2022 AgRESEARCH ANNUAL REPORT

A YEAR IN REVIEW

Real. Life. Solutions.™

UTAgRESEARCH
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Colleagues, Friends, and Supporters of UT AgResearch,

The year 2022 was filled with new opportunities, excitement, and commendable progress toward implementation of the AgResearch Strategic Action Plan (ASAP).

On behalf of the AgResearch administration, I am particularly proud of our work and grateful to receive $50 million in American Rescue Plan grant funds. This historic investment will bring about unprecedented equipment upgrades and innovative infrastructures to our ten mission-critical AgResearch and Education Centers across the state. The resulting research innovations, along with workforce development education—including experiential learning and a platform for technology transfer—will help safeguard food security and economic prosperity in Tennessee. These innovations provide Real. Life. Solutions. to Tennesseans and people around the world by increasing the resiliency to supply chain disruptions due to natural or man-made calamities. Planning is underway, with purchases and construction on several projects to begin in 2023.

Our faculty deserve a pat on the back for highly commendable successes in securing competitive grants. The portfolio of the funding agencies was quite diverse, including federal agencies (DARPA, NASA, NSF, NIH, and USDA-NIFA), independent non-profit organizations such as the Foundation for Food and Agriculture Research, industries, and international organizations. Particularly noteworthy are the $3 million award by the International Federation of Association Football (FIFA) to Professor John Sorochan and his turfgrass team in the Department of Plant Sciences; and the $30 million USDA award of an integrated climate-smart commodity partnership project awarded to a team of researchers, Extension professionals and external stakeholders led by Professor Pat Keyser in the UT School of Natural Resources (formerly the Department of Forestry, Wildlife and Fisheries). These highly competitive grants are strong testaments to our faculty's sought-after technical expertise. They are not only conducive to fulfilling our land-grant mission but also bring pride and prominence to the Institute, the University, and the state of Tennessee.

Equally admirable are the prestigious national and international honors and awards bestowed to our faculty. The recognitions range from being named as professional Fellows or Fulbright Scholars or receiving Lifetime Achievement and Emerging Leadership Awards, to being elected as presidents of professional societies and serving on highly selective national and international scientific advisory committees.

This year also saw considerable changes in faculty capacity, primarily from retirements, and we welcomed a number of new people to the UTIA community. To remain relevant in addressing the growing needs of our constituents, AgResearch is searching for fifteen full-time equivalent research faculty across twenty-one reimagined strategic faculty positions with joint appointments. These scholars will contribute to the University's five-year $50-million initiative to recruit top tier researchers across multiple disciplines to address some of the most pressing and complex challenges of our time, including genomics and quantitative-based solutions for food and nutrition security, climate-smart agriculture, and circular bioeconomy. Once these positions are filled, UT AgResearch will pass the 100 full-time equivalent research faculty mark for the first time across more than 150 faculty with joint appointments.

It's an exciting time for UT AgResearch, and I am pleased to present to you our 2022 Impact Report highlighting our efforts and successes.

Hongwei Xin
Dean and Director, UT AgResearch
University of Tennessee Institute of Agriculture

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This report was produced by the Office of the Dean of UT AgResearch.

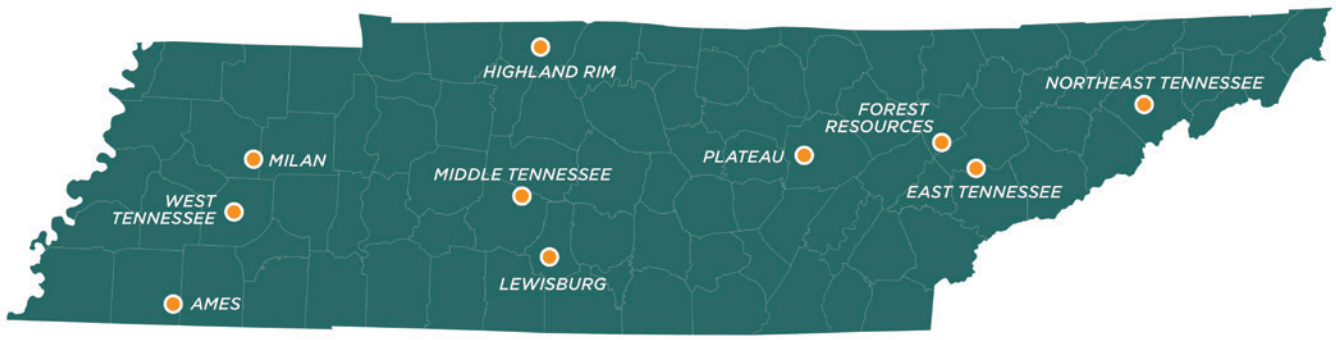
Special thanks to Kim Linton, executive assistant to the dean of UT AgResearch; Lisa Stearns, vice chancellor of marketing and communications for the UT Institute of Agriculture; Office of Marketing and Communications staff members Beth Hall Davis, Brittany Decker, Margeaux Emery, Julia Ewoldt, Patricia McDaniels, Sam Morris, Tory Salvador, and Tara Slusher; and Smith Center communications leader Mary Shelley-Snell.

Our Land-Grant Mission

Created in 1862 with the passage of the Morrill Land-Grant College Act, the nation's land-grant institutions provide excellence in teaching, research, and extension to educate the next generation of farmers, ranchers, and citizens seeking post-secondary education. Key to the land-grant system are agricultural experiment stations, which were established in 1887 by the federal Hatch Act. In Tennessee, the UT AgResearch system includes ten stations, now named UT AgResearch and Education Centers.

Each of our ten AgResearch and Education Centers serves as a unique outdoor laboratory, and together they are representative of the state's diverse agricultural and natural resource production as well as its soils, topographies, and climate. The combined 39,000-plus acres conduct approximately 1,000 field trials each year, demonstrating timely problem-solving research under real-world conditions to farmers, land managers, and allied industries through in-person or virtual field days and technical publications.

