

# BSE

Biological Systems Engineering Department

---

## 2023 ANNUAL REPORT



WASHINGTON STATE UNIVERSITY

College of Agricultural, Human,  
and Natural Resource Sciences

# CONTENTS

## 01 | WHAT IS BIOLOGICAL SYSTEMS ENGINEERING?

## 02 | LETTER FROM THE CHAIR

## 07 | IN REMEMBRANCE

## 10 | RESEARCH

Shulin Chen named National Academy of Inventors senior member . . . . .	11
Cultivating Excellence: Empowering the Next Generation in Agriculture . . . . .	12
High School and Undergraduate Research Interns . . . . .	13
Washington State University emphasizes food packaging . . . . .	14
WSU and Heritage University scientists to share research at March 31 symposiumn . . . . .	16
Birgitte Ahring receives Anjan Bose Outstanding Researcher Award . . . . .	18
Lav Khot and CAHNRS highlighted during NIFA's National Washington Day . . . . .	18
New academy on climate resilience to connect specialty crop professionals . . . . .	19
WSU lands top 15 ranking for best U.S. agricultural sciences college. . . . .	20
Biofuels pioneer Bin Yang named Fellow of American Institute of Chemical Engineers . . . . .	21
Grant aims for smarter harvesting . . . . .	22
Media Advisory: WSU scientists available to discuss new National Climate Assessment . . . . .	23
Juming Tang among seven WSU faculty recognized as highly cited researchers . . . . .	24
Students and faculty participate in 2023 ASABE annual international meeting . . . . .	25
AgAID Digital AgAthOn 2023 . . . . .	26

## 27 | OUTREACH & PARTNERSHIPS

BSE faculty research and outreach make local and global impact . . . . .	28
Visiting scholars . . . . .	37
Our affiliated faculty . . . . .	38
Our adjunct faculty . . . . .	39
Success stories from alumni . . . . .	40
University initiative partners . . . . .	44

## 46 | ACADEMICS

Students awards and recognitions . . . . .	47
Poster awards and best graduate seminar presenters . . . . .	48
Departmental awards and recognition for students . . . . .	49
Graduate student clubs . . . . .	50
Welcoming new BSE students . . . . .	56
2023 graduates . . . . .	57
2023 peer reviewed publications . . . . .	60
Conference and symposium announcements . . . . .	64
Support Biological Systems Engineering . . . . .	Inside back cover



Above: Wheat data collection by Dr. Sankaran's Graduate Students.

Front cover: Dr. Sankaran's Lab Group (Front: Lochana Marasinghe, Trevor Buchanan, Kingsley Umani, Back: Toky Andriamihajaso, Chamaporn Paiboonvorachat, Milton Valencia-Ortiz) participating in field data collection in wheat breeding trail using unmanned aerial system and LiCOR photosynthetic system.



GRADUATE STUDENT SHAFIK KIRAGA IS INSTALLING SOIL MOISTURE SENSORS IN A SMART VINEYARD.

# WHAT IS BIOLOGICAL SYSTEMS ENGINEERING?

Washington State University's Department of Biological Systems Engineering (BSE) trains students and serves society by developing engineering solutions for sustainable agriculture, food, energy, and water. Our internationally prominent programs connect Washington State and the world.

BSE scientists discover and apply engineering principles and methods to the processes of our natural world and provide advanced graduate education to engineering professionals. Faculty and students work primarily in one of four areas:

- Agricultural Automation Engineering
- Bioenergy and Bioproducts Engineering
- Food Engineering
- Land, Air, Water Resources and Environmental Engineering (LAWREE)

Ranked seventh nationally and tenth in the world

in research by EduRank, BSE develops engineering solutions to address some of the most pressing contemporary issues: adaptation and resilience to global warming, increasing productivity of agriculture through robotics and digital agriculture, new technologies for food quality and safety, improved nutrition, and a healthier environment.

BSE infrastructure and research teams are based at four locations: WSU Pullman, WSU Tri-Cities, WSU Irrigated Agriculture Research and Extension Center at Prosser, and WSU Puyallup Research and Extension Center. World-class laboratories at each of these locations address key issues facing agriculture in Washington and globally.

Partners, stakeholders, and friends will find many of our latest accomplishments, highlights, news, and advances from this past year in the following pages.

# LETTER FROM THE CHAIR

This is my fourth newsletter as department chair. As in my last letter, I want to thank our faculty, staff members, and students for their support and friendship. The Department of Biological Systems Engineering is a great family. Our diverse opinions, points of view, cultural differences, the respect we show each other and our unconditional commitment to the well-being of all members of our community create a solid ground for professional and personal growth for each of us and for the department.

Overall, the performance indicators of the department continued to improve in 2023. The department's expenditures grew in the last four years (2020: \$4.7 million; 2021: \$5.2 million; 2022: \$5.8 million; 2023: \$7.5 million). The expenditure per faculty also grew (2020: \$286K; 2021: \$304K; 2022: \$342K; 2023: \$468K). In 2023, our faculty members secured \$6 million in new funds and close to \$50 million as co-PI. Our department has very high research productivity indicators. Last year, our department published 115 peer-reviewed publications (7 publications per faculty member). According to the US News & World Report, our program ranked 15th among our peers in the US. EduRank, which focuses on research indicators, ranked our department 10th worldwide (7th in the US). Our average h-index is high: 52, with an average number of citations per year of 1,174. According to Google Scholar, nine BSE faculty members are among the 60 most-cited researchers from WSU. Our program's number of graduate students remains stable (58 doctoral degree students and 9 master's degree students).

The social impacts of our work are significant. Our department has one of

the best food engineering programs in the world. Professor Gustavo Barbosa-Cánovas is one of the world's pioneers in nonthermal technologies for food processing (e.g., electric pulses, high pressure, cold plasma). These technologies are now used industrially (for example, electric pulses are commonly used in potato processing). He has authored more than 30 books that are used worldwide to train food engineers. The groundbreaking work of Professor Juming Tang, developing and patenting 915 MHz single-mode microwave thermal sterilization (MATS) for chilled, ready-to-eat meals, received acceptance several years ago from the Federal Drug Administration and USDA Food Safety and Inspection Service and has been licensed for commercialization by 915 Labs (a company of Tata Group). Professor Shyam Sablani developed high-barrier polymer packaging for shelf-stable and refrigerated food products. These high-barrier packages are now used commercially for packaging sterilized and pasteurized foods.

Our Land, Air, Water Resources, and Environmental Engineering (LAWREE) scientists have also been significantly impacting Washington agriculture. Professor Joan Wu is conducting a spatiotemporal and agroecomic assessment of water erosion on rainfed, wheat-based croplands in the inland Pacific Northwest. Her model helps to explain how geophysical (i.e., climate, soil, and topography) and anthropogenic (land use and management) factors affect water erosion responsible for soil dust storms. Her results inform scientists and practitioners working at the nexus of agricultural activities and ecosystems, and to a broader audience (e.g., conservation



**Manuel Garcia-Pérez**  
Department Chair & Professor

districts and voluntary environmental stewardship programs), planning, prioritization, monitoring, education, and outreach for resource conservation. Dr. Wu also works with colleagues to develop a scalable, portable, easy-to-use tool for optimal placement of Green Stormwater Infrastructure. Professor Claudio Stöckle developed the well-known crop model "CropSyst," which is widely used to predict crop yields and to study the effect of climate change on agriculture. Dr. Kirti Rajagopalan's regional-scale agroecosystem model development and application has enhanced regional agencies' capacity to manage natural resources in a changing climate. Her results are used by Bonneville Power Administration to determine the firm hydropower energy production levels for the upcoming decade based on estimates of flows and demands. These estimations are used by the Washington State Department of Agriculture and Washington State Department of Ecology

as a critical input for long-term planning. Professor Troy Peters found that the most popular irrigation system in Washington State, the center pivot, can decrease water and power use by 18% by modifying the sprinkler configuration, called low elevation spray application (LESA). This new configuration is being increasingly adopted throughout the Pacific Northwest. Dr. Peters also developed the Irrigation Scheduler Mobile App. It is a free, online irrigation scheduling tool for simplified check-book-style irrigation scheduling. It is fully integrated with most of the agricultural weather networks in the west. Daily crop water use (ET) estimates and rainfall data are automatically inputted. Dr. Lav Khot is the director of AgWeatherNet (AWN), a data and decision tool supporting a diverse set of stakeholders (including agriculture and animal production with over \$10 billion of annual impact). Today, AWN has 400 public and private stations, more than 24,000 registered users, and a web portal receiving over 50K hits daily. Dr. Khot and team are rebuilding AWN to realize a futuristic Washington Weather Sensing Network that contributes toward resilient agriculture, animal, and human health systems.

Although our agricultural automation program is relatively new, it is growing fast and helping our farmers advance through precision agriculture. Professor Qin Zhang's work with Case IH and John Deere resulted in a new concept of autonomous systems (automated guidance system, auto-steer system). The technology was integrated into agricultural tractors to conduct autonomous annual plant production on combine harvesters. The Center for Precision and Automated Agricultural Systems (CPAAS) performs basic and applied research as well as Extension and outreach activities on precision,

automated, and smart farming technologies that have provided the basis for the rapid growth of private companies' commercialization efforts and farmers' adoption of these technologies.

One such technology is the "hand-held blossom thinning device" commercialized by Automated Ag (Moses Lake, WA), which has been adopted by cherry tree fruit growers and others to improve productivity and the health and safety of farm workers. As labor availability and cost are the most challenging problems specialty crop industries in Washington and around the country face, this technology is having a substantial and positive impact on the industry. Professor Manoj Karkee's cellulose nanocrystals-based frost control material is the other impactful technology recently being commercialized by Sappi. Frost events periodically lead to devastating crop losses, the frequency of which are increasing with increased extreme weather events. This technology is expected to save hundreds of millions of dollars for the Washington specialty crop industry, particularly in the years with late-season frost. Dr. Karkee's program has also developed robotic systems for various specialty crop operations, including fruit picking, crop thinning and pollination, and tree training and pruning. Two US patents have protected these technologies, and two are currently being commercialized: (I) A robotic apple harvesting technology is being commercialized through a partnership with FF Robotics (Haifa, Israel), which is expected to substantially reduce the cost and increase the profitability and sustainability of the \$2 billion Washington apple industry, where harvest labor cost can go as high as \$5,000 per acre. (II) An automated green shoot thinning machine for vineyards is being commercialized through a partnership with Vine Tech

Equipment (Prosser, WA), which is expected to reduce green shoot thinning cost by \$1,000 per acre.

Dr. Khot's program has developed a localized weather and crop physiology sensing system (CPSS) for automated heat stress mitigation in apples. This technology is aimed to reduce heat stress-instigated sunburn and related damages that cause more than 30% of apple crop loss annually, costing over \$300 million in economic losses for Washington apple growers. This technology is now being retrofitted for intelligent frost management in sweet cherry and blueberry crops and will help reduce over \$120 million in crop loss annually. Besides improving economics, CPSS technology critically helps in resource conservation (e.g., natural gas, water, energy) and improves labor efficiency and safety. Dr. Khot's program has also developed fixed and movable intelligent crop protection application technologies that help reduce pesticide residue levels and use on fresh-market fruit crops while improving ag worker health and safety. His collaborative research and Extension efforts have seen growth in commercial adoption of intelligent sprayers in Washington State, with over 60 units in operation in 2023.

Dr. Sindhuja Sankaran is a leading expert in the nascent and evolving field of phenomics. This involves the design, development, integration, testing, and deployment of a range of cutting-edge sensor technologies to advance crop phenotype monitoring—an important component of plant breeding, crop science, and precision agriculture research and applications. Dr. Sankaran's research program developed phenomics techniques using unmanned aerial systems and the AGIcam system—internet-of-things (IoT) based sensor

system—are expected to reduce labor costs (a key challenge in agricultural sector) by 1.5 and 7 times, respectively. The phenomics tools developed in her program have been integrated into different breeding programs in Washington State.

Our Biomass Conversion and Bioproducts program is developing new technologies that convert the carbon fixed by photosynthesis into green fuels and chemicals. In the future, our agriculture will not only be a source of food but will also provide essential components of the fiber, fuels, and chemicals used by society. Agriculture will also contribute to carbon storage at a large scale. The bioenergy program is impacting today's agricultural organic waste management strategies and, at the same time, is helping to create this new industry. Dr. Birgitte Ahring and Dr. Shulin Chen are two of the world's foremost experts in anaerobic digestion (AD) systems. Their work has helped to increase the rate of AD adoption in the state of Washington. Both have contributed to the creation of new companies. They have been developing novel syngas-cleaning nutrient recovery technologies that are contributing to the creation of next-generation AD systems. Washington State University is a world leader in sustainable aviation fuels and is co-lead with the Massachusetts Institute of Technology on the Aviation Sustainability Center (ASCENT) project. Department Chair and Professor Manuel Garcia-Pérez's group and others at WSU worked on SAF techno-economic analyses which formed the basis for the sustainable aviation fuel (SAF) rules of thumb recommended by the International Civil Aviation Organization (ICAO). This information is now used globally as an initial criterion for selecting SAF conversion technologies. Dr. Garcia-Pérez is leading the US technical support efforts

in Latin America to catalyze the growth of SAF in the region. WSU has created the world-leading training program in SAF, focusing on members of roundtables from Latin America.

Dr. Garcia-Pérez and the WSU outreach program have been critical in promoting biochar production and utilization in the Pacific Northwest. BSE Analytical lab has analyzed much of the char produced in the region. His group conducted the first studies on *Arundo donax* torrefaction for Portland General Electric. These studies resulted in the construction of the 500 tons of char per week Restoration Fuels production plant in John Day, Oregon. Though biochar produced by Oregon Biochar Solutions (<https://www.chardirect.com/>) could not initially be commercialized—because boilers were an approved technology by the International Biochar Initiative (IBI)—Dr. Garcia-Pérez worked with IBI to obtain approval for boilers to be used for biochar production. Today, Oregon Biochar Solutions commercializes 45,000 cubic yards per year and is an important player in the voluntary carbon market. Dr. Garcia-Pérez is also working with leading petroleum companies to develop databases for biomass pyrolysis oils.

Professor Hanwu Lei has been making significant contributions in developing fuels from waste plastics and is currently working with industry to crack the polymers into monomers and oligomers, then to synthesize the units back into polymers using innovative copolymer blocks that support plastic and asphaltene comingling. These revolutionary materials will aid in building new types of roads that are more tolerant of extreme weather and climatic conditions.

Dr. Bin Yang's major research includes understanding the fundamental

mechanisms of cutting-edge biomass processing technologies for advanced biofuels and bioproducts to advance and facilitate the commercialization process as well as improve our knowledge of emerging technologies to meet near- and long-term needs. He has pioneered new biomass pretreatment technology and manufacturing technologies to process biomass into jet fuel, bioplastics, carbon fiber, supercapacitor, and other bioproducts. Notably, he has invented and developed lignin-based jet fuel with two issued patents. His achievements have been thoroughly recognized through his recent awards in 2023 and 2024, including being named Fellow of the American Institute of Chemical Engineers 2023 and the Fulbright-Tocqueville Distinguished Chair Award 2024.

2023 was a year of significant changes. Last year, we lost Professor Day L. Bassett (1922–2023), Dr. Keith Saxton, who worked in the department between 1976 and 2000, and Mr. William Bowe (1952–2024). Day, Keith, and Bill worked in the department for 38, 24, and 31 years, respectively. Each was a beloved and respected member of our department. The department would like to remember their lives and celebrate their humanity, contributions, and legacy with this newsletter.

Professors Pius Ndegwa and Qin Zhang retired last year after serving in the department for 19 and 14 years, respectively. Both are now emeritus faculty members. Last year, two new faculty members in food engineering (Dr. Kang Huang and Dr. Youngsoo Lee) joined the department. We also successfully hired Brian Nyquist as our new food engineering pilot plant manager. The department has now received approval from the dean and the provost to begin the hiring process of a new faculty

member in agricultural automation. I've been influenced lately by two recent books on BSE's history, written by Professor Larry James. His observations that "the formation and evolution of this department was driven by major national and global trends and events" and "we were a little ship carried by the currents of a big ocean" have profoundly shaped my perception of our past and future. BSE's development and growth over our first 100 years were driven both by revolutions in general-purpose technologies (mechanization, electrification, irrigation, computing, biotechnology) that found applications in agriculture as well as by local and global societal events (e.g., creation of department and colleges, funding allocations, creation of the Agricultural Experimental Station, world wars, accreditations, construction of new building). Similar forces are at play today: a revolution in artificial intelligence and machine learning, quantum computing, biotechnology and genetics, renewable energy and sustainable technologies, blockchain and distributed ledger technologies, 5G and next-generation telecommunications, augmented and virtual reality, advanced manufacturing, and robotics. Likewise, significant societal movements are driving the evolution of agriculture: climate change and environment, fluctuating commodity prices, population growth and urbanization, rising consumer awareness about food health and nutrition, growing interest in traditional agricultural knowledge, water scarcity, and the need to maintain soil health. The landscape of higher education is also evolving, driven by technological advancements such as online learning, artificial intelligence, globalization, mobility and migration, funding and affordability, job market alignment, demographic shifts, equity and inclusion, and concerns and sustainability

goals. These powerful forces are shaping our present-day department while charting a path forward.

The future of agricultural systems engineering is exciting. Our department is well positioned to grow. It is critical that we remain leaders in precision agriculture. Advanced sensors, drones, and GPS technology are reducing waste, optimizing resource use, increasing crop yields, and are helping farmers apply water, fertilizers, and pesticides more efficiently. Dr. Khot's work is critical for the department's growth. Automated machinery and robots are becoming more common in planting, harvesting, and monitoring crops as well as handling repetitive tasks, improving efficiency, and addressing labor shortages. Dr. Karkee's work is critical toward ensuring Washington agriculture takes advantage of the many opportunities this technology brings. Big data and artificial intelligence are being used to analyze crop health, predict weather patterns, and make informed decisions. This will continue to be an area of interest for future growth.

Our faculty members are focusing on sustainability, soil health, water conservation, and reducing the carbon footprint of farming practices. We contribute to the development of systems for more sustainable irrigation (Dr. Peters), renewable energy integration (bioenergy group), and reducing chemical use (Dr. Khot). Engineering plants that are more resistant to pests, diseases, and environmental stressors is likewise a key area of development. Dr. Sankaran's work in phenomics is critical for developing more resistant crops. As climate change impacts agriculture, engineering solutions will help crops adapt to new conditions, such as altered rainfall patterns or extreme temperatures. The work of Drs. Karkee, Khot, Rajagopalan is helping

Washington agriculture to adapt to climate change. Our department also has expertise in several components needed to integrate devices in agriculture for real-time monitoring and control of farming operations.

Our challenge is coalescing our knowledge at the department and college levels to show the viability of futuristic dairies, orchards, and large farms. Our food engineers continue to work to optimize farm product handling, processing, and distribution. They develop innovative technologies to enhance food products' flavor, nutrition, and functionality. Our nonthermal and thermal technology programs, led by Professors Tang and Barbosa-Cánovas, have made significant contributions to methods that preserve and enhance the nutritional value of food during processing and storage. We aim to increase the interaction between our food engineers and the state's industry. Our faculty members should continue making similar significant contributions toward creating circular economies, including contributions to biorefineries that will process agricultural and forest carbon into fuels, chemicals, and materials.

The rapidly changing higher education industry will also drive BSE growth. We need to take advantage of online learning and digital platforms to increase the flexibility and accessibility of our programs. In the future, our students should be able to take courses from anywhere in the world, at any time. AI and data analytics advances will likely help our unit develop more personalized learning experiences with educational content tailored to individual student's needs and learning styles. Virtual and augmented reality will transform how subjects are taught, providing immersive learning experiences. We need We need to develop more modular and stackable

credentials, where students earn certificates or badges for specific skills that can be combined into broader qualifications. Our department should lead interdisciplinary education and encourage students to draw on knowledge from various fields to solve complex problems. Our students should have more global collaboration and cultural exchange opportunities, enriching their

educational experience. We will also pursue offering adult education and professional development opportunities to help foster and create an adaptable Washington workforce.

In summary, Washington's agricultural future will be impacted by our capacity to contribute to the development of many of these technologies and facilitate their adoption. By embracing

these trends, the department will grow. The department 15 years from now will indeed be very different. I hope we will honor the achievements of our predecessors while continuing to treat each other like family! Let's work together to ensure BSE is a great place to work, study, conduct research, and dream of a better world!

As always, Go Cougs!

# 2023 OVERALL DEPARTMENT INDICATORS

**\$7.5M** Overall departmental research expenditures

Average faculty expenditure:

**\$417k**

**115**

Number of peer-reviewed publications

Average publications per faculty member

**7**

Number of PhD students:

**58**

(graduated in 2023: 10)

Number of MSc students:

**9**

(graduated in 2023: 3)

Average h-index:

**52**

According to Google Scholar, **9 BSE FACULTY** are among the

**60 most cited researchers** at WSU

**1,174**

Average number of citations per faculty member

In **EduRank**, BSE is ranked **7<sup>TH</sup> IN THE U.S.** and **10<sup>TH</sup> IN THE WORLD** for agricultural engineering ([edurank.org/engineering/agricultural](http://edurank.org/engineering/agricultural))



In a recent **U.S. News & World Report**, WSU **RANKS 15<sup>TH</sup>** for agricultural engineering

# IN REMEMBRANCE OF

## Dr. Day L. Bassett

---



Dr. Day L. Bassett, member of the BSE faculty for 38 years, passed away December 4, 2023, in Pullman at age 101. Dr. Bassett, who was born June 4, 1922, and raised in Layton, Utah, received a BS in agricultural engineering (1948), a BS in civil engineering (1950), and an MS in irrigation engineering (1952) from Utah State University, as well as a PhD in agricultural engineering from the University of Idaho (1973).

He joined the WSU Agricultural Engineering faculty in 1954 after serving as a 2nd lieutenant and B-17 and B-29 bomber pilot in the Army Air Corp during World War II (1942–46). He also served as an engineer with the Bureau of Plant

Industry, Soils, and Agricultural Engineering, Logan, Utah (1948–52), and as a WSU Extension agent (Settler Assistance Program) in Grant County (1952–54) and Adams County (1954) prior to coming to Pullman.

Dr. Bassett taught agricultural mechanization courses in farm irrigation and drainage; turf irrigation engineering; soil and water conservation engineering; and water and erosion control to undergraduate and graduate agricultural engineers. He served as major professor or guidance committee member for numerous graduate students and advised undergraduates. In 1987, the College of Agriculture and Home Economics recognized his “excellence in teaching” by honoring him as a Featured Teacher.

The primary foci of Dr. Bassett’s research were the design and management of surface and trickle irrigation systems, and irrigation with limited water. He developed a mathematical model of water flow in small, earth-lined channels and used it to advance furrow irrigation system design and management. His work in irrigation water management involved the use of pan evaporation data and, later in his career, infrared thermometry to schedule irrigations. He also collaborated with Dr. Keith Saxton on a mathematical plant growth model (Dr. Saxton’s soil-plant-atmosphere-water

model) for irrigation water management and planning. He actively participated in regional trickle- and surge-flow surface irrigation studies and collaborated on various trickle irrigation studies with Pat Middleton and other researchers at the Irrigated Agriculture Research and Extension Center in Prosser, Washington. In the early 1970s he worked with colleagues at Cornell, Purdue, and Texas A&M Universities on the use of satellites in farming.

