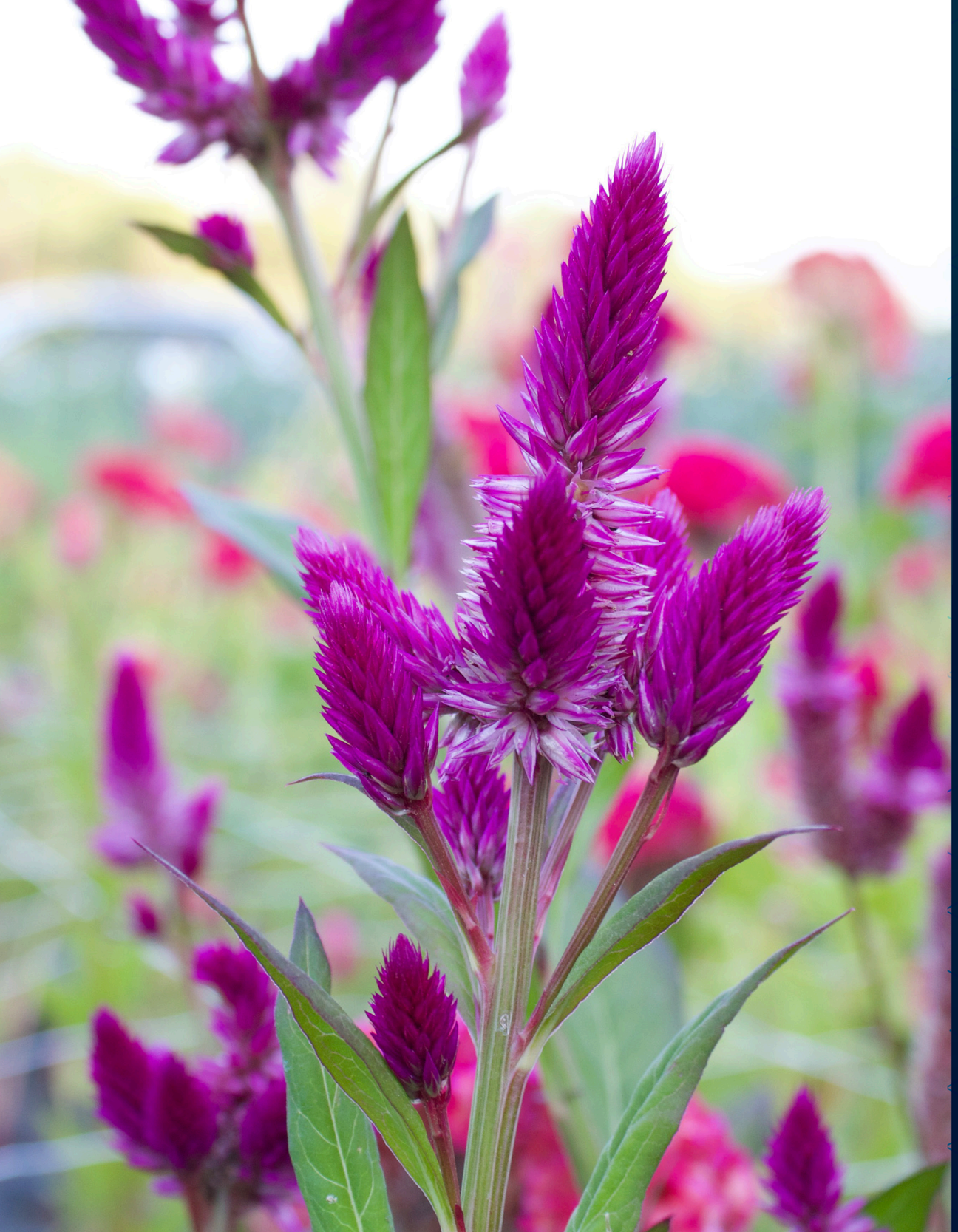
- 2023 -

STRATEGIC DISCUSSIONS FOR NEBRASKA

DATA DRIVES NEBRASKA

Technology Advancements Impact Agriculture and Natural Resources

UNIVERSITY *of* NEBRASKA–LINCOLN



“Technology may look different for every farmer or rancher in Nebraska, but technology will assist in advancing the next 20-30 years by increasing the ability to be sustainable.”

Travis Mulliniks, Department of Animal Science

INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES

University of Nebraska–Lincoln Institute of Agriculture and Natural Resources (IANR) focuses on people and the food, energy, water, natural resources, and communities that sustain them.

IANR scientific innovation in the land-grant mission areas of teaching, research, and Extension places Nebraska on the leading edge of food production, environmental stewardship, human nutrition, business development and youth engagement.

IANR comprises the College of Agricultural Sciences and Natural Resources (CASNR), the Agricultural Research Division (ARD), Nebraska Extension, and the ARD and Extension components of three departments in the College of Education and Human Services.

The Nebraska Legislature created IANR in 1973 through the enactment of LB149. IANR is committed to growing the future of Nebraska's people, businesses, and communities.

ABOUT STRATEGIC DISCUSSIONS FOR NEBRASKA

Strategic Discussions for Nebraska (SDN) is an annual publication covering research and Extension projects within IANR.

SDN shares the IANR story by translating research-based science to be understood by the general audience. SDN has been produced annually since 2008, each focusing on a different overall topic.

As their senior capstone experience, students in the Agricultural and Environmental Sciences Communication (AESC) in the Department of Agricultural Leadership, Education and Communication (ALEC) create all content for SDN.

Each year, University Communication provides graphic design support and IANR Media offers website design expertise. IANR provides funding, business, and liaison services for the production of this publication.

A sincere appreciation is expressed for the original vision and financial support of the Robert and Ardis James Family Foundation, which founded SDN in 2007.

DATA DRIVES NEBRASKA

STRATEGIC DISCUSSIONS FOR NEBRASKA 2023

We are pleased to present the 2023 edition of Strategic Discussions for Nebraska (SDN) – *Data Drives Nebraska: Technology Advancements Impact Agriculture and Natural Resources.*

SDN is an annual publication produced in the Institute of Agriculture and Natural Resources (IANR) that highlights faculty research, Extension projects, and student initiatives. One goal of SDN is to highlight topics that Nebraskans find useful. A second goal is to share the story of IANR by not only explaining notable initiatives but also highlighting the impact each initiative has on the state.

"SDN is a critical part of telling the narrative of our progress at IANR, through our amazing students, faculty, staff, and partners," said Michael J. Boehm, University of Nebraska Vice President for Agriculture and Natural Resources and Harlan Vice Chancellor of the University of Nebraska–Lincoln IANR.

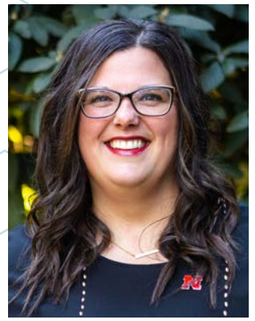
The hope for SDN is to connect Nebraskans with information about university efforts that might benefit them. In recent years, SDN has rotated through the six IANR communities as a publication theme. This 2023 edition begins that rotation over again, focusing on the overarching topic of *Computational Sciences and Technology* that was last highlighted in 2017 (visit sdn.unl.edu for a digital version of this edition).

Specifically, this edition outlines technology developments and the impact on people, animals, and plants. From GPS collars used to help ranchers, to spatial technologies used to track pronghorns and better understand their behavior, to using a video game to introduce youth to the impact of the Eastern Red Cedar – SDN explains these initiatives and offers websites to learn more and get involved. There are several topics for Nebraskans included – there is likely something for everyone!

New in 2023, this edition also includes several feature stories about unique projects in IANR. Most notably, the PGA golf management students providing students with unmatched exposure to technology, such as the TrackMan Golf Simulator and the College of Agricultural Sciences and Natural Resources (CASNR) offering Change Maker Scholarships for students to explore their innovative ideas. Further, a faculty member in the Department of Plant Pathology made predictions in 2004 about the future of plants – peek inside to see if these predictions came true! The feature stories offer an additional lens into IANR, showcasing fun, distinctive work.

Senior students in the Agricultural and Environmental Sciences Communication (AESC) program write the stories, take photos, and prepare promotional content for the SDN publication as part of their senior capstone experience. These writers are highlighted on the next pages with photos, majors, and hometowns.

Thank you for your continued support of the university and Strategic Discussions for Nebraska! We look forward to connecting with you. Follow us on Facebook and Instagram @sdn_unl or visit our website sdn.unl.edu to see all editions and more information.



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Students in the Agricultural and Environmental Sciences Communication program in the Department of Agricultural Leadership, Education, and Communication write the stories for the Strategic Discussions for Nebraska publication.

The senior capstone course provides a learning experience similar to those students may encounter in the workplace, emphasizing accurate, clear, and objective communication of science-based information.

During the course, students learn about scientific research being conducted at the university and the diverse funding sources required to support that research.

Throughout one semester, the students interview scientists from many disciplines and write stories, take photos, create videos, and design social media content based on those interviews. The stories in this publication were reviewed by the sources and approved for publication.

STUDENT PROFILES

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NEBRASKA WEIGHS IN ON CATTLE EMISSION CONVERSATION

Research Focuses on Cattle Greenhouse Gas Emissions

By Emily Hatterman

The environmental impacts of cattle emissions have been a contentious conversation in recent years. Some climate-conscious consumers are concerned with cattle emissions' potential and impact. Researchers at the University of Nebraska–Lincoln are discovering results that may improve and optimize our management practices and ease those concerns.

Galen Erickson, professor in the Department of Animal Science at the University of Nebraska-Lincoln, and Tala Awada, professor and associate dean in the Agricultural Research Division, conduct transdisciplinary research to better understand cattle's emissions of greenhouse gases, and the cycle of capturing and storing these gases to fully understand cattle's role in environmental issues.

"The conversation on cattle and climate has produced some incorrect assumptions," Erickson said. "However, sound data collected across many years and various environments have produced quite accurate information. At this point, information truly shows the accurate picture of the effect of cattle on the environment and on climate – and cattle actually contribute to a smaller portion of the overall emissions, than originally thought."

Awada said the research is transdisciplinary and investigates the whole production system of beef with the purpose of creating a sustainable, profitable, and resilient system. The research on greenhouse gas emissions is just one component of this multifaceted research so the information provided to the consumer is science-based, relevant and sound.

"The goal is to make sure that the consumer's decision is based on sound information, rather than incorrect information," Erickson said.

"The goal is to make sure that the consumer's decision is based on sound information, rather than incorrect information."

Galen Erickson

Impact of Cattle Biological Systems

Cattle have always naturally produced methane, so it is important for consumers to understand the biological systems that cause cattle to belch methane and the actual environmental impact of doing so.

Due to cattle's unique four-chambered stomach, they naturally produce methane because of the oxygen-lacking environment that bacteria in their stomach live in, Erickson said. Just like humans, after cattle digest feed, they breathe out carbon dioxide (CO_2), but cattle also belch methane after eating.

Methane has drawn concern because it is known as a more potent greenhouse gas, Erickson said, because it has a higher ability to trap heat. However, he said in 2019, a group of atmospheric scientists from Oxford found that methane is not as potent as previously believed because it only lasts in the atmosphere for 10 years.

In contrast, CO_2 lasts around a thousand years. Another difference between methane and CO_2 is the amount found in the atmosphere. CO_2, mostly coming from energy and fossil fuel use, makes up for 79% of all greenhouse gases whereas methane only accounts for 11%, according to the EPA.

Optimizing Grazing Systems Leads to Best Results

In Nebraska, a large part of a cattle's lifespan is spent out on pasture, which will play a major role in carbon sequestration, Erickson said.

"Optimizing grazing systems is the best way to ensure that carbon is being taken up by the pasture, cattle are growing from utilization of the forage, and greenhouse gas emissions are being offset of cattle from birth to slaughter," Erickson said.

Pasture grazing for 180 days of the year is the best way to ensure cattle do not have a negative impact on the climate, according to Erickson.

For example, while pasture grazing is important, weather conditions in Nebraska do not allow producers to have cattle graze year-round because of the grass's growth. Erickson said

finishing cattle in dry lots allows for a year-round beef supply and a faster rate of gain, further reducing negative impacts.

"When optimized grazing is applied based on the climate and the region, there is more carbon sequestered than what cattle breathe out in CO2 and produce in methane," Erickson said.

The Research Behind It All

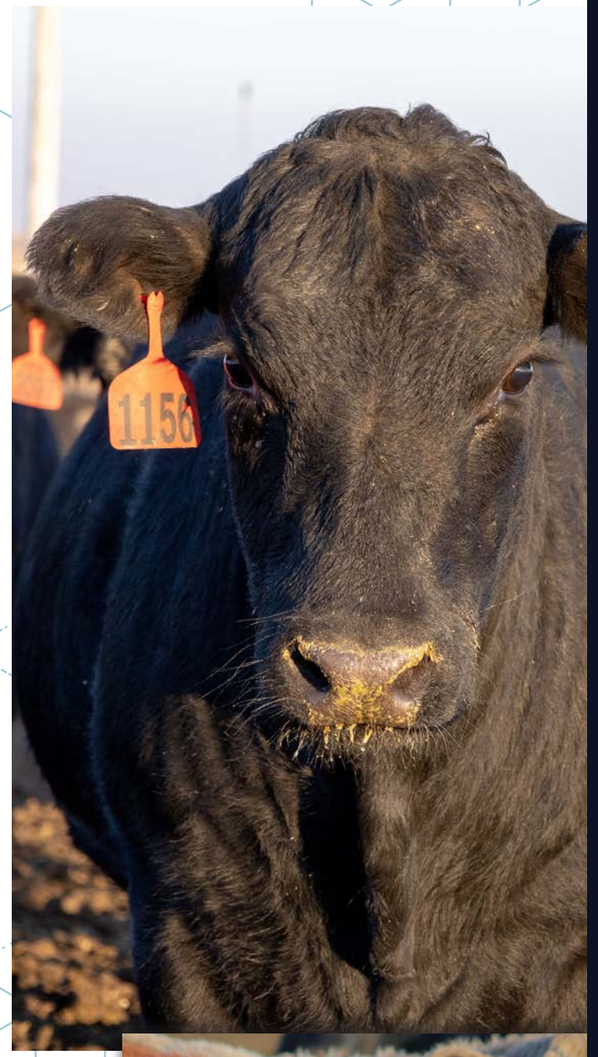
Erickson, Awada, and their team at the University of Nebraska-Lincoln and the United States Department of Agriculture Agricultural Research Service (USDA ARS) compare two different cow-calf systems, measuring carbon sequestration and greenhouse gas emissions of the system.

The research is part of the Long Term Agro-ecosystem Research (LTAR) USDA-funded network, where the team records cattle's emissions on pasture and dry lots at the Eastern Nebraska Research and Education Center (ENREC).

"For the one year of above-average precipitation, the grazing system had a positive impact on the environment," Awada said. "We continue with our measurements to capture inter- and intra- annual variability in greenhouse gases as impacted by climate and management practices before we can draw conclusions"

Along with Erickson and Awada other team members include Andy Suyker, Andrea Watson, Yijie Xiong and Jim MacDonald along with Virginia Jin and Marty Schmer from the USDA. These researchers continue to not only record cattle's emissions but also work to find different inputs (such as diet additives) that could reduce cattle's methane emissions as well.

Living in a state-run on agriculture and cattle specifically, all Nebraskans should be rooting for consumers to have evidence-supported information available when debating on whether to pick up beef products for their next meal.



KEY TAKEAWAYS

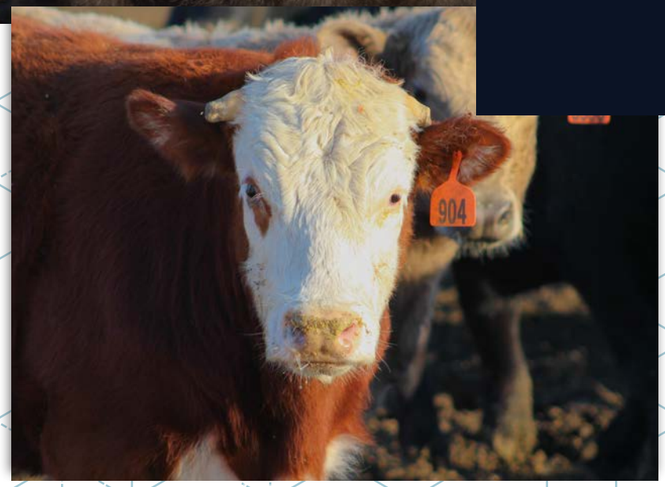
1 Cattle's potential impact on climate issues has been a continuous conversation in recent years.

2 Methane, a greenhouse gas, has always been naturally produced by cattle due to their ruminant digestive system.

3 Because of methane's shorter lifespan of 10 years, it is not accumulating in the atmosphere as long as other greenhouse gases.

4 A UNL team is researching emissions and carbon uptake in pastures and dry lots to analyze the impact the entire system has on the environment and have found cattle's emissions environmental impact varies and may not be as bad as previously thought.

5 For more information about cattle's greenhouse gas emissions and the research Erickson and Awada are conducting visit https://extension.unl.edu/statewide/enre/about-enrec-research/.



Locating the Future of Ranching

GPS-Driven Collar Technology Innovating Ranching Practices in Nebraska

• By Chandra Spangler

Cattle producers and researchers are navigating novel ways to use Global Positioning System (GPS), a technology that assists in finding precise locations of cattle in various settings, to make ranch operations efficient and provide precision decision management tools to sustain Nebraska's beef industry.

Precision decision management tools, such as GPS collars and virtual fencing, are currently collecting data at the Gudmundsen Sandhills Laboratory and private ranches.

Yijie Xiong, assistant professor in the Departments of Animal Science and Biological Systems Engineering at the University of Nebraska-Lincoln, works with colleague Travis Mulliniks, associate professor in the Department of Animal Science, to further research the usability of the technology.

Jack Keating, founder of Corral Technologies, created a virtual fencing system to improve ranch profitability and efficiency.

GPS collars and virtual fencing has the merit of solving the complex problem of increasing input prices and flatlined outputs, as well as improves soil and rangeland health. Specifically, the technology decreases the input costs of labor, fencing, and provides enhanced information for nutrition management and increases the outputs through predictability of grazing patterns, health, and more.

"Technology may look different for every rancher, but technology will assist in moving forward in the next 20-30 years through increasing ranchers' ability to be sustainable," Mulliniks said.

Jack Keating holding tracking collar

New Technology Enters the Ranch

A GPS collar system using Internet of Things (IoT) technology is one example of technology actively used on ranches across Nebraska.

For example, each cow wears a IoT-GPS collar with sensor technology either on one side or both sides of the neck. This sensor communicates the cow's current location and movement patterns in real-time through a wireless connection to a phone or a laptop, Xiong said.

This wireless connection that tracks location creates another opportunity for the ranch – virtual fencing.

A virtual fence can be created through adding designated coordinates via a software interface on a computer that function as the fence. Xiong said that once the cows begin to exit the coordinates, an alarm sounds on the collar. As the cow exits further, another alarm sounds. Assuming the cow is persistent and exits further, the system would deliver a gentle shock to keep them from leaving the designated area.

"The newer GPS collars can visualize the data or the location of the cattle in real-time, making it a lot easier to access the data, download the data, and see where cattle are located," Xiong said.

