Seek

RESEARCH MAGAZINE FOR KANSAS STATE UNIVERSITY

SPRING 2023

FEATURED INSIDE:

Laser focus
Physicists earn international renown

Risk and reward
Researchers step up to help farmers

Anatomy of a breakthrough
The science behind health challenges

Layers of regrowth

Great Plains ranchers have used controlled burning — also called prescribed burning — for centuries to impede the growth of invasive plants on the Kansas prairie.

The practice supports prairie health by controlling weedy plants that rob moisture and nutrients from more desirable, nutritious grasses that cattle graze. It also helps reduce the risk of wildfire, controls unwanted trees and brush, and rejuvenates the grassland.

See page 20 to learn how Kansas State University researchers are helping ranchers and farmers navigate the challenges of the modern-day farm, including weather uncertainties, natural disasters, crop pests, livestock diseases and more.

Photo courtesy of Gardiner Angus Ranch/Julie Tucker.

About Seek
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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KANSAS STATE UNIVERSITY

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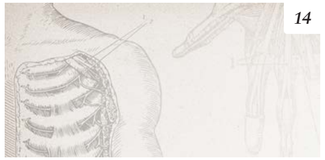

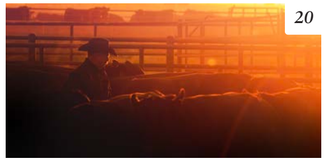

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Seek more

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Editor's note: A special thanks to the Gardiner Angus Ranch and Julie Tucker for providing many photos in this issue. Photo credits include: front and back cover; inside cover; pages 20-21; page 22; top left and both bottom photos on page 23; page 26; and both photos on page 27.

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*

"This is an exciting time for Kansas State University as we work together to define, create and model the next-generation land-grant university.

Welcome to the spring 2023 issue of Kansas State University's Seek magazine, our award-winning publication highlighting the breadth of research and scholarship, discovery and impact taking place at K-State — in our laboratories, our research facilities, our field stations and our communities.

K-State is a public research university with a growing research portfolio and an expanding reach of discovery, innovation and impact. Research is an integral part of our mission as a land-grant university. And we are forging stronger and more substantive connections between research and economic development every day. Our bold Economic Prosperity Plan leverages K-State's research strengths, faculty expertise and unique facilities to help to create new jobs and bring new investments into Kansas. This plan will help to make the state globally competitive for attracting and growing businesses in key industry sectors such as animal health, agriculture and biodefense.

But we don't stop there. Our new Game-changing Research Initiation Program, or GRIP, is investing in the most promising transdisciplinary research teams to pursue research on big problems, grand challenges and emerging opportunities. Whether in artificial intelligence, cybersecurity, new materials, energy solutions, global food systems, water security, health care or vaccine production, K-State researchers are at the leading edge, creating the technologies that will secure our future and training the next generation of professionals in critical fields.

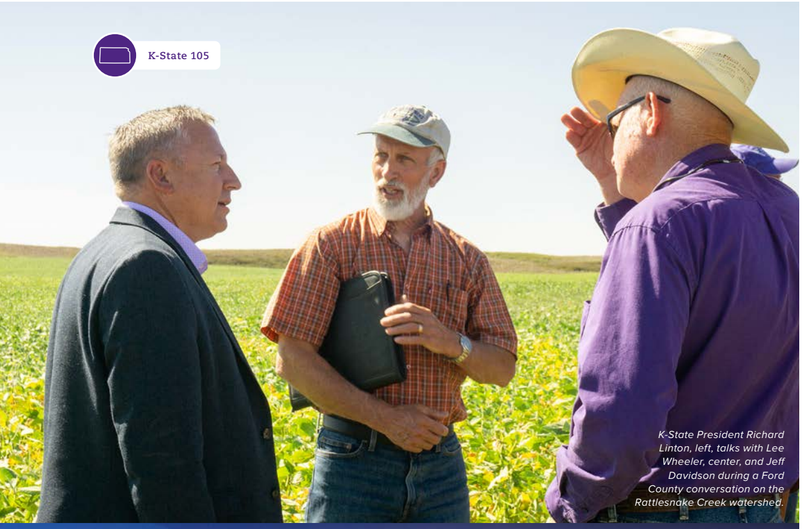
This issue of Seek is packed with stories about amazing research, conducted by amazing people, and having amazing impact — throughout the state, across the nation and around the world. The cover story and main feature highlight two of the themes of our Economic Prosperity Plan: digital agriculture and advanced analytics, and food and agriculture systems innovation. A second feature highlights one of our unique and most productive research facilities, the James R. Macdonald Laboratory, which studies atomic, molecular and optical, or AMO, physics. K-State's AMO program is one of the largest of its kind and consistently ranks among the very top programs in the nation. The Macdonald Lab has been continuously funded for nearly five decades by the U.S. Department of Energy, or DOE, and has received research funding in excess of $100 million during its history from DOE and numerous other federal agencies.

The third feature story highlights research that aligns with another theme of our Economic Prosperity Plan: K-State 105. You can learn about the new Sunderland Foundation Innovation Lab in Hale Library and how it is supporting research and enabling discovery by students, faculty and community members.

In our final feature, you can read about important new research on human health and how we are translating new knowledge and understanding to improve the lives of Kansans. Finally, there are several shorter features that highlight faculty and students as well as a recent announcement about an exciting new K-State 105 partnership.

Thank you for your interest, your support, your partnership and your engagement. This is an exciting time for Kansas State University as we work together to define, create and model the next-generation land-grant university. Research, discovery, technology commercialization and economic prosperity will all be core elements of our exciting future.

David V. Rosowsky, Ph.D.
Vice President for Research



K-State President Richard Linton, left, talks with Lee Wheeler, center, and Jeff Davidson during a Ford County conversation on the Rattlesnake Creek watershed.

Laurie Pieper with GO Topeka, center, participates in an economic development panel discussion in Shawnee County.

ENGAGEMENT

The university *for* Kansans

As the nation's first operational land-grant university, Kansas State University is demonstrating its commitment to the people of Kansas and their communities through the presidential community visit initiative. This academic year, K-State has visited nine communities throughout the state — representing 71 of Kansas' 105 counties — to listen and learn from the Kansans who live there. At each community visit, President Richard Linton and a K-State team participate in conversations that highlight university partnerships, including research partnerships, and K-State Research and Extension relationships.

The nine communities for the 2022-2023 academic year included the Flint Hills region, Ford County, the Greater Kansas City area, Central Kansas/Salina, Shawnee County/Topeka, Sedgwick County/Wichita, Crawford County, Finney County and Thomas County.

Many K-State research partnerships have been highlighted across the state so far.

- At the Ford County community visit, local farmers demonstrated the benefits of K-State water management research from the College of Agriculture, the Carl. R. Ice College of Engineering and K-State Research and Extension. See page 20 to read more about the ways that K-State research is helping the modern-day farmer.
- Conversations at the Central Kansas/Salina community visit emphasized aerospace innovation and the role of K-State Salina as a premiere location for advanced aid mobility flight training, testing and research.
- In Shawnee County, a panel discussion for the newly launched K-State 105 initiative focused on partnerships with GO Topeka, NetWork Kansas and K-State Research and Extension. See page 34 to learn more about the NetWork Kansas partnership.

AGRICULTURE

A global food security net

Sabita Ranabhat, Kansas State University doctoral student in entomology, is uncovering the benefits of insecticide netting in stored grain areas. Her research evaluates if long-lasting, insecticide netting can be combined with other pest management strategies at food facilities — such as fumigation — to improve the safety and bulk storage of grain.

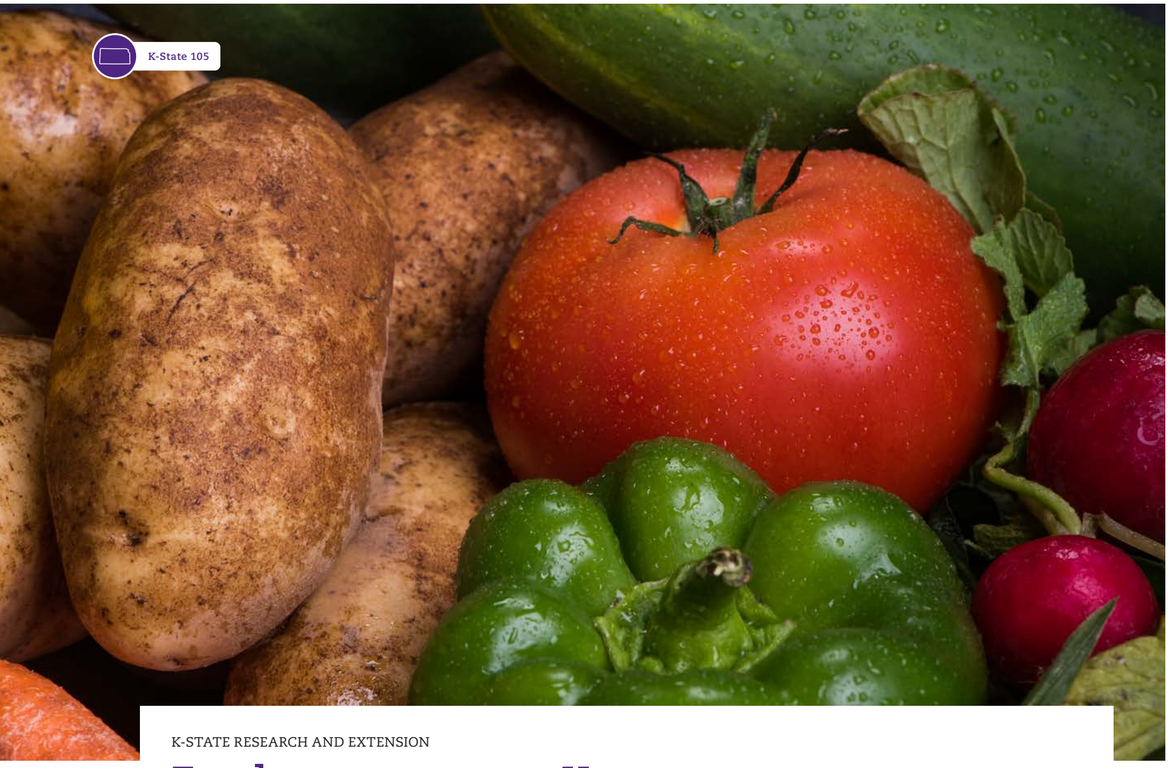
Globally, farmers lose as little as 2% but sometimes as much as 50% of their harvested crop in storage, marketing and processing from stored product insects, which Ranabhat said causes $100 billion in economic losses. As a possible solution, Ranabhat is using insecticide netting to cover vents and other openings in storage facilities, or otherwise keep them away from grain.

While the work is still early, the insecticide netting seems to reduce the number of fumigations needed in storage facilities by 58% and even as much as 100%, while reducing the incidence of insects and their offspring, Ranabhat said.

"A huge benefit of this tactic is that it confines insecticide use to the net and away from the commodities," said Ranabhat, who researches in the College of Agriculture. "However, we don't know whether the use of insecticide netting can reduce fumigant use and preserve them as a last resort. So, I am evaluating whether we can use insecticide netting to improve the effectiveness of fumigation."

Ranabhat recently received a graduate student award from the World Food Prize Foundation for her work.

See page 20 to read about other K-State research that is helping global food security.



K-STATE RESEARCH AND EXTENSION

Food access across Kansas

Two recent grants are helping K-State Research and Extension teams build on university strengths in local food systems and rural grocery cooperatives.

A three-year, nearly $750,000 U.S. Department of Agriculture grant is establishing the Center for Local Food Systems at K-State to support and enhance food systems across the state.

"In a very general sense, a food system is a way of talking about the entire process that begins with food production on farms and ends with food on everyone's plates — and even beyond that to the question of food waste reduction," said Londa Nwadike, a food safety specialist with dual extension appointments in Kansas and Missouri.