Dr. Bassett had several international assignments during his WSU career. They included three at the University of Jordan, one in Portugal, and a major two-year irrigation management project in Pakistan.

He also took sabbatical leave to collaborate on surface irrigation modeling at the University of California, Davis, in 1966 and for PhD study at the University of Idaho in 1973. He was a member of the American Society of Agricultural Engineers and served in the US Air Force Reserve for many years, retiring at the rank of lieutenant colonel.

Dr. Bassett retired from WSU January 31, 1989, and continued to teach part-time in the department for another three years. He enjoyed his grandchildren and traveling with his wife of 70 years, Zella, until an unfortunate fall claimed her life in 2016. He lived in Pullman until his passing.

## Dr. Keith E. Saxton

---



Dr. Keith E. Saxton, a member of the BSE's graduate faculty for 24 years, passed away July 31, 2023, in Pullman at age 85. Dr. Saxton came to WSU in 1976 as a research agricultural engineer and hydrologist employed by the US Department of Agriculture, Agricultural Research Service (USDA-ARS). In 1992 he was selected to lead and coordinate USDA-ARS's The Columbia Plateau Wind Erosion and Air Quality Research Plan. During his 24 years in the department, he advised numerous graduate students and served on the guidance committees of many more.

Dr. Saxton was born December 22, 1937, in Dawes County, Nebraska. He earned a BS in agricultural engineering from the University of Nebraska in 1961, an MS in civil engineering from the University of Wisconsin in 1965, and a PhD in agricultural engineering from Iowa State University in 1972. Prior to coming to Pullman, he served as a USDA-ARS research agricultural engineer for a total

of 15 years in Lincoln, Nebraska; Madison, Wisconsin; Columbia, Missouri; and Ames, Iowa.

Dr. Saxton was known worldwide for his expertise in hydrologic modeling, specifically evapotranspiration (ET), infiltration, and soil water budgets; predicting hydraulic properties of soil from texture and other physical attributes; simulating the soil-plant-atmosphere-water (SPAW) system; and reducing water and wind erosion of soil from agricultural land in the Columbia Plateau. He wrote the ET chapter in the American Society of Agricultural Engineers' Monograph No. 5, "Hydrologic Modeling of Small Watersheds"; the infiltration chapter of the Hydrology Handbook of the American Society of Civil Engineers; the infiltration component of the USDA Water Erosion Prediction Project (WEPP) model; and the chapter on soil water movement and infiltration in McGraw Hill's Handbook of Applied Hydrology. He was also a major contributor to No-Tillage Seeding in Conservation Agriculture, published by the Food and Agriculture Organization of the United Nations in 2007.

One of his most significant contributions was adapting Cross Slot no-till seed drill opener technology from New Zealand to North American conditions. This research helped reduce water and wind erosion of soil from agricultural lands of the northwestern United States and prairie provinces of western Canada.

Another major contribution was leading the USDA-ARS project to reduce wind erosion of soil from agricultural land of the Columbia Plateau, particularly of particles less than 10 micrometers in diameter (PM10) that contribute to

respiratory problems. His work with conservation tillage and no-till farming systems curbed wind-blown dust and associated respiratory problems throughout the Columbia Plateau. His USDA-ARS supervisor, Dr. Robert Papendick, retired research leader of the Land Management and Water Conservation unit at WSU in Pullman, noted that "dust storms in the region have been reduced significantly and are now few and far between due to the efforts of Dr. Saxton and his team." Additionally, he served on the National Agricultural Air Quality Task Force that advised the secretary of agriculture on all aspects of air quality related to agriculture.

Dr. Saxton was also recognized internationally for:

- Devising and improving his SPAW model to evaluate irrigation scheduling methods, determining optimum planting dates, his studies on deficit irrigation, and examining wetland and pond hydrology.
- Developing a computer model that simulates dust storms, predicting the contribution of dust emissions from agricultural fields to regional PM10 concentrations. The model was an important tool for assessing the impact of different no-till technologies and of practices that contributed to regional air quality.
- Being a key member of the 30-year Solutions to Environmental and Economic Problems (STEEP) project that developed new wheat varieties, improved tillage techniques, and improved pest control strategies for growing crops profitably while

reducing soil erosion up to four-fold in the ten-million-acre region stretching from the Cascade Mountain Range to the Palouse, Columbia, and Snake River Valleys in Washington, Oregon, and Idaho.

Dr. Saxton authored or coauthored more than 70 refereed journal articles, numerous technical publications, monographs, popular press articles, and a plethora of invited papers and presentations. In 1975, he received a Paper Award (honor-

able mention) from the American Society of Agricultural Engineers (ASAE). He also received the Best Paper Award for 2011 from the Soil Science Society of America. He was a registered professional engineer in Idaho and Missouri.

As a member of ASAE he served as a regional officer and on several technical committees, chairing many of them. He was elected ASAE fellow in 1999. Other professional memberships included the American Society of Civil Engineers, the

Soil Conservation Society of America, and the Organization of Professional Employees of the USDA. He was recognized as the USDA-ARS Engineer of the Year.

After retiring December 1, 2000, Dr. Saxton became a USDA-ARS volunteer and private engineering consultant. He enjoyed his retirement years with his wife of 66 years, Mary Lou, in Pullman until his passing.

## Mr. William E. (Bill) Bowe

---



Mr. William E. (Bill) Bowe, 71, was an engineering technician in BSE for 31 years from 1978 until 2009. He passed away from cancer on February 18, 2024, after a brave battle.

Bill was born in Walla Walla, Washington, on March 17, 1952, and grew up on

a family farm near Prescott, Washington. He earned a BS in agronomy from WSU in 1974 before moving to Hawaii to work in the sugar cane industry. He was employed in the engineering departments of the Pioneer Mill Company's sugar plantation, and after a short stint at the University of Hawaii, the Lihue Plantation. He gained valuable experience and knowledge in drip irrigation while in Hawaii.

Bill was hired in 1978 to support BSE's research program in irrigation engineering. His clever mind, expertise, and patience were invaluable to faculty and numerous students. He assisted them with brainstorming and fabricating research equipment and experimental apparatus; planning and conducting experiments; and collecting and analyzing data. He was also an invaluable asset to the teaching program by designing, building, and setting up experimental apparatus; assisting with laboratory, in-class, and individual instruction; and

helping students with their undergraduate projects and graduate theses. He also enthusiastically pitched in wherever he was needed to assist fellow technicians and buoy research efforts throughout the department.

Bill retired from WSU in 2009 and moved to western Washington where he worked briefly for the Snohomish Conservation District, the US Environmental Protection Agency, and the Camano Center. He fully retired in 2013 and enjoyed his grandchildren with his wife of 50 years, Sue, on Camano Island until his death.

BIOLOGICAL SYSTEMS ENGINEERING

# RESEARCH

Scientists and learners from all corners of the United States and the world come together at BSE. Research in our department generates knowledge and develops technologies for environmental stewardship, renewable

energy, productive and sustainable agriculture, and safe and nutritious foods. The following section showcases current advances and milestones, faculty success stories and awards, and more.



CHAMAPORN PAIBOONVORACHAT (PHD STUDENT) AND TOKY ANDRIAMIHAJASOA (MS FULBRIGHT STUDENT) COLLECTING PHYSIOLOGICAL DATA FROM WHEAT PLANT USING PORTABLE PHOTOSYNTHESIS SYSTEM.

# Shulin Chen named National Academy of Inventors senior member

Department of Biological Systems Engineering professor Shulin Chen has been honored as a senior member of the National Academy of Inventors. He will be inducted formally at the Academy’s annual meeting in June in Washington, D.C.

Chen has produced biochemicals from organic waste using microbial “cell factories,” yeasts that synthesize target biochemicals using metabolic pathways. His team also developed a method for extracting high-value products from potato peels, a waste by-product of potato processing. His

method turns phytochemical and nutrient-rich waste into a revenue stream. Chen holds ten U.S. patents for his innovations.

Chen’s research focuses on making industrial processes more sustainable. His projects include development of bioconversion processes and systems for the production of biofuel, bioenergy, and bioproducts. Using anaerobic digestion systems, his research team has invented a process to convert manure and other dairy-industry waste to bioenergy which will reduce greenhouse gas emissions. His team’s



**Shulin Chen**  
Professor

systems also recover nutrients from wastewater, alleviating concerns about surface and groundwater.



Dr. Liang Yu with Dr. Shulin Chen’s graduate students working with industrial partners on pilot testing their new anaerobic digestion technology.

# Cultivating Excellence: Empowering the Next Generation in Agriculture

## High School and Undergraduate Research Interns at Biological Systems Engineering

At the heart of our department's mission is a commitment to nurturing emerging talent through mentorship. Our faculty members have been mentoring high school and undergraduate students in developing their research and communication skills, offering a glimpse into the rigors and rewards of academic pursuit, and fostering a spirit of curiosity and ambition among these emerging talents. Several students

(listed below) engaged in a one-on-one collaboration with faculty members on research projects associated with agricultural technology, climate change, and sustainable agriculture. Drs. Manoj Karkee, Kirti Rajagopalan, Lav Khot, and Sindhuja Sankaran are a part of the AgAID, AI Institute for Agriculture, Undergraduate Research Internship (URI) program. Dr. Sindhuja Sankaran also leads a USDA-NIFA Research and Extension Experiences for Undergraduates (REEU) program on Agricultural Data Science. WSU

AgWeatherNet, directed by Dr. Lav Khot, also offers up to four paid internships on an annual basis. These programs also offer co-mentorship opportunities to graduate students, developing their leadership skills.

In addition, faculty members work with undergraduate capstone project teams, primarily from computer science and other engineering disciplines, to develop technological or data-driven solutions for agricultural and biological applications.



INTERNS VISITING THE HAZELNUT/BERRY FARM

**Our featured 2023 intern is Nicholas Kraabel**, an AgAID Institute intern who worked with two graduate students Supriya Savalkar and Bhupinderjeet Singh in Kirti Rajagopalan’s lab. He built an AI framework for temporal downscaling of weather data and presented his work at the American Geophysical Union’s Fall meeting in 2023 at

San Francisco. He is leading a related journal manuscript submission. He won the 2024 Washington State University Excellence in Undergraduate Research Award, among several over university and college level awards. He is currently pursuing graduate studies at Penn State University.



## High School and Undergraduate Research Interns

Student Name	School/Institute	Mentor
Nick Kraabel	Washington State University (AgAID)	Dr. Kirti Rajagopalan Supriya Savalkar Bhupinderjeet Singh
Wendy Haw	University of California, Merced (AgAID)	Dr. Kirti Rajagopalan Bhupinderjeet Singh
Adrianna Ferris	Washington State University (AgWeatherNet)	Dr. Lav Khot Derek Waver
Ali Alsmael	Washington State University (AgAID)	Dr. Lav Khot Srikant Gorthi Jake Schrader
Dylan Driscoll	Washington State University (AgWeatherNet)	Dr. Lav Khot Sean Hill
Freddy Jimenez Nieves	Washington State University (Precision Agriculture Lab)	Dr. Lav Khot Basavaraj Amogi
Joshua Oliver	Washington State University (AgAID)	Dr. Lav Khot Srikanth Gorthi
Nelson Goosman	Washington State University (AgAID)	Dr. Lav Khot Basavaraj Amogi
Shannon Whiting	Washington State University (AgWeatherNet)	Dr. Lav Khot Sean Hill
Shelby L Wright	Columbia Basin College (NSF REEU)	Dr. Lav Khot Dr. Rayapati Naidu
Pham, Vy Kha	Washington State University (Animal Sciences, the Honor College)	Dr. Liang Yu
Deven Biehler	Washington State University (AgAID)	Dr. Manoj Karkee
Abhilash Ambati, Aidan Gooding, Henry Le, Trang Hoang	Washington State University (Senior Design Team)	Dr. Sindhuja Sankaran Kesevan Veloo
Aidan Bachart, Forest Cook, Shreyas Jagular	Washington State University (Senior Design Team)	Dr. Sindhuja Sankaran Dr. Worasit Sangjan
Anisha Yodtare	Pullman High School	Dr. Sindhuja Sankaran Milton Valencia-Ortiz
Josie Dieu	University of Arizona (REEU)	Dr. Sindhuja Sankaran Milton Valencia-Ortiz
Jordan Muehlbauer, Zachary Clifton Hall	Washington State University (Senior Design Team)	Drs. Sindhuja Sankaran Worasit Sangjan
Prashanth Vankudoth	Indian Institute of Technology - Kharagpur, India	Dr. Sindhuja Sankaran
Vardhini Telu Giri	Indian Institute of Technology - Kharagpur, India	Dr. Sindhuja Sankaran

## Washington State University emphasizes food packaging

Nationwide, industries have been struggling to find well-trained workers, and the packaging and flexible packaging industries have not been immune.

FlexPack Voice recently profiled the Packaging Training Program at Washington State University to show this school's emphasis on training the future workforce.

Shyam S. Sablani, Ph.D., a professor in Washington State University's food packaging program discusses this with FlexPack Voice in a question-and-answer session, in the September/October 2022 issue (Vol. 3, Issue 5).

### **FLEXPAC VOICE: Tell us about the packaging program at your school.**

**Shyam S. Sablani:** The packaging program at Washington State University is an integral part of the food engineering graduate program in the Department of Biological Systems Engineering. Students in the program are trained in conventional and novel food processing and packaging technologies and receive master of science or doctoral degrees from the Voiland College of Engineering and Architecture. In the packaging area, students acquire skills in the design and development of commercially viable and sustainable packaging

for food. Students study package fabrication methods, physical properties of packaging materials, packaging waste management, active and intelligent packaging, and shelf life of packaged foods.

### **FPV: What are the key skills that employers are looking for when hiring from your program?**

**SS:** Food manufacturing companies hire our graduates. The companies appreciate that our students receive systematic training in conventional and advanced food processing technologies, in addition to food packaging. Through research, students gain hands-on experiences in packaging material and



GRADUATE STUDENT, SUNIL KUMAR ANALYZING PROPERTIES OF FRUIT BEFORE AND AFTER THERMAL PROCESSING.

component testing using laboratory equipment. They are experienced in designing experiments to study the influence of manufacturing processes on package performance and the shelf-life determination of packaged foods. In addition, employers want our graduates who have acquired soft skills, including communication, interpersonal, presentation, oral, and written. And they want workers who can easily adapt to change and are critical thinkers, as well as highly motivated.

**FPV: What emphasis do you put on flexible packaging?**

**SS:** We primarily use flexible packaging materials in our research related to advanced food preservation technologies. We emphasize using novel technologies and methods to

improve gas and vapor permeabilities of multilayer packaging films, the influence of food processing technologies on barrier properties of films, food and packaging interaction, and the influence of barrier properties on the shelf life of packaged foods.

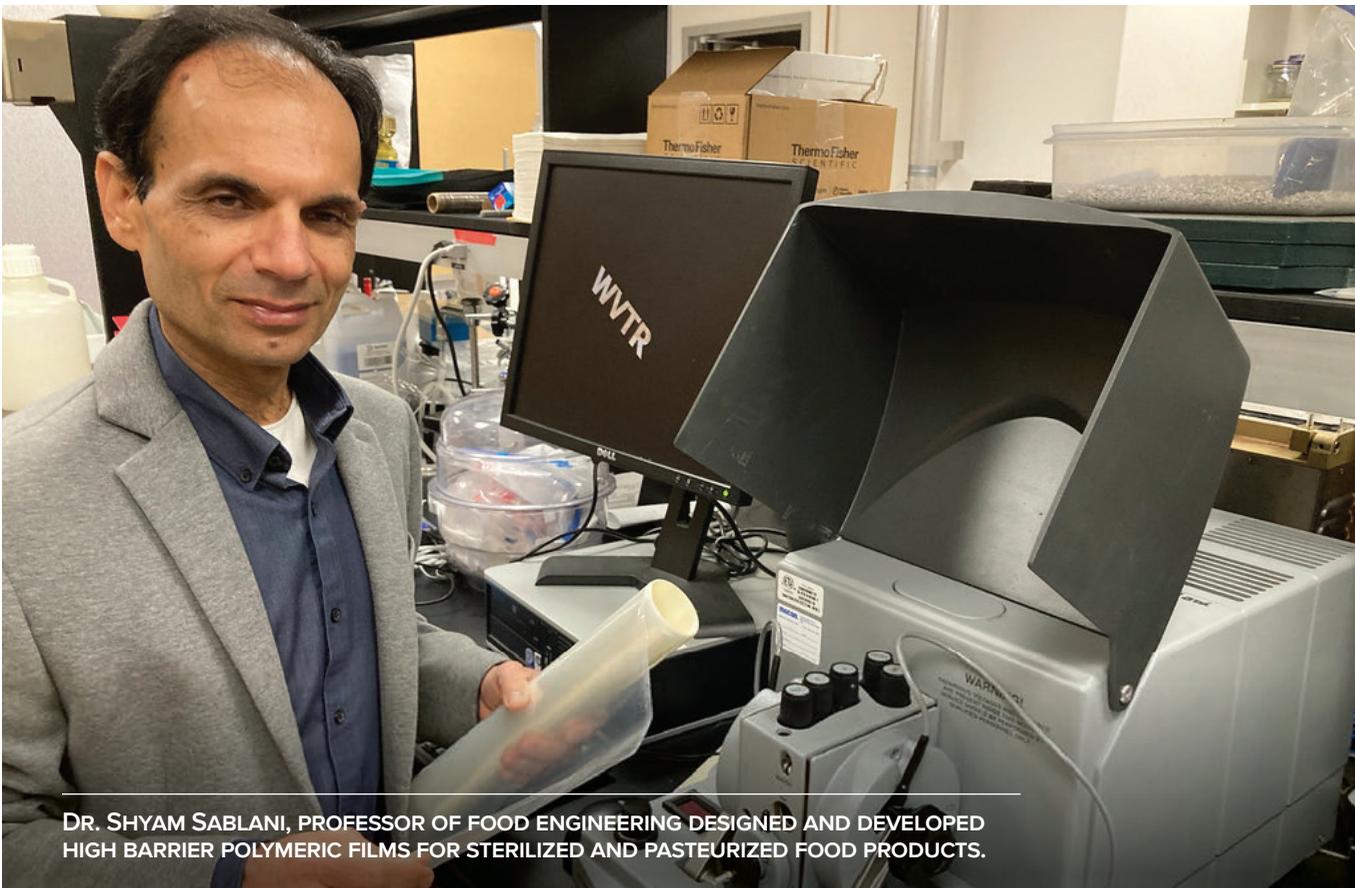
**FPV: What do you see as the future challenges in the packaging industry?**

**SS:** Packages are necessary for food safety and shelf-life extension. Yet, consumers may only see the negative aspect of packages and consider packaging as increasing the burden on the environment. The packaging industry needs to educate consumers about the role of packaging in improving the safety and shelf life of food. In collaboration with research

institutions and universities, the packaging industry needs to develop more sustainable packaging solutions, including reusable packaging and recycling of packaging materials. The industry needs to work with state and city governments and private entities to develop infrastructures for cost-effective collection of packages after use to reuse and recycle.

**FPV: Anything you would like to add?**

**SS:** Consumer contribution is central to the development of sustainable packaging solutions. There is a need to educate consumers about their role in reducing and managing packaging waste.



**DR. SHYAM SABLANI, PROFESSOR OF FOOD ENGINEERING DESIGNED AND DEVELOPED HIGH BARRIER POLYMERIC FILMS FOR STERILIZED AND PASTEURIZED FOOD PRODUCTS.**

## WSU and Heritage University scientists to share research at March 31 symposium

By Angela Sams, College of Agricultural, Human, and Natural Resource Sciences

Martin Churuvija uses stereo cameras such as the one pictured to scan cherry trees and build 3D images.

Scientists at Washington State University's Irrigated Agriculture Research and Extension Center (IAREC) will share their research alongside Heritage University undergraduate students during the Honoring Undergraduate and Graduate Scholars Symposium (HUGSS) this Friday, March 31.

The event, set to take place on the Heritage University campus in

Toppenish, Washington, represents an ongoing alliance between the two universities while helping graduate students improve their mentoring skills.

"The symposium allows students to present research results and enables WSU to reach out to more Heritage University students, encouraging them to work with us in the coming summer and beyond," WSU IAREC Director Naidu Rayapati said. "HUGSS also demonstrates the value of WSU's mutually beneficial partnership with Heritage University."

Because of its casual atmosphere and relatively small number of participants, HUGSS helps

undergraduates build their confidence as they ask questions, learn about different fields of research, and interact with graduate students. It also provides a pathway for students from underserved communities to enhance their education, which could lead to more job opportunities.

"The symposium offers an atmosphere where undergraduate and graduate students can talk to each other and build peer mentoring relationships," said Rayapati. "Hopefully this will inspire many undergraduates to seek higher education."

Martin Churuvija, an agricultural



**MARTIN CHURUVIJA USES STEREO CAMERAS SUCH AS THE ONE PICTURED TO SCAN CHERRY TREES AND BUILD 3D IMAGES. SCIENTISTS AT WASHINGTON STATE UNIVERSITY'S IRRIGATED AGRICULTURE RESEARCH AND EXTENSION CENTER (IAREC) WILL SHARE THEIR RESEARCH ALONGSIDE HERITAGE UNIVERSITY UNDERGRADUATE STUDENTS DURING THE HONORING UNDERGRADUATE AND GRADUATE SCHOLARS SYMPOSIUM (HUGSS) THIS FRIDAY, MARCH 31.**

automation engineering PhD student in WSU’s Department of Biological Systems Engineering, is one of several researchers presenting at HUGSS.

Churuvija is studying tree pruning process automation in cherry and apple orchards. He uses stereo cameras to scan trees, building 3D images that help robots understand their structure, and determine which branches need to be pruned.

“There’s still room for improvement, but I believe we’ll see collaboration between machines and humans in these activities,” he said.

Churuvija thinks that HUGSS can help younger students envision new possibilities for themselves.

“An event like this opens doors for students, inspiring them and showing them what they can achieve,” he said. “It also shows them that PhD researchers aren’t necessarily geniuses — they’re often average people with unwavering determination!”

Juan Munguia, who is pursuing a master’s degree in horticulture at WSU, hopes that HUGSS will help undergraduates develop an interest in the agriculture industry.

“It only takes one idea to spark someone’s imagination,” he said. “This is a great way to encourage students to become future researchers and get them interested in agriculture. This could really help the agriculture industry.”

Munguia will present his research on calcium disorders in Cosmic Crisp® and Honeycrisp apples. Both varieties are highly susceptible to calcium deficiencies, which can lead to substantial crop loss.

Historically, growers have added foliar sprays to increase calcium, but the method has proven to be ineffective. As a potential solution, Munguia is testing plant growth regulators that manipulate the growth of the tree by temporarily inhibiting shoot growth or shifting the movement of calcium from the shoots to the fruit.

“If we can reduce calcium deficiency disorders, we can potentially reduce the price of the apple, making it better for consumers and growers,” Munguia explained.

Salik Khanal, a post-doctoral researcher at WSU’s Center for Precision and Automated Agricultural Systems, hopes his HUGSS presentation will help motivate the students who attend.

Khanal’s research focuses on 2D and 3D image processing and its use in robotic field operations in agriculture. Detecting and measuring tree fruits such as apples is necessary for robotic harvesting. Similar image processing

techniques are also used in orchard operations like thinning, pruning, and harvesting.

Claire Castillo, a PhD student majoring in land, air, water resources, and environmental engineering, will present her efforts to develop a methodology for finding the minimum irrigation system design capacity using historical evapotranspiration and its variability. Castillo is trying to determine how irrigation systems can provide an optimal amount of water to crops, avoiding crop stress yet ensuring adequate and economical irrigation design capacities.

Castillo is excited to attend HUGSS so she can see what fellow scientists are working on and share her research with others.

“The event will expose me to other current research and trends,” Castillo said. “It will help me learn about topics that can be studied in the future.”



Dr. Manoj Karkee with his graduate students Martin Churuvija and Uddhav Bhattarai

## Birgitte Ahring receives Anjan Bose Outstanding Researcher Award

**Birgitte Ahring**, professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering and with the Bioproducts, Sciences and Engineering Laboratory at the WSU Tri-Cities campus, is a prolific researcher and a global leader in biomass conversion research for producing biofuels and high-value bioproducts.

With WSU since 2008, she has published more than 500 articles in peer-reviewed journals. Overall, she has been cited 33,702 times in her career and has an h-index of 93.

Her research is mission-driven and is focused on solving bottlenecks for bringing new and better technologies for biofuels and bioproducts to the market, including pathways to produce sustainable biofuels in the aviation industry from lignin, fungi, and other forms of biomass.

She has been recognized around the world for her breakthroughs, including recently being named “Washingtonian of the Day” by Governor Jay Inslee.



**Birgitte Ahring**  
Professor

## Lav Khot and CAHNRS highlighted during NIFA’s National Washington Day — May 10, 2023

NIFA’s support allows WSU’s College of Agricultural, Human, and Natural Resource Sciences (CAHNRS) to bring new ideas to light that improve our food supply, protect our environment and natural resources, and keep Washington agriculture competitive. More than 73% of CAHNRS extramural funding is from federal sources, the most important of which is USDA-NIFA. This support enables an incredible range of practical discovery and education.

Lav Khot, as WSU’s AgWeatherNet director, is in charge of the network’s nearly 400 solar-powered weather stations located across Washington state. This helps Northwest agricultural producers to navigate complex and

uncertain climate and economic environments.

NIFA underwrites work by WSU economists serving farmers and ranchers through the Western Extension Risk Management Education Center, which helps producers manage the evolving risks, such as drought, market, wildfire, regulatory and labor challenges, that they face across the diverse western region.

For more information on NIFA’s State of Success, National Washington Day, please visit the USDA / NIFA website.

[nifa.usda.gov/about-nifa/blogs/state-success-national-washington-day](https://nifa.usda.gov/about-nifa/blogs/state-success-national-washington-day)



**Lav Khot**  
Associate Professor

# New academy on climate resilience to connect specialty crop professionals

By Seth Truscott, College of Agricultural, Human, and Natural Resource Sciences

A new training effort through WSU's Center for Sustaining Agriculture and Natural Resources will connect specialty-crop growing regions nationwide to aid in resiliency for growers of grapes and other specialty crops.

A team led by scientists at Washington State University's Center for Sustaining Agriculture & Natural Resources (CSANR) is establishing the Specialty Crop Climate Change Extension Academy to improve Extension and USDA professionals' capacity to support climate preparedness.

The new training academy is being funded by a \$1.5 million Climate Hub grant from the USDA Agriculture and Food Research Initiative's Foundational and Applied Science Program. Its goal is to facilitate forward-thinking conversations about climate change resiliency among professionals in the fruits, vegetables, seeds, and other specialty crops industries.

"This new academy is about finding peers in specialty crop agriculture and making connections across regions," said Chad Kruger, CSANR director and lead investigator of the training project, titled "Analogues for Dialogs."

This fall, team members will recruit a cohort of 20 Extension and USDA Climate Hub professionals in major centers of U.S. fruit and vegetable production to the academy. Recruits will learn about climate change factors and communication strategies, developing



Grapes grow in a modern Washington vineyard.

their ability to support grower preparedness.

A major focus of the project is fostering cross-regional connections through climate analogs: for each target region, an "analog" site will be chosen with a current climate that matches the target's expected future. Participants from paired sites will engage virtually and through site visits.

"Conversations that help growers get to know their counterparts, and what they're dealing with, will empower them more than us simply giving them information," said project manager Teal Potter, a postdoctoral researcher with CSANR. "We're looking for people who know there's a need to prepare for a changing climate, but don't really know what to do about it."

Collaborating with the grant team, Siddharth Chaudhary and Kirti Rajagopalan, scientists with WSU's Department of Biological Systems

Engineering, study the value of analogs for cross-regional conversations on climate change adaptation. Their recently published research in *Scientific Reports* characterized analogs for all specialty crop counties in the U.S., bringing together Extension professionals from paired locations to discuss regional practices.

Team members represent WSU, the University of Florida, the University of Minnesota, and the Ag and Food Systems Institute, and work in partnership with six regional USDA Climate Hubs.

Academy participants will be admitted this fall, with training beginning early in 2024.

Agricultural and Extension professionals can connect with CSANR to learn about opportunities for participation and further strategies for climate change adaptation.

# WSU lands top 15 ranking for best U.S. agricultural sciences college

Oct. 11, 2023 by Angela Sams

College ranking and review website Niche named Washington State University's College of Agricultural, Human, and Natural Resource Sciences (CAHNRS) as one of the 15 best U.S. agricultural sciences colleges for 2024.

"This ranking represents the valuable and impactful work of CAHNRS faculty, staff, and students," said Wendy Powers, Cashup Davis Family Endowed Dean of CAHNRS. "Through agricultural sciences research and outreach, our college supports growers, partners, and producers while fostering a resilient Washington where communities, families, and individuals thrive. CAHNRS graduates are empowered with knowledge and prepared to pursue careers that are vital to global food security."

Encompassing 13 academic departments and schools, 22 majors, and 27 graduate programs, CAHNRS leads WSU's land-grant mission of service through education and research.

Working to improve quality of life for the people of Washington state and the world, the college promotes healthy communities, families, and children; sustains the economy and the environment; and continually advances the science and practice of agriculture.

CAHNRS is a leading driver of research at WSU, contributing to nearly 40% of the university's external funding budget. Research within the college reflects the diversity of Washington's communities, businesses, agriculture



(Photo: Adobe Stock)

systems, natural resources, and landscapes, helping feed a growing population, protect natural resources, and create greater capacities for resilience in the face of change.

CAHNRS students work with renowned faculty committed to the training of future scientists as they pursue meaningful research projects and extend science to serve communities at home and around the world. Each CAHNRS graduate leaves equipped with the knowledge base, experience, and interpersonal communication skills to be job-ready on day one.

As part of the college, WSU Extension has provided educational, personal, and professional development opportunities statewide for more than 100 years, operating through 40 county and tribal offices as well as four research and Extension centers.

"CAHNRS teaching, research, and Extension collaborations benefit our

undergraduate and graduate students because our faculty address real-world challenges in and out of the classroom," said Nancy Deringer, interim associate dean for CAHNRS Student Success and Academic Programs. "Our growing industry collaborations allow students to frequently engage in transformative educational experiences from their first year through their senior capstone. Employers seek out CAHNRS students because of their hands-on experiences and readiness to address the challenges of today and tomorrow."

In 2021, CAHNRS was ranked as the 17th best agriculture college by school and program ranking website College Values Online.

Learn more about the CAHNRS mission.

[cahnrs.wsu.edu](http://cahnrs.wsu.edu)

# Biofuels pioneer Bin Yang named Fellow of American Institute of Chemical Engineers

By Seth Truscott

Developing new and sustainable fuels and products from biomass, Professor Bin Yang is a newly named Fellow of the American Institute of Chemical Engineers (AIChE), a professional society of more than 60,000 scientists. Here, he works with members of his lab at WSU Tri-Cities.

Washington State University Professor Bin Yang's work creating plant-based fuels that are easier on the environment and the pocketbook has earned him international recognition from the American Institute of Chemical Engineers.

Yang is now one of the newest Fellows of the institute, a professional society of more than 60,000 scientists in 110 countries. He will be honored at the institute's annual meeting, Nov. 5–10, at Orlando, Florida.

"I take nature as my inspiration," said Yang, who works to understand and develop advanced biofuels and bioproducts from plant biomass — crops and plant residue used to create energy — while sharing knowledge and training the next generation of scientists.

"My ultimate goal is a real sustainability revolution," he said. "I'm working to develop sustainable low-carbon fuels that reduce climate change."

Fellow is the highest grade of membership in the institute, which fosters exchange on the frontiers of research in energy, sustainability, nanotechnology, and chemical plant



safety and security. Fellows provide guidance and contribute to activities aiding development of safe and useful products for the benefit of society.

"I'm humbled and deeply grateful for this award," said Yang, who thanked peers and colleagues who supported his nomination.

Involved with AIChE for the past 20 years, he has been a volunteer leader, organizing topical sessions and serving as a session chair. He is one of three WSU scientists to be named Fellows of the Institute. Yong Wang and Richard Zollars, faculty in the Voiland College of Engineering and Architecture, were previously named Fellows.

Based at WSU Tri-Cities for over a decade, Yang has pioneered new technologies to process biomass into jet fuel, bioplastics, carbon fiber, supercapacitors, hydrogen carriers, and other bioproducts.

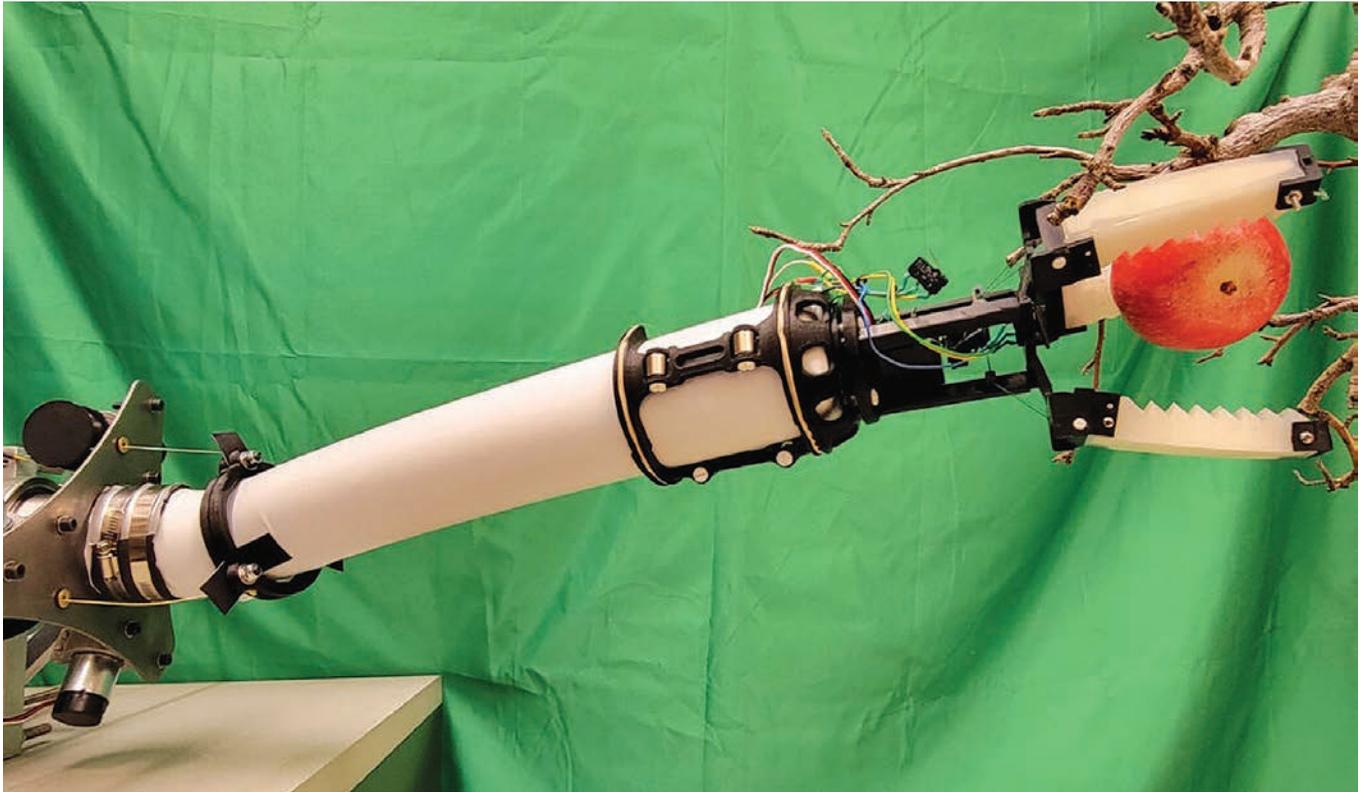
"Biofuels and bioproducts play a crucial role in decarbonization efforts by promoting sustainable alternatives to fossil-based products and processes," Yang said. "Innovation is key to achieving a sustainable future for the world."

A member of the university's Bioproducts, Sciences and Engineering Laboratory (BSEL), Yang also studies how microbes can produce a biodegradable plastic. He was a 2019 Fulbright Distinguished Chair in Energy and Sustainable Use of Natural Resources; holds six patents; has authored more than 135 papers and book chapters; and serves as an editorial and advisory board member for leading biorefinery journals.

Learn more about Yang's work at his research site.

<https://labs.wsu.edu/bin-yang>

## Grant aims for smarter harvesting



Apple picking robot prototype.

Nov. 9, 2023 by Tina Hilding

WSU researchers have been awarded a \$1.2 million National Science Foundation grant to improve the efficiency of automated apple harvesting robotics.

Led by Ming Luo, Flaherty assistant professor in the School of Mechanical and Materials Engineering, the interdisciplinary team of researchers will develop a cyber-physical system that aims to integrate human intelligence and machine learning, enhance decision-making and actuation, and improve picking efficiency. The team includes Yan Yan from computer science, Manoj Karkee from biological systems engineering, Matthew Whiting from horticulture and landscape architecture, and

graduate students Ryan Dorosh and Christopher Ninatanta.

Agricultural robotic technologies currently are inefficient for orchard operations because of the unpredictable environment there as compared to industrial settings, said Luo.

As part of the three-year project, the researchers will create a network for human-robot interaction. The network will enable robots to function effectively in farm fields, allowing users to remotely monitor and guide the robots in addressing challenging tasks through teleoperation. Additionally, the robots will learn from the user's input to enhance their harvesting efficiency.

The researchers are developing a simple, low-cost robot system with a

soft body and a fabric arm. The design is intended to delicately harvest apples without causing damage to the trees, while also allowing the robot to respond quickly.

“Safety is a concern because the robot might accidentally collide with the tree,” said Luo. “Rigid robots require time to calculate the optimal path for apple picking with minimal damage, which is time-consuming. Therefore, we designed a soft robot that ensures safety in human-robot interactions and is also gentler on the trees. This reduces the computation time required for obstacle avoidance.”

The robot will eventually automatically help with other operations, like flower thinning, pollination, and pruning as well.

# WSU scientists available to discuss new National Climate Assessment

**WSU climate scientists speak on challenges and adaptations facing US and Northwest in new 5th National Climate Assessment**

**What:** Washington State University climate scientists Deepti Singh and Kirti Rajagopalan will be available for interviews about the newly released 5th National Climate Assessment (NCA5).

**When:** Tuesday, Nov. 14, through Friday, Nov. 17, 2023

Details: Singh and Rajagopalan are part of a large team of researchers at WSU, Oregon State University, Cascadia Consulting Group, and other institutions around the nation contributing to the 5th National Climate Assessment (NCA5). Rajagopalan was an author on the Northwest chapter, and Singh was an author on the Climate Trends chapter and lead author on the Compound Events cross-cutting chapter.

Aimed at decision makers and the public, NCA5 analyzes the effects of global climate change on the environment, agriculture, energy use, human health, ecosystems, and other systems across the U.S. The assessment is part of the U.S. Global Change Research Program’s mandate to deliver a report to Congress and the President every four years and is developed with input from more than 400 climate experts from governments, Tribes and Indigenous communities, universities, NGOs, and the private sector.

**Northwest Chapter key takeaways:**

- Frontline communities are overburdened by the



Irrigation infrastructure along the Yakima River.

consequences of climate change.

- Ecosystems are changing in response to extreme events and human activity.
- Climate change amplifies health inequities and affects heritage and sense of place.
- Impacts to regional economies have cascading effects on livelihoods and wellbeing.
- Infrastructure is being stressed by climate change but can also enable adaptation.

**Climate Trends and Compound Events highlights:**

- Stronger evidence that human activities are changing the climate, and changes are not the same everywhere. For example, western states are warming up faster than eastern ones.

- Some extreme weather events are becoming more frequent and severe in different parts of U.S., such as heatwaves, droughts, wildfires and heavy rains.

- Compound events — back-to-back or simultaneous extremes — are also happening nationally; examples in the PNW: cascading effects of 2020 wildfire season followed by drought and extreme heat in 2021.

- Climate risks experienced today will increase with warming. We need to adapt to changing conditions to reduce continuing harm and negative impacts to community health, livelihoods, food, and resources. We know what we need to do to reduce global warming.

Singh and Rajagopalan can speak to their work on the NCA5

# Juming Tang among seven WSU faculty recognized as highly cited researchers

By WSU News & Media Relations

Food engineer Juming Tang and catalysis researcher Yong Wang are the newest Washington State University faculty to be added to the 2023 list of the world’s most Highly Cited Researchers. They join five other WSU faculty who have been on the list recognizing researchers whose studies are most often cited in their fields: Dan “Annie” Du, Dogan Gursoy, Kris Kowdley, Yuehe Lin, and Nathan McDowell.

This recognition means these researchers have authored multiple papers which rank in the top 1% by citations for their fields and publication year in the Web of Science over the past decade. Of the world’s population

of scientists, Highly Cited Researchers are 1 in 1,000.

Clarivate, the analytics company that runs the Web of Science research platform, creates the Highly Cited Researchers List every year using both quantitative and qualitative analysis to identify researchers who have demonstrated significant influence in their fields

Tang holds 15 U.S. and international patents leading to global commercialization of microwave-assisted thermal processing technologies for production of shelf-stable, chilled, or frozen meals free from pathogens. His research has led to understanding and development for pathogen control



### Juming Tang

Regents Professor and Distinguished Chair of Food Engineering Biological Systems Engineering, College of Agricultural, Human, and Natural Resource Sciences

in low-moisture foods, such as baby formula, spice, nuts, and chocolates. He has conducted research on food drying technologies for improved energy efficiency and quality as well as preserving ready-to-eat meals for future space programs.



DR. TANG VISITING TREE-TOP IN WENATCHEE, MAY 2023

# Students and faculty participate in 2023 ASABE annual international meeting



Since 1907, the American Society of Agricultural and Biological Engineers (ASABE), an international educational and scientific professional organization, has been dedicated to offering agricultural and biological engineering solutions in agricultural, food, and biological systems. This year, the ASABE Annual International Meeting (AIM) was held in Omaha, Nebraska, July 8-12, 2023. The Department of Biological Systems Engineering (BSE) was represented by 32 members. Sixteen students received ASABE AIM travel awards from the department. In addition to active participation in several leadership roles (technical

committee, technical community, moderation, volunteering, career fair, etc.), BSE faculty and students made 35 oral and eight poster presentations in different technical sessions within diverse communities. Do-Gyun Kim received second place in ASABE’s Association of Korean Agricultural, Biological, and Food Engineers (AKABFE) Spotlight Competition. Xu Zhou also received two awards from the Association of Overseas Chinese Agricultural, Biological, and Food Engineers (AOCABFE), first place for best student paper award and third place for best student presentation award. We congratulate the award

recipients and appreciate all graduate students and faculty members for their participation and presence at 2023 ASABE AIM.

AIM also provided a great opportunity for our meeting participants to interact with our alumni and supporters. Dr. Manual Garcia-Pérez and Dr. Juming Tang briefed Dr. Norm Scott on the developments in the department since his last visit in 2021. Dr. Abhilash Chandel (alumnus) received the Outstanding Reviewer Award at the event.

**Recipients of ASABE**

**AIM travel awards:**

- Achyut Paudel
- Amin Norouzi Kandelati
- Atif Bilal Asad
- Basavaraj Amogi
- Do-Gyun Kim
- Kesevan Veloo
- Martin Churuvija

- Meghana Mendon
- Melba Denson
- Milton Valencia Ortiz
- Priyanka Upadhyaya
- Redwan Khan
- Rongge Zou
- Samrat Dahal
- Worasit Sangjan
- Xu Zhou

**Other participants included:**

- Dr. Manual Garcia-Pérez
- Dr. Juming Tang
- Dr. Kirti Rajagopalan
- Dr. Liang Yu
- Bhupinderjeet Singh
- Chenchen Kang
- Dattatray Bhalekar

- Dawood Ahmed
- Jake Schrader
- Karisma Yumnam
- Kingsley Umani
- Marie Qian
- Meghana Mendon
- Ranjan Sapkota
- Safal Kshetri
- Srikanth Gorthi

# AgAID Digital AgAthOn 2023

Almost 200 students from around the U.S. had the chance to work on two challenges for the agricultural industry as part of the NSF/USDA-NIFA-funded AgAID Institute’s Digital Agathon. The event was held on the Washington State University Pullman campus as well as in Corvallis, Oregon, and Merced, California.

A huge thanks goes to Drs. Kirti Rajagopalan and Sindhuja Sankaran for their role in this event (organizing, logistics, training, mentoring, and judging). Congratulations to all our BSE students across the campuses who participated and stayed competitive in this event.

A special congratulations to: Bhupinderjeet Singh and his team on winning the second prize for the water challenge competition! And to Srikanth Gorthi and his team for winning the fourth prize in the labor challenge!



Bhupi’s Team winning the second prize for the Water Challenge Competition.



AgAid Digital AgAthOn 2023 Participants

# OUTREACH & PARTNERSHIPS

Scientists in BSE work across the state of Washington and partner with global minds and industries to advance the state of our profession.

We are cross-disciplinary collaborators, editors, ambassadors, and mentors. Through societal involvement and fruitful collaboration with peers at the U.S. Department of Energy's Pacific Northwest National Laboratory, Massachusetts Institute of Technology, the U.S. Army's Natick Soldier Center, and other institutions here in Washington and far afield, we share ideas and spark discovery.

Ahead, learn about some of our department's latest efforts to serve and connect to our colleagues and stakeholders.



