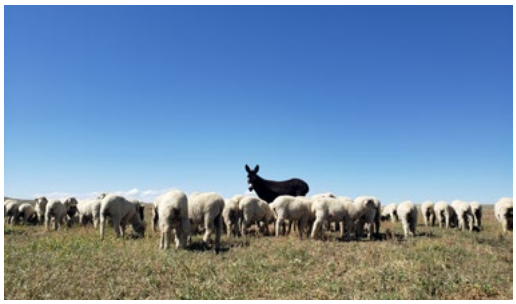

UNIVERSITY OF WYOMING
AGRICULTURAL EXPERIMENT STATION

Laramie Research & Extension Center

2024 ANNUAL REPORT

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Issued in furtherance of State Agricultural Experiment Station work of the 1887 Hatch Act, as amended through public law 107–293, November 13, 2002, in cooperation with the U.S. Department of Agriculture. Brian Mealor, interim director, Wyoming Agricultural Experiment Station, University of Wyoming, College of Agriculture, Life Sciences and Natural Resources, Laramie, Wyoming 82071.

Facilities & Activities Overview

The Laramie Research and Extension Center (LREC) is located west of Laramie, Wyoming, with a history of research and outreach in this area dating back to 1891. LREC is comprised of ~9,000 acres of rangeland and ~450 acres of irrigated hay meadows, the Cliff and Martha Hansen Teaching Arena, and our greenhouse facilities. The total land base includes pastures and meadows immediately west of Laramie, Wyoming, and on the way to Wheatland, Wyoming, at the McGuire Ranch. LREC is led by a director, six unit managers, and accountant Amy Newman in addition to a team of technicians and student workers.

In terms of agricultural production, LREC produces hay, beef cattle, sheep, and swine. Hay production is concentrated west of Laramie, Wyoming, and relies upon flood irrigation with water from the Pioneer Canal-Lake Hattie irrigation district. Beef cattle include commercial and purebred cattle and feed yard facilities with a ~225 head capacity. Sheep production is focused on Rambouillet sheep selected for moderate frame, bone, and muscle. Ewes are selected for growth, maternal instinct, and twinning rates, all with an eye on high-quality wool production. Swine production relies on artificial insemination with the best boars available to produce high-quality and functional show pigs that sell through the 307 Elite Sale. Pigs are produced for meat classes, the livestock judging team, the meat lab, and various research projects, with future plans for more commercial-type sows. The grazing livestock production program relies on native rangeland and improved pastures that are important for wildlife and botanical diversity.

LREC also includes a 20,000-square-foot greenhouse facility that hosts specialized teaching and research space. The facility includes 6 greenhouses in 18 sections with a total of 11,000 square feet of greenhouse space in addition to 3 acres of small plot space outside. This space is critical for research and teaching in all disciplines studying plants. Importantly, LREC also includes the Cliff and Martha Hansen Teaching Arena, which hosts many events, including youth livestock clinics, high school and collegiate rodeos, livestock sales, and more. The arena is often used for animal science labs, university clubs and rodeo, and 4-H horse projects. Our arena manager is also the teamster caring for Pistol and Pete, our Haflinger team, which attends many different events around the state. Pistol and Pete are a popular feature of LREC and are used for feeding hay through the winter as well. We are also fortunate to house the mighty mascot Cowboy Joe and support our rodeo team through facilities and pasture.

LREC is also an important resource for student experiential learning. In the past year alone, LREC was used for 19 different classes in 7 general topic areas, including Agricultural Economics (AGEC), Agriculture (AGRI), Animal Science (ANSC), Food Science (FDSC), Plant Sciences (PLNT), Rangeland Ecology & Watershed Management (REWM), and Ranch Management & Agricultural Leadership (RMAL). Moreover, LREC is important for many people in the areas of teaching, research, and extension. In this report, you will find a summary of efforts in teaching, research, and extension by more than 60 individuals, including 21 student researchers, 27 faculty researchers and instructors, 10 collaborators from other organizations (CSU, NDSU, USDA-ARS, USDA-NRCS, Red Angus Association of America), 2 research associates, and our team of managers. There are also many people whose names are not listed in this report, including ranchers from around the state and surrounding states, the Wyoming Wool Growers Association, and more.

We hope this report gives you insights into the important and diverse production, extension, teaching, and research activities at LREC in 2024. Please reach out any time and know that you are welcome at LREC!

