUBLICATIONS AND ARTICLES

Entrekin, S., others, and **B. Haggard**. 2014. Final Report to Arkansas Game and Fish Commission – Gulf Mountain: Freshwater Effects from Natural Gas Development, State Wildlife Grant T37-02.

Scott, E., J. Gile, and **B. Haggard**. 2014. Final Report to Beaver Water District – Relation of chlorine demand to the water quality of Beaver Lake, Arkansas, Water Resources Center Technical Publication MSC XXX

Scott, T. and **B. Haggard**. 2015. Final Report to the Beaver Watershed Alliance – Evaluating the assessment methodology for the chlorophyll-a and Secchi transparency at Beaver Lake, Arkansas, Arkansas, Water Resources Center Technical Publication MSC XXX.

Henry, C.G., E.D. Vories, M.M. Anders, S.L. Hirsh, M.L. Reba, K.B. Watkins and J.T. Hardke. 2014. Irrigation Water Requirements for Rice Irrigation Systems in Arkansas. Submitted to the B.R. Wells Rice Research Series.

McDougall, W.M., **C.G. Henry**, M.L. Rea and D.K. Carman. 2014. A Pump Monitoring Approach ot Irrigation Pumping Plant Testing. Presented at the 2014 ASABE and CSBE/SCGAB Annual International Meeting. Montreal, Quebec Canada, July 13-16, 2014. Paper Number 1928167. ASABE St. Joseph, MI.

Henry, C. G., W. M. McDougall, C.D. Allen, M. L. Reba and D. K. Carman. 2014. Can Variable Frequency Drives Reduce Irrigation Costs for Rice Producers? Presented at the 2014 ASABE and CSBE/SCGAB Annual International Meeting. Montreal, Quebec Canada, July 13-16, 2014. Paper Number 1928170. ASABE St. Joseph, MI.

Lim, T. A. Glen, E. Erb, T. Bay, R. Meinen, **G. Henry**, D. Hamilton, A. Douridas. 2014. North American Manure Exo: Creating a Permanent Sustainable Base for Hands-on Manure Applicator Education. Presented at the 2014 ASABE and CSBE/SCGAB Annual International Meeting. Montreal, Quebec Canada, July 13-16, 2014. Paper Number 1896480. ASABE St. Joseph, MI.

Henry, C. G. and M. L. Reba. 2014. Arkansas Irrigation Update. Written for annual WERA-1022 report.

Henry, C. G. and K. B. Watkins. 2014. An Evaluation of the Water Demand Forecast Report for the Arkansas Water Plan. Special report developed and provided at the request of the Arkansas Natural Resource Commission. The report investigated concerns and provided recommendations for the Arkansas Water Plan Demand Report.

Liang, Y., A.C. Harding and D.W. Nutter. 2014. Energy assessment of a poultry processing plant. ASABE Annual Meeting paper No. 141893613. St. Joseph, MI.

Richardson, G. A., **G. S. Osborn**. 2014. Effects of Sediment Resuspension and Oxygenation on Oxygen Uptake Rate. Paper No. 14-1896896. Annual Meeting ASABE 2014, Montreal, CA.

Sammy Sadaka. Proper Drying and Storage Can Add Value to Corn Crop. January 14, 2014. Farm Press Newspaper Article by Larry Stalcup.

10-6 Delta Farm Press – Reducing risk for new herbicide technologies (**Dharmendra Saraswat**) Available at: http://deltafarmpress.com/management/reducing-risk-new-herbicide-technologies Accessed 16 December 2014.

August- Great Lakes Christmas Tree Journal, 9(4) Fall 2014 - Counting on Us (J. Robbins, H. Stoven, C. Landgren, R. Ehsani, Y. She, J. Maja, **D. Saraswat**, J. N. Leiva, J. Puffer, and S. Doane)

August- Mobile Monthly- Cotton Advisor (**Dharmendra Saraswat**) Available at: http://dtnpf-digital.com/article/Mobile_Monthly/1766112/218347/article.html Accessed 16 December 2014.