AGRESEARCH AND EDUCATION CENTERS ACROSS TENNESSEE

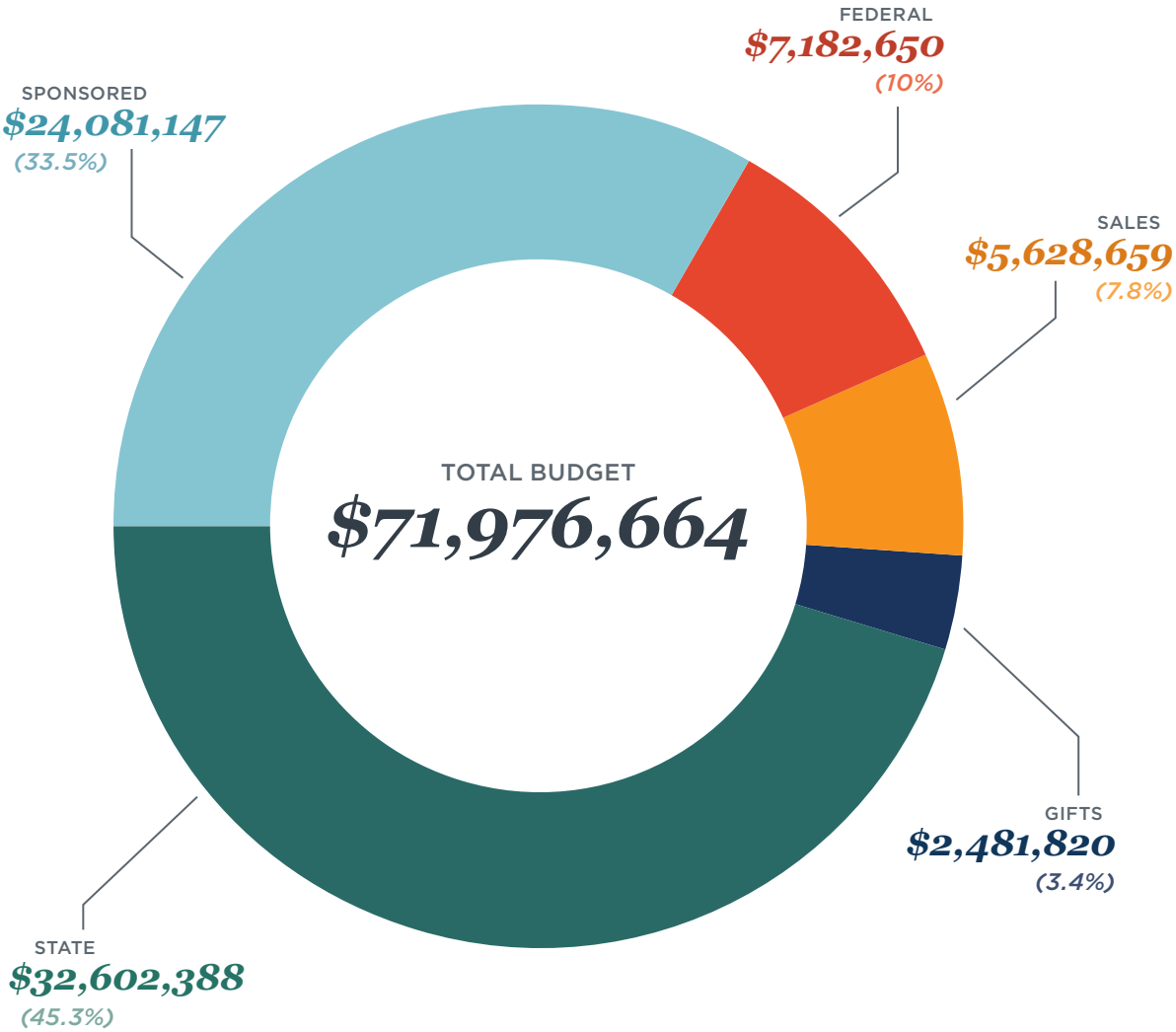


Key Facts:

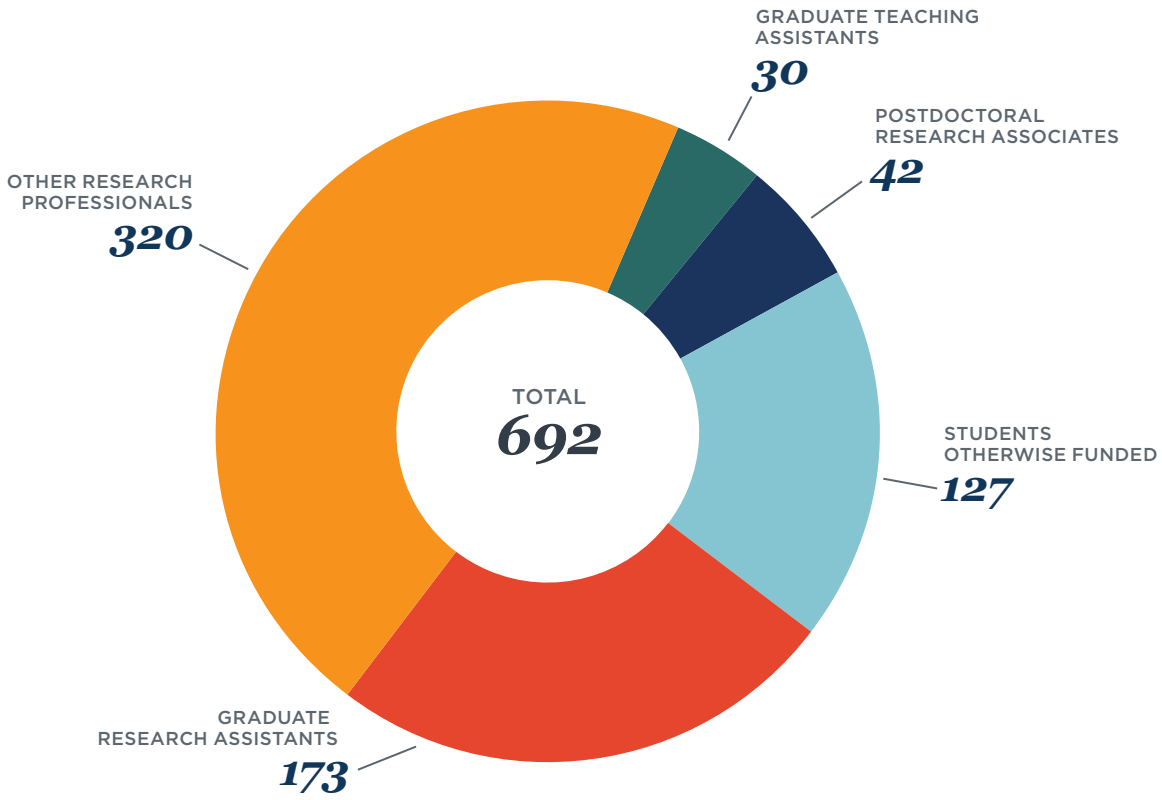
- UT AgResearch includes **132 faculty** and **692 staff** (of which approximately 330 are graduate assistants/students) across eight academic departments and ten AgResearch and Education Centers.
- Our diversified and balanced research portfolio supports Tennessee's **$81-billion economy** related to agriculture and forestry industries, which is just over one-tenth of the state's total economic output.
- Strategic research initiatives as well as partnerships address current and emerging scientific, social, and economic challenges.

Fiscal Summary

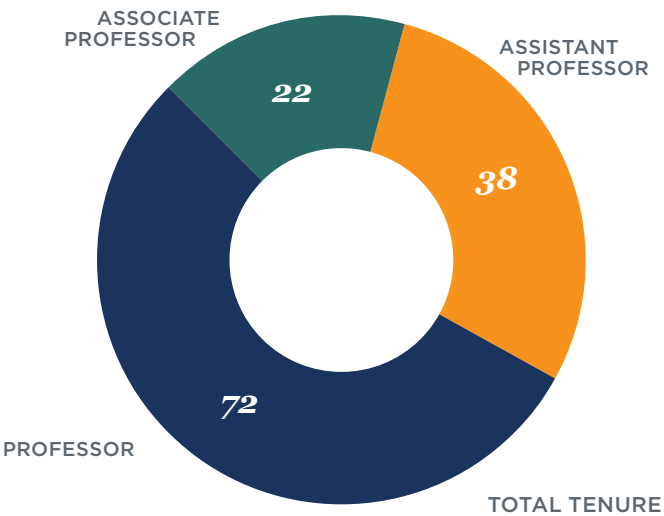
The 2022 UT AgResearch budget totaled approximately **$72 million**. This includes federal and state appropriations, publicly and privately funded research grants and sponsorships, gifts, endowments, and sales of commodities produced on the AgResearch and Education Centers. We are pleased to report that this is an **increase of 8.65 percent over the total 2021 budget of $66,249,343**, with the difference mainly attributable to a $4,518,581 increase in sponsored research. State appropriations also grew by $1,039,000 and commodity sales and gifts to the various programs and facilities each grew by well over $900,000. At $994,192, sales increased by nearly 22 percent. Gifts to UT AgResearch were valued at $935,045.



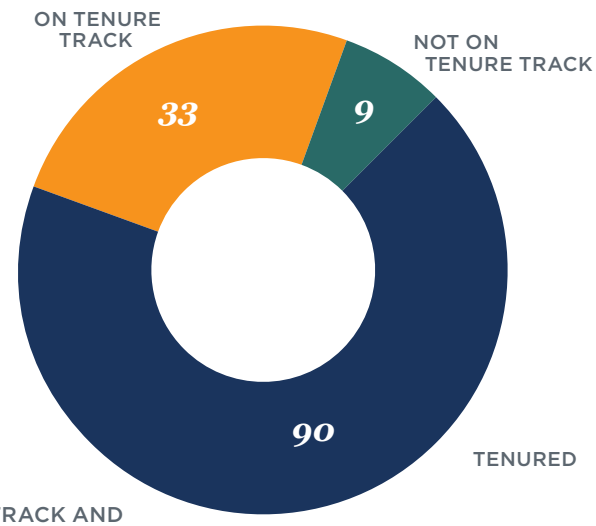
RESEARCH PROFESSIONAL STAFF



FACULTY RANK



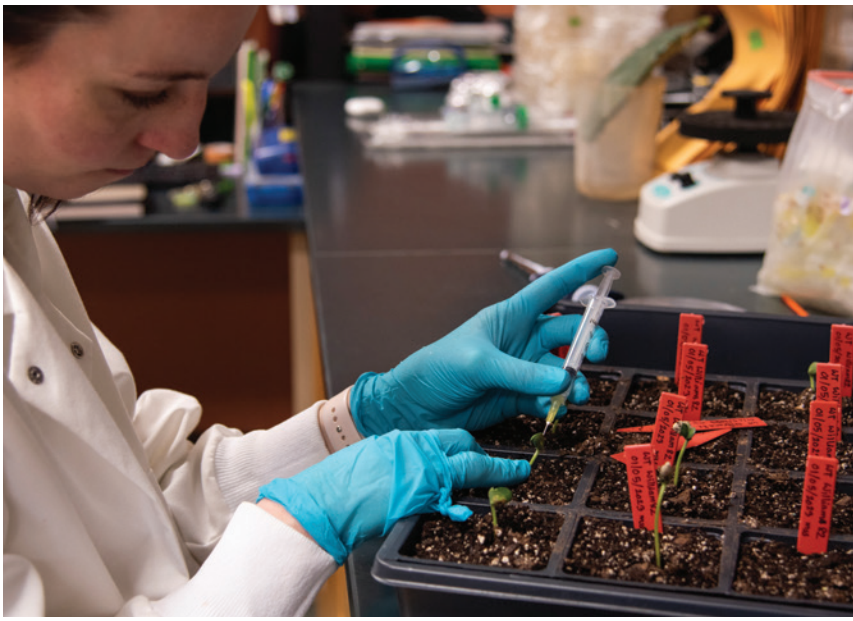
TENURE STATUS



TOTAL TENURE TRACK AND NON-TENURE TRACK FACULTY

132

Research to Benefit Everyone



REAL. LIFE. SOLUTIONS. TO TWO MAJOR AGRICULTURAL PROBLEMS

In August 2022, AgResearch plant molecular biologist Tarek Hewesi (*opposite page, above top left*) confirmed the function of two of his laboratory's recently discovered ten soybean resistance genes to confer extreme resistance against the two most virulent races of soybean cyst nematode, race 2 and 3.

The discovery of the novel genes represents a breakthrough that paves the way for development of soybean cyst nematode varieties using transgenics, genome editing, or traditional breeding. The use of the novel resistance genes individually or in combination is expected to provide a high level of protection against soybean cyst nematode for decades.

The finding is highly significant because soybean cyst nematode causes an estimated annual loss of $1.5 billion in the US alone, and all commercially available soybean varieties are currently susceptible. While many efforts have been made to optimize and improve soybean yield, significant yield losses frequently occur in almost all soybean growing regions due to cyst nematode.

The Hewezi lab and UT Research Foundation are collaborating with seed company GDM to bring new cultivars with soybean cyst nematode resistance to the market in the next few years.

Another of agriculture's most damaging pests is the southern root-knot nematode. This nematode infects more than 2,000 plant species and causes worldwide annual yield loss of more than $170 billion across vegetable, row crop, and ornamental plant industries, and no reliable genetic resistance presently exists.

To identify novel sources of genetic resistance to southern root-knot nematode, the Hewezi lab used nematode pathogenicity factors as probes to identify tomato susceptibility genes. His team identified more than 100 tomato susceptibility genes targeted by nematode pathogenicity factors. In a breakthrough, his team found that partial inactivation of some of these genes not only enhances tomato resistance to this devastating parasite but also increases plant growth and development.

Currently, the Hewezi lab is working towards producing stable genome-edited tomato lines in which these genes are inactivated. This will provide opportunities to integrate nematode resistance into susceptible elite tomato cultivars. Because of the ability of southern root-knot nematode to infect more than 2,000 plant species, the tomato susceptibility genes are more than likely conserved across plant species. Therefore, the lab foresees that homologous genes can be used to engineer resistance to this damaging soilborne pest in vegetables, row crop, and ornamental plants, making this discovery of broad importance to agriculture, both in the US and worldwide.

Students work in the field making notes on wild food gardens for S3-Cambodia.

SMITH CENTER FOR INTERNATIONAL SUSTAINABLE AGRICULTURE

Scaling Suitable, Sustainable Technologies in Cambodia

The Smith Center for International Sustainable Agriculture was launched in 2017, endowed through generous donations from Donnie (BS animal science, '80) and Terry Smith (BS elementary education, '80). The Smith Center is positioning UTIA as the go-to organization for global engagement in the agricultural-related sciences among US land-grant institutions. The center does this by cultivating greater global engagement across all faculty, staff, and students; by increasing the number of strategic global partnerships; and by communicating the importance of UTIA's global work.

Building on prior research in Cambodia, one of the programs the Smith Center leads is a USAID Feed the Future activity, bringing three sustainable intensification technologies to scale: vegetable grafting, cover/relay cropping, and wild garden production. The S3-Cambodia project is scaling these technologies to farmers in Cambodia through the private sector and school communities.

S3-Cambodia promotes the diversification and resilience of smallholder systems by introducing new sources of income and nutrition during seasonal "food gaps" across different agricultural spaces. This project has supported the establishment of six plant nursery businesses and nine school gardens. The perennial school gardens, or "food forests" are low maintenance and provide not only food and medicinal plants but also habitat that increases biodiversity at schools. The project is also establishing these gardens in health clinics and pagodas as a way to create greater impact in the community. Two of the field technicians from the National University of Battambang have completed university degrees while seeing this project through to completion.

Channaty Ngang has worked on S3-Cambodia throughout her master's degree and is now pursuing her PhD in Thailand.

EYE-TRACKING RESEARCH

New Techniques to Understand Human Behavior and Decision Making

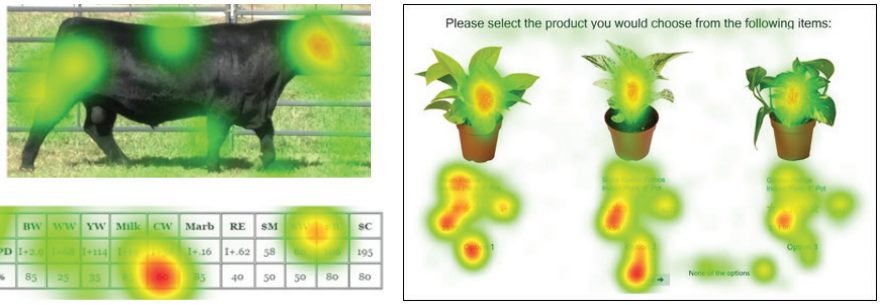
Natalie Bumgarner, associate professor in the Department of Plant Sciences, is wearing eye-tracking glasses to capture visual attention data.

While vision is a primary means of information acquisition, not everything in sight is processed equally. In 2021, the Institute's Research, Education and Marketing Lab (R.E.M. Lab) was founded to help researchers understand how what people see impacts their decision making. Founded by Alicia Rihn and Charles Martinez in the Department of Agricultural and Resource Economics and Elizabeth Eckelkamp in the Department of Animal Science, the lab aims to improve understanding of visual attention factors influencing behavior. In 2022, research efforts began in earnest. The lab uses state-of-the-art technologies, including eye-tracking glasses, to record what people view as they complete tasks (e.g., purchasing decisions, livestock selection, risk management strategies, and information search) and then connects what was viewed by participants with actions taken to direct future research, marketing, and outreach endeavors.

Three projects are currently underway. The first addresses bull selection by breeders. Investigators are trying to detect correlations between information viewed and price estimation. Results can provide key insights on breeders' use of indexes and animal imagery when deciding on bulls. In turn, this information can improve ease of use and education, information acquisition, and marketing and promotional efforts.

The second project addresses e-commerce sales of ornamental plants. While tremendous potential exists to sell plants using e-commerce, consumers' use of online information regarding plants is not well understood. In this study, participants view an online website displaying plants with different attributes and select their preferred item. Ultimately, understanding consumers' perceived risk and use of online information while making choices can be used to improve usability of online platforms when selling plants direct to consumers.

The third study addresses in-store purchasing behavior for Tennessee dairy products. Participants will wear eye-tracking glasses as they visit a farm shop selling dairy products. The results will provide insights on how people visually process the retail environment in an agritourism setting. Actionable recommendations may address improving retail displays, store layout, and the customer experience.



Heatmaps generated by eye-tracking glasses demonstrate visual attention concentration. Red indicates areas of higher concentration, followed by yellow, and green. Buyers of bulls in the Southeast appear to be more interested in facial features and hindquarters along with hundredweight.