Sincerely,

Dr. John Derek Scasta, LREC Director, jscasta@uwyo.edu

UNIT REPORTS

Sheep Unit Report
Manager: Kalli Koepke

Inventory

- 350 head mature Rambouillet ewes
- 97 head ewe lamb replacements
- 7 head mature sires
- 3 head teasers
- 373 head feedlot lambs
- 12 head ram lambs

2024 Summary

We maintained 447 head of Rambouillet ewes this year, 97 of those as replacement ewe lambs. We lambed 255 head of ewes in 2024. We will lamb out 350 head in the 2025 season. We maintained 7 head of breeding sires and 3 teaser rams. The feedlot lambs are made up of 100 head participating in the Wyoming Wool Growers Ram Sire Test, 126 head participating in the Lamb-a-Year program, and 147 head of Katahdin lambs fed out on a feeding project. We finished the lambing season with 167% lambing rate, 6.3% death loss, and 124% weaning rate. The remainder of the lamb crop not retained was sent to Centennial Livestock Auction for market.

Projects for the unit this year have consisted of a new lambing feedlot, a new corral in our Shrader pasture that is dual use for the meadows as well, and a new fence line on the paradise meadow.

The LREC Sheep Unit helps with many important extension, research, and teaching activities that are crucial to UW and the state, including the Wyoming Wool Growers Ram performance test and sale; Lamb-A-Year program; Albany County 4-H sheep program; UW Extension Sheep Task Force; 7220 National Wool Invitational, which hosts collegiate, 4-H, and FFA judging teams; state FFA and 4-H competitions; and several animal science classes.

Beef Unit Report
Manager: Ben Hollinger

Inventory

- ~150 bred mature cows (including purebred Herefords and Red Angus, as well as crossbreds)
- 65 crossbred bred heifers
- 65 yearling heifers
- 8 bulls (including black Angus, Hereford, and Red Angus)

2024 Summary

We use a combination of artificial insemination and natural breeding. The LREC Beef Unit is moving toward building a herd of two small subsets of purebred Herefords and Red Angus and a larger set of commercial crossbred Red Baldies. We are interested in Herefords and Red Angus and their performance at high altitude and respective levels of susceptibility to brisket, or high-altitude, disease. The goal is to produce quality crossbred cattle that will thrive at high altitudes.

This year we sold some calves at Torrington Livestock Market and put another set through a feedyard in Wyoming to track them through until slaughter. Calves are typically backgrounded for 30–45 days on cut hay meadows and broke to the feed bunk at LREC until they are sold or put on a research study. Calving begins in late February for heifers and about two weeks later in mid-March for mature cattle. After artificial insemination (typically around June 1), mature cattle head to our summer pasture 40 minutes northeast of Laramie at the McGuire Ranch, where they are on a grazing study and have cleanup bulls turned out until late July or early August.

Cattle are typically brought home to LREC from summer pastures in October or November and are grazed on hay meadows or river bottoms. Feeding hay usually begins around Christmas.

The Beef Unit helps with the advanced beef production class by providing opportunities for students to assist with vaccinating and calving, and provides cattle for BCS labs, among other activities. We also assist with the bull test class by having students help with feeding and doctoring bulls, fitting and picturing bulls, building sale catalogs and fliers, and putting together the sale day.

Swine Unit Report
Manager: Patrick Parker

Inventory

- 15 breeding sows
- 5 replacement gilts
- 2 boars
- 100 pigs born in 2024

2024 Summary

The swine unit has 15 Hampshire cross sows that farrow twice a year. All sows are artificially inseminated with purchased semen. Two boars are maintained in the herd to use as teasers. Most of the production from these sows goes to support teaching and the UW Meat Lab. The UW judging teams, as well as judging teams from the surrounding states, utilize our swine herd for practice and contests.

There are very few swine herds that are open to the public, so we have a great opportunity to teach generations about the swine industry. We also provide feeder pigs for the 307 Elite Sale; this is usually an online sale that supports 4-H and FFA kids with their fair projects. The unit provides hands-on teaching for multiple college and grade-school classes.

The LREC Swine Unit has provided the facility needs and production requirements for a wide range of research projects, from human biomedical projects to feeding and supplementation projects. All feeder or fat pigs not used for teaching or research needs are marketed through the Centennial Livestock Auction.

The swine unit helps with many important extension, research, and teaching activities that are crucial to UW and the region, including Wyoming State Fair, the National Western Stock Show in Denver, Albany County 4-H swine program, 4th Grade Rendezvous, Albany County Cattlewomen's Ag Expo, and several animal science classes.

Arena and Equine Report
Manager: Elias Hutchinson

Inventory

- 2 Haflinger draft geldings
- 2 Quarter Horse saddle horses
- 1 American Shetland gelding pony
- 4 BLM guardian burros

2024 Summary

This past year, there were many different individual events hosted at the Cliff and Martha Hansen Teaching Arena. These included horse clinics, livestock judging and fitting clinics, agility dog competitions, ag expo, youth rodeos, Laramie River Rendezvous (UW College Rodeo), ranch rodeos, archery shoots, bull sale, and UW Extension seminars.

