Sustainable Southwest Beef

knowledge and tools for ranch and rangeland resilience

Sustainable Southwest Beef CAP Newsletter
July 2022

A Message From The Leadership

Hello all:

A lot has happened since we met in Las Cruces in May! At that meeting, we were all excited by opportunities to interact with one another and to learn more about ongoing research at the College Ranch and Jornada Range. Thanks to Sheri Spiegal, Andrew Cox, Kirsten Romig and so many more for planning and hosting such informative and enjoyable opening day. A highlight for in-person participants was the Criollo Steak Dinner provided by Cindy Tolle, Evergreen Livestock & Ranching, and Chef Scott Brinker.

Chef Scott Brinker grilling Raramuri Criollo steaks for the 2022 Annual All-Hands Meeting

The second day we focused toward the future with series of team breakouts followed by facilitated discussions around 1) communication with stakeholders, 2 year 3 and 4 priorities, and 3) extending the project impact beyond the funding cycle. Thank you to Besangie Sellars and Adam Cless of Office of Educational Innovation and Outcomes for facilitating the report out sessions and preparation of the Year 3 Annual Meeting Facilitation Discussion Summary available in the Basecamp All.

Looking toward the upcoming years, we can't think of a better group of people to work with than the folks in the group photo below and all of you who couldn't attend in person.

Enjoy this issue of the newsletter which is loaded with updates about Extension, Education, and Research accomplishments that make us all proud.

Thanks for all you do!

Welcome!

Bianca Birkenstock joined the project as a doctoral student with Glenn Duff and Rick Estell. She is evaluating methane production with Criollo calves along with methane production on perennial versus annual pastures. Originally from South Africa, Bianca received her B.S. degree from Alcorn State and her M.S. from NMSU where she evaluated impacts of transportation on cortisol levels and ruminal microbiome.

MacKenzie Smithyman joined the project under Glenn Duff's supervision and is working on the with Criollo finishing project. She plans to use the data for

developing energy equations for Criollo cross calves. Originally from Washington, MacKenzie received her B.S. degree from Washington State University and her M.S. degree from NMSU where she evaluated impacts of water intake on health and performance of newly-received beef heifers.

Luis Ochoa is a Graduate Research Assistant in the Department of Animal and Range Sciences at New Mexico State University, working on a M.S. in Reproductive Physiology under Dr. Craig Gifford. He grew up on his family's cattle ranch raising Brangus cattle in the state of Chihuahua, Mexico, where his interest in beef cattle production and land stewardship grew. Luis earned his B.S. in Animal Science from Texas A&M University. During his undergraduate career, he worked for the College of Veterinary Medicine of Texas A&M, where he later became the Animal Care Supervisor of the research and teaching herds. Luis's research will focus on animal health and bovine respiratory disease in calves; he will also assist in extension efforts through workshop organization and facilitating projects.

Tiana Nez, an NMSU MS, student is supporting the Precision Ranching Team with drone monitoring research during the summer.

Kudos

Sheri Spiegal was named the USDA-ARS 2022 Herbert L. Rothbart Outstanding Early Career Research Scientist, which is the top early career award in ARS. Dr. Spiegal was recognized for her collaborative, systems-level research on nutrient management and holistic agricultural indicator systems. Congratulations Sheri!

Congratulations to Andres Cibils who was selected as the Director of the Southern Plains Climate Hub Director. He will begin this new position at El Reno, Oklahoma, on August 1. We thank him for his support to the project as a NIFA Program Leader and are excited that he can continue to collaborate with our project in this important new role!

Congratulations to the BlueSTEM Agrilearning Center which saw 15 High School Seniors graduated from their program through three partner schools, including two students who were Valedictorian of their class.

Moving On

Best wishes to Valerie York who left OEIE for another opportunity in May.