8-6 Ashley County Ledger – iOS App helps farmers computer possible changes on budget decisions (**Dharmendra Saraswat,** Archie Flanders)

8-1 Daily World – iOS, Android apps to guide you through 2014 Arkansas Rice Expo (Dharmendra Saraswat)

7-30 England Democrat – Rice Expo set for Aug. 1 at Stuttgart; Janet Carson, many others to speak (Janet Carson, **Dharmendra Saraswat**)

7-30 Booneville Democrat – App simplifies farmers' finances (Dharmendra Saraswat, Archie Flanders)

7-25 Agfax - New iPhone app simplifies farmers' finances (**Dharmendra Saraswat**, Archie Flanders)

March - Cotton Farming.com - 'Cotton Advisor' to be released in March (**Dharmendra Saraswat**) Available at: http://www.cottonfarming.com/uncategorized/an-app-that-performs-cotton-advisor-to-be-released-in-march/ Accessed 16 December 2014.

Mid-February 2014 Progressive Farmer (Jason Norsworthy, **Dharmendra Saraswat**, Bob Scott) Available at: http://dtnpf-digital.com/publication/?m=27946&l=1 Accessed 16 December 2014.

12-20 Mena Star - Manure Valuator app calculates manure value (**Dharmendra Saraswat**, Karl VanDevender)

12-5 Agfax - Manure Valuator app automates calculating manure value (**Dharmendra Saraswat**, Karl VanDevender)

Zhu, J. 2014. The U.S. experience in dealing with non-point source pollution to rivers and lakes. In: the Proceedings of "The 5th International Conference on Environmental Technology and Knowledge Transfer (5th ICET)", Hefei, China,

PUBLISHED ABSTRACTS OF CONFERENCE PRESENTATIONS

May 15-16.

Henry, C. G., W. M. McDougall, C.D. Allen, M. L. Reba, E. D. Vories, J. C. Henggeler and D. K. Carman. 2014. Can Variable Frequency Drives Reduce Irrigation Costs for Rice Producers? Presented at the 2014 Rice Technical Working Group on February 18-21 at the Sheraton in New Orleans, LA.

Chiu, Y.J., M. L. Reba, D. Carman, **C. Henry**. 2014. Development of a wireless sensor network for monitoring and managing water depth in production rice fields. Presented at the 2014 Rice Technical Working Group on February 18-21 at the Sheraton in New Orleans, LA.

Reba, M. L., P. Counce, **C. Henry**, E. Vories, and Y. J. Chiu. 2014. Sensitivity of Measure Evapotranspiration and Growth Stage of Rice in the Mid-south. Presented at the 2014 Rice Technical Working Group on February 18-21 at the Sheraton in New Orleans, LA.

Teaser, N., **C. Henry**, M. Anders, and A. McClung. 2014. A genetic Approach to Producing Rice using less Irrigation Water. Presented at the 2014 Rice Technical Working Group on February 18-21 at the Sheraton in New Orleans, LA.

McDougall, W. M., **C. G. Henry**, M. L. Reba, and D. K. Carman. 2014. A Pump Monitoring Approach to Irrigation Pumping Plant Testing. Presented at the 2014 Arkansas Crop Protection Association Research Conference. December 1-2, Fayetteville, AR.

Gaspar, J. P., **C. G. Henry**, P. B. Francis, L. Espinoza, M. Ismanov, S. Hirsh, A. P. Horton, and H. James. 2014. The Effects of Soil Treatments, Deep Tillage and Application of Gypsum, across various target irrigation deficit on soil moisture tension and crop yields for furrow irrigated soybeans. Presented at the 2014 Arkansas Crop Protection Association Research Conference. December 1-2, Fayetteville, AR.

Kim, J.-W. 2014. Building Blocks of Bio/Nano Technology. The 9th IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), Honolulu, Hawaii, USA.

Kim, J.-W. 2015. Nanoparticle-Based Disease Diagnostics and Therapeutics, The 1st Seminar of Bioindustrial Applications:

"Bioinstrumentation", El bosque University, Bogota D.C., Columbia.

Kim, J.-W. 2015. Nanobiotechnology for Hybrid Device Development, The 1st Seminar of Bioindustrial Applications: "Bioinstrumentation", El bosque University, Bogota D.C., Columbia.