This data is used to better understand grazing patterns and the needs for the cattle. Through simple data visualization, producers and researchers can see heat maps of where cattle graze the most. From this, they can better adjust their virtual fence coordinates for precise pasture management to fit the cattle feed needs.

Virtual fencing also allows ranchers to choose the exact coordinates to contain their cattle without having to add physical fence, saving the rancher time, money, resources, and potentially increasing grazing capacity.

Sustaining Resources Long-Term

The implementation of practices to protect and enhance forage, water, and soil is vital for long-term sustainability in grazing for cattle. Healthier soils that are more drought and flood resistant grow more nutrient dense forage eaten by cattle. With high grazing costs, nutrient dense forage is a need for producers.

"Grazing costs in Nebraska are not cheap – they are one of the highest in the United States," Mulliniks said.

Precision ranch management creates long-lasting resources to help decrease the state's grazing costs, Xiong said.

Benefits from GPS collars and virtual fencing include increased grassland management through grazing distribution and increased nutrient density of forage, according to Keating. Profits rise from increasing carrying capacities, healthier animals, and a reduction in fencing supplies.

"Utilizing the forage resources more precisely can have many benefits for the long-term sustainability of the forage and pasture quality condition."

Yijie Xiong

"Utilizing the forage resources more precisely can have many benefits for the long-term sustainability of the forage and pasture quality condition," Xiong said.

Pinpointing Production, and Efficiency

Cattle production outputs such as weaning weight and reproduction have flatlined over the last 30 years, but inputs have risen. Mulliniks said technology can provide an opportunity to decrease production costs while increasing production outputs.

To combat this issue, Xiong said virtual fencing can be used to efficiently manage the cattle to graze evenly, increasing the number of cattle per acre and decreasing supplemental feed prices. Based on the data collected, Mulliniks and Xiong will soon be able to determine the number of cattle per acre needed for profitability to increase.

Jack Keating on tablet

"From a cattle management standpoint, about 65% of the annual cow-calf operation cost comes from nutrition," Mulliniks said.

By increasing grazing distribution or grazing pastures more evenly, the opportunity is created to decrease grazing costs by decreasing the need for additional harvested forages or the ability to increase the number of cattle grazing those acres, Mulliniks said.

"The goal is to increase weaning weights for calves by up to 20 pounds because those calves can graze outside of the virtual boundaries cattle are contained to," Keating said.

The GPS technology and virtual fencing allows them to graze a wider area than they typically would, based on current grazing patterns.

Connecting to the Future

Technology must continue to be advanced for general consumers to adopt it. One advancement is providing a data-driven decision aid, according to Xiong.

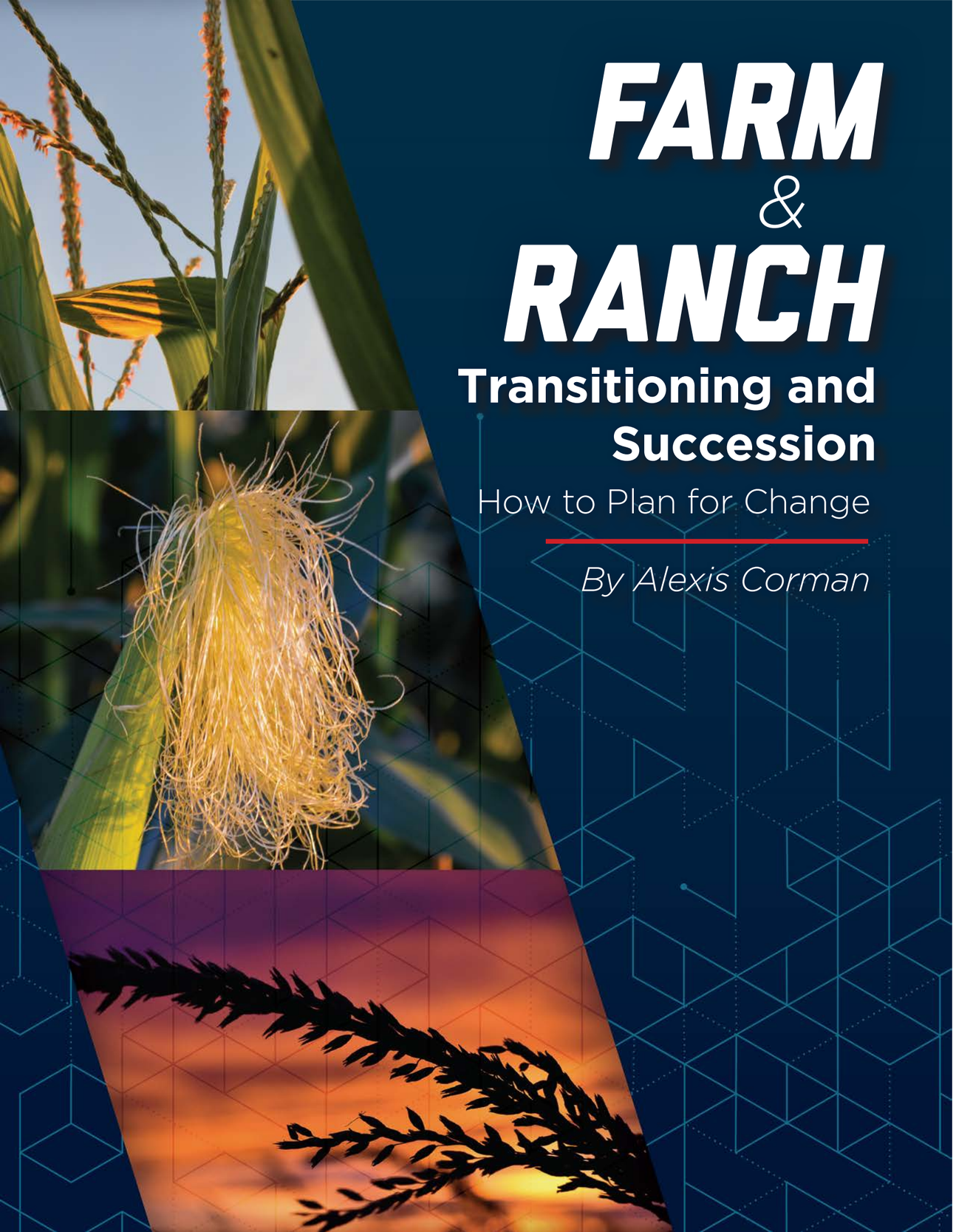
"Heat detection, calving alerts, and genetic differences based on grazing are the focus of the future to make sure ranchers have the tools to be successful on their operation," Keating said.

However, limited signal in rural areas and short battery life reduces consumers' willingness to utilize GPS collars. Fixing this may increase consumer demand, which would lower the cost.

The efforts of researchers, ranchers, and analysts to make GPS collar and virtual fencing data useful will be pivotal for sustaining Nebraska's resources and increasing output costs long-term.

KEY TAKEAWAYS

1. GPS technology and newer connectivity infrastructure, such as IoT-GPS collars and virtual fencing, are now more commonly available for rancher to use on cattle with the opportunity to increase profitability in the long-term.
2. Virtual fencing can be used to distribute cattle across rangelands to graze evenly and timely, increasing profitability and decreasing supplemental feed costs.
3. By managing forage, water, and soil more efficiently, healthier soils will be more nutrient dense, making them more drought and flood resistant.
4. To combat the issue of limited connectivity in rural areas, focus is placed on the connectivity infrastructure and use of solar-powered batteries to increase consumer demand and lower costs.
5. For more information, please visit beef.unl.edu or contact a local Nebraska Extension agent by visiting epd.unl.edu.



FARM & RANCH

Transitioning and Succession

How to Plan for Change

By Alexis Corman

When it comes to farming, the boomer generation never really want to quit, yet sometimes quitting is inevitable for health and happiness. Planning for when succession or transition time comes is critical and communication within families becomes a key component to success.

Allan Vyhnalek, extension educator in the Department of Agricultural Economics at the University of Nebraska–Lincoln, helps families think about the best planning and succession process for their operation.

“The vast majority of issues in farm transitioning stem from a lack of communication (or no communication at all) within families,” Vyhnalek said.

He further explained that current landowners need income from assets as they move away from management of their operation while new farmers trying to get started are faced with high capital prices.

To combat this issue, Vyhnalek initiated a program called Nebraska Land Link with Jessica Groskopf. Land Link connects landowners without a transition plan or successor to new farmers wanting to begin. The goal is to keep operations alive and give younger aspiring producers an opportunity.

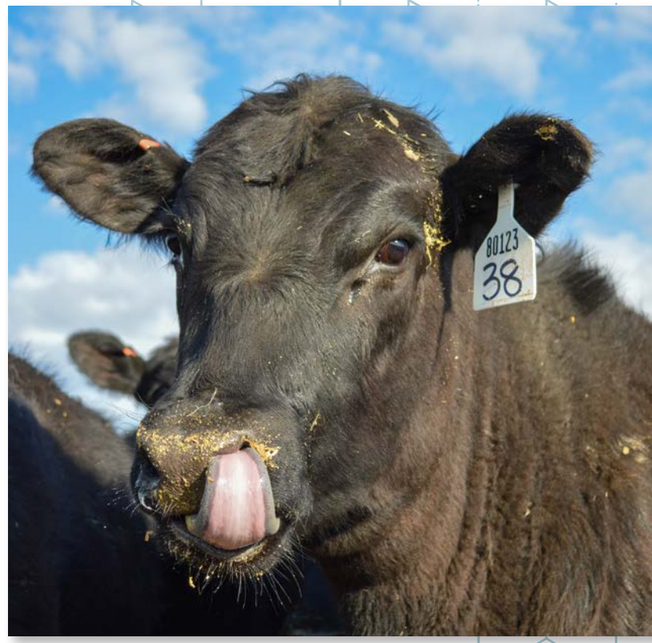
Alex Burnett, Nebraska farmer, was the first successful land seeker to match with a landowner in the Nebraska Land Link program. After losing his family’s dairy farm and struggling to get started on his own, Burnett decided to try the program.

Why Are Famers Not Retiring?

Before the ratio of 20 land-seekers for everyone landowner can be stabilized, the reasons why farmers are not retiring must be determined.

“Farmers are retiring at a later age and some of them are only semi-retiring,” Vyhnalek said. “There are many reasons why this is the case – it may be about control, economics, not having a successor, or all the above.”

Most farmers have been a part of their operation for decades and are unsure about retirement, so it is common that planning is not a priority.



Why Do Farmers Avoid Planning?

There are many reasons people avoid discussing a plan with their families – some farmers assume the process is too complicated, some do not want to face their own mortality, and others are afraid if something is planned now it will be wrong in the future.

Vyhnalek created a graphic of the “Circle of Inaction” to provide a visual for those ready to start the planning process.

“This cycle may repeat over and over until something changes that forces a plan to be made,” Vyhnalek said. “Most producers get stuck on step 4 of the process, that is what needs to be improved.”

Three major types of planning need to take place for successful farm transitioning: end of life documents, estate plans, and business succession plans.

Communication is key to planning, but communication is often difficult to begin when discussing these topics. Families should approach the process with an open mind for input and decision-making to ensure ability to work together through the process.

The Nebraska Land Link program is also available for those struggling to get started.

Justin Corman fixing combine

“Transition is going to happen, whether there is a successor or not.”

Allan Vyhnalek

How does Nebraska Land Link work?

The goal of Nebraska Land Link is to match land-seekers with landowners who are looking to move away from their operations.

“Transition is going to happen, whether there is a successor or not,” Vyhnalek said.

The Nebraska Land Link Program is one solution for families without a successor, but a desire for the operation to be continued.

“In today’s world, it is hard for a young person who wants to get into farming to find land and resources to get an operation running,” Vyhnalek said.

The cost of land and equipment has more than doubled over the last two decades and competition with the development market only drives costs higher.

To combat this, Nebraska Land Link connects new farmers seeking land to start their own operation with landowners who are looking to lease, sell, or gift their land to a newcomer.

“We were dairy farmers who had cattle and corn for many years,” Burnett said. “Unfortunately, we struggled to compete with big operations, so we ended up losing it all and that is when I found this program.”

Get Involved with Nebraska Land Link

There are three main parts to the Nebraska Land Link Program.

First, those interested complete an online application specific to whether they are a land seekers or landowner. Applications are accepted on a rolling basis. https://cap.unl.edu/landlink/

Second, Nebraska Extension members interview applicants to confirm accuracy of information and determine a match before information is shared with landowners for their decision.

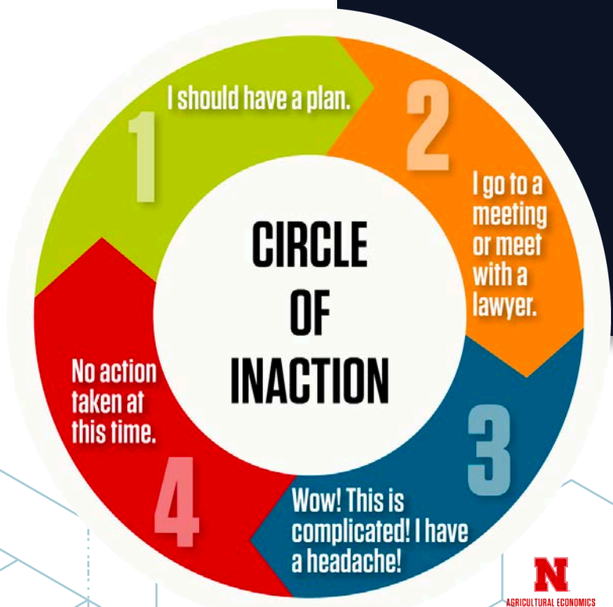
“Once applicants have been reviewed, information is then given to landowners to interview candidates,” Vyhnalek said.

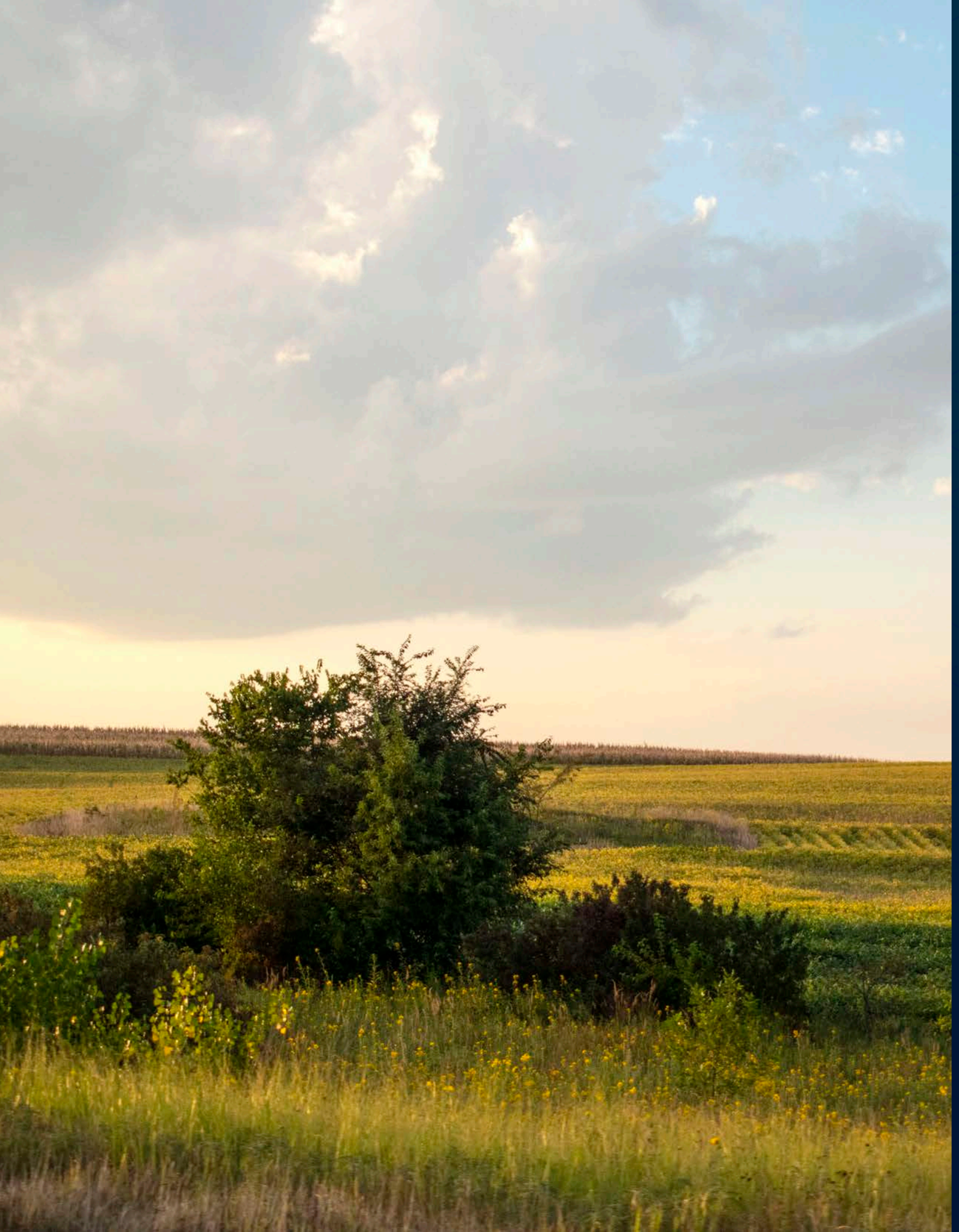
Third, additional education is provided to both parties on navigating the transition process. Questions, communication tips, negotiations, and goal setting are supported by Nebraska Extension once a match has been made.

In just over one year, Burnett was matched with a landowner in Alliance, Nebraska. Once Burnett was chosen, a deal was made in which the first year, all would work together to make transition as easy as possible. Burnett then officially takes over the operation upon retirement.

KEY TAKEAWAYS

1. Farm transitioning is challenging for many families and succession planning can help those struggling to create a plan.
2. Farmers are retiring at a later age for several reasons, so it is important to have family conversations about farm planning before a critical life event forces a rash decision.
3. Even if things change, it is better to have a plan that requires slight changes than to have no plan at all.
4. *Nebraska Land Link* is one program available to connect new farmers or land seekers with farmers and producers who are looking to transition their farm.
5. For more information on farm transition, succession planning, upcoming talks or webinars, visit https://cap.unl.edu/succession and for the Nebraska Land Link program visit https://cap.unl.edu/landlink





DATA AND TECHNOLOGY AIDES IN CONSERVATION AND PROTECTION

AWESM-ly Spaced Out
Spatial Technologies Track Pronghorn and Promote Nebraska Precision Conservation

Protecting our Prairies With... A Video Game!
Prairie Protector: Understanding Nebraska's Eastern Red Cedar Encroachment

AWESM-ly Spaced Out

Spatial Technologies Track Pronghorn and Promote Nebraska Precision Conservation

By Kianie David

"Pronghorn (Antilocapra americana) populations have fluctuated drastically since the early 1900s due to shifts in land use resulting from westward expansion across the United States. Today, pronghorn in Nebraska roam the western part of the state to the Sandhills, the eastern most edge of the species' current range."

Pronghorn Spatial Ecology in Nebraska
https://awesmlab.unl.edu/pronghorn-spatial-ecology-nebraska/

Andrew Little (Left)
Katie Piecora (Bellow)
holding GPS trackers

Nebraska is an agricultural hub that utilizes 92% of its land to raise livestock and grow crops, leaving minimal space for native wildlife like pronghorn.