K-State also recently received a $175,000 USDA Rural Cooperative Development grant to improve rural food cooperative awareness and success. Food cooperatives are grocers owned by the patrons.

"For many years, the Rural Grocery Initiative has shared information on innovative ownership models in rural grocery," said Rial Carver, program manager for the K-State Rural Grocery Initiative. "The cooperative model has always been part of this conversation, but not a focal point. This grant project will change that, allowing our program to hone our expertise in rural grocery cooperative development and provide direct support to communities interested in the cooperative model."

The grant also will establish the Kansas Cooperative Development Center at K-State.

Timothy Durrett, left, and Ruth Welti are studying oilseed crops for biofuel production.

ARTS AND SCIENCES

Advancing biofuel production

Kansas State University researchers are part of a five-year collaborative grant from the U.S. Department of Energy to improve oilseed crops for use as biofuels and other bioproducts.

Timothy Durrett, associate professor of biochemistry and molecular biophysics, and Ruth Welti, university distinguished professor of biology, received nearly $1.9 million to better understand how changing the biochemistry of oilseed plants alters their oil production.

The research group in the College of Arts and Sciences is working with camelina and pennycress — nonfood oilseed crops — that can be used as cover crops by farmers. Durrett says these plants have not benefited from the breeding that has increased yield in other crops. This research will help scientists better understand how the plants synthesize fatty acids to make lipids while also improving oil production and crop profitability.

As part of the collaboration, Durrett is working to more efficiently produce transgenic plants. Welti, director of the Kansas Lipidomics Research Center at K-State, is analyzing how the oils are changing in the altered plants.

ARTS AND SCIENCES

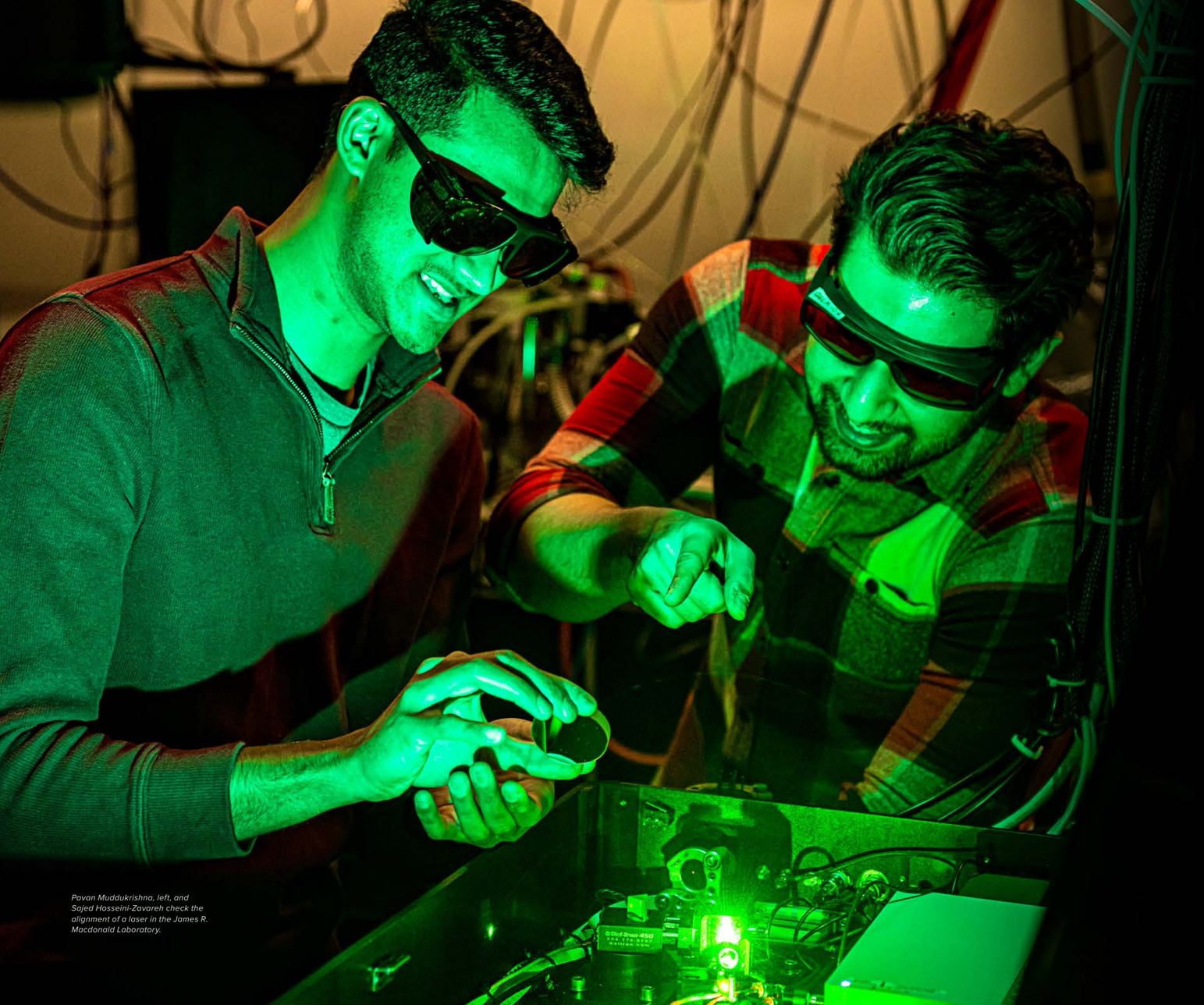
English professor named Kansas poet laureate

Kansas has a new poet laureate: Traci Brimhall, Kansas State University professor of English and director of creative writing. The Kansas Creative Arts Industries Commission selected Brimhall as the poet laureate of Kansas for 2023-2026.

"I'm greatly looking forward to serving Kansas as its next poet laureate," said Brimhall, who is in the College of Arts and Sciences. "I love sharing poetry and building community, and it's a privilege to get to do both in this role."

As the new poet laureate of Kansas, Brimhall will conduct public readings, workshops, lectures and presentations that serve communities across the state. Her plans for the laureateship will focus on connecting with Kansans through the shared experience of language, Kansas' agricultural roots and food.

The poet laureate of Kansas is an honorary position of the Kansas Creative Arts Industries Commission that promotes the arts, especially the reading and writing of poetry, for all Kansans. The program was established in 2004.



Pavan Muddukrishna, left, and Sajed Hosseini-Zavareh check the alignment of a laser in the James R. Macdonald Laboratory.

LASER FOCUS

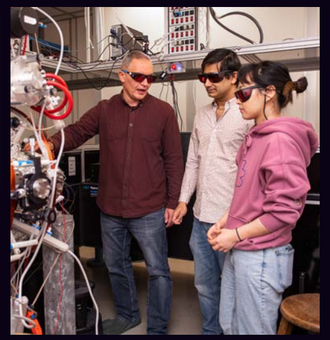
Elite physics researchers earn international renown

By Jeff Morris

Science tells us the average blink of an eye lasts about one-tenth of one second, or 100 milliseconds. Colloquially, humans use the phrase "the blink of an eye" to indicate something that happens very quickly. Yet, deep within Cardwell Hall in the James R. Macdonald Laboratory at Kansas State University, physicists are making discoveries using laser pulses that make the blink of an eye look slower than a drawn-out college football television replay.

Since the 1920s most motion pictures have been filmed at 24 frames per second, a speed at which our eyes don't easily discern individual frames. Today, many sports programs run at 30 frames per second or higher to allow for replay. By comparison, an ongoing experiment creating movies of molecular reactions at the Macdonald Lab is currently measuring 10,000 laser pulses — movie frames — per second. Each of those frames is much shorter than a billionth of a second, far beyond the ability of humans to perceive them or modern electronics to resolve them. But soon the lab expects an even more elaborated laser that will produce 100,000 of those ultrashort pulses per second.

This quantum research delves into the arcane world of physics, where individual molecules are injected into an ultrahigh vacuum then hit with laser pulses to see how they react. Elemental science seeks to uncover how particles react to light and explain how natural phenomena, such as photosynthesis, work at the most basic level. It is high-impact basic research with real-world implications, and it all happens in the unassuming basement of Cardwell Hall in the prototypical midwestern college town of Manhattan, Kansas.



> What we are studying happens extremely fast and on a microscopically small-length scale.
>
> - ARTEM RUDENKO

Lab Director Artem Rudenko serves as the chief scientist behind this effort, the latest in a string of world-class physicists who have guided the Macdonald Lab during the past few decades. Rudenko, Cortelyou-Rust professor in the physics department in the College of Arts and Sciences, manages the U.S. Department of Energy, or DOE, grant that funds the lab. In the lab's nearly 50-year history, scientists have generated more than $100 million in research grants, which is the largest continuous funding for any K-State department.

As a director, Rudenko oversees two research faculty members and a technical staff of four. He leads a joint effort of nine physics faculty members, all supported by the DOE grant. The lab also supports 15 graduate students and as many as a dozen postdoctoral researchers.

A humble wall plaque near the entrance of the lab pays homage to James R. Macdonald, who joined the physics department in 1968. Macdonald's spirit of attacking the universe's toughest problems with gusto is alive and well today. The lab literally hums with the energy of experiments being conducted using some of the world's most sophisticated lasers and equipment.

"What we are studying happens extremely fast and on a microscopically small-length scale," Rudenko said.

A shift in focus

The rapid pace of advancements in modern physics and technology led to the Macdonald Lab's pivot from atomic collisions to molecular and optical science decades ago and has resulted in collaborations with top physicists from around the world.

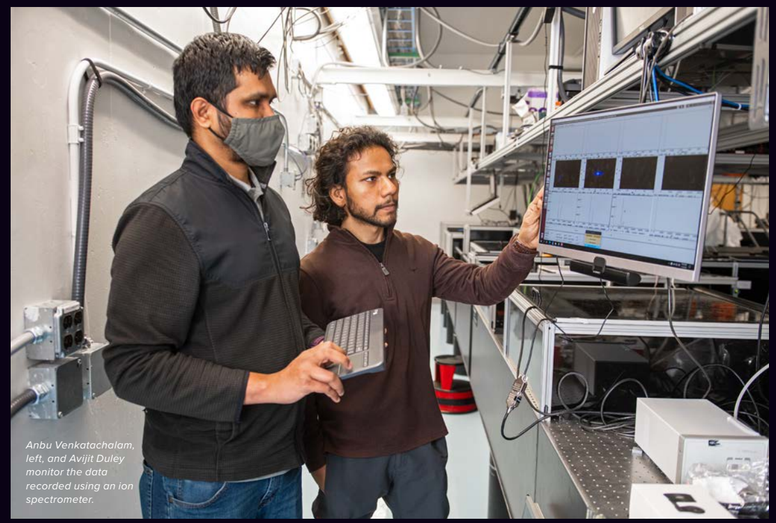
A typical experiment in the lab attempts to measure the effect of light on a single molecule in a vacuum to determine if or how the molecule changes its structure. High-end, commercial lasers substitute for the power of the sun to create data that will eventually lead to 3D graphics describing the reaction. This in turn provides knowledge about some of the most essential mysteries of nature, such as the inner workings of photosynthesis. Millions of data points are created and captured, providing a trove of information for analysis and discovery.

Rudenko's path to heading an elite lab includes stops at some of the most preeminent physics labs in the world. The Ukrainian native earned his doctoral degree in Moscow then worked at the Max Planck Society in Heidelberg and Hamburg, Germany, before arriving at K-State. All along the way, he encountered K-State researchers who interfaced with their peers at the highest levels of physics.

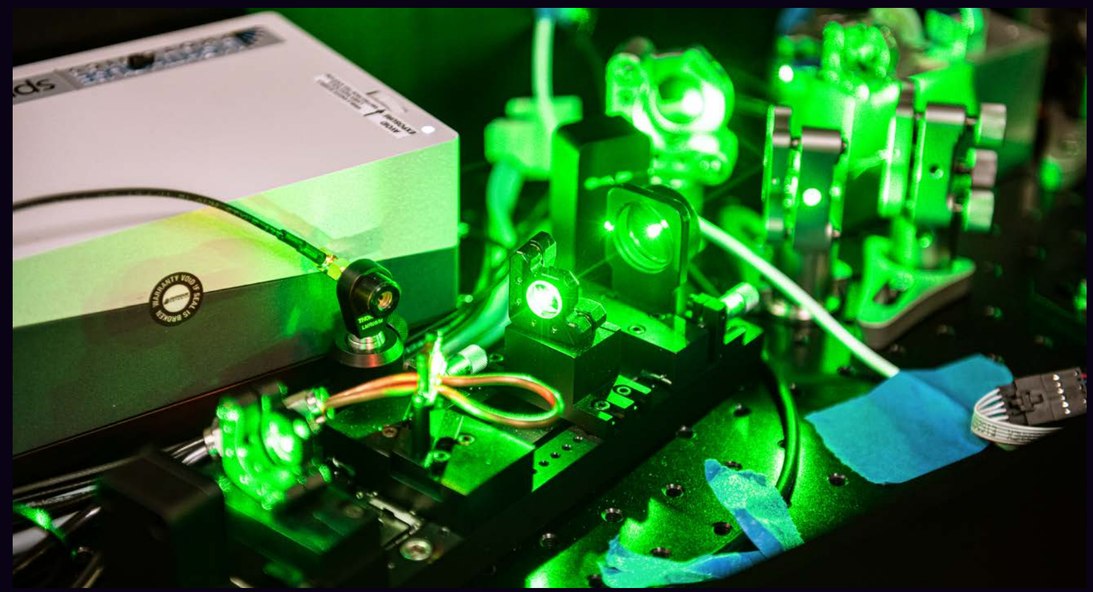
Above left: *Artem Rudenko leads a physics team of students, researchers and faculty members who collaborate internationally.*

Top right: *Rudenko discusses an ongoing experiment with Surjendu Bhattacharyya, center, and Keyu Chen.*

Bottom right: *Rudenko and Avijit Duley review the newly built high-harmonic generation beamline.*



Anbu Venkatachalam, left, and Avijit Duley monitor the data recorded using an ion spectrometer.



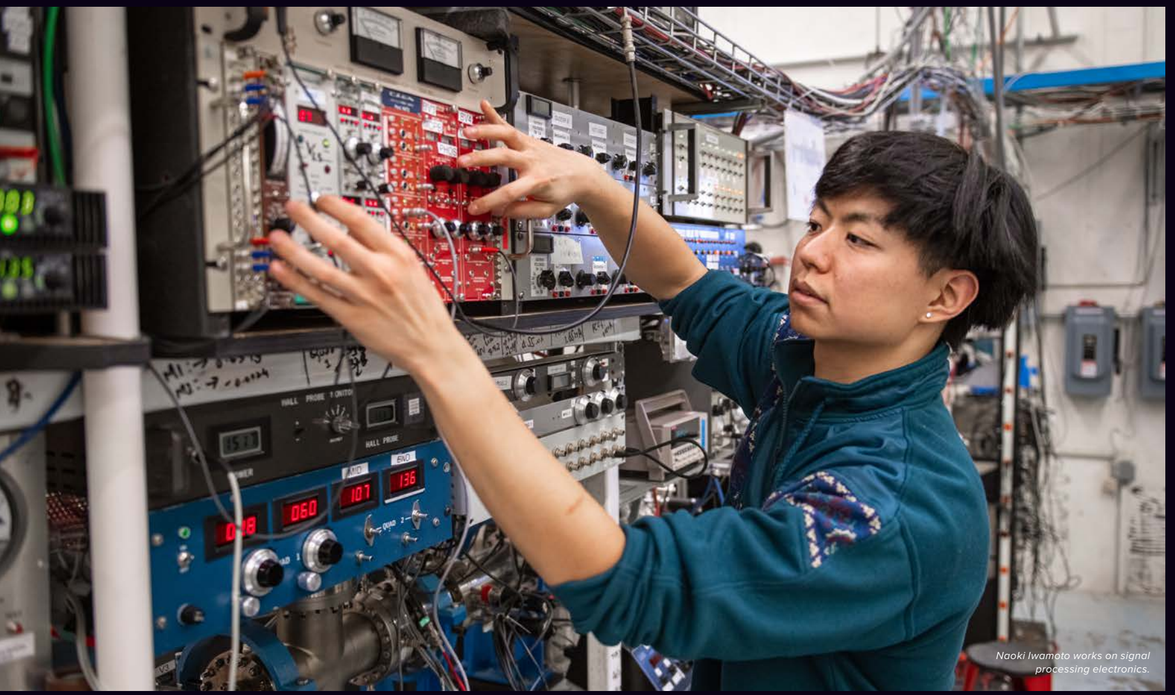
> Our scientists and graduate students are highly sought after as collaborators on projects that stretch the very boundaries of science. This lab is a sparkling star in a constellation of very bright lights.
>
> - DAVID ROSOWSKY

It was a natural fit to join a department that houses multiple current and emeritus university distinguished professors and scientists who regularly work on projects of global impact, such as the Deep Underground Neutrino Experiment, or DUNE, and CERN, home of the Large Hadron Collider.

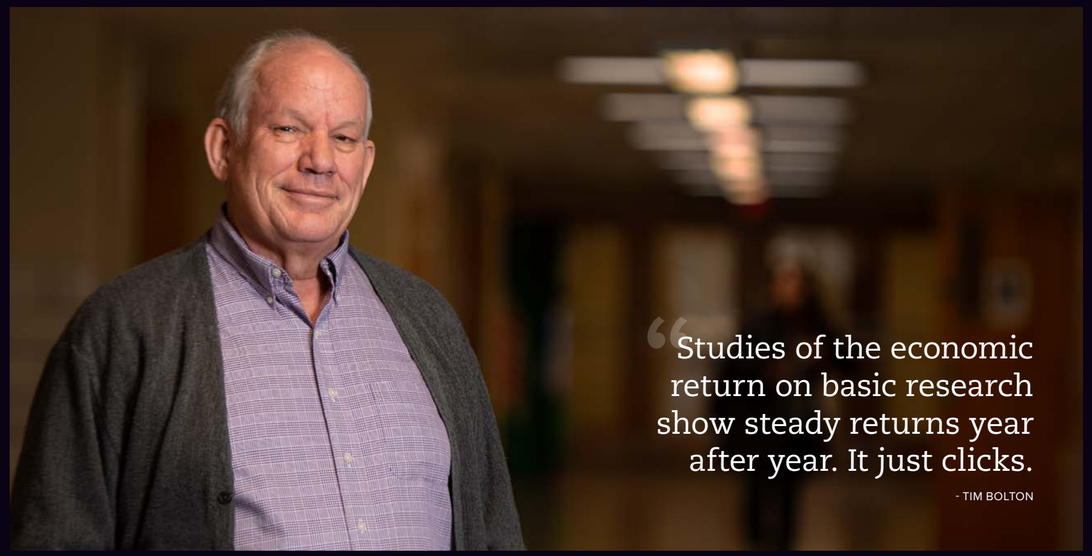
K-State continues to build its reputation developed during the past 50 years. Rudenko attributes the continuous DOE funding to consistent scientific output and discovery. He sees the future of the lab with a more robust structure supporting the study of ultrafast molecular reactions. Solidifying an international reputation takes continued technological support and a long-term vision for acquiring talent. In addition to scientific discovery, the lab is a prodigious producer of world-class scientists — many graduate students follow an academic career in national labs or high-tech companies, Rudenko said.

David Rosowsky, K-State vice president for research, sees the need for a higher public profile for the physics department and MacDonald Lab.

"When it comes to physics, Macdonald Lab scientists frequently interact with SLAC, Fermilab, Sanford Underground Research Facility, CERN, NIST and other world-class facilities," Rosowsky said. "Our scientists and graduate students are highly sought after as collaborators on projects that stretch the very boundaries of science. This lab is a sparkling star in a constellation of very bright lights. The state of Kansas and the general population need to know about the wonderful asset that provides very real economic benefits to our region."



Naoki Iwamoto works on signal processing electronics.



> Studies of the economic return on basic research show steady returns year after year. It just clicks.
>
> - TIM BOLTON

Real-world solutions

Tim Bolton serves as the William & Joan Porter professor and K-State physics department head and offers a unique perspective since taking the department helm last summer. For the previous three years, Bolton served in a full-time position on the project management team for DUNE at LBNF, or the Long-Baseline Neutrino Facility. The project is a $3.1 billion science experiment being managed by the DOE Office of High Energy Physics.

Bolton, who has co-authored more than 500 scientific papers, is justifiably proud of the K-State atomic, molecular and optical research teams that routinely work at SLAC National Accelerator Laboratory at Stanford University, Lawrence Berkeley National Laboratory in California and DESY in Hamburg, Germany, among other top scientific locales. But he also points to recent department work on remote sensing, biophysics and materials such as graphene, where discoveries lead to practical, real-world applications.

Scientists in the physics department conduct research at many levels, from the aforementioned global collaborations to discoveries that have local impact with crucial agriculture and manufacturing industries in Kansas. On-campus collaborations with biologists, agricultural scientists and other researchers happen regularly. The intersection among these disciplines provides fascinating technology, such as the ability to use drones and lasers to measure methane emissions from farms and cattle operations.

Bolton knows basic research is a long game requiring a strategic outlook by those who fund research grants and universities.

"One of the great successes of the United States is that it bought into this basic research and it really pays off consistently," Bolton said. "Studies of the economic return on basic research show steady returns year after year. It just clicks. You get something back, maybe not in six months, maybe not even in six years, but you get something back."

The nation, DOE and the state of Kansas are seeing a tremendous return on the investment in K-State and the Macdonald Lab. Rudenko, Bolton, Rosowsky and their teams remain laser-focused on the future.

Back to the lab

Macdonald Lab teams combine high-end laser beams, sophisticated detectors, electronics and software to measure reactions involving individual atoms in molecules moving at unfathomable speeds. The lab contains some of the most advanced instruments in the world that help shed light on the innermost workings of particles. One thing is certain: The lab will continue to evolve and remain a valuable asset to the brilliant scientists who seek new discoveries.

As you leave the basement lab and prepare to ascend the stairs to the lecture halls on the first floor of Cardwell Hall, a sign on the wall sits in silent testament to the history of one of K-State's most successful labs: The James R. Macdonald Laboratory, An Atomic Physics Research Facility Funded by the U.S. Department of Energy.

James R. Macdonald would be proud of what his namesake has become. But pay attention — if you blink you'll miss it. k

Seek more

Read more about the people behind the research projects at the James R. Macdonald Laboratory.

ANATOMY OF A BREAKTHROUGH

The science behind some of today's health challenges

By Michelle Geering

From the discovery of germs and their role in illnesses, to the introduction of anesthesia for pain prevention during surgery, to the use of insulin as a diabetes treatment, to unearthing the secrets of DNA, scientific research over the decades has improved human health. At Kansas State University, researchers are leaders in areas such as vaccine development, cancer screening technology and biomedical applications.

Every experiment plays a part in future progress. Researchers and students at K-State are working across a variety of disciplines to solve some of today's human health challenges. The next breakthrough in human health could be just around the corner and discovered in a K-State laboratory.

Small specimen, big possibilities

Curiosity drives scientific innovation. For Erika Geisbrecht, professor of biochemistry and molecular biophysics in the College of Arts and Sciences, understanding the why and how fuels her passion for discovery.

Protein aggregate diseases are disorders caused by abnormal protein accumulation in cells. They can result in neurodegenerative diseases, such as Alzheimer's disease, Parkinson's disease or muscular disorders like myofibrillar myopathy. Currently, there is no known cause or cure for these diseases.

The fruit fly may hold the answers.

According to Geisbrecht, the fruit fly has similar genes to humans, making it a great model organism. By studying the fruit fly, or *Drosophila melanogaster*, Geisbrecht is able to understand how muscle diseases form and affect human health.

"For 80% of the known human disease genes, the fruit fly has a similar gene that performs the same function in the cell," she said. "Even though the body structure of a fruit fly looks different, all of the basic proteins and genes that make up the organism are the same. We can then mutate a gene in the fruit fly and follow it throughout embryonic development — where all muscles are made — and study through the entire life span."

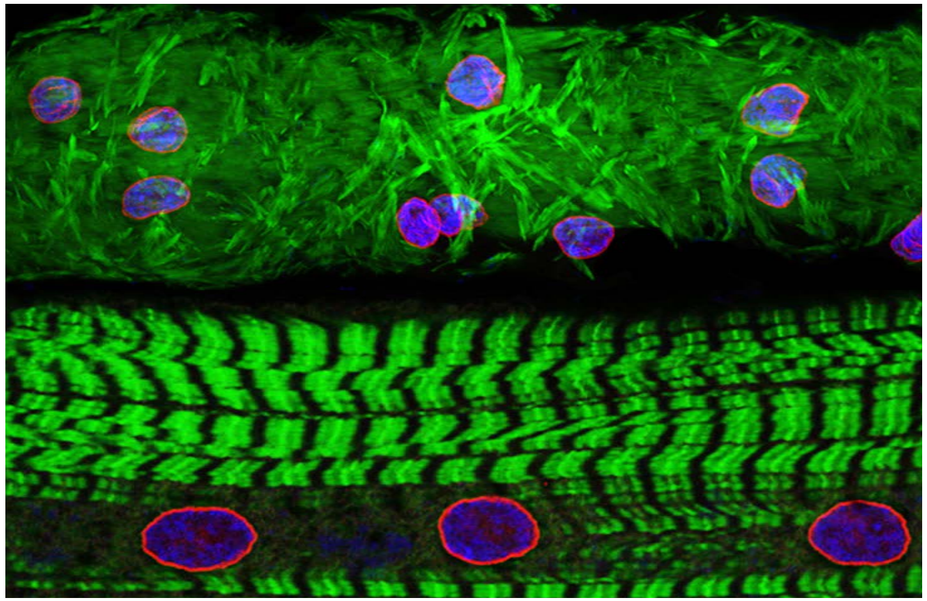
Geisbrecht said many proteins for muscular diseases are in cells throughout the body but only affect the cells in muscle tissues. With nearly $2 million in National Institutes of Health funding, researchers in her lab study the consequences of gene mutations to understand how muscle degeneration and disease occur.

"The work we do in my lab is important to understanding the basic biology of how things work," she said. "Muscle diseases are incredibly understudied, but also applicable to understanding certain neurodegenerative diseases since the mechanisms of the diseases are similar. We have made great progress in understanding how cells function."

In addition to understanding cell function, another important aspect of her work in the lab and classroom is preparing students to take what they learn at K-State and apply it in their future careers.

"It's really important for students to see basic research, understand how it's done and then translate that into future patient therapy," Geisbrecht said. "They are the future of science. They see that research takes time and can understand why we don't have a cure for some diseases."

> "It's really important for students to see basic research, understand how it's done and then translate that into future patient therapy."
>
> – ERIKA GEISBRECHT



Left: *This image compares healthy and diseased fruit fly muscles. The bottom panel shows patterns of healthy muscles with the DNA and nuclei shown in purple and red. The top panel shows a diseased muscle and shows the loss of muscle integrity and smaller, displaced nuclei. (Photo credit: Erika Geisbrecht)*

Right: *Erika Geisbrecht, left, and Jared Ridder use the fruit fly as a model organism to understand how muscle diseases develop and affect human health.*

Above left: *Yanli Wang, right, works with a participant in a blood pressure education workshop.*

Above right: *Tandalayo Kidd, left, and Yanli Wang discuss options on how to present blood pressure educational materials to study participants.*

Engaging for the heart

According to the high blood pressure guidelines released by American Heart Association and American College of Cardiology in 2017, nearly 50% of American adults have hypertension, or high blood pressure. The general public needs help to better understand the risks and effects that high blood pressure has on the body as well as how to control and manage blood pressure.

Yanli Wang, doctoral student in human nutrition in the College of Health and Human Sciences, has a solution that will soon be available in all 105 Kansas counties, thanks to a partnership with K-State Research and Extension.

For her graduate research, Wang held focus group discussions to get a baseline understanding of what adults know about high blood pressure. This information provided direction for educational materials and intervention workshops Wang held in early 2023 to help adults broaden their knowledge on preventing and controlling high blood pressure, especially in nonpharmaceutical ways.

Wang found that those surveyed had limited or inaccurate information about high blood pressure, the effects high blood pressure has on different organs in the body, the role nutrition plays in regulating blood pressure and the myth that medication is the only way to control blood pressure levels.

"I did notice some misconceptions about high blood pressure," Wang said. "Additionally, most participants only had a very basic knowledge of blood pressure, but did not understand how it affects the body — the heart, the arteries, the brain, the bones and the kidneys."

Tandalayo Kidd, food, nutrition, dietetics and health department head and professor, challenged Wang to provide information that was not readily available to the general public in an engaging format.

"For the majority of people on high blood pressure medication, they can make some lifestyle changes to decrease the amount of medication being taken or completely go off it," said Kidd, who is also a registered dietician and licensed practical nurse. "If someone is told to modify their diet to control high blood pressure, they need to know how best to do that. For instance, eating potassium-rich foods and lowering sodium intake are beneficial in lowering blood pressure. There is a natural, biological relationship between sodium and potassium — the more potassium-rich foods consumed, the more sodium is excreted from the body through urine."

Through a pilot study, Wang tested the effectiveness of the educational materials she developed. Participants either participated in a four-week intervention group by attending 30-minute workshops or received the educational materials to review on their own.

Once finalized, Wang's educational modules and information packets will be available through K-State Research and Extension.

Understanding blood pressure numbers

Blood pressure measures the force of blood on artery walls. The first number in a blood pressure reading is the systolic blood pressure, which is the pressure in arteries as the heart beats. The second number is the diastolic blood pressure, or the pressure in arteries as the heart rests between beats.

- **Normal:** Less than 120 mm Hg systolic and less than 80 mm Hg diastolic.
- **Elevated:** 120-129 mm Hg systolic and less than 80 mm Hg diastolic.
- **High blood pressure – stage 1:** 130-139 mm Hg systolic or 80-89 mm Hg diastolic.
- **High blood pressure – stage 2:** 140 mm Hg systolic or higher or 90 mm Hg diastolic or higher.
- **Hypertensive crisis (contact doctor immediately):** Higher than 180 mm Hg systolic and/or higher than 120 mm Hg diastolic.

Source: American Heart Association

Improving daily life

An estimated 5-10% of Americans live with language, speech, swallowing or hearing disorders. Individuals experiencing issues with articulation, fluency, voice and resonance, language, cognition, hearing, swallowing, social communication and communication modalities can get help and support at K-State's Speech and Hearing Center.

"Our practice focuses on the needs of the population across the life span," said Melanie Hilgers, clinic director and clinical associate professor. "The center provides quality services to those with communication, hearing or swallowing issues, as well as quality education and training to future speech-language pathologists."

Dysphagia, or swallowing difficulty, is a unique component studied in speech-language pathology. This field has traditionally focused on concerns with sound and word production, but swallowing difficulties tie in closely with these areas and have become part of speech-language pathologists' work. This disorder is common in aging adults and in individuals with neurological disorders, such as Parkinson's disease, or those who have had a stroke, traumatic brain injury or feeding disorder. Dysphagia can lead to choking or aspirating food, poor nutrition, dehydration and other medical concerns.

Jane Garcia, professor of applied human sciences in the College of Health and Human Sciences, specializes in communication and swallowing disorders caused by neurological disorders. Her research explores using thickened liquids as an intervention tool to assist in safe beverage consumption for those with swallowing disorders. Garcia said the level of diet modification is adjusted to the needs of each patient and can be used in tandem with restorative swallowing therapies.

"Thin liquids, like water, are challenging to swallow as they move fast and their control in the mouth can be difficult when swallowing is impaired," Garcia said. "By making thin liquids a little more viscous, patients may be able to swallow beverages safely and lessen their risk of health complications like aspiration pneumonia or the need for a feeding tube. When individuals are able to safely continue to take food and drink by mouth, it is important for recovery and quality of life." k

> "When individuals are able to safely continue to take food and drink by mouth, it is important for recovery and quality of life.
>
> - JANE GARCIA

Jane Garcia, center, uses a 3D model to teach students, Katie Zimmerman, left, and Kara Rodriquez about swallowing disorders.

Seek more

Watch a video and learn more about the Speech and Hearing Center.

Food and agriculture systems innovation

Digital agriculture and advanced analytics

Risk and reward

In challenging times, K-State researchers step up to help farmers

By Pat Melgares

Say this about modern-day farmers: They're a resilient bunch. They have to be. Surviving in a business that feeds billions of people worldwide includes navigating the uncertainties of weather, fluctuating prices, natural disasters, environmental regulations, crop pests, livestock diseases and more.

"The key lies in the meaning of life," said Mark Gardiner, who owns Gardiner Angus Ranch in Ashland, Kansas, with his family. "As farmers, we are fortunate to have this life. All walks of life have strife. You can choose to live or die. We choose to live and be thankful. Like many before us and after us, you get back up and go to work one step at a time."

Six years ago — on March 6, 2017 — Gardiner narrowly escaped as a devastating wildfire swept through much of southwest Kansas and northwest Oklahoma. Known as the Starbuck Fire, the wind-whipped blaze torched an estimated 800,000 acres in the two states, including 480,000 acres in Clark County, Kansas.

In the aftermath, the fire's devastation was unmistakable across the region as well as at the Gardiner Angus Ranch, where 44,000 of the farm's 48,000 acres had burned, taking along with it 600 cows, 270 miles of fence, 7,500 large bales of hay, several implements and farm structures, and Mark Gardiner's family home.

Most other challenges of today's farm families are less sudden. But they can be just as harsh. It's a reality that Kansas State University aims to ease through research focused on helping people like Gardiner as they navigate the modern-day farm.

Clark County rancher Mark Gardiner walks among a herd of cattle at Gardiner Angus Ranch near Ashland, Kansas. (Photo credit: Gardiner Angus Ranch/ Julie Tucker)

Above: *Despite a devastating fire that wiped out much of his business — and nearly took his life — Mark Gardiner continues to thrive. (Photo courtesy of Gardiner Angus Ranch)*

Right page: *Photo credits: Top left and both bottom photos are from Gardiner Angus Ranch/Julie Tucker.*

Navigating risk

The Kansas Department of Agriculture lists agriculture's economic impact in the state at $76 billion, supporting more than 256,000 jobs — about 14% of the state's workforce. Kansas has more than 45 million acres of farmland, which makes up 87.5% of all Kansas land. More than 21 million acres are harvested for crops and 14 million are for grazing animals.

> "You never really get away from risk in this business."
>
> - PAT JANSSEN

The Federal Crop Insurance Corp. reported that Kansas farmers were paid more than $1.8 billion in 2022 to cover losses in crop production. But that only takes into account those who grow crops, and only those who had purchased crop insurance.

"You never really get away from risk in this business, but if you take care of that side of your operation properly, and have crop insurance, well then you'll still be here to play another year," said Pat Janssen, who farms near Dodge City.

In the K-State College of Agriculture, agricultural economists, too, have helped farmers build their safety net. As one example, Edward Perry and Jisang Yu, both associate professors, and Jesse Tack, professor, reported findings of a 2020 study that indicated a 1 degree Celsius increase in temperature was associated with farmers' yield risk increasing by approximately 32% for corn and 11% for soybeans — two major crops in Kansas.

Yu said production losses linked to drought are even larger than those linked to heat — and larger still in instances where heat and drought are combined.

That information is important to farmers' annual decisions on such input costs as seed and fertilizer, based on their yield goals. Tack notes that when forecasts indicate the likelihood for increased heat and drought, producers may devote fewer inputs to production — much like investors shy away from risky stocks.

Yu describes his research as examining the production impacts of crop insurance and the effect of weather on the "riskiness of farming."

"For farmers, the most important element in the context of risk management is to have a clear objective so that they can optimize production accordingly," Yu said.

"I would liken farming to a chess match rather than gambling," Janssen said. "Through strategic planning and having a plan for six months or even two years down the road, you can mitigate a lot of risks."

Drought hits hard

Few topics raise eyebrows in farm country like water, especially having enough of it. For most of the past decade, farmers raising crops on dryland, or nonirrigated, acres have labored in drought, often hoping that all-too-infrequent rains will come at just the right time when crops can use it.

Chip Redmond, manager of the Kansas Mesonet, which is a K-State network of weather stations, said defining drought is difficult. The National Integrated Drought Information System, a program administered by the National Oceanic and Atmospheric Administration, has more than 150 definitions of the word.

The definition that seems to stick: "A deficiency of precipitation over an extended period of time … resulting in a water shortage." Agricultural drought happens when crops and livestock are affected.

In any case, drought affects most of Kansas. As of January 2023, the U.S. Drought Monitor listed 87 of the state's 105 counties with U.S. Department of Agriculture disaster designations, which affects just under 2 million people — two-thirds of the state's population. The same agency lists 2022 as the 17th driest year on record, based on 128 years of Kansas data.

For nearly a dozen years, K-State researchers have been getting ahead of some drought concerns by conducting research in other countries where semi-arid and drought conditions are the norm. The university currently hosts four projects — called Feed the Future innovation labs — funded by the U.S. Agency for International Development.

These labs address important drought-related issues, such as growing crops — sorghum, millet and wheat —that rely less on irrigated water; sustainability and increasing productivity without damaging the environment; and wheat genetics. Another university innovation lab addresses post-harvest food losses. Together, the four labs conduct work in 12 countries and three continents.

"We work in the Sahel region across the entire African continent from Senegal to Ethiopia," said Tim Dalton, director of K-State's Feed the Future Innovation Lab for Collaborative Research on Sorghum and Millet. "One major issue we have is to improve heat and drought tolerance of sorghum and millet grown in these regions. Insight on what works there is relevant for Kansas and is one of the clearest examples of why global cooperation is so important."

"As we've seen the past year with the war in Ukraine, nobody has the benefit of being completely isolated by local decisions in agriculture," said Susan Metzger, director of the Kansas Center

for Agricultural Resources and the Environment at K-State. "Being connected to not only the exchange of commodities, but also having a community that exchanges knowledge and discovery is so incredibly important."

Jonathan Aguilar, an irrigation engineer at K-State's Southwest Research and Extension Center in Garden City, said in-state studies to manage water more effectively are a major focus of many K-State Research and Extension activities in western Kansas.

"One area in which K-State can help farmers is on how to prepare their currently irrigated land to dryland farming while they still have access and infrastructure for irrigation water," said Aguilar, also an associate professor in the Carl and Melinda Helwig Department of Biological and Agricultural Engineering in the Carl R. Ice College of Engineering.

K-State researchers have been national leaders in drip irrigation technology, a system of hoses either on or below the ground to deliver water and nutrients directly to the plant's root zone. Aguilar and a team recently completed a project on the feasibility of implementing mobile drip irrigation — in which polyurethane tubes similar to garden hoses are attached above ground to a center pivot sprinkler — in western Kansas.

"We found that about a 35% reduction in soil surface evaporation can be achieved during the early stages of a crop," he said. "But adoption by farmers is so far slow due to such factors as overall system management, cost and modified cropping practices."

Still, Aguilar believes researchers are on the right track.

"Since the limiting factor in western Kansas is water, improving soil health will be key to capitalizing on the precipitation that dryland farmers can rely on," Aguilar said. "Through research, we've found that crop rotation, insect and weed management, crop variety selection and better cropping practices will be key in helping transitioning dryland farmers to be economically competitive."

> "Since the limiting factor in western Kansas is water, improving soil health will be key to capitalizing on the precipitation that dryland farmers can rely on."
>
> - JONATHAN AGUILAR

Managing the Ogallala Aquifer

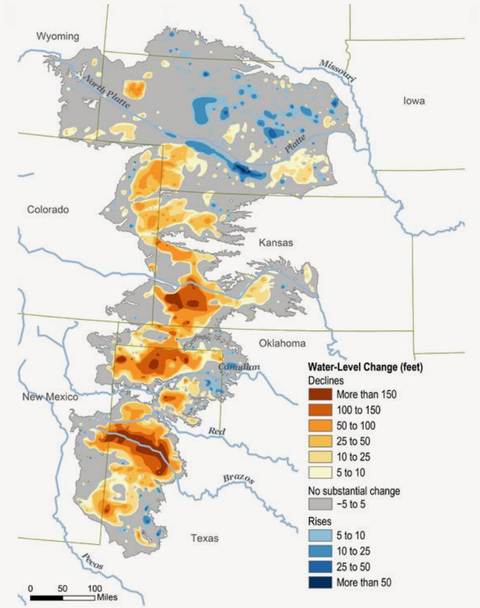
No discussion of Kansas water and agriculture is complete without talking about the mighty Ogallala Aquifer, a shallow water table aquifer that stretches across 174,000 square miles and touches parts of eight states, including the western third of Kansas. The Ogallala Aquifer is part of the High Plains Aquifer, which includes the Great Bend Prairie and Equus Beds aquifers in south central Kansas.

The Ogallala Aquifer provides far more water for Kansas croplands than any other aquifer in the state. Various sources indicate that 80% to 95% of groundwater pumped from the Ogallala Aquifer goes to irrigated agriculture.

The problem is that the Ogallala Aquifer is not an infinite resource, and the rate at which water has been taken out over 100 years has far exceeded the rate at which the aquifer has recharged itself.

"Given the depth to water, groundwater usage and the semi-arid climate, the Ogallala tends to be in a state of decline," said Brownie Wilson, a GIS/Support Services manager with the Kansas Geological Survey's geohydrology section.

K-State, West Texas A&M University and Texas A&M University formed the Ogallala Aquifer Program, or OAP, in 2003 to develop a long-term approach to quickly address emerging research questions related to the aquifer. Funded by the USDA, the OAP competitively funds one or two years of research for immediate projects related to the Ogallala Aquifer, Metzger said.



Left: The Ogallala Aquifer stretches 174,000 square miles across parts of eight states, including much of western Kansas, which is an area considered one of the most fertile agricultural regions in the U.S. This map shows the water level changes from before the Ogallala Aquifer was tapped to 2015. (Graphic credit: Fourth National Climate Assessment/U.S. Geological Survey)

Right: K-State researchers are closely involved in efforts to conserve water in the Ogallala Aquifer region.

> “In the past, a volunteer fire department may respond to a fire and be done in two to four hours. Now, fires are lasting days.
>
> - MARK NEELY

“Projects have ranged from soil health practices to economic questions such as what the boom in the dairy industry is going to do to the value of water in the state,” Metzger said. “Literally hundreds of questions have been answered within one to two years from when they were first posed. These are rigorous research projects because of the OAP partnership.”

In early 2022, K-State agricultural economists Gabe Sampson, associate professor, and Nathan Hendricks, professor, reported study findings that land values in the Ogallala Aquifer region are $3.8 billion greater today than they would be without access to the aquifer, largely because of crop production on that land. But they also studied cattle production and found that access to the aquifer increased animal sales by $2.4 million annually in Kansas and increased the number of cattle on feed by 2.4 million head.

So how much water is left in the aquifer? Wilson said it’s hard to know exactly, but the Kansas Geological Survey draws its estimates on the Ogallala Aquifer’s life by assuming a minimum flow rate of 200 gallons per minute over the course of the summer.

“With that metric, the lifetime answer varies by location and is driven by how much water is in the ground currently, how much is used each year and what the rates of decline are,” Wilson said. “Some areas of the aquifer have 25 years or less until they’re depleted; some have 100 years or more.

“Some are there already.”

Getting back to business

Dry grassland is only one factor that has contributed to wildfires in parts of Kansas in recent years. Mark Neely, the state fire management officer for the Kansas Forest Service, said some of the effective barriers against fire include grass strips mowed in different vertical arrangements; plowed or disked rows; moist bottom woodlands; and prescribed burns that reduce woody encroachments.

“A lack of prescribed fire on rangeland allows woody species to encroach, especially eastern red cedar, which provides a high fuel load that releases more energy and is harder to suppress,” Neely said.

Neely said the Kansas Forest Service, an independent agency in K-State Research and Extension, has fire personnel in six Kansas fire districts and provides assistance to local fire authorities. He said the agency typically responds to 20-30 fires per year, though fire incidents “have gotten bigger and more destructive.”

“In the past, a volunteer fire department may respond to a fire and be done in two to four hours,” he said. “Now, fires are lasting days, which is stressing the volunteer service and their employers.”

Since the 2017 Starbuck Fire, the Gardiner family has mostly rebuilt operations to pre-fire existence. Gardiner lauded K-State Research and Extension’s help, as well as support and guidance from such state organizations as the Kansas Livestock Association and the National Cattlemen’s Beef Association.

In fact, he added, Gardiner Angus Ranch may be stronger today because of the tough times.

“This event also restored my faith in mankind,” Gardiner said. “The outpouring of support from so many will never be forgotten. We ‘get’ to live this great life and business. My father, Henry Gardiner, always said, ‘We can do this … so let’s get to doing.’” k

Left page: *The March 2017 Starbuck Fire burned an estimated 800,000 acres in northwest Oklahoma and southwest Kansas. Charred grazing land and a large plume of smoke west of Gardiner Angus Ranch in Ashland, Kansas, tell the story of the devastation. (Photo courtesy of Gardiner Angus Ranch)*

Above: *Hot, dry conditions have contributed to wildfire risk in Kansas during the past decade. Cattle and crops have been resilient. (Photo credit: Gardiner Angus Ranch/ Julie Tucker)*

Seek more

Learn more about the challenges of the modern-day farm and explore additional resources.

The Sunderland Foundation Innovation Lab offers engagement, learning and research opportunities for community members such as Jarrett Lippert.

Where dreams come to life

Sunderland Foundation Innovation Lab offers a space of exploration and creativity

By Lindley Lund

Jarrett Lippert had always wanted a cup holder. The 15-year-old has spastic quadriplegic cerebral palsy and uses a wheelchair — one that lacked a cup holder. So, when Lippert visited Kansas State University's Sunderland Foundation Innovation Lab in Hale Library as part of Manhattan-Ogden USD 383's STEM Camp, one thing caught his eye: the 3D printers.

A few days later, a self-designed, royal purple cup holder adorned with a Powercat was attached to his wheelchair, fresh from the lab's 3D printers.

"It's a really cool cup holder, and it feels like I really accomplished something," Lippert said. "I'm grateful to the lab for helping me accomplish that dream of a cup holder."

Lippert's story is exactly what Jeff Sheldon, innovation lab associate director, had in mind when the idea for the lab was initiated in early 2018. K-State wanted to offer a state-of-the-art facility — the first innovation lab of its kind in the state of Kansas — with the latest innovative technology and tools for anyone in the community to explore and unleash their greatest creativities.

The lab helps K-State offer new engagement, learning and research opportunities for the university and community alike.

"People can come to the lab and be masters of their own domains," Sheldon said. "They can fail as many times as they need to be able to succeed, and they can learn at their own paces."

The innovation lab opened its doors in 2021 as part of the restoration and recovery following the Hale Library fire. The Sunderland Foundation gifted K-State with $2.5 million for the creation of the lab, which is a collaboration between the Division of Information Technology and K-State Libraries.

A facility for all

From an artificial intelligence studio to a recording studio, the innovation lab offers many resources that are used by researchers, students, community members and local organizations.

"The lab provided all the materials and equipment the students needed," said Hannah Sullivan, a K-State College of Education senior in music education who assisted with USD 383's STEM Camp focused on science, technology, engineering and mathematics.

The students in the camp, thanks to the equipment and materials from the lab, had the opportunity to take apart commonly used items and recreate them into something new, such as transforming a space heater into luggage that also had the ability to heat up food.

"The lab encourages critical thinking and problem-solving opportunities," said Gerae Cragg, a USD 383 teacher who helped teach the STEM Camp. "It helps develop those different skills that students might not get the opportunity to use every day."

It's that kind of creativity and imagination that the innovation lab staff members hope everyone unleashes when they enter the lab, regardless of their age.

"I think when you get older you kind of lose that for a variety of reasons. For a lot of people, it's that they don't have the tools and they don't have the space," said Tara Coleman, programming services coordinator for the lab. "We want to make that accessible. We want to open the lab up and give people that opportunity to explore and fix things on their own."

Advancing research and studies

For years, Melinda Cro searched for an immersive lab experience to advance her students' research and linguistic development. As a K-State professor of modern languages, she wanted to create an opportunity for students to fully explore the French language and immerse themselves in early modern culture in their own ways, such as understanding a 17th-century playwright's cultural and linguistic influence today.

Below: *Students use the sewing machines in the makerspace of the Sunderland Foundation Innovation Lab.*

> We want to open the lab up and give people that opportunity to explore and fix things on their own.
>
> - TARA COLEMAN

Above: *The Sunderland Foundation Innovation Lab leadership team includes, from left, Charles Appelseth, Tara Coleman, Jeff Sheldon and Jahvelle Rhone.*

Cro discovered the innovation lab and realized it was everything she needed. In the lab, her students had free rein to select resources that would benefit the research questions they had chosen to pursue. In using everything from the makerspace and Liquid Galaxy display to the 3D printers and One Button+ Studio, Cro's students researched and produced final projects that were anything but the traditional paper.

"Having a world-class, immersive lab that helps students to explore and prepare for a public engagement that pushes an interrogation of the medium of research and communication is invaluable," said Cro, also the College of Arts and Sciences assistant dean of students. "Spaces like this are imperative and help us to stretch our research and pedagogy in ways that prepare students to be accomplished and creative problem-solvers in the long term."

The resources in the lab also allow students to advance their studies beyond what they learn in the classroom.

"The lab equips students with lifelong learning tools and experiences by offering an opportunity to acquire technological skills and expertise that frequently go beyond the capacity of the individual departments and colleges," said Joe Mocnik, dean of K-State Libraries. "Transferable skills are probably the most important elements for long-term success and that is where our effort to enhance the technological literacies has been most successful."

Jake Roderick, freshman in fashion studies in the College of Health and Human Sciences, uses many of the technologies, including the 3D printers, makerspace and artificial intelligence studio.

"Having these resources available allows me to learn and have access to many tools that I did not realize could be applied to fashion," Roderick said. "The innovation lab can really be applied to almost any major. There are so many tools that can help inspire innovation in anybody."

See page 38 to learn how other fashion studies researchers are using the innovation lab.

Kansas is the clientele

The influence of the lab goes beyond the K-State Manhattan campus.

Heather McCrea, the Kenneth S. Davis professor of history, and Traci Brimhall, poet laureate of Kansas and K-State professor of English, conducted research on the Winfield State Training School, a now-closed mental health institution in Winfield, Kansas.

The research was presented in a pop-up exhibition in the Winfield Public Library, adorned with large-scale images from the Winfield State Training School that were created in the innovation lab.

"The tools and insights of employees and faculty at the Sunderland Foundation Innovation Lab were instrumental in transferring seemingly esoteric historic ephemera into meaningful visuals to draw public interest in lesser-known narratives of the past," McCrea said. "Professor Brimhall and I are grateful for the creative leadership offered by the lab to transform ideas into visual tools to bring history into dialogue with the present."

Studios and spaces

The Sunderland Foundation Innovation Lab includes multiple spaces for research and creative projects.

- Artificial intelligence studio.
- Collaboration spaces.
- Fabspace.
- Immersion studio. (coming soon)
- Liquid Galaxy display.
- Makerspace.
- Media studio.
- Media gallery.
- One Button+ Studio.
- Sound studio.
- Video production studio. (coming soon)

The innovation lab includes a fabspace with multiple 3D printers and other state-of-the-art technology.

The lab's leaders have the goal to continue connecting with people across Kansas to better shape K-State's community outreach and help support small businesses.

The work aligns with the university's Economic Prosperity Plan and K-State 105 initiative to engage with all 105 counties in Kansas.

"The lab is a place where you can literally walk in with an idea and walk out with a product," said Jahvelle Rhone, lab media coordinator. "We help people bring their ideas to fruition."

Innovation lab leaders also hope to strengthen the university's strategic plan to become the next-generation land-grant university by building partnerships with other higher education institutions who want to provide similar services.

"I try to always remember that Kansas is the community we serve," Sheldon said. "Kansas is our clientele and we want it to be a place for everyone."

The lab makes connections beyond the state and has been involved in virtual events featuring national agencies.

From August to December of 2022, the lab hosted a location for a virtual national security innovation training by the Defense Advanced Research Projects Agency from the U.S. Department of Defense. During these events, researchers had the opportunity to come together to watch a high-quality viewing of the training.

"I see how the seed that the Sunderland Foundation Innovation Lab planted is sprouting into a major focus to put our institution on the leading edge of academic evolution," said Gary Pratt, K-State vice president for information technology and chief information officer.

Whether it's a national security training, a cross-century cultural analysis project or a K-State cup holder, the innovation lab is here to support all Kansans, and Americans, in whatever they may set their minds to.

"It's a great opportunity for anyone who has a dream and wants it to come to life," Lippert said.

Seek more

Read more about the Sunderland Foundation Innovation Lab.

Jarrett Lippert created this cup holder using the 3D printers in the innovation lab.

Artists can use the resources in the innovation lab's makerspace to strengthen their calligraphy skills.

A statewide network

New partnership strengthens communities across Kansas

By Erin Pennington

Kansas State University and NetWork Kansas are partnering to create a statewide network of committed, creative partners to advance community vitality, increase small business startups, expand existing businesses and increase direct investment attracted to all 105 counties in the state.

NetWork Kansas advances communities by supporting entrepreneurship-led economic development. The statewide initiative that involves K-State will address specific community and business needs to enable economic growth, including:

- Technical assistance.
- Access to capital.
- Child care.
- Infrastructure.
- Housing.

The initiative will build on K-State's status as a leader in community vitality and NetWork Kansas' partner networks and e-communities throughout the state by focusing on creating sustainable growth across the state through:

- A statewide economic development liaison network.
- Regional, community and business support.
- Support for business creation and expansion.
- Workforce development.
- Technical solutions for Kansas companies.

While urban and rural communities have similar challenges, including moderate-income housing, child care and health care, there are major distinctions that require different models of engagement. For this reason, the initiative will initially establish two Learn Together community partnerships that will allow it to build effective programs to address the distinct challenges of urban and rural Kansas communities.

The urban Learn Together partner is GO Topeka. The partnership creates success for companies and entrepreneurs through an aggressive economic development strategy that capitalizes on the unique strengths of the Shawnee County community.

The rural Learn Together partner is the Northwest Kansas Economic Innovation Center Inc., or NWKEICI, which provides economic and entrepreneurial assistance to businesses in northwest and north central Kansas. The private operating foundation serves 26 counties in the region with various programs.

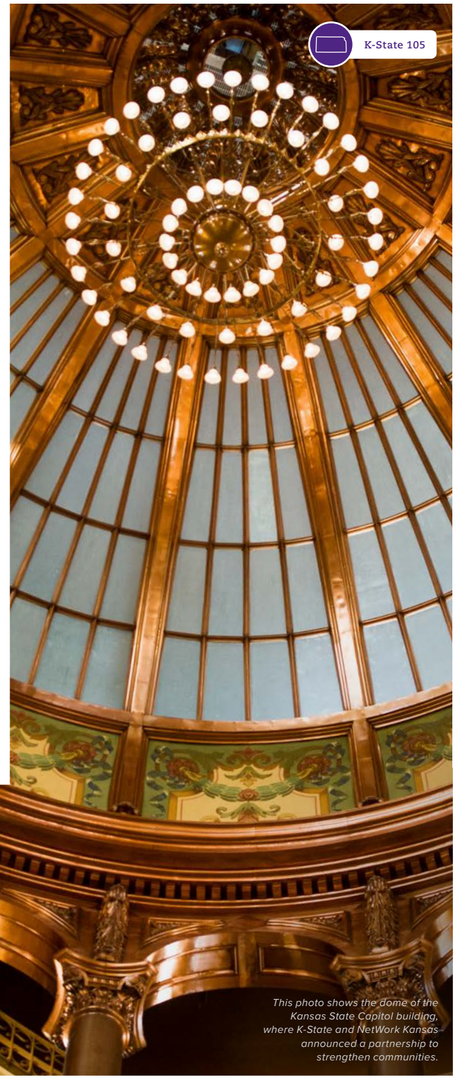
Together, with these partners, K-State will connect university resources to address individual community challenges.

"We firmly believe that if civic and community leaders are committed to locally driven growth strategies and are connected to a broad range of technical, business and support services, all communities can grow and thrive," said Richard Linton, K-State president.

See page 4 to learn more about the K-State presidential community visit initiative to continue engaging with all 105 counties in Kansas.

Seek more

Learn more about the NetWork Kansas partnership with K-State.



This photo shows the dome of the Kansas State Capitol building, where K-State and NetWork Kansas announced a partnership to strengthen communities.

A novel inventor

Scientist's hydrogel work aids in cancer research

By Jarrett Whitson

Xiuzhi "Susan" Sun has a research career full of patented success.

Sun, a university distinguished professor at Kansas State University, has an achievements list that includes creating the Biomaterials and Technology Lab and receiving 16 U.S. and international patents.

One of her patented technologies is a peptide-based hydrogel called PepGel, which Sun discovered in 2009 while studying peptide structures and adhesion properties with students in her lab. They noticed their sample became a liquid and then turned back into hydrogel. This self-healing trait is what makes PepGel uniquely applicable to tissue engineering as well as testing drug efficacy, toxicity and delivery.

"We were amazed because we thought it could have a lot of life science and medical applications," said Sun, who researches in the grain science and industry department in the College of Agriculture and the Carl and Melinda Helwig Department of Biological and Agricultural Engineering in the Carl R. Ice College of Engineering.

The researchers quickly filed and received their first patent in 2014 and have since received three more PepGel-related patents. The research led Sun to create PepGel LLC, a startup company that offers products and services — such as cell expansion and 3D drug testing — to labs and companies.

"PepGel is a novel tool for cancer research because it can aid in designing drugs to provide more accurate testing results," Sun said.

Sun has been growing various cancer cells in PepGel to study effective drug treatments. Her research shows that some shapes of cancer cells are very easy to cure, while others can develop drug-resistant behavior and present more challenges.

Additionally, Sun and her team have successfully modified PepGel and culture conditions to grow stem cells such as human-induced pluripotent stem cells, or hiPSCs. These cells are derived from skin or blood cells and enable the development of an unlimited source of any type of human cells needed for therapeutic purposes. Sun is using them in 3D models to test the efficacy and toxicity screening of drugs, as well as food compounds and medicines.

"We generated a 3D colony of hepatocytes — a type of liver cell — differentiated from the hiPSCs," Sun said. "They have very good gene markers that are closer to real human liver cells than other existing technologies. We hope we can generate hepatocytes good enough for liver cell therapy usage, but for now the cells we have are very good for drug testing."

Below left: *This vial contains PepGel, which is a patented peptide-based hydrogel that Xiuzhi "Susan" Sun created in 2009.*

Below right: *Sun experiments with PepGel in her lab.*

Resounding resilience

Military trauma specialist finds common theme in long-term study

By Malorie Sougéy

You might think studying trauma can only lead to dark places, but Briana Nelson Goff has learned otherwise during the course of more than 30 years of trauma research.

Through a career studying military trauma, as well as international and disaster trauma, she has found a common thread among trauma survivors.

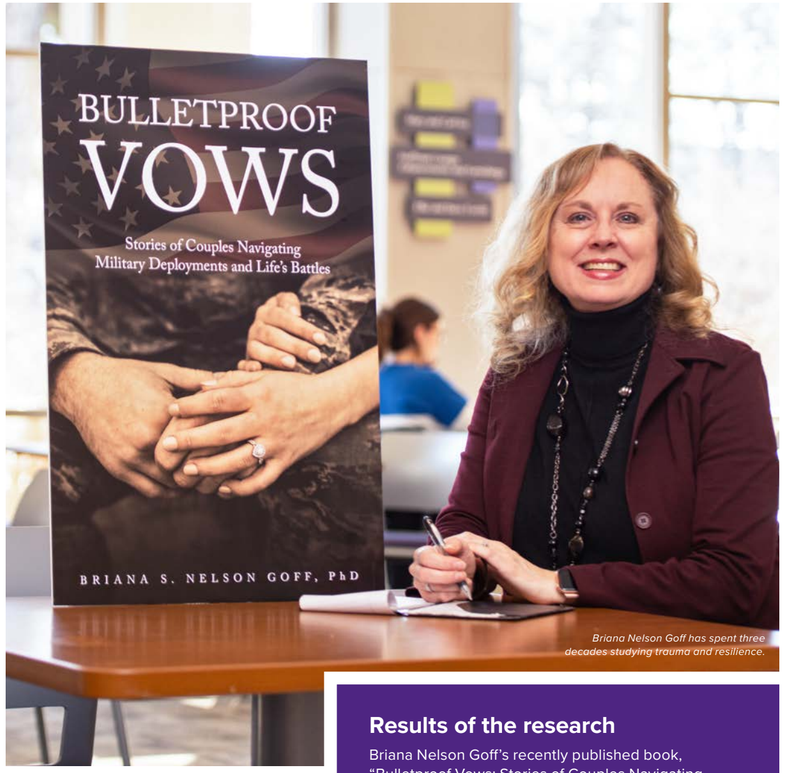
"Resilience is a part of every trauma survivor's journey — and they have so much resilience," she said.

Nelson Goff, professor of applied human sciences in the Kansas State University College of Health and Human Sciences, conducts research focused on trauma and PTSD in couples and families. In 2005, she began a long-term study on the topic with 50 military couples stationed at Fort Riley and Fort Leavenworth, both in Kansas.

Using data collected through interviews and surveys, she and her team of students analyzed relationship satisfaction as it related to PTSD, or post-traumatic stress disorder, symptom measures. They found that PTSD has a negative effect on relationship satisfaction, something Nelson Goff had suspected but never before had quantitative data to support. Even so, many couples said they grew from the experiences.

"I remember being amazed and honestly shocked at the resilience they described," Nelson Goff said. "They described how they survived the deployments and other traumas and how they were better because of — or despite — those experiences. They had hope for the future."

In 2015, 10 years after the first interviews, Nelson Goff conducted a follow-up study with 26 of the original couples. With information spanning 10 years — before, during and after deployments — Nelson Goff found that despite the adverse effects of PTSD on relationship satisfaction, most couples endured and adapted.



Briana Nelson Goff has spent three decades studying trauma and resilience.

"The soldiers saw death and destruction — all the horrors of war," said Nelson Goff. "Many deployed and came home multiple times. The soldiers and spouses supported each other through it all. They show us resilience is possible."

Throughout her career, Nelson Goff has authored more than 40 academic publications about the effects of trauma on the couple relationship. k

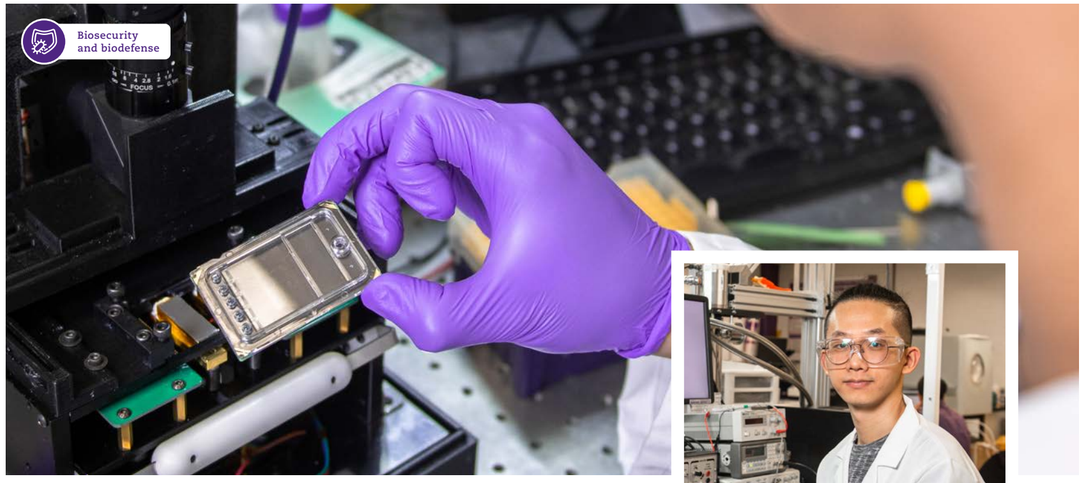
Results of the research

Briana Nelson Goff's recently published book, "Bulletproof Vows: Stories of Couples Navigating Military Deployments and Life's Battles," is the culmination of more than 30 years of trauma research. It tells the stories of eight post-9/11 Army couples, interviewed first in 2005 and again in 2015.

"This book gives us a glimpse into their lives, but it also provides hope," said Nelson Goff. "Hope that even after enduring combat, war, disability and death, there is still life to live."

Seek more

Read more about the recently published book.



Lab on a chip

Changing *E. coli* detection with electrical signals and droplets

By Jarrett Whitson

Shiga toxin-producing *E. coli*, or STEC, causes more than $342 million in annual economic losses nationwide, according to the U.S. Department of Agriculture.

Kuan-Lun Ho wants to solve that.

Ho, doctoral student in mechanical and nuclear engineering in the Kansas State University Carl R. Ice College of Engineering, is making STEC testing more accessible and more efficient throughout the beef industry in Kansas and beyond.

Ho works under the guidance of faculty mentor Shih-Kang "Scott" Fan, professor in the Alan Levin Department of Mechanical and Nuclear Engineering. Ho is researching the application of digital polymerase chain reaction, or dPCR, testing and digital microfluidics, or DMF, for the detection of STEC.

Beginning with a bulk droplet from a beef culture broth containing PCR reagents and STECs, Ho places them onto a DMF chip that he helped create. Next, he applies electrical signals to make many tiny droplets and move them into microwells before applying more electrical signals of different frequencies to trap the STECs in the microwells.

"A lot of people can use microwells on their device but our specialty is that we can apply the electrical signals to the droplets," Ho said. "That means we can use the electrical signals to capture the specific type of *E. coli* we want and distinguish between live and dead STECs."

That's important because the researchers want to target live STECs that can make people sick or even die.

"The diagnostic method — traditional PCR — cannot differentiate between live and dead STECs," Ho said. "Traditionally, people need to perform an additional culture step to ensure there are enough viable STECs for detection. However, we do not require a culture step and can detect live STECs on our platform."

Another important aspect of Ho's research is multiplex digital PCR. This uses chemicals in a PCR reagent, called primers and probes, designed to give a fluorescent signal during the reaction. Ultimately, this allows Ho to design different colors for different types of *E. coli* and makes it easier to detect STEC.

"Kuan-Lun showed significant improvements and aims to implement a novel lab-on-a-chip technique to enrich food safety and health care," Fan said.

Ho is also part of a NASA-funded project that is studying radiation-induced cancer biomarkers. The project is a NASA Established Program to Stimulate Competitive Research, or EPSCoR, grant that also involves other researchers at Kansas State University, Wichita State University and the University of Kansas Medical Center.

Ho is using DMF chips to manipulate cell-containing hydrogels and media for cell culture, specifically cultured liver and colon cells, to study the effects of radiation. k

Above left: *Kuan-Lun Ho places a cartridge onto a digital microfluidics system before adding oil and samples.*

Above right: *Ho is improving Shiga toxin-producing E. coli detection to advance food safety in the beef industry.*

A critical stitch

Fashion studies researcher designs firefighting gear for women

By Taylor Provine

Celeste Graciano is focused on finding the right fit in protective gear for firefighters who are women.

Graciano, senior in fashion studies in the College of Health and Human Sciences at Kansas State University, is working with faculty mentor Yingying Wu, assistant professor of fashion studies, who is leading the five-year project to understand problems with existing firefighting protective gear. The U.S. Department of Agriculture National Institute of Food and Agriculture is supporting the project. The team is creating new female-specific firefighting turnout coats and pants.

"Many firefighting personal protective equipment manufacturers do not provide gender-specific PPEs to firemen and firewomen," Graciano said. "Commonly, both firefighting turnout coats and pants have been designed for men and sized down for women."

This is problematic because it is critical to design gear that fits female body shapes well so that female firefighters can perform essential tasks, such as walking, reaching and climbing stairs while being well protected, Graciano added.

"Fit is a critical issue," Graciano said. "For instance, if a firewoman's gear is too big, it's going to add extra weight. For female firefighters with smaller frames, that extra weight might be detrimental depending on what situation they are in."

Using 3D body scans, the researchers were able to get a general representation for firewomen's body size and shape, which they found to be different from the general female population.

Celeste Graciano works on a prototype of firefighting turnout coats and pants for women.

Based on an understanding of firewomen's body shape and size, as well as their concerns over existing firefighting turnout coats and pants, Graciano is developing new female-specific designs that address several problem areas discovered in existing gear. Some problem areas have included bust and hip areas that are too tight, waist areas that are too tight, sleeves that are too long or inseams that are too short. Other problems are often not enough pockets and knee pads that are in incorrect locations.

"We wanted to add princess seams so we could contour it more over the bust and taper it in at the waist," Graciano said. "Other changes were for proportional needs, such as shortening the sleeves, coat and pants, and making them higher waisted."

The researchers have created a prototype of the female-specific coat and pants, which includes many of these changes. Graciano drafted much of the pattern by hand and then digitized the paper patterns using a scanner in the Sunderland Foundation Innovation Lab at Hale Library. See page 28 to learn more about the capabilities of the innovation lab and how it helps researchers.

The team is currently working on a second prototype, which will include material updates that are similar to traditional firefighter gear.

Wu's long-term project goals are to have the gear fitted in trials and patented to be commercially available for female firefighters. Graciano and Wu have presented this research at two international conferences and received a best paper award at the International Textile and Apparel Association annual meeting.

Wu said functional design research, particularly functional design research for underserved populations such as women, children and the elderly, is important and needed in the future.

"There are so many females in the workforce and their needs have been neglected," Wu said. "Once this project is completed, we are going to expand our findings to include females in other industries as well."

