Seek

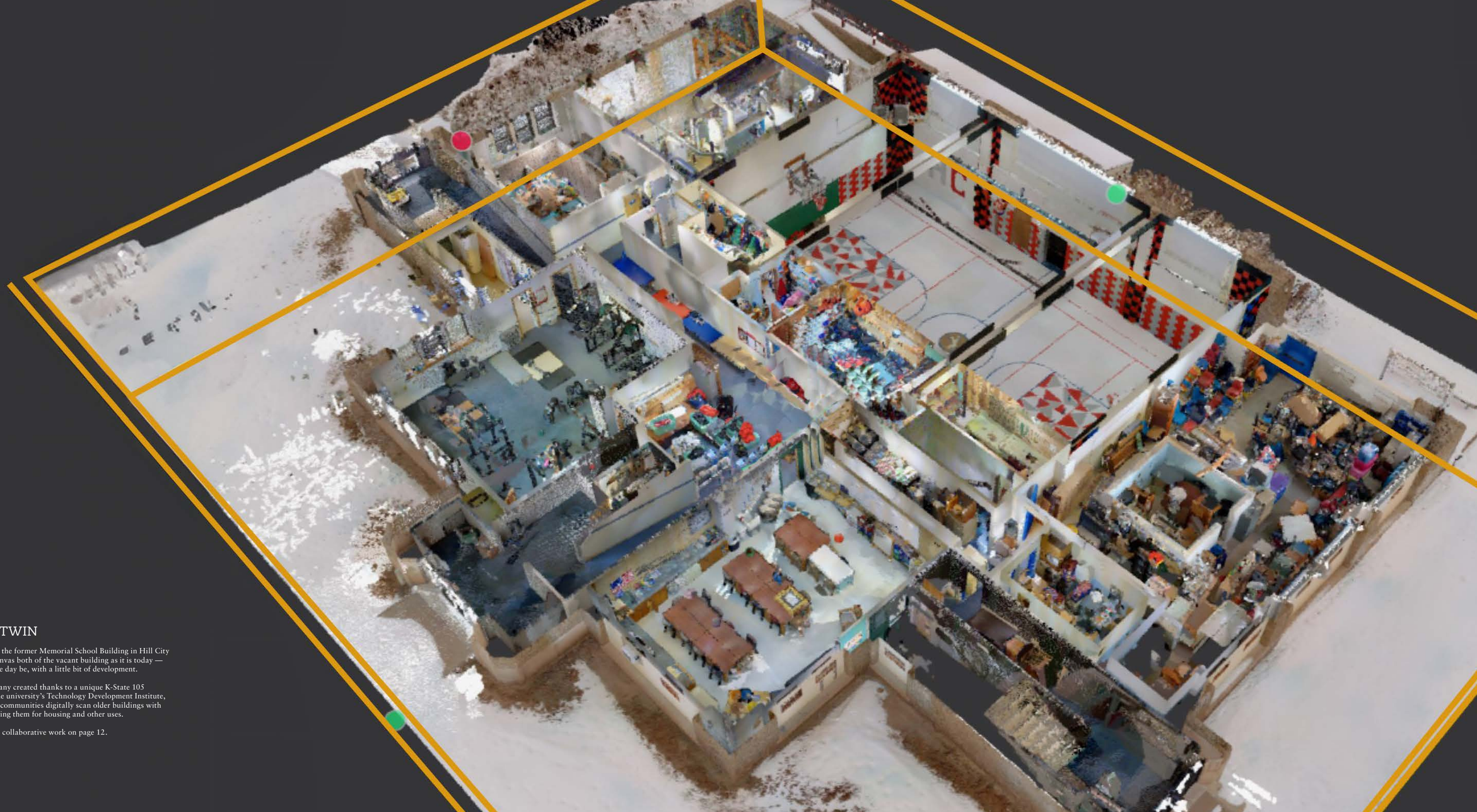
RESEARCH MAGAZINE FOR KANSAS STATE UNIVERSITY
FALL 2024

FEATURED INSIDE:

Where the bison roam
Building back a prairie home

A liquid lifeline
Solving water challenges

Keeping watch
Protecting Kansas from animal disease



A DIGITAL TWIN

This ‘digital twin’ of the former Memorial School Building in Hill City is an inch-by-inch canvas both of the vacant building as it is today — and what it could one day be, with a little bit of development.

The scan is one of many created thanks to a unique K-State 105 initiative, through the university’s Technology Development Institute, to help rural Kansas communities digitally scan older buildings with the goal of redeveloping them for housing and other uses.

Read more about the collaborative work on page 12.

On the cover:
Water is one of society's most pressing challenges, but big obstacles call for next-generation solutions, and K-State researchers are answering the call. Read more on page 22.

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Seek is Kansas State University's flagship research magazine and invites readers to "See" "K"-State's research, scholarly and creative activities, and discoveries. Seek is produced by the Office of the Vice President for Research and the Division of Communications and Marketing.

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"We take immense pride in the groundbreaking research and scholarly work accomplished by our faculty at K-State, and we are thrilled to share these stories with you in this issue."

I am excited to introduce the Fall 2024 issue of Kansas State University's award-winning research magazine, Seek. We take immense pride in the groundbreaking research and scholarly work accomplished by our faculty at K-State, and we are thrilled to share these stories with you in this issue.

Our cover story tackles one of the most pressing challenges facing Kansas and the world — water. K-State researchers are at the forefront of this global issue. Through both individual projects and the newly established Kansas Water Institute, they are breaking down disciplinary barriers to pioneer innovative solutions for today's water problems.

Our second feature highlights a symbol near and dear to Kansans: the bison. Also known as the American buffalo, the bison is far more than just a historical icon. K-State researchers are continuously uncovering new insights into the profound impact these majestic grazers have on our ecosystems, both locally and beyond.

The third feature focuses on one of K-State's greatest research strengths: wheat. Our geneticists are working tirelessly to develop new wheat varieties with improved traits, including reducing adverse gluten reactions. Additionally, our milling science researchers are creating new products to meet evolving consumer demands and expand market opportunities. Meanwhile, pet food scientists are advancing research in animal nutrition, offering better options in this rapidly growing sector.

Finally, at the K-State Veterinary Diagnostic Laboratory, our researchers are the first line of defense against devastating animal diseases. Through large-scale disease testing, published maps and reports, they ensure the health of animals, both large and small.

As always, this issue also shines a spotlight on the outstanding work being done by our graduate and undergraduate students, university distinguished professors and other faculty members. We are also proud to feature ongoing engagement initiatives led by K-State.

I hope you enjoy this issue, learn more about the groundbreaking work happening at K-State, and see how it is making an impact both in Kansas and around the world.

Hans Coetzee, Ph.D.
Interim Vice President for Research

Understanding economic prosperity

Throughout the magazine, look for these icons to learn more about the four areas of K-State's Economic Prosperity Plan and to read more about research in each area.

- Food and agriculture systems innovation
- Digital agriculture and advanced analytics
- Biosecurity and biodefense
- K-State 105

Read more about the Economic Prosperity Plan. *k-state.edu/economic-prosperity*

ENGAGEMENT

Next-gen biomanufacturing, aerospace

Federal investments back $50 million in K-State initiatives

Kansas State University continues to be a leader in training and research in the biomanufacturing and aerospace industries, as federal government investments back $50 million in university initiatives.

In Manhattan, $7 million in federal funding announced in August will go toward the construction of the new Biomanufacturing Core and Training Facility, which will accelerate the university's ability to lead cutting-edge research and workforce development in the rapidly expanding field of biomanufacturing.

At K-State Salina, a transformational federal grant announced in April will help build a $28 million facility that will serve as the Aerospace Education Hub for several of the campus's aerospace training and research programs. A separate but related $5.5 million grant will provide aviation training equipment to amplify K-State Salina's pilot training partnership with the National Oceanic and Atmospheric Administration, or NOAA.

"We are incredibly grateful to Sen. Jerry Moran and the federal government for supporting us to receive this funding," President Richard Linton said. "This investment opens the doors to great opportunities for K-State to develop educational programs, career pathways and research outcomes in the biomanufacturing and aerospace industries. This is what being a next-generation land-grant university is all about."

Biomanufacturing Core and Training Initiative

The Biomanufacturing Core and Training Facility is one of four state-of-the-art facilities integral to the initiative. It will advance vaccine production by adhering to the highest safety standards set by regulatory agencies while producing critical biologics to combat zoonotic diseases and other health threats. It will also provide hands-on training for the next generation of biosecurity researchers to ensure that Kansas remains at the forefront of biomanufacturing expertise.

As K-State leads advancements in biomanufacturing, it is also strengthening the state's economy by attracting jobs and top-tier industry partners to Kansas. This initiative enhances both the agricultural and public health sectors, ensuring a safer, more prosperous future for the state and beyond.

Along with the Biomanufacturing Core and Training Facility, the initiative features three additional cutting-edge facilities that will help K-State tackle critical public health issues:

- Focusing on zoonotic and foreign animal diseases, the Biosecurity Research Institute Biologics Development Module facility will develop diagnostics, vaccines and therapeutics to safeguard food security and public health.
- The College of Veterinary Medicine Biologics Development Module specializes in large-scale biologics production. This facility enhances vaccine efficacy through advanced protein purification techniques, ensuring that life-saving biologics can be produced efficiently.

- Currently under construction in Seaton Hall, the Biomanufacturing Training and Education Center will provide students with hands-on biomanufacturing experience, creating a highly skilled talent pipeline that supports the state's growing biomanufacturing industry.

K-State's commitment to biomanufacturing is more than an educational endeavor — it's a mission to enhance public health, boost economic growth and establish Kansas as a national hub for biomanufacturing excellence. With this initiative, K-State is developing the technologies of tomorrow and shaping a workforce capable of leading innovation in biosecurity for decades to come.

See *Shorts*

Aerospace Education Hub

The Aerospace Education Hub and the partnership with NOAA reflect K-State Salina's continued commitment to aeronautics education, especially as the aerospace industry continues to grow in its demand for groundbreaking research and well-equipped, job-ready graduates.

The new facility is the second phase to revitalize the southernmost end of the K-State Salina campus as the General Atomics Aerospace Innovation Ramp, following General Atomics' $10 million investment — the largest corporate gift in K-State history — to kick off the revitalization plan in October 2022.

The anchor of the Aerospace Innovation Ramp is the Aerospace Education Hub, which will house the Kansas AAM Flight Test and Training Center, the Advanced Composites Laboratory and the Aviation Maintenance Training Center.

- K-State Salina's Applied Aerospace Research Center is nationally recognized for its work in promoting the commercialization of uncrewed aircraft systems. In addition to its current work, the new facility allows the center to expand its scope to include emerging aerospace technologies in advanced air mobility and commercial space applications. The new Kansas AAM Flight Test and Training Center will focus on providing regional air mobility and autonomous vehicle usage in the air transport of passengers and goods.
- When completed, the new Advanced Composites Laboratory will be an innovative educational facility that delivers holistic education on composite materials, including immersive and industry-driven experiences for learners and valuable research and knowledge for industry partners.
- An expanded Aviation Maintenance Training Center doubles the current space allocated for K-State Salina's aviation maintenance training program. The center provides educational opportunities at all levels, from technical certification to bachelor's degree credentials.

As part of the separate $5.5 million federal grant, NOAA will collaborate with K-State Salina to grow the pilot training program. That partnership leverages the resources in K-State Salina's existing undergraduate aviation programs and will equip students with the science, technology, engineering and math skills required to join the NOAA Commissioned Officer Corps, one of the eight federal uniformed services.

It is also helping K-State Salina acquire aviation training equipment to create a custom, full-motion simulator based on the dynamic and diverse flight environments NOAA officers need to be familiar with on duty.

ENGINEERING

Experts in semiconductor security, climate-smart practices

Two researchers in K-State's Carl R. Ice College of Engineering received grants this spring from the National Science Foundation's Faculty Early Career Development Program, also known as the CAREER award, in recognition and support of their promising work in their respective fields of study.

Xiaolong Guo, assistant professor in the Mike Wiegers Department of Electrical and Computer Engineering, is using his $490,000 CAREER award to develop an automated tool to detect security issues in computer hardware without human effort or specialized knowledge, saving semiconductor manufacturers valuable time and money.

The five-year project, "CAREER: When Learning Meets Reasoning: Mitigating Security Risks with Large Language Models and Causality Inference," will also integrate a dataset to train large language models and feature a cloud-based platform for testing solutions.

"Our project focuses on tackling security risks in hardware caused by software," Guo said. "As hardware becomes more complex, finding these flaws manually is tough and costly. The tools we are developing will automate this process, helping semiconductor manufacturers save both time and money."

Vaishali Sharda, assistant professor in the Carl and Melinda Helwig Department of Biological and Agricultural Engineering, is using her more-than-$500,000 CAREER award to develop and refine models that can generate future climate scenarios and give agricultural producers the knowledge and insight needed to adjust toward climate-smart practices.

The five-year project, "CAS-Climate: Multiscale Data and Model Synthesis Informed Approach for Assessing Climate Resilience of Crop Production Systems," intends to create an all-in-one system that can help crop producers better sustain water resources, as well as manage nutrients and soils, by combining inputs from on-the-ground sensors and satellite and remotely sensed data.

"Ensuring the sustainability of water resources, especially under a changing climate and increasingly extreme weather conditions, necessitates a shift in farming practices," Sharda said. "There is a need to integrate scientific and engineering expertise, assess a range of scenarios and develop resilience metrics to prolong the viability of nonrenewable water resources."

See *Shorts*

ARTS AND SCIENCES

Treating deadly pneumonia, sepsis

Bacterial pneumonia and sepsis are leading causes of hospitalization and death. Researchers in the Division of Biology in the College of Arts and Sciences have discovered that dysfunction of the body's immune response to bacterial infection may be part of the problem.

Pankaj Baral, assistant professor of biology, and Prabhu Raj Joshi, doctoral student in microbiology, are studying how nervous and immune system crosstalk, or bilateral signaling, impacts the body's ability to fight pneumonia caused by the Gram-negative bacteria known as carbapenem-resistant *Klebsiella pneumoniae*, or CRKP.

The researchers published their study, "Lung-innervating nociceptor sensory neurons promote pneumonic sepsis during carbapenem-resistant Klebsiella pneumoniae lung infection," in Science Advances, a member of the Science family of journals.

CRKP bacteria are the most common cause of hospital-acquired lung infections and are a major contributor to fatal pneumonia-induced sepsis, or pneumonic sepsis, among hospitalized patients. The U.S. Centers for Disease Control and Prevention considers CRKP and other Gram-negative bacteria an urgent public health threat and states that an alternative non-antibiotic treatment for Gram-negative pneumonia and pneumonic sepsis is essential.

Baral and Joshi's study investigated the role of neuroimmune signaling in bacterial pneumonia, focusing on lung-innervating nociceptor sensory neurons — neurons that mediate pain — during lung infection with CRKP.

Normally, the sensory nervous system protects the body by sensing and responding to noxious stimuli. However, the study showed that during lung infection by CRKP, the sensory nervous system is detrimental, and lung-innervating sensory neurons, meant to defend against pneumonia and sepsis, seem to be the culprit.

"Our study showed that nociceptor activation and pain sensations, normally considered critical defense mechanisms, actually enhance CRKP infection and pneumonia lethality," said Joshi. "So, we think that CRKP might employ nociceptor neuron activation to establish infection and cause severe disease such as sepsis."

This discovery could help scientists develop a non-antibiotic sepsis treatment that targets nociceptor neurons or blocks their receptor signaling pathways.

In fact, the team is collaborating with researchers at the University of Kansas to perform high-throughput screening of small molecules to identify the most potent chemical inhibitors of nociceptor signaling for use as a therapeutic treatment for Gram-negative pneumonia and sepsis.

Baral's research has received funding from the National Institutes of Health, the American Lung Association, the American Heart Association and Kansas State University's Johnson Cancer Research Center.

ENGAGEMENT

Precision agriculture research partnership puts Clay Center farm on a world stage

To get to be a farmer, Brian Martin first has to be a decider.

What to grow. How much of it to grow. What seed to use. Where to grow it. When to plant it — both in time of day, and in time of season. How far apart (and how deep) to plant it. When to treat it. How to treat it. When to harvest it.

For the third-generation Kansas farmer and his wife Lori, some of these decisions — like the one they made to convert to no-till operations in the 1990s — are easier if only in that they're made once and at a bigger scale. Others are made every day and for every acre of land.

Any number of factors — all of which independently vary across hundreds of acres of farmland at Martin Farms — influence the decisions he makes as he tries to be the most efficient, cost-effective and environmentally conscious farmer he can be.

But a unique partnership with Kansas State University over the past 30 years has helped equip Martin, and farmers like him across the country and globe, with precision agriculture techniques, practices and knowledge.

These innovations — while helpful to Martin Farms across 2,000 acres of farmland in northcentral Kansas — are real-world use-cases that also inform agriculture research, implementation and product development around the globe, said Ajay Sharda, professor of biological and agricultural engineering and director of K-State's Institute for Digital Agriculture and Advanced Analytics, or ID3A. He has worked directly with Martin Farms since he arrived at K-State in 2014.

"This partnership has been just amazing, considering that we do not have our own farmland at this scale, and these projects — which are basically with real-world, state-of-the-art technologies — are happening on field scale in active collaboration with the growers and in active discussion with the global growers," Sharda said.

On Martin's farm, Sharda and a team of interdisciplinary faculty, graduate students and undergraduate students have studied precision agriculture practices and technology.

That has included advanced planters and aerial seeders that can sow seeds and nutrients at variable rates and cameras that can identify specific weeds to target in a field.

All of that work is backed by advanced sensors and data on conditions such as electrical conductivity, soil moisture and temperature and nutrient needs that give Martin and the researchers a more precise idea of field conditions, and how to use them to their advantage.

K-State researchers like Ajay Sharda, left, have cultivated multi-decade partnerships with Kansas farmers like Brian Martin, right, that have led to international solutions in the field of precision agriculture.

Digital agriculture and advanced analytics

"Think about it. Never before in the history of humankind have we produced this much food on our planet."

- RAJ KHOSLA

Global leaders

The close partnership between K-State researchers and Martin Farms was recently on full display as the capstone tour of the International Conference on Precision Agriculture, hosted this year in partnership with K-State.

Hundreds of preeminent experts in precision agriculture from more than 40 countries gathered for several days over the summer in Manhattan, where they shared some of the latest research and innovation in the field.

K-State President Richard Linton thanked attendees for visiting Kansas, and he reiterated the university's commitment to crafting agriculture innovations for Kansas that can become solutions for the global community.

"As we think about precision agriculture — in maximizing the outputs while minimizing the inputs and saving the valuable resource that is water — we want to be partners and we want to be global leaders," Linton told attendees at the start of the conference. "We can solve problems for Kansas, work on issues for the U.S. and be active globally as well."

Raj Khosla, founder and past-president of the International Society of Precision Agriculture, emphasized the value of the research, and how well it translates to any agricultural operation around the world — from single-digit acre plots in Asia to the relatively massive, thousand-acre farms across the American Midwest.

"Precision agriculture is scale independent," said Khosla, who is also a professor and head of K-State's agronomy department. "Think about it. Never before in the history of humankind have we produced this much food on our planet."

But he challenged attendees to think about the "five Rs" of precision agriculture — the Right Input, Right Rate, Right Time, Right Place and Right Manner — in making even more monumental progress as precision agriculture technology becomes more accessible and affordable.

As the conference wrapped with a tour of Martin Farms, Brian Martin urged attendees to take what they learned in Kansas and implement it in every corner of the world.

The land was first homesteaded by his grandfather two generations ago, and when Martin took over in the 1990s, he knew he had an obligation to maintain and keep the land viable for generations to come.

That's when he first partnered with K-State, to implement and study no-till practices that could keep more nutrients in the soil and keep it from eroding in the first place.

As Martin continues his partnership with researchers like Ajay Sharda, he said he is excited to see each new innovation K-State is able to make in precision agriculture.

"The thing that is great about all of this is that as each step goes, we're conserving our resources more and more, and we're not having soil erosion," Martin said. "As you can see in my field, it's completely covered. I'm not worried at night when a big storm comes in, because I know all of that soil will still be there the next day."

Big bluestem, bigger dreams

K-State's 85th Goldwater Scholar leads study of one of North America's most important grasses

By Emily Boragine

For Helen Winters, her K-State classroom and research site has been in 26 different locations across 22 U.S. states.

Winters is a senior studying biology and fisheries, wildlife, conservation and environmental biology. She is the university's 85th Goldwater scholar and is about to lead a multi-year research project on climate adaptation in 26 populations of big bluestem grass — one of the most common and crucial grasses in the prairies and plains of North America.

An initial interest in plants and animals as a curious undergraduate led Winters to become a key contributor in a comprehensive research project started by doctoral student Jack Sytsma in the lab of Loretta Johnson, a professor of biology.