Andrew Little, assistant professor and extension specialist in the School of Natural Resources at the University of Nebraska–Lincoln, utilizes spatial technology, such as global positioning systems (GPS), to learn about wildlife movement patterns.

Little said researchers gather data using spatial technology to inform landowners and different agencies on how to plan and implement conservation practices that benefit the environment while also maximizing agricultural profit.

"Increased agricultural output, larger field sizes and the removal of non-crop native plants has contributed to declines in wildlife populations across Nebraska over the last 50 years," Little said.

From individual fields to entire landscapes, Little's lab, known as the Applied Wildlife Ecology & Spatial Movement (AWESM) Lab, is focused on studying wildlife and habitat management in major agricultural areas. The AWESM Lab provides science-based information to help landowners and management agencies balance the needs of agriculturally dominated landscapes and create diverse ecosystems.

Katie Piecora, graduate research assistant working with Little in applied ecology, currently researches the movement of pronghorn which has not been heavily monitored in Nebraska for 20 years.

"The AWESM Lab's research is critical to help inform management decisions and guide the development of strategies to conserve wildlife while protecting the assets of Nebraska's ranchers and landowners," Little said.

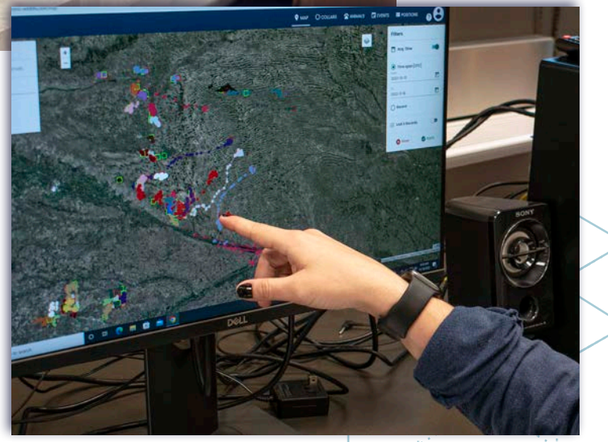
GPS Collars Track Pronghorn

Since February 2021, Piecora has collared 110 individual pronghorn currently living in Nebraska with GPS collars. These collars track the pronghorns' location like apps on cell phones track peoples' location.

"Using GPS collars is advantageous when researching roaming animals like the pronghorn because they collect substantial amounts of data over hundreds of miles and over several months," Piecora said.

GPS Collars (Left)

Tracking Pronghorn across the state (Below)



Piecora said that GPS collars record pronghorn locations every two and half hours and send these positions through a satellite to a database where researchers can access the data at the University of Nebraska–Lincoln.

"Current data shows that, regardless of season, sex, or area, that pronghorn are strongly selecting to stay in locations with crops which substantiates what we've been hearing from farmers and landowners," Piecora said.

Piecora's research aims to answer two key project objectives by identifying the movement and habitat use of adult pronghorn and evaluating their survival.

Data Findings Support Nebraska's Natural Resources and Farmers

The usage of spatial technologies is essential to Nebraska because the data collected by using them advocates for the protection of native species while also improving the land for crop and livestock producers.

Piecora said that Nebraska's native grasslands have greatly changed through increased crop production and infrastructure which can negatively impact wildlife.

"Understanding how wildlife like pronghorn respond to agricultural changes is key to effectively managing grasslands to maximize wildlife populations, while also maintaining sufficient agricultural and energy outputs," Piecora said.

After analyzing their data, researchers communicate their findings into formats that are readily available to the public. This provides landowners with accessible information capable of improving their land and resource yields.

"Every acre of land in Nebraska counts, so it is important to balance the state's need for agriculture, while also protecting our natural resources including soil, water, and wildlife."

Andrew Little

The AWESM Lab research team focuses on identifying new ways to increase farmers' income by showing how they could benefit from the introduction of native ecosystems and wildlife on their properties. Ecotourism is one example.

"Collaborative research and extension projects benefit both Nebraska's farmers and wildlife by helping landowners best manage their farm to feed a growing world while ensuring conservation of Nebraska's important natural resources," Little said.

Spatial Technology-Driven Conservation: Nebraska's Future

Data collected through spatial research paves the way toward informing agencies and landowners about creating diverse ecosystems that will increase their profit margins and conserve the future of Nebraska's wildlife and landscapes.

"Every acre of land in Nebraska counts, so it is important to balance the state's need for agriculture, while also protecting our natural resources including soil, water, and wildlife," Little said.

Findings from Piecora's research will help the public make informed land management decisions, conserve pronghorn, and protect the assets of farmers and ranchers statewide.

Little and the AWESM Lab are also working with Iowa State University to implement the STRIPS, or Science-based Trials of Rowcrops Integrated with Prairie Strips, Project across 3 of the University of Nebraska's Research and Extension Centers. The goal of these prairie strips will be to increase biodiversity and highlight to landowners the benefits that prairie strips can bring to their land and operations.

"This project is another example of how we can use spatial technology to strategically target privately-owned lands for conservation adoption," Little said. "The end goal is to simultaneously maximize profitability for producers and conserve our important natural resources in Nebraska."

KEY TAKEAWAYS

1. Little and his research team at the AWESM Lab conduct research to help landowners find compromises that will both protect our natural resources and improve their land for crops and livestock.

2. Spatial technologies, such as GPS collars, track the movements of wildlife over long distances through satellite tracking and data collection.

3. Piecora's pronghorn research aims to answer two key project objectives by identifying the movement and habitat use of male and female pronghorn and evaluating their survival.

4. Scientific observations made by extension researchers are used for precision conservation projects like prairie strips to highlight to landowners the benefits that conservation lands on their property can bring to their operations. Benefits include an increase in financial gain, agricultural resources, and creating diverse native ecosystems.

5. For more information about the Applied Wildlife Ecology & Spatial Movement Lab and the research Little and Piecora conduct, follow them on Instagram, Twitter, or Facebook at @awesmlab or visit https://awesmlab.unl.edu/.

PROTECTING OUR PRAIRIES WITH... A VIDEO GAME!

Prairie Protector: Understanding Nebraska's Eastern Red Cedar Encroachment

By Jenifer Velazquez-Perfecto

Students are learning the importance of managing Eastern Red Cedar as a driver of grassland loss through Prairie Protector, a video game released in the summer of 2019, which introduces youth to one of Nebraska's top ecological threats.

Jenny Keshwani, associate professor and science literacy specialist in the Department of Biological Systems Engineering and Dirac Twidwell, associate professor in the Department of Agronomy and Horticulture, both at the University of Nebraska–Lincoln, and Conner Lunn, a software developer and graduate of Biological Systems Engineering, created Prairie Protector, a new innovative video game to create awareness among Nebraska middle schoolers on Eastern Red Cedar encroachment that has negatively impacted Nebraskans by converting the grasslands that have historically dominated the state.

"Eastern Red Cedar encroachment impacts every Nebraskan citizen, but those that do not live near grasslands may not be aware of the consequences it has in their area," Twidwell said.

Middle school students were chosen as the primary audience to play this video game because they are old enough to understand the concept of Eastern Red Cedar encroachment, yet young enough to have interest in playing a video game.

Teachers from across the Nebraska panhandle were asked to share the game with students. Once the students play the game for one week, they spent time with Keshwani answering questions about what they learned from the game.

"The video game helps students develop some agency in the types of environmental problems facing Nebraska," Keshwani said.

Importance of Educating Youth

Eastern Red Cedar encroachment is increasing at a rate of 2 million acres of land per year in the Great Plains, according to Twidwell. It, along with other invading woody species, are responsible for the collapse of North America's grassland biome, and the loss of this much grassland has a profound effect on Nebraska's rangeland agriculture and other ecosystem services.

Twidwell said Nebraska lost 420,000 tons of rangeland biomass in 2019 (compared to the amount that would have been produced without increases in woody plants since 1990).

"Eastern Red Cedar has impacted water quality and quantity, and increased the West Nile virus and tick-borne diseases compared to intact grasslands. It also drives collapses in the biodiversity of grasslands and compromises wildlife conservation efforts," Twidwell said.

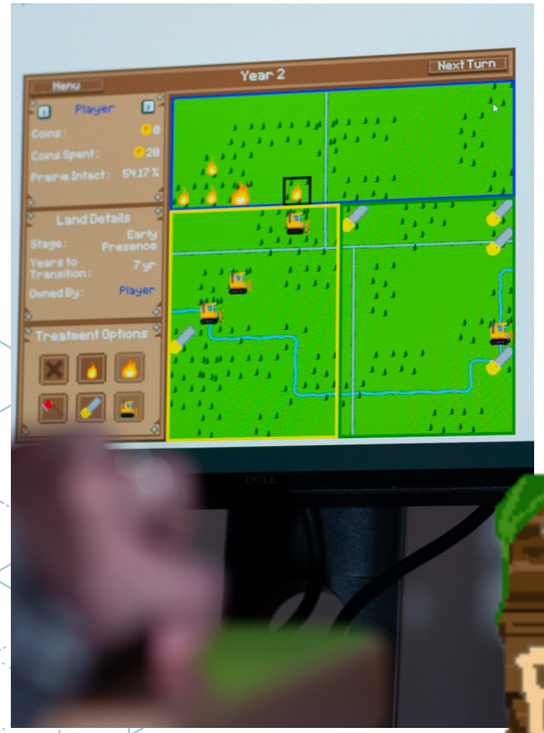
"The Prairie Protector video game helps students develop some agency in the types of environmental problems facing Nebraska."

Jenny Keshwani

The loss of rangeland biomass in 2019 is important to the beef industry and is equivalent to losing 690,000 round bales that year, he said. Of course, that production is critical in tough years, like this one, and puts additional stressors on consumers facing the consequences of higher beef prices.

"Grasslands are critically important in the state of Nebraska and unfortunately, they have been taken for granted," Twidwell said.

Prairie Protector is important for students to play because it teaches them about Eastern Red Cedar encroachment, how it will negatively impact the growth of grassland in the future, the challenges of managing woody encroachment, and consequently affecting other industries that rely on grasslands.



Prairie Protector game (Left)
Pairie Protector Logo (Right)

Lessons Learned: Middle School Edition

Data and debriefing sessions with students playing Prairie Protector suggest students develop empathy for landowners by playing the video game. The game is quite interactive!

To play, students are given a plot of land infested with Eastern Red Cedars. Next, students are provided with treatment options and through trial and error, they learn which treatments work best.

"Students learn to see that trees are not always good, and fire is not always bad," Keshwani said. "For instance, prescribed fires are one of the main ways to manage Eastern Red Cedar encroachment."

Some treatments take years to show results and others are more expensive, she added. Through the interaction, students also realize the action a neighbor takes make a big difference in the game's outcome.

"A landowner in Nebraska can burn down trees on their land, but if a neighbor fails to control the Eastern Red Cedar, it will still continue affecting the surrounding land," Lunn said.

By playing this game, students learn different land management treatments available to landowners and understand the work that is required to keep the Eastern Red Cedar under control.

Anyone can access this game for free through a web browser at www.prairieprotector.com.

The Future of Educating Students

In the future, Twidwell hopes to see an increase in literacy on the biggest threat to grasslands.

"The public education system needs to build awareness, build literacy, and then create support and solutions to the drivers of grassland loss. And, Eastern Red Cedar encroachment is widely known as one of those top drivers," Twidwell said.

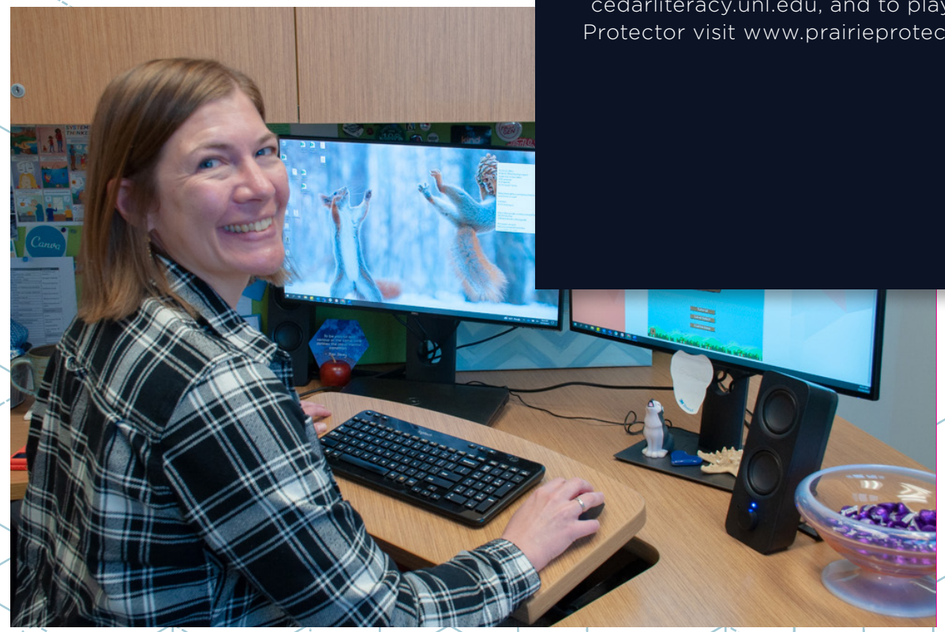
To help these efforts, teachers can spend time covering the Central Grasslands Roadmap, an external online source to increasing the conservation of North America's central grasslands.

In the next five years, Keshwani plans to provide students with a 2.0 version of the video game that includes more biodiversity and information on the amount to water that is consumed to keep the Eastern Red Cedar alive. Both animals and water are needed to manage the rangeland ecosystem.

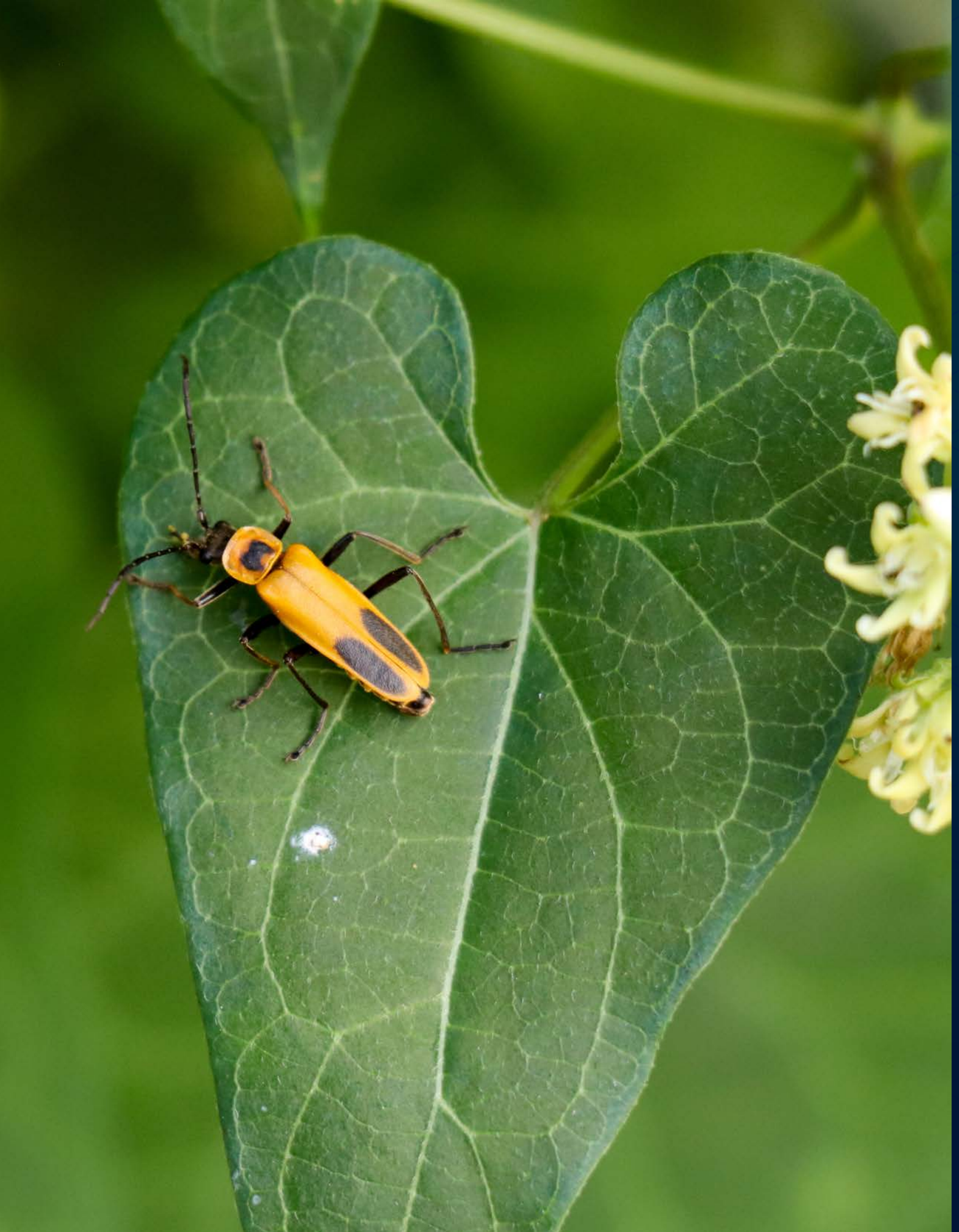
"Right now, the video game is one of the few resources that students are exposed to on this issue, but even more resources need to be provided in the future," Twidwell said.

KEY TAKEAWAYS

1. Video games are now being used to teach Nebraska students about environmental threats in the state.
2. The video game, Prairie Protector, introduces Eastern Red Cedar encroachment (a top threat in the state) to middle school students.
3. Prairie Protector teaches students decision-making and problem-solving skills are essential, lowering the consequences they would have to face in the future.
4. In the next five years, Keshwani plans to provide students with a new 2.0 version of the video game that includes more biodiversity and information on the amount to water that is consumed to keep the Eastern Red Cedar alive.
5. For more information about Eastern Red Cedar encroachment, please visit cedarliteracy.unl.edu, and to play Prairie Protector visit www.prairieprotector.com



Jenny Keshwani



DATA AND TECHNOLOGY IMPROVES PLANT HEALTH

THE SPIDERCAM GIVES A SPIDER'S EYE VIEW

Nebraska's One-of-a-Kind Device Assists in Plant Research

By Gracie Stout

The Spidercam -- a novel floating camera set collects advanced images to better understand how different types of crops breed.

The first of its kind in the United States, the Spidercam gathers more in-depth data for researchers at the Eastern Nebraska Research Extension and Education Center (ENREEC) in Mead, Nebraska.

Geng (Frank) Bai, Research assistant professor, and Yufeng Ge, associate professor both in the Department of Biological Systems Engineering at the University of Nebraska–Lincoln, manage the Spidercam core facility to better understand plants by proximal remote sensing.

"The Spidercam is an automatic phenotyping tool used for crop breeding to quantify how plants handle (a)biotic stress at a high spatiotemporal resolution," Bai said.

The goal of breeding is to increase the crop yield, improve its resistance to insects or pests, or even speed up the maturity of the plant, which ultimately benefits all consumers.

Spidercam

Advantages of the Spidercam

The Spidercam can do a large amount of work automatically with better accuracy, compared with the traditional, labor-intensive methods.

"Instead of sending a large group of people to the field, our Spidercam system measures the plant traits accurately from a distance," Bai said.

This research assists with growing the knowledge on many disciplines, including plant breeding, genetics, engineering, remote sensing, and data science. Ge said.

This information allows deeper understanding on how crops produce higher yield with better quality yet doing so with more effective usage of sources such as water and nitrogen.

"The Spidercam removes the need for growers to drive tractor or control sensors – instead, it is all automatic," Ge said.

The Spidercam allows Bai and Ge to see what works during growing as they are happening. Gathering this precise information allows for the most accurate decisions to be made in real time. Although the Spidercam does not run continuously, it does spend a fair amount of time in the air.

A Unique Camera System

The set-up of the Spidercam is intricate, and it takes time and patience. Everything that is located at the ENREEC site has purpose and accounts for how the Spidercam efficiently runs.

For example, the type of wire the Spidercam sits on is specific to its function and the location of the elevated control system is precise to the needs of the collected data. Each part of the device is intentionally developed to maximize effectiveness, Bai said.

The Spidercam is connected to durable cable suspension system held up by poles on each corner of the field, which allows it to reach every corner of the plot site, like what one would see on a football field, Ge said. Because of this design, the Spidercam can capture a picture of every plant, mainly from the top and occasionally from the side of the plants in the test field.

The sensors on the Spidercam contain visible, hyperspectral, and thermal infrared cameras. High-resolution images are needed to do study on crop improvement and the level and type of stress the plants endure. The sensors can also detect when a plant is under stress allowing for preventative measures to be taken.

Close-up of gauges (Above)
Spidercam control center (Right)

Overlooking the field at ENREEC, a two-story building holds the electronic control system for the Spidercam. One can manually move the Spidercam, if needed. A subsurface drip irrigation system is incorporated within the field, which helps control and monitor the different amounts of water the crops receive.

“One of the challenges with field research is really the variability of the environment,” Ge said. “For precise control of the soil moisture content of a plot of land, the subsurface drip irrigation system is used.”

David Scoby, Laboratory Research Manager, manages the research field. Scoby plants and harvests crops, applies nutrients and chemicals, manages the drip irrigation system, and assists Bai with mounting the Spidercam dolly.

“There are 128 plots including different kinds of crops and different kinds of hybrids – everything has to be planned out ahead of time,” Scoby said.

The Future of Spidercam

The information Spidercam collects will change how farmers make decisions about what to plant, what inputs to use, and how to manage their crop. While there currently is not room for the Spidercam technology to be replicated on every field in Nebraska, the information collected will gather data that will be useful for all Nebraska farmers in the future.

“There are farmers and extension educators coming to us and seeing the kind of research and information we generated and transferring it into application for farmers,” said Bai

Both Bai and Ge see the Spidercam growing over the years by hopefully having more than one and having it cover larger fields.

“The goal is for the Spidercam to be able to connect with some of those more advanced breeding and molecular techniques like genome editing, digital twin in plants,” Ge said.

“There are farmers and Extension educators coming to us to see the kind of research and information we can generate and transfer into application for farmers.”

David Scoby

KEY TAKEAWAYS

1 The Spidercam is a one-of-a-kind floating camera system that captures in-depth photos of plants to measure growth and detect stresses.

2 The first of its kind in the United States, the Spidercam gathers in-depth data for researchers at the Eastern Nebraska Research Extension and Education Center (ENREEC) in Mead, Nebraska, with full automation.

3 The Spidercam is connected to durable cable suspension system held up by poles on each corner of the field, which allows it to reach location capturing a picture of every plant in the test field.

4 Data from the Spidercam accelerates the improvement of crops for higher yield, better quality, and more efficient use of resources, and eventually have a big impact on growers’ economy.

5 For more information regarding Spidercam, please visit https://ard.unl.edu/phenotyping/field-phenotyping-facility

PREDICTING THE NEXT GENERATION OF PLANT TECHNOLOGY

Statistics Helping Build A Brighter Future For Nebraska's Farmers

By Emma Hoffschneider

Statistical methods of genomic prediction, or the mathematics behind the farm, are crucial in creating more efficient seeds and improving overall seed performance.

Like humans, individual seeds have specific genetic makeups. For example, a seed's genotype is its DNA sequence and its phenotype is the physical traits. Genomic prediction is the process of utilizing this genotypic data (DNA) to predict an individual seed's phenotype (physical traits).

Reka Howard, associate professor in the Department of Statistics at the University of Nebraska-Lincoln, explores ways to use DNA data from seeds to save farmers time and money.

"Genomic prediction allows for predicting the performance of plants that have molecular marker information without physically planting seeds in the field. It enables plant breeders to select parents for crossing without the burden of planting and harvesting." Howard said.

George Graef, professor in the Department of Agronomy and Horticulture at the university also studies the application of genomic prediction to produce higher-performing soybean cultivars for farmers.

Together, this work enhances desirable characteristics in crops such as drought resistance and high yield through efficient seed breeding practices – ultimately helping Nebraska growers produce more while using less.

"Looking at the historical rate of gains, the agricultural industry is behind where it needs to be," Graef said. "But using methods like genomic selection, can hopefully increase the rate of gain and continue to improve yield and productivity for farmers."

The Science Behind The Yield

The advancement of plant performance comes by crossing the best characteristics together to form an optimal product. Genomic prediction's ability to accurately predict a plant's phenotype, or the performance of the plant, depends on how closely the plant's genotype is related to the final phenotype.

"Without genomic prediction, plant breeding is a longer-term endeavor that requires years to make the crosses, develop the populations, evaluate the progenies and select the superior individuals from those," Graef said.

That is why Dr. Howard's work with statistical methods in genomic prediction is crucial. The challenge at hand is to determine what other information is useful to include in these models and how to construct the equations to use all the information and provide a more accurate prediction of the phenotype.

"The value of being able to predict performance based on genotype information, even if that prediction is less than perfect, is huge. If one can obtain a prediction accuracy of even 60%, that could eliminate the need for a huge amount of plot testing and make the whole process more efficient," Graef said.

"Now, the genomic data can be collected and through statistical methods, the performance of the plant can be predicted before even planting it," Howard said.

This process is much quicker and more efficient for growers, saving both time and money.

Influencing Plant Genetics

Collaboration is key to innovation – and Howard and Graef's teams are eliminating the unknowns in plant breeding.

"When selecting parents of a cross, it is crucial to have the best genotypes," Graef said. "By breeding the best genotypes (DNA), the hope is that they will produce progenies with best phenotypes (physical traits)."

That said, the impact the environment has on performance is a key element not to overlook, he said. For example, a variety that excels in irrigated production in central Nebraska may not excel in eastern Iowa due to the different weather and other environmental conditions.

Genomic prediction's accuracy increases when breeders analyze the relationships between specific genotypes and phenotypes across multiple environments.

"It is in the combination of the genotypic data and the environmental data collected over the years where the significance of these methods starts to gain traction," Graef said.

"When a number of individual varieties are evaluated across multiple environments, one can better define relationships between genotype and phenotype," Graef said. "Then one can compare them to the untested set of genotypes and make predictions about which of those untested genotypes would be expected to have the best phenotype (like yield) in a certain environment or across environments."

"Even a 1-2% change in the annual gain over time is going to be significant because it changes the production outcome."

George Graef

These methods allow breeders to select the best parents to cross for specific environments, which influences plant genetics and overall seed performance.

A Lasting Impact

Although utilizing genomic prediction on a large scale will not happen immediately, there is no doubting its long-term benefits in plant breeding.

Through her research, Howard takes great pride in knowing the work she performs has a lasting impact on the agricultural industry.

"Genomic prediction is now one of the main drivers for advancing genetic gains at a faster rate, moving the seed industry forward," Howard said. "This work is neat because it is not trivial. Intentionally combining the data makes a difference."

According to the United Nations, the world's population is projected to reach 9.8 billion people by the year 2050. Utilizing tools like genomic prediction will allow the agricultural industry to continue to innovate and meet the increasing demand.

Challenges like loss of productive farmland worldwide, losses due to unpredictable and changing climate patterns, and a growing world population emphasize the need to increase crop production per unit land area to meet future needs for food, feed, fiber and fuel. While the agricultural industry may be behind, using technological advancements like statistical methods in genomic prediction will help close the gap.

"Even a 1-2% change in the annual gain over time is going to be significant because it changes the production outcome," Graef said. "Instead of being below the projected demand levels, in 50 years, we could be meeting or exceeding them."

KEY TAKEAWAYS

1. Statistical methods of genomic prediction, or the mathematics behind the farm, are crucial in creating more efficient varieties and improving overall crop performance.

2. Like humans, individual seeds have specific genetic makeups. Genomic prediction is the process of utilizing genotypic data (DNA) to predict an individual's phenotype (physical traits).

3. The advancement of seed technology comes by crossing the best characteristics of different varieties together to form an optimal product.

4. The development of more accurate prediction models by combing genotypic data with environmental and other data may enable breeders to select more optimal varieties for specific environments.

5. For more information about statistical methods in genomic prediction and the research Howard is conducting, please visit https://statistics.unl.edu/reka-howard.

Plant Pathology of the *Past, Present,* and *Future*

Technology Use in Plant Pathology Strengthens Nebraska Agriculture

By Noelle Philippi

Kyle Broderick looking under the microscope

Pathogens in plants can be detrimental to Nebraska crops as well as the surrounding environment, and researchers in plant pathology regularly work to find solutions for these issues.

The Plant and Pest Diagnostic Clinic at the University of Nebraska–Lincoln is using emerging technology like handheld microscopes, PCR testing, and drone photography to identify and treat diseases in crops.

This clinic is an extension of the Department of Plant Pathology and provides affordable diagnosis of common ailments for Nebraska crops.

Anne Vidaver, professor emerita in plant pathology at the university, published her predictions for the future of the field in a 2004 article titled "The Accidental Plant Pathologist." The article included 20 predictions for the year 2025 spanning academia, disease, policy, and technology.

As 2025 approaches, many initial predictions have come true, but there have also been unprecedented leaps in the technology used in plant pathology that Vidaver could not have anticipated.

Kyle Broderick, coordinator of the Plant and Pest Diagnostic Clinic, works with these new developments and continues to identify areas for innovation based on current needs.

Technology Use in Pathogen Diagnosis

One prominent development in minimizing plant diseases is in the use of technology as a diagnostic tool. In 2004, Vidaver predicted: *"Use of handheld devices/sensors for field detection and identification of pathogens will be common."*

This prediction has proved to be accurate for the university's on-campus diagnostic lab.

Broderick is familiar with issues damaging Nebraska crops.

"There are three diseases that can be found in nearly any cornfield in Nebraska in August nearly every year: bacterial leaf streak, gray leaf spot, and northern corn leaf blight," Broderick said. "All three can look similar but may require different management approaches."

Broderick confirmed Vidaver's 2004 prediction that the Plant and Pest Diagnostic Clinic now uses handheld microscopes to diagnose and

treat diseases in the field. Handheld devices make it possible to bring diagnostic tools out to an affected field, rather than waiting on mailed in samples.

These devices make it easy to quickly identify common diseases in crops. Catching these diseases early lessens their economic impact in Nebraska agriculture.

“To have a continuous supply of food, it is highly beneficial to have someone who knows not only about how to grow food, but the good and bad microorganisms associated with the crops,” Vidaver said.

Not all disease mitigation strategies require technological advancements.

For example, farmers suspecting a harmful pathogen in their crops can simply fill out a form and send in a sample of the affected plant to the clinic and receive results within 5 days of submission. This form can be found at go.unl.edu/plantclinic.

This service provides a simple method for farmers across the state to receive quick diagnostic answers. Once samples are received, researchers at the clinic use strategies like microscopy, PCR technology, and symptomology to identify issues.

Additionally, Broderick said the clinic tracks pathogen appearances to notify farmers of transmissible diseases in nearby fields.

Drone Technology in Agriculture

Because Vidaver’s predictions were in 2004, some technological advancements could not have been predicted – one being drone technology.

Her original article anticipated advancements in technology would allow for increased speed and accuracy in diagnosing issues with crops, but did not anticipate exactly what technology would assist in this progression.

One way this prediction has been fulfilled is through the use of drones in diagnosis.

“Drones allow for better and faster disease detection,” Broderick said. “It is difficult to reach the middle of a cornfield at the end of July in Nebraska, but drones make this task significantly easier and cheaper.”

Broderick explained how variations in fields’ color can indicate a disease presence in a crop. By looking from above, it is much easier to see if sections of a field lack color, which can quickly identify a starting point for further testing.

Vidaver elaborated that drones are also being used to deliver pesticides and biocontrol organisms to specific locations.

Plant Pathology in the Future

Looking towards the future, plant pathology only becomes more important. A changing climate can lead to new and unprecedented diseases threatening crops across the world.

Vidaver predicted climate change will mean more microorganisms with the potential to harm crops, stating “New and reemerging disease problems will continue to be with us, and climate changes will play a role in disease problem emergence.”

“The severity of climate changes is still unclear, but with the melting of glaciers, microorganisms that have been frozen for thousands of years may be able to reproduce,” Vidaver said. “These microorganisms may be beneficial, detrimental, or innocuous – no one truly knows.”

However, this could mean diseases once thought to be eradicated could reemerge.

Climate change research is still developing, but the impact it has on agriculture has already begun. Plant pathologists are prepared to face the agricultural challenges that will arise from a warming planet and more frequent and prolonged adverse environmental conditions.

“As long as we have plants, there is a need for people to work to keep them as healthy as possible,” Vidaver said.

Vidaver founded the Doctorate of Plant Health at the university – one of only two in the United States teaching students to approach plant health holistically. In this program, students learn about both harmful and helpful microorganisms and their impact on the health of crops.

“As long as we have plants, there is a need for people to work to keep them as healthy as possible.“

Anne Vidaver

KEY TAKEAWAYS

1 Diseases in plants can be detrimental to Nebraska crops and researchers in plant pathology continually work to find solutions for these issues.

2 The Plant and Pest Diagnostic Clinic at the University of Nebraska–Lincoln is now using emerging technology like handheld microscopes, PCR testing, and drone technology to identify and treat diseases in crops.

3 Predictions for the future of plant pathology were published in a 2004 article including 20 predictions for the year 2025 spanning academia, disease, policy, and technology.

4 Many of the initial predictions have come true, like the use of innovative devices and climate change concerns), but there have also been unprecedented and exciting leaps in the technology used in the field of plant pathology that could not have been anticipated.

5 To learn more about recent projects in the plant pathology department, visit https://plantpathology.unl.edu/

Good Bugs Reduce Pesticide Use in Nebraska

A Healthy Field Increases Yields and Creates a Home for Beneficial Insects

By Taylor Gregory-Jensen

Many farmers battle with insects that are pests, but some insects are beneficial and needed to keep pests controlled. Farming practices play an important role in creating a home for these good bugs and many practices can even help conserve good bugs, reduce pests, and result in higher crop yields.

Matheus Ribeiro, post-doctoral research associate in the Department of Entomology at the University of Nebraska–Lincoln, studies the best ways to manage pests, but also pays close attention to preserving beneficial insects.

Field crop entomology is the interaction of the insects in and around the fields – including both beneficial bugs and pests, Ribeiro said.

Julie Peterson, associate professor also in the Department of Entomology at the university, studies additional ways to convert annual crop production into perennial grasses to support beneficial insects, such as bees, butterflies, dung beetles and lady beetles – insects that actually provide services to plants and animals in the area.

“Having perennial grasses, like wildflowers and other diversity of mixed plants, can help support the beneficial insects,” Peterson said. “For example, grasses next to a crop field provide a habitat for good insects where they are supported and even increased, which ultimately benefits the crops.”

These beneficial insects can actually help increase crop yields and reduce the need for pesticides.

“Integrated pest management focuses on the importance of maintaining the crops, insects, and wildlife with all the beneficial insects and pest eating bugs,” Ribeiro said. “Good bugs will make a big difference in reducing the number of pesticides that might need to be used to control and manage pests.”

Impacts of Beneficial Insects

Beneficial insects provide a wide variety of services for the ecosystem, such as food for other wildlife, pollination, and decomposition, Peterson said.

Good bugs also provide a natural, biological control for field crops. Lady beetles are a great example of this biological control.

“If producers can create a habitat for the lady beetles, the good bugs will start moving into the corn field,” Peterson said. “For example, lady beetles eat pests, such as the eggs of the western bean cutworm, which results in the reduced need for large amounts of chemicals.”

Decomposition is another service beneficial bugs can give back to the ecosystem. For instance, Peterson said the dung beetle is a great example of a beneficial insect.

"Dung beetles help get the decomposition cycle going in the fields," Peterson said. "Specifically, dung beetles help break down the dung and get the nutrients back in the soil, and that is good for the soil."

Dung beetles act quickly before pests can lay eggs, which also helps to control the number of pests.

Understanding the biology of a pest is key to being able to manage pests and learn for the future, Ribeiro said.

Preservation of Good Bugs

Preserving beneficial insects is crucial because the interaction of a field insects plays a large role in the health of the crops.

"The goal is not just finding for a silver bullet to solve all the issues related to pest management," Peterson said. "The goal is to find solutions that can work together to control the pests."

Entomologists are realizing the need for more biological control and integrated pest management practices, such as creating grass areas next to fields, adding more flowers for pollinators, and using precision technology to apply chemicals more specifically.

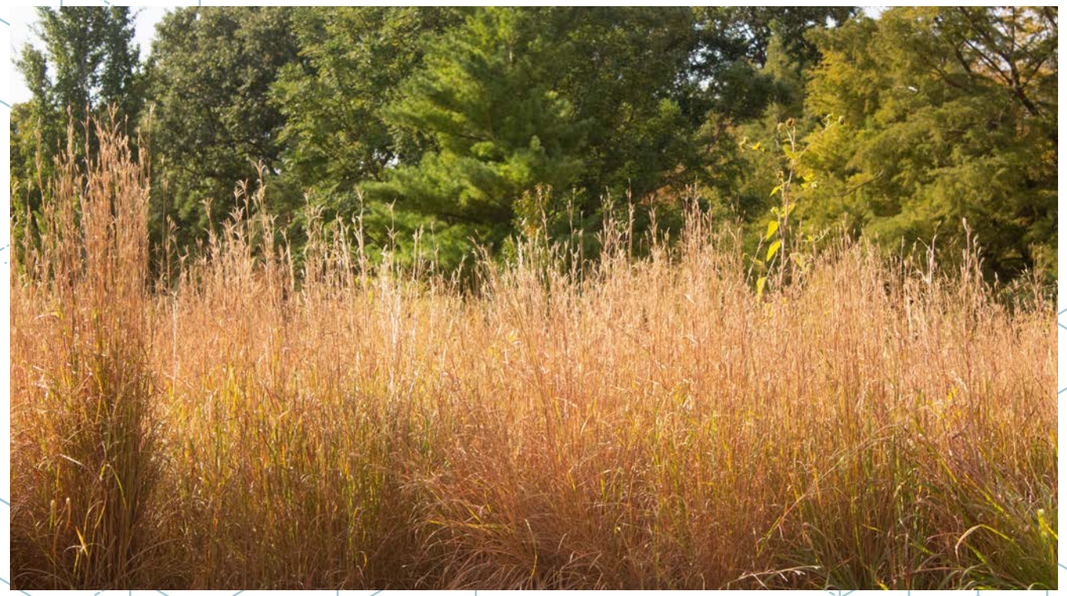
"Pesticides have become more selective and do not harm anything other than the specific pest it is mean to target, which is a big change from the past," Ribeiro said.

Integrated Field Crop Management is the Future

Integrated field crop management is the future of maintaining habitats for beneficial insects and increasing Nebraska crop yields. Peterson said data is collected from many fields in western Nebraska to help learn the behaviors of the beneficial insects.

Incorporating all the knowledge from research into a field plan is the best way for growers to find what works best for the ecosystem of their fields. Peterson's team uses the research data they collect from local fields to help talk to growers about best practices and the importance during field days.

"Agriculture is a challenging environment, not only for researchers, but specifically for the growers," Ribeiro said. "CropWatch is a university provided resource available to the public that regularly shares new information to growers and covers different types of growing systems and topics to help growers make informed crop management decisions."



"Good bugs will make a big difference in reducing the number of pesticides that might need to be used to control and manage pests."

Matheus Ribeiro

KEY TAKEAWAYS

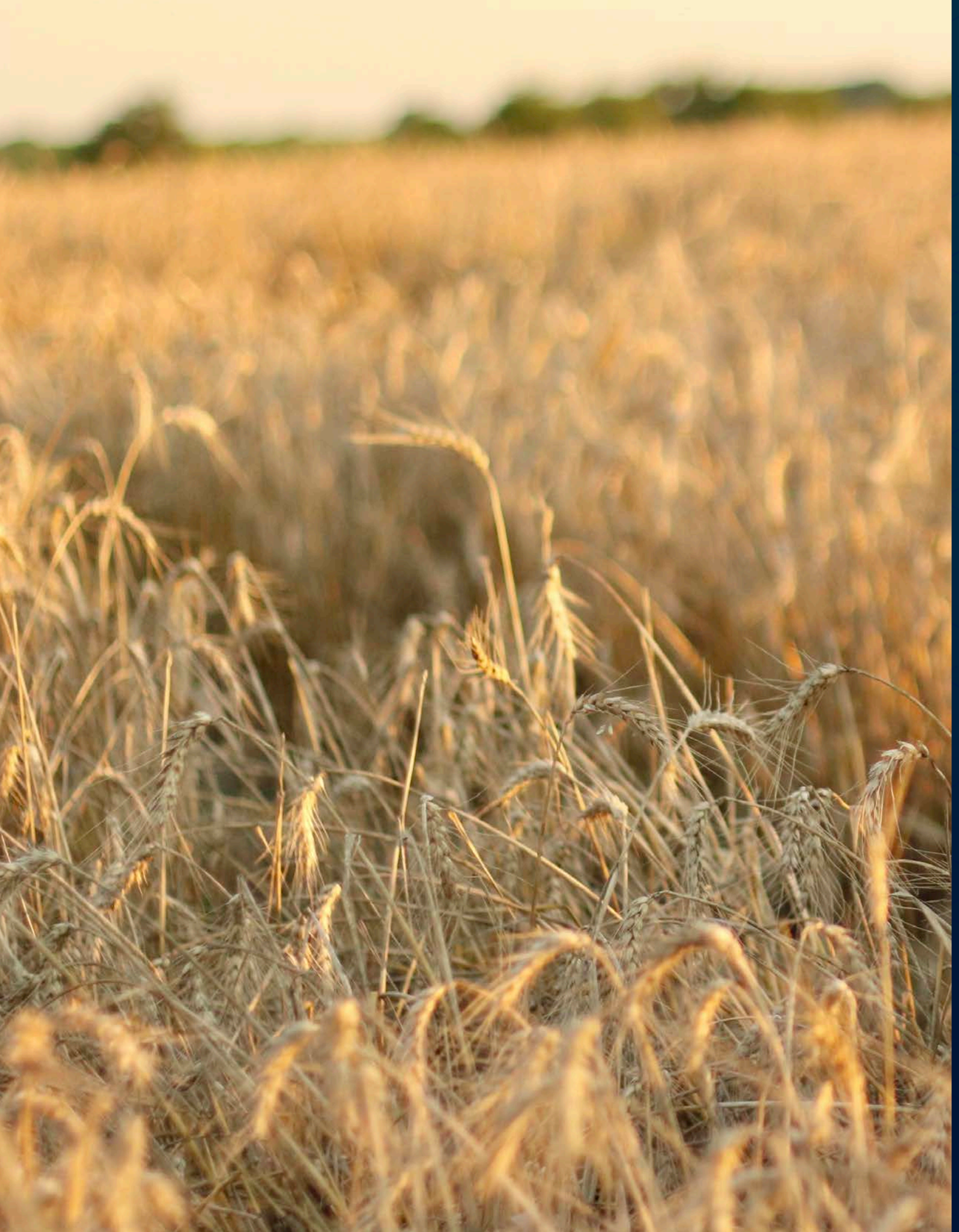
1. Many farmers battle with insects that are pests, but some insects are good and needed to keep pests controlled. Farming practices play an important role in creating a home for these good bugs and many practices can even help conserve good bugs, reduce pests, and result in higher crop yields.

2. Beneficial insects provide important services in field crop areas, such as food for other wildlife, biological control, pollination, and decomposition.

3. Beneficial insects can also help increase crop yields and reduce the need for pesticides.

4. CropWatch (https://cropwatch.unl.edu/) is a great resource available to the public to gather suggestions from researchers and experts in the area of beneficial bugs.

5. For more information about field crop entomology and the research Peterson and Ribeiro are conducting, please visit https://entomology.unl.edu/agroecosystems/ or West Central Research, Extension, and Education Center at https://extension.unl.edu/statewide/westcentral/.



TECHNOLOGY PROVIDES REAL-TIME DATA

Sentinel Fertigation:
Data Improves Nebraska's Nitrogen Issue
Using Satellite Imagery to Provide Real-Time Nitrogen Recommendations

How Properly Using Inputs Can Lead to Sustainability
Policy Design is Driving Force Behind Decision Making

Improving Nitrogen Management
Precision Agriculture Technology Improves Nebraska Agriculture

SENTINEL FERTIGATION: DATA IMPROVES NEBRASKA'S NITROGEN ISSUE

Using Satellite Imagery to Provide Real-Time Nitrogen Recommendations

By Saskia Lanwermann

Jackson Stansell
CEO and Founder of Sentinel Fertigation

Sentinel Fertigation is a start-up company based in Lincoln, Nebraska that uses satellite imagery to provide real-time nitrogen management recommendations to farmers throughout the growing season.

The N-Time™ Fertigation Management System not only allow farmers to operate more efficiently, but also help to minimize groundwater nitrate contamination occurring in various areas of Nebraska.

Jackson Stansell, CEO and Founder of Sentinel Fertigation, came to the University of Nebraska- Lincoln in 2019 to complete a master's degree in the Department of Biological Systems Engineering. Under the direction of Joe Luck, associate professor in the department, Stansell joined a project and developed a software– N-Time™ Fertigation Management System - that provides real-time nitrogen application scheduling recommendations based on satellite imagery.

Simply stated, N-Time™ analyzes and identifies the best time to apply nitrogen via fertigation on corn fields to increase farmers' efficiency while reducing environmental impacts.

Nitrogen is one of the most essential nutrients in crop production, Luck said.

The most efficient way to apply nitrogen to the crop is through fertigation. Luck described fertigation as a technique that applies fertilizer to crops through an irrigation system. However, he further said that overuse of nitrogen and irrigation water can lead to groundwater contamination. Finding the balance is the key to success.

Stansell and Luck conducted on-farm research trials and collected data indicate that 100% of farmers increased nitrogen use efficiency with Sentinel Fertigation.

Finding a way to use nitrogen more efficiently is critical to Nebraska because it is not only the most heavily irrigated state in the United States, but it also has critical groundwater resources that must be protected. Improving nitrogen application would not only improve yields, but also drinking water quality.

Improving Efficiency in Nitrogen Application

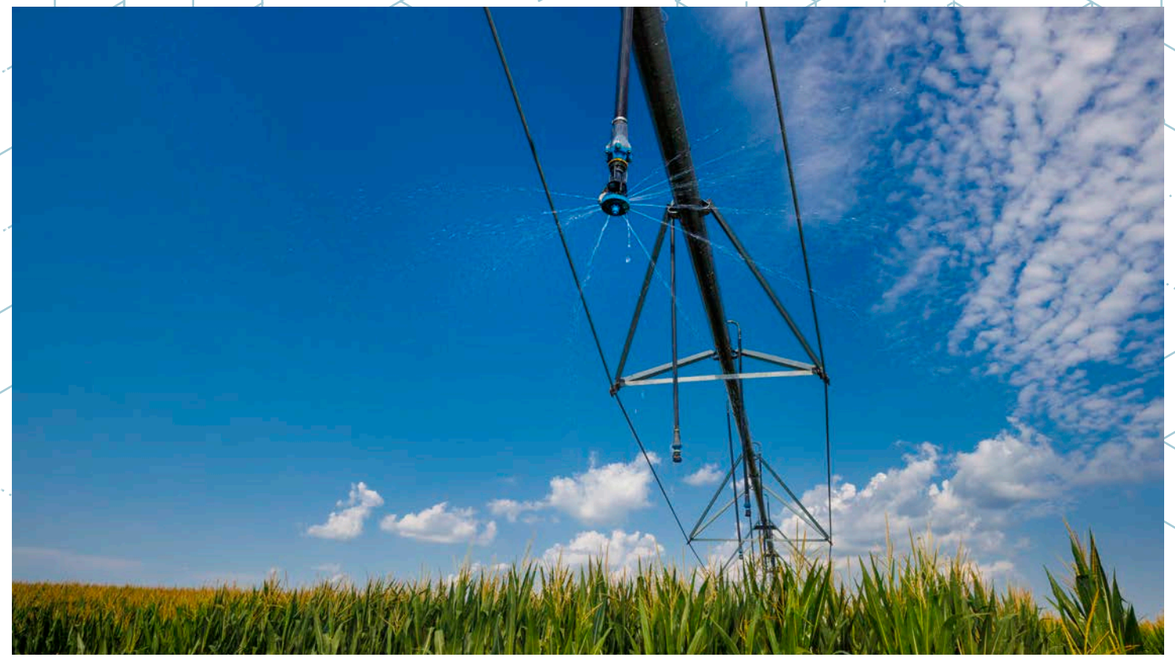
Sentinel Fertigation makes farming more efficient and profitable because it allows farmers to fertigate their fields only when needed, lowering input costs.

Nitrogen is one of the highest cost inputs on farms, Stansell said. Optimizing its use not only increases yield, but also farmers' profitability.

The N-Time™ software platform Stansell developed uses two different kinds of satellite images that come in on a daily and weekly basis to provide real-time application scheduling recommendations. These images visualize the crop canopy at resolutions as high as thirty centimeters per pixel.

"The imagery reports if corn is nitrogen deficient or not," Luck said. "In real life, yellow corn generally indicates that the plant is lacking nitrogen which would ultimately lead to significant yield loss."

On the software, nitrogen-deficient areas are indicated in a lighter color to help farmers see where more nitrogen needs to be applied within the field.



Sentinel Fertigation is Unique

Sentinel Fertigation is the only technology of its kind.

“There is no other technology on the market that is dedicated to fertigation management from the nitrogen scheduling perspective,” Luck said.

Compared to other nitrogen management tools, Sentinel Fertigation not only tells farmers when the best time is to apply nitrogen, but the N-Time™ can also isolate nitrogen stress from other stress factors. Luck said this is highly innovative and important for precise scheduling recommendations.

Further, Stansell said on-farm research from 2019-2021 saw improvement in nitrogen use efficiency in every trial.

“The technology boosts nitrogen use efficiency by approximately 25%, which ultimately results in about 43 pounds of nitrogen saved per acre,” Stansell said. “With corn and fertilizer prices in 2022, that would have resulted in nearly a $30 savings per acre.”

Future of Sentinel Fertigation

Sentinel Fertigation continues to improve its software by making the technology available to more farmers, including more crops beyond corn, and increasing the information on nitrogen for crops.

First, N-time™ is currently being used on nearly 8,000 acres in Nebraska and Kansas with the goal to make Sentinel Fertigation accessible to most farmers.

“We seek to meet farmers where they are,” Stansell said.

The team works with and trains certified service provider partners, agronomic specialists who work with farmers individually to find the best way to implement N-Time™ on their farms with the technology that they own.

“Even if farmers have a pumping system for nitrogen that lacks technology advancement, they could still run the software,” Luck said.

Second, Stansell also plans to expand to include additional crops, beyond corn.

“The need for this technology is something that is not just applicable to field corn that we grow in Nebraska,” Luck said.

N-Time™ could also be applied to crops like wheat and potatoes, he said.

Finally, as of 2023, Sentinel fertigation focuses on when to apply nitrogen. In the future, the start-up also wants to provide recommendations on how much nitrogen farmers need to apply per fertigation event as well.

“The goal of Sentinel Fertigation is to provide software that empowers farmers with precision fertigation management tools and integrates their fertigation data, mobile machinery data and irrigation data in one place,” Stansell said.

KEY TAKEAWAYS

1 Overuse of nitrogen and irrigation water leads to groundwater contamination in Nebraska.

2 Under the direction of Joe Luck, Jackson Stansell developed N-Time™ Fertigation Management System, a software platform designed to help farmers increase their nitrogen use efficiency and profitability.

3 Sentinel Fertigation’s core product, N-Time™, uses two different kinds of satellite imagery to give real-time scheduling recommendations throughout the growing season.

4 The on-farm research trials from 2019 to 2021 showed that farmers who used N-Time™ were able to increase nitrogen use efficiency by an average of 25%.

5 For more information about Sentinel Fertigation, please visit https://www.sentinelfertigation.com/.

“Nitrogen is one of the most essential nutrients in crop production.”

Joe Luck

How Properly Using Inputs Can Lead to Sustainability

Policy Design is Driving Force Behind Decision Making

By Jared DeHaan

Every farmer uses one type of input, either limited or potentially polluting, to make sure their field crops produce quality yields. Limited inputs are natural resources, such as water, that have limitations to how much is available for usage. Potentially polluting inputs, such as nitrogen, are resources that have the potential to negatively impact the ecosystem.

Because of this, policies are put in place to protect and prohibit excessive uses of natural resources.

Karina Schoengold, associate professor in the Department of Agricultural Economics at the University of Nebraska–Lincoln, explores how environmental policy design influences how Nebraskans make decisions regarding limited and polluting inputs.

"Nebraska is fortunate to have such a large aquifer, like the Ogallala Aquifer," Schoengold said. "There are also rivers that depend on the same water, so we must find a way to jointly manage those resources when using an input like water."

Erin Haacker, courtesy assistant professor in the School of Natural Resources at the university studies groundwater extraction, particularly with the Ogallala Aquifer that is in western Nebraska which allows us to know more about this scarce resource.

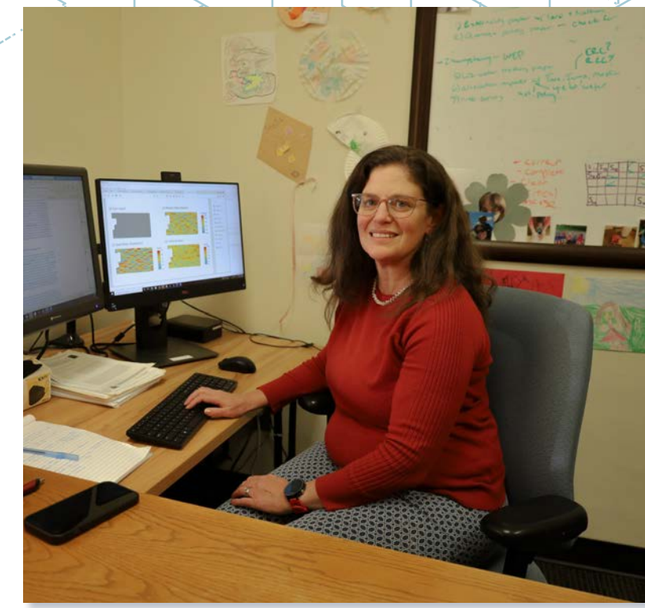
"Through making groundwater models, the physical limits of the aquifer can be determined," Haacker said. "Then, changes can be observed, and groundwater measurements can be gathered."

Having the basic understanding of how people use inputs leads to better decisions when using natural resources, which can ultimately lead to a more sustainable future.

"The main focus is to ensure that inputs are used in an efficient and effective manner that accounts for current and long-term impacts of the resources," Schoengold said.

"Economics is all about scarce inputs because all natural resources are scarce to some extent. Policies can also help manage potentially polluting inputs."

Karina Schoengold



Karina Schoengold

Possible Impacts of Using Inputs

Knowing how to properly use water and distinguish the amount needed to perform a task can help determine how to use this resource and make decisions in the future.

Because water is a limited input, policy design affects how people use it as well as how they make decisions about its use.

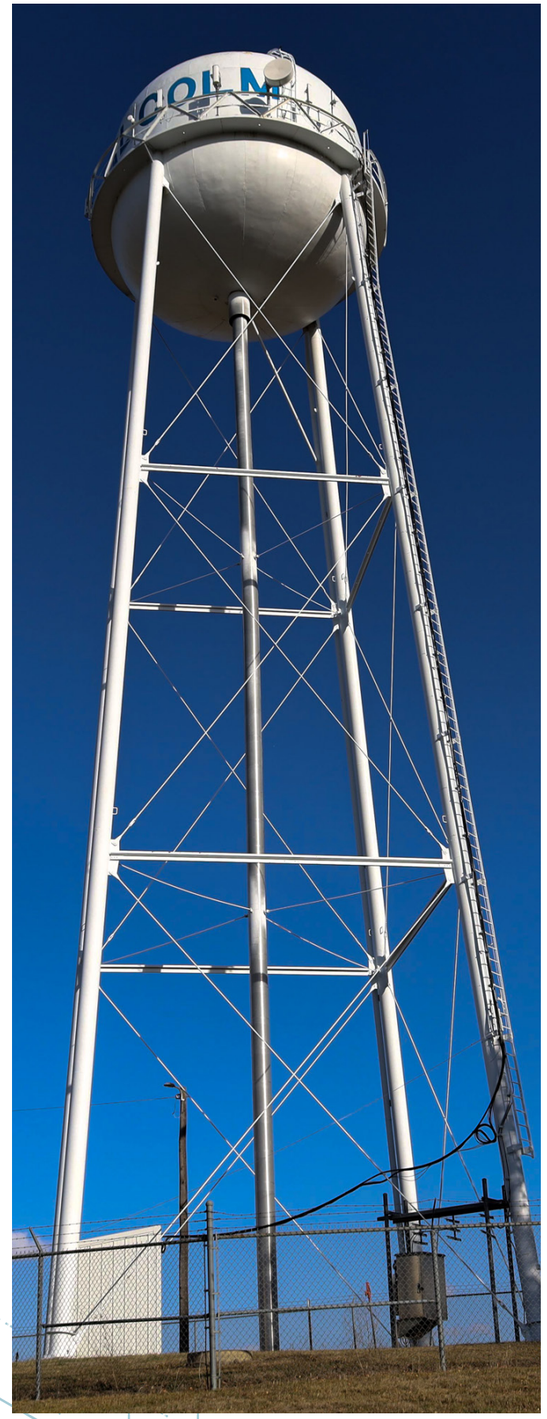
"Policies are constructed to help people understand how to use natural resources safely and efficiently," Schoengold said.

These policies impact the economics across the state as well.

"Economics is all about scarce inputs because all natural resources are scarce to some extent," Schoengold said. "Policies can also help manage potentially polluting inputs."