News you can use

On Ranch Demonstration at the Dugout Ranch

On March 10th 2022, Matt and Kristen Redd from The Nature Conservancy's Dugout Ranch, located in Monticello UT, hosted an On-Ranch Demonstration organized by the Sustainable Southwest Beef Project's extension team. The purpose of the event was to share information about the Raramuri Criollo cattle and other sustainability-focused research and restoration

projects taking place on the ranch. The weather was near freezing and windy, but around 40 brave souls showed up nonetheless. Those in attendance included researchers, students, government agency officials, educators, and local producers.

The day began with a welcome and overview of the Sustainable Southwest Beef Project from project co-PI Sheri Spiegal (USDA/Jornada). Matt Redd (TNC/Canyonlands Research Center) presented on ranch management with Raramuri Criollo, followed by presentations on Criollo research by Danielle Duni (Montana State University), Kari Veblen (Utah State University), and Sheri Spiegal. Following lunch, Wally MacFarlane (Utah State University) presented on riparian restoration, then Tara Bishop (USDA Forest Service) and Mike Duniway (USGS) presented on their rangeland and climate change research. Then it was off to see some of the Raramuri Criollo cattle and more informal discussion about what it's like to ranch Criollo on a large scale. After that, participants could either go for a tour of the riparian restoration work that has been done along the waterways, or embark on a tour of the various rangeland research stations on the ranch.

Overall, the event was a success despite the inclement weather. It was great to get out and see the ranch, and there were some terrific discussions, thought provoking questions, and relationship building. Mark your calendars for the next On-Ranch Demonstration in Pine Valley, CA, May 18th, 2023!

Teachers Learn about Sustainable Southwest Beef Project

On July 8, 5th and 6th grade teachers from throughout New Mexico attended a teacher workshop hosted by the Asombro Institute for Science Education in Las Cruces. They learned about the Sustainable Southwest Beef Project from extension team member Skye Aney. Asombro educators then taught teachers how to bring the research themes to their classrooms through the Get Out and Graze lesson and other lessons developed for the project and available at https://asombro.org/free/. Teachers' anonymous evaluations of the workshop were incredibly complimentary. For example, one teacher wrote that the workshop was "extremely fun and engaging," and another wrote they wished they could structure their entire class using the model we provided for the workshop. We look forward to hearing how they used the lessons with their students this fall.

Teachers learn how precision tools like water level sensors assist ranchers.

Technologies for precision ranching on rangelands of the Southwest US

Ranching in the southwest consists predominantly of cow-calf operations extensively managed on desert and arid rangelands. The challenge of overseeing extensive operations is usually compounded by the need to monitor multiple herds and pastures while driving long distances across difficult terrain, and with limited labor assistance. Most of the ranchers in the southwest are also witnessing in first person the effects of increasing droughts and heat waves on their land and cattle, and quite often indicate a strong desire to incorporate technologies to manage their ranches proactively and not to react to problems

months or years later.

A priority for many ranchers in the southwest is how to monitor their cattle, land, and ranch infrastructure regularly and efficiently and with less labor and cost. To address this need, the Southwest Beef CAP project is testing digital tools that have a promising potential to improve ranch operational efficiencies while enhancing rangeland resilience in the Southwestern US. Testing includes multi-sensor platforms that can reduce monitoring efforts and improve efficiencies in a ranch, significantly.

Infrastructure for Long Range Wide Area Network (LoRa WAN) communication has been installed at the Clayton Livestock Research Center (CLRC) of NMSU and at two neighbor ranches in Southwest NM, the Chihuahuan Desert Rangeland Research Center of NMSU and the LTER- Jornada Experimental Range administered by the USDA-ARS. The testing infrastructure includes a network of LoRa WAN gateways distributed across sites. Briefly, gateways use conventional radio frequency for collection of data from high throughput sensors, and rely on cellular coverage, WiFi connectivity or ethernet connection as communication alternatives to send acquired sensor data to a network server and the NMSU dashboard server. Over the past year, permanent and portable LoRA WAN gateways allowed monitoring over a 300 square mile area of desert rangeland, including water level in multiple cattle drinking troughs and water storage tanks and rangeland use across herds of heritage or improved cattle breeds. In the two ranches of Southwest NM, gateways were positioned strategically at different locations of the landscape to overlook the entire Jornada Basin, extending from the Summerford mountains on the south to the San Andres wildlife refuge on the northeast of the basin. Gateways mounted on trailers use solar power and cellular communication. Trailers can be moved around canyons, creeks, and pastures with dense woody vegetation to improve data collection that otherwise cannot be done using a permanent network infrastructure. Furthermore, this combination of multiple gateways allowed bypassing issues of poor data acquisition usually associated with increasing number of sensors, sensor data traffic and the use of one or few gateways.

Gateways were installed using existing ranch infrastructure or mounted on trailers to allow extended LoRa WAN coverage across large sections of the jornada basin. LoRa WAN is an effective communication option for ranchers that have the interest to invest on monitoring systems that will enable the real-time tracking of cattle and ranch water infrastructure at low cost.

The digital ranching infrastructure also includes cow collars with LoRa WAN trackers equipped with global position system, triaxial accelerometer, temperature sensor, and power sensor. The design of collars includes a 4-ft long nylon strap with metal or plastic buckle, and a 500 g counterweight. This neck

strap and weight allowed stabilizing the tracker permanently on a top position. The benefits of the new collar were threefold. The stabilization of the GPS antenna improved systematically the collection of accurate GPS-animal data. The consistent placement of the triaxial accelerometer, over time and across cows, allowed a more homogeneous collection of axial motion data relative to changes in neck and head movements and locomotion. Motion data collected on a same or similar representation is expected to yield a more accurate classification of relevant animal behaviors eventually serving as indicators of animal health, wellbeing, breeding, and performance. Finally, the improved line-of-sight and transmission of sensor data to alternative gateways in the network systematically reduced data packet loss, which has been hassle in past deployments.

Cattle neck collars with LoRa WAN sensors are being used for real-time monitoring of heritage Criollo, Brahman, Brangus, and Angus herds moving across large desert pastures. Trackers integrate Global Position System and triaxial accelerometers with temperature and power sensors. A counterweight is used to stabilize the mounting of the tracker on a top position, across cows and over time. This allows analytics and classifications of animal behavior using position and activity data with a same feature representation

Another element and perhaps a more relevant tool for ranches that operate on desert rangelands, is the use of sensors installed in drinking troughs and storage tanks, and tipping bucket rain gauges, which are being tested as part of the LoRa WAN Ranching ecosystem. Rain Gauge sensors indicate a threefold or even greater variations of precipitation in space and time across the CDRRC. On the other hand, ultrasonic technology in water level sensors allows the real-time monitoring of water levels in drinking and storage tanks located over 20 miles apart. Different algorithms are being tested to measure deviations of water level in tanks to develop customizable alert systems that can be used to warn ranchers about rapid declines of water in storage and drinking tanks.

Water level sensors (top panel) and rain gauge sensors (bottom panel) use LoRa WAN technology to transmit data to permanent or portable gateways placed across remote locations. Real-time monitoring of precipitation and deviations of water level in tanks reduce routine, often expensive monitoring tasks in a Ranches.

Virtual fencing is a second multi-sensor platform being tested in this project. In addition to the benefits of near real time GPS and activity tracking, virtual fencing includes the concept of remote livestock herding. This concept is particularly attractive for conservation ranching initiatives that must achieve prescribed grazing objectives or meet specific vegetation management goals across heterogeneous rangeland pastures. Once properly implemented, the technology could serve as a cost-effective tool to meet specific grazing distribution objectives and grazing rotation plans in low stocking rate systems that also require to herd few head of cattle across large rangeland pastures. Technically, virtual fencing integrates onboard technology for audio warnings and electric pulse for the operant conditioning of livestock behavior. Thus, properly introduced cattle must rely on audio tone signals and not electric pulse (usually no greater than 1/3 of the pulse produced by a conventional electric fence) to alter trajectories, change behaviors, or stay inside a predefined virtual fence paddock. Virtual fence collars being tested use both cellular and Bluetooth communication to transfer sensor data and manage virtual fence configurations. Virtual fencing collars doesn't depend on cellular connectivity to operate and can store data onboard in case of limited cellular connectivity. Collars operate on a 3.6 v lithium battery and are equipped with side solar panels to extend battery life. Embedded sensors include a triaxial accelerometer and a GPS receiver that can be customized for different data collection applications and power use. This project aims to test and develop best management practices to guide on various applications of virtual herding while optimizing power system capabilities and avoiding adverse effects on animals.

First trials are being executed at the Chihuahuan Desert Rangeland Research center, NMSU. Nursing Brangus cattle equipped with NoFence collars are being trained for use in virtual herding applications. Preliminary results indicate that cows learn within 1 to 3 days the association between the electric pulse and a warning audio tone, learning rapidly to reverse or alter their trajectory immediately after hearing the warning tone. In the virtual herding language, 'warnings' refer to the frequency of audio tones, 'pulses' to the number of

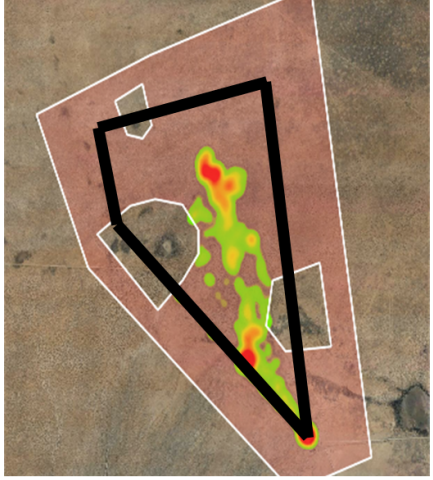
electric stimulations an animal receives, and ‘escape’ when an animal fails to respond to three consecutive warnings and corresponding pulse. Escapes set collars to a standby operation mode until animals return to the predefined virtual fence pasture. This feature minimizes adverse welfare effects on training animals.

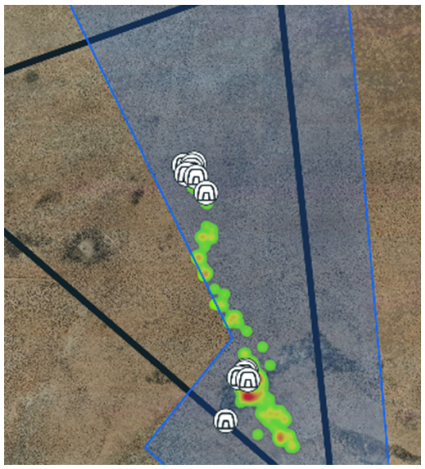
Nursing Brangus cows equipped with a virtual herding and tracking collar. The collar uses both Cellular and Bluetooth communication. Two small solar panels on the sides help extend battery life

Cattle quickly learned the operation of collars. Heatmap panels show GPS animal positions in the allowed (polygon) and excluded (outside polygon) grazing zone either, before (left) or 24 h after the introduction of cows to a training virtual fence polygon.

Scale up trials have been recently implemented to test the technology in a 1,200 acre pasture of desert rangeland. Previously trained cattle were gradually introduced to virtual fence configurations with increasing degree of complexity for periods of 5 days. Configurations tested included a single grazing block located either, west or east of the permanent water point, or a large grazing block with virtual enclosures that were set to exclude cattle from predefined areas. Cattle used the allocated grazing areas most of the time and responded properly to the audio warning signals by minimizing the number of electric pulses and the ratio of electric pulses to audio tones over time. Cattle apparently can adapt rapidly to changes in virtual fence configurations. A good practice identified during trials has been to set new virtual fence configurations during hours of the day when cattle are visiting water. In this way unnecessary pulses are avoided while cattle can learn about the new configuration with ease. Spatial memory on preferred grazing resources developed during trials apparently interacted with changes of virtual fence configurations, requiring additional reinforcement on some cattle to relearn new configurations. Equally important is to include water locations, resting areas and supplementation points inside a virtual fence polygon to ease the recapture of escaping cattle. Future studies will be scaled to entire grazing herds to assess the application of the technology during the different phases of the production cycle, as well as on possible applications for conservation ranching initiatives. This project is collaborating with NMSU extension staff and county agents in demonstration workshops that are intended to disseminate information on digital ranching technologies across the state.

For additional information contact sutsumi@nmu.edu



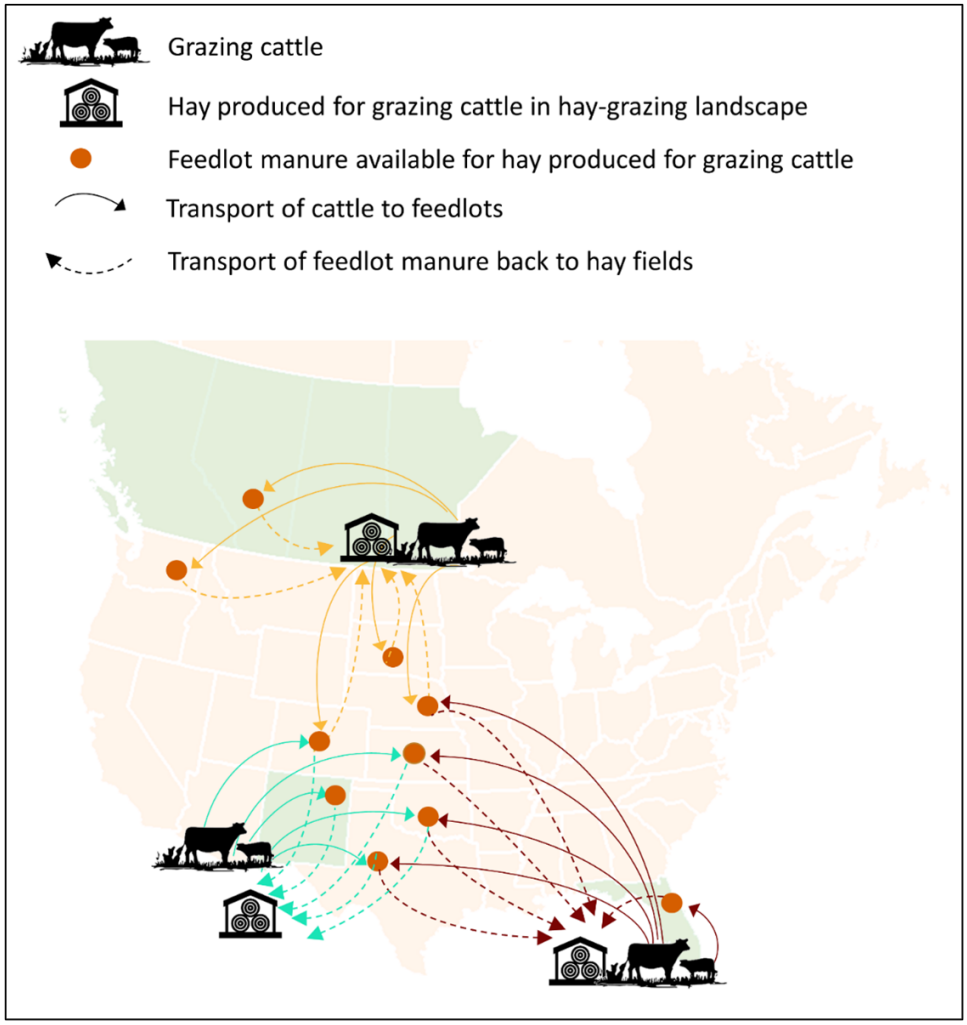


Heatmaps show that cows quickly learned changes of virtual fence configurations consisting either in single grazing blocks without (left panels) or with grazing exclosures (above panel)