The project, which is funded by the U.S. Department of Agriculture, seeks to model and predict the potentially significant ecological and agricultural impacts of climate change on big bluestem. That work could then inform future conservation efforts and contribute to more effective strategies amid changing climates.

Helen and Jack traveled to 26 sites in 22 states, from Michigan to Louisiana and Colorado to North Carolina, to study big bluestem across its range. They observed significant variations in the species. In drier western regions, big bluestem tended to be smaller with higher photosynthetic rates and greater drought tolerance, while on the eastern edge, it grew larger but with lower photosynthetic rates and drought tolerance.

To determine if these observed differences are genetic or environmental adaptations, the team collected seeds from the various populations and planted them in a K-State greenhouse under strictly controlled conditions to understand the variations and what causes them.

The researchers also took the samples to four sites — Colby, Hays and Manhattan, Kansas, and Carbondale, Illinois — that were selected for the wide range of annual rainfall they each receive. The team will track how these different big bluestem populations respond or survive, which will provide an understanding of how big bluestem populations have adapted.

> "I want to do something that's a bit different than what has been done in years past. And I'm slowly figuring out what that's going to be."
>
> - HELEN WINTERS

"Depending on how many plants survive, it could be around 156 plants per site, which is a lot of work to measure, especially considering the site we have in Illinois," Winters said.

Along with mapping and modeling the effects of climate change on big bluestem, the team is also working to develop recommendations for restoration and conservation practices to mitigate those effects. One tactic could include transplanting populations of drought-tolerant big bluestem from western regions into eastern areas where drought is predicted.

As the team gains a deeper understanding of the vital tall grass, Winters is committed to advancing the research, while developing her own skills as a researcher.

"I want to do something that's a bit different than what has been done in years past. And I'm slowly figuring out what that's going to be," she said. k

In the greenhouse, Helen Winters regularly takes measurements of the big bluestem samples' photosynthetic rates and water potential, which is a proxy for drought tolerance.

Needle in a protein haystack

Graduate student investigates connection between protein degradation and cancer cell reproduction

By Kate Kennedy

Researchers estimate there are tens of thousands of different proteins in the human body. Determining how and which of these molecules trigger physiological disfunction may seem like searching for a needle in a protein-packed haystack, but one Kansas State University student is up for the challenge.

Wei Wu, a graduate student and doctoral candidate in chemistry, came to K-State from the Chinese province Heilongjiang with her sights set on food science. Along the way, however, she discovered a love for chemistry. After obtaining her bachelor's degree in food science and industry in 2018, Wu began graduate research under the guidance of Ping Li, associate professor of chemistry in the College of Arts and Sciences.

Under Li's leadership, the Protein and Biopolymer Analysis Core Lab aims to understand the relationship between protein methyltransferases — a classification of enzymes crucial to human physiology — and the reproduction of cancerous cells.

"Protein is the biomolecule that directly participates in cellular activities," Wu said. "The dysfunction of protein, whether too much, too little or too unstable, can disrupt normal cellular activities and potentially lead to cancer."

Specifically, Wu now investigates the effect of excessive growth of the protein N-terminal transferase 1, or NTMT1.

"Protein NTMT1 is over-expressed in many cancers, and we want to know its effect on cancer cell proliferation," Wu said. "If the over-expressed NTMT1 promotes cancer cell growth, it could be a potential target for cancer treatment. In our lab, we developed molecules that can enter cancer cells and specifically degrade NTMT1."

After degrading the proteins, Wu observed proliferation was inhibited in both 2D and 3D cell culturing. She uses a mass spectrometer, a device which measures molecular properties like mass and structure, to analyze the NTMT1-related cellular activities or pathways that resulted in the inhibition.

Wu said their research provides significant insight into a world of great unknowns.

"There are more than 25,000 known proteins, but for most of them, the functions and their roles in the cellular activities remain unknown," Wu said. "In our research, we observed cancer cell proliferation inhibition, suggesting NTMT1 could be a potential target for cancer treatment. Now, we and other groups can focus on NTMT1 and the mechanisms behind it."

Wu travelled overseas to work with Bayer Crop Science in China during summer 2024. She said her internship allowed her to continue biological molecule research with a focus on protein characterization to support safety assessments and regulatory submissions.

"I have the opportunity to use various types of mass spectrometry designed for different applications and can also connect with experts across different fields," Wu said.

Wu's goal after graduating is to stay in the industry, preferably in pharmaceuticals or agriculture. However, she said gene editing and enzyme-directed evolution have piqued her interest, and she hopes to further expand her knowledge in other fields. k

> "There are more than 25,000 known proteins, but for most of them, the functions and their roles in the cellular activities remain unknown."
>
> - WEI WU

Inside the Protein and Biopolymer Analysis Core Lab, Wei Wu utilizes a peptide synthesizer to synthesize peptides used as precursors for her final compounds.

K-State 105

Seek more

View additional photos and 3D image scans from TDI projects.

DIGITAL TWIN ON THE RANGE

Through K-State 105, Technology Development Institute helps revitalize rural buildings

By Jennifer Tidball

You'll find Lea Ann Seiler's dream in the windswept prairie of southwest Kansas.

It's in a building from the year 1884, located on the main street of Jetmore, a town with a population of just under 800 people. It's the type of charming Kansas town where friendly drivers honk in passing to greet each other, and pedestrians stop to say hello.

Right now, on the street level, the dream looks like a soon-to-be completed retail and coffee shop called Farmhouse Fresh, where Seiler will serve coffee, soups, salads and pastries as well as fresh flowers and retail. The second floor is an old and empty apartment that Seiler hopes to renovate into a living space that could be used by local professionals.

Seiler and her husband Gary have spent eight years working on the space, often encountering unexpected setbacks during the renovation process.

Now they are one step closer.

That's because Kansas State University research and engagement are helping to make the dream a reality, thanks to the K-State 105 initiative and the Technology Development Institute.

"K-State is making things possible in rural communities, not just for me, but for all the other rural communities that have buildings like this," said Seiler, also an entrepreneurship manager with NetWork Kansas. "This project would not have happened without K-State 105."

Economic prosperity for rural communities

K-State 105 funding has enabled the K-State Technology Development Institute, or TDI, to create a digital twin of the building in Jetmore using a state-of-the-art NavVis scanning system. Seiler will use the digital twin for multiple parts of the renovation, including developing HVAC, electrical and plumbing systems that work together.

The Jetmore building in Hodgeman County is part of a larger K-State 105 project that partners TDI with the Innovation Center in northwest Kansas to use the NavVis system to create digital twins of underutilized buildings that can be provided to developers with dimensionally accurate 3D models of the buildings. This aids in developing plans and cost estimates to put the buildings back into use.

"TDI originally acquired the NavVis system as part of an American Rescue Plan Act grant through the U.S. Economic Development Administration to help manufacturing companies with facility layout and workflow design," said Bret Lanz, TDI commercialization director. "But through our discussions with economic development officials and housing specialists, we discovered that there was a huge need to repurpose a wide range of buildings in rural communities to help address housing and child care needs.

"While a number of these buildings had been identified, attempting to get architects and developers out to the rural communities to evaluate buildings was nearly impossible," Lanz added.

And that's where K-State 105 comes in.

K-State 105 is an economic growth and community engagement initiative for all 105 counties in Kansas. The initiative is a key driver of K-State's Economic Prosperity Plan, and it is a pillar of the Next-Gen K-State strategic plan. K-State 105 has received funding from the Kansas Legislature to collaborate with partners on work that advances economic prosperity in Kansas — work that is happening in communities like Jetmore.

Similarly, the Technology Development Institute in the K-State Carl R. Ice College of Engineering serves entrepreneurs, innovators and manufacturers across Kansas to develop new technologies and products and implement advanced manufacturing technologies.

"We are making the research, resources and expertise of higher education accessible to Kansans in rural and urban communities across the Sunflower State," said Jessica Gnad, K-State 105 director. "Through its work to create digital twins across Kansas, the K-State Technology Development Institute is an important piece of building economic prosperity in rural communities."

> "We are making the research, resources and expertise of higher education accessible to Kansans in rural and urban communities across the Sunflower State."
>
> - JESSICA GNAD

The TDI digital twin project supported by K-State 105 funding involves more than 16 locations across the state. At these locations, TDI engineers are using the NavVis system to create virtual walk-throughs of buildings.

Now rural communities can contact developers and provide them with a virtual walk-through of the building and a complete, dimensionally accurate 3D digital file of the facility to begin gathering cost estimates of what it would take to repurpose the buildings.

"This is a critical first step in moving projects such as these forward," Lanz said.

Lea Ann and Gary Seiler are collaborating with TDI as they renovate a building from 1884 on the main street of Jetmore, Kansas.

Digital twin creation

On a sunny summer day in Jetmore, Tom Harris, an engineer with TDI, straps on the NavVis system, which looks like a giant white backpack with a camera overhead. He walks up the creaky steps to the second floor and starts scanning the building. Step-by-step, he slowly walks the empty space and captures images, while the NavVis system beeps periodically.

Within an hour, he's able to pull up an initial 3D scan of the whole floor on a computer screen. After a couple of days of post-processing, the full scan will be available for Seiler to view online as easily as if she were using Google Street View.

Not only can the NavVis system create the ability to virtually walk through the buildings, but it also captures the buildings' dimensions with up to 5 mm accuracy. The digital twin provides engineers, architects, developers and contractors with building information without having to be on-site — they can view the files in the cloud or download and review the digital model in computer-aided design software, such as Revit or AutoCAD.

"Most rural communities do not have the resources to have someone manually go in and measure out the building and recreate that in AutoCAD, so now they have a 3D model to begin working with," Lanz said.

In another K-State 105-funded digital twin project, TDI is collaborating with researchers in the College of Health and Human Sciences to scan child care facilities in four locations: Wamego in Pottawatomie County, Phillipsburg in Phillips County, Hillsboro in Marion County and Lewis in Edwards County.


This digital twin shows the second floor of the 1884 building in Jetmore. Lea Ann Seiler will use this digital twin as she renovates this old and empty apartment into living space.

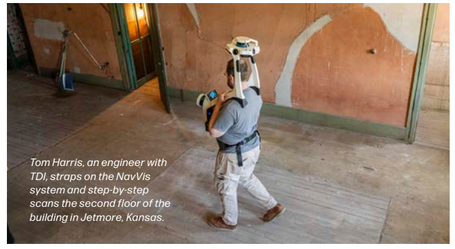
"By taking a closer look at the layout of a building and how the space is being utilized, there are modifications that could be made to the layout to improve child learning and development," Lanz said.