Extension Publications and Literature

Henry, C. G. and Jason Kelly. 2014. ET gage (Atmometer) Chart for Irrigated Corn. University of Arkansas Extension. Available at http://www.uaex.edu/environment-nature/water/docs/irrig-ET-Gage-Sheet-Corn.pdf. 2pp.

Henry, C. G. L. Espinoza, M. Ismanov, P. Francis and J. Ross. 2014. ET gage (Atmometer) Chart for Irrigated Soybeans. University of Arkansas Extension. Available at http://www.uaex.edu/environment-nature/water/docs/irrig-ET-Gage-Sheet-Soybean.pdf. 2pp.

Liang, Y., Daniels, M., Roberts, T.L., Watkins, K.B. and McCullough, S. 2014. Particulate matter and air quality standards. University of Arkansas Division of Agriculture. Factsheet. In print.

Tabler, T., F. D. Clark, J. R. Moyle, **Y. Liang**, J. Wells, and M. Farnell. 2014. Windrow composting broiler litter between flocks. Publication No. 2818. January. Mississippi State University Extension Service

Tabler, T., **Y. Liang**, J. R. Moyle, F. D. Clark, M. Farnell, and J. Wells. 2014. Managing heat and minimum ventilation systems in the broiler house. Publication No. 2854. October. Mississippi State University Extension Service.

Czarick, M., **Y. Liang** and B. Fairchild. 2014. Increasing evaporative cooling pad set temperatures. The University of Georgia College of Agricultural & Environmental Sciences Cooperative Extension Newsletter. 26(5): June.

Sadaka, S. G. Atungulu, G. S. Osborn. 2014. On-Farm Wheat Drying and Storage. UA CES Publication. (approved for publication)

Scott, B., **D. Saraswat**, P. Spradley, and R. Baker. 2014. Flag the Technology. (University of Arkansas Cooperative Extension Service Fact Sheet FSA 2162). Available at: http://www.uaex.edu/publications/PDF/FSA-2162.pdf Accessed 14 December 2014.

Professional Presentations

Haggard, B. West Fork Water Quality Monitoring – Update. Beaver Lake Watershed Symposium, Beaver Watershed Alliance, Huntsville, Arkansas, September 2014.

Haggard, B. Trends in the Illinois River Watershed. Illinois River Watershed Partnership, Watershed Sanctuary, Cave Springs, Arkansas December 2014

Haggard, B. New Directors Presentation. National Institutes for Water Resources, Washington DC, February 2014

Haggard, B. Trends in the Illinois River Watershed. Arkansas Environmental Law Conference, Eureka Springs, Arkansas, May 2014.

Fox, G. and **B. Haggard**. Update on Research and Extension Priorities from the Illinois River Watershed Symposium. Illinois River Watershed Partnership, Watershed Sanctuary, Cave Springs, Arkansas December 2014

Kim, J.-W. 2014. Building Blocks of Bio/Nano Technology. The 9th IEEE International Conference on Nano/Micro Engineered and Molecular Systems (IEEE-NEMS), Honolulu, Hawaii, USA.

Kim, J.-W. 2014. Nanoparticle-Based Disease Diagnostics and Therapeutics, The 1st Seminar of Bioindustrial Applications: "Bioinstrumentation", El bosque University, Bogota D.C., Columbia.

Kim, J.-W. 2014. Nanobiotechnology for Hybrid Device Development, The 1st Seminar of Bioindustrial Applications: "Bioinstrumentation", El bosque University, Bogota D.C., Columbia.

Kim, J.-W. 2014. Building Blocks of Bio/Nano Technology for Advanced Materials and Devices. 2014 i-bio Seminar, School of Interdisciplinary Bioscience & Bioengineering, Pohang University of Science and Technology (POSTECH), Pohang, Korea.

Li, Y. 2014. Nanobiosensor for biodetection in agriculture and food. An invited presentation at CIGR2014 International Meeting, September 15-19, 2014, Beijing, China.

Li, Y. 2014. A nanopore-based aptasensor for rapid detection of pathogens. An invited presentation at ISTPA 2014, September 11-15, 2014, Beijing, China.

Li, Y. 2014. Nanotechnology-based biosensors for rapid detection of pathogenic bacteria and virus in agriculture and food. An invited presentation at Shenyang Agricultural University, September 2, 2014, Shenyang, Liaoning Province, China.

Li, Y. 2014. Biosensing technology and their applications in agricultural production. An invited presentation at Jiamushi Institute of Rice Research, September 7, 2014, Shenyang, Helongjiang Province, China.

Liang, Y., A.C. Harding and D.W. Nutter. 2014. Energy assessment of a poultry processing plant. ASABE Annual Meeting paper No. 141893613. St. Joseph, MI.

Marty Matlock, January 10, 2014 National Pork Board, Des Moines, IA .Frameworks for Sustainability in US Animal Agriculture –Keynote

Marty Matlock January 29, 2014 Monsanto Corp., St. Louis, MO. Key Performance Indicators for Sustainable Agriculture

Marty Matlock, February 7, 2014 National Soybean Board Annual Meeting, Little Rock, AR. A Framework for Sustainable Soybean Production - Keynote

Marty Matlock, February 19, 2014, National Pork Board Environmental Committee Meeting, Phoenix, AZ. Key Performance Indicators for US Pork: Benchmark Results

Marty Matlock, March 17, 2014, United States Soybean Export Council Meeting, Washington, DC. Metrics for Water Sustainability in US Soybean Production - Keynote

Marty Matlock, April 2, 2014, National Institute for Animal Agriculture Annual Meeting, Omaha, NE. Metrics for Sustainable Agriculture: Measuring what Matters - Keynote

Marty Matlock, May 5, 2014, Smart Water Leadership Conference, Washington, DC. The Business of Sustainability: Continuous Improvement and Risk Management

Marty Matlock, July 15, 2014, ASABE Annual Meeting, Montreal, Quebec, Canada. Key Performance Indicators, Metrics and Benchmarks for Sustainable Agriculture - Keynote

Marty Matlock, July 17, 2014, Riceland Industries Annual Board Meeting, Stuttgart, AR. Key Performance Indicators for Sustainable Rice Production - Keynote and Facilitator

Marty Matlock, August 11, 2014, American Chemical Society Annual Meeting, San Francisco, CA Life Cycle Assessment Methods for Animal Agriculture Sustainability Benchmarking

Marty Matlock, August 20, 2014, Dairy CAP Model ing Meeting, Chicago, IL. Simulating climate change for US agricultural production – Keynote and Facilitator
Marty Matlock September 17, 2014 Pork Sustainability Summit, Chicago, IL Key Performance Indicators, Metrics and Benchmarks for Sustainable Pork Production - Keynote and Facilitator

Marty Matlock, September 23, 2014, Cargill Animal Nutrition Sustainability Summit, Minneapolis, MN. A Common Framework for Sustainability in US Agriculture –Keynote

Marty Matlock, September 26, 2014, US Poultry and Egg Federation Annual Meeting, Destin, FL. Key Performance Indicators, Metrics and Benchmarks for Sustainable Poultry Production - Keynote

Marty Matlock, October 7, 2014, National Roundtable for Sustainable Aquaculture, Denver, CO. Key Performance Indicators, Metrics and Benchmarks for Sustainable Aquaculture Production - Keynote and Facilitator

Marty Matlock, October 9, 2014, USSEC-FEFAC Meeting, Des Moines, IA. A Framework for Sustainable Soybean Production

Marty Matlock, October 16, 2014, World Nutrition Forum, Munich, GE. The Role of Animal Agriculture in Feeding 10 Billion People by 2050 –Keynote

Marty Matlock, November 2, 2014 The Global Roundtable on Sustainable Beef, Sao Paulo, BR Sustainability is Not Monometric –Keynote

Marty Matlock, November 20, 2014, US Poultry and Egg Federation Annual Meeting, Atlanta, GA. Benchmarking Poultry Key Performance Indicators for the US - Facilitator

Marty Matlock, December 2, 2014, Canadian Sustainable Beef Summit, Toronto, Canada. Metrics for Beef Sustainability –Keynote

Marty Matlock, December 3, 2014, Testimony before the US Senate Committee on Forestry and Agriculture. The role of regulation in reducing water quality impacts from agriculture – why voluntary reductions work

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

Osborn, G. Scott: Invited presenter for Arkansas Commercialization Retreat, June 26-27, 2014. Winthrop Rockefeller Conference Center. "Starting a Company Based on University IP".

Osborn, G. Scott: Invited Panelist for Freshman Engineering Program, "Expectations of Faculty" made to Living/ Learning Community of Engineering Scholars.

Ben Runkle: "Field research above the Arctic Circle: Carbon flows in the Siberian permafrost", Presentation for ASABE Sectional Meeting, University of Arkansas, 3 October 2014.

PUBLICATIONS

Ben Runkle: "Field research above the Arctic Circle: Carbon flows in the Siberian permafrost", Seminar for Sigma Xi Scientific Honors Society, University of Arkansas, 5 September 2014.

Sammy Sadaka. Feb 2014. Thermal Conversion of Animal Manure to Biofuel. Invited webinar. http://www.extension.org/pages/70393/thermal-conversion-of-animal-manure-to-biofuel#.VL-upkfF98E

Sammy Sadaka. Grain Drying and Storage presentation. November 19, 2015. Wynne Warehouse, Wynne, AR. A group of 24 producers

Saraswat, D. 2014. Flag the Technology Cloud (FTTCloud)- updates and Newer apps. In 2014 *Row-Crop In-Service Training*, Forrest City, AR, December 9.

Saraswat, D. 2014. GeoInformatics for Environmental Sustainability. In *Arkansas Society of Professional Engineers Central Chapter Meeting*, Little Rock, October 14.

Saraswat, D. 2014. 8-digit HUC Watershed Prioritization in Arkansas-Risk Assessment Matrix Approach. In *ANRC NPS Annual Stakeholder Meeting*, Little Rock, September 17.

Saraswat, D., J.R. Frankenberger, N. Pai, S. Ale, P. Daggupati, K.R. Douglas-Mankin, and M.A. Youseff. 2014. Documentation and Reporting Procedures for Water Quality Models. In *2014ASABE/CSBE Annual International Meeting*, Montreal, CA, July 13-16.

Saraswat, D. and J. Robbins. 2014. UAV's: What, Why, and Beyond. In *Arkansas Farm Bureau's Soybean Wheat, and Feed Grains Commodity Board Meeting*, Marianna, AR, July 1.

Saraswat, D. and J. Robbins. 2014. Emerging Technologies in Precision Agriculture: Arkansas Based Efforts. In *The Spring Meeting of Agricultural Council of Arkansas*, West Memphis, AR, May 13.

Saraswat, D. 2014. Flag the Technology Cloud (FTTCloud)- Features for Commercial Applicator Account. In *Arkansas Agricultural Aviation Association (Fly-Ins)*. Carlisle, AR, March 31 (repeated at Newport, AR on April 7).

Saraswat, D. and J. Robbins. 2014. UAS in Precision Agriculture. In *Unmanned Systems Alliance of Oklahoma (USA-OK)*, Broken Arrow, OK, March 28.

Saraswat, D. 2014. Geospatial Technologies: Opportunities for Agricultural Engineers. In *Special Seminar for students, staff, and faculty of Allahabad Agricultural Institute Deemed University*, Allahabad, India, February 28.

Saraswat, D. 2014. Herbicide Drift Prevention Using Crowd Based Approach. In *2014 Arkansas Crop Management Conference*. North Little Rock, AR, January 21.

Saraswat, D. 2014. Flag the Technology Cloud (FTTCloud). In *17th Annual National Conservation Systems Cotton & Rice Conference*. Tunica, MS, January 15.

Saraswat, D. 2014. Cotton Education App. In *Beltwide Cotton Conferences*, New Orleans, LA, January 8.

Zhu, Jun: Invited speaker at the 2014' Yangling International Agri-Science Forum, Yangling, China, November 4-5, 2014 with a presentation titled "Fermentative hydrogen production from liquid swine manure supplemented with glucose using an anaerobic sequencing batch reactor".

ORAL OR POSTER PRESENTATIONS

Carrier DJ. "Transition between India and the US in terms of graduate studies." Indian Society of Agricultural Engineering Udaipur, India, February 2014.

Djioleu A and **Carrier DJ**. "Extraction of natural products prior to saccharification could prove beneficial for a biochemical refinery platform". Oral presented at the AR EPSCoR annual meeting, Rockefeller Institute, Petit Jean, AR, July 2014

Djioleu A and **Carrier DJ.** "Inhibition of cellulase and β-glucosidase activity by compounds from dilute acid prehydrolysate of switchgrass". Oral presented at the American Society of Agricultural and Biological Engineers (ASABE) annual meeting Montreal, QC, July 2014

Rajan, K and **Carrier, DJ.** "A step towards understanding the inhibition of cellulases by rice straw hydrolyzates." 2014 Annual Research Symposium, Arkansas Center for Plant Powered Production, Morrilton, AR.

Rajan, K and **Carrier, DJ.** "Effect of rice straw hydrolyzates on commercial cellulase, endo-cellulase and β–glucosidase model enzyme substrate systems." Gamma Sigma Delta, Student Oral competition, 2014.

Djioleu A and **Carrier DJ**. "Identification of inhibitory compounds to β-glucosidase by switchgrass dilute acid prehydrolysates." Poster presented at the 36th Symposium of Biotechnology for Fuels and Chemicals, Clearwater Beach, FL, May 2014.

Frederick, N., Zhang, N., Djioleu, A., Ge, X., Xu, J., Martin, E. and **Carrier, DJ**. "Biomass pretreatment: Methods in recovering and fermenting sugars with reduced water usage." Poster presented at 36th Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL, May 2014.

Rajan, K and **Carrier, DJ**. "Saccharification of rice straw." Poster presented at 36th Symposium on Biotechnology for Fuels and Chemicals , Clearwater, FL, May 2014.

Sakul R, **Carrier DJ** and Martin E. "Determination of partition coefficient for terpineol from *Pinus taeda l.* extracts using centrifugal partition chromatography." Poster presented at the 36th Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL, May 2014.

Rajan, K and **Carrier, DJ**. "Cellulosic biofuels: Characterizing the inhibitors in chemically treated rice straw and increasing the saccharification efficiency of commercial cellulases." 2014 Annual International meeting, American Society of Agricultural and Biological Engineers, Montreal, Canada. Jul 16, 2014.

Rajan, K and **Carrier, DJ.** "Cellulosic ethanol: Enhancing enzymatic hydrolysis through optimizing the production of inhibitors during preprocessing of rice straw." Graduate student research competitions, University of Arkansas, Fayetteville, AR. Nov. 12, 2014.
Awarded first prize under the Crop and Soil sciences category.

Djioleu A and **Carrier DJ**. "Separation of antimicrobial and antioxidant compounds from sweetgum bark water extract." Poster presented at the From Abstract to Contract Graduate Research Competition, Fayetteville, AR, November 2014.

Frederick, N., Buser, M., Li, M., Wilkins, M. and **Carrier, DJ**. "Switchgrass: Storage and its effect on saccharification." Poster presented at the Arkansas P3 Annual Research Symposium, Petit Jean, Arkansas, July 2014.

Sakul, R., **Carrier, DJ** and Martin, E. "Producing pine essential oils from forestry residue." Poster presented at the P3 Annual Research Symposium, Petit Jean, Arkansas, July 2014.

Kyle Lawrence, Elizabeth Martin and **Danielle Julie Carrier**. "Effects of concentrated buffer on enzymatic saccharification of Loblolly pine." Poster presented at the Arkansas P3 Annual Research Symposium, Petit Jean, Arkansas, July 2014.

Nelson Herringer and **Danielle Julie Carrier**. "Pine saccharification using fungi." Poster presented at the Arkansas P3 Annual Research Symposium, Petit Jean, Arkansas, July 2014.

Sakul R, Gibson KE, Adams J, Almeida G, Martin EM, **Carrier DJ.** "Determination of partition coefficients for components of essential oil from *Pinuus taeda l.* extracts using centrifugal the 24th World Congress on Biosensors, May 27-30, 2014, Melbourne, Australia. Paper No. P1.169.

Li, Z.M., Y. Fu, and **Y. Li***. Self-assembled monolayers-based impedance immunosensor for rapid detection of *Escherichia coli* O157:H7 using screen-printed interdigitated microelectrodes. Presented at CIGR2014 International Meeting, September 15-19, 2014, Beijing, China. Paper No. 2-14-0962.