The arena and Mary Mead classroom are utilized almost continuously throughout the school year as well as during the summer, with a daily schedule of events going from 6 a.m.–10 p.m., 7 days a week. Specific UW groups that consistently utilize the space are College of Ag classes; livestock judging, wool judging, rodeo, ranch horse, and equestrian teams; and Albany County 4-H. Hansen is a gathering place not only for the university but for the public as well. With the versatility of the space and access to the classroom, many groups make use of Hansen.

The UW remuda of saddle horses, draft team, mascot, and burros are a very busy bunch. All the equines except the burros are used to help teach numerous labs and classes in ANSC during the school year. In addition, they also facilitate learning opportunities for aspiring equestrians on club teams, such as the Ranch Horse Versatility Team, Equestrian Team, and the Pistol and Pete Teamsters, a new draft horse club. Cowboy Joe, the Shetland pony, appears at countless UW sports and alumni functions throughout the year.

The Pistol and Pete draft team are arguably the busiest mascots at UW. In the past year, the team appeared at many events, including Laramie Jubilee Days, Sheridan WYO Days, UW President's Christmas Party, campus events, Wyoming State Fair, Cheyenne Frontier Days, etc. The team is also used to feed the sheep during the winter at LREC. They feed about 1 ton a day, 5 days a week, from December 1 to April 1—rain or shine, and even in -30oF weather. Unlike a tractor, they will always start in the cold.

We have continued our project using BLM burros as guarding animals in hopes to curb the prevailing predatory pressures on our sheep herd. It has been a learning experience finding the most efficient integration and management practices for the burros and sheep. Since their introduction, we have had massive success and have seen no predatory death loss in groups paired with a burro.

The arena and equine unit helps with many important extension, research, and teaching activities that are crucial to UW and the region, including ANSC horsemanship clinics, Albany County Fair Horse Competition, 4-H mock horse shows, 4-H Sheep and Goat Clinic, UW Livestock Judging Clinic, 4-H Showcase Showdown, Bull Test Field Day, and the ag expo, in addition to several animal science classes.

Hay and Irrigation Unit Report
Manager: Landon Hoffer

Inventory

- 450 hay meadow acres
- Annual total hay production: 900-1,100 tons (2–2.5 tons per acre)
- 2024 Production: ~1,000 tons

2024 Summary

January, February, and March are spent spreading manure from the feedlot pens onto the hay meadows around the farm. Hay meadows are dragged and liquid fertilizer is spread in March and April. Early April is our small window to burn any ditches that need it and fix irrigation structures. Irrigation water normally arrives the last week of April and so we are busy 6–8 hours per day irrigating in May and June. The majority of meadows are flood irrigated using tarp dams and ditches. Thirty-five acres is under a wheel line irrigation system. Irrigation water is turned off by July 1. Haying takes place in July and August. In September, our fields are sprayed for weeds. September and October have been times where we get caught up on any large-scale outdoor projects before winter. November and December are when the bulk of our large winter shop/welding projects take place. We are looking to using gated pipe for better distribution and control of irrigation water in our meadows.

Greenhouse Unit Report
Manager: Ryan Pendleton

2024 Summary

2024 was a busy year for the LREC Greenhouse. The year started with staff continuing the ongoing care of research plants inside the 11,000 square feet of greenhouse space. This involved daily watering, weekly fertilizing, and consistent monitoring for pests and disease. Appropriate integrated pest management (IPM) strategies were used to manage any pests or disease problems that occurred.

UW researchers who utilized the LREC greenhouse in 2024 were from many different departments and disciplines, including zoology, weed science, horticulture, forage agronomy, chemical engineering, molecular biology, botany, soil science, and ecosystem science.

The beginning of the year also means the beginning of the spring semester at the University of Wyoming. The Greenhouse Design and Management class was taught at the LREC Greenhouse during the spring semester of 2024.

Summer of 2024 at the LREC Greenhouse involved the preparation of our outdoor field space. The LREC Greenhouse has 3 acres of irrigated and dryland micro-plots for research. Preparation of these plots involved tilling and herbicide applications. Some irrigated and dryland plots were not utilized in the summer of 2024, so the LREC Greenhouse staff planted cover crops to improve soil health, fix nitrogen, and suppress weed populations. In the summer of 2024, they planted a mix of oilseed radish and crimson clover.

Also during the summer of 2024, the University of Wyoming started a new course in controlled environment agriculture (CEA). As part of the class, a lab teaching students plant propagation techniques was held at the LREC Greenhouse.

During the fall of 2024, the processing/drying room at the LREC Greenhouse was heavily used. This room has 4 drying ovens and a Wiley mill, which researchers use to process plant samples from research done across the state of Wyoming and collect data. The high volume of use of this area continued throughout the fall semester.

Fall semester classes taught at the LREC Greenhouse in 2024 included the ecology of crop protection lab and horticultural science lab.

As in other seasