THE LINK

BIOLOGICAL AND AGRICULTURAL ENGINEERING | FALL 2021 | CARL R. ICE COLLEGE OF ENGINEERING

KANSAS STATE UNIVERSITY | Carl and Melinda Helwig Department of Biological and Agricultural Engineering

FROM THE DEPARTMENT HEAD

Campus was quiet this summer as COVID-19 protocols limited face-to-face activities. As I write this note in July 2021, "looking forward to August" are frequent words. Most are looking forward to the energy students bring, and the hustle and bustle of people moving between classes and meetings. Faculty are looking forward to classrooms full of students. However, my sentiments lean toward something said by Mike Rowe, "I'm looking forward to the future and feeling grateful for the past." Despite COVID-19 and the challenges of the 2020-2021 academic year, as department head, I have reason to look back and be grateful.

The BAE department celebrated the official naming of the Carl and Melinda Helwig Department of Biological and Agricultural Engineering during the unveiling of new departmental signage in April 2021. I am grateful for the generosity of Carl and Melinda Helwig in naming the department and supporting the Helwig Farms Quarter-Scale Tractor Team. I am also grateful other alumni contributions have resulted in three new scholarships for our undergraduate students and that BAE awarded its first endowed environmental engineering scholarship. Generous alumni and friends continue to invest time and financial resources in departmental functions, undergraduate scholarships and student learning opportunities.

I am grateful the university and state of Kansas allowed the department to move forward with renovating the center basement area in Seaton Hall. Faculty and the professional team worked together virtually to define needs and develop a vision. An architecture firm finalized the renovation plans in summer 2020 and in early fall these were approved by the state architect. The basement has been transformed into quality teaching and research space. This was a huge accomplishment since west Seaton Hall was constructed in 1957 and we had more than 50 years of historical items to sort through. Renovating the space was one thing, but reaching the ultimate goal of utilizing it for quality teaching, research, extension and student activities will be the true reward when we begin a new academic year.

I am grateful for the faculty and professional staff's commitment to students. Often over the past year they helped struggling students to succeed and make it through the pandemic. BAE graduate students and post docs were responsible for moving projects forward despite COVID-19 protocols. Henry Ford once noted what I had an opportunity to observe first hand, "If everyone is moving forward together, then success takes care of itself."

We hope your curiosity will pique your interest in stopping by Seaton Hall and seeing the new departmental signage and renovated space. Each new door offers opportunities to learn and discover within the Carl and Melinda Helwig Department of Biological and Agricultural Engineering. This 2021 issue of The LINK provides a glimpse of my gratitude for the commitment of BAE faculty, staff, students, friends and alumni. Thank you for your continued financial support and engagement in department activities, and for providing opportunities for our students to succeed beyond campus.

Joseph P. Harner III
Department head and professor

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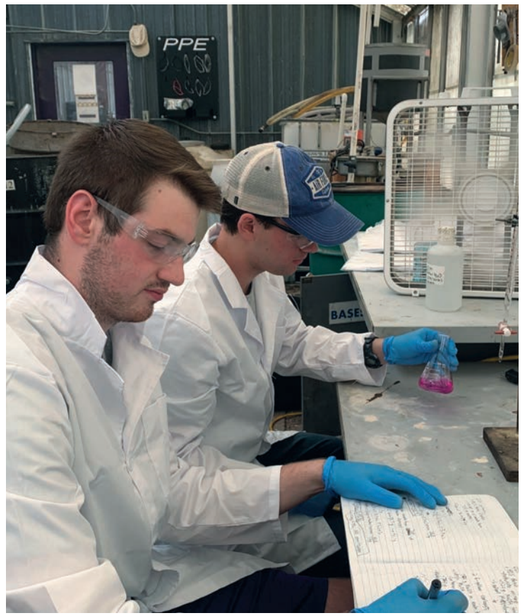


ABOVE: HOLDEN BRYANT, LEFT, AND BEN PROFFITT, CONDUCT A TITRATION ON WASTE COOKING OIL IN PREPARATION FOR PRODUCTION OF BIODIESEL.

ON THE COVER: CARL AND MELINDA HELWIG IN FRONT OF NAMED DEPARTMENT SIGNAGE

IN THIS ISSUE

RESEARCH
GLOBAL IMPACT
EXCELLENCE
EDUCATION
INNOVATION

THE LINK is published by the Carl and Melinda Helwig Department of Biological and Agricultural Engineering in the Kansas State University Carl R. Ice College of Engineering, 1016 Seaton Hall, 920 N. Martin Luther King Jr. Drive, Manhattan, KS 66506. It is available online at **bae.k-state.edu**.

Fall 2021
Editing and design . . . . . Engineering Communications
Photography . . . . . K-State Division of Communications and Marketing, David Mayes

Investigating early soybean planting in Kansas

The U.S. is a major soybean [Glycine max (L.) Merr.] producer as well as supplier for the world. Several factors contribute toward the yield of soybeans, including genetic traits of the cultivar, environmental conditions and management practices. Continuously changing weather patterns across the country and in the Midwest have intrigued the scientific community to reexamine how agronomic practices play with environmental conditions to impact yield.

Planting soybeans after finishing corn planting has been a general practice in Kansas. However, several research findings in neighboring Midwestern states have indicated producers can profit from planting soybeans earlier. So, BAE faculty member Vaishali Sharda, and her graduate students, Meenakshi Rawat and Rintu Sen, are conducting a field study to identify best early planting dates for soybeans and then studying the impact on soybean yields under varying environmental conditions. Funded by the Kansas Soybean Commission, the project is underway at two experimental sites in northeast and north central Kansas.

GRADUATE STUDENTS RINTU SEN AND MEENAKSHI RAWAT WITH COLLABORATORS FROM THE DEPARTMENT OF AGRONOMY AT THE SOYBEAN PLANTING DATE RESEARCH PLOT

With a long-term goal of modeling the impact of different planting dates and environmental factors on soybean production, data collection at both experimental sites is underway and includes information on stand counts at different vegetative growth stages, soil samples, biomass and leaf area index, or LAI. It is expected initial results from this first year of research will help set up groundwork for future seasons to study the long-term impact of early planting on soybean yield. The team also expects to understand whether environmental and management factors might play a role in impacting overall yield. These include, but are not limited to, best management practices, e.g. for tillage; soil properties; soil temperature; and soil moisture. The results can provide research-based critical knowledge to farmers in the region for modifying their planting management practices for closing yield gaps.

Prescribed Fires

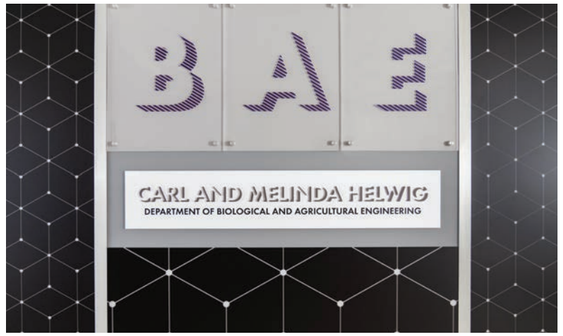
Air quality specialist, Zifei Liu, from the BAE department, and range management specialist, Walter H. Fick, from the department of agronomy, have teamed up with fire-sensing and simulation researchers at the University of Kansas, Georgia State University and the University of Missouri to develop an innovative community sensing, planning and learning infrastructure to support smart and safe prescribed burning for communities that use prescribed fires for land management. The effort is supported by the NSF Smart and Connected Communities program, which encourages integrative research that addresses fundamental technological and social science dimensions of smart and connected communities, and pilots solutions together with communities.

The project uses a holistic data-driven approach that enables comprehensive technical support for smart and safe planning of prescribed fires. The multiscale sensing and data fusion integrate the complementary data from satellites, unmanned aircraft systems and crowd sensing, which have been treated in isolation in the past, to provide never-before-processed information about prescribed burning. The proposed cloud-based tool will serve the community as an informative guide and smart cyber connection for landowners to optimally plan their prescribed fires. It will then collect and share data while training them to learn the most effective burn techniques.

The team is working with communities in the Gypsum Hills and Cherokee Strip regions to develop unique education and outreach programs, and learning materials to provide interdisciplinary training to farmers, landowners, firefighters, environmental regulators and the general public. The interdisciplinary nature of the research team provides strong potential for building a smart and connected society for fire management, from the local community to a broader society.

Carl and Melinda Helwig naming

investment translates to student opportunity



Carl and Melinda Helwig, Columbus, Kansas, have invested in the naming of the Carl and Melinda Helwig Department of Biological and Agricultural Engineering in the Carl R. Ice College of Engineering at Kansas State University. On April 23, the college celebrated this naming in the Helwigs' honor.

This investment will empower the department to recruit and retain top faculty, support deserving students and provide flexible funding for department leaders to take advantage of emerging opportunities.

"I am extremely honored that Carl and Melinda Helwig have chosen to invest in the department of biological and agricultural engineering," said Joseph Harner, department head and professor. "The Helwigs are committed to assuring undergraduate students have extracurricular experiential learning opportunities beyond the classroom. Their generous gift enables students to participate in a team environment working on product design, testing, manufacturing and marketing prior to entering the professional workforce."

Carl and Melinda Helwig, owners of Helwig Farms, raised wheat, corn, soybeans and grain sorghum on their southeast Kansas farm. The Helwigs also competed in tractor-pulling competitions and placed nationally in the early 1980s. Neither attended Kansas State University, but in recent years became important supporters and mentors of K-State students by investing in the university's quarter-scale tractor team, which demonstrates the power of engineering and inspired innovation. They felt a kinship with the students of this team and were motivated to support them.

"We are honored to support K-State as it educates the next generation of engineering professionals," Carl Helwig said. "We have had a good life, been fortunate in grain production and enjoyed the thrill of competition. We want students to have every opportunity to be on top."

A gift of this magnitude is truly transformational for the college and the university.

"Carl and Melinda Helwig personify the generosity of the K-State family," K-State President Richard Myers said. "Their investment in the success of the College of Engineering faculty, students and programs not only elevates the college but brings prestige to the university and helps propel K-State toward being nationally recognized as a student-centered, public research university."

As Kansas State University's strategic partner for philanthropy, the KSU Foundation inspires and guides philanthropy toward university priorities to boldly advance the K-State family. Visit **ksufoundation.org** for more information.

Student awards

ATM Outstanding Senior | *Jesse Rice*

"My favorite experience from being in agricultural technology management is walking into Seaton Hall and being able to know everyone I see in the halls before and after each class, and throwing up a big 'farmer' wave. You can still find that small-town feeling in a few places on campus, and one of them is in the Carl and Melinda Helwig Department of Biological and Agricultural Engineering.

After graduation, I will be moving to Des Moines, Iowa, to work full-time as a product support representative for John Deere at its Intelligent Solutions Group facility."

BSE Outstanding Senior | *Molly Smith*

"One of my favorite college memories was my junior year when my class and the seniors, after spending a lot of time together studying, realized we enjoyed each other's company and all decided to go to the Britt's Farm social. We had great fun petting animals, joking around and going down the giant slide.

I do not yet have plans set following my graduation in December; however, I am very excited to intern with Bartlett & West this summer in its Lawrence office within the water resources engineering division."

BAE Graduate Student of the Year | *Jikai Zhao*

Jikai Zhao, Ph.D. candidate, received the 2021 Graduate Student of the Year Award from the Carl and Melinda Helwig Department of Biological and Agricultural Engineering in recognition of his outstanding academic performance, accomplishments and overall contribution to BAE and the profession. Zhao was recognized in terms of coursework — 4.0 GPA, research and professional activities. During the past two years he published eight, high-quality peer-reviewed journal articles as first author; three peer-reviewed journal articles as co-author; and one book chapter.

K-STATE TEAM RECEIVES USGS GRANT

Harmful cyanobacteria blooms, also known as cyanoHABs or blue-green algae, are an emerging challenge to managing reservoirs and other freshwater systems in Kansas and across the globe because of the myriad of ecological, economic and human health issues they cause.

To address this concern, a Kansas State University research team is developing novel mobile monitoring platforms to better understand spatial dynamics of cyanoHABs. The team will then use the data to couple mechanistic and machine-learning models to improve cyanoHAB prediction.

Trisha Moore, associate professor and Peggy and Gary Edwards Cornerstone teaching scholar in the Carl and Melinda Helwig Department of Biological and Agricultural Engineering, will lead the three-year project, "Integrated data science — mechanistic modeling framework to predict cyanoHABS in contrasting freshwater systems." The project has been funded for $249,746 by the U.S. Department of Interior's U.S. Geological Survey, or USGS, program.

Through collaboration with USGS water scientists, Moore and her K-State colleagues — Aleksey Sheshukov, associate professor, and Daniel Flippo, associate professor and Patrick Wilburn Keystone research scholar, both from the biological and agricultural engineering department; and Lior Shamir, associate professor and Nick Chong Keystone research scholar in the computer science department — will work in bodies of water in Kansas and New York to test transferability of the models across different freshwater systems.

"Our aim is to advance understanding of the complex environmental interactions under which cyanoHABs develop and persist as well as to provide tools to help lake managers better monitor and forecast these blooms," Moore said. "CyanoHABs impact our state, national and global economies and ecosystems. This project has the potential to support both high-impact research and outreach while providing opportunities to train graduate students and engage undergraduates in research and discovery."

COMPREHENSIVE **VALORIZATION** AND **EVALUATION** OF INDUSTRIAL HEMP

JIKAI ZHAO, PH.D. CANDIDATE, EXAMINES ETHANOL DISTILLATION.

Industrial hemp, or Cannabis sativa L., is a versatile and drought-resistant crop. However, due to the intoxicating component delta-9-tetrahydrocannabinol, in past decades, the legislative restraint of industrial hemp cultivation and processing in western Europe, the U.S. and Canada to inhibit its abuse and illegal utilization for drug production, markedly enfeebled its economic importance. Therefore industrial hemp is often recognized as an underdeveloped and underutilized crop. Recently, legislation loosening has reintroduced the commercial interests of industrial hemp, allowing legal cultivation and research of various industrial hemp varieties with a THC content below 0.3%. Regulatory changes are leading to a resurgent commercial exploration of this crop for food, feed, pharmaceutical and industrial applications.

Hempseed is of great interest with important nutritional and functional features of its bioactive compounds. Hempseed protein contains a large number of essential amino acids with excellent digestibility and functionality. Beneficial effects of hempseed are also attributed to the high content of lipids with a unique and perfectly balanced ratio between polyunsaturated and saturated fatty acids for human nutrition. The unsaponifiable portion is a crucial source of interesting compounds including β-sitosterol, campesterol, phytol, cycloartenol and γ-tocopherol. In addition, hempseed also contains carbohydrates, dietary fibers and minerals. These specific constituents have been reported to play an antihypertensive and hemostatic role in human health. In this regard, Professor Donghai Wang; his Ph.D. student, Jikai Zhao;

JIKAI ZHAO, PH.D. CANDIDATE, COLLECTS SUGAR AND ETHANOL CONCENTRATIONS DATA USING A 1260 HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY SYSTEM.

and his postdoc, Youjie Xu, investigated 13 varieties of industrial hemp with focus on comprehensive understanding of the nutritional value of hempseed for human food and potential of a new crop in the agricultural food system.