The institute continues providing scanning services to existing manufacturers who may be looking to expand or wish to evaluate the use of various automation technologies.

TDI also supports the rural housing focus area of K-State 105 by providing scans of rural buildings — abandoned schools, hotels, hospitals or senior care centers that are no longer in use — that could be repurposed for housing expansion in local communities.

Such is the case in rural communities like Jetmore, where Lea Ann Seiler sees the value of TDI's scanning work helping shuttered spaces — like her dream building in downtown Jetmore — become great places to live.

"Housing is such a big issue in Kansas right now, especially in rural Kansas," Seiler said. "These buildings that sit empty can be utilized so much better now. It will make a world of difference." k


Tom Harris, an engineer with TDI, straps on the NavVis system and step-by-step scans the second floor of the building in Jetmore, Kansas.

WHERE *the* BISON ROAM

Biologists are protecting and preserving bison and their prairie home

By Taylor Provine

This used to be their home.

Before European colonization and before the Kansas State Agricultural College was founded as the nation's first operational land-grant institution, bison were both the most widespread and the most abundant large animal in North America. But they were nearly driven to extinction.

By the time the Kansas Legislature renamed the college Kansas State University in 1959, bison hadn't lived in the area for almost a century.

Then they returned.

The Konza Prairie Biological Station, an 8,600-acre native tallgrass prairie, has been a site for long-term ecological research, education and prairie conservation since 1971. In 1987, bison were reintroduced to the Konza Prairie, and have been part of the station's ecological research program ever since.

K-State researchers are working to understand how the large, widespread animal affected the prairie ecosystem — when they were common, after they were nearly eradicated and now that the bison are returning, albeit in smaller numbers.

> "The Konza Prairie tests how the presence of these mega grazers and fire affect the prairie. Konza is a leader in developing the theory about how grasslands all over the globe are maintained over time."
>
> - ALLISON LOUTHAN

They're working to preserve a prairie home for the bison to forever roam.

Bison-built landscapes

Bison are important to the prairie because they were one of the large animals that played a part in shaping the landscape.

Understanding them, then, is important to understanding the future of the prairie.

A study led by Zak Ratajczak and Allison Louthan, both assistant professors of biology in the College of Arts and Sciences in the Division of Biology, is looking at ways in which the prairie — in the presence of bison — is affected by climate change and drought.

"Computer simulations of future climate in the central United States and Kansas in general suggest that we will be looking at more frequent droughts and when they occur, will likely last much longer," Ratajczak said.

Researchers are trying to determine how the prairie ecosystem — particularly through plant biomass that is grazed, at least by bison — will respond to climate change.

Large enough for bison to pass through, these structures on the Konza Prairie simulate drought, with a partially open roof.

"It's important to know the effect of that, hopefully before this kind of drought happens," Ratajczak said

To study and replicate that climate change, Ratajczak and Louthan are building large structures out on the prairie to simulate a lack of rainfall, or drought. These structures have partially covered roofs but are otherwise open on the sides to allow the bison to pass through.

Other research sites have used these types of structures for climate change research, but in ungrazed areas. K-State's research is the first of its kind at this scale, helping to determine the practical aspects of conducting such studies with bison and other large animals.

"The Konza Prairie tests how the presence of these mega grazers and fire affect the prairie," Louthan said. "Konza is a leader in developing the theory about how grasslands all over the globe are maintained over time."

The long-term goal of the project is to discover ways in which the prairie adapts to climate change. Ratajczak is particularly interested in addressing several unanswered questions on exactly how much of the prairie ecosystem changes. For example, does climate change substantially decrease the amount of forage for grazers? Does the amount of biodiversity decrease?

Allison Louthan

Zak Ratajczak

The researchers have observed that when bison are in an area, some of the smaller grasses are more abundant. This is important because the smaller grasses are more common in more heavily droughted areas to the west where there is less precipitation.

"It's very possible that adding bison into a system could actually make it more able to cope with drought because grazed areas have higher densities of these grass species that are really good at handling drought," Louthan said.

In the shallows of a wallow

On a superficial level, the prairie is resplendent in more than 600 species of tall grasses, wildflowers and other plant life.

But hidden in this flora are the fauna comprised of dozens of species of fish, amphibians, reptiles and mammals. They form an interconnected web of smaller, but no less important, ecosystems, including the bison wallow.

Bison wallows — round, dusty, large depressions in the prairie — are created when the large animals roll in the dirt repeatedly in the same area. As the soil compresses, it makes a shallow bowl, and some wallows collect water as it rains.

Eva Horne, teaching professor of biology and assistant director of the Konza Prairie Biological Station, is studying bison wallows and where bison create them in relation to where they spend their time.

"If we want to understand the North American grasslands, we need to understand the grazers that evolved here with our grassland," Horne said. "By understanding what they do now, maybe we can understand what the prairies were like long ago."

> "If we want to understand the North American grasslands, we need to understand the grazers that evolved here with our grassland."
>
> - EVA HORNE

Horne recently published an article that shows the wallows are most concentrated on low slopes, or flat surfaces, at higher elevations with higher rates of fire. These spots are where the bison also spend most of their time.

Eva Horne studies bison wallows and how they increase the diversity of other organisms that live on prairie.

> “Bison are a keystone species — they change the environment and increase the diversity of the other organisms that live on the prairie.”
>
> - EVA HORNE

She’s also studying other organisms that use the wallows.

“There are at least three species of frogs that breed in the wallows, and numerous different insects and arthropods can be found in them,” Horne said. “It changes the diversity of the plants around the wallows, even when they’re dry, because sometimes annual species of plants that don’t have any other place to live can grow in those wallows.”

Although it is not precisely known why bison wallow, some common hypotheses are that they use the dust to keep insects off or help shed their winter fur, Horne said. But these reasons might not be as important as the effects on the prairie around them.

“They create the wallows, and they destroy cedar trees,” Horne said. “They don’t stand in and mess up streams because they get most of their water from what they eat and the rainfall that collects in the wallows.”

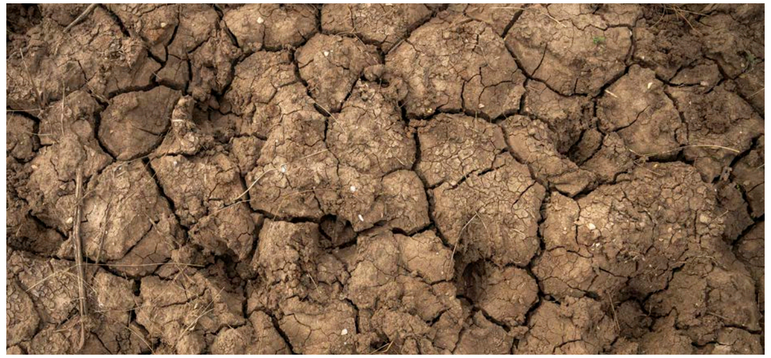
They’re keepers of the prairie.

“Bison are a keystone species — they change the environment and increase the diversity of the other organisms that live on the prairie,” Horne said.

Great grazers

Bison were the original grazers of the prairie. Their grazing was important to the prairie’s ecosystem and its biodiversity. But as the bison were slowly eradicated, so were other species, such as certain populations of tallgrass birds.

To study the current effects of grazing on the prairie, researchers are studying another widespread, large ruminant — cattle — that is the nearest living relative of bison and grazes the prairie in much the same way bison once did.



Bison wallows, pictured above, are round, dusty, large depressions in the prairie that are created when bison roll repeatedly in the dirt.

Seek more

Experience the sounds of bison moving about their prairie home.

Alice Boyle, professor of biology, and Walter Dodds, university distinguished professor of biology, are part of a multi-partner project — including The Nature Conservancy, the National Park Service, Kansas Grazing Lands Coalition and private producers — using virtual fencing to control where cattle graze to study grassland bird populations and streams in the Flint Hills of Kansas.

The study is using special cattle collars and advanced GPS tracking to create areas where the cattle can and cannot graze without the need for physical fences, which can be expensive and hard to move to accommodate cattle operations.

According to Boyle, when cattle are kept from grazing in certain areas, vegetation can grow taller and denser.

“It’s the variability that we’re going for,” Boyle said. “With this project we are trying to push the habitat in different ways to create the kinds of conditions that we think are going to benefit the grassland bird populations in general. The species that are being forced out are globally disappearing, and I think it’s our duty to do something about that.”

> “The species that are being forced out are globally disappearing, and I think it’s our duty to do something about that.”
>
> - ALICE BOYLE

Areas of taller, denser vegetation are needed because they provide a nesting refuge for prairie chickens and other threatened birds. Prairie chickens create their nests on the ground and without tall vegetation, their nests are unprotected, leaving them vulnerable to predators, Boyle said.

Another important part of the study is testing how virtual fencing might protect vegetation near the waterways of the Flint Hills.

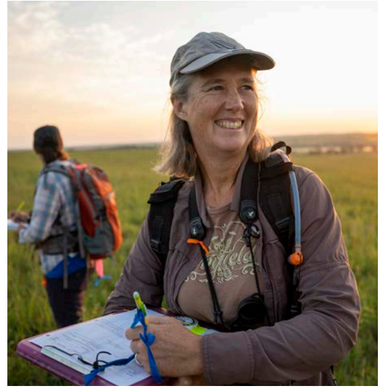
These riparian zones — the areas bordering bodies of water — are important for maintaining water quality and quantity because the plants within them intercept sediment and nutrient pollution that can come from cattle operations.

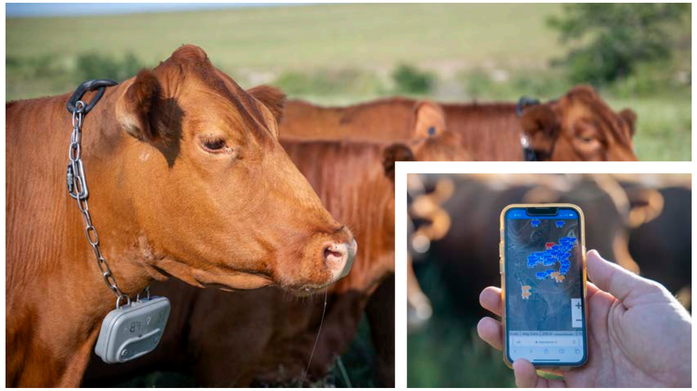
“Other studies don’t take place in whole watersheds,” Dodds said. “What happens upstream will influence downstream waters. Our study has two watersheds where cattle can access the whole watershed and graze. Then we have a separate two where we have the virtual fences, keeping most of the animals out of the water and away from the streams.”

The overarching goal of this study is preserving the biodiversity of the prairie. Prairie streams have their own unique organisms, and some are endangered species, Dodds said.

“If the water quality is bad, then your chances of preserving the organisms that rely on the waterways is as well,” Dodds said.

Alice Boyle, bottom left, and Walter Dodds, above, are studying how virtual fencing might help protect grassland bird populations and vegetation near the waterways of the Flint Hills.





Food and agriculture systems innovation

K-State 105

A LIQUID LIFELINE

In water challenges, interdisciplinary researchers are finding big solutions

By Malorie Sougéy

In the history of humankind, no resource has been as significant as water — the namesake and lifeblood of the Blue Planet. It holds the memories of our past and the hope for our future.

Researchers at Kansas State University — in individual projects and in collaboration with the Kansas Water Institute — are working to ensure water quality, recommend climate-smart practices and prevent water loss so it remains a reliable resource.

It's research with profound implications for families, food and the future, and K-State is leading the way.

The lifeblood of human health

We can't live without water. But what happens when the water we drink to survive gets contaminated, and the resource threatens our health?

K-State geologists Matthew Kirk and Karin Goldberg, both in the College of Arts and Sciences, are testing domestic well water in Kansas for nitrate levels that could lead to health complications if left untreated.

Kirk, associate professor of geology, studies declining water quality in the Great Bend Prairie aquifer, which provides drinking water to more than 30,000 south-central Kansans via private wells, through the Kansas Groundwater Geopaths program.

Through the program, Kirk leads teams of students from K-State and community colleges in Barton County and Dodge City to sample water from domestic wells and analyze the water chemistry to measure concentrations of specific contaminants — often nitrate from fertilizer use in nearby crop fields — and overall contamination levels.

Kirk said high nitrate levels in drinking water can cause infant mortality, birth defects and cancer. His team has sampled 90 wells in south-central Kansas since 2020. Half of them have had nitrate above the standard for clean water as defined by the Environmental Protection Agency, or EPA.

Once the results are in, Kirk discusses the findings, potential reasons for elevated contamination and water treatment options with the well owners. Many are startled to hear the findings.

One resident's well test showed results of 50 milligrams of nitrate per liter in her water — five times the EPA standard.

"She had no idea that she should be getting her water tested, and she had no idea there was a problem," Kirk said. "She was just drinking that water."

Similarly, Karin Goldberg, associate professor of geology, conducts water quality research in three Kansas counties with significant cancer rates in their population. Each county has elevated rates of a certain type: lung cancer in Lincoln County, colorectal cancer in Russell County and breast cancer in Ellsworth County.

K-State Research and Extension agents brought this problem to the Johnson Cancer Research Center and Goldberg's team. The group is now investigating whether these abnormally high cancer rates could be related to water contamination by fertilizers, herbicides and other agricultural chemicals in these farming communities.

At private wells and residences in these counties, Goldberg and her students test for water contaminants and elevated radon levels. They also record family health histories focused on cancer incidence rates.

Goldberg's team will use the data they collect to create a map overlaying the results of the water and radon testing and cancer histories with the distribution of land use — distinguishing cropland from pastures, denoting oil and gas fields and reported spills, and outlining other items that could have impacted water quality — to determine potential correlation between the contaminants and cancer incidence.

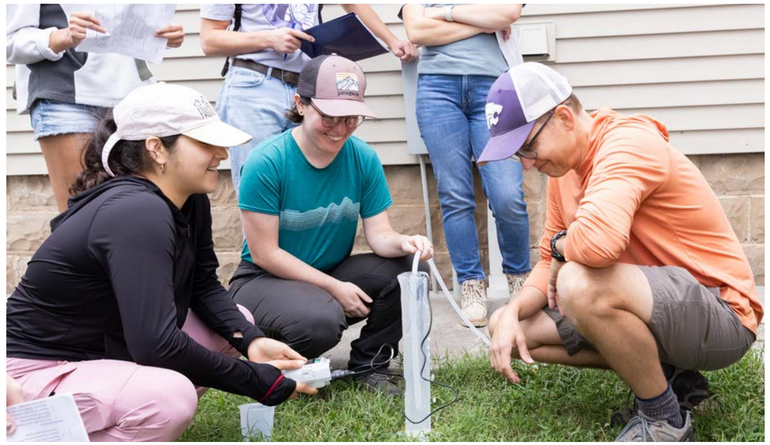
Community education is important to both the Goldberg and Kirk teams' work. Goldberg's team will use the results of their studies to inform residents about how their water compares to EPA safe drinking standards. They will also give affected communities suggestions about how they can address dangerous contamination levels.

Kirk's students create a map of their findings and generate a poster to present at a public forum at the end of the program each fall.

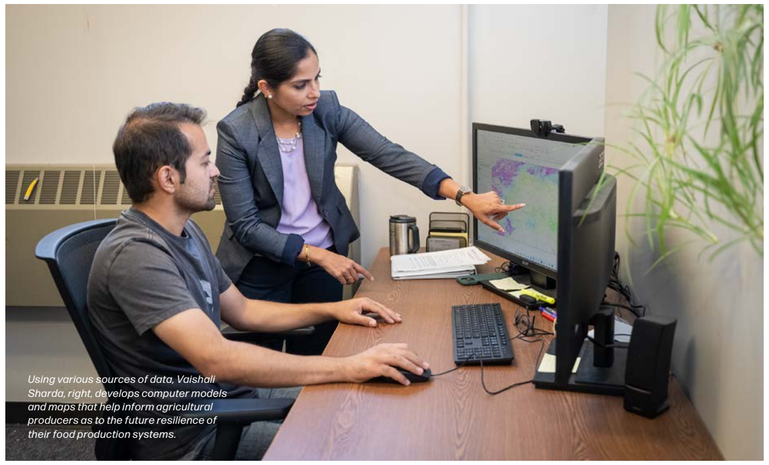
It's research with real and direct impact.

"We're getting out there and talking to the folks who are drinking the water," Kirk said. "The students are seeing the real-world effects of their work. The data from that well isn't just some number on a page. It's a beating heart."

> "The students are seeing the real-world effects of their work. The data from that well isn't just some number on a page. It's a beating heart."
>
> - MATTHEW KIRK



Matthew Kirk, right, helps two K-State undergraduate students learn techniques for collecting groundwater samples from private water wells in Barton County.



Using various sources of data, Vaishali Sharda, right, develops computer models and maps that help inform agricultural producers as to the future resilience of their food production systems.

Growing more with less

Kansas is known as the breadbasket of the nation, but without adjustments to the way farmers use water, that basket could soon be left empty.

By developing and implementing new irrigation practices with the power of machine learning and computer modeling, Vaishali Sharda and Daran Rudnick are ensuring that the water keeps flowing.

Sharda, associate professor of biological and agricultural engineering in the Carl R. Ice College of Engineering, uses data to create food security solutions for the future.

Her research starts with data collection in a western Kansas field. Through soil moisture sensors and aerial imagery from drones, as well as aircraft and satellite sources, she learns about crop stress and field moisture levels.

Sharda integrates the data she collects into multiple computer models, and the results have the potential to help producers forecast the availability of water and the resilience of food production systems in the future.

Once the models are complete, Sharda gives recommendations for optimized irrigation and crop management strategies. With the right combination of irrigation amount and timing, the same amount of crop can be produced while using much less water, she said.

"If we show producers that these strategies can maintain, if not increase, crop production while using much less water, then that would allow our water resources to last much longer into the future than what is forecast right now," Sharda said.

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>
> - VAISHALI SHARDA

Daran Rudnick, professor in the Carl R. Ice College of Engineering and director of sustainable irrigation in the College of Agriculture, has a similar idea. He runs a program in western Kansas called Testing Ag Performance Solutions, or TAPS. Through this program, local producers supply innovative irrigation ideas, and K-State researchers put them to the test with the latest agricultural technology.

It's a competition for the producers, but everybody wins because of the discovery that comes from the game — producers get real-time, actionable data from commercial technology, and the research team gets data on the efficiency, profitability and biophysical responses of the treatments.

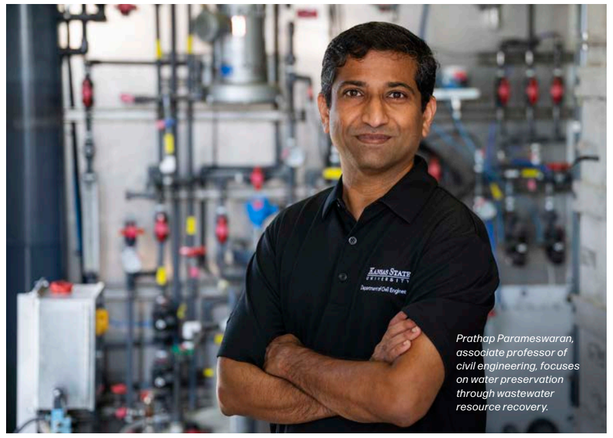
Rudnick also helped start TAPS programs in Nebraska, Oklahoma and Colorado, and he uses artificial intelligence, or AI, to leverage the data

sets from all four states and examine specific practices like limited irrigated corn production.

"AI is extremely powerful when we don't fully grasp the connections or why something resulted from various inputs," Rudnick said. "We know that these variables influence that output, and we have all this data to add — canopy temperature, weather variables, soil conditions — and we let this model identify the pathways and the influencing factors."

> "We need institutions like K-State that can see and intertwine all of these disciplines to address the system, to really move us as a society forward."
>
> - DARAN RUDNICK

The competition and the technology work together to advance our understanding of irrigation and address some of the biggest questions and decisions that agriculture producers face every day.



Prathap Parameswaran, associate professor of civil engineering, focuses on water preservation through wastewater resource recovery.

"These questions are highly complex, and they go beyond any of our disciplines," Rudnick said. "We need institutions like K-State that can see and intertwine all of these disciplines to address the system, to really move us as a society forward."

Jeanne Falk-Jones, multi-county agronomy specialist, left, scouts the TAPS field with Helen Giefer, Thomas County extension agent, at the TAPS Technology Field Day in Colby, Kansas.

Preserving a precious resource

On the path to sustainability and in preparation for a world with less water, every drop matters.

Prathap Parameswaran, associate professor of civil engineering, has taken an innovative approach to water conservation: resource recovery from swine wastewater.

"We do not consider waste as waste," Parameswaran said. "We just think of it as misplaced resources. We are recovering everything from it, and water is one main product."

Other recovered products include fertilizers, stabilized biosolids for sustainable land application, and organic acids for use in bioplastics manufacturing and animal food additives.

To recover these resources, Parameswaran pairs anaerobic membrane bioreactor, or AnMBR, technology with ecological systems like wetlands.

Wastewater from the livestock production system enters an AnMBR unit, which saves energy by treating it in the absence of oxygen. Wetlands are then used to filter and polish the resulting water, which may still contain some nutrients or organic carbon. This polishing occurs with plants — in this case native species like cattails — which absorb the remaining nutrients and carbon.

This process sustains the wetlands, recovers the resources, and cleans the water enough to be discharged back into the land or reused in agriculture.

"The novelty is really producing simultaneous products to achieve total resource recovery — not to just produce, digest and capture the energy, but to produce water for reuse and to make fertilizer products and organic acids all at the same time," Parameswaran said.

Another K-State research team is working to preserve soil moisture and nutrients to sustain crops and Kansas agriculture.

Microbial Innovations for Climate-Resilient Agriculture, or MICRA, is a project by an interdisciplinary team of engineers, mathematicians and scientists from K-State, as well as partners at the University of Nebraska-Lincoln and Langston University.

Melanie Derby, professor of mechanical and nuclear engineering, leads the K-State team and the collaboration alongside project manager Mirit Shamir.

The MICRA team's research plans include three phases, or thrusts. Thrust one explores using the wetting bacteria *Bacillus subtilis* to maintain soil moisture. The bacteria produce a surfactant — a substance that reduces the surface tension of a liquid, helps maintain more water in the soil and reduces evaporation rates.

Doctoral students Nishadini Widanagamage and Shahnawaz Alam Dip measure and record soil moisture content for the MICRA project.

In thrust two, the wetting bacteria is combined with biochar, a carbon-rich material made from organic waste or biomass. This combination could potentially improve both moisture retention and nutrient dynamics, specifically phosphorous, which affects plant growth.

Thrusts one and two have three research stages, starting in the lab, then moving to a greenhouse and concluding with field experiments. Thrust three then focuses on bringing the results to producers and exploring their perceptions of potentially using these soil amendments.

Mirit Shamir

Melanie Derby

The preliminary results have been promising. The MICRA team has seen a reduced evaporation rate from inserting wetting bacteria and biochar into the soil in initial tests.

"With climate change and drier, hotter days, we will need to use more water," Shamir said. "As the natural resources are depleting, that will be a problem. We hope that our research will help reduce the amount of irrigation that's needed in the field, which will preserve the livelihoods of rural communities."

> "We hope that our research will help reduce the amount of irrigation that's needed in the field, which will preserve the livelihoods of rural communities."
>
> - MIRIT SHAMIR

Seek more

Learn more about K-State water initiatives, including the Kansas Water Institute and K-State 105's Know Your Water.

Biosecurity and biodefense

KEEPING WATCH

The Kansas State Veterinary Diagnostic Laboratory is the state's front-line defense against devastating animal diseases

By Rafael Garcia

The samples that could determine the fate of Kansas' economy come to a small backroom at the back of Kansas State University's College of Veterinary Medicine at dusk and dawn, as they do at midday and midnight.

They come hand-delivered by courier or in nondescript packages and United States Postal Services mailers.

They come alongside other biological matter — individual samples of cancer in cats and viruses in dogs — all with varying levels of importance but certainly no lack of urgency.

Because no matter the scope or scale, with animal lives on the line, nothing matters more than accurate and timely test results at the Kansas State Veterinary Diagnostic Laboratory, or KSVDL.

As the state's largest and only public veterinary diagnostics lab, the KSVDL is the laboratory clearinghouse that veterinarians around the state and country know and rely on to diagnose and track the diseases that could wreak havoc on individual households and the U.S. agricultural economy at large.

"We serve so many people here, and we have many resources to help people with a wide range of animal issues," said Jamie Retallick, director of the KSVDL. "We have people with zoo and wildlife backgrounds, people with poultry backgrounds, people with swine backgrounds — and that's just down the hall. There are all of these resources here to help, and we do this work often in the background."

"We serve so many people here, and we have many resources to help people with a wide range of animal issues."

- JAMIE RETALLICK

LOGISTICS OF LARGE-SCALE ANIMAL DISEASE TESTING

Few kinds of professional schools are as wide-ranging as veterinary medicine, and the same holds true for the battery of diagnostic testing necessary to support the profession.

Imagine all the kinds of testing a human might see in health care — from virology to bacteriology to toxicology. Now imagine that same gamut of testing for various kinds of animals, including small companion animals like cats and dogs, large animals like cattle and swine, and zoo and exotic animals like elephants and orangutans.

That's why the KSVDL's staff members —including faculty, professional staff and veterinary students, residents and interns spread across more than a dozen specialized departments in three facilities on the north end of K-State's campus — conduct more than 500 types of tests for clients.

Veterinarians and animal producers in all 50 states and 52 countries send hundreds of samples to the KSVDL each day, usually by overnight freight but sometimes by hand delivery.

It's a huge logistical undertaking, but it's one that the KSVDL is well-prepared and trained to accommodate, especially when it has practice processing thousands of animal tests in a short timeframe. The lab is also equipped to handle some human sample testing, and it was called into action in 2020 to help process COVID tests and provide relief to the Kansas Department of Health and Environment's state lab in the first few months of the pandemic.

Additionally, the KSVDL, through its necropsy unit, is often called to help determine why animals died. This can be as part of criminal or insurance investigations, but it can also be at the request of pet or livestock owners who want peace of mind or need to know to ensure they or their other animals aren't also at risk.

Although much of its work entails practical testing of real-world samples, the laboratory also conducts and supports other K-State research and performs research to develop new tests to serve clients — studying both the pathogenesis of disease and epidemiology of animal disease spread.

With the KSVDL's extensive selection of instrumentation and diverse faculty expertise, it bolsters various areas of research, ranging among infectious disease, cancer, water quality, toxins and others.

The wide range of KSVDL services and testing add to several of K-State's efforts in biosecurity, including advancing diagnostics, prophylactics and therapeutic countermeasures for combating infectious animal diseases. Through surveillance, testing and research, the KSVDL emphasizes work to protect against zoonotic and foreign animal diseases that threaten animal agriculture, the food supply and human health.

For example, KSVDL faculty and staff worked alongside researchers to help them complete COVID research studies early in the pandemic, while researchers also helped with COVID testing by the KSVDL. Diagnostics and research are intimately intertwined and share many of the same skill sets.

"Both research and diagnostics are foundational sciences that lead to discovery of new knowledge important for meeting the land-grant mission of increasing knowledge for the well-being of all people," Retallick said. "It is important for the KSVDL to perform and collaborate in areas of research as it contributes to scientific knowledge and better diagnostic testing to serve all clients, including researchers."

PROTECTING U.S. ANIMALS

Much of the KSVDL's lab is the routine but important work of providing diagnostic testing for small animal veterinarians. Think toxicology panels for cats that have gotten into something they shouldn't have or histological testing on masses removed from the skin of dogs.

Hunters also directly submit samples of deer tissue to monitor for chronic wasting disease as it ebbs around the state.

"There might be kids who are showing animals at the 4-H fair, but few people know that to go to that fair, they had to have certain animals tested, and we did that for them," Retallick said. "We stand quietly behind those kids so that they can participate in those kinds of activities."

But one of the most important roles the KSVDL plays is surveilling for and responding to any potential outbreaks of foreign animal diseases on Kansas soil.

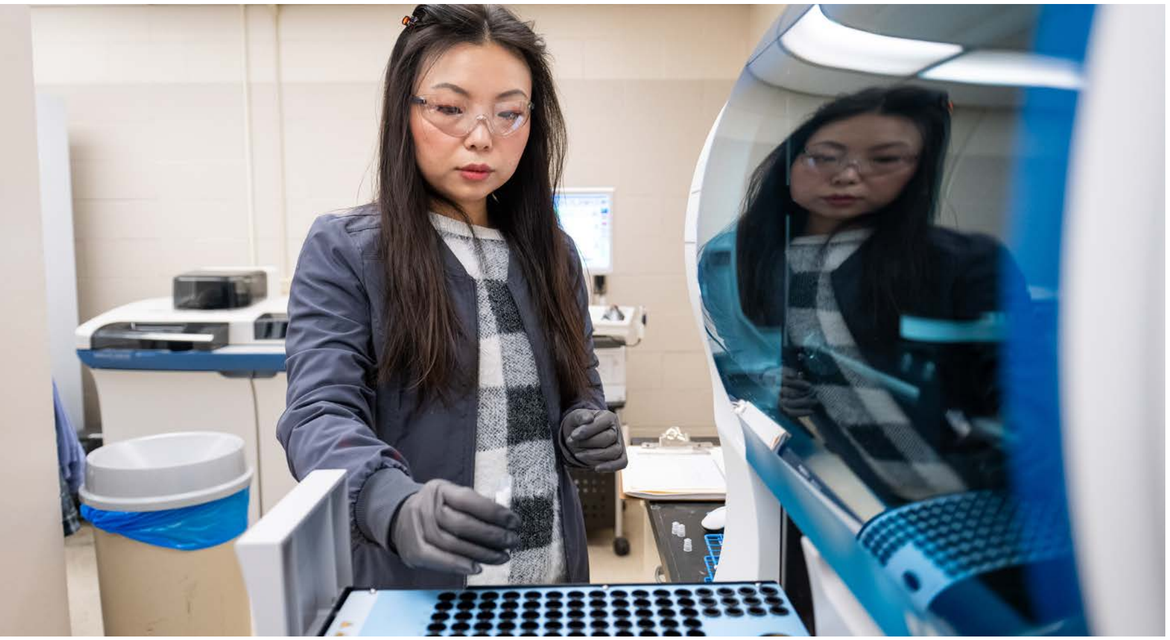
The KSVDL is a member of the U.S. Department of Agriculture's National Animal Health Laboratory Network, which monitors for outbreaks of diseases, such as African swine fever and foot-and-mouth disease, that could lay ruin to the nation's livestock industry.

Not to be confused with the hand, foot and mouth disease that affects humans, foot-and-mouth disease primarily affects cloven-hoofed animals like cattle and swine. While not necessarily deadly, the highly infectious virus leads to fever, blisters and weight loss and leaves animals weakened for months.

"We say it is not if a foreign animal disease outbreak will happen — it's when," Retallick said. "There will someday be an outbreak, and as a part of that network, we know we'll be put into action to test samples."

Emily Walker, medical technologist in the KSVDL's clinical pathology laboratory, tests a sample of dog urine for its specific gravity, or the balance of water content and waste, through a refractometer.

Jennifer Rogosch and Sarah Ochoa Sanchez, diagnostic technicians in the KSVDL's rabies virus laboratory, work on Fluorescent Antibody Virus Neutralization assays, which are used to measure animals' level of protection against the rabies virus.



Mabel Wen Todd, medical technologist in the KSVDL's clinical pathology unit, loads a sample on the Stago Compact Max Coagulation Analyzer, which measures blood clotting times.

While more than 70% of the world has seen foot-and-mouth disease in the past couple of decades, the U.S. has been free of the virus since 1929.

That's thanks in large part to aggressive border customs and surveillance efforts, said Justin Smith, animal health commissioner at the Kansas Department of Agriculture.

"Kansas has a huge livestock industry, and with it, a tremendous amount of movement. That makes us vulnerable to a lot of disease incursions, and one of our greatest fears is a foreign animal disease like foot-and-mouth disease," Smith said. "Foot-and-mouth disease would severely cripple the nation's ability to trade with other countries."

Smith's office and state veterinarians positioned around Kansas work directly with local livestock producers, feedlots and slaughterhouses to immediately sample and test any suspected cases of foot-and-mouth disease, as well as other regulatory or reportable animal diseases, and send them to the KSVDL to get tested — be it during business hours or at 2 a.m.

It's both quality and health assurance, Smith said.

"There is a lot of routine surveillance for common diseases that allows us to ensure that Kansas' livestock industry is healthy and that people want our products," Smith said. "They serve not just Kansas, but a lot of surrounding states and industry, and they are the tip of the iceberg in terms of diagnostic work."

A GROWING DEMAND

For more common but still serious diseases, the KSVDL regularly publishes reports, maps and trends of animal diseases around the state, said Gregg Hanzlicek, clinical professor and director of production animal field investigations.

Hanzlicek also helps facilitate the lab's outreach and continuing education efforts, which include regular webinars, newsletters and visits to counties around the state.

"It helps our veterinarians be more aware of things that might be changing in the environment or in the industries they work in, and from there, they help the producers manage and prevent numerous diseases," he said.

Megan Potter, a veterinary clinician and part-owner at Abilene Animal Hospital, said that local practitioners like her often have an idea of what a certain case might be before sending it to the KSVDL for testing. The tests provide both confirmation and peace of mind, as well as expertise on the latest trends and strains of diseases.

"They get a wide variety of cases, so you get out of your local area a bit," she said. "And you can draw on the information that the diagnostic lab has gained from other clinicians."

> "The animal agriculture industry is more proactive about potential diseases, and if there is something that exists in their facilities, they want to know exactly what it is before it becomes an outbreak."
>
> - JAMIE RETALLICK

In the past couple of decades, the KSVDL has grown dramatically from a pool of about 10 faculty and 50 staff to 22 faculty and about 100 staff, mostly to manage a caseload that has more than doubled to more than half a million tests per year.

That can be a difficult feat, especially since most other similar state veterinary laboratories around the country are based in a single facility. The KSVDL has to shuttle samples between laboratory spaces in three separate buildings on the north end of the university's campus.

Retallick said the surge in casework has largely been because of an increased awareness and desire to prevent disease outbreaks like highly pathogenic avian influenza.

"The animal agriculture industry is more proactive about potential diseases, and if there is something that exists in their facilities, they want to know exactly what it is before it becomes an outbreak," Retallick said.

"There's also the fact that pets are a bigger part of families, and their owners want the same level of care and testing they might get for a family member," she added. "More pets and animals are also traveling, and to go into a certain country, you might need specific tests to be done."

The KSVDL's rabies laboratory also processes titer tests from several foreign countries, predominantly in Latin America — with the laboratory even staffing a Spanish-language hotline for veterinarians from those countries.

Despite the growth in testing, the KSVDL has remained largely self-supported. The laboratory receives some state funding to support salaries, and some federal grants help cover foreign disease surveillance, but most of the KSVDL's revenue comes from the nominal fees it charges clients for testing.

But beyond low prices and rapid test turnaround times, the most important reason the KSVDL has built its reputation around the state, nation and world is its communication with clients, Hanzlicek said.

> "When they call us, they get a hold of someone who is an expert in the lab and can talk them through their cases," Hanzlicek said. "Someone is always available and willing to answer questions."
>
> - GREGG HANZLICEK

"When they call us, they get a hold of someone who is an expert in the lab and can talk them through their cases," Hanzlicek said. "Someone is always

Brad Hill, diagnostic technician in the KSVDL's toxicology laboratory, loads a sample on the Inductively Coupled Plasma Mass Spectrometer, or ICP-MS, for a bovine trace mineral panel.

NOURISHING FOOD INNOVATION

ONE GRAIN AT A TIME

K-State researchers are driving innovations in cereal and plant science

Eduard Akhunov and his team of plant pathologists work on developing resources and tools for improving bread wheat.

Inside the humble loaf of bread lies a biological progression that parallels humanity's spread around the globe. Wheat genetics are a record of the plant's rich history, and recent breakthroughs in sequencing are mapping its genome and revealing the potential for future resilience and nutritional improvements.

"For wheat, high genetic diversity is crucial for developing improved crops and adapting to changing conditions," said Eduard Akhunov, professor of plant pathology and director of the Wheat Genetics Resource Center at Kansas State University. "CRISPR is a new way of generating this diversity — with recent developments in this technology, we can edit not just a single gene or a dozen genes, but hundreds, and do it relatively quickly."

Akhunov's latest work — CRISPR-modified wheat that reduces gluten toxicity without affecting bread-dough quality — exemplifies the trend for 'consumer-minded' food research, which prioritizes health and sustainability alongside crop yield.

With a comprehensive plant pathology program and one of the world's few grain science programs, K-State brings cutting-edge research in biotechnology, food processing and proteins directly to the plate — or the pet food bowl.

"For wheat, high genetic diversity is crucial for developing improved crops and adapting to changing conditions."

- EDUARD AKHUNOV

WHEAT'S WILD ROOTS ENHANCE DIVERSITY

The wheat used to bake bread is hexaploid, having six sets of chromosomes and multiple copies of the same gene, which evolved through successive natural hybridizations and genome-doubling events among ancestral grasses. Much of Akhunov's work focuses on understanding how such genetic redundancy shapes wheat's agronomic traits. Increasingly, wheat's wild relatives are critical to unlocking this complexity.

Akhunov recently led an international study that sequenced nearly 1,000 wheat lines from distinct geographic regions that span a wide range of global environments. When comparing genomes, the researchers found chromosome segments from key wild ancestors of modern wheat.

"Early forms of domesticated wheat come from the narrow geographic range where humans lived 10,000 years ago," Akhunov said. "As humans carried wheat to new regions, it encountered wild ancestors again, leading to accidental crossbreeding. This process enriched wheat genetic diversity and likely was used to develop wheat adapted to various climatic conditions, including drought and heat stress."

Akhunov and his team at the Kansas Wheat Innovation Center, which holds a gene bank with 4,000 accessions from 38 wild wheat relatives, collaborate with the K-State and USDA Agricultural Research Service wheat breeding programs to replicate this natural process and systematically introduce genetic diversity from wild ancestors into modern wheat. They screen large populations for useful traits, such as grain quality, pathogen resistance or resilience to stress environments.

Beyond targeting gluten allergies, Akhunov envisions strong potential in using the power of both wild relative genetics and gene editing technologies for improving wheat.

"Combined with CRISPR, wild relatives of wheat are a great source of genetic diversity for improving wheat nutritional value, yield and resilience to biotic and abiotic stressors," he said.

"The possibilities are exciting."

FIXING FLOURS, FLAVORS AND WRINKLES

With growing awareness of protein-rich diets, flours from pulses like chickpeas, lentils and peas are gaining popularity. These nutrient-dense flours — rich in protein, fiber and essential minerals — are increasingly used to supplement or replace traditional wheat flours.

Yonghui Li's laboratory integrates wet chemistry, engineering principles, computational simulation and applied machine learning to deepen the knowledge and advance the research on proteins and peptides.

Yonghui Li, associate professor of grain chemistry and director of the Wheat Quality Lab at K-State, is developing innovative processing techniques to address challenges in utilizing pulses, such as poor flow properties and suboptimal functionality. His solutions stem from in-depth studies into flour particle-size optimization and protein modification.

"By modulating protein structures, we can create new functionalities, interacting with other molecules to deliver different food textures and structures," he said. "This complexity and versatility offers many opportunities in food science."

Li's research extends beyond pulse flours to address issues with plant-based meat substitutes, including dry texture and off flavors. One solution involves conjugating pea protein with polysaccharides, improving water- and oil-holding capacities and enhancing surface texturization for juicier bites. Additionally, his modified pea protein serves as a natural emulsifier for products including egg-free mayonnaise.

He investigates peptides from hydrolyzed proteins — created by breaking down food proteins with enzymes and fractionating them via chromatography — as potential bioactive antioxidants with nutraceutical benefits.

"We've patented peptides from sorghum and corn that slow lipid oxidation and offer nutritional advantages," Li said. "Our wheat bran peptides also show promise in combating skin-aging enzymes, and we're getting interesting results."

PETS DESERVE GOOD NUTRITION, TOO

The pet food industry is booming, with recent estimates valuing the U.S. market alone at more than $64 billion. Despite this, only a handful of academic programs worldwide focus on companion animal nutrition.

Julia Pezzali, assistant professor and director of K-State's Pet Food Program, notes that many consumers view corn, wheat and other grains in pet kibble as bulk fillers.

"Data show that the digestibility of protein and amino acids in plant-based ingredients, when heat processed, can be as high as animal-based ingredients," she said. "Grains are an excellent source of energy and nutrients and can be safely included in pet food."

Humanization trends — where owners want their pets' diets to mirror their own — are driving demand for higher-protein diets, including raw-meat diets.

Pezzali's work will focus on making sure pets get the right amount of protein through improved understanding of amino acid requirements. She champions the indicator amino acid oxidation, or IAAO, method, which more accurately measures amino acid requirements for adult dogs and cats than conventional methods.

"While high-protein diets are a popular trend in the pet food industry, we need to consider the impact of excess protein on animal health and also on the environment," Pezzali said. "By determining amino acid requirements, we will be able to provide recommendations to the industry to provide the best nutrition for our pets with fewer environmental impacts."