SMART ORCHARD FIELD DAY, AUGUST 2023

## Birgitte Ahring

Dr. Ahring is a leader in the field of anaerobic processes. Since 2017 she has been serving on the advisory board for the Energy System Program of the Walla Walla Community College. In 2021 Dr. Ahring co-taught ChE 560. She served as major advisor for 5 PhD students (3 in BSE, 1 Eng. Science, and 1 in ChE) and acted as a committee member for 5 other PhD students. Dr. Ahring's research expenditure in 2021 was very high at \$915,754. So far, Dr. Ahring has graduated 54 PhD students, 18 of whom graduated since she joined WSU. She has published 393 peer-reviewed publications, 35 book chapters, and 10 patents. Of all WSU faculty who are indexed in Google Scholar, Dr. Ahring ranks

9th in WSU citations (34,590 total; 1,862 in 2021, h-96). Major technical and scientific achievements for 2021 include: (1) technology to increase the carbon conversion efficiency of sewage sludge by anaerobic digestion, (2) technology to convert CO<sub>2</sub> from into CH<sub>4</sub>, (3) bio-augmentation to reduce CH<sub>4</sub> emission from ruminants, (4) in-situ bio-reductive dechlorination, (5) production of acetic acid from CO<sub>2</sub>. In 2021 Dr. Ahring was awarded the Chancellor's Distinguished Research Excellence Award, in 2022 she was awarded the Washingtonian of the Day award by Washington State Governor Jay Inslee, and in 2023 she was awarded the Anjan Bose Outstanding Researcher Award.



**Birgitte Ahring**  
Professor

## Gustavo Barbosa-Cánovas

Dr. Barbosa-Cánovas is a renowned leader in food engineering. Is well known for his contributions as editor to many textbooks used worldwide for teaching food processing of nonthermal technologies. In 2021 was appointed as distinguished international professor by the Monterrey Institute of Technology (Mexico). Fourteen years ago he founded the Journal of Food Engineering Reviews, published by Springer, and continues to serve as editor in chief. This journal is now ranked 17th out of 250 food science and technology publications. He

has been acting for more than 20 years as editor in chief of the Food Engineering book series with more than 70 titles translated to Spanish, Chinese, and Arabic. He is one of the founders and current executive secretary of the Ibero American Society of Food Technology. Dr. Barbosa-Cánovas is also the Institute of Food Technologists (IFT) representative within the International Association of Food Science and Technology. Acting as designated chair of the 2024 Conference of Food Engineering that was held in Seattle.



**Gustavo Barbosa-Cánovas**  
Professor

## Shulin Chen

Dr. Chen is well known for his contributions to biomass biochemical conversion technologies (e.g., algae, anaerobic digestion). Since 2020, he has been acting as leader of the biomass conversion and bioproducts research area. In his tenure in the department, to date Dr. Chen has graduated 39 PhD students and 27 MSc. His publications are highly cited, with an h-index of 89 and more than 24,000 citations. Dr. Chen ranks 21st among the most-cited WSU

researchers. His contribution to the area of commercialization was recognized via the WSU 2022 Innovation and Entrepreneurship Award. In 2023 he was named as a senior member of the National Academy of Inventors. Dr. Chen serves on the editorial board of the Journal of Energy and the International Journal of Green Technology. He also serves as the technical advisor for the spin-off company Integrated Lipid Biofuels LLC.



**Shulin Chen**  
Professor

## Manuel Garcia-Perez

Dr. Garcia-Perez is the current BSE Chair and Former Director of Bioproducts, Sciences, and Engineering Laboratory (BSEL): His current research focuses on the fundamentals of biomass thermochemical conversion to maximize bio-oil and carbon yields, bio-oil chemistry, refining and hydrotreatment, biochar chemistry, and the development of engineered biochar for environmental services and sustainable aviation fuel technologies. He has published nearly 200 peer-reviewed manuscripts and has advised

22 PhD students and 11 MS students. In 2023, he advised 8 PhD students. Garcia-Pérez advised the capstone project for 7 undergraduate students (Department of Chemical Engineering and Bioengineering) and hosted 2 summer student interns. His publications have been cited 15,566 times in 2023 and had an h-index of 70. In 2023, he organized two international conferences, Biochar III and Pyroliq II. He is the chief editor of the *Journal of Biomass and Bioenergy* and reviewer editor for the *Journal of Analytical and Applied Pyrolysis*.

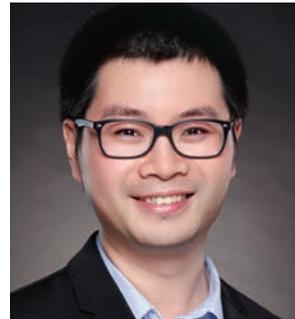


**Manuel Garcia-Perez**  
Professor and Chair

## Kang Huang

Dr. Huang's research in food and biomaterials engineering addresses key challenges at the intersection of food, microbes, and materials within agricultural and food systems. His approach integrates multidisciplinary methods from food process engineering, material science, mathematical modeling, microbiology, molecular imaging, and high-speed photography to tackle essential scientific questions. Over recent

years, he has developed innovative technologies, including novel biobased antimicrobial formulations, multifunctional materials, and AI-enabled detection systems suitable for both preharvest and postharvest applications. Dr. Huang has published over 60 peer-reviewed journal articles, conference papers, and book chapters, in collaboration with numerous institutions worldwide.



**Kang Huang**  
Assistant Professor

## Manoj Karkee

Dr. Karkee's research program focuses on developing automated and robotic solutions for specialty crop farming operations such as tree fruit pollination, thinning, and harvesting. When commercially adopted, these technologies are expected to reduce labor use, improve labor safety, reduce production costs, enhance crop yield and quality, and increase long-term sustainability of industries that rely heavily on seasonal labor. Dr. Karkee has trained 18 PhD students, 7 MS students, 7 postdoctoral researchers, and has published over 100 peer-reviewed research articles. His work has been recognized widely, as reflected by awards such as

the ASABE Rain Bird Engineering Concept of the Year Award (2020) and Pioneer in AI and IoT (2019). He has served WSU as a member of the CAHNRS Tenure and Promotion Committee and the Faculty Research Advisory Committee. He served as the chair of the International Federation of Automatic Control's TC8.1 Technical Committee on Control in Agriculture from 2017 to 2023. Currently, Dr. Karkee is an associate editor for both ASABE publications and *Computers and Electronics in Agriculture*. In 2022, his work was featured 14 times in national and international media and he was awarded the best paper award by the ASABE.



**Manoj Karkee**  
Professor

## Lav R. Khot

Dr. Khot's research and Extension program focuses on sensing and automation technologies for precision management of production agriculture. Dr. Khot's program has several active projects supported by USDA National Institute of Food and Agriculture (NIFA), Foundation for Food and Agriculture Research (FFAR), and state and local commodity commissions. He is lead PI of the newly formed AI Institute for Transforming Workforce and Decision Support (AgAID) and coleads the Farm Operations Intelligence program. He is involved in the organization of several Extension events, like Weather School, Drones in Agriculture, Smart Farm field days, and related sessions in regional and international conferences. These efforts help ensure optimal use of resources, such as chemicals, water, energy, and labor, as well as improved produce quality. Dr. Khot is the recipient of 2021

Fruit + Vegetable 40 Under 40 class from Fruit Growers News and 2018 New Innovator in Food and Agriculture Research Award from the Foundation for Food and Agriculture Research. He has published over 100 peer-reviewed papers in this area and over 350 combined national and international conference talks, Extension/outreach workshops, and short courses. He currently serves as the associate editor for the *Journal of the American Society of Agricultural and Biological Engineers*. He also chaired the Mechanization, Digitization, Sensing, and Robotics Workgroup of the International Society of Horticultural Science (ISHS) (2018–2023) and a multistate group (S1069: Research and Extension for Unmanned Aircraft Systems [UAS] Applications in U.S. Agriculture and Natural Resources) (2021–2022).



**Lav R. Khot**  
Associate Professor and  
Director of AgWeatherNet

## Youngsoo Lee

Dr. Youngsoo Lee is a trained food engineer with more than 20 years of experience in education and research. His teaching and research focuses are food processing and engineering, specifically encapsulation, drying, and material science. His current research focuses on nano- and microencapsulation of bioactive compounds, pre- and probiotics using biopolymers. He is also interested in improving various drying processes for enhanced food quality and

reduced energy consumption. He has been collaborating with colleagues in academia as well as industry. He served the National Science Foundation (NSF) Industry-University Cooperative Research Centers (IUCRC) Program's Center for Advanced Research in Drying (CARD) as the site-director. He is currently the associate editor of *Journal of Food Science and Food Science and Biotechnology*.



**Youngsoo Lee**  
Associate Professor

## Hanwu Lei

Dr. Hanwu Lei serves as division editor for *International Journal of Agricultural and Biological Engineering* and academic editor for both *Journal of Global Ecology and Environment* and *International Journal of Environment and Climate Change*. He is a member of the editorial boards of *Nature Partner Journal (NPJ) Materials Sustainability*, *International Journal of Agricultural and Biological Engineering*, *Journal of Sustainable Bioenergy Systems*, and *Annals of Material Science and Engineering*. Dr. Lei has been working with biomass-derived carbon,

activated carbon, nanocellulose, nanocarbon, carbon catalyst production, carbon and zeolite catalysis, syngas and hydrogen production, bio-aromatics, and bio-jet fuels. His research investigates the mechanisms responsible for the generation of fuel components and high-value chemicals and bioproducts from biomass and municipal solid wastes and addresses fundamental and applied questions in conversions. Dr. Lei's jet fuel research has made headlines worldwide. Reaching 230.6 million people, according to WSU News, his research has been reported on



**Hanwu Lei**  
Professor

by more than 300 major international outlets and includes TV broadcastings. Dr. Lei is a top 1% cited author (Web of Science, as of September/October 2023) in engineering and chemistry, with over 180 peer-reviewed articles to his record, a total of 10,982 citations (2,057 in 2023), and an h-index of 60 in Google Scholar (January 13, 2024). Dr. Lei is among 14 researchers earning high marks at WSU for chemistry's ranking of best scientists, 226th world, 61st nationally (WSU Insider: "WSU scholars earn high marks in 2023 rankings"). Some of his students and postdocs are now professors

at esteemed international universities, including Université Catholique de Louvain, Central Luzon State University, Tongji University, China Agricultural University, and East China University of Science and Technology, among others. Dr. Lei is the invited panel member for the US Department of Energy, National Science Foundation, and USDA National Institute of Food and Agriculture grant programs, and he has been invited grant reviewer for international research programs in the Netherlands, Chile, Canada, Czech Republic, Israel, Hong Kong, and France.

## Pius Ndegwa

Dr. Ndegwa's research, teaching, and Extension long-term goals include evaluation, development, and dissemination of knowledge and technologies to: (i) quantify and mitigate odor, particulates, and other gaseous emissions (NH<sub>3</sub>, H<sub>2</sub>S, CH<sub>4</sub>, and NO<sub>x</sub>) from livestock production systems, (ii) manage and utilize manure and manure nutrients, and (iii) reduce impacts from manure and associated wastes on water resources. His research projects during the 2021 year included: (1) densification of manure nutrients to enhance the economics of their export to distant lands (from production regions) to allow for environmentally friendly utilization and (2) development of a novel vermifilter technology for treatment of dairy wastewater with the aim of recovering nutrients in the forms of earthworm meal and vermicasts

and to reduce its concentration in the liquid stream. The liquid stream, from the vermifilter, is safely used in irrigation in larger volumes and on nearby crop fields, while recovered nutrients, in more concentrated forms, can be exported away from regions with high concentrations of dairy production. Dr. Ndegwa is associate editor of three journals supported by ASABE and serves on the Superior Paper Awards Committee and on two subject-area committees (Air Quality and Animal Waste Management) of the ASABE. Dr. Ndegwa is also serving as faculty advisor for the student chapter of ASABE, Graduate Student Admission Committee, and on the Faculty Research Advisory Committee (FRAC) for the College of Agricultural, Human, and Natural Resource Sciences (CAHNRS). Dr. Ndegwa retired in 2023.



**Pius Ndegwa**  
Professor

## Troy Peters

On average, Dr. Peters teaches more than 30 Extension workshops each year to educate growers and other irrigation professionals. He created the Irrigation Scheduler Mobile app that is used in 12 western US states and two Canadian provinces. This application has been used at more than 10,000 fields for irrigation scheduling. Dr. Peters also created and maintains an irrigation website ([irrigation.wsu.edu](http://irrigation.wsu.edu)), which is widely

used for its irrigation calculators. It includes tools to estimate crop water use and irrigation system design capacity based on historical average evapotranspiration (ET) for many different areas and crops. Dr. Peters has published more than 100 peer-reviewed journal papers and Extension publications. He advises graduate students and publishes an average of five peer-reviewed journal publications per year. A major focus of his Extension program is low



**Troy Peters**  
Professor and Extension  
Irrigation Specialist

## Troy Peters (continued)

elevation spray application, a modification to center pivots that increases irrigation application efficiency by 15% to 20% and uses significantly less pumping energy. Thanks to his efforts, these systems are being installed throughout the West. In 2023, Dr. Peters focused on developing web-based tools to help farmers, state water managers, and irrigation districts to make more informed decisions. This includes a tool that compares the cost-benefit of various irrigation technologies so that farmers can compare their

actual cost per acre-foot of water conserved. Dr. Peters is also working on machine learning to interpret soil moisture sensor signals for irrigation automation, quantifying the suppression of ET from sprinkler water losses, irrigation water quality measures, remote detection of water stress, long-term soil health of vineyards under different water management strategies, evaporative cooling of raspberries, water conservation in irrigated mint, mint distillation, and ET using satellites and drones.

## Kirti Rajagopalan

Dr. Rajagopalan's program leads research related to natural resources management in agricultural watersheds. The lab recently developed the first spatially explicit mapping of tillage practices in the dryland agricultural production region of the Pacific Northwest, US, and is currently in the process of integrating this into the Washington Conservation Commission and local conservation districts' planning and reporting processes. As part of the AgAID agricultural AI institute, the lab has been developing biophysics-guided AI models of streamflow prediction, snowpack prediction, and explainability frameworks to understand the behavior of complex hydrology and crop models and to inform model improvements. The lab also works on quantifying the skill and value of seasonal forecasts in informing water leasing decisions and exploring agricultural water

market opportunities to augment streamflow for environmental purposes at critical times of the year. Climate change research led by the lab was leveraged to initiate a Climate Analogs Academy training program, in which a network of special crop Extension professionals across the US are engaging in targeted dialogues to catalyze actions to prepare our agroecosystems for future climates. These dialogues are critical to bridge the significant gap that exists in the translation of climate change knowledge into societal action and impact. Additionally, Dr. Rajagopalan was a coauthor in the Fifth National Climate Assessment, the US government's preeminent report on climate change impacts, risks and responses, and the scientific foundation to support informed decision-making across the US.



**Kirti Rajagopalan**  
Assistant Professor

## Shyam Sablani

Dr. Sablani's current research interests are developing sustainable and ecofriendly packaging for food applications, food supply chain technologies, food safety technologies, and educational tools for enhanced food engineering education. His research has informed the development of next-generation barrier packaging, which incorporates ethylene vinyl alcohol, metal oxide-coated polyethylene terephthalate,

and oxygen scavengers. His research has contributed to an improved understanding of the relationship between state/phase transitions and physico-chemical stability, which helps with the design and formulation of dehydrated and frozen foods with a higher nutritional content and a longer shelf life. Sablani is a recipient of the 2024 Yang Liu Award for Teaching International Students, the 2024 CAHNRS/WSU



**Shyam Sablani**  
Professor

Faculty Excellence in Research Award and 2018 Faculty Excellence in Advising Award, the 2021 Frozen Food Foundation Freezing Research Award, and the 2016 Institute of Food Technologists (IFT) Marcel Loncin Research Prize.

Recently, he was named 2024 IFT Fellow and selected for the Fulbright US Scholar Award to Thailand in academic year 2024–25. Sablani is currently the scientific editor of the *Journal of Food Engineering*.

## Sindhuja Sankaran

Dr. Sankaran is a leading expert in the nascent and evolving field of phenomics. This involves the design, development, integration, testing, and deployment of a range of cutting-edge sensor technologies to advance crop phenotype monitoring—an important component of plant breeding, crop science, and precision agriculture research and applications. Sankaran has published over 100 peer-reviewed articles and has given over 120+ outreach talks. Her publications have an h-index and an i10-index of 37 and 81, respectively, with over 8,000 citations. She leads the USDA National Institute of Food and Agriculture Research and Extension Experiences for Undergraduates (REEU) project on phenomics big data management. She is an active member of the American Society of Agricultural and Biological Engineers (ASABE), the National Association of Plant Breeders, and the North American Plant Phenotyping Network. She is an associate editor for societal journals, including the *Journal of the ASABE* and the *Plant Phenome Journal*. She was recognized as Outstanding Associate Editor for her services in both journals, and has received the ASABE Leadership Citation, the International Society for Horticultural Science (ISHS) Medal, and the

Early Career Excellence Award among other awards.

The year 2023 was a strong teaching and mentoring year for her. She taught two courses as the lead instructor. In addition, within her research group she mentored three MS students, four PhD students, a visiting scholar, and a postdoctoral associate. She was also involved in undergraduate research and education through her USDA-NIFA REEU program, mentoring three senior design student teams from the School of Electrical Engineering and Computer Science, serving as an advisor to an honors thesis student and mentoring two international students virtually. Two high school students interested in exploring biological engineering participated in her lab research activities. In 2023, she was a part of four federally funded projects (two as lead) and a WSU lead on the US-Israel Binational Agricultural Research and Development Fund (BARD) project (funded). She is also currently the WSU representative in a multistate project, NC1212 (Exploring the Plant Phenome in Controlled and Field Environments).



**Sindhuja Sankaran**  
Associate Professor

## Juming Tang

Dr. Tang has trained more than 50 PhD students, 20 postdoctoral fellows, and 50 visiting students and scholars. He has published more than 400 peer-reviewed scientific papers. His research has resulted in 14 US and international patents. Dr. Tang has led two industrial consortia on advanced thermal processing technologies, with membership representing the US Army Natick Soldier Systems Center and more than 20 companies. His laboratory developed 915 MHz microwave assisted thermal steril-

ization (MATS) technology, with acceptance from the US Food and Drug Administration and non-objection from the USDA Food Safety and Inspection Service. He directed a Center of Excellence for Food Safety, supported by the USDA National Institute of Food and Agriculture, on the application of microwave assisted pasteurization systems (MAPS) for control of bacterial and viral pathogens in ready-to-eat meals. Both MATS and MAPS are licensed for global commercialization.



**Juming Tang**  
Regents Professor, Member of the U.S. Academy of Engineering

## Juming Tang (continued)

Contamination and survival of bacterial pathogens, such as *Salmonella*, in low-moisture foods, including spices, peanut butters, baby formula, wheat flours, and dry fruits, are emerging food safety concerns. These pathogens are extremely heat tolerant in low-moisture environments, creating challenges for the food industry in developing and validating effective thermal control treatments. Over the past ten years, Dr. Tang's team has systematically studied the fundamental mechanisms for the increased thermal resistance of *Salmonella* in low-moisture foods and developed qualitative relationship between thermal reduction of the bacteria and water activity of low-moisture foods. Based on those findings, during 2023 new strategies were proposed in several published papers that have been validated

on pilot-scale devices for thermal control of pathogens in different food systems. These main findings/case studies are summarized in a review article "Developing Thermal Control of Salmonella in Low-Moisture Foods Using Predictive Models" in *Food Safety Magazine* (August/September issue of 2023). These results have positively influenced the R&D activities at food companies, based on feedback and free consultation inquiries from food companies.

Dr. Tang is a Highly Cited Researcher (1 in 1,000), among 7,125 worldwide selected by Clarivate. He was elected to the Washington State Academy of Sciences in 2019 and the US National Academy of Engineering in 2021. He is a fellow of the International Microwave Power Institute, ASABE, the IFT, and the US National Academy of Inventors.

## Joan Wu

Dr. Wu's research focuses on hydrologic modeling for conservation of land and water resources. She collaborates extensively with researchers at the USDA Agricultural Research Service, US Forest Service, and other institutions on the continuous development and application of the Watershed Erosion Prediction Program (WEPP) model. In a recent project supported through USDA National Institute of Food and Agriculture, Dr. Wu and team applied the WEPP model to evaluate long-term trends of water erosion as impacted by physical and anthropogenic factors in wheat-based cropping systems in the inland Pacific Northwest. Programs that have incentivized the adoption of agricultural conservation practices need ways to quantify and prioritize the resulting benefit. The findings from this project provided critical information for measuring conservation practice effectiveness and benefits stemming from program policies and activities. In another study funded by the US Environmental Protection Agency through the Puget Sound Partnership, Dr. Wu and team developed a framework based on

the Hydrologic Sensitivity Index approach to optimize the placement of Green Stormwater Infrastructure (GSI) in the rapidly urbanizing Puget Sound Region. The framework, scalable and transferrable, can help practitioners and regulatory staff to make informed decisions about placing GSI to mitigate the adverse impacts of urban stormwater runoff.

Dr. Wu teaches BSE 512 Research and Teaching Methods, a core course for all BSE graduate students. She provides ample service at unit-, college-, and university levels and to her professional societies and government.

She is the recipient of the WSU CAHNRS Excellence in Teaching Award (2018) and the Excellence in Advising Award (2022). Dr. Wu is part of the W-4188 team (Soil, Water, and Environmental Physics to Sustain Agriculture and Natural Resources) recognized for National Excellence in Multistate Research (2021) by the Western Association of Agricultural Experiment Station Directors.



**Joan Wu**  
Professor

## Bin Yang

Dr. Yang is a professor in the Department of Biological Systems Engineering and the Bioproduct, Sciences & Engineering Laboratory at Washington State University. His major research interests include advancing and understanding fundamental mechanisms of cutting-edge biomass processing technologies for advanced biofuels and bioproducts, facilitating the commercialization process, and improving our knowledge of emerging technologies to meet near- and long-term needs worldwide. He has authored more than 135 peer-reviewed papers and book chapters and has six issued patents. He also serves as an advisory editor board

member for leading biorefinery journals. Dr. Yang recently has pioneered new biomass pretreatment technology and manufacturing technologies to process biomass into jet fuel, bioplastics, carbon fiber, supercapacitor, and other bioproducts. The impacts of his accomplishments have been amply documented in his recent awards, including Fellow of the American Institute of Chemical Engineers, the Fulbright Distinguished Chair in Energy and Sustainable Use of Natural Resources, and the Defense Advanced Research Projects Agency (DARPA) Young Faculty Award.



**Bin Yang**  
Professor

## Liang Yu

Dr. Yu is an assistant professor in the Department of Biological Systems Engineering at Washington State University. He is a licensed professional engineer (PE) in the state of Washington. He is also a guest editor for the *Journal of Fermentation* entitled Energy converter-anaerobic digestion, a faculty senator for the non-tenure track faculty, an Anti-Hazing Advisory Committee member and a member with the Undergraduate Research Scholarship Review Committee at WSU. Dr. Yu's research primarily revolves around the development of biorefinery-based industrial symbiosis and circular economy. To achieve this goal, he employs multiscale mathematical modeling techniques, including but not limited to molecular simulation, computational fluid dynamics (CFD), bioprocess control, simulation, optimization,

integration, techno-economic analysis (TEA), life cycle assessment (LCA), and machine learning. Specifically, Dr. Yu is working on the development, optimization, integration, and scaling-up of an advanced anaerobic digestion-based biorefinery with hydrothermal pretreatment to convert animal manure, food waste, biosolids, and other organic wastes into renewable natural gas (RNG), organic fertilizer, clean water, and other high-value bioproducts. Dr. Yu's research has been supported by the Department of Energy (DOE) and the Department of Agriculture (USDA). He has published more than 60 papers in high-quality, peer-reviewed scientific journals, such as *Applied Energy*, *Bioresource Technology*, *Chemical Engineering Science*, *AIChE Journal*, among others, and holds five patents.