Recycling nutrients in the beef supply chain through circular manuresheds

Operators of beef supply chains strive to optimize food production, environmental stewardship, and social wellbeing. Yet many inquisitive consumers and policymakers have ongoing concerns about greenhouse gas emissions and water use. The Sustainable Southwest Beef Project is investigating three types of solutions: 1) matching cattle genetics with grazing environment, 2) improving real-time information about cattle location and water trough levels on extensive ranches, and 3) building better coordination among actors in beef supply chains. The Supply Chain Team aims to increase understanding about components of beef supply chains – which can span many components across great distances – and the flows of resources and information among the components. A major focus is the flow of nutrients. Hay is a major input into ranching operations, especially during times of drought. Yet hay requires fertilizer, which is a major source of greenhouse gas emissions. Our team asked whether it would be possible to use the manure concentrated at cattle feedlots instead of fertilizer to grow hay for grazing cattle. Though the manure resource would need to be transported with fossil fuels, we know from our work with the Integrated Farm System

Model that greenhouse gas emissions from fertilizer production greatly outweighs emissions from road transport in the US beef industry. Thus, substituting manure nutrients for commercial fertilizers may reduce the greenhouse gas emissions of the beef industry overall. Moreover, recycling manure nutrients could help feedlot operators who are responsible for managing concentrated stocks of manure, and also improve soil quality of hayfields in certain cases. We constructed four datasets to learn more about nutrient magnitudes and distances for transport, to be used to eventually estimate greenhouse gas emissions saved from manure recycling. The datasets will also improve understanding about the economics of manure recycling across links of the beef supply chain.



We found that the manure nutrients from major feedlot destinations could supply a considerable proportion of the P used by hay for grazing cattle: 34% of the P requirements in New Mexico, 36% in Florida, and 6% in western Canada. The average distance to return the resource was 647 km for New Mexico, 1,884 km for Florida, and 1,587 km for western Canada (see map). Our findings have encouraged us to look into the circular management of feedlot manure from cattle originating on New Mexico ranches to learn more about the potential avoidance of greenhouse gas emissions from fertilizers by using manure. However, this reflects only part of a greater, multi-factor assessment of tradeoffs. The Sustainable Southwest Beef Project will partner with scientists and stakeholders in the Long-Term Agroecosystem Research Network's

“Manureshed” Initiative to assess the tradeoffs now and in the future, and to communicate those tradeoffs to concerned producers, consumers, and policy makers.

The article describing the datasets can be found in the Spiegal et al. (2022) article listed under Journal Articles (Published), below.

Past Events

The BlueSTEM AgriLearning Center had a number of events:

- At the Kingfisher County Outdoor Education Days, students and teachers presented eight workshops to 4th - 5th graders about bees, pollinators, growing your food, and sustainable food production for the future. Approximately 300 students from Kingfisher County (Oklahoma) attended the event.
- BlueSTEM staff, including our High School summer interns, were given a special presentation by Lynne Porter, Education Director of the Oklahoma City National Memorial & Museum, regarding their new virtual lab called Environmental Science. The demonstration allows the participant to learn about soil, hardiness zones, preserving the Survivor Tree, planting with the future in mind, and managing the Memorial Park. The education arm of the OKC NM&M also has virtual labs about forensics and building structures for catastrophic events.
- Every Wednesday and Saturday morning from 8 am - 12 noon, two of our student interns are working at the community Farmer's Market with fresh veggies we have grown at BlueSTEM, homemade breads, salsa, cookies, pies, etc. The Market is hosted by a local business that supports the community with gardening supplies, hardware, and gifts.
- Staff and summer interns hosted about 40 educators from around the country who were participants in the American Farm Bureau professional development activity. The tour focused on prairie grasses, remote sensing, and animal nutrition technology.
- Hosted an informational luncheon for the USDA Grazinglands Research Laboratory scientists and technicians and presented a short program about what all we do at BlueSTEM, how ARS researchers and technicians can benefit from our students' involvement, and ideas for collaboration between USDA and BlueSTEM.
- The BlueSTEM gardens was one of 5 stops on the El Reno Chamber of Commerce's Annual Garden Party Tour as one of five locations included as one of the locations. BlueSTEM has a strong partnership with the Canadian County (Oklahoma) Master Gardeners program, and many of the CCMG were on hand along with BlueSTEM student interns and Board of Directors.
- Hosted a teacher professional development workshop, Structure & Function: From Soil to Pollen to Drones" in connection with Dr. Craig Wilson, Director of the USDA Future Scientists Program at Texas A&M University. Topics discussed included the 3-STEP Process of Science