Hemp biomass also contains higher cellulose content compared to corn stover, wheat straw and other woody biomass, indicating its potential as a competitive candidate for biomass-to-bioproducts valorization. In order to render hemp biomass amenable to enzymatic hydrolysis and microbial fermentation, physicochemical pretreatment coupled with extreme post-washing has been commonly proposed. This traditional processing inevitably induces water overconsumption and chemical loss. In order to address this issue, Wang and Zhao proposed an integration process in which hemp biomass was pretreated by acid and alkali individually after solid and liquid separation, and acid and alkali pretreated filtrate were mixed for lignin recovery and then used as a buffer for enzymatic hydrolysis of their mixed biomass. Strikingly, this novel process applies to four genotypes of industrial hemp biomass harvested from two planting locations, Haysville and Manhattan. Findings from their research provides new perspectives for engineering design to promote commercial exploration of hemp biomass-based bioproducts.

Senior Spotlight | Elizabeth Seidl

Elizabeth Seidl, BSE senior in the biological option, competed in the Carl R. Ice College of Engineering virtual Undergraduate Research and Creative Inquiry Showcase in April. Participants across all engineering departments submitted an abstract, digital poster and three-minute recorded video explaining their research. Seidl, along with her research advisor, Lisa Wilken, associate professor, placed second in the showcase with her poster, "Phytic Acid: A Plant-based Purification Strategy." Their research within Wilken's bioseperations laboratory studies low-cost purification of recombinant proteins, specifically the recombinant human albumin serum using phytic acid. Alternative purification methods have the potential to largely reduce capital costs of plant-based recombinant proteins.

Seidl spent the summer participating in the Center of MechanoBiology Undergraduates Expanding Boundaries Research Experience for Undergraduates, or REU, Program at the University of Pennsylvania in Philadelphia. Seidl was a member of Dennis Discher's laboratory studying genomic effects on DNA damage within embryonic chicken hearts. Her project has taught her both experimental and computational skills, utilizing dimensional analysis tools with statistical analysis software R. The Center of MechanoBiology aims to investigate mechanical forces in molecules, cells and tissues in plants and animals, cross-disciplinary within biology and engineering. The biological systems engineering program at K-State has prepared Seidl for exciting opportunities within mechanobiology through its diverse required coursework of fundamental mechanical engineering and applied biological engineering courses. With this experience within the Discher laboratory, Seidl is excited to pursue graduate school after graduation within biomedical engineering or bioengineering. She is also hoping to bring this valuable experience and learned skills back to the BAE department and to the bioseperations laboratory.

A PANDEMIC, SENIOR DESIGN AND TECHNOLOGY

Senior design was impacted by the global pandemic, just as every other aspect of life at K-State during the 2020-2021 academic year. While the pandemic negatives of limited class sizes, social distancing and masks made senior design different than previous years, it did make the course more relevant to the way contemporary business and industry works. In fall 2020, students learned to leverage available technology to its limits to plan their design projects, work remotely and schedule resources around COVID-19 restrictions — all relevant skills for their future careers.

During the 2020-2021 academic year BSE students completed projects related to the design of a transmission, a bioprocess, two streambank stabilization projects for the Kansas River and gully erosion control. Students were able to still go out and conduct site visits and surveys, but client and vendor conversation had to be technology based. Lab experiments and testing were still possible, but required extra care and greater planning to maintain social distances and lower lab population densities. Design team meetings, traditionally occurring at the end of a class meeting or in the hallway, had to be scheduled and took place via video conferencing. Through planning and dedication, students navigated these challenges and were still able to produce high-quality design projects.

CONTRIBUTIONS TO CAMPUS SUSTAINABILITY

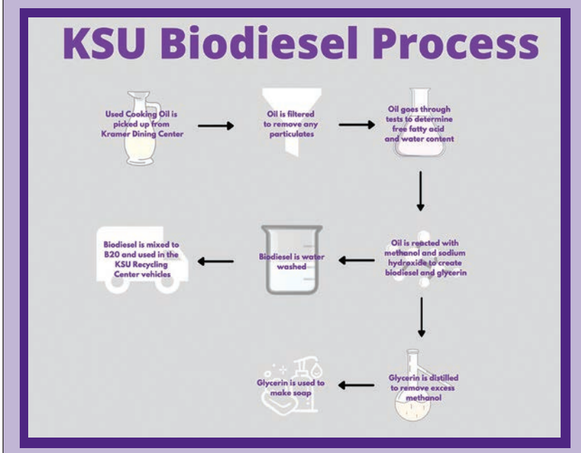
The KSU Biodiesel Initiative, or KSBI, is a student-run organization that produces biodiesel with used cooking oil from the dining centers on the K-State campus. The biodiesel is blended with conventional diesel and used to fuel the K-State Recycling Center vehicles, an important part of the university's sustainability effort.

The KSBI is a multidisciplinary team of students and advisors across the K-State campus, including the Carl R. Ice College of Engineering and the College of Agriculture. Students gain real-world experiences in all aspects of biodiesel production that translates to internships and job opportunities. KSBI members are sought out by milling companies, refineries, oil seed crush plants, biomedical research organizations, biodiesel producers and other processing industries.

Edwin Brokesh, assistant professor in BAE, is one of the initiative's primary advisors and oversees campus biodiesel production and serves biodiesel producers and consumers across Kansas through his extension activities. As new additions to the KSBI, Lisa Wilken, associate professor, and Reagan Hurla, undergraduate researcher, are working to diversify co-product opportunities by reusing and refining the KSBI waste stream. Their research involves design and testing of multiple glycerin refinery methods using physico-chemical treatments consisting of sequential saponification, acidification, phase separation and extraction. To aid their understanding of successful coproduct refining strategies, Wilken and Hurla collaborated with Loyola University, and attended the 2021 National Biodiesel Conference and Expo, and the 2021 Kansas Biodiesel Consortium's Workshop on Sustainability of the Biodiesel Industry.

Wilken and Hurla aim to produce refined glycerin suitable for bioplastic, and solid or liquid soap that can be used by campus facilities or Cats Cupboard. Their research has helped to further extend KSBI's role in the K-State sustainability effort.

The K-State Biodiesel Initiative is supported by the Kansas Soybean Commission.



TREVOR PARKE, CHEMICAL ENGINEERING STUDENT, AND MOLLY SMITH, BIOLOGICAL SYSTEMS ENGINEERING STUDENT, ARE ACCOMPANIED BY LISA WILKEN, ASSOCIATE PROFESSOR, AT THE 2020 NATIONAL BIODIESEL CONFERENCE.

BAE RESEARCH PLOT ROBOT HEADS OUT TO FIELD FOR INITIAL TESTING

Calvin Dahms, master's student in machinery systems, is putting his two research plot robots through their initial field testing. One robot is purple and will stay in Kansas to measure electromagnetic, or EM, soil readings from wheat research plots, while his sister robot, who is fashionably "safety" orange, will do the same task in Oklahoma under direction of Oklahoma State University personnel.

The two robots each carry a six-foot-long EM sensor that will take soil readings as the wheat grows to use in phenotyping research (RII: Track-2: FEC: Building Field-based Ecophysiological Genome to Phenome Prediction, a grant from the National Science Foundation for Stephen Welch, PI). The pair have several redundant systems to keep their wheels off the research wheat including a machine-learning algorithm that has been trained to recognize wheat. The orange robot suffered some damage in early June when the straps holding it down slipped off and the machine flew out of a truck at 40 mph. It was not a perfect 10.00 for landing but close since there was minimal damage.

KUBOTA DONATES USE OF SKID-STEER LOADER

Kubota has donated use of a brand new SSV65 skid-steer loader to the BAE department following a proposal by Dan Flippo for preliminary traction studies and possible enhancements on skid-steer vehicles. This adds to the already donated yearly loan of Kubota's M7 tractor the department uses for crop field trials. BAE thanks Kubota for its support of students and the department.