**Liang Yu**  
Assistant Professor

## Qin Zhang

Dr. Zhang is a member of the Washington State Academy of Sciences and a Fellow of the International Academy of Agricultural and Biosystems Engineering (IAABE). He is a Trustee, Foundation Board of ASABE, Fellow of ASABE, and also a Full Member of the Club of Bologna. He serves as an Academic Committee Member, Key Laboratory on Integrated Systems for Precision Agriculture, China Agricultural University, and a Member of the External

Advisory Committee, Demonstration Teaching Center for Agricultural Engineering Curriculum, Northwest A&F University, China. Dr. Zhang is the current chair editor of *Computer and Electronics in Agriculture*, the editor in chief for *Springer's Encyclopedia of Smart Agriculture Technologies*, and a guest editor for Springer's Agricultural Automation Book Series. Dr. Zhang retired in 2023.



**Qin Zhang**  
Professor

## Professors Emeriti



**Claudio O. Stöckle, Ph.D.**  
Years of Service: 1989-2022



**Denny C. Davis, Ph.D.**  
Years of Service: 1976-2012



**Ralph P. Cavalieri, Ph.D.**  
Years of Service: 1985-2016



**Larry G. James, Ph.D.**  
Years of Service: 1977-2013



**Pius Ndegwa, Ph.D.**  
Years of Service: 2004-2023

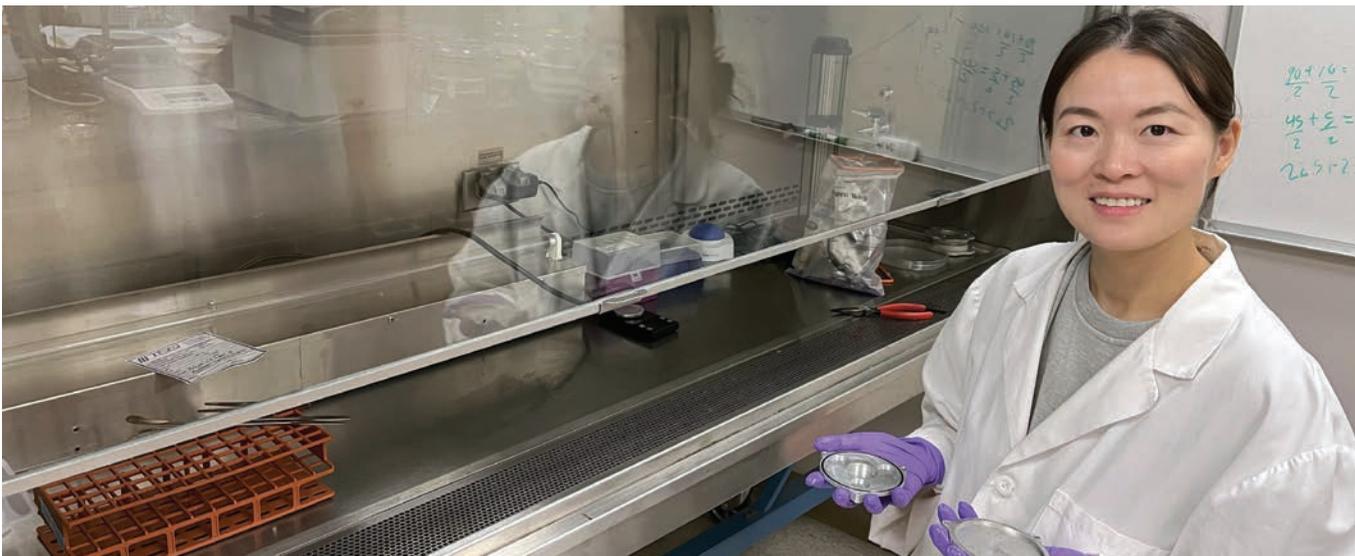


**Qin Zhang, Ph.D.**  
Years of Service: 2009-2023

# Visiting Scholars

Students and researchers from all over the world are attracted by BSE’s world-renowned faculty, expertise, and laboratory research experiences. BSE receives numerous visiting scholars from different countries who are supported by their respective universities and governmental agencies. This year, we welcomed and trained the following scholars:

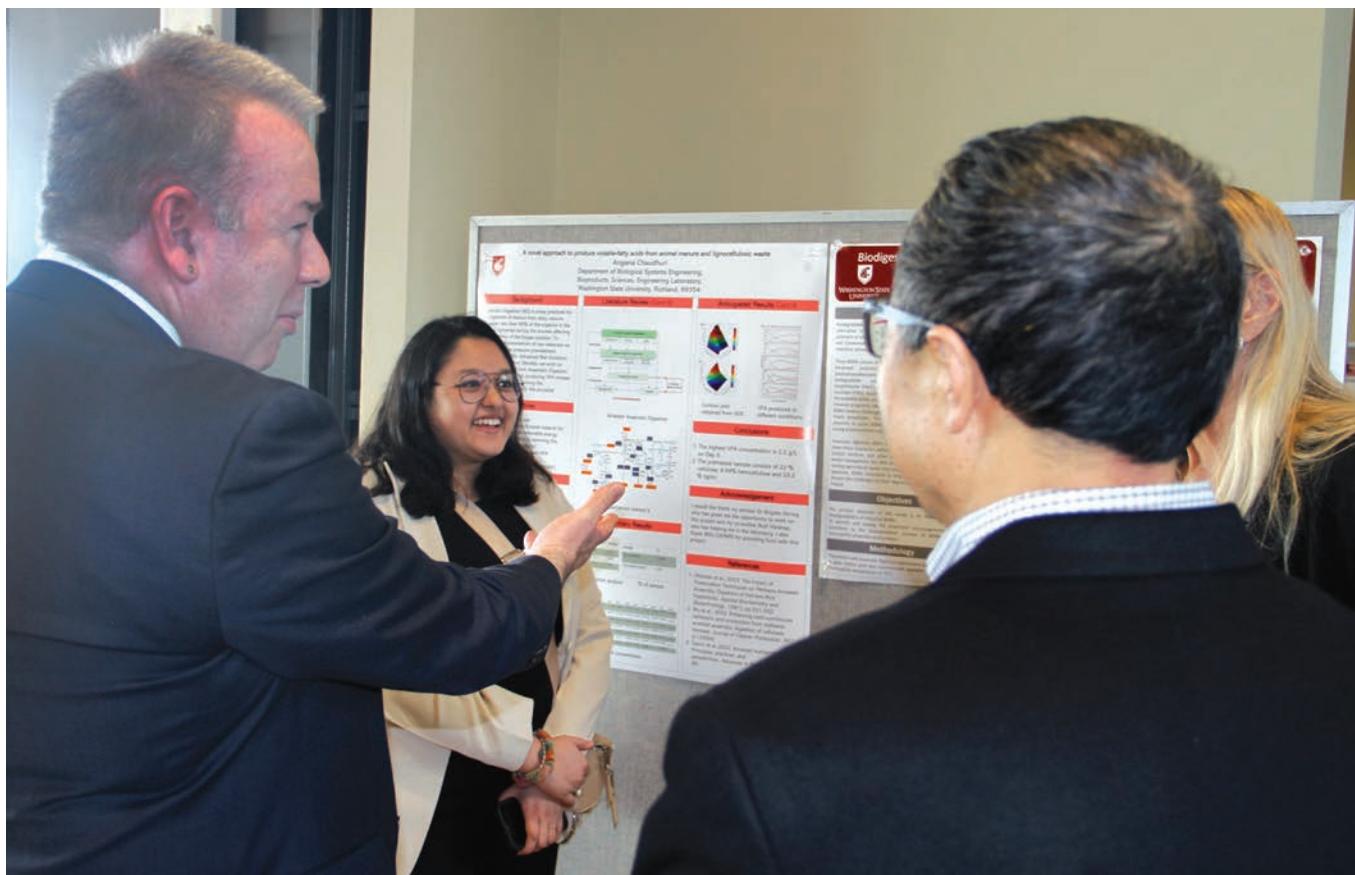
Visiting Scholar Name	Title	Country	Inviting BSE Faculty
Shuang Zhang	Visiting Scholar	China	Tang
Jan Alkoussa	Visiting Scholar	France	Sablani
Tayyaba Alvi	Visiting Scholar	Pakistan	Sablani
Juan Felipe Silva	Visiting Scholar	Colombia	Garcia-Pérez
Salik Khanal	Visiting Scholar	Portugal	Karkee
Nisit Pukrongta	Visiting Scholar	Thailand	Khot
Diego Fernando Restrepo Holguin	Visiting Scholar	Colombia	Sankaran
Jessica Silva	Visiting Scholar	Colombia	Garcia-Pérez
Ali Tahir	Visiting Scholar	Pakistan	Sablani
Camila Valderrama Ocampo	Visiting Scholar	Colombia	Garcia-Pérez
Andres Valencia	Visiting Scholar	Colombia	Garcia-Pérez
Mohamed Hechmi Aissoui	Visiting Faculty	France	Garcia-Pérez
Eid Alsbou	Visiting Faculty	Jordan	Garcia-Pérez
Loredana Dumitrascu	Visiting Faculty	Romania	Barbosa-Cánovas
Sweta Rai	Visiting Faculty	India	Sablani
Burcu Tenderis	Visiting Faculty	Turkey	Sablani



Visiting scholar Dr. Shuang Zhang conducting microbial tests with the new test cell.

# Our Affiliated Faculty

Affiliated Faculty Name	Current Title	Email
Elizabeth Beers	Professor at Wenatchee Tree Fruit Research and Extension Center	ebeers@wsu.edu
Markus Flury	Professor at Puyallup Research and Extension Center	flury@wsu.edu
Girish Ganjyal	Professor at School of Food Science	girish.ganjyal@wsu.edu
Joshua Heyne	Director of Bioproducts Science and Engineering Lab (Tri-Cities)	joshua.heyne@wsu.edu
Anand Jayakaran	Professor at Puyallup Research and Extension Center	anand.jayakaran@wsu.edu
Hongfei Lin	Professor at Voiland School of Chemical Engineering and Bioengineering	hongfei.lin@wsu.edu
Hang Liu	Associate Professor at CAHNRS Office of Research	hangliu@wsu.edu
Jonathan Male	Assistant Vice Chancellor at the Office of Research	jonathan.male@wsu.edu
Jean Sabin McEwen	Associate Professor at Voiland School of Chemical Engineering and Bioengineering	js.mcewen@wsu.edu
Jenifer McIntyre	Associate Professor at Puyallup Research and Extension Center	jen.mcintyre@wsu.edu
Peter Pfromm	Professor at Voiland School of Chemical Engineering and Bioengineering	peter.pfromm@wsu.edu
Michael Wolcott	Interim Vice President for Research	wolcott@wsu.edu
Vikram Yadama	Director and Professor of Civil and Environmental Engineering	vyadama@wsu.edu



Graduate Student, Angana Chaudhuri, explaining her research to Drs. Jonathan Male, Shulin Chen and Birgitte Ahring.

# Our Adjunct Faculty

Adjunct Faculty Name	Current Title	Email
Pavlo Bohutskyi	Chemical Engineering Scientist	pavlo.bohutskyi@pnnl.gov
David Brown	Meter Group Inc. Scientist	dave.brown@wsu.edu
Joaquin Casanova	Engineering Consultant	joaquincasanova@protonmail.com
Farid Chejne	Professor at Universidad Nacional de Colombia	fchejne@unal.edu.co
William Elliot	Research Engineer	belliot@wsu.edu
David Gustafson	Chemical Engineering Scientist	david.i.gustafson@wsu.edu
Gerrit Hoogenboom	Professor at University of Florida	gerrit.hoogenboom@wsu.edu
Francisco Leal-Yepes	Assistant Professor at Cornell University	f.leal-yepes@wsu.edu
Jian Liu	Senior Research Engineer at Pacific Northwest National Laboratory	jian.liu@pnnl.gov
Mariefel Olarte	Chemical Engineer	mariefel.olarte@pnnl.gov
Nigel Pickering	Water Resources Specialist	nigel.pickering@wsu.edu
Wei-Jun Qian	Bioanalytical Chemist	weijun.qian@pnnl.gov
Peter Robichaud	Research Engineer	probichaud@fs.fed.us
Vicki Thompson	Distinguished Staff Engineer	vicki.thompson@inl.gov
Melvin Tucker	Senior Researcher	melvin_tucker@nrel.gov
Shaojin Wang	Professor at Northwest A&F University (China)	shaojinwang@nwsuaf.edu.cn
Mark Wigmosta	Environmental Engineer at Pacific Northwest National Laboratory	mark.wigmosta@wsu.edu
Vivian Wu	Research Leader at USDA	vivianchwu@gmail.com



Dr. Vivian Wu, Adjunct Faculty, posing with co-advisor, Dr. Juming Tang and their student, Dr. Jiewen Guan.

# Success stories from alumni

## Uddhav Bhattarai

I completed my PhD in biological and agricultural engineering from #AgRobotics lab within the Center for Precision and Automated Agricultural Systems at Washington State University in May 2023. During my studies at WSU, I worked in areas of agricultural automation, robotics, computer vision, machine vision, and precision agriculture to tackle real-world challenges in fruit crop production.

As a postdoctoral scholar at the University of California, Davis, I am applying the knowledge I gained at WSU to develop practical precision agriculture solutions. My current research focuses on developing hardware and software

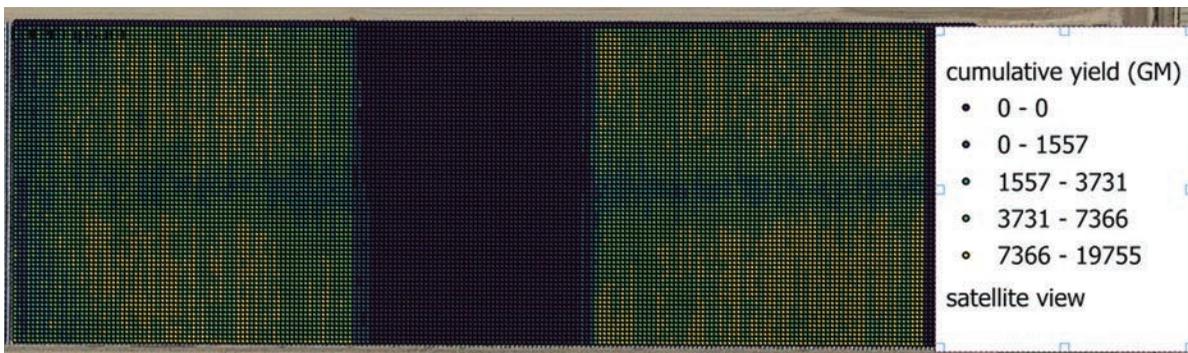
that can accurately measure fruit yield and track picker activities during harvest using advanced machine learning techniques. These tools are crucial for creating yield maps, managing resources, improving pest control, and optimizing fertilization, all of which contribute to enhancing crop health and productivity. I am grateful to my PhD advisor, Manoj Karkee, and WSU faculty and staff for their support and mentorship throughout my academic journey. The experiences I gained at WSU were instrumental in my professional and academic development.



Uddhav Bhattarai



Instrumented picking carts in action during a commercial strawberry harvest in Salinas, California, developed by UC Davis. Equipped with GPS, IMU, load cells, and a microcomputer, these carts collect precise data on picker location, movement, and harvested yield.



High-resolution yield map for a single harvest day, illustrating yield variation across the field (yellow: high yield; blue: low yield). By combining yield maps from multiple harvest days, a comprehensive seasonal yield map can be generated.

## Mugal Samrat Dahal

I completed my PhD in biological and agricultural engineering from WSU in December 2023. After graduating, I began my career at the King County Wastewater Treatment Division, where I serve as a hydrologic and hydraulic modeler. My primary responsibility is to minimize the number of combined sewer overflows (CSOs) in our wastewater conveyance system. This role requires a deep understanding of hydrology and hydraulics to effectively manage and optimize the flow of wastewater, ensuring that our system operates efficiently and sustainably. In addition to my work on reducing CSOs, I provide crucial support to the engineering team by developing and refining sewer models. These models are essential for planning, designing, and implementing infrastructure improvements. Through this work, I have honed my skills in data analysis, system optimization, and project management, contributing significantly to the ongoing efforts to maintain and enhance the region's wastewater treatment capabilities.

The modeling discipline I learned during my time at Washington State University has been incredibly beneficial in my career. The work ethic instilled in me during my studies has been invaluable in my professional journey. I am particularly grateful to my advisor, Dr. Joan Wu, for shaping me into a proficient modeler. Her guidance and mentorship were pivotal in my development. I am committed to working hard and excelling in my endeavors, with the hope of making WSU and the Department of Biological Systems Engineering (BSE) family proud to call me one of their alumni.



Mugal Samrat Dahal



Observation of newly constructed storage tank for efficient wastewater conveyance.

## Supriya Karekar

I am an accomplished Fermentation Scientist with extensive experience in microbial process development, scaling, and optimization across various industries. I hold a Ph.D. in Biological Systems Engineering from Washington State University under the mentorship of Professor Birgitte Ahring, where I developed fermentation systems for energy-efficient microbial processes. My doctoral work centered on screening microbes and developing acetogenic microbial cultures for gas-liquid fermentation, focusing on converting greenhouse gases like carbon dioxide using hydrogen supplementation into industrially important chemicals, while also applying these systems to methane reduction and enhanced biogas production.

During my Ph.D., I gained valuable industry experience at Lanzatech, where I led the design and operation of a gas-liquid fermentation system to produce ethanol from syngas at a pilot plant. I also completed an internship at Pacific Northwest National Laboratory, conducting

resource assessments of CO<sub>2</sub> emissions and hydrogen production plants across the U.S., further refining my ability to address real-world challenges.

After completing my Ph.D., I joined Zymergen, where I optimized microbial fermentation processes for pharmaceutical molecules and enhanced strain performance through high-throughput screening. At The Every Company, as Fermentation Manager, I drove process innovations that significantly increased product titers and successfully scaled processes from bench to commercial scale, working closely with cross-functional teams to deliver impactful results.

Currently, I focus on pursuing new opportunities and leveraging my expertise in microbial fermentation, process development, and scaling to address key sustainability challenges in various industries.



Supriya Karekar

## Pavitra Kumar

Graduate school can be a wonderful turning point in a career path—and that was so for me. I received her PhD (food engineering) in fall 2019, working with Dr. Shyam Sablani. Dr. Shyam Sablani's knowledge, guidance, and support helped to facilitate my personal and professional growth. My work focused on understanding changes in frozen food texture and properties during storage and transportation. During her PhD program tenure, I had the opportunity to learn new skills and sharpen my technical food engineering knowledge. Graduate school taught me the confidence to embrace new opportunities and learn from them. This has helped me take on new challenges in my career and enjoy the process.

During the course of my graduate program, I explored the physics of frozen food and developed an understanding of how water behaves in a food product—some of the fundamentals she obtained. This education has led me to extend and apply certain principles to food product development and accept head-on challenges and new projects in her career.

Additionally, I cherish the time she spent at WSU and BSE meeting people from varied cultural backgrounds, spending time with them, and working with them. Years spent with the Food Engineering Club also provided wonderful memories. These experiences led to valued memories and lifelong friendships.

WSU graduate school has also opened a plethora of opportunities for me to hone my communication skills—the several gatherings and events where I was given the opportunity to present my research were eye-opening experiences for me

Today, I am based out of my home country, India, and am building my professional career in the Indian food industry. I am currently employed by STEERLife India Private Ltd., a food and nutraceutical business, where I work as senior manager of R&D. In my current role, I explore the uses of technology to develop healthy food products and supplements and changes the landscape of the food industry. She enjoys the color and the chaos back home in India and wishes to



Pavitra Kumar

continue to work toward creating a healthy world with nutritious food, aided by engineering and technology.

## Ren Yang

I am a proud alumnus of Washington State University, where I completed my PhD in food engineering in 2020 under the mentorship of esteemed Dr. Juming Tang. My academic journey at WSU didn't stop there; I spent an additional three years as a postdoctoral researcher, further honing my expertise and contributing to groundbreaking research.

In October 2023, I embarked on a new chapter of my career as an assistant professor at South Dakota State University. Here, I am not only continuing my research in food engineering and food safety but also delving into innovative areas such as biomass processing and the enhancement of agricultural sustainability. My passion lies in advancing both thermal and nonthermal technologies, including humid heat, cold plasma, and UV radiation. By integrating mathematical and AI modeling, I aim to revolutionize these technologies, making significant strides in food safety and engineering. My journey is a testament to the exceptional education and mentorship I received at WSU, and I am excited to inspire the next generation

of scientists and engineers with the knowledge and experience I've gained.

I recently had the honor of becoming an adjunct faculty member in WSU's Department of Biological Systems Engineering. I look forward to contributing to WSU's mission through active research collaboration, publication, mentoring, and teaching. I aim to strengthen the collaboration between SDSU and WSU through collaborative grant proposals and joint projects, leveraging my extensive network to enrich both departments' research and educational programs.



Ren Yang



Dr. Yang investigating the use of UV laser technology to inactivate foodborne pathogens on industrial contact surfaces.

# University Initiative Partners

## **Bioproducts, Sciences, and Engineering Laboratory (BSEL):**

This laboratory provides space for critical research in identifying pathways to convert lignocellulosic materials into fuels, chemicals, and materials. BSEL opened in May 2008 as a 57,000 sq. ft. research and teaching laboratory operated jointly between WSU and Pacific Northwest National Laboratory. BSE faculty working at BSEL include Dr. Birgitte Ahring, Dr. Bin Yang, and Dr. Hanwu Lei who work with biofuels, biochemicals, biomaterials, and bioprocesses. Dr. Joshua Heyne, affiliate faculty at the Department of Biological Systems Engineering, is the BSEL director. Learn more about BSEL <https://tricitie.wsu.edu/research/bsel>.

## **The Aviation Sustainability Center (ASCENT):**

This cooperative aviation research organization is co-led by WSU and the Massachusetts Institute of Technology. ASCENT works to create science-based solutions to the aviation industry's biggest challenges. The center focuses on meeting environmental and energy goals of next-generation air transportation systems. BSE contributions include exploring ways to produce sustainable aviation fuels at the commercial scale as an engine for rural economic development and job creation. Michael Wolcott directs the center. Learn more about ASCENT <https://ascent.aero>.

## **WSU-PNNL Bioproducts Institute:**

The institute is a joint research collaboration of WSU and the US Department of Energy's Pacific Northwest National Laboratory (PNNL). This institute leverages cutting-edge science, engineering, and analysis to transform engineering plants, turn industrial, agricultural, and municipal waste into valuable materials and chemicals, and develop a pipeline of talent to meet future workforce needs. It also aims to be a leader in education, research, and innovation for production of high-value engineered materials and chemicals from underutilized waste materials. The institute coordinates all activities in biomass processing and bioproducts with PNNL. Current co-directors of the WSU-PNNL Bioproducts Institute are: Joshua Haynes and Corrine Fuller. Learn more at <https://natlab.wsu.edu/bioproducts>.



Dr. Josh Hayne and his graduate student Conor Faulhaber working on the seal swelling test.

## **Center for Precision and Automated Agricultural Systems (CPAAS):**

This center offers a framework for precision/smart agriculture and automation efforts at WSU. Its mission is to develop a world-preminent and Washington-relevant research and educational program in agriculture automation and precision farming. The center has three core faculty from BSE who specialize in mechatronics and automation, machine vision and agricultural robotics, and precision/smart agriculture. The center has recruited affiliated faculty from seven other departments. Professor Manoj Karkee is the current director of CPAAS <https://cpaas.wsu.edu>.

## **WSU Puyallup Research and Extension Center:**

Located near the Seattle metropolitan area, this center creates opportunities for research, Extension outreach, and teaching for the increasingly urbanized Puget Sound region. Programs focus on watershed science, horticulture, production agriculture, forestry, and community health in the urban-rural interface. The center

currently stands at the intersection of rural and urban communities bridging pristine and developed ecosystems. Todd Murray is the director. Learn more: <https://puyallup.wsu.edu>.

### **WSU Prosser Irrigated Agriculture Research and Extension Center:**

An estimated two-thirds of the state's agricultural production comes from irrigated land. The WSU Irrigated Agriculture Research and Extension Center (IAREC), the world's largest such center, focuses its basic as well as applied research on agricultural commodities and production systems relevant to the Columbia Basin and the Yakima Valley. This center partners with growers and commodity commissions to turn research-based knowledge into practical applications. IAREC is home to 16 WSU faculty scientists, 10 USDA-ARS scientists, and 1 WSDA scientist. The research activities stem from over 30 graduate students, multiple postdocs, visiting scientists, and over ten undergraduate interns from local community colleges. IAREC is the home of the Clean Plant Center Northwest, the Center for Precision and Automated Agricultural Systems (CPAAS), and Agricultural Weather Network (AgWeatherNet; AWN). The research at IAREC resulted in the creation of the Washington wine industry. The center solves many relevant and pressing issues related to water conservation, pests, diseases, and cropping systems. New crops are tested and developed, while artificial intelligence in agriculture is also being developed and tested at IAREC's smart farm testbeds. Dr. Naidu Rayapati is the director there. Learn more: <https://iarec.wsu.edu>.

### **AgWeatherNet:**

The WSU's AgWeatherNet (AWN) is the first and one of the largest agricultural weather networks in the United States. AWN provides a diverse group of stakeholders with accurate and precise weather observations and station-specific forecasts, while also maintaining a set of decision support tools for precision agriculture, animal production management, and ag worker health and safety. Washington State public and state agencies also benefit from quality AWN weather data and climatology. Excellence is achieved in AWN's weather data products through an end-to-end quality assurance system. AWN has over 360 public and private stations recording air temperature, relative humidity and solar radiation at 1.5 meters, wind speed at 2 meters, primary and secondary precipitation at 0.6 meters above ground level (AGL), and soil temperature and water potential at 5 cm and 20 cm depths. AWN is going through major infrastructure upgrades with about 50 (target 100) World Meteorological Organization (WMO) standard Tier 1 mesonet towers, all built in the last three years. Besides weather sensing at 1.5 to 2 meters, these stations also monitor wind speed and direction at 10 meters and air temperature at 9 meters AGL. Such data and associated products flow through a free-to-use public web portal ([weather.wsu.edu](http://weather.wsu.edu)) and is accessed by over 24,900 registered users on a daily basis. The AWN portal receives an average of 50,000 views per day. The web portal has several decision support tools that address crop irrigation scheduling, crop phenology assessment, cold/heat stress management in horticultural crops, worker heat stress awareness, and cattle comfort and planning, among others. AWN also has piloted the integration of air quality index (AQI) sensors into the network stations, with 50 stations currently collected AQI data that are critical for human and animal health systems. Dr. Lav Khot is the current director.



Aerial view of a Yakima Valley orchard in Prosser, Washington, showing a utility vehicle equipped for image collection. Pictured: BSE graduate student, Achyut Paudel, and Jostan Brown, Oregon State University (OSU).

# ACADEMICS



The LAWREE group and other BSE students at a regulating reservoir in Yakima with Roza Irrigation District Manager

**Students in BSE become scientific leaders who improve agriculture, food safety and security, and the global economy. Our students achieve advanced engineering degrees in food, land, air, water and environment, agricultural automation, bioproducts, and bioenergy. BSE enjoys an excellent track record in placing our graduate students at universities, national laboratories, and global companies.**

# Students Awards and Recognitions



Rongge Zou

## Graduate school announces Rongge Zou as a winner of Albrecht Scholarship May 3, 2023 WSU Insider

The graduate school announces that Rongge Zou is a winner of The Richard R. and Constance M. Albrecht Scholarship. This award is for all active doctoral graduate students in good standing who have successfully passed their preliminary examination.

The winners had peer-reviewed publications/shows/recital. They also have successful grant proposals/awards while showing service to the institution, profession, and community. Each awardee was given \$1,500.



Austin Gluth

## Three Minute Thesis — Austin Gluth wins the Tri-Cities 3MT Thesis Competition (3/8/2023)

On behalf of Dr. Garcia-Pérez, we would like to congratulate Austin Gluth for winning the Tri-Cities 3MT Thesis Competition that took place yesterday! The competition had seven participants and four of them were our BSE graduate students: Austin Gluth (advisor Dr. Bin Yang), Renan Stefanini Lopes (advisor: Dr. Birgitte Ahring), Budi Harahap (advisor: Dr. Birgitte Ahring), Rongge Zou (advisor: Dr. Hanwu Lei).



Jake Schrader

## Three Minute Thesis — Jake Schrader (PhD) and Kesevan Veloo (MS) win the BSE competition

March 7, 2023

On behalf of Dr. Manuel Garcia-Pérez, we want to thank Kesevan, Jake, Austin, Samrat, Renan, and Milton for participating in BSE's 3MT Thesis Competition! Also, a big thanks to our faculty judges and the audience!

Kesevan Veloo moves on to the CAHNRS competition in the MS category.

The winners in the PhD category moving on to the CAHNRS competition are Jake Schrader, Austin Gluth, and Samrat Dahal.

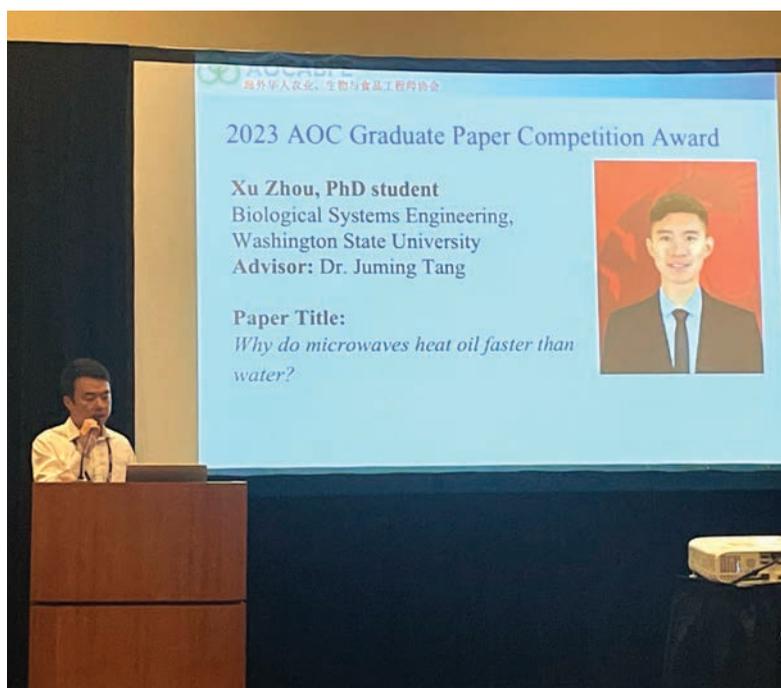


Kesevan Veloo

## Xu Zhou wins oral presentation and paper awards at ASABE and AOCABFE

Food engineering PhD student Xu Zhou has received the Best Student Oral Presentation award at the 2023 ASABE Annual International Meeting that took place July 8-12, in Omaha, Nebraska. His research also secured first place in the Graduate Student Paper Competition by the Association of Overseas Chinese Agricultural, Biological, and Food Engineers (AOCABFE).

Xu Zhou is a recent PhD candidate from Dr. Juming Tang's research group. His research on why microwaves heat oil faster than water challenges common misconceptions and explores the scientific principles behind rapid heating of vegetable oils in microwaves. This research opens new opportunities for the food industry to utilize microwave energy for electrifying industrial heating of oils.



For more information, visit ASABE AIM. <https://asabe.org/Poster>

## Xu Zhou awarded the Robert F. Schiffmann Memorial Scholarship

Xu Zhou has been honored with the Robert F. Schiffmann Memorial Scholarship at the 57th annual International Microwave Power Institute (IMPI) symposium that took place June 27-29 in Denver, Colorado. This scholarship recognizes students who demonstrate strong academic performance. Established in 2022, it serves as a tribute to Robert Schiffmann, IMPI's esteemed long-serving President, and his enduring legacy.

Congratulations to Xu Zhou and his advisor Dr. Juming Tang on this scholarship.



# Departmental Awards and Recognition for Students

Event	Award	Advisor
<b>BSYSE 512 Spring 2023 Poster Award</b>	First Place: Kingsley Umani Second Place: S.M. Hasan Shahriar Rahat Third Place: Valentina Sierra Jimenez	Dr. Sindhuja Sankaran Dr. Shulin Chen Dr. Manuel Garcia-Pérez
<b>BSYSE 598 Fall 2023 Graduate Seminar Best Presenter</b>	First Place: Xu Zhou Second Place: Martin Churuvija Third Place: Mark Jacob Schrader	Dr. Juming Tang Dr. Manoj Karkee Dr. Lav Khot
<b>BSE 3MT Thesis Competition</b>	First Place - PhD: Mark Jacob Schrader Second Place - PhD: Austin Gluth Third Place - PhD: Mugal Samrat Dahal First Place - MS: Kesevan Veloo	Dr. Lav Khot Dr. Bin Yang Dr. Joan Wu Dr. Sindhuja Sankaran

## BSE Outstanding Graduate Student Awards

Student	Award	Advisor
<b>Basavaraj Amogi</b>	Walter and Vinnie Hinz Scholarship & Alfred and Genevieve Gallucci Scholarship	Dr. Lav Khot
<b>Milton Valencia Ortiz</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Sindhuja Sankaran
<b>Priyanka Upadhyaya</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Manoj Karkee
<b>Chenchen Kang</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Qin Zhang & Dr. Manoj Karkee
<b>Achyut Paudel</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Manoj Karkee
<b>Xu Zhou</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Juming Tang
<b>Austin Gluth</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Bin Yang
<b>Rongge Zou</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Rongge Zou
<b>Zixuan He</b>	Arnie & Marta Kegel Endowed Fellowship	Dr. Manoj Karkee

## WSU Awards

Student	Award	Advisor
<b>Oluwatumise Dada</b>	Viola Vestal Coulter Scholarship	Dr. Shulin Chen

# Graduate Student Clubs

Our engineering clubs provide opportunities for students and faculty to explore their interests while making friends. Clubs encourage students to learn more about leadership, communication, and how to present their research and projects. Club members are actively engaged in professional societies, paper competitions, and have the chance to earn travel grants and acquire prestigious industrial internships.

- Agricultural Automation and Engineering Club
- American Society of Agricultural and Biological Engineers (ASABE) – WSU Chapter
- Biomass Engineering Club
- Food Engineering Club



BIOMASS ENGINEERING CLUB GRADUATE STUDENTS AT THE CAHNRS FALL FESTIVAL

## Agricultural Automation Engineering Club

The Agricultural Automation Engineering Club (AAEC) aims to foster a global exchange of knowledge and expertise, provide students with industrial exposure, and incorporate engineering solutions to growers' problems. The club focused on coordinating the AgTalk series, industrial trips, hands-on workshops, and panel discussions with grower stakeholders.

The club's activities commenced in March with a tour of Meter Group Inc., Pullman, where students from various departments were introduced to diverse environmental sensors and the processes involved in their manufacturing.

In June, the new AgTalk series was introduced. Bringing together experienced professionals and graduate students from various countries to share their expertise and insights on agricultural advancements from their respective nations, the first AgTalk presentation featured Mr. Eric Mozannini, a visiting scholar from University of Torino, Italy at WSU Precision Agriculture lab, who presented his research on crop protection technologies in Europe. Dr. Alan Campbell, an experienced plant physiologist and the former owner of Smart Vineyards and Northwest Vineyards (NW) Consulting, gave the second talk in August. The students learned how his company has helped growers produce quality wine grapes in the Pacific Northwest through precision irrigation management driven by wireless monitoring of soil moisture and tension. The third speaker was Dr. Siddhartha Khare, an Assistant Professor in Geomatics Engineering division of the Civil Engineering Department at the Indian Institute of Technology Roorkee, India. Dr. Khare founded BhoomiCam Pvt. Ltd., a start-up company focused on precision agriculture in India. BhoomiCam was selected top five best start-ups in the Indian geospatial industry under Geospatial World Start-Up Catalyst program.

The club also cohosted a guest seminar with the Prosser Graduate Student Association (PGSA) at the WSU Irrigated

Agriculture Research and Extension Center (IAREC) on "Humanistic Intelligence and Its Use in Climate Smart Agriculture" by Mr. Sarang Nerkar, an Electrical and Computer Engineer from the University of Toronto, Canada. The speaker discussed how human and robot interaction could help to better manage vineyards. Mr. Nerkar founded a start-up in India that helps vine growers with precision harvesting and management using virtual reality. The last speaker in the AgTalk series was Mr. Yacine Mahdid, a passionate entrepreneur and researcher with a keen interest in machine learning, biological learning, neuroscience, and optimization of inefficient processes. Mr. Yacine founded a startup company Axya, which is structuring the outsourcing process in North America and aims to solve supply chain issues within the spare parts industry.

Club members also helped organize the 2023 Smart Orchard Field Day. Organized by innov8.ag (a private partner) and Washington State University (Investigators Bernardita Sallato and Lav Khot), field day took place on August 2, 2023, at Washington Fruit and Produce Co., managed Smart Apple Orchard testbed at Grandview, WA. This event provided farmers and agricultural professionals with an opportunity to learn about the latest technologies and data-driven approaches to orchard management. Several members also shared their research to grower stakeholders during the field day. This Smart Apple Orchard testbed Project, funded by the Washington Tree Fruit Research Commission (WTFRC), is exploring cutting-edge farming solutions that incorporate sensors, drones, tractors, autonomous vehicles, and machine-learning algorithms to optimize crop yields and reduce waste. By providing farmers with real-time data on environmental factors, such as soil moisture,

At the 2023 Smart Apple Orchard Field Day, attendees had the chance to see the project's outcomes in action and learn from experts in the field. The event featured live demonstrations of crop monitoring and management technology, as well as presentations from industry leaders on best practices for orchard management.



Smart Apple Orchard Field Day 2023

## American Society of Agricultural and Biological Engineers (ASABE)

The American Society of Agricultural and Biological Engineers—Student Engineering Branch (WSU ASABE-SEB) of Washington State University is a Registered Student Organization (RSO), established on September 21, 2012. The primary purpose of the ASABE-SEB at WSU is to promote and support the mission of the American Society of Agricultural and Biological Engineers (ASABE). This society aims to gather, organize, and disseminate ideas and information for advancing agricultural, biological, food, environmental, and ecological engineering. By participating in ASABE-SEB at WSU, students can engage with ASABE professionals and develop technical and soft skills.

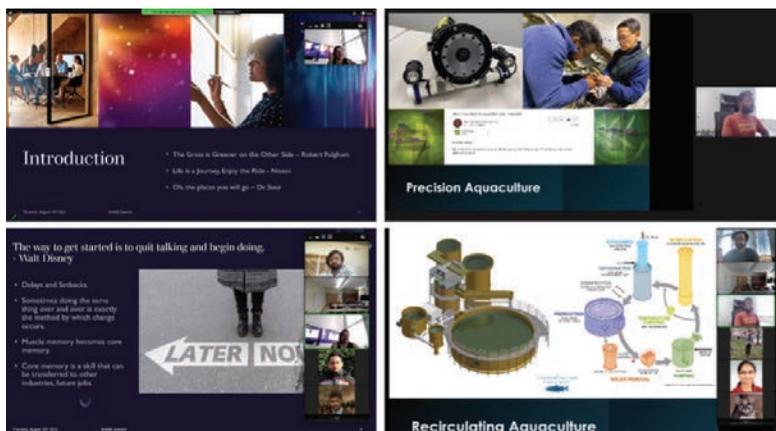
Our student branch also serves to enhance communication

and collaboration among students and faculty within and across departments. Through various events, workshops, and networking opportunities, we aim to foster meaningful connections, friendships, and professional relationships. The ASABE-SEB at WSU provides a supportive community where students can gain valuable insights, knowledge, and career opportunities from experienced professionals and fellow enthusiasts in the field.

During the academic year of 2023–2024, we organized several activities to support BSE departmental students, the student community within and outside WSU, and other scholars (postdoctoral associates, faculty members, etc.) as described below:

**Academic Seminars:** Transitioning into professional life after graduation is one of the key challenges for graduate students. Therefore, our ASABE-SEB organized a seminar series titled Transition into the Next Phase After Graduate Life. This series, featuring BSE alumni as speakers, facilitated connections between graduate students and successful alumni who shared their own graduate student experiences and experiences transitioning into current profession(s), along with further career opportunities. Our invited speakers were Dr. Rakesh Ranjan, a research scientist affiliated with The Conservation Fund Freshwater Institute, Dr. Iva Jovanovic, a process development engineer at Intel Inc., and Dr. Femi Peter Algae, a research agricultural engineer at US Department of Agriculture, Agricultural Research Service (USDA-ARS). The seminars served as a platform for graduate students and postdoctoral researchers to engage in thoughtful discussions and gain valuable perspectives, enabling them to prepare for the next phase of their professional careers.

**Lightning Talk Competition:** Communicating research confidently and effectively is one of the key aspects of research. To develop and foster these skills, the ASABE-SEB organized a Lightning Talk Competition for departmental graduate students. A total of 11 students participated in this competition, and Supriya Savalkar, Mohammad Mezbah UI Hoque, and Martin Churuvija secured first, second, and third place, respectively. Many of these students competed in the department and college-level 3MT Thesis Competition.



Our notable alumni provided seminars via a virtual platform.



Lightning talk competition organized by ASABE-SEB.

## American Society of Agricultural and Biological Engineers (ASABE)

**Panel Discussion:** Finally, in collaboration with Western Sustainable Agriculture Research and Education—Professional Development Program (Western SARE-PDP), the Agricultural AI for Transforming Workforce and Decision Support (AgAID, AI Institute in Agriculture), and the Centre for Sustaining Agriculture and Natural Resources (CSANR), the ASABE-SEB organized a panel discussion on the evolving landscape of climate policy and climate change policy-related careers, research, and Extension opportunities in agriculture and natural resources. The panel discussion was divided into two sessions: the first session highlighted the career opportunities for graduate students and scholars in the climate policy landscape, and the second session highlighted the research and Extension opportunities for researchers. The panel discussion was a hybrid event, and around 130 participants attended both sessions in-person and online. The panelists were from multiple federal and state agencies and were involved in climate policy at different levels. Dr. Rachel Melnick (Division Director for Global Climate Change, United States Department of Agriculture), Dr. Julian Reyes (Climate Adaptation Program Lead, The White House Office of Science and Technology Policy), Dr. Dani Gelardi (Washington Soil Health Initiative Lead, Washington State Department of Agriculture), and



The above-mentioned events were planned and organized by ASABE-SEB's leadership team: Md Redwan Ahmad Khan (President), Prabesh Khanal (Vice President), Keshawa Dadalage (Secretary), and Meghana Mendon (Treasurer).

Dr. Karen Hills (Sustainable Farms and Fields Program Manager, Washington Conservation Commission) shared their expertise and insights, providing our attendees (graduate students, staff, and faculty within/outside WSU) with valuable perspectives about career opportunities for graduate students on the climate change policy landscape and research and Extension opportunities for everyone while paving the path for research dissemination and implementation.



GRADUATE STUDENTS ATTENDING THE ASABE ANNUAL MEETING

## Biomass Engineering Club (BEC)

The Biomass Engineering Club (BEC) at WSU is dedicated to advancing the science and technologies that transform biomass, such as crop waste, into valuable products, fuels, and compounds. BEC strives to create a strong bond among biomass engineering students, faculty, and other interested individuals to foster a sense of community. The

club encourages leadership, enhances presentation and communication skills, and introduces students to various facets of their field to stimulate greater interest in the profession.

Faculty advisor for BEC: Manuel Garcia-Pérez.

### 1. CAHNRS Fall Festival

BEC participated in the fall festival for the second consecutive year and featured an interactive game called Pyromaze. This engaging activity captivated students and visitors by highlighting key research lab processes, including pyrolysis, fractionation, and the purification of valuable compounds. These processes convert biomass, often considered waste, into valuable products, like bio-oil, char, and syngas. These products help to create a sustainable economy. The compounds add value to the biofuel industry and exhibit various environmental applications, including as soil amendment, as catalysts, for biofuels, and toward absorption of pollutants. Participants who played and won could spin a wheel and win exciting prizes.



### 2. Participation in the Northwest Bioenergy Summit

BEC participated in the Northwest Bioenergy Summit, which focuses on developing and implementing bioenergy solutions in the Pacific Northwest. The conference brought together industry professionals, researchers, and policymakers to discuss advancements in bioenergy technologies, sustainability practices, and the role of bioenergy in reducing carbon emissions. The summit featured conference panels and five posters from BEC.

Additionally, BEC had the opportunity to visit Palouse Falls with five visiting scholars, who were excited to experience the natural beauty of the Palouse region.



## Biomass Engineering Club

### 3. Discussion Panel

BEC organized a discussion table focused on women's self-empowerment in STEM fields. The event featured insightful contributions from eight women and two men from the department. These discussions highlighted some of the various challenges and opportunities in STEM fields, along with varying perspectives. The event was a great success that inspired and supported those pursuing careers in STEM. BEC currently has plans to host a similar discussion in the future.



### 4. Visit to the WSU Nuclear Science Center

BEC organized a visit to the WSU Nuclear Science Center (NSC), which is a multidisciplinary research facility focused on nuclear science, radiochemistry, and related fields. The NSC provides state-of-the-art instrumentation and a collaborative environment for research and education. The NSC is part of the WSU/Pacific Northwest National Laboratory's Nuclear Science and Technology Institute, contributing significantly to nuclear research, security, and nonproliferation efforts. Visiting the NSC was beneficial for BEC members, as it offers exposure to advanced research tools, hands-on experience, and networking opportunities with experts in the field.