Lin, J.H., R. Wang, P.X. Jiao, Y.T. Li, X.H. Wen, **Y. Li**, M. Liao, and M.H. Wang. 2014. An improved impedance biosensor based on interdigitated array microelectrode for rapid detection of avian influenza virus. Presented at the 24th World Congress on Biosensors, May 27-30, 2014, Melbourne, Australia. Paper No. P2.020.

Wang, H., **Y. Li**, and M.F. Slavik. 2014. Rapid and simultaneous detection of Campylobacter and Salmonella in poultry samples using magnetic nanobeads and quantum dots based fluorescent immunosensor. Presented at IAFP 2014 Annual Meeting, August 3-6, 2014, Indianapolis, IN. Paper No. P2-92.

Wang, R., and **Y. Li***. 2014. Bio-nanogate controlled enzymatic reaction for virus sensing. Presented at the 24th World Congress on Biosensors, May 27-30, 2014, Melbourne, Australia. Paper No. P1.141.

Wang, R., L. Wang, X.F. Yu, B.W. Kong, and **Y. Li***. 2014. Fluorescent Ca2+ indicator based B Cells biosensor for rapid detection of E. coli O157:H7 in foods. Presented at IAFP 2014 Annual Meeting, August 3-6, 2014, Indianapolis, IN. Paper No. P2-116.

Wang, Y.X., B.H. Zhang, R. Wang, S.S. Abdullah, and **Y. Li***. 2014. A portable impedance biosensing system based on a laptop with LabVIEW for detection of avian influenza virus. Presented at ASABE 2014 Annual International Meeting, July 13-16, 2014, Montreal, Canada. ASABE Paper No. 1897866.

Xu, M., R. Wang, and **Y. Li***. 2014. Screen-printed electrode based aptasensor for rapid detection of E. coli O157:H7 in foods. Presented at IAFP 2014 Annual Meeting, August 3-6, 2014, Indianapolis, IN. Paper No. P2-149.

Xu, L.Z., Z. Callaway, R. Wang, and **Y. Li***. 2014. A fluorescent aptasensor coupled with nanobeads-based immunomagnetic separation for simultaneous detection of four foodborne pathogens. Presented at ASABE 2014 Annual International Meeting, July 13-16, 2014, Montreal, Canada. ASABE Paper No. 1895935.

Richardson, G., **G. S. Osborn**. Effects of Sediment Resuspension and Oxygenation on Oxygen Uptake Rate. 2014 Annual Meeting ASABE, Montreal, CA.

Osborn, G. S. Dissolved Air Flotation for Removal of Algae and Nutrients from Surface Water. 2014 Annual Meeting ASABE, Montreal, CA.

PUBLICATIONS

Runkle B.R.K., Wille C., Langer M., Boike J., Sachs T., Pfeiffer E.-M., Kutzbach L. Multi-annual evapotranspiration in the Lena River Delta. Presentation at the 3rd General Assembly of the PAGE21 Project, 12-14 November 2014, Twente, the Netherlands.

Wille C., **Runkle B.R.K.**, Schreiber P., Sachs T., Langer M., Boike J., Pfeiffer E.-M., Kutzbach L. Inter-annual variability of growing season CO_2 and CH_4 fluxes of Siberian lowland tundra. Presentation at the 3rd General Assembly of the PAGE21 Project, 12-14 November 2014, Twente, the Netherlands.

Cresto Aleina F., **Runkle B.R.K.**, Kleinen T., Kutzbach L., Boike J., Brovkin V. Upscaling micro-topography in high-latitude peatlands. Presentation at the 3rd General Assembly of the PAGE21 Project, 12-14 November 2014, Twente, the Netherlands.

Gagandeep Ubhi and **Sammy Sadaka.** 2014. Novel Technique to Quantify Grain Respiration Rates for Early Detection of Spoilage and Pests Infestation. Poster presented during the ASABE Section Meeting.

Gagandeep Ubhi and **Sammy Sadaka.** 2014. Utilization of Heated Rice Hulls as a Solid Heat Transfer Medium for Faster Grain Drying and Spoilage Prevention. Poster Presented during the Abstract to Contract Student Competition. University of Arkansas at Fayetteville.