CALE MCCABE, SENIOR IN BAE, USES THE SKID STEER FOR HELWIG FARMS QUARTER-SCALE TRACTOR TEAM TRACK REPAIRS.


CAN DATA LOGGING BEING DONE IN PREPARATION OF SKID-STEERING TRACTION STUDIES.

RAIN BIRD ENGINEERING CONCEPT OF THE YEAR AWARD

AJAY SHARDA

DAN FLIPPO

SYLVESTER BADUA

The American Society of Agricultural and Biological Engineers has awarded its annual Rain Bird Engineering Concept of the Year award to K-State associate professors **Ajay Sharda** and **Dan Flippo**, who have led a project, which will use robotic machines to collect data that can help farmers make better decisions when planting crops, from development to filing a patent and integrating their idea into on-farm machinery. The award is sponsored by Rain Bird International.

"In farming, data is a most precious commodity," said Sharda, noting that current methods to collect research data on the effectiveness of machines to plant seeds relies heavily on manpower.

"Every year, our graduate students spend weeks in the field to measure seed depth by manually digging around emerged seeds to capture data on plant spacing," Sharda said. "This is a difficult task to complete during the summer and difficult to capture on multiple sites due to the lack of sufficient manpower. So it puts limitations on the amount of data that can be captured."

The K-State researchers have proposed automating this process by developing a prototype for seed location and sensing (SLS), which they tested in field conditions. The system they are developing incorporates a color camera, laser line scanner and a global navigation satellite systems (GNSS) unit to collect real-time data.

So far, their research has gone well, according to Sharda.

"The system provided the performance we desired and very accurate data during preliminary tests," he said. "Our SLS system thus became the first product in industry and academia to provide real-time seeding depth, spacing and geo-location information."

Their work is still early and because the patent is not yet final, Sharda can't get too far into the details. But the researchers have already built a couple of improvements to their original work, and are expecting the next version in time for the 2022 planting season.

"One of the major equipment manufacturers has leased this technology for future development … and has integrated it with a 12-row planter to help us verify the technology in field conditions," Sharda said.

K-State's work is being conducted in its recently formed laboratory — Fusing Automation and Robotics in Ag Machine Systems (FARMS) — located in the Carl R. Ice College of Engineering. Sharda credited doctoral student **Sylvester Badua**, "who did the majority of the work to develop the SLS system."

ASABE, an educational and scientific organization founded in 1907, recognizes one project with its Concept of the Year award to honor unique contributions to developing or advancing a new engineering concept. The K-State team was named this year's winner during ASABE's summer meeting.

RAHMANI AWARDED USDA GRANT

Vahid Rahmani, assistant professor in the Carl and Melinda Helwig Department of Biological and Agricultural Engineering at Kansas State University, has received a U.S. Department of Agriculture – Research Education and Economics grant to improve evapotranspiration and soil moisture information across the U.S.

Rahmani is the K-State lead on the nearly $500,000 three-year project with Steven Quiring, professor and the lead at Ohio State University. Operating under the USDA National Institute of Food and Agriculture program, the pair will partner in conducting research on "Leveraging Machine Learning to High-Resolution Soil Moisture and Evapotranspiration Data to Support Farm-Scale Decision Making."

This project addresses the critical need to enhance accuracy and utility of national evapotranspiration and soil moisture products by integrating new data sources and scaling them to farm-scale.

"We will apply state-of-the-art artificial intelligence and machine-learning techniques using a wide range of observed and remote sensing information," Rahmani said. "Our efforts will contribute to advancing algorithms used for estimating evapotranspiration and soil moisture with higher spatial and temporal resolution for the contiguous United States."

The expected end result will be an operational cloud-based software system that will generate national-scale, daily gridded products using the latest available data.

"With its broad scope, this project will contribute to the recognition of research excellence at both K-State and the Carl R. Ice College of Engineering," Rahmani said. "Undergraduate and graduate students will be trained with the latest techniques in tackling these critical engineering and agricultural issues."

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