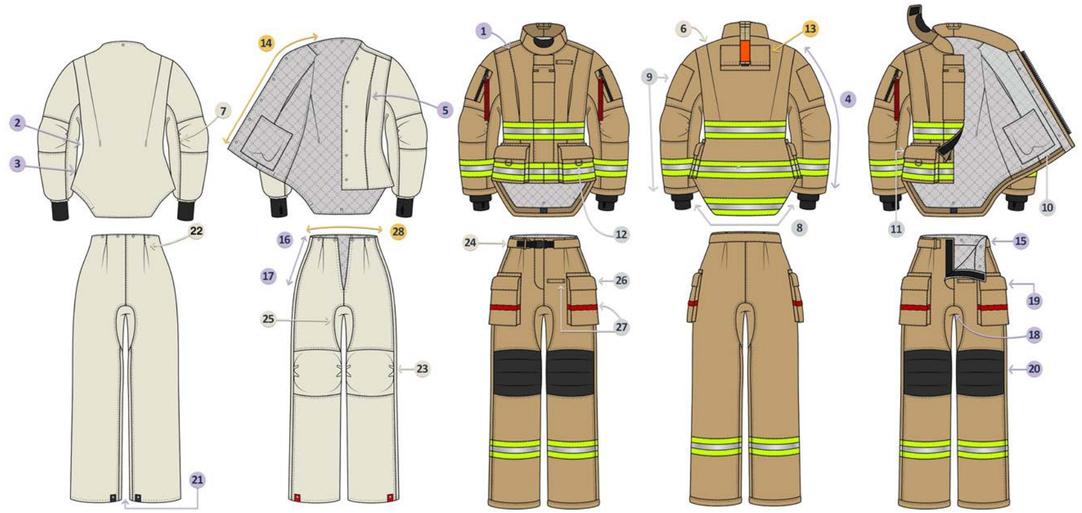
Seek more

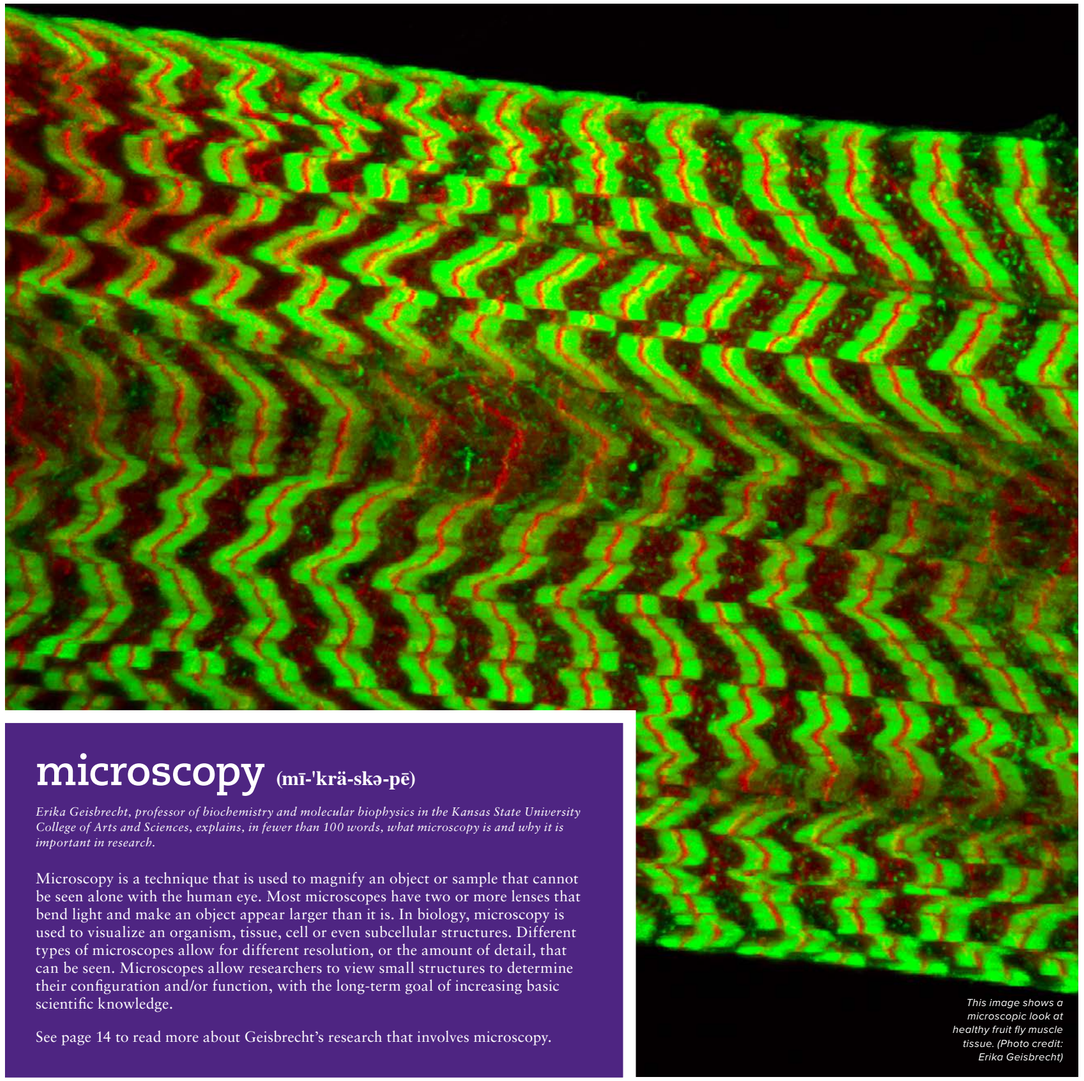
Watch a video about the research behind the firefighting gear.

Graphic below:
Celeste Graciano developed the digital prototype graphics below to show the proposed changes in the garment features for the turnout coat, pants and lining. (Graphic credit: Celeste Graciano)

Label	Turnout coat	Label	Turnout pants
1	Princess seams	15	High waist
2	Higher waist	16	Smaller at waist
3	Coat hip flare	17	Widens at hip
4	Shortened sleeves	18	Raised crotch
5	Bust pleat	19	Raised pockets
6	Expansion pleat	20	Raised kneepads
7	Elbow gathers	21	Shortened inseam
8	Tail coat	22	Waist pleats
9	Sleeve pockets	23	Knee gathers
10	Lining pockets	24	Adjustable waist
11	Patch pockets	25	Crotch gusset
12	Pocket d-rings	26	Patch pockets
13	Drag rescue device	27	Tool loops
14	Detachable lining	28	Detachable lining

Female features. Storage features.
Mobility features. Required by the National Fire Protection Association 1971.





This image shows a microscopic look at healthy fruit fly muscle tissue. (Photo credit: Erika Geisbrecht)

microscopy (mī-'krä-skə-pē)

Erika Geisbrecht, professor of biochemistry and molecular biophysics in the Kansas State University College of Arts and Sciences, explains, in fewer than 100 words, what microscopy is and why it is important in research.

Microscopy is a technique that is used to magnify an object or sample that cannot be seen alone with the human eye. Most microscopes have two or more lenses that bend light and make an object appear larger than it is. In biology, microscopy is used to visualize an organism, tissue, cell or even subcellular structures. Different types of microscopes allow for different resolution, or the amount of detail, that can be seen. Microscopes allow researchers to view small structures to determine their configuration and/or function, with the long-term goal of increasing basic scientific knowledge.

See page 14 to read more about Geisbrecht's research that involves microscopy.

A place of discovery

The laboratory is a place of innovation and discovery, no matter the decade. In this undated Kansas State University photo, students conduct soil tests in an early agricultural laboratory. Today, K-State is home to many laboratories where researchers seek to improve our world and our knowledge of it. See page 8 to read about the James R. Macdonald Laboratory that focuses on atomic, molecular and optical physics and see page 28 to learn how the Sunderland Foundation Innovation Lab offers engagement and research space for the university and community.

Photo courtesy of the Richard L. D. and Marjorie J. Morse Department of Special Collections.

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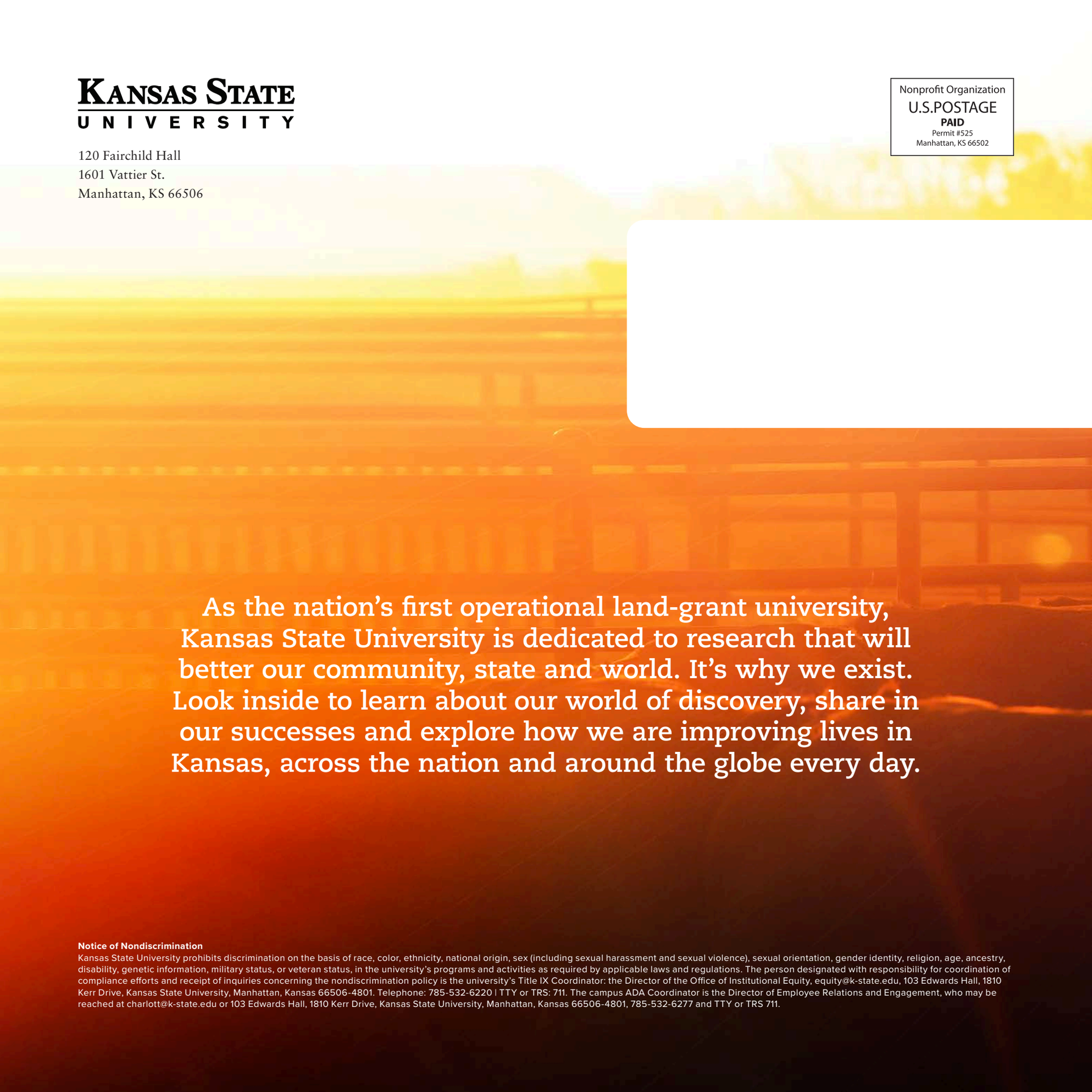

As the nation's first operational land-grant university, Kansas State University is dedicated to research that will better our community, state and world. It's why we exist. Look inside to learn about our world of discovery, share in our successes and explore how we are improving lives in Kansas, across the nation and around the globe every day.