Pezzali noted that future trends for her field include precise nutrition, focusing on the needs of specific breeds or individual animals.

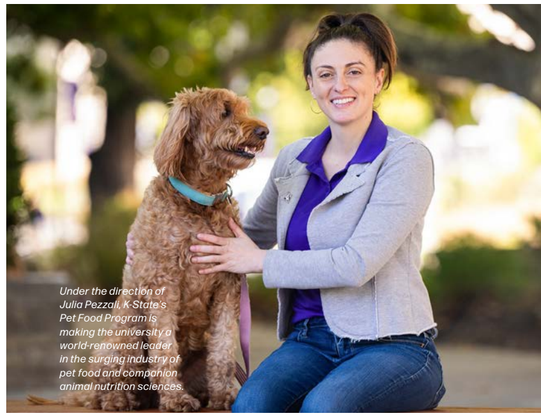
"This can be based on factors such as genetics and their environment to look at the animal holistically," she said.

SEEDING THE FUTURE

As construction begins on the Global Center for Grain and Food Innovation, a new generation of scientists and entrepreneurs will soon bring their ideas to life at K-State.

This state-of-the-art facility integrates the university's grain, animal and precision agriculture programs with advanced labs and pilot-scale facilities to support interdisciplinary research and innovation in food product development, food safety and food security.

Key spaces in the center will include modern labs for milling and baking, experimental baking and teaching, and industry partners; a dry processing, wet processing and non-food-grade pilot plant; and three floors with fully accessible teaching and research spaces.



Under the direction of Julia Pezzali, K-State's Pet Food Program is making the university a world-renowned leader in the surging industry of pet food and companion animal nutrition sciences.

"By determining amino acid requirements, we will be able to provide recommendations to the industry to provide the best nutrition for our pets with fewer environmental impacts."

- JULIA PEZZALI

In the new facility, 30% of the space will be allocated for on-site collaboration between public resources and private enterprises, fostering an interdisciplinary environment for effective problem-solving. Focused teams of industry partners and K-State researchers and students will ideate and co-locate to develop unique and desired outcomes that will help feed the world.

Some of the anticipated outcomes include revolutionizing and nurturing interdisciplinary research, recruiting and retaining world-class faculty and outstanding students, creating high-tech space for collaborative partnerships with private industry and outside partners, and developing future agricultural leaders.

Seek more

See additional renderings and learn more about the Global Center for Grain and Food Innovation.

This story was adapted for print from a version published by K-State Media.

Mathematical organs

Chemical engineer transforms preclinical process with machine learning and math

By Brennan Bestwick

For every intended and desired chemical reaction that makes a drug candidate a promising medical treatment, there always remain various unintended and unknown reactions that pharmaceutical researchers must determine before creating the next revolutionary drug.

Traditionally, the best option has been to first test these chemical reactions in animals — a process that is costly, imprecise and slow, especially when thousands of reactions might need to be tested.

Fortunately, Davood Pourkargar is working on a faster, more efficient alternative.

Pourkargar, an assistant professor in the Tim Taylor Department of Chemical Engineering at Kansas State University, has received a grant from the National Science Foundation to develop a physics-informed computational framework to predict disease progression and drug delivery dynamics more precisely. The framework will use "organ-on-a-chip" technology, which uses tiny microfluidic chips lined with small volumes of fluid and living cells, that researchers can use to mimic and study an organ's responses to stimuli like drugs.

Compared to animal testing, the technology gives researchers a more accurate, if computer-based, representation of the physical human organ system and its behaviors — with all experimentation occurring in a laboratory setting.

He will then use his mathematical presentation of the organs to design experiments and optimize drug discovery.

"My focus is on developing a digital twin framework by combining computational physiological modeling and machine learning to accelerate the discovery process," Pourkargar said. "When we verify our understanding of the physiology using organ-on-a-chip systems, it is much easier to tailor that knowledge to the real organs."

Pourkargar is no stranger to the challenge of untangling the mysteries of complex process networks. Before joining K-State in 2020, his research focused on applying computational modeling for automation in the chemical and energy industry. At K-State, he leads the Intelligent and Sustainable Process Systems Lab and credits collaborations with K-State colleagues for his interest in biological systems.

"The structure and behavior of human organs are complex, similar to highly integrated chemical, biological and energy systems," Pourkargar said. "Many well-established computational modeling and process systems engineering tools can be reframed to address challenging problems in human biology and medicine."

Pourkargar spent summer 2024 at California's Terasaki Institute for Biomedical Innovation, learning from biomedicine and tissue engineering leaders before beginning his experiments at K-State.

Pourkargar's organ-on-a-chip experiments will start with cells from the liver — a remarkably complex organ that lacks the drug options needed to treat diseases such as non-alcoholic fatty liver disease. Pourkargar chose the intricate organ in order to establish a strong foundation for his research.

Once his computational method is optimized, Pourkargar envisions a future where drug discovery is accelerated, and development costs are significantly reduced.

The potential for better patient options and fewer side effects is revolutionary, he said.

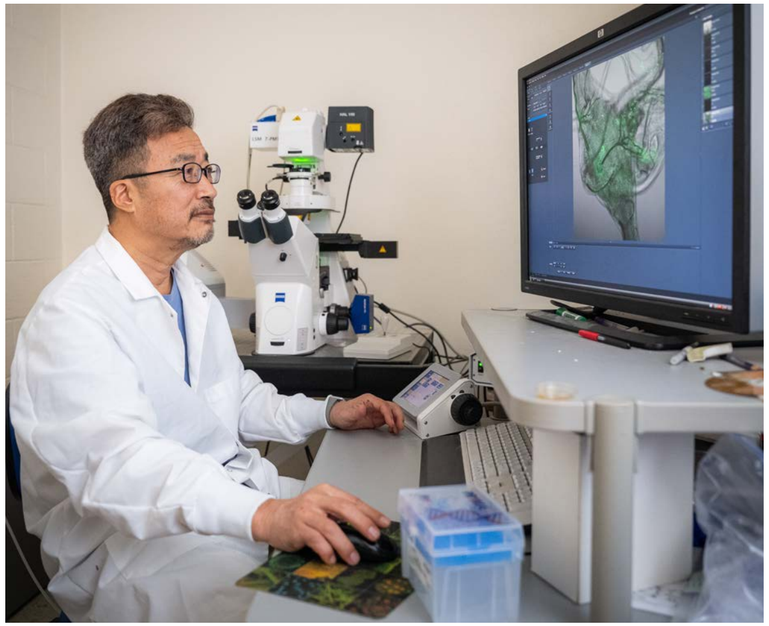
"If we have a comprehensive mathematical model that can predict organ dynamics correctly, we can do experiments in parallel billions of times on different conditions on a computer," Pourkargar said. "And that will give us some insight to get the most probable drug candidates much faster." k

> "When we verify our understanding of the physiology using organ-on-a-chip systems, it is much easier to tailor that knowledge to the real organs."
>
> - DAVOOD POURKARGAR

Sequencing a solution

Entomologist's ambitions include saving the honeybee and solving red meat allergy

By Michelle Geering



Saving honeybees and solving the mystery behind red meat allergies are two of the world's most perplexing insect-related challenges.

Yoonseong Park is working on both.

Park, university distinguished professor of entomology in the College of Agriculture, studies the molecular physiology of arthropods — including creatures like insects, ticks and mites — to improve human life.

Park is researching solutions to keep honeybees and their hives free of Varroa mites, which feed on the bees and spread viruses within the colony. Using genome sequencing, Park aims to develop a control agent that will kill Varroa mites without harming honeybees or humans.

"The Varroa mite problem is a worldwide issue, and they are the No. 1 enemy of the honeybee," Park said. "We have been studying insect and acari genome sequences for a while to identify potential targets that are only harmful to the pests."

That sequencing work led to a breakthrough in which Park found a Varroa mite-specific neuropeptide that could be targeted with a pesticide — a discovery for which he was awarded an international patent. Park continues to test a chemical compound and application strategy to keep bee colonies free of mites and their viruses.

While saving the honeybee is a passion of Park's, he is equally passionate about understanding the leading factors for alpha-gal syndrome, or red meat allergy.

Alpha-gal syndrome was first identified and studied in the early 2000s. Scientists know bites from the lone star tick, primarily found in the U.S., can cause the meat allergy, but not everyone with this type of tick bite develops it. Park is working toward understanding why some people remain unaffected, while others develop alpha-gal syndrome.

The entomologist is looking for distinguishable markers in both tick saliva and human blood samples to better understand the syndrome and how it manifests. Park has found that when ticks feed on human blood, allergen production incidence significantly increases compared to when ticks feed on the blood of other animals. Park also examines human blood samples to identify genetic markers that may indicate if a person is susceptible to developing alpha-gal syndrome.

Pests can be harmful to nations' economies, industries and human health. Finding a new method or technology for controlling pests continues to drive Park forward in his work. The next pest or insect challenge could be just around the corner, and Park recognizes the need to help develop the next generation of great entomologists.

"There is great satisfaction in finding a solution by thinking about a problem, and research allows me to do that," Park said. "It is also invigorating to work with young scientists who are ambitious and energetic." k

> "There is great satisfaction in finding a solution by thinking about a problem, and research allows me to do that."
>
> - YOONSEONG PARK

Bison (bī-sən), buffalo (bə-fə-ˌlō)

Bess Bookout, doctoral student in biology, explains the differences between bison, left, and buffalo, right, in 100 words or less:

While "bison" and "buffalo" are terms commonly used for the same animal in the U.S., they're actually two entirely different lineages of bovine, with different body structures adapted to different environments.

Buffalo, a group of species that closely resembles cows, are best adapted for the hot, grassy savannas and plains of Africa and Asia.

Bison, on the other hand, are split between two varieties: the American bison in North America and the European bison. They are typically wooly, with bodies built for cold and pushing through snow, and have huge spines that allow for a lot of muscle.

Read more about the American bison, or buffalo, and its prairie home on page 16.

Milling milestones

In 1905, J.T. Willard installed Kansas State University's first flour mill in the chemistry lab in Denison Hall. Willard added the mill to test the milling quality of hard winter wheat developed for Kansas and the Great Plains. The university formally established the department of milling in 1910. This undated photo shows flour mill rollers.

Today, the College of Agriculture's department of grain science and industry, which contains the milling science and management program, uses the Hal Ross Flour Mill for teaching, research and training.

See page 34 to learn more about the department's ongoing research, as well as work to create a next-generation facility for grain scientists of the future.

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