Moving forward, the lab will be incorporating galvanic skin response and facial mapping technologies that allow researchers to measure participant emotional response to different stimuli in specific settings. Combined, these technologies will help us understand the factors that drive purchasing decisions and behaviors.

$30 MILLION PROJECT AIMS TO EMPOWER GRASSLAND FARMERS IN CLIMATE-SMART AGRICULTURE

In 2022, UTIA received a $30 million grant to help grassland farmers enter the emerging carbon economy while enhancing productivity and ecological benefits. Funded by the US Department of Agriculture, this project is one of seventy selected projects under the USDA's first pool of the Partnerships for Climate-Smart Commodities, for which $2.8 billion has been allocated.

The project focuses on a nine-state region that represents the core of grassland agriculture for the eastern US. The goal is to equip and empower grassland farmers to enter the carbon economy while enhancing operation resiliency and optimizing profitability, soil health, and biodiversity. Pat Keyser, director for the Center for Native Grasslands Management and professor in the UT School of Natural Resources (formerly the Department of Forestry, Wildlife and Fisheries), is leader of the project, which involves a large team of researchers, Extension specialists and agents, and external stakeholders.

Grasslands are the single largest agricultural land use in the US and agriculture's largest and most effective carbon-storage system. Given the extent of this agroecosystem, grasslands offer the greatest opportunity to make a strong, positive impact on agriculture across the region and foster engagement in emerging carbon markets. Even modest changes in management practices can have a tremendous impact on soil carbon, greenhouse gas emissions, and associated economic implications for producers.

The grant from USDA represents an outstanding opportunity to contribute to improved management of our state and region's grasslands, pastures, and hayfields. Just as importantly, it provides a path forward that can link family farms throughout the Mid-South to emerging agricultural carbon markets to achieve both healthier grasslands and more profitable operations.

Keyser's team has built a diverse partnership of twenty-eight entities across the eastern US to collaborate with 245 working farms. These farm partners will play a critical role in the success of the project by testing innovative grassland management strategies, providing an opportunity to validate the carbon and greenhouse gas benefits, and being the platform for aggressive outreach programs.

The team will also evaluate trade-offs for producers, the beef sector, and national agricultural policy with respect to climate-smart farming, soil health, biodiversity conservation, and a productive beef sector.

UT is the lead partner on this project. Other partners include the University of Arkansas, Alabama Cooperative Extension, University of Kentucky, University of Missouri, Clemson University, North Carolina State University, Purdue University, Tennessee State University, Virginia State University, Virginia Tech, Tyson Foods, Inc., JBS Foods, Corteva, Farm Credit Mid-America, Ecosystem Services Marketing Consortium, American Forage and Grassland Council, National Grazing Lands Coalition, National Cattlemen's Beef Association, US Roundtable for Sustainable Beef, multiple state cattle associations, American and Tennessee Farm Bureau Federations, The Nature Conservancy, American Bird Conservancy, Monarch Joint Venture, National Bobwhite Conservation Initiative, Tennessee Department of Agriculture, Missouri Department of Conservation, and Virginia Department of Conservation and Recreation.

ONE HEALTH INITIATIVE

UPDATE ON UT'S ONE HEALTH INITIATIVE

The UT One Health Initiative is a UT System-wide approach aimed at preserving and promoting human, animal, plant, and environmental health while advancing economic growth. Housed within UT AgResearch, One Health scholars participate in studies that seek to understand the myriad of factors that threaten human and animal health and the health of our environment. In the two years since its founding, the UT One Health Initiative has attracted more than $12 million in external funding, with studies of interest including climate change; emerging infectious diseases transmitted by water, food, and insects; as well as producer stress and mental health. A complete description of the initiative can be found online at **onehealth.tennessee.edu**.

Among the efforts attracting national and international attention is a $2.75 million grant awarded to investigate the movement of amphibian pathogens in wildlife trade networks. Matt Gray, a wildlife professor in the School of Natural Resources (formerly the Department of Forestry, Wildlife and Fisheries) and associate director of the UTIA Center for Wildlife Health is the principal investigator. The project is funded by the Ecology and Evolution of Infectious Diseases Program, a joint program of the National Science Foundation, National Institutes of Health, and the US Department of Agriculture. The project's two UT co-principal investigators are Neelam Poudyal, also a professor in the School of Natural Resources; and Nina Fefferman, director of the National Institute for Mathematical and Biological Synthesis and professor in Ecology and Evolutionary Biology. Fefferman is also an associate director of the UT One Health Initiative.

For the next five years, the team will determine what aspects of amphibian trade, like species composition and the number of animals, influence pathogen occurrence. With more than 2.5 million amphibians imported in the US each year for pet amphibian trade and more than 600 million live animals moving throughout more than 180 nations per year, the need for advanced pathogen mitigation is critical. This is the first study to investigate the bidirectional coupling between socioeconomic factors and pathogen dynamics across a tractable wildlife trade network. This project is focusing on amphibian pathogens but will be used as a model for other pathogens of concern. Many infectious outbreaks, like mpox, chronic wasting disease, and COVID-19, have been linked to wildlife trade. These outbreaks cost economies trillions of dollars, cripple biodiversity, and result in substantial loss of human life.

The grant recognizes the importance of our researchers' work to protect the health of humans and the natural world around us. The synergies that exist within the UT One Health Initiative and the contributing institutions are unique and incredibly important to our nation and the global society.

"Global and domestic trade of wildlife is one of the major pathways for movement and introduction of wildlife and zoonotic pathogens."

– Matt Gray, UTIA professor of wildlife studies

Gray and his colleagues also planned and presented the first ever Global Amphibian and Reptile Disease Conference. More than 250 scientists from twenty-five countries gathered to address herpetofauna diseases and their management. This inaugural conference was hosted at the University of Tennessee, Knoxville. Topics ranged from herpetofauna and One Health to mathematical modeling of amphibian and reptile diseases to the importance of diversity, equity, and inclusion in science.

LARGEST WORLD CUP EVER TO FEATURE UT AgRESEARCH EXPERTISE

With forty-eight teams expected to participate, the 2026 FIFA World Cup is slated to be the largest World Cup ever. Half of the world's population is expected to watch the tournament. Front and center will be the playing fields, known as "pitches" and John Sorochan, distinguished professor of turfgrass science and management in the Department of Plant Sciences, will be overseeing each field.

Sorochan and his team including UTIA faculty, staff, and students as well as turfgrass specialists from Sorochan's alma mater, Michigan State University, will work to identify the best turf system for each of the sixteen North American host stadiums and as many as 150 practice fields that stretch across four time zones and three climate zones. As part of the massive project, FIFA is funding all the research and overhead expenses and providing UT with an in-kind gift in the form of a 4,000-square-foot, climate-controlled building, with growth lights for turfgrass research for the 2026 World Cup and beyond. An identical facility is being constructed in East Lansing, Michigan.

All stadiums must meet FIFA's requirements for pitch specifications, and all World Cup fields must be real grass, not artificial turf. Most of the existing grass fields need renovations to meet FIFA standards. To create the very best fields with comparable playing conditions, Sorochan's team will grow test plots of grass, experiment with installation methods over different surfaces in varying conditions, and perform a myriad of experiments to ensure optimum performance and safety for the athletes.

The Center for Athletic Field Safety is known for its mission to develop the best, the safest natural grass playing fields. This effort with FIFA will provide subsequent benefits for all-natural grass playing fields for youth and professional sports.

Above Left: *A turfgrass plot is tested for angled ball bounce with ball performance captured using high-speed video.*

Above Right: *Project director John Sorochan, left, and Herbert College of Agriculture Associate Dean John Stier discuss the natural turf playing surfaces to be used in the 2026 World Cup, in sixteen stadiums throughout the US, Canada, and Mexico.*

Left: *UT turfgrass team members John Thomas, left, and Taylor Williams collect data at a sports turf research plot.*

"This is a great honor for the university and our widely recognized turfgrass program. Nothing demonstrates the world-class expertise and capabilities of our research faculty more than being asked to lead a team of this significance on the world stage."

– UT Knoxville Chancellor Donde Plowman

The team must also determine what lies under the grass. Soccer fields are built with subsurface layers for drainage and irrigation topped by gravel and a sand root zone layer.

Finally, the researchers must make sure all the World Cup fields perform comparably. The team will use technology to drop soccer balls and measure their bounce to ensure the reaction is comparable on each surface. They'll shoot balls across the test fields at the same speed and angle to ensure they bounce and roll consistently and travel the same distance.

More than ten years ago Sorochan and colleague Jim Brosnan were key to the partnership that formed the Center for Athletic Field Safety (CAFS) at the Plant Sciences Unit of UTIA's East Tennessee AgResearch and Education Center. Natural grass-playing surfaces are compared to synthetic surfaces to improve athletic performance, reduce injuries, and develop longer-wearing fields at the center.

NEW STUDY TO CONTRIBUTE TO GROWING AN ORGANIC FOOD INDUSTRY

Consumer interest and awareness of issues related to human health, animal welfare, and environmental protection are on the rise, and organic dairy and meat production lead the list of the fastest-growing organic industries in the United States. However, this sector is still the smallest contributor of total organic sales.

In the Southeast, tall fescue grass is the predominant cattle feed. While this cool-season grass grows well in the fall and spring, production and quality diminish during the summer. A new study led by UT AgResearch will focus on integrating warm-season grasses organically in the tall fescue systems and studying the agronomic and ecological implications of such organic forage systems.

“Native warm-season grasses outperform other grass species in soil organic matter accumulation, nutrient-use efficiency, climate resiliency, and many other ways,” says Sindhu Jagadamma, associate professor of soil science in the Department of Biosystems Engineering and Soil Science and lead investigator for the project. “So, achieving these ancillary benefits in addition to providing high-quality organic animal feed is a winning strategy for producers.”

With a four-year, $750,000 grant from the USDA National Institute of Food and Agriculture (NIFA), Jagadamma and a team of scientists and Extension specialists will perform on-station and on-farm trials in Tennessee and Arkansas to study organic forage yield and nutritive value, weed suppression, soil health, and economic benefits, then work with UT and University of Arkansas Extension to inform producers of their findings. The team includes Patrick Keyser, School of Natural Resources (formerly the Department of Forestry, Wildlife and Fisheries); Saha Debasish, Department of Biosystems Engineering and Soil Science; and Andrew Griffith, Department of Agricultural and Resource Economics. In addition, Song Cui from Middle Tennessee State University, Dirk Philipp from the University of Arkansas, and Christine Nieman from USDA Agricultural Research Service are also working on this project.

PRECISION LIVESTOCK FARMING
The Future of Animal Production

UT AgResearch continues to invest in precision livestock farming so Tennessee and US producers can remain profitable and competitive in the global market. Significant improvements in the production efficiency of all livestock sectors is needed to meet the anticipated growth in demand for animal proteins worldwide over the next thirty years. Precision livestock farming techniques involve improving an individual animal's health and well-being through real-time monitoring of the animal's condition. Behavior as well as biological and physiological changes are monitored, and environmental conditions are measured on an individual animal basis, providing data that allows producers to make better animal, herd, or flock management decisions based upon quantifiable, objective measures. Timely decisions can result in higher process efficiency along with improved animal health and welfare. Human working conditions should improve, too, as will the environmental impact of individual and regional agricultural operations. While many of the faculty involved in the effort are members of the Departments of Biosystems Engineering and Soil Science and Animal Science, more than two dozen researchers and staff across multiple departments are engaged in the work.

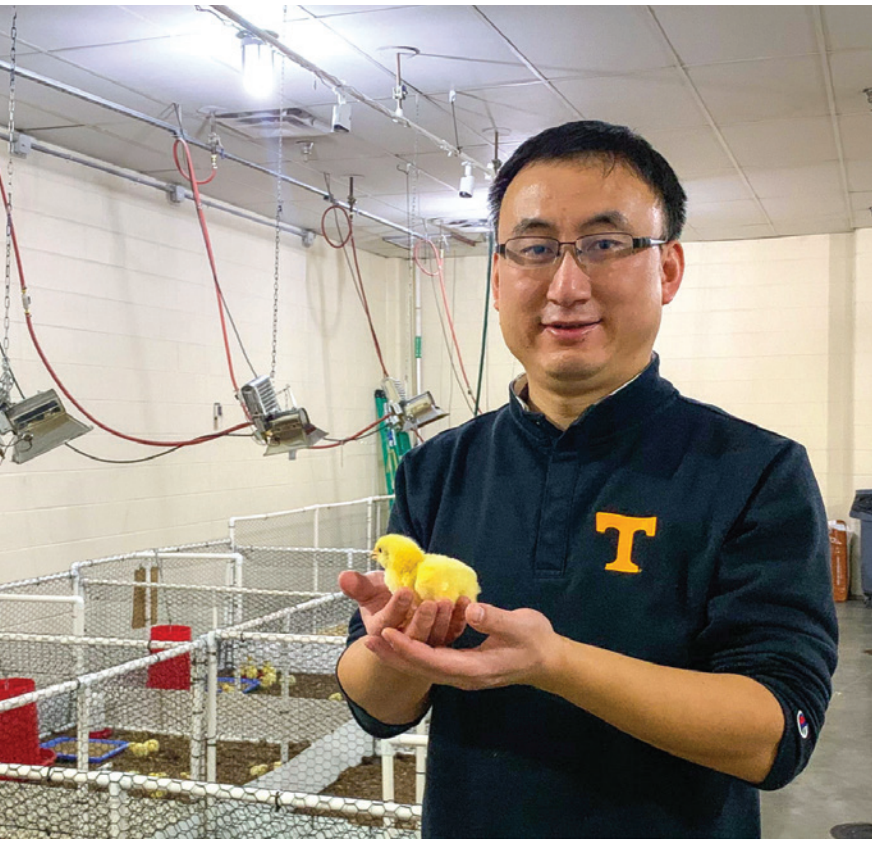
In 2022 AgResearch updated and realigned the capabilities at two of its ten AgResearch and Education Centers to better accommodate research efforts. The Little River Animal and Environment Unit of the East Tennessee AgResearch and Education Center near Knoxville started installing milking robots in late fall for monitoring its dairy herd, and the Middle Tennessee AgResearch and Education Center at Spring Hill worked to refocus its facilities to support precision beef research. Middle Tennessee also initiated planning for the construction of four state-of-the-art commercial sized poultry production houses and a laboratory to better serve the state and region's growing interest in poultry production.

DEVELOPING COST-EFFECTIVE METHODS TO COLLECT CATTLE PHENOTYPES

What would be the value of knowing the characteristics of a particular cow or bull just by looking at one of its cells? A lot, if you're a cattle breeder or buyer. UTIA's research team of Troy Rowan, Jon Beever, and Kurt Lamour has been awarded a grant from the Agricultural Genome to Phenome Initiative (AG2PI) to advance research in developing cost-effective methods for collecting molecular phenotypes in cattle.

The project is one of eleven seed grants awarded by AG2PI to twenty institutions across the country in the second of three rounds of grant competition. Awarded grants help to address genome-to-phenome issues and develop solutions for research needs and identify gaps as well as sharing opportunities. Work began in early 2022.

AG2PI is a three-year project funded by the US Department of Agriculture's National Institute of Food and Agriculture. The goal of AG2PI is to connect crop and livestock scientists to each other and to those working in data science, statistics, engineering, and social sciences to identify shared problems and collaborate on solutions. The UTIA research team, which includes researchers from the Departments of Animal Science and Plant Sciences, will explore the use of computationally identified genes in beef stocker calves to identify latent phenotypes and to predict future calf performance and health outcomes. Although the focus is on cattle, the team hopes the technology could be applied across species and in genome to phenome applications.



PRECISION LIVESTOCK BROILER WELL-BEING

A research team from the Department of Animal Science was awarded $1 million to create and implement a computer vision system to monitor poultry production. The grant was funded by the Agriculture and Food Research Initiative, a competitive grants program of the USDA National Institute of Food and Agriculture.

Precision livestock farming systems have been implemented on larger animals for some time to monitor things like activity, agitation, and other indications of animal stress and welfare. However, researchers say it has been more difficult to monitor poultry, since they are much smaller and their populations are higher in production systems. This project involves creating a computer vision system to track animal-based measures (ABMs) for poultry in real time.