Polluting inputs have negative effects on people and the ecosystem. For example, water contamination and air pollution are two possible impacts from using polluting inputs.

"People use nitrogen fertilizers to increase productivity in their plant and crop yields," Schoengold said. "However, if there is runoff or flooding, that resource can pollute the water or create algae blooms that have negative impacts on the environment."



Algae blooms are the rapid growth of algae in water that can cause harm to the local ecosystem, humans, and animals. To avoid these issues, people need to understand how inputs should be applied.

Decision-Making Regarding Inputs

Ways individuals make decisions with polluting and limited inputs is critical because it leads to the longevity of natural resources in the environment. Further, people can gain useful information from understanding what others in their area are doing with these resources.

“If people are given information about the amount water their neighbors are using, that could potentially affect how they manage their water resources,” Schoengold said.

However, assumptions about inputs can potentially have negative impacts on how humans make decisions. For example, many misunderstand the design of an aquifer.

“The Ogallala Aquifer base has a slight tilt to it,” Haacker said. “The natural flow is from west to east.”

For those who do not understand that there is a tilt, they could believe that excessive extraction of groundwater in Texas would deplete water availability in Nebraska.

Further, water being extracted at a higher rate in Texas does not mean that there will be less water in Nebraska. This is because water in the aquifer flows from west to east and not north to south.

“Enough people could have the same misconception about groundwater which could then turn into mistaken common knowledge,” Haacker said.

What Drives Policy Design?

Policy design is essential for Nebraskans to understand inputs because it directly impacts how they use different resources. Further, how individuals make decisions regarding inputs can directly impact how environmental policies are designed.

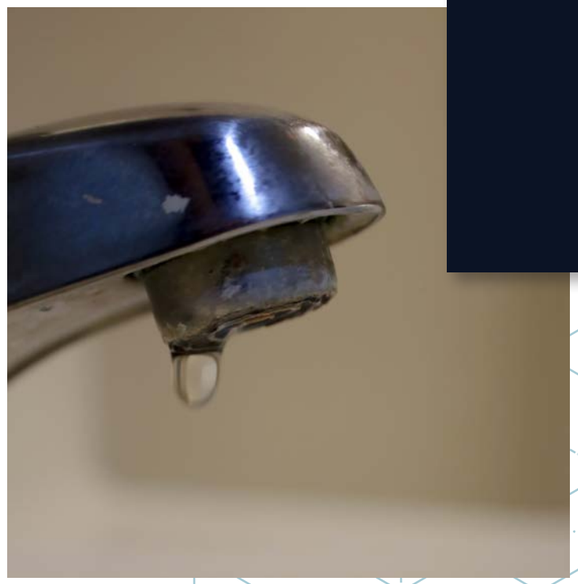
Schoengold said it is critical for policies to be designed that ensure natural resources are used effectively and efficiently.

“Policies can directly be affected by incentives,” Schoengold said. “For instance, putting a tax on a resource could potentially limit the usage of it.”

An incentive is something that motivates an individual to do something. Within environmental policy, tax incentives are one tool to reduce environmental damages when using inputs.

For example, in the San Luis Valley of Colorado, the local community imposed a variable tax to limit water extraction for irrigation. Based on this, withdrawals of water were reduced by 32% (on average) across all crops after the self-imposed tax was put into place.

Tax incentives greatly affect the role of policy but can also affect one’s decision making as well.



KEY TAKEAWAYS

1. Having the basic understanding of how people use inputs leads to better decisions when using natural resources, which can ultimately lead to a more sustainable future.

2. Limited inputs are natural resources that have limitations to how much is available for usage. Potentially polluting inputs are resources that have the potential of negatively impacting an individual or ecosystem.

3. Policies are put in place to protect and prohibit excessive uses of natural resources.

4. Ways individuals make decisions with polluting and limited inputs is critical because it leads to the longevity of natural resources in the environment.

5. For more information about polluting and scarce inputs and the research Schoengold is conducting , please visit https://agecon.unl.edu/faculty or the Nebraska Water Center at https://watercenter.unl.edu.

Improving Nitrogen Management

Precision Agriculture Technology Improves Nebraska Agriculture

By Abigayle Warm

"The majority of decisions Nebraska farmers must make each year are focused on irrigation management, nitrogen application, and pest control issues."

Joe Luck

Nitrogen is an essential nutrient for plant growth. But when nitrogen is applied at a fixed rate, whether a crop needs it or not, it can result in water pollution and unnecessary costs for farmers due to over-application. Precision agriculture is addressing this issue with sensor technology.

Joe Luck, associate professor in the Department of Biological Systems Engineering, and Taro Mieno, associate professor in the Department of Agricultural Economics both at the University of Nebraska-Lincoln are bringing precision agriculture sensor technology to farmers across eastern Nebraska to improve nitrogen management practices in their row crop operations.

"The majority of decisions Nebraska farmers must make each year are focused on irrigation management, nitrogen application, and pest control issues," Luck said.

Angela and Kerry Knuth of Mead, Nebraska are third-generation farmers who tested precision agriculture's sensor technology in 2018 to improve the nitrogen management practices they use on their farm.

"Sustainable management of resources, like nitrogen, is of utmost importance to the future of our farm," Knuth said.

Luck and his team at the Eastern Nebraska Research, Extension, and Education Center (ENREC) worked with over 80 growers to gauge nitrogen requirement variability within and between different fields across central and eastern Nebraska to develop the most sustainable nitrogen application methods.

Sensor Technology

The goal of sensor technology is to increase the efficiency of nitrogen use as fertilizer while reducing nitrate loss to groundwater.

"Identifying the specific amount of nitrogen needed within a field using sensor technology not only reduces over application of nitrogen, but also decreases pollution," Mieno said.

Sensor application allows growers to apply nitrogen based on the specific needs of each plant.

"Sensors are located on the sprayer to essentially read the plant and detect whether it is nitrogen deficient, and if so, the amount of nitrogen needed is applied," Luck said.

Luck's team also uses drone sensors to take an aerial scan of the field. This scan maps the field

and shows where it may be nitrogen deficient and then estimates the nitrogen requirement of the field.

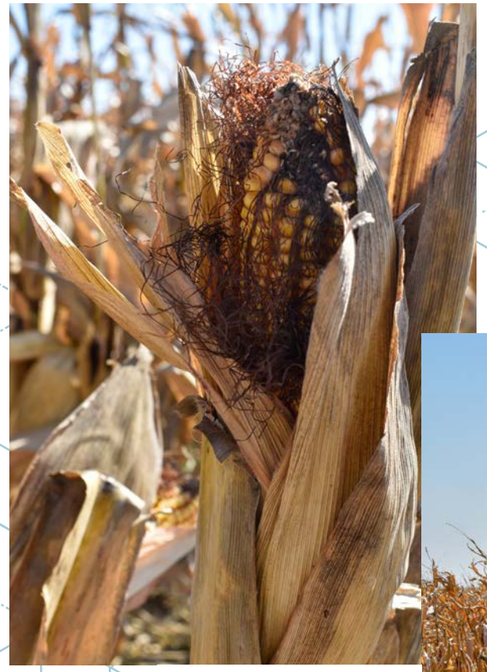
In addition, Mieno observes data points from sensor technology in relation to nitrogen application, specifically, the yield data which provides up 20,000 data points in a single field.

Comparing Cost

For a management practice to be effective, it must be both economically and environmentally sustainable.

"Optimal site-specific nitrogen application is not just contributing to profitable production, but also to minimizing the environmental impact of agricultural production," Mieno said.

The chances of a grower adopting a new practice such as sensor application weighs heavily on whether implementing it can be done without burdening the operation with added costs.



Joe Luck & assistant, Taylor, showing drone

"When explaining this process to growers, most ask about success rate of using sensor technology, but all need to know how much it will cost to implement a new practice," Luck said.

To show cost comparisons, Luck compares sensor application cost and irrigated corn yields to the grower's current nitrogen practices. According to this data, Luck said that 54 out of 62 sites managed nitrogen more efficiently with sensor application.

As an example, the Knuth's traditionally applied 40-50 pounds of nitrogen up front and then returned with a Y- drop sprayer application through the growing season. The sensor application reduced the amount of nitrogen they were using in the field they strip tested.

Future of Sensor Technology

The future of sensor technology is tracking real time data, taking a full circle look at agricultural production, as well as expanding geographically.

Luck hopes that sensor systems can be developed to detect the nitrogen and moisture profile of their fields in real-time.

"One thing about nitrogen is once it is on the field, it is not seen," Luck said.

By creating a real-time visualization system, growers can see how crops change in response to elements like rain, drought, and other stressors over the growing season.

This increases growers' knowledge and accuracy of nitrogen management in response to different variables, making the use of the resource in fields more sustainable, he said.

Luck's team aims to connect the dots between nitrogen management in crop production to livestock production systems for a full circle look at how resource management impacts all areas of production.

"Nebraska agriculture is a circular economy," Luck said. "It includes livestock production, pastureland management, grain production, and the fuel it takes to haul it to them."

Second, Mieno has recently partnered with precision agriculture engineers to gain a broader perspective on nitrogen management. His goal is expanding sensor technology databases to observe yield, weather, nitrogen rate within the field, and electric conductivity to optimize site-specific applications to more crop types.

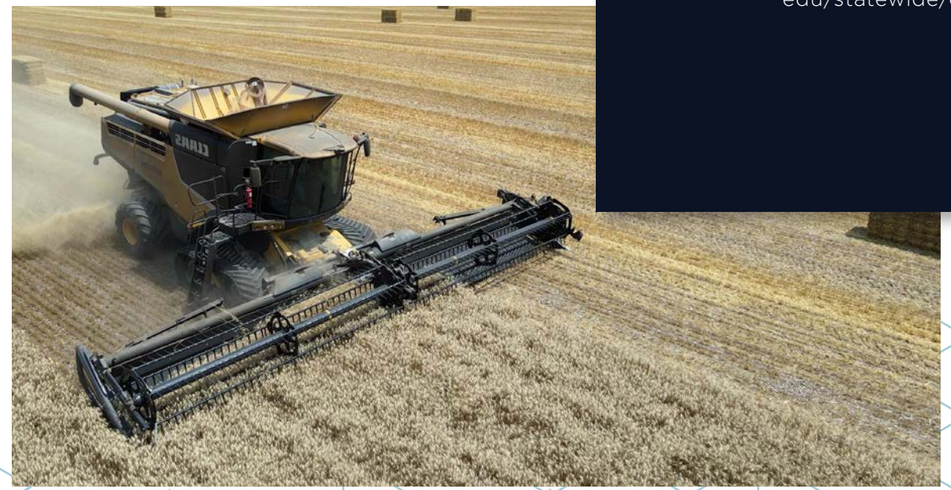
He will also continue to expand geographically, running randomized nitrogen experiments on fields across Nebraska, Illinois, Ohio, Montana, and parts of South America.

"Agriculture is global and is critical for global food security," Mieno said. "Branching out geographically was an obvious next step."

Ultimately, the future of sensor technology is to minimize nitrate waste, while maintaining high-level yield to feed a growing population.

KEY TAKEAWAYS

1. Precision agriculture, such as sensor technology, helps with nitrogen management.
2. Research teams at the Eastern Nebraska Research, Extension, and Education Center (ENREEC) have worked with over 80 growers to gauge nitrogen requirement variability within and between different fields across eastern Nebraska to develop the most sustainable nitrogen application methods.
3. Precision agriculture's sprayer sensor technology allows growers to use a responsive approach to applying nitrogen to fields.
4. The ultimate goal of this research is to minimize nitrate waste, while maintaining high-level yield production to feed a growing population.
5. For more information on research projects conducted by ENREEC, please visit: https://extension.unl.edu/statewide/enre/enrec/



INNOVATIVE TECHNOLOGY IMPACTS

Technology in the Tee Box
Digital Data Advances Golf Management Program

NUtrack: Tracking Livestock Behaviors to Improve Health
Computer Vision System Creates Solutions for Improving Animal Well-Being

Nebraska Veterinary Diagnostic Center Provides Protection
Rapid Testing and Vaccine Development Keeps People and Animals Safe

Technology in the Tee Box

Digital Data Advances Golf Management Program

By Brianna Gable

Technology advancements in golf management, paired with a focus on agriculture, create a premier experience and result in comprehensive expertise.

The Professional Golfers' Association of America (PGA) Golf Management program in the College of Agricultural Sciences and Natural Resources (CASNR) at the University of Nebraska-Lincoln provides students with unmatched exposure to technology.

Nebraska's golf industry, with more than 200 courses, is in a favorable position to recruit exceptional graduates of the program and grow the sport.

Brad Goetsch, assistant professor of practice in the PGA Golf Management program, leverages new technology to exhibit the dynamic pathways within golf management to recruit prospective students like Blare Bauer, a December 2022 graduate of the program.

Technological resources available at the university's program, such as high-speed camera systems and doppler radar, improve industry experiences and employability for all students.

"Learning how to use the systems and understand the data has prepared me for real-world experiences," Bauer said. "Experiences with the TrackMan Golf Simulator and other digital tools in our golf lab give a competitive edge when applying for jobs."

In addition to technology, Dann Husmann, director of the PGA Golf Management program at the university, said the program's unique position in CASNR enables students to gain insight on turfgrass and soil management – something not offered in other programs.

"Understanding the dynamics of the soil under the turf has a direct influence and impact on the health of the turf and what a golfer sees on a green grass golf course," Husmann said.

"Experiences with the TrackMan Golf Simulator and other digital tools in our golf lab give a competitive edge when applying for jobs."

Blare Bauer

Technology Boosts the Program's Course

The PGA program is equipped with state-of-the-art lab spaces that feature TrackMan Golf Simulators, GCQuad Launch Monitors, and Phantom High-Speed Cameras. Along with Goetsch's personal outreach to prospective students, Husmann said PGA's premier facilities drive recruitment and retention.

"Our program has technology from each manufacturer brand represented within our collection, which no other program does," Goetsch said. "Our students also feel like their desires are accounted for because the program is broad."

Bauer said technological advancements have allowed him to thoughtfully consider wind speed, course slope, and yardage to increase accuracy, even when playing in simulation.

"Access to simulators in our program is essential to keeping our golf game dialed in," Bauer said. "For instance, we can be playing virtual golf at Pebble Beach in California, from Nebraska, during the winter months."

Advanced technology in these programs analyzes facets of a player's game that affect overall success on the course, including club impact, golf ball flight, and body movement. Goetsch adopted TrackMan's educational curriculum to teach students to operate the equipment and interpret data, leading to a certification upon successful completion of the course.

"Teaching students responsible use of technology, not using it as a crutch, is a critical piece of the game," Goetsch said. "Students understand its place as a tool within the human interpersonal interaction that always needs to take place."

Based on what they learn from the technology, Husmann said students recognize patterns in data to create actionable information for beginning, intermediate, and advanced golfers they may coach during their career. The definite scientific feedback is pivotal in correcting and improving specific aspects of a player's game, influencing enjoyment on the course.

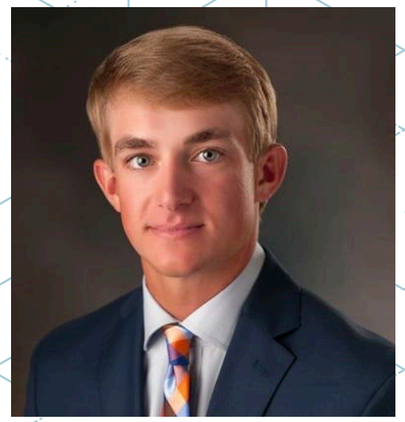
"Upon graduation, PGA students can provide clients a lesson or series of lessons to improve a certain facet of their golf game when called upon," Husmann said.

Student in Digital Lab

Driving the Future of Golf

The future of golf technology in education is promising as equipment becomes more portable and affordable. In addition, engineers are capitalizing on new-age materials to improve equipment mass and software compatibility.

"Advancements in the golf industry are an example of modern engineering and a testament to the quality of the manufacturers who have studied and produced this technology," Bauer said.



Brad Goetsch (Top)
Blare Bauer (Bottom-Left)
Dann Husmann (Bottom-Right)

KEY TAKEAWAYS

1. The Professional Golfers' Association of America (PGA) Golf Management program provides students with unmatched exposure to technology, resulting in comprehensive expertise.

2. Nebraska's golf industry, with more than 200 courses, is in a favorable position to recruit exceptional graduates of the program and grow the sport.

3. The PGA program is equipped with state-of-the-art lab spaces that feature TrackMan Golf Simulators, GCQuad Launch Monitors, and Phantom High-Speed Cameras.

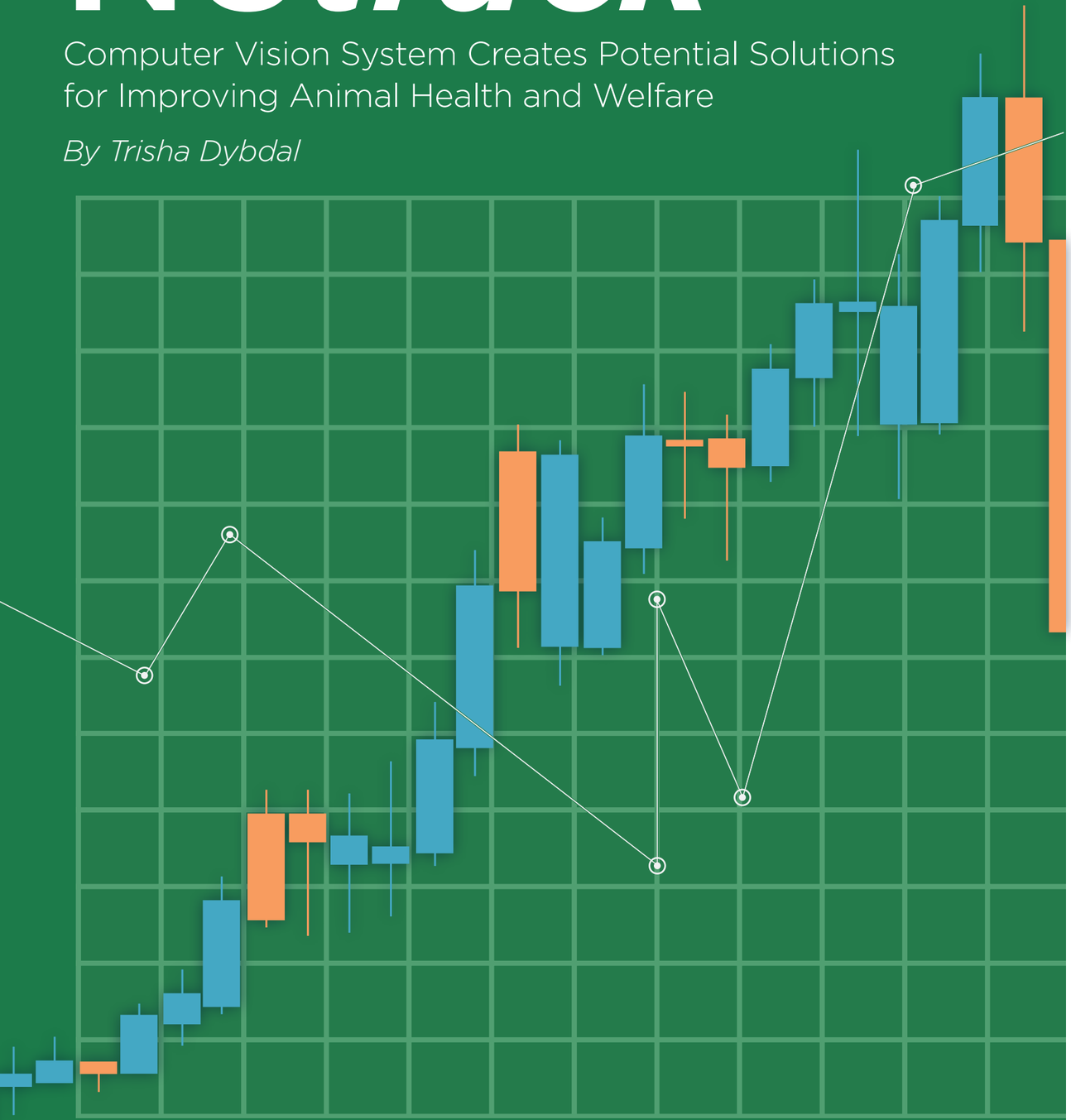
4. Technological resources such as high-speed camera systems and doppler radar improve industry experiences and employability for all students.