Saraswat, D. and B. Scott. 2014. Cloud based, Open Source Software Application for Mitigating Herbicide Drift. In *2014 AGU Fall Meeting*, San Francisco, CA, December 16.

Singh, G. and **D. Saraswat**. 2014. Water Quality Impacts of Best Management Practices in L'Anguille River Watershed, Arkansas. In *the seventh-annual contest, "From Abstract to Contract: Graduate Student Research Poster Competition*, Fayetteville, AR, November 15 (Second Place Award)

OTHER CREATIVE ENDEAVORS

R. Bair, T. M. McVey , C. Reavis, D. Smith. 2014. "Design an Anaerobic Digester to Produce Fuel from Food Wastes to Power Campus Transit Buses". Second place, G.B. Gunlogson National Student Design Competition, held at the 2014 annual international conference of the American Society of Agricultural and Biological Engineers (ASABE), Montreal, Canada, July 13-17, 2014. Faculty mentor: **T. A. Costello**.

EXCELLENT PAPER 2014 Japanese Society of Limnology

The effect of periphyton stoichiometry and light on biological phosphorus immobilization and release in streams by W. M. Drake, J.T. Scott, M. Evans-White, **B. Haggard**, A. Sharpley, C.W. Rogers, and E.M. Grantz. Limnology (2012) 13:97-106

[Patents pending]

Kim, J.-W., Deaton, R. & Kim, J.-H. DNA-linked nanoparticle building blocks for nanostructure assembly and methods of producing the same. US patent application No 13/690,305.

Tung, S. & **Kim, J.-W.** Method of fabricating a nanochannel system for DNA sequencing and characterization. US patent application No13/768,960.

Osborn, G. Scott: Founder and Board Member of BlueInGreen, LLC, a company formed to commercialize UA owned inventions from my research and products that I designed. In 2014, BlueInGreen realized $4.3 million in sales including Arkansas projects to disinfect wastewater for the City of Fayetteville, drinking water treatment for the City of Clarksville, and treat lagoon wastewater for Sager Creek Vegetable Co. (formerly Allen Canning) in Siloam Springs, as well as projects in 5 other states. Raised $2 million in private funding. BlueInGreen directly employed 14 people including the CEO, 5 full-time engineers, 1 part-time engineer, 1 full-time technician, part-time undergraduate engineering students, sales staff, and support staff. BlueInGreen has generated approximately $10 million in revenue since its creation in 2004.

Ben Runkle Hosted the following talk:

Reba, M. Preserving Water Resources for Agriculture in the Arkansas Delta, UA BAEG Seminar, Fayetteville, AR, 18 November 2014.

Sammy Sadaka. Arkansas Grain Drying and Storage. Website. http://uaex.edu/farm-ranch/crops-commercial-horticulture/Grain_drying_and_storage/

Sammy Sadaka. On-Farm Rice Drying and Storage. Website. http://uaex.edu/farm-ranch/crops-commercial-horticulture/Grain_drying_and_storage/rice_drying_and_storage.aspx

Sammy Sadaka. On-Farm Corn Drying and Storage. Website. http://uaex.edu/farm-ranch/crops-commercial-horticulture/Grain_drying_and_storage/corn_drying_and_storage.aspx

Sammy Sadaka. On-Farm Wheat Drying and Storage. Website. http://uaex.edu/farm-ranch/crops-commercial-horticulture/Grain_drying_and_storage/wheat_drying_and_storage.aspx

Sammy Sadaka. On-Farm Soybean Drying and Storage. Website. http://uaex.edu/farm-ranch/crops-commercial-horticulture/Grain_drying_and_storage/soybean_drying_and_storage.aspx

Publications

Patents

Osborn, G.S., M.D. Matlock, S. Teltschik. 8,919,743 System and Method for Dissolving Gases in Fluids and for Delivery of Dissolved Gases. Issued December 30, 2014.

Osborn, G. S., **M. D. Matlock**, S. S. Teltschik. 2012. Japanese Patent 5127702. UA Disclosure Ref. No. 04-24. System and Method for Dissolving Gases in Fluids and for Delivery of Dissolved Gases. Issued 11/9/12. Patentee– The Board of Trustees of the University of Arkansas.

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

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