Yang Zhao is the lead investigator on the project. He says the program will track welfare-related comfort behaviors like stretching, preening, and dustbathing as well as production-related behaviors like eating and drinking using lightweight deep learning and algorithms to identify individual birds. The researchers will then develop a benchmark database with detailed notes on the birds' behaviors. At an estimated cost of $2,500 per house, the computer vision system is both practical and affordable for broiler growers. The artificial intelligence and video image analysis will allow researchers to examine the interactions of the poultry's animal-based measures with management factors and collect baseline data.

Zhao said, "Despite strong interest in precision livestock farming for poultry farming across the world, few systems have been developed for the commercial production environments. This project provides us timely supports to develop an affordable system that may assist broiler growers to automatically collect bird behavioral responses and better manage the flocks at commercial farms. With collaborations among researchers, Extension specialists, and industry allies, this work will further enhance the impact of the UT Precision Livestock Farming program in Tennessee, the United States, and the world."

Zhao and his team expect to demonstrate the system in 2025.

Researchers from UTIA include Yang Zhao and Maria Prado, also of the Department of Animal Science, as well as Robert Burns, Hao Gan, Shawn Hawkins, and Daniel Berckmans, of the Department of Biosystems Engineering and Soil Science. Hairong Qi, from the UT Department of Electrical Engineering and Computer Science, is also assisting on the project.

Image courtesy NASA

ADVANCING A BIOECONOMY ON EARTH AND SUSTAINABILITY BEYOND OUR PLANET

For more than a decade the UT Center for Renewable Carbon has been working to create and disseminate the science and new technologies that enable the sustainable use of carbon from biomass for materials, chemicals, fuels, and energy. This includes identifying sustainable source feedstock, supply chain logistics, and the structure and chemistry of manufacturing inputs, as well as valuable uses for manufacturing products and co-products. Collaborating with colleagues across the region and nation, including scientists at the Oak Ridge National Laboratory and the National Renewable Energy Laboratory, as well as industry, the center's faculty are also training future scientists required for advanced industries to develop a sustainable and economically viable bioeconomy. Finally, they advise community stakeholders and industry leaders who are building the new bioeconomy.

Novel or underutilized winter oilseed crops such as pennycress (shown above left), camelina, carinata, and flax hold the potential to meet increased demand for foods as well as to be marketed as feedstock for biofuel production. In 2022 Edward Yu, a professor in the Department of Agricultural and Resource Economics, worked to understand whether any one of these regional cover crops is a good agronomic fit as a winter crop in a corn/soybean rotation and also as biofuel feedstock. As a co-leader of the Tennessee team for the feedstock supply chain analysis under the Aviation Sustainability Center, Yu worked on economic analysis of potential oilseed species and helped prepare budgets for pennycress, camelina, and canola. He also instructed a mathematical programming model in a graduate level course and applied it to identify the potential values of biofuel coproducts in feed ration.

While the Center for Renewable Carbon is working to advance our earthly economy, UT AgResearch is literally reaching to advance human sustainability beyond our world. Kellie Walters, an assistant professor in the Department of Plant Sciences, is one of ten researchers nationally to be funded by the National Aeronautics and Space Administration (NASA) as part of its Space Biology TIDES (Thrive In DEep Space) initiative. TIDES is working to determine the effects of deep-space stressors like radiation and reduced gravity on multiple organisms. This work will support animal research that will enhance our understanding of human responses to the deep-space environment and plant research that will enable human exploration either through the production of micronutrients and food during deep-space missions or the establishment of bioregenerative life support systems. As one of ten investigators from eight institutions in seven states receiving 2022 grants, Walters' work is focused on helping humans thrive in deep-space environments. The TIDES initiative is expected to enable long-duration missions and improve life on Earth through innovative research.

FIELD DAYS

Beef and Forage Field Day

The Middle Tennessee AgResearch and Education Center at Spring Hill held its first Beef and Forage Field Day in 2022. The purpose of the event was to highlight precision livestock farming technology studied at the center. The event consisted of four different sessions on beef and forage and multiple displays for precision livestock equipment to be utilized in future research. Overall, 275 people attended the inaugural event.

Butterfly Festival

The UT Arboretum Society and the UT Forest AgResearch and Education Center staff hosted the seventh annual UT Arboretum Butterfly Festival on Saturday, September 17, at the center in Oak Ridge. The mission and purpose of the event is to provide educational opportunities for the public and to learn how to protect pollinators. The UT Insect Zoo, two butterfly tents, educational lectures, and children's art activities were featured during the 3-hour event. Over 300 live Painted Lady butterflies were released as part of educational outreach activities. It was a team effort to host over 1,500 attendees, with help and support provided by volunteers, Tennessee Extension Master Gardeners, and staff and students from areas throughout the UT Institute of Agriculture, including the Department of Entomology and Plant Pathology, UT Extension, UT AgResearch, and the East Tennessee AgResearch and Education Center.

Milan

Held in person for the first time since 2018, the AgResearch and Education Center at Milan's thirty-second biennial Milan No-Till Field Day took place July 28, 2022. Fifty researchers and Extension agents presented at more than sixty sessions throughout the day, and the event welcomed more than 1200 visitors from fourteen different states.

Tennessee Governor Bill Lee addresses guests at the 2022 Milan No-Till Field Day.

The Milan No-Till Field Day originally began in 1981 as a way to teach local producers the benefits of no-till farming versus traditional tillage. Tours through fields at the research center focused on planter set up, weed control, and cover crops.

Now, the field day has turned into the largest in the nation devoted to conservation tillage. As no-till farming is now the most prominent type of row crop farming in Tennessee, tours focus on the latest technologies and research in the industry and how those new technologies, such as precision and climate-smart agriculture, can be integrated into a no-till system.

"We have some of the best experts in the country that can talk about picking out the best hostas, picking out the best varieties, and cultivars of plants that are going to do well in Tennessee, do well in your yard, pick out the best grasses and how to manage them."

–Scott Stewart, director, West Tennessee AgResearch and Education Center

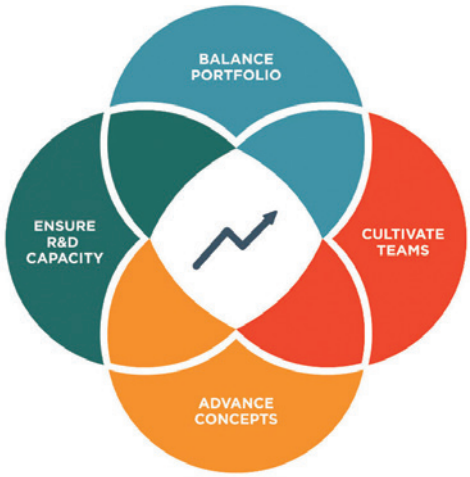
Summer Celebration

Summer Celebration at the West Tennessee AgResearch and Education Center was welcomed back in 2022, in person for the first time since 2019. The theme was The Power of Plants to recognize the therapeutic nature of gardening. More than 1,000 people from across the state attended the event, held at the UT Gardens, Jackson.

Investing in People and Research Capacity

Investing in People and Enhancing Research Capacity

Implementation of the AgResearch Strategic Action Plan continued in 2022. As such, UT AgResearch is continually investing in the future of the state, nation and world through specific and dedicated efforts to support the agricultural and natural resource research of our faculty and their students. Among our most important investments in 2022 are:



- Continued construction on the new Energy and Environmental Science Research Building on the UT Institute of Agriculture campus in Knoxville. This new building, which replaces the former Ellington Plant Science Building, will include 157,000 square feet over four stories. This facility will house teaching laboratories, research and public service labs, offices, and new classrooms for faculty in multiple departments, including the Department of Entomology and Plant Pathology, the Department of Plant Sciences, the newly formed School of Natural Resources (formerly the Department of Forestry, Wildlife and Fisheries) and the Smith Center for International Sustainable Agriculture.
- The installation of two new milking robot systems under the same roof at the East Tennessee AgResearch and Education Center Little River Unit. The robot systems are functioning alongside the traditional dairy production system. This unique arrangement will allow researchers to conduct side-by-side comparisons of milking robots versus conventional systems to answer a number of production-related questions. Use of milking robots has become trendy among dairy producers, but there are a lot of questions to be answered. The systems will also provide comparative educational opportunities as the newly renovated facility has an observational hall. Associated infrastructure to support the robots, i.e. a feed storage and delivery system, have also been installed.
- With the $50 million American Rescue Plan grant funding, plans are under development to invest in a variety of vital infrastructure projects and modern equipment for row crop, livestock and poultry, controlled-environment agriculture, and forestry research and innovation. Included among the plans is a next-generation, commercial-sized broiler research facility at the Middle Tennessee AgResearch and Education Center.
- Upgrades to the Center for Athletic Field Safety at the East Tennessee AgResearch and Education Center have begun as a result of the high-profile and high-impact FIFA award.
- To address the changing needs of our constituents, AgResearch began searching for fifteen full-time equivalent research faculty across twenty-one reimagined strategic positions. These scholars will contribute to the University's five-year $50-million initiative to address complex challenges including genomics/synthetic biology, climate-smart agriculture and forestry, data science, food and nutrition security, and circular bioeconomy.