5. For more information, visit https://grassland.unl.edu/pgm.

NU*track*

Computer Vision System Creates Potential Solutions for Improving Animal Health and Welfare

By Trisha Dybdal



Subtle changes in an animals daily behaviors can be an early indication of a potential change in health, welfare, or performance. However, these subtle changes are not something that producers are able to observe or track.

A research team at the University of Nebraska–Lincoln has been working to change this by developing a computer vision platform that can track these subtle changes in an animals daily behavior.

Ty Schmidt, associate professor, and Benny Mote, associate professor in the Department of Animal Science and Eric Psota, adjunct research professor, Ben Riggan, associate professor, and Lance Pérez, Dean, College of Engineering at the university, have teamed up to create the NU*track* Livestock Monitoring System - a computer vision based platform that is able to track subtle changes in the time an animal spends walking, standing, lying, sitting, and resting.

The NU*track* system is also able to determine the amount of time an animal spends at the feeder and distance walked each day. With these capabilities, the system may soon be a tool to assist producers to track the health of their livestock.

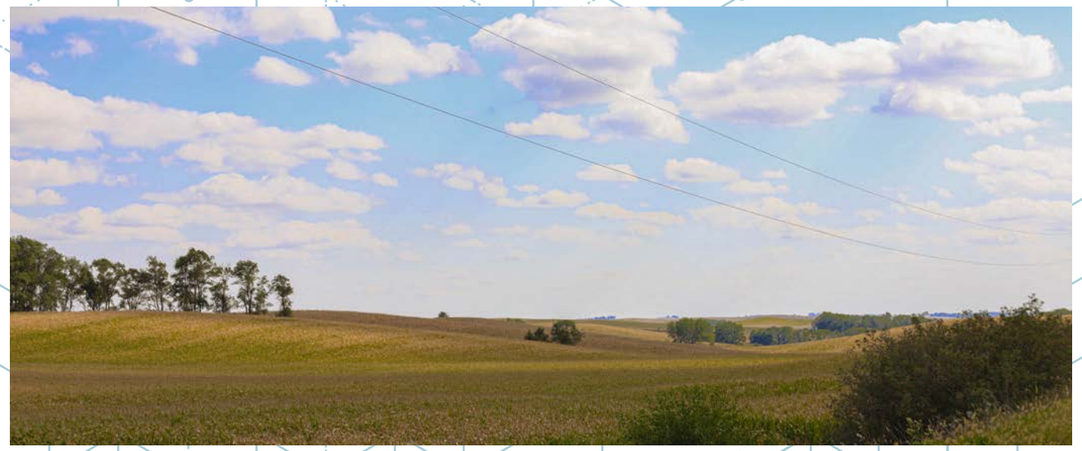
While NU*track* is not yet ready for use by commercial producer, the research team is hopeful that eventually the system will be commercially developed into a product that could assist producers in the identification of sick or injured animals, allowing them to treat the animals and create an action plan to combat the issue.

"One goal for developing the NU*track* system is to create a tool that can assist producers in rapidly and accurately identifying sick or injured animals through tracking subtle changes in the animals behavior," Schmidt said.

The NU*track* system utilizes commercially available security cameras that can be installed over top of a pen and captures continuous video of the animals. The captured video is broken down into individual images and processed using proprietary computer vision programming created here at the university. This computer vision program allows the NU*track* system to identify individual animals and track the behaviors of each individual animal.

"Ultimately, the team envisions the NU*track* system to assist producers by providing them a daily report on their computer of animals that need special attention," Schmidt said.

With the NU*track* systems ability to track the behavior of individual animals, the team envisions numerous areas of livestock production where NU*track* can assist Nebraska's livestock industry, Mote said.



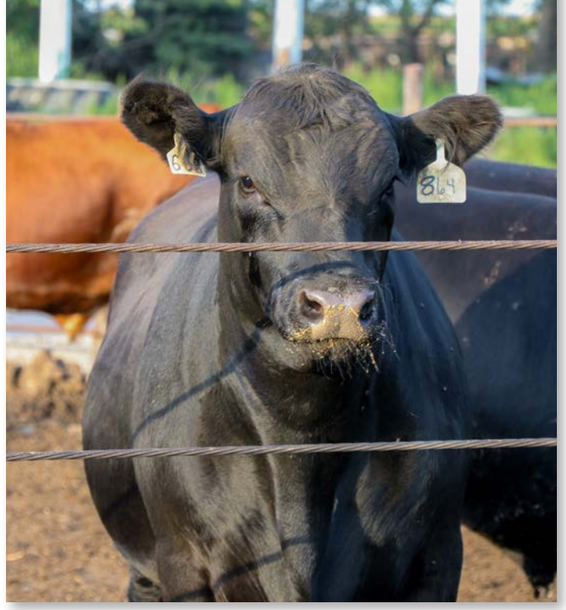
Specifically, the NUtrack system:

1. Assists in selection of genetically efficient animals (animals that burn less calories due to not being excessively/needlessly active), which could possibly reduce the cost of gain and ultimately increase production efficiency.
2. Accurately determines the number of animals loaded or off loaded that could be a significant tool managing animal inventory.
3. Ensures that potential labor shortages will not compromise the health and welfare of livestock, especially at a time of significant labor challenges.

NU*track* has many opportunities for assisting livestock producers to become even more successful. The three components above are just a peak into to what NU*track* will be able to offer producers.

"NUtrack will ultimately improve the overall production of livestock operations."

Ty Schmidt



NU*track* Process

Currently, NU*track* has only been validated on tracking group housed pigs, but in the future, the research team looks to expand the research to tracking the behaviors of feedlot cattle.

"NU*track* was developed to track individual animals by looking for certain features of pigs including the ears, hip, snout, and shoulders," Mote said.

Doing so allows the system to accurately track the pig's movements. Specifically, each pig is tagged with a regular ear tag to enhance the system's ability to maintain individual identification and provide a means for the producer to visually identify a specific pig. These tags vary color and alpha-numeric sequence and the system is trained to recognize these specific color/number combinations.

"Different colored ear tags are used to make tracking easy for both NU*track* and the human observer," Mote said.

When the team started the development of NU*track*, a key feature for the system was to try and make it an affordable system that could easily be installed by the producer.

"For producers to use a system like NU*track*, it is vital that the cost of operating the system is financially feasible," Schmidt said. "The industry needed something that can accurately track animals without needing expensive technology and the NU*track* system does that."

Benefits of NUtrack

The NU*track* system is a refined computer vision platform that allows the system to be able adapt quickly to keep track of individual pigs within a group setting.

This system is different from other types of precision livestock technology that are designed to monitor the environment (such as temperature, air quality, humidity), water usage, and food intake, as well as other factors.

What really sets the NU*track* system apart from other types of precision livestock technology is that NU*track* focuses on individual animals in group housed settings.

"By tracking animal's behaviors and identifying subtle changes, the system potentially will be able to assist producers in the early identification of sick or injured animals , which would increase a producer's ability to ensure that they are providing their livestock with the highest level of health and welfare, "Schmidt said. "This, in turn, will ultimately improve the overall production of livestock operations."

Future of the NU*track* System

With technology always changing throughout the agricultural industry, it is important to keep up with those changes.

"The future of NU*track* relies on the continued advancements in the field of computer vision, and as the field of computer vision progresses, so will the capabilities of the system," Schmidt said.

Having affordable options is also beneficial.

"Technology not only is constantly improving, we are also seeing it become cheaper and as things keep progressing," Mote said. "Hopefully this will make NU*track* more affordable."

With technology changing, it has allowed the NU*track* team to create a system that producers would want and be able to use.

"The ultimate goal is for NU*track*, or a variation of the technology, to be in every swine facility and every feedlot in Nebraska," Schmidt said. "With it, producers could sit with a cup of coffee each morning and review a printout with valuable information that identifies exactly which animals need to be checked more closely."

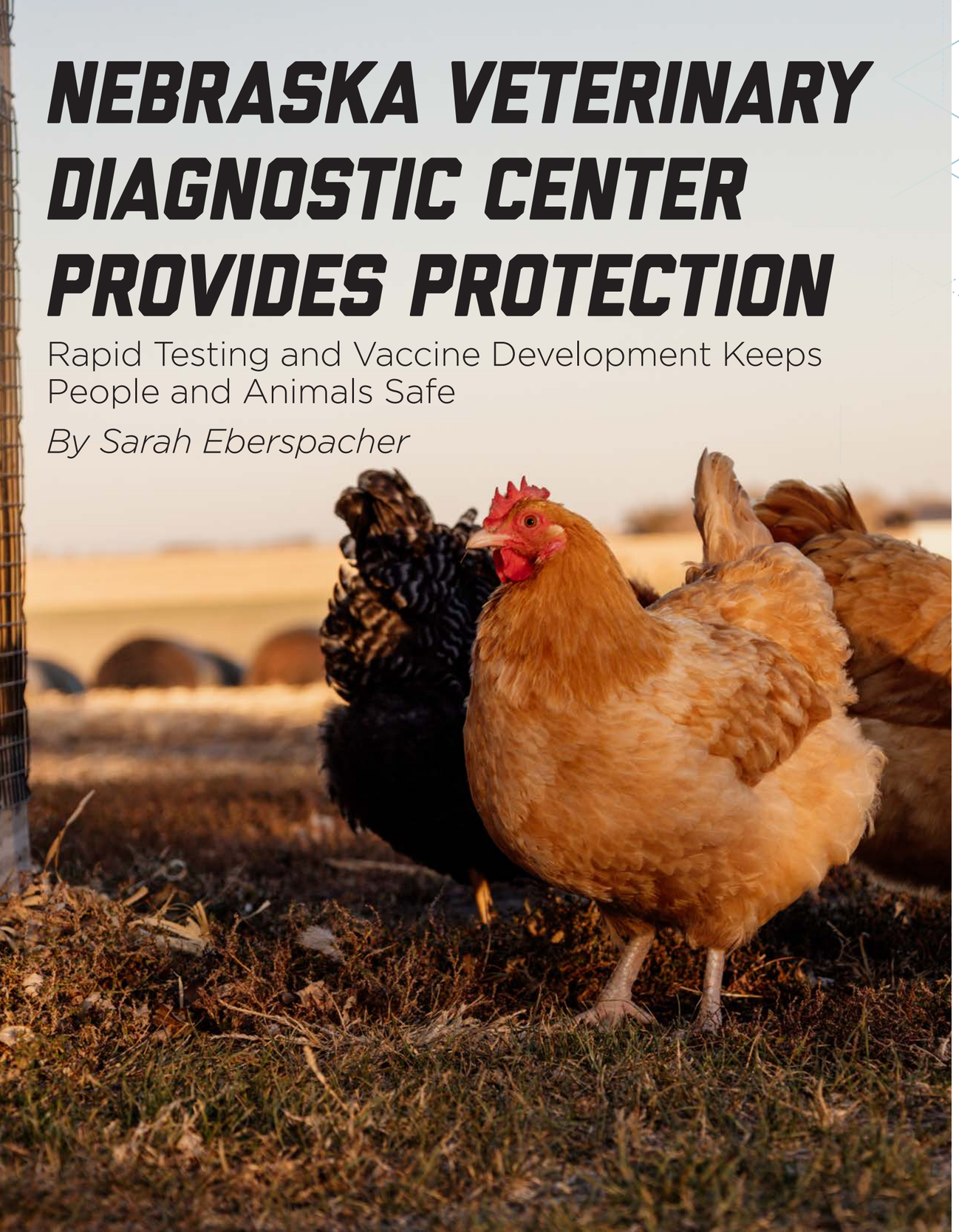
KEY TAKEAWAYS

1. The development of technology like the NU*track* system may allow producers to learn more about their livestock – particularly if changes in behavior may be an early indicator that animals are becoming sick before symptoms are visible.
2. While it is not yet available to the public, the NU*track* research team is hopeful that the NU*track* system, or something similar, will eventually allow producers to be aware of the illnesses that might impact their livestock so they can create an action plan to combat the issue.
3. Today, using the NU*track* system as a research tool, the research team will help Nebraska's livestock industry, by reducing costs of grain, identifying sick animals early, and offering needed 'labor' support.
4. The NU*track* system may not be limited to just livestock. Currently the research team is also working with the Lincoln Children's Zoo to track the behavior of cheetahs.
5. For more information about the NU*track* system visit https://animalscience.unl.edu/nutrack-livestock-monitoring

NEBRASKA VETERINARY DIAGNOSTIC CENTER PROVIDES PROTECTION

Rapid Testing and Vaccine Development Keeps People and Animals Safe

By Sarah Eberspacher



> *"Our main mission is to serve veterinarians and animal owners in the state of Nebraska."*
>
> *Bruce Brodersen*

Viruses can be spread in many ways and affect both humans and animals. The Nebraska Veterinary Diagnostic Center (NVDC) at the University of Nebraska-Lincoln, a medical laboratory for veterinarians, provides rapid testing and conducts research to develop tests for many different infectious agents – providing protection for Nebraskans and their animals.

Bruce Brodersen, director of the Diagnostic Center, and his team conduct tests that cover all aspects of animal health to assist veterinarians across Nebraska.

"Our main mission is to serve veterinarians and animal owners in the state of Nebraska," Brodersen said.

The Diagnostic Center performs testing on blood samples, tissue samples, and other biological specimens to give Nebraska veterinarians and animal owners the answers they need to prevent illnesses and care for their animals. Many testing programs provide support for regulatory agencies allowing exportation and trade as well as surveillance for the presence of emerging, high consequence, and transboundary diseases. The most recent research efforts in the NVDC focus on pinkeye in cattle and bacterial pathogens which cause respiratory disease in cattle.

The NVDC extends services beyond veterinary medicine and conducted all COVID -19 testing for the university during the pandemic. Their turnaround was some of the quickest in the state.

Additionally, Scott McVey, Director of the School of Veterinary Medicine and Biomedical Sciences and Hiep Vu, Associate Professor in the Department of Animal Science at the university, are creating a potential vaccine for African Swine Fever.

The potential threat of African Swine fever entering the United States would be detrimental to the pork industry. Being proactive, these researchers work through the Diagnostic Center with a collaborative international community to combat this serious disease threat.

Serving the Nebraska Community

The Diagnostic Center operates with a budget that includes a variety of resources, including University appropriated dollars, revenue generated from testing, and USDA grants.

"Recent high priority work of the Center has been COIVID-19 testing and testing for highly pathogenic avian influenza in domestic poultry and wildlife," Brodersen said.

COVID-19 Testing

The Diagnostic Center is adaptable for testing viruses that infect humans. Similar to livestock testing, the Diagnostic Center works quickly to get results out in a timely manner to limit the spread of the virus.

The NVDC served as a main site for COVID-19 testing in the Lincoln community. Not only did the center conduct all COVID-19 testing for the university, test samples from staff and other local entities were collected and analyzed.

"On average, COVID-19 test results at the center were shared between 6 and 8 hours after samples were received," Brodersen said. "The most COVID-19 samples we had in a day were around 5,000, but we were set up and knew how to handle large volumes of samples like that."

Further, with Avian Influenza outbreaks occurring in birds around Nebraska, the Diagnostic Center performs tests on all flocks suspected of being infected with the virus. and provides same-day test results in high priority situations.

Avian Influenza

Avian Influenza has an 80 to 90% mortality rate and is responsible for the deaths of millions of birds, including chickens and turkeys that are used for human consumption, Brodersen said.

"There were millions of birds that had to be depopulated to stop spread of the Avian Influenza virus," Brodersen said. "It is extremely important to provide accurate test results in a very timely manner so producers and governmental veterinarians can respond to an outbreak appropriately."

The Diagnostic Center works as a medical laboratory for veterinarians and receives most test samples through FedEx, UPS, and post offices.

International Community Collaboration

Research on African Swine Fever, a deadly viral disease with a 95% fatality rate, must be completed in certified laboratories; therefore, Nebraska internationally to combat this serious disease threat.

"The impact of African Swine Fever is twofold: 1) the direct impact of the disease and 2) impacts and limitations on international trade," Vu said.

In the event of an African Swine Fever outbreak, all exposed pigs must be euthanized and can not be used for meat. Therefore, if the virus spreads, there could be a major pork shortages with a devastating number of euthanized pigs, McVey said.

African Swine Fever has not been detected in America, however, the virus spreads rapidly, so McVey and his team are diligently learning how to mitigate risk in order to avoid the virus entering the United States. The virus has recently infected pigs in the Dominican Republic and Haiti in the western hemisphere.

"This virus spreads from direct, close contact and, if contracted, persists in pork products and environments where infected pigs were housed," McVey said. The virus can also be transmitted through Argasid ticks.

Vu and McVey work with several countries, including Vietnam, China and Tanzania, that are impacted by this virus to understand the complexity of the strains.

"The viral proteins that stimulate protective immunity are not fully characterized at this time," Vu said.

As such, Vu and his team are studying the African Swine Fever proteins in the Nebraska Center for Virology to determine which proteins to target in hopes of creating a vaccine and eliminating the threat of limited pork productions.

KEY TAKEAWAYS

1. The Nebraska Veterinary Diagnostic Center provides rapid testing and conducts research intended to help the livestock industry – ultimately to provide protection for Nebraskans and their animals.

2. Primarily, the Diagnostic Center is a full-service laboratory that supports the animal industry and economic vitality of Nebraska

3. They also extended their services beyond animals and conducted all COVID-19 testing for the University of Nebraska system faculty, staff, and students during the pandemic to limit exposure.

4. The potential threat of African Swine fever making its way to the United States would be detrimental to the pork industry, so to stay ahead of the issue, Nebraska researchers in the Diagnostic Center work with a collaborative international community to combat this serious disease threat.

5. For more information please visit: https://vbms.unl.edu/nvdc or https://news.unl.edu/newsrooms/today/article/vu-to-lead-research-project-in-fight-against-african-swine-fever/

YOUTH ENGAGEMENT WITH DATA AND TECHNOLOGY

Operation Innovation
Change Maker Scholarship Program Innovates Opportunity

Taking College Topics to Nebraska High Schools
CASNR Faculty Integrate Agricultural Topics

THE CASNR CHANGE MAKER

Operation

INNOVATION

Change Maker Scholarship Program Innovates Opportunity

By Brianna Gable

A spirit of innovation pulses through a community of students known as Change Makers who bring innovative ideas to the table for the betterment of greater Nebraska.