### 5. Seminars

BEC organized three guest lectures featuring invited professors who are leading experts in biomass thermochemical conversion, modeling, and the extraction of bioactive compounds. These topics are fundamental to our department's research focus and academic goals.



## Food Engineering Club

Dr. Sonar from BlueNalu presented on advanced new trend in seafood R&D in spring 2024 during a seminar organized by the Food Engineering Club (FEC). BlueNalu is pioneering cell-cultured techniques to create fish meat that mimics the real textures and flavors, offering an innovative approach to producing protein-based fish products. This method not only promises eco-friendly food options but also significantly reduces the carbon footprint associated with traditional seafood production and processing.

FEC's strong connections and collaboration with industry, including companies like BlueNalu, provided valuable opportunities to gain insights into practical, real-world scenarios. Additionally, a robust and supportive alumni network from WSU brings diverse perspectives and



DR. CHANDRASHEKHAR SONAR PRESENTING "THE TREND OF FOOD TECHNOLOGICAL APPLICATION AND INDUSTRY."

deepens understanding and industry engagement while also complementing standard classroom education and research.



## Department of Biological Systems Engineering

# Welcoming New BSE Students

In 2023, we welcomed 17 new graduate students from around the world.

Name	Degree	Last School Attended	Research Area	Advisor
Pathirannehelage S. Abeysinghe	PhD	National University of Sciences & Technology – Islamabad	Automation	Manoj Karkee
Anika Afrin	PhD	Technion-Israel Institute – Haifa, Israel	Automation	Lav Khot & Troy Peters
Toky Andriamihajaso	MS	Indian Agricultural Research Institute – New Delhi	Automation	Lav Khot
Keshawa M. Dadallage	PhD	Scripps College – Claremont, Calif.	Bioenergy	Manuel Garcia-Perez
Conor Faulhaber	PhD	University of Ibadan – Nigeria	Bioenergy	Shulin Chen
Teshan U. Habarakada Liyanage	PhD	Idaho State University – Pocatello, Idaho	Bioenergy	Bin Yang
Wenqing Hu	PhD	Washington State University – Pullman, Wash.	Bioenergy	Birgitte Ahring
Prabesh Khanal	MS	Bangladesh University of Engineering & Technology – Dhaka, Bangladesh	Bioenergy	Manuel Garcia-Perez & Vikram Yadama
Yiwei Liu	MS	University of Illinois, IL	Food Engineering	Dr. Y. Lee
Divyanth Loganathan Girija	MS	Indian Institute of Technology, India	Automation	Dr. M. Karkee
Ehsan Norouzi Kandlati	PhD	University of Tabriz, Iran	LAWREE	Dr. K. Rajagopalan
Chamaporn Paiboonvorachat	PhD	Southern Illinois University, IL	Automation	Dr. S. Sankaran
Ariel Nicole Ramos	PhD	Washington State University, WA	Automation	Dr. M. Karkee
Daniel Santosa	PhD	Washington State University, WA	Bioenergy	Dr. B. Yang
Syed Usama Bin Sabir	PhD	Air University Islamabad, Pakistan	Automation	Dr. M. Karkee
Claudia M. Valderrama	PhD	Universidad Industrial De Santander, Colombia	Bioenergy	Dr. M. Garcia-Pérez
Cheng You Wu	PhD	National Ilan University, Taiwan	Food Engineering	Drs. J. Tang/V. Wu

## 2023 Graduates

Our heartfelt congratulations to the 13 doctoral students and 3 master's students who graduated in 2023. Our graduates will follow their chosen paths, discovering new ways to shape the future in national laboratories, institutions of higher learning, and throughout the agricultural industry.

Name	Degree	Area	Title Of Dissertation	Advisor
Zeyad Ali Albahr	PhD	Food Engineering	Evaluating Thermal and Storage Stability of Selected Food Products Processed Using Microwave and High Pressure Assisted Thermal Processes	Dr. Shyam Sablani
Basavaraj Amogi	PhD	Automation	Edge-Intelligence Enabled Infield Sensing System for Heat Stress Mitigation in Apple Orchard	Dr. Lav Khot
Uddhav Bhattarai	PhD	Automation	Robotic Blossom Thinning System for Tree Fruit Crops	Dr. Manoj Karkee
Claire Castillo	PhD	LAWREE	Methods and Costs of Optimized Irrigation System Design Capacity Using Historical Evapotranspiration	Dr. Troy Peters
Mugal Samrat Dahal	PhD	LAWREE	Modeling Hydrological Processes and Key Factors Influencing Nonpoint Source Pollution in Agricultural and Urban Settings	Dr. Joan Wu
Melba Denson	PhD	Bioenergy	Contributions to Understanding Oligomeric Sugars Derived from Biomass Pyrolysis	Dr. Manuel Garcia-Perez
Fnu (Fitri) Fitria	PhD	Bioenergy	Understanding the Roles of Mineral Matter in Biomass Processing to Biofuels	Dr. Bin Yang
Marwan Gagaa	PhD	Bioenergy	Fractionation and Characterization of a Pine Pyrolysis Bio-Oil and In Vivo and In Silico Analysis of Its Anti-IL-17 Effects on Haca Human Keratinocytes	Dr. Manuel Garcia-Perez
Whitney Garcia	MS	Bioenergy	Profiling the Gut Microbiome Influence on Host Xenobiotic Metabolism in Response to Benzo[A]Pyrene and 1-Nitropyrene Exposure	Dr. Birgitte Ahring
Chenchen Kang	PhD	Automation	Decision-Support System for Water Stress Assessment and Deficit Irrigation Management in Wine Grapes	Dr. Qin Zhang Dr. Manoj Karkee
Worasit Sangjan	PhD	Automation	Integration of Multiscale Sensing Data for Phenomics Applications	Dr. Sindhuja Sankaran
Renan Stefanini Lopes	PhD	Bioenergy	Enteric Methane Mitigation Strategies with Homoacetogens from Kangaroo	Dr. Birgitte Ahring
Sicheng Sun	PhD	Food Engineering	Thermal Resistance and Survival of Salmonella in Chocolate Products as Influenced by Water Activity	Dr. Juming Tang
Daniel Ullom	MS	LAWREE	Nitrogen Removal in Bioretention Systems with Hydraulic Controls	Dr. Anand Jayakaran Dr. Joan Wu
Kesevan Veloo	MS	Automation	Phenomics for Evaluating Drought Tolerance in Different Wheat Varieties for Sustainable Crop Production	Dr. Sindhuja Sankaran



Dr. Sindhuja Sankaran hooding her graduate student, Dr. Worasit Sangjan



Dr. Manoj Karkee hooding his graduate student, Uddhav Bhattarai

2023 Graduates continued

## COMMENCEMENT 2023



New Graduates, Dr. Jiewen Guan and Dr. Rane Bhargavi with their advisors, Dr. Juming Tang and Dr. Vivian Wu



Dr. Juming Tang, Dr. Garcia-Perez, Dr. Xu Zhu, Dr. Melba Denson, Dr. Marwan Gagaa, Dr. Worasit, Sangjan, Kesevan Veloo, MS, Dr. Sinduja Sankaran



Dr. Uddhav Bhattarai, Dr. Qin Zhang, Dr. Chenchen Kang



Dr. Manoj Karkee and Dr. Chenchen Kang



Dr. Juming Tang with his graduating students Dr. Sicheng Sun and Dr. Jiewen Guan

# 2023 Peer-Reviewed Publications

- Alvi, T., M.K.I. Khan, A.A. Maan, M. Shahid, and S. S. Sablani. 2023. Microwaves as Sustainable Approach for Artificial Ripening of Date Fruit cv. Khupra to Reduce Fruit Waste. *Food Bioscience* 54. DOI: 10.1016/j.fbio.2023.102829.
- Amogi, B.R., R. Ranjan, and L.R. Khot. 2023. Mask R-CNN Aided Fruit Surface Temperature Monitoring Algorithm with Edge Compute Enabled Internet of Things System for Automated Apple Heat Stress Management. *Information Processing in Agriculture*. <https://doi.org/10.1016/j.inpa.2023.12.001>.
- Bai, M., E. Huo, Y. Sun, S. Wang, Y. Zhao, Q. Zhang, C. Wang, R. Zou, M. Qian, and H. Lei. 2023. Supercritical Water Co-gasification Mechanism of Lignin and Low Density Polyethylene into Syngas: ReaxFF Molecular Dynamic Simulation and Density Functional Theory Calculation. *Fuel Processing Technology* 250:107877. DOI: 10.1016/j.fuproc.2023.107877.
- Bai, M., Z. Song, Z. Yang, Z. Guo, Y. Liu, H. Guo, H. Lei, and E. Huo. 2023. Catalytic Conversion Mechanism of Guaiacol as the Intermediate of Lignin Catalytic Pyrolysis on MgO Surface: Density Functional Theory Calculation. *Journal of Molecular Liquids* 369:120920. DOI: 10.1016/j.molliq.2022.120920.
- Bayano-Tejero, S., M. Karkee, A. Rodríguez-Lizana, and R.R. Sola-Guirado. 2023. Estimation of Harvested Fruit Weight Using Volume Measurements with Distance Sensors: A Case Study with Olives in a Big Box. *Computers and Electronics in Agriculture* 205:107620.
- Berhanu, A., I. Mutanda, J. Taolin, M.A. Qaria, and B. Yang. A Review of Microbial Degradation of Per- and Polyfluoroalkyl Substances (PFAS): Biotransformation Routes and Enzymes. *Science of the Total Environment* 859:160010. DOI: 10.1016/j.scitotenv.2022.160010.
- Borrenpohl, D., and M. Karkee. 2023. Automated Pruning Decisions in Dormant Sweet Cherry Canopies Using Instance Segmentation. *Computers and Electronics in Agriculture* 207:107716.
- Cai, J., R. Lopez, and Y. Lee. 2023. Effect of Feed Material Properties on Microencapsulation by Spray Drying with a Three-Fluid Nozzle: Soybean Oil Encapsulated in Maltodextrin and Sugar Beet Pectin. *Journal of Food Processing and Preservation*.
- Chandel, A.K., B.A. Amogi, L.R. Khot, C. Stockle, and R.T. Peters. 2022. Digitizing Crop Water Use with Data-Driven Approaches. *Resource Magazine* 29(4):14–16.
- Chandel, A.K., M.M. Moyer, M. Keller, L.R. Khot, and G.-A. Hoheisel. 2022. Soil and Climate Geographic Information System Data-Derived Risk Mapping for Grape Phylloxera in Washington State. *Frontiers in Plant Science* 13:827393. <https://doi.org/10.3389/fpls.2022.827393>.
- Chandel, A.K., A.P. Rathnayake, and L.R. Khot. 2022. Mapping Apple Canopy Attributes Using Aerial Multispectral Imagery for Precision Crop Inputs Management. *Acta Horticulturae* 1346:537–546. <https://doi.org/10.17660/ActaHortic.2022.1346.68>.
- Chaudhary, S., K. Rajagopalan, C. Kruger, M. Brady, C. Fraisse, D. Gustafson, S. Hall, G. Hoogenboom, R. Melnick, J. Reyes, and C. Stöckle. 2023. Analogs for Dialogs: A Network Climate. *Horticulturae* 9(4):492.
- Chen, X., F. Li, J. Tang, H. Shi, J. Xie, and Y. Jiao. 2023. Temperature Uniformity of Frozen Pork with Various Combinations of Fat and Lean Portions Tempered in Radio Frequency. *Journal of Food Engineering* 111396. <https://doi.org/10.1016/j.jfoodeng.2022.111396>.
- Dahal, M.S., J.Q. Wu, M. Dobre, and R.P. Ewing. 2023, in press. Simulation of Long-term Water Erosion in Rainfed Croplands of Eastern Washington. *ASABE*.
- Dai, L., O. Karakas, S. Lata, K. Cobb, H. Lei, C. He, Y. Cheng, P. Chen, and R. Ruan. 2023. Holistic Utilization of Waste Plastics Through a Tandem Process. *Journal of Environmental Chemical Engineering* 11(5):110547. DOI: 10.1016/j.jece.2023.110547.
- Dai, L., H. Zhao, N. Zhou, K. Cobb, P. Chen, Y. Cheng, H. Lei, R. Zou, Y. Wang, and R. Ruan. 2023. Catalytic Microwave-Assisted Pyrolysis of Plastic Waste to Produce Naphtha for a Circular Economy. *Resources, Conservation and Recycling* 198:107154. DOI: 10.1016/j.resconrec.2023.107154.
- De Oliveira, D.C., E.S. Lora, O. Venturini, D.M.Y. Maya, and M. Garcia-Perez. 2023. Biomass Gasification Gas Cleaning Systems Integrated to Fischer-Tropsch—A Review of Impurities Removal and Cleaning Pathways. *Renewable and Sustainable Energy Reviews* 172:113047. <https://doi.org/10.1016/j.rser.2022.113047>.
- Divyanth, L.G., D. Rathore, P. Senthilkumar, P. Patidar, X. Zhang, M. Karkee, R. Machavaram, and P. Soni. 2023. Estimating Depth from RGB Images Using Deep-Learning for Robotic Applications in Apple Orchards. *Smart Agricultural Technology* 6:100345.
- Do-Gyun, K., S. Witherrite, L. Yu, Q. Zhao, and S. Chen. 2023. Novel Ammonia Recovery from Anaerobic Digestion by Integrating Biogas Stripping and Gypsum Absorption. *Process Safety and Environmental Protection* 180:48–55. <https://doi.org/10.1016/j.psep.2023.09.059>.
- Domes-Denson, M., E. Terell, P. Kostetskyy, M. Olarte, L. Broadbelt, and M. Garcia-Perez. 2023. Elucidation of Structure and Physical Properties of Pyrolytic Sugar Oligomers Derived from Cellulose Depolymerization/Dehydration Reactions: A Density Functional Theory Study. *Energy & Fuels* 37(11):7834–7847. <https://doi.org/10.1021/acs.energyfuels.3c00641>.
- Domes-Denson, M., E. Terell, P. Kostetskyy, M. Olarte, L. Broadbelt, and M. Garcia-Perez. 2023. Theoretical Insights on the Fragmentation Reaction of Oligomeric Sugars to Remove Acetol and Glycoaldehyde. *Energy & Fuels* 37(18):13997–1400. <https://doi.org/10.1021/acs.energyfuels.3c01924>.
- D'Silva, T.C., S.A. Khan, S. Kumar, D. Kumar, A. Isha, S. Deb, S. Yadav, B. Illathukandy, R. Chandra, V.K. Vijay, P.M. Subbarao, Z. Bagi, K.L. Kovacs, L. Yu, B.P. Gandhi, and K.T. Semple. 2023. Biohydrogen Production Through Dark Fermentation from Waste Biomass: Current Status and Future Perspectives on Biorefinery Development. *Fuel* 350:128842.
- Dunteman, A., Y. Lee, and S.-Y. Lee. 2023. A Qualitative Look at Perception and Experience of Sodium Reduction Strategies in the Food Industry Through Focus Groups and Individual Interviews. *Journal of Food Science*. DOI: 10.1111/1750-3841.16564.
- Ellison, C., M. Garcia-Perez, C. Mullen, and Y. Madhav. 2023. Thermochemical Behaviour of Alkali Treated Biomass: A Thermogravimetric and Py-GC-MS/FID Study. *Sustainable Energy & Fuels* 7:3306–3315. DOI: 10.1039/D3SE00213F.
- Enriquez, F.A., and B.K. Ahring. 2023. Strategies to Overcome Mass Transfer Limitations of Hydrogen During Anaerobic Gaseous Fermentations: A Comprehensive Review. *Bioresource Technology* 128948.
- Fang, H., C. Zhao, C. Li, Y. Song, L. Yu, X. Song, J. Wu, and L. Yang. 2023. Direct Consolidated Bioprocessing for D-Glucaric Acid Production from Lignocellulose under Subcritical Water Pretreatment. *Chemical Engineering Journal* 454:140339.

27. Fitria, A.K., M. Dewa, J. Liu, S. Ha, and B. Yang. 2023. Development of Sulfonated Carbon-Based Solid Acid Catalysts Derived from Biorefinery Residues and Biomass Ash for Xylan Hydrolysis. *Bioresources Technology Report* 24:101607.
28. Fitria, J.L., and B. Yang. 2023. Roles of Mineral Matter in Biomass Processing to Biofuels. *Biofuels, Bioproducts & Biorefining* 17(3):696–717. <https://doi.org/10.1002/bbb.2468>.
29. Gabriel, M.-M., S. Sethupathy, M. Zhang, L. Xu, A. Ghaznavi, J. Xu, B. Yang, J. Sun, and D. Zhu. 2023. Characterization and 3D Printing of a Biodegradable PLA/TPU Thermoplastic Blend with Laccase-Modified Lignin as a Nucleating Agent. *International Journal of Biological Macromolecules* 236:123881.
30. Gezahegn, Y., Y.K. Hong, J. Tang, P. Pedrow, S.S. Sablani, F. Liu, and Z.W. Tang. 2023. Development and Validation of Analytical Charts for Microwave Assisted Thermal Pasteurization of Selected Food Products. *Journal of Food Engineering* 349:111434. DOI: 10.1016/j.jfoodeng.2023.111434.
31. Giduthuri, A.T., and B.K. Ahiring. 2023. Current Status and Prospects of Valorizing Organic Waste via Arrested Anaerobic Digestion: Production and Separation of Volatile Fatty Acids. *Fermentation* 9(1):13.
32. Giduthuri, A., U. Sanyal, M.F. Guo, B.K. Ahiring, and K. Ramasamy. 2023. Towards Developing a Pathway for Efficient Conversion of Syngas-Derived Olefins to Sustainable Aviation Fuel in High Yields and Selectivity. 2023 AIChE Annual Meeting.
33. Guan, J.W., A. Lacombe, B. Rane, J. Tang, S.S. Sablani, and V.C.H. Wu. 2023. Efficacy of Gaseous Chlorine Dioxide (ClO<sub>2</sub>) Treatment on Quality Parameters and Against *Listeria innocua* Growth on Apple Surfaces under Controlled Atmosphere (CA) Storage Condition and Post-treatment Quality Analysis. *Food Control* 152:109791. DOI: 10.1016/j.foodcont.2023.109791.
34. Harahap, B.M., and B.K. Ahiring. 2023. Acetate Production from Syngas Produced from Lignocellulosic Biomass Materials along with Gaseous Fermentation of the Syngas: A Review. *Microorganisms* 11(4):995.
35. Harahap, B.M., and B.K. Ahiring. 2023. Production of Medium-Chain Volatile Fatty Acids from the Organic Fraction of Municipal Solid Waste through Sequential Arrested Anaerobic Digestion Followed by Chain Elongation. 45th Symposium for Biomaterials, Fuels and Chemicals.
36. Hendrickson, M.L., C.A. Langton, and J.Q. Wu. 2023, in press. Concrete Testing Case for Closure of Hanford's 241-C Underground Storage Tanks. *American Concrete Institute* 361:71–91.
37. Jadhav, H.B., S.S. Sablani, P. Gogate, U. Annapure, F. Casanova, G.A. Nayik, K. Alaskar, N. Sarwar, S. Ramiwas, and A.M. Khaneghah. 2023. Factors Governing Consumers Buying Behavior Concerning Nutraceutical Product. *Food Science and Nutrition* 11(9):4988–5003. DOI: 10.1002/fsn3.3518.
38. Jindal, M., A. Kumar, S. Rawat, B. Yang, and B. Thallada. 2023. Reductive Catalytic Cracking of Industrial Phenolics to Selective Cyclohexanols. *Applied Catalysis A General*. 653:119068.
39. Kalyanaraman, A., M. Burnett, A. Fern, L. Khot, and J. Viers. 2022. Special Report: The AgAID AI Institute for Transforming Workforce and Decision Support in Agriculture. *Computers and Electronics in Agriculture* 197:106944. <https://www.sciencedirect.com/science/article/pii/S0168169922002617>.
40. Kang, C., G. Diverres, P. Achyut, M. Karkee, Q. Zhang, and M. Keller. 2023. Estimating Soil and Grapevine Water Status Using Ground Based Hyperspectral Imaging under Diffused Lighting Conditions: Addressing the Effect of Lighting Variability in Vineyards. *Computers and Electronics in Agriculture* 212:108175.
41. Kang, C., G. Diverres, M. Karkee, Q. Zhang, and M. Keller. 2023. Decision-Support System for Precision Regulated Deficit Irrigation Management for Wine Grapes. *Computers and Electronics in Agriculture* 208:107777.
42. Karekar, S.C., and B.K. Ahiring. 2023. Reducing Methane Production from Rumen Cultures by Bioaugmentation with Homoacetogenic Bacteria. *Biocatalysis and Agricultural Biotechnology* 47:102526.
43. Karekar, S.C., T. Seiple, B.K. Ahiring, and C. Fuller. 2023. Assessing Feasible H<sub>2</sub>-CO<sub>2</sub> Sources in the US as Feedstocks for Sustainable Aviation Fuel Precursors: Acetic Acid and Ethanol Production via Hydrogenotrophic Pathways. *Journal of Environmental Management* 345:118641.
44. Kim, Y., L. Ma, K. Huang, and N. Nitin. 2023. Bio-based Antimicrobial Compositions and Sensing Technologies to Improve Food Safety. *Current Opinion in Biotechnology* 79:102871.
45. Kim, D.G., S. Witherrite, L. Yu, Q. Zhao, and S. Chen. 2023. Novel Ammonia Recovery from Anaerobic Digestion by Integrating Biogas Stripping and Gypsum Absorption. *Process Safety and Environmental Protection* 180:48–55.
46. Kong, X., H. Wu, K. Lu, X. Zhang, Y. Zhu, and H. Lei. 2023. Galvanic Replacement Reaction: Enabling the Creation of Active Catalytic Structures. *ACS Applied Materials & Interfaces* 15(35):41205–41223. DOI: 10.1021/acsaami.3c08922.
47. Kumar, A., M. Jindal, S. Rawat, J. Kumar, P. Sripadi, B. Yang, and B. Thallada. 2023. Upgradation of Sugarcane Bagasse Lignin: Fractionation to Cyclic Alcohols Production. *Catalysis Today* 408:182–193. DOI: <https://doi.org/10.1016/j.cattod.2022.05.037>.
48. Lei, Y., S. Kelker, and Y. Lee. 2023. A Nozzle Simulation Chip Toward High Throughput Formation of Curcumin-Loaded Zein Nanoparticles with Tunable Properties. *Journal of Food Science* 88:3524–3537. DOI: 10.1111/1750-3841.16676.
49. Li, X., A. Gluth, S. Feng, W.-J. Qian, and B. Yang. 2023. Harnessing Redox Proteomics to Study Metabolic Regulation and Stress Response in Lignin-Fed *Rhodococci*. *Biotechnology for Biofuels and Bioproducts* 16:180. <https://doi.org/10.1186/s13068-023-02424-x>.
50. Lin, X., H. Lei, C. Wang, M. Qian, W. Mateo, X. Chen, Y. Guo, and E. Huo. 2023. The Effects of Pore Structures and Functional Groups on the Catalytic Performance of Activated Carbon Catalysts for the Co-pyrolysis of Biomass and Plastic into Aromatics and Hydrogen-Rich Syngas. *Renewable Energy* 202:855–864. DOI: 10.1016/j.renene.2022.11.122.
51. Lin, J., Z. Xu, Q. Zhang, Y. Cao, O. Mašek, H. Lei, and D.C.W. Tsang. 2023. Enhanced Adsorption of Aromatic VOCs on Hydrophobic Porous Biochar Produced via Microwave Rapid Pyrolysis. *Bioresource Technology* 393:130085. DOI: 10.1016/j.biortech.2023.130085.
52. Liu, X., and Y. Lee. 2023. Fabrication of Zein-Nanoparticles via Ultrasonic Treatment and Encapsulation of Curcumin. *LWT* 188:11599. DOI: 10.1016/j.lwt.2023.115299.
53. Liu, S., S. Quek, and K. Huang. 2023. Advanced Strategies to Overcome the Challenges of Bacteriophage-Based Antimicrobial Treatments in Food and Agricultural Systems. *Critical Reviews in Food Science and Nutrition*.
54. Lopes, R.S., and B.K. Ahiring. 2023. Enhancing Acetic Acid Production in In-vitro Rumen Cultures by Addition of a Homoacetogenic Consortia from a Kangaroo: Unravelling the Impact of Inhibition of Methanogens and Effects of Biochar on Rumen Fermentations. *Fermentation* 9(10):885.