Learning; Next Generation Science Standards; intertwining physical, life, earth & space, engineering, and technology sciences; using digital microscopes; beekeeping; plant identification in the field (by Greg Scott of the Oklahoma Conservation Commission); soil science; using drones in agriculture & research; rainfall simulator demonstration (by Cheryl Cheadle of Blue Thumb); how BlueSTEM can help; and networking STEM around the state.

- BlueSTEM connected with more than 200 educators as a vendor at Oklahoma Ag in the Classroom Conference in July.
- Drone consultant, Theron Conley, brought a DJI Air 2S all in one drone with camera to train staff and students on how to use the technology and images for STEM, agriculture, virtual field trips, advertising, search & rescue, and more. Additionally, BlueSTEM is planning to expand their remote sensing and drone curriculum.
- State Superintendent of Public Instruction Joy Hoffmeister, several of her staff members, and leadership from Redlands Community College toured the BlueSTEM program in July. Mrs Hoffmeister is interested in non-traditional academic settings and the benefits to teachers and students. Several BlueSTEM students and community stakeholders participated in and guided the tour.

Upcoming Events

Precision Ranching Technologies Workshop for Extension personnel and interested producers, Corona NM. Date TBD in late October.
Contact Craig Gifford, cgifford@nmsu.edu for more information.

On-Ranch Demonstration at Rancho Corta Madera, Pine Valley CA. May 18, 2023.
Contact Skye Aney, sierra25@nmsu.edu for more information.

Journal Articles (Published)

- Spiegal, S., Vendramini, J.M.B., Bittman, S., Silveira, M.L., Gifford, C., Rotz, C.A., Ragosta, J.P., Kleinman, P.J.A., 2022. Recycling nutrients in the beef supply chain through circular manuresheds: Data to assess tradeoffs. Journal of Environmental Quality https://doi.org/https://doi.org/10.1002/jeq2.20365

  Steiner, Jean L. Carolina B. Brandani, Adrian Chappell, Jose Castaño-Sanchez, Mikaela Hoellrich, Matthew M. McIntosh, Shelemia Nyamuryekung'e, Nicole Pietrasiak, Alan Rotz, Nicholas P. Webb. 202_ Distinctive dryland soil carbon transformations and management: Insights from arid rangelands of SW United States. Adv. Soil Sci. (accepted 7/19/2022

Conference Papers and Presentations

- Ann Marshall, BlueSTEM Education Director, presented a water quality workshop at the Southwestern Oklahoma State University's Southwest Alliance for Girls' Enrichment in Science, Technology, Engineering, the Arts/Humanities, and Mathematics (SAGE STEAM) camp. The campers are middle school and junior high girls from around Oklahoma.

  BlueSTEM staff presented information about plants, soil, and seeds to middle school and junior high students who were participants at the Oklahoma City National Memorial & Museum STEM Camp in July,.

  Nyamuryekung'e, S., R. E. Estell, D. K. James, A. F. Cibils, M. M. McIntosh, S. Spiegal, and S. A. Utsumi. 2022. Heritage Raramuri Criollo cattle production as a potential strategy for conservation of black grama in the Chihuahuan Desert. ASAS Natl Mtg Oklahoma City.

  Nyamuryekung'e, S., G. Duff, A. F. Cibils, R. E. Estell, S. A. Utsumi, M. Funk, A. Cox, Q. Gong, H. Cao, S. Spiegal, V. Gouvea, and C. B. Brandani. 2022. Field testing of LoRa-WAN sensors for real-time tracking and biosensing of Brangus and Raramuri Criollo cattle foraging on a small pasture. ASAS Natl Mtg Oklahoma City.

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