The College of Agricultural Sciences and Natural Resources (CASNR) at the University of Nebraska-Lincoln launched the Change Maker program to enhance the future of Nebraska by developing solutions to key issues that historically impact Nebraska's workforce, economy, and natural resources.

Jack Bunch & supervisor setting traps

"Change Makers better our college and Nebraska because they are drawn to look at a problem and think outside of the box to find a solution."

Megan Rothenberger

Megan Rothenberger, CASNR student success coordinator, said the quick pitch program targets eight grand challenges: feeding the world, new energy, biodiversity, sustainability and the environment, engaging diverse communities, water for the future, climate in the future, health, and developing tomorrow's leaders.

"Projects within each of these grand challenges are important because they showcase the breadth of CASNR disciplines, and the current generation of students is highly interested in finding solutions to them," Rothenberger said.

Both Nebraska and out-of-state students pitch their big ideas in a two-minute video contest judged by a panel of CASNR affiliates, and chosen winners develop their idea throughout their college career.

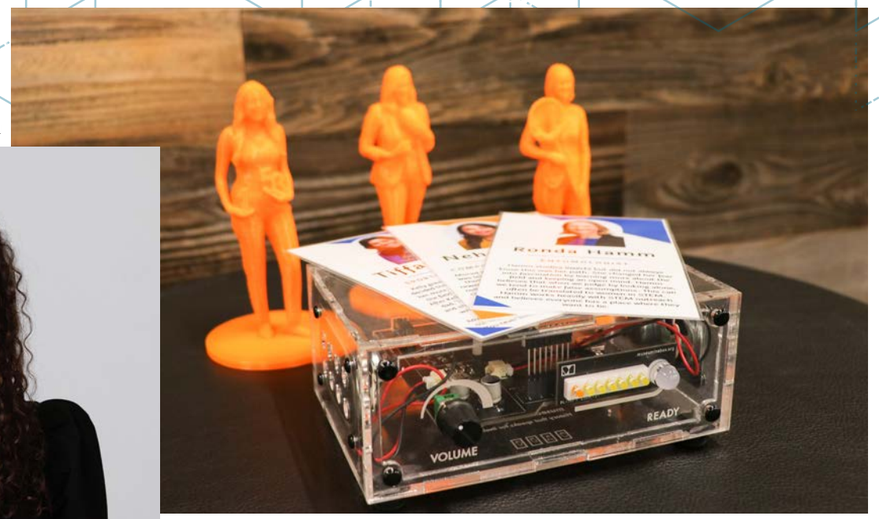
"Change Makers better our college and Nebraska because they are drawn to look at a problem and think outside of the box to find a solution," Rothenberger said.

A Spark for Change

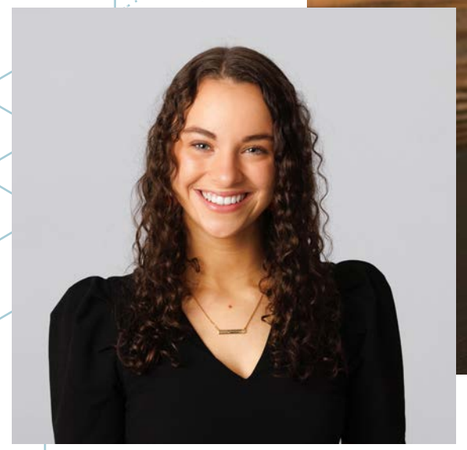
In addition to solving key societal issues, the Change Maker program prioritizes individual development and plays an important role in establishing a community for students.

"Change Makers have a trusted resource on campus who is invested in their success and their ideas," Rothenberger said.

Rothenberger said students engage with mentors regularly to monitor project progress and develop plans of action. If personal and professional growth was not enough, the renewable scholarship helps make college financially possible.



Lydia Storm



"The Change Maker scholarships allow college to be more affordable and, in some cases, makes the university and CASNR the best college choice for them," Rothenberger said.

For students Jack Bunch and Lydia Storm, their journey as a Change Maker is a testament to the program's depth, each excelling in unique ways.

Forging a Path in Forensics

Jack Bunch, a sophomore forensic science student from Irvine, California, recognized his desire to study forensic science would take him out of state, but it was not until he was awarded a Change Maker scholarship that he would settle on Nebraska.

"This scholarship award made a critical difference in being able to financially pursue my education in Nebraska and study in the forensic science area," Bunch said.

For his Change Maker pitch, Bunch recognized few schools have installed forensics education, so he pitched an idea to engage diverse communities by building a forensic science curriculum for high school classrooms.

"Life science teachers who want to offer forensics as an elective can implement this lesson plan to spark new ideas and inspire students to consider a career in forensics," Bunch said.

For his project, Bunch developed an experiment that analyzes fly and maggot presence to determine the process of decomposition in organs. He performed tests at the university's crime scene house in various environments to select the best methods to implement in the lesson plan.

Alongside his mentor, Larry Barksdale, assistant professor of practice in the College of Agricultural Sciences and Natural Resources, Bunch successfully imitated the responsibilities of a forensic scientist within the experiment for students.

Out of the Box Empowerment

Lydia Storm, a junior biochemistry and forensic science student from Lawrence, Kansas, knew from experience that women in STEM face discrimination and empowering young women became the focal point of her Change Maker pitch.

With a goal of developing tomorrow's leaders, Storm developed a concept entitled Museum in a Box during her freshman year at the university. Audio coding and 3D printing collide to tell the stories of women in STEM, inspiring listeners to channel their passion.

"There is a need for more integration in classrooms to close the gender and wage gap," Storm said. "It is an honor to fight this battle for equality."

For her project, Storm created miniature statues of notable women in STEM that carry a small sticker encoded with their story that will begin to play aloud when placed on the portable, acrylic box. At completion, Storm said elementary programs will utilize guided curriculum with the technology to build confidence in young women.

"This programming will inspire girls to follow their dreams and create a ripple effect," Storm said.

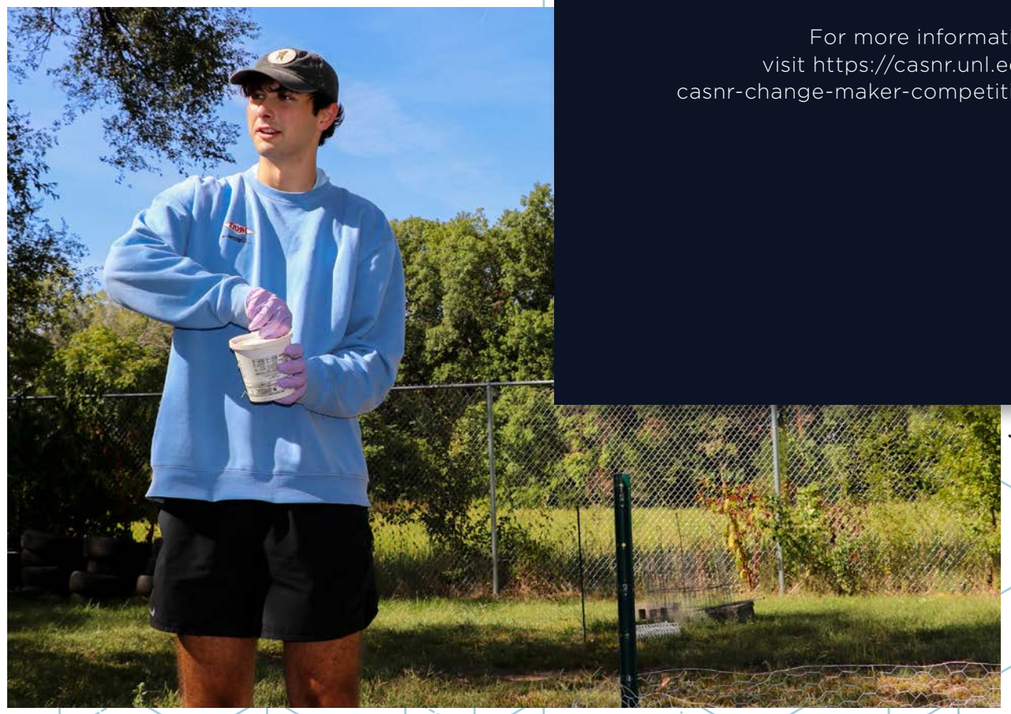
Making a Mark

Since the program's inception in April 2020, scholarships have been awarded to 30 CASNR students with one thing in common: a spirit of innovation.

"In 10 years, the Change Maker cohort will be a cyclical program that is synonymous with the ground-breaking ideas and spirit of innovation that CASNR has to offer," Rothenberger said.

KEY TAKEAWAYS

1. Change Makers enhance the future of Nebraska by developing solutions to key issues that historically impact Nebraska's workforce, economy, and natural resources.
2. Change Maker is a quick pitch program targeted at solving eight grand challenges related to humans and the environment.
3. Recipients engage with mentors regularly to monitor project progress, develop plans of action, and discuss overall well-being during their Change Maker experience.
4. Change Maker scholarships have been awarded to 30 students since program inception in April 2020, making college financially possible.
5. For more information, visit https://casnr.unl.edu/casnr-change-maker-competition.



Jack Bunch

TAKING COLLEGE TOPICS TO NEBRASKA HIGH SCHOOLS

CASNR FACULTY INTEGRATE AGRICULTURAL TOPICS

BY JADYN HECKENLIVELY

Faculty in the College of Agriculture Sciences and Natural Resources (CASNR) at the University of Nebraska-Lincoln are working closely with high schools in Nebraska to share resources and create concepts for students to learn more about agriculture and natural resources.

Fabio Mattos, associate professor, Jeff Peterson, assistant professor of practice, and Cory Walters, associate professor, all in the Department of Agricultural Economics at the university developed a commodity marketing course for the high school level.

"Some students do not have a good understanding of what kind of jobs or careers are available within commodity marketing," Mattos said. "The curriculum helps students learn they have the possibility to do commodity marketing for their family operations or explore other types of related careers."

Additionally, Bailey Feit and Tammera Mittelstet, the CASNR K-12 Education Pathways coordinators, work with high schools to incorporate natural resource and agricultural concepts into curriculums by utilizing the broad topics of Food, Energy, Water, and Societal Systems (FEWSS, pronounced like the word fuse).

The goal is to offer Nebraska high school students a better understanding of the big picture of agriculture and natural resources and career opportunities within them.

"Careers are ever changing so to help students prepare for any type of job or career, it is beneficial for a focus program like this to be involved in high schools," Feit said.

Commodity Marketing Curriculum

"Commodity marketing is essentially the selling or buying of commodities. Studying commodity marketing is important not only to learn different strategies to buy and sell commodities, but also to understand how markets work and how prices for commodities are determined", Mattos said.

Mattos' commodity marketing curriculum is designed to teach students through module topics such as describing commodities, how commodities are bought and sold, how producers market commodities, trading in futures markets, and students also have the opportunity to practice knowledge in marketing and trading simulators.

"Careers are ever changing so to help students prepare for any type of job or career, it is beneficial for a focus program like this to be involved in high schools."

Bailey Feit

"The program gives high school students a general introduction about marketing and identifies main topics for them to learn," Mattos said.

Mattos created the course to include lecture material, worksheets, and videos that are accessed through an online platform for students and teachers. He said the curriculum teaches students a basic understanding of commodity marking earlier in life, to give them broader idea of career opportunities available for them in their future.

"It is useful for students to learn more about one of the key pieces that can generate profits for their family operations or state economy," Mattos said.

So far, the program has run two pilots including 29 schools to develop the program. Mattos, Peterson and Walters have gained positive feedback and continues to build the program.

FEWSS Brings Agriculture to the City

The introduction of the FEWSS program began at Northeast High School in Lincoln, Nebraska with the goal of adding concepts related to food, energy, water, and societal systems into daily high school lessons.

"Northeast High School does not currently have any agricultural education programming," Feit said. "By using the lens of FEWSS, agriculture topics are infused to the curriculum – it is so much more than agricultural education." Insert photo of FEWSS activity at Northeast

FEWSS encourages the use of agricultural and natural resources topics in a different way, such as exploring agriculture from a policy lens or environmental lens.

For instance, Feit said a social studies class studying societal systems might include discussion about how agriculture is a main economic driver in Nebraska. In doing so, students learn that there many jobs in Nebraska that are related to agriculture, but also suitable for those that grew up in urban areas.

"One in four jobs in Nebraska is related to agriculture and natural resources," Mittelstet said. "If students do not know what any of the concepts are, it is hard to encourage them to take a look at that as a career."

Feit said the FEWSS program is designed to help bridge this gap and introduce agricultural and environmental topics more directly to high school students, particularly those in an urban setting that may or may not have direct connections to the agricultural industry.

The Future of Agricultural Education in Nebraska High Schools

Mattos and Feit are hoping to have growth in the future of both programs. With the success from the commodity marketing curriculum, Mattos has received interest from schools outside of Nebraska as well.

"We have primarily focused on the needs of high schools in Nebraska, but if any teacher in any high school in the country believes that the curriculum is useful for them, we will be glad to have it used by anyone in the country," Mattos said.

Growth is also a main goal for the future of the FEWSS program as they hope to be able to use the cross curricular opportunity in more schools across the state to benefit the future of Nebraska.

"Broadening students' focus and allowing them to explore new topics is beneficial," Feit said. "The students are likely our future Nebraska citizens, so it is important for them to be knowledgeable, educated, aware, and interested in these topics."

KEY TAKEAWAYS

1. Faculty in CASNR are working closely with high schools in Nebraska to share resources and create concepts for students to learn more about agriculture and natural resources.

2. Two new distinct programs were created to bring college topics to high school classrooms: The Food, Energy, Water, and Societal Systems (FEWSS) program and a commodity marketing curriculum.

3. The FEWSS program integrates agricultural and natural resource topics into everyday classes through different lenses, such as a policy point of view or an environmental perspective.

4. The commodity marketing curriculum is designed as a six-module format to educate students on the general topics of commodity marketing and job opportunities within the industry.

5. For more information about the commodity marketing curriculum and to become involved, contact Fabio Mattos at fmattos@unl.edu or visit https://agecon.unl.edu/commodity-marketing-high-school-students. For more information on the FEWSS program visit https://casnr.unl.edu/k-12-partners

IANR COMMUNITIES OF PRACTICE AND DISCOVERY

In 2011, six IANR communities of practice and discovery were formed as intentional focus areas of strength within IANR in an effort to propel Nebraska forward. The six communities include:

Computational Sciences – striving to efficiently and effectively analyze and report large sets of high-quality data in ways to be shared with the public.

Science Literacy – encouraging members of society to analyze complex challenges and make science-informed decisions in real-world situations.

Healthy Systems for Agricultural Production and Natural Resources – building on expertise in soil health, water resources, ecology, risk analysis, and plant and animal systems to help Nebraskans develop resilient agricultural production and natural resources systems.

Drivers of Economic Vitality for Nebraska – strengthening Nebraska's entrepreneurial approaches to stimulate economic development and increase the vitality of Nebraska's communities and the quality of life of its people.

Healthy Humans – establishing a research-based understanding to advance human health in relationships to healthy communities by conducting studies from basic biomedical research directed to understand disease, to nutritional foods and strategies that promote physical and mental well-being.

Stress Biology – improving production, health, and well-being for animal, plant, and human systems to better understand how organisms and systems adapt to stressors such as drought, insects, heat, and cold.

In recent years, Strategic Discussions for Nebraska (SDN) has rotated through the IANR communities as a publication theme as a way of highlighting these intentional IANR focus areas.

To date, SDN topics have included:

2017 – Computational Sciences

2018 – Science Literacy

2019 – Healthy Systems for Agricultural Production and Natural Resources

2020 – Drivers of Economic Vitality

2021 – Healthy Humans

2022 – Stress Biology

Every year, the goal of SDN is to provide a snapshot of IANR research, teaching, and Extension efforts.

In 2023, SDN circles back on the IANR communities, covering research and projects on computational sciences, big data, and technology. New this year–this edition includes a mix of both research and feature stories that highlight ways data drives Nebraska.

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BRIEF HISTORY OF THE LAND-GRANT MODEL OF PUBLIC EDUCATION

By Mary Garbacz

The University of Nebraska is one of more than 100 land-grant institutions in the United States and its territories. Although the University of Nebraska–Lincoln was the original campus of the University of Nebraska, the land-grant mission extends to all four campuses of the University of Nebraska system. The land-grant college system was established by the passage of the Morrill Act in 1862.

THE MORRILL ACT OF 1862

On July 2, 1862, President Abraham Lincoln signed into law a bill that donated land to each state for the establishment of colleges to provide a liberal and practical education to the "industrial class," or the common person. These colleges would provide instruction in agriculture, military tactics, the mechanic arts and classical studies. Because of the land granted to each state and territory, the Morrill Act of 1862 became known as the land-grant act.

Sponsored by U.S. Congressman Justin Smith Morrill of Vermont, the bill allotted 30,000 acres of public land for each sitting senator and representative in Congress to establish these colleges. Morrill could not have known the future impact this law would have in providing equal opportunity to education to people in the United States and its territories.

Today, there are more than 100 land-grant institutions in the United States and its territories, each focusing on teaching, research and outreach – taking new knowledge to the people.

The University of Nebraska was founded on February 15, 1869 and designated a land-grant institution under the 1862 Morrill Act. The land-grant system formed the framework for the land-grant institutions' missions of teaching, research and Extension.

HATCH ACT OF 1887

Twenty-five years after the Morrill Act was passed, the Hatch Act of 1887 provided funding for agricultural research programs at state land-grant agricultural experiment stations in the 50 states of the United States, the District of Columbia and the U.S. territories. The Hatch Act established agricultural experiment stations in connection with the land-grant colleges so research could be conducted and applied in practice.

Named for Congressman William Henry Hatch, the Hatch Act established not only experiment stations, but also distribution of information to the people of the United States on subjects connected with agriculture. The Hatch Act also provided an annual payment to each state and territory for the expenses of research, as well as for printing and distributing the results.

Hatch research activities involve a range of options related to agriculture, land use, natural resources, family, human nutrition, community development, forestry and more and can be local, state, regional or national in scope. A further requirement of the Hatch Act of 1887 is that new information is to be extended to the public.

THE MORRILL ACT OF 1890

The Morrill Act of 1890 also established funding for land-grant institutions specifically for African-Americans. These institutions are sometimes called "1890 schools." These 16 public institutions, plus one private institution, are among the more than 100 historically black colleges and universities in the United States. The Morrill Act of 1890 also forbade racial discrimination in admissions policies for institutions receiving these federal funds.

SMITH-LEVER ACT OF 1914

The Smith-Lever Act of 1914 created a Cooperative Extension Service within each land-grant institution. Cooperative Extension, a partnership between the U.S. Department of Agriculture and agricultural colleges, helps to extend information produced by the research of scientists within each college's experiment station.

EQUITY IN EDUCATIONAL LAND-GRANT STATUS ACT OF 1994

The Equity in Educational Land-Grant Status Act of 1994 provided land-grant status for certain American Indian colleges and institutions, bringing higher education to reservation communities. The act directed the U.S. Secretary of the Treasury to establish a 1994 Institutions Endowment Fund and the U.S. Secretary of Agriculture to make capacity-building grants to these institutions.

“Collaborative research and Extension projects benefit both farmers and wildlife by helping landowners best manage their farm to feed a growing world while ensuring conservation of Nebraska’s important natural resources.”

Andy Little, School of Natural Resources

IANR

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