55. Louw, J., E.S. Dogbe, B. Yang, and J.F. Görgens. 2023. Prioritization of Bioproducts for Production in Biorefineries Based on Techno-economic Assessments: Could Benchmarking Enhance Comparability? *Renewable and Sustainable Energy Reviews* 118:113840.
56. Luo, X., K. Huang, Y. Niu, X. Zhang, Y. An, R. Liu, S. Xiong, and Y. Hu. 2023. Effects of Freezing Methods on Physicochemical Properties, Protein/Fat Oxidation and Odor Characteristics of Surimi Gels with Different Cross-Linking Degrees. *Food Chemistry* 432:137268.
57. Mahat, A., J.Q. Wu, A.D. Jayakaran, and R.P. Ewing. 2023. Optimizing Placement of Bioretention Systems in the US Puget Sound Region. *Journal of the American Water Resources Association*.
58. Mainali, K., and M. Garcia-Perez. 2023. Effect of  $H_3PO_4$  and NaOH Additives on the Co-Carbonization of Cellulose and N-Containing Compounds to Produce N-Doped Chars. *Journal of Analytical and Applied Pyrolysis* 169:105837. <https://doi.org/10.1016/j.jaap.2022.105837>.
59. Mainali, K., and M. Garcia-Perez. 2023. Understanding Organic N / Cellulose Integration During Pyrolysis / Carbonization to Produce N-Doped Carbon Materials. *Journal of Analytical and Applied Pyrolysis* 169:105791. <https://doi.org/10.1016/j.jaap.2022.105791>.
60. Mainali, K., S.H. Mood, S. Chen, and M. Garcia-Perez. 2023. Partial Wet Oxidation of Dairy Manure as a Pretreatment Process to Produce Acetic Acid "A Source Growth of Methanogens." *Waste Management & Research*.
61. Mainali, K., S. Haghighi Mood, M.R. Pelaez-Samaniego, V. Sierra-Jimenez, and M. Garcia-Perez. 2023. Production and Applications of N-doped Carbons from Bio-Resources: A Review. *Catalysis Today* 423:114248. <https://doi.org/10.1016/j.cattod.2023.114248>.
62. Mainali, K., C.A. Mullen, V. Sierra Jimenez, M. Garcia-Perez, and M. Sarker. 2023. An Optimization of N and C Efficiency in Biochar Production from Model Compounds: A Response Surface Approach. *Bioresource Technology Reports* 24:1016646. <https://doi.org/10.1016/j.biteb.2023.101646>.
63. Manrique, R., E. Terrell, P. Kostetsky, F. Chejne, M. Olarte, L. Broadbelt, and M. Garcia-Perez. 2023. Elucidating Biomass-Derived Pyrolytic Lignin Structures from Demethylation Reactions Through Density Functional Theory Calculations. *Energy & Fuels* 37(7):5189–5205. <https://doi.org/10.1021/acs.energyfuels.2c04292>.
64. Martinez-Fernandez, J.S., X. Gu, A. Berim, D.R. Gang, and S. Chen. 2023. Sequential Hydrothermal Extraction Chemistry for Recovering Bioactives from Potato Peels. *The Journal of Supercritical Fluids* 199:105962.
65. Martinez-Smit, C., F. Chejne, and M. Garcia-Perez. 2023. Novel Strategy to Produce Polyaromatic Compounds at Low Temperature for the Production of Secondary Chars. *Journal of Analytical and Applied Pyrolysis* 106135. <https://doi.org/10.1016/j.jaap.2023.106135>.
66. Martinez-Valencia, L., S. Peterson, K. Brant, A.B. King, M. Garcia-Perez, and M. Wolcott. Impact of Services in the Supply Chain Configuration of Sustainable Aviation Fuel: The Case of  $CO_2$  Emission Reductions in the U.S. *Journal of Cleaner Production* 404:136934. <https://doi.org/10.1016/j.jclepro.2023.136934>.
67. McCoy, M.L., G.-A. Hoheisel, L.R. Khot, and M.M. Moyer. 2022. Adjusting Air-Assistance and Nozzle Style for Optimized Airblast Sprayer Use in Eastern Washington Vineyards. *American Journal of Enology and Viticulture* 6(Suppl 1):9–19. <https://doi.org/10.5344/catalyst.2021.21001>.
68. Molaei, B., A. Chandel, R.T. Peters, L.R. Khot, A. Khan, F. Maureira, and C.O. Stockle. 2023. Investigating the Application of Artificial Hot and Cold Reference Surfaces for Improved Etc Estimation Using the UAS-METRIC Energy Balance Model. *Agricultural Water Management* 284(20):108346. <https://doi.org/10.1016/j.agwat.2023.108346>.
69. Molaei, B., R.T. Peters, A.K. Chandel, L.R. Khot, C.O. Stockle, and C.S. Campbell. 2023. Measuring Evapotranspiration Suppression from the Wind Drift and Spray Water Losses for LESA and MESA Sprinklers in a Center Pivot Irrigation System. *Water* 15(13):2444. <https://doi.org/10.3390/w15132444>.
70. Molaei, B., R.T. Peters, L.R. Khot, and C.O. Stöckle. 2022. Assessing Suitability of Auto-Selection of Hot and Cold Anchor Pixels of the UAS-METRIC Model for Developing Crop Water Use Maps. *Remote Sensing* 14(18):4454. <https://doi.org/10.3390/rs14184454>.
71. Mu, X., L. He, P. Heinemann, J. Schupp, and M. Karkee. 2023. Mask R-CNN Based Apple Flower Detection and King Flower Identification for Precision Pollination. *Smart Agricultural Technology* 4:100151.
72. Mu, X., M. Hussain, L. He, P. Heinemann, J. Schupp, M. Karkee, and M. Zhu. 2023. An Advanced Robotic System for Precision Chemical Thinning of Apple Blossoms. *Journal of the ASABE* 66(5):1125–1134. DOI: 10.13031/ja.15678.
73. Mufute, N.L., M. Yost, D. Larsen, B. Barker, R.T. Peters, and M. Zamora-Re. 2023, accepted. Center Pivot Maintenance Trends in the Western United States. *Journal of Irrigation and Drainage Engineering*.
74. Murid, M., M.K.I. Khan, M. Asif, and S.S. Sablani. 2023. Preferential Binding Effect of Cocoa Powder on Fried Donuts Through the Electrostatic Coating Method. *International Journal of Food Science and Technology*. DOI: 10.1111/ijfs.16222.
75. Patel, J., A. Parshi, Z. Tang, J. Tang, and S. Sablani. 2023. Storage Stability of Vitamin C Fortified Purple Mashed Potatoes Processed with Microwave Assisted Thermal Sterilization System. *Food Innovation and Advances* 2(2):106–114.
76. Paudel, A., J.R. Davidson, C. Grimm, and M. Karkee. 2023. Vision-Based Normalized Canopy Area Estimation for Variable Nitrogen Application in Apple Orchards. *Smart Agricultural Technology* 100309.
77. Pinheiro-Pires, A.P., M. Garcia-Perez, M. Olarte, M. Denson, E. Terrell, and Y. Han. 2023. Comparison of the Chemical Composition of Liquids from the Pyrolysis and Hydrothermal Liquefaction of Lignocellulosic Materials. *Energy & Fuels* 37(10):7221–7236. <https://doi.org/10.1021/acs.energyfuels.2c03239>.
78. Pinheiro-Pires, A.P., M. Olarte, M. Garcia-Perez, and Y. Han. 2023. Co-Hydrotreatment of Yellow Greases and Pyrolysis Oil Water Insoluble Fraction: Part I: Experimental Design to Increase Kerosine Yield and Reduce Coke Formation. *Energy & Fuels* 37(3):2100–2114. <https://doi.org/10.1021/acs.energyfuels.2c03250>.
79. Qiu, Y., Z. Johnson, X. Gu, P. Bohutskyi, and S. Chen. 2023. Dairy Manure Fermentation at Hyperthermophilic Temperature Enabled Superior Activity of Thermostable Hydrolytic Enzymes Linked to Genus *Caldicoprobacter*. *Bioresource Technology*. <http://dx.doi.org/10.2139/ssrn.4523706>.
80. Quinn, K., S. Haghighi-Mood, E. Cervates, M. Garcia-Perez, and N. Abu-Lail. 2023. Forces Governing the Transport of Pathogenic and Nonpathogenic *Escherichia coli* in Nitrogen and Magnesium Doped Biochar Amended Sand Columns. *Microbiology Research* 14(1):218–228. <https://doi.org/10.3390/microbiolres14010018>.

81. Rane, B., A. Lacombe, J. Guan, D.F. Bridges, S. Sablani, J. Tang, and V.C. Wu. 2023. Gaseous Chlorine Dioxide Inactivation of Microbial Contamination on Whole Black Pepper Corns. *Journal of Food Safety*. <https://doi.org/10.1111/jfs.12948>.
82. Rane, B., A. Lacombe, J.W. Guan, L. Lucero, D.F. Bridges, S.S. Sablani, J. Tang, and V.C.H. Wu. 2023. Reduction of *Aspergillus flavus* and Aflatoxin on Almond Kernels Using Gaseous Chlorine Dioxide Fumigation. *Food Chemistry* 402:134161. DOI: 10.1016/j.foodchem.2022.134161.
83. Ranjan, R., B.R. Amogi, A.K. Chandel, L.R. Khot, B.V. Sallato, and R.T. Peters. 2023. Efficacy Evaluation of Apple Sunburn Mitigation Techniques in WA 38 Cultivar Using Crop Physiology Sensing System. *Computers and Electronics in Agriculture*. <https://doi.org/10.1016/j.compag.2023.108501>.
84. Ross, C., S.S. Sablani, and J. Tang. 2023. Preserving Ready-to-Eat Meals Using Microwave Technologies for Future Space Programs. *Foods* 12:1322. DOI: 10.3390/foods12061322.
85. Ruan, H., Z. Xu, A. Kumar, M. Feng, A. Lipton, E. Walter, R. Gieleciak, H. Paudel, Y. Duan, and B. Yang. 2022. Elucidating the Reaction Pathways of Veratrylglycero- $\beta$ -Guaiaacyl Ether Degradation over Metal-Free Solid Acid Catalysts with Hydrogen. *ChemSusChem* 16:e202202001 (1 of 9). DOI: 10.1002/cssc.202202001.
86. Sadeghi, H., and R.T. Peters. 2023. Closure to "An Explicit Equation to the Maximum Water Application Depth in Center Pivot Irrigation." *Journal of Irrigation and Drainage Engineering* 149(10). <https://doi.org/10.1061/JIEDH.IRENG-10167>.
87. Sahni, R., R. Ranjan, L.R. Khot, G.-A. Hoheisel, and M.J. Grieshop. 2023, in press. Comparative Spray Performance of a Solid Set Canopy Delivery System and an Airblast Sprayer in Modern Apple Orchards. *Journal of ASABE*.
88. Shen, X., Y. Su, Z. Hua, H. Zhu, G. GÜnlü, C. Ross, M. Mendoza, I. Hanrahan, J. Tang, and M.J. Zhu. 2023. *Listeria monocytogenes* Cross-Contamination During Apple Waxing and Subsequent Survival under Different Storage Conditions. *Food Microbiology* 110:104166. <https://doi.org/10.1016/j.fm.2022.104166>.
89. Shu, D., J. Zhang, R. Ruan, H. Lei, Y. Wang, M. Qian, R. Zou, E. Huo, D. Duan, L. Gan, D. Zhou, Y. Zhao, and L. Dai. 2023. Insights into Preparation Methods and Functions of Carbon-Based Solid Acids. *Molecules* 29(1):247. DOI: 10.3390/molecules29010247.
90. Sierra-Jimenez, V., J.P. Mathews, M. Chejne, F. Chejne, A. Dufour, and M. Garcia-Perez. 2023. Atomistic Modeling of Lignocellulosic and Carbonaceous Fuels and Their Pyrolysis Reactions: A Review. *Energy & Fuels* 37(23):18408–18440. <https://doi.org/10.1021/acs.energyfuels.3c02901>.
91. Strawn, D.G., A. Crump, D. Peak, M. Garcia-Perez, and G. Moller. 2023. Reactivity of Fe-Amended Biochar for Phosphorous Removal and Recycling from Wastewater. *PLOS Water*. <https://doi.org/10.1371/journal.pwat.0000092>.
92. Sun, S.C., Y.C. Xie, R. Yang, M.J. Zhu, S.S. Sablani, and J. Tang. 2023. The Influence of Temperature and Water Activity on Thermal Resistance of *Salmonella* in Milk Chocolate. *Food Control* 143:109292. DOI: 10.1016/j.foodcont.2022.109292.
93. Sun, S., Y. Xie, X. Zhou, M.-J. Zhu, S.S. Sablani, and J. Tang. 2023. Survival and Thermal Resistance of *Salmonella* in Chocolate Products with Different Water Activities over 12 Months. *Food Research International* 172. DOI: 10.1016/j.foodres.2023.113209.
94. Tourang, M., X. Xiong, S. Sarkhosh, and S. Chen. 2023. Polyhydroxybutyrate (PHB) Biosynthesis by an Engineered *Yarrowia lipolytica* Using Co-Substrate Strategy. *Fermentation* 9(12):1003. <https://doi.org/10.3390/fermentation9121003>.
95. Tu, S., J. Irudayaraj, and Y. Lee. 2023. Characterizing Spray-Dried Powders Through NIR Spectroscopy: Effect of Two Preparation Strategies for Calibration Samples and Comparison of Two Types of NIR Spectrometers. *Foods* 12(3):467. <https://doi.org/10.3390/foods12030467>.
96. Upadhyaya, P., M. Karkee, S. Kshetri, and A. Paudel. 2023. Automated Lag-Phase Detection in Wine Grapes Using a Mobile Vision System. *Smart Agricultural Technology* 100381.
97. Villota, E.M., H. Lei, S.M.A. Villota, M. Qian, W. Mateo, Y. Zhao, E. Huo, Q. Zhang, X. Lin, and Z. Huang. 2023, accepted. Adsorption Isotherm and Kinetics of Methylene Blue Dye on Chemically-Activated Porous Carbon from Douglas-fir. *Materials International*.
98. Willsea, N., V. Blanco, K. Rajagopalan, T. Campbell, O. Howe, and L. Kalcsits. 2023. Reviewing the Tradeoffs Between Sunburn Mitigation and Red Color Development in Apple under a Changing Climate. *Horticulturae* 9(4):492. <https://doi.org/10.3390/horticulturae9040492>.
99. Yang, R., and J. Tang. 2023. Developing Thermal Control of Salmonella in Low-Moisture Foods Using Predictive Models. *Food Safety Magazine*. <https://www.food-safety.com/articles/8787-developing-thermal-control-of-salmonella-in-low-moisture-foods-using-predictive-models>.
100. Yildiz, S., G.Y. Shin, B.G. Franco, J. Tanh, S. Sablani, and G.V. Barbosa-Cánovas. 2023. Equivalent Processing for Pasteurization of a Pineapple Juice-Coconut Milk Blend by Selected Nonthermal Technologies. *Journal of Food Science*. DOI: 10.1111/1750-3841.16403.
101. You, A., N. Parayil, J.G. Krishna, U. Bhattarai, R. Sapkota, D. Ahmed, M. Whiting, M. Karkee, C. Grimm, and J.R. Davidson. 2023. Semi-autonomous Precision Pruning of Upright Fruiting Offshoot Orchard Systems: An Integrated Approach. *IEEE Robotics & Automation Magazine*. DOI: 10.1109/MRA.2023.3309098.
102. Yourek, M., M. Liu, F. Scarpore, K. Rajagopalan, K. Malek, J. Boll, M. Huang, M. Chen, and J.C. Adam. 2023. Downscaling Global Land-Use/Cover Change Scenarios for Regional Analysis of Food, Energy, and Water Subsystems. *Frontiers in Environmental Science* 11:86.
103. Yu, L., D.G. Kim, P. Ai, H. Yuan, J. Ma, Q. Zhao, and S. Chen. 2023. Effects of Metal and Metal Ion on Biomethane Productivity during Anaerobic Digestion of Dairy Manure. *Fermentation* 9(3):262.
104. Yu, Z.L., Y.X. Wei, C.C. Fu, S.S. Sablani, Z.E. Huang, C. Han, D.N. Li, Z.J. Sun, and H.Z. Qin. 2023. Antimicrobial Activity of Gamma-Poly (Glutamic Acid), a Preservative Coating for Cherries. *Colloids and Surfaces B: Biointerfaces* 225:113272. DOI: 10.1016/j.colsurfb.2023.113272.
105. Yu, X., B. Yang, W. Zhu, T. Deng, Y. Pu, A. Ragauskas, and H. Wang. Towards Functionalized Lignin and Its Derivatives for High-Value Material Applications. *Industrial Crops and Products* 200(Part A):116824.
106. Zhang, Q., Y. Cao, M. He, H. Lei, H. Song, D.S. Alessi, and D.C.W. Tsang. 2023. Improved Energy Recovery from Yard Waste by Water-Starved Hydrothermal Treatment: Effects of Process Water and Pressure. *Bioresource Technology* 394:130211. DOI: 10.1016/j.biortech.2023.130211.

107. Zhang, Q., J. Chen, X. Guo, H. Lei, R. Zou, E. Huo, X. Kong, W. Liu, M. Wang, Z. Ma, and B. Li. 2023. Mussel-Inspired Polydopamine-Modified Biochar Microsphere for Reinforcing Polylactic Acid Composite Films: Emphasizing the Achievement of Excellent Thermal and Mechanical Properties. *International Journal of Biological Macromolecules* 260(2):129567.
108. Zhou, X., Y. Gezahegn, S. Zhang, Z. Tang, P.S. Takhar, P.D. Pedrow, S.S. Sablani, and J. Tang. 2023. Theoretical Reasons for Rapid Heating of Vegetable Oils by Microwaves. *Current Research in Food Science*. <https://doi.org/10.1016/j.crf.2023.100641>.
109. Zhou, X., P.D. Pedrow, S. Bohnet, S.S. Sablani, and J. Tang. 2023. Heating Performance of Microwave Ovens Powered by Magnetron and Solid-State Generators. *Innovative Food Science & Emerging Technologies* 83:103210. <https://doi.org/10.1016/j.ifset.2022.103240>.
110. Zhou, X., Z. Tang, P.D. Pedrow, S.S. Sablani, and J. Tang. 2023. Microwave Heating Based on Solid-State Generators: New Insights into Heating Pattern, Uniformity, and Energy Absorption in Foods. *Journal of Food Engineering* 357:11165. <https://doi.org/10.1016/j.jfoodeng.2023.111650>.
111. Zhu, D., B. Yang, H. Wang, and M. Shahnavaz. 2023. Editorial: Lignin Valorization: Recent Trends and Future Perspective. *Frontiers in Bioengineering and Biotechnology* 11:1190128. DOI: 10.3389/fbioe.2023.1190128.
112. Zou, R., C. Wang, M. Qian, R. Lei, Y. Zhao, Q. Zhang, E. Huo, X. Kong, X. Lin, L. Wang, X. Zhang, A. Gluth, B. Harahap, Y. Wang, L. Dai, J. Zhao, R. Ruan, and H. Lei. 2023. Catalytic Fast Co-pyrolysis of Douglas Fir and Low-Density Polyethylene with Nanocellulose-Derived Carbon Catalyst for Enhancing Selectivity of Hydrogen in Syngas and Mono-aromatic Hydrocarbon in Bio-oil Products. *Chemical Engineering Journal* 474:145640. DOI: 10.2139/ssrn.4434973.
113. Zou, R., X. Zhou, M. Qian, C. Wang, D. Boldor, H. Lei, and X. Zhang. 2023. Advancements and Applications of Microwave-Assisted Deep Eutectic Solvent (MW-DES) Lignin Extraction: A Comprehensive Review. *Green Chemistry*. DOI: 10.1039/D3GC04501C.

# OUTREACH AND PARTNERSHIPS

## 2024 Conference on Food Engineering (CoFE'24)

Three food engineering professors from our department, Juming Tang, Shyam Sablani, and Gustavo Barbosa-Cánovas, together with Yanyun Zhao of Oregon State University, are organizing an international Conference on Food Engineering (CoFE'24), which will take place at the Seattle Convention Center during fall 2024.

All CoFEs are organized by the U.S. Society of Food Engineering every two to three years; the first conference was held in 1989. Colleagues from around the world are actively involved with the events, which include plenary and invited lectures, oral and poster presentations, and great participation by graduate students.

## ASABE Conferences

July 13–16, 2025 Annual International Meeting,  
Toronto, Ontario, Canada.

# SUPPORT

## BIOLOGICAL SYSTEMS ENGINEERING

Donate and support BSE online at: [foundation.wsu.edu/give](https://foundation.wsu.edu/give)

Click “search” and enter “Biological Systems Engineering Development Fund”

### Funding Priorities:

- Scholarships to support graduate students.
- Construction of a pilot plant for the biomass and bioproducts program.
- Maintenance and replacement of equipment in the Biological Systems Engineering central analytical lab. These very important tools that support BSE’s research mission are more than 15 years old.
- Endowed chair position for expertise in food engineering; biomass conversion and bioproducts; land, air, water resources, and environmental engineering; and agricultural automation.



## Biological Systems Engineering

L. J. Smith Hall 213  
1935 E. Grimes Way  
PO Box 646120  
Pullman, WA 99164-6120  
**(509) 335-1578**

[bsyse.wsu.edu](http://bsyse.wsu.edu)



WASHINGTON STATE UNIVERSITY  
**College of Agricultural, Human,  
and Natural Resource Sciences**