Implementation of the AgResearch Strategic Action Plan continued in 2022. The plan includes a commitment to support new faculty initiatives by funding instrumentation needed to conduct cutting-edge research. A list of grants awarded in 2022 is included in this report.

AMERICAN RESCUE PLAN (ARP) FUNDING

UT AgResearch has been fortunate to receive $50 million from the American Rescue Plan. These funds are being applied to modernize and improve infrastructure and agricultural research equipment at ten AgResearch and Education Centers throughout Tennessee. The improvements are necessary for supporting AgResearch stakeholders, strengthening communities, reviving the American economy, and overall improving the quality of life for the citizens of Tennessee and beyond. We are conscientiously, respectfully, and intentionally planning the use of the funds to facilitate research through infrastructure improvements and updated equipment to produce current, relevant, and innovative research. We are driven to pursue research that brings Real. Life. Solutions. to worldwide challenges such as food security for our growing population, food and fiber availability in a shrinking agriculture footprint, animal production, well-being and security, labor shortages in agriculture, and mitigating changing climatic conditions.

RESEARCH INSTRUMENTATION GRANTS PROGRAM

The Research Instrumentation Grants Program (RIGs) is intended to support UTIA faculty through targeted investment in research instrumentation necessary for pursuit of successful competitive extramural proposals. This year AgResearch invested a total of $235,565 across nine faculty proposals. Since 2020, more than $1.87 million have been distributed in support of equipment for AgResearch faculty and staff.

- **Jennifer DeBruyn** (Department of Biosystems Engineering and Soil Science), Debasish Saha, Sindhu Jagadamma, Mark Radosevich, Joe Zhuang, Sean Schaeffer. Improving departmental cold storage capacity to protect sensitive research samples.
- **Matthew Gray** (School of Natural Resources, formerly the Department of Forestry, Wildlife and Fisheries), Debra Miller, Mark Wilber, Shige Eda. Expanding One Health Research Capacity in UTIA.
- **Mi Li** (Center for Renewable Carbon; School of Natural Resources, formerly the Department of Forestry, Wildlife and Fisheries), Niki Labbe, Nourredine Abdoulmoumine, Wei Wang. Acquiring Haze Measuring System for AgResearch.
- **Tao Wu** (Department of Food Science), Qixin Zhong, Vermont Dia. Acquisition of a Planetary Ball Mill to Support Research on Food Material Science.
- **Charles Martinez** (Department of Agricultural and Resource Economics), Alicia Rihn. Galvanic Skin Response Sensor to Identify Stressors in Behavioral Economics.
- **Kellie Walters** (Department of Plant Sciences). Support for a freeze dryer to maintain and improve research capacity for compound quantification.
- **Daniel Mathew** (Department of Animal Science), Lannett Edwards, Sarah Moorey, Kyle McLean, Lew Strickland. Acquisition of the MIRI TL6 for Advancement of Oocyte and Embryo Health.
- **David Harper** (Center for Renewable Carbon; School of Natural Resources, formerly the Department of Forestry, Wildlife and Fisheries). Purchase of a Power-compensated HyperDSC.
- **Tong Wang** (Department of Food Science), Vermont Dia. Cryo-system to aid the identification antifreezing agent.

Noteworthy Achievements

Noteworthy Achievements

PLANT SCIENTIST NAMED AAAS FELLOW

Carl Sams, 2020 Institute Professor within UTIA, was named among the 2021 Class of Fellows in American Association for the Advancement of Science. The newly elected Fellows were announced January 26, 2022, prior to the AAAS annual meeting. AAAS Fellows are recognized as among the most distinguished scientists, engineers and innovators across America and the world. Sams has been recognized for distinguished contributions to horticulture and plant physiology.

Sams has been with UTIA thirty-seven years and is the Austin Distinguished Professor in the Department of Plant Sciences. He has previously earned the recognition as a Fellow with the American Society of Horticultural Sciences. His research focuses on disease resistance in plants, hydroponics and mineral nutrition. His work also includes grafting plant varieties, as well as environmental factors important to human nutrition, pest resistance and greenhouse production.

Among his recent work, Sams is among the campus leaders in a project known as the "Fresh Electric Farm," where kale is grown under LED lights for increased nutritional value. Sams also researches the use of botanical oils as pesticides and growth regulators, work that has become a commercial success. He has also been honored with the UT AgResearch Impact Award.

"I tell my students our goal is to help farmers feed and clothe our grandchildren while preserving natural resources for our great grandchildren and beyond."

– Carl Sams

FOOD SCIENTIST NAMED UTIA'S 2022 INSTITUTE PROFESSOR

Tong Wang, a professor in the Department of Food Science, was named as the 2022 Charles E. Wharton Institute Professor, UTIA's greatest honor. In 2021, along with Vermont Dia, Wang was awarded a $550,000 grant from the National Science Foundation (NSF) to understand ice recrystallization and to study the mechanisms on how to restrict the growth of ice crystals. NSF awards are not common among food scientists. When explaining the work in an article for The Conversation, Wang wrote that ice recrystallization, commonly called "freezer burn," damages and destroys organic cells–the smallest living units found in animals and plants. "It is just as much a problem when storing harvested food crops or biomedical research materials–like cell cultures–as it is for storing frozen pizza or peas and can lead to a lot of waste." Among her other accolades, Wang was named as the recipient of the 2020 Alton E. Bailey Award presented by the American Oil Chemists' Society (AOCS). In 2016 she was named an AOCS Fellow and was recognized with the AOCS' Timothy L. Mounts Award in 2013. Throughout her career Wang has received numerous industry and federal research grants that support her creative work and has trained thirty-six graduate students and twenty post doctoral appointees and visiting scientists.

INTERNAL FACULTY AND STAFF AWARDS

The University of Tennessee Institute of Agriculture recognized some of its top faculty, staff, researchers, and Extension experts at UTIA's annual awards and promotions luncheon on the UTIA campus in Knoxville August 16, 2022. The awards honor the extraordinary performance and dedication of UTIA employees. Many of the awards are gifts made possible by faculty, alumni, and friends of the Institute.

The Office of the UTIA Senior Vice Chancellor and Senior Vice President hosted the award winners. **Tong Wang,** professor in the Department of Food Science, was awarded the Charles E. Wharton Institute Professor Award. The award is UTIA's highest honor.

Other winners from UT AgResearch include:

AGRESEARCH DEAN'S AWARD FOR OUTSTANDING SUPPORT STAFF

Cassie Halvorsen, Department of Plant Sciences

AGRESEARCH DEAN'S AWARD FOR OUTSTANDING PROFESSIONAL STAFF

Kathy M. Dalton, Coordinator III, Office of Sponsored Programs

J. Mark Young, IT Specialist III, Information Technology Services

Jason Williams, UT AgResearch and Education Center at Milan

AGRESEARCH IMPACT AWARD

Qixin Zhong, Department of Food Science

AGRESEARCH MID-CAREER FACULTY RESEARCH EXCELLENCE AWARD

Chris Boyer, Department of Agricultural and Resource Economics

CAVENDER AWARD FOR BEST PUBLICATION (TWO AWARDS)

Alicia Rihn, Kimberly Jensen and **David Hughes,** UTIA Department of Agricultural and Resource Economics for *Tennessee's Wine Industry: Consumer Perceptions, Quality Assurance Programs, and Marketing Strategies W 1063*

Rebecca Butler, Jennifer Chandler, Rebecca Trout Fryxell and Karen Vail, UTIA Department of Entomology and Plant Pathology for *Managing Ticks on School Grounds PB 1895*

WILLIAMS – "PROF" LIDVALL OUTSTANDING TEACHING AWARD

Cheryl Kojima, Department of Animal Science

WILLIAM T. MILES AWARD FOR COMMUNITY SERVICE

Michael Ross, Department of Plant Sciences

J.E. MOSS ACHIEVEMENT AWARD

John Sorochan, Department of Plant Sciences

WEBSTER PENDERGRASS AWARD

David Lockwood, Department of Plant Sciences

B. RAY THOMPSON AWARD

Emma Willcox, School of Natural Resources

T.J. WHATLEY DISTINGUISHED YOUNG SCIENTIST AWARD

Hao Gan, Department of Biosystems Engineering and Soil Science

INTERNAL FACULTY AND STAFF AWARDS (continued)

PROMOTION TO ASSOCIATE PROFESSOR WITH TENURE

Nourredine H. Abdoulmoumine
Department of Biosystems Engineering and Soil Science

Denita Hadziabdic-Guerry
Department of Entomology and Plant Pathology

Sindhu Jagadamma
Department of Biosystems Engineering and Soil Science

John P. Munafo
Department of Food Science

Carlos J. Trejo-Pech
Department of Agricultural and Resource Economics

Jennifer K. Richards
Department of Agricultural Leadership, Education and Communications

Avat Shekoofa
Department of Plant Sciences

PROMOTION TO PROFESSOR

Chris N. Boyer
Department of Agricultural and Resource Economics

Brad P. Collett
Department of Plant Sciences

Jennifer M. DeBruyn
Department of Biosystems Engineering and Soil Science

Shawn A. Hawkins
Department of Biosystems Engineering and Soil Science

Tarek A. Hewezi
Department of Plant Sciences

Brandon J. Horvath
Department of Plant Sciences

Heather M. Kelly
Department of Entomology and Plant Pathology

Jaehoon Lee
Department of Biosystems Engineering and Soil Science

J. Kevin Moulton
Department of Entomology and Plant Pathology

Neelam C. Poudyal
School of Natural Resources (formerly the Department of Forestry, Wildlife and Fisheries)

ADDITIONAL AGRESEARCH AWARDS

Jennifer Burns of the Plateau AgResearch and Education Center, **Christy King** of the East Tennessee AgResearch and Education Center, and **LesLee Smelser** of the Milan AgResearch and Education Center, each received a 2021 Director's Award for Support Service.

Jason Williams of the Milan AgResearch and Education Center was presented the 2021 Director's Award for Outstanding Professional Service. Williams has served the Center as a research associate for 25 years and plays an integral role in its success.

A LEGACY OF SERVICE

After serving for twelve years as director of the East Tennessee AgResearch and Education Center, ***Bobby Simpson*** *retired in July of 2022 leaving an extraordinary record of twenty-eight years of service. Prior to serving as director, Simpson was associate director from 1995 to 2010, assisting in the management of the center's resources to maximize research output and assist faculty. He also helped plan and conduct educational events, including field days, worked with animal care and use guidelines, and managed staff training and development. His passion included working with students to give them hands-on, on-farm experience.*

Simpson was a devoted resource and supporter of UT AgResearch but also served for three years early in his career on the research and Extension faculty at the Southwest Research and Extension Center for the University of Arkansas and as a postdoctoral fellow for the USDA Agricultural Research Service at the Subtropical Agricultural Research Station in Brooksville, Florida. For those appointments he studied beef cattle management, particularly nutrition and reproduction. From 1981-1986, he also served as an associate Extension agent with North Carolina Cooperative Extension Service. Simpson is a lifelong Volunteer, having earned his BS and MS from UT and his PhD from North Carolina State.

NATIONAL AND INTERNATIONAL AWARDS AND ACCOMPLISHMENTS

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

Chris Boyer received the Distinguished Professional Contribution Award from the Southern Agricultural Economics Association (SAEA). The award is given to individuals who have demonstrated significant service to the association.

James Larson received the Lifetime Achievement Award from the Southern Agricultural Economics Association. The award recognizes Larson's significant and enduring contributions to the agricultural economics profession.

Andrew Muhammad was awarded the 2022 Patrick J. Byrne Emerging Leadership Award by the Food Distribution Research Society (FDRS); Muhammad has also been tapped by the Board for International Food and Agricultural Development to serve on its Subcommittee on Systemic Solutions for Climate Change Adaptation and Mitigation in Agricultural, Nutrition and Food Systems.

Andrew Muhammad and former graduate student Emily Greear received the 2021 Best Article Award by the *Agricultural and Resource Economics Review*. They were recognized at the 2022 Northeastern Agricultural and Resource Economics Association's annual meeting.

Alicia Rihn received the Forty Under 40 Award by Greenhouse Product News for 2022. The award recognizes remarkable young talent in the horticultural industry.

Margarita Velandia, professor and interim head of the Department of Agricultural and Resource Economics, is the newly appointed president of the Food Distribution Research Society (FDRS).

DEPARTMENT OF ANIMAL SCIENCE AND UTIA GENOMICS CENTER FOR THE ADVANCEMENT OF AGRICULTURE

Troy Rowan wrote an invited review, "Genetic decision tools for increasing cow efficiency and sustainability in forage-based beef systems," that appeared in *Applied Animal Science* (December 2022) and was selected as an Editor's Choice paper.

DEPARTMENT OF ENTOMOLOGY AND PLANT PATHOLOGY

Bonnie Ownley was selected as a 2022 American Phytopathological Society Fellow. The award recognizes Ownley's many contributions and accomplishments in plant pathology, soil systems, biological disease control, and professional service.

SCHOOL OF NATURAL RESOURCES

Neelam Poudyal received a Fulbright Scholar Award for 2022-2023. Poudyal visited the Institute of Forestry, Pokhara Campus of Tribhuvan University in Nepal to conduct research on sustaining human-wildlife coexistence in the fringe areas of Nepal's national parks.

Adam Taylor received a Fulbright-Saastamoinen Foundation Grant in Health and Environmental Sciences. Taylor will spend much of 2023 at the University of Eastern Finland European Forest Institute in Joensuu researching the carbon connections between forests and forest products and climate change.

DEPARTMENT OF PLANT SCIENCES

Carl Sams was elected as a member of the 2021 class of American Association for the Advancement of Science (AAAS) Fellows, one of the highest honors in science. Sams has been recognized for distinguished contributions to horticulture and plant physiology.

Derrick Stowell, administrator for the University of Tennessee Gardens' Education and Horticultural Therapy Program, is the recipient of the 2022 American Horticultural Society's Horticultural Therapy Award.

UT AGRESEARCH ADMINISTRATION

Hongwei Xin, AgResearch dean and director, was awarded the Kishida International Award at the American Society of Agricultural and Biological Engineers (ASABE) 2022 Annual International Annual Meeting. The award recognizes outstanding contributions to food and fiber production, improved living, and education of people outside the United States.

BONNIE OWNLEY

2022 New Faculty and Leadership Hires

Perceval Noel Assogba

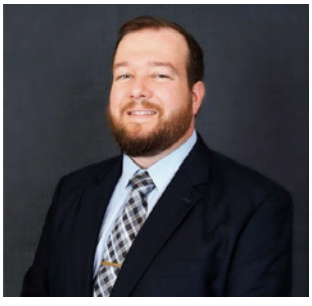
- Assistant Professor
- School of Natural Resources
- 65 percent research/35 percent teaching
- Forest economics and management

Matt Backus

- Assistant Director
- Ames AgResearch and Education Center
- 100 percent administration

Adrienne Blalack

- Assistant Director of Proposals
- UTIA Office of Sponsored Programs
- 100 percent administration



Tyler Granberry

- Assistant Professor
- Department of Agricultural Leadership, Education and Communications
- 30 percent research/70 percent teaching
- Agricultural education

Taylor Owens

- Assistant Budget Director
- 100 percent administration

Ethan Parker

- Research Center Director
- East Tennessee AgResearch and Education Center
- 100 percent administration

Tom Tabler

- Professor
- Department of Animal Science
- 30 percent research/70 percent Extension
- Poultry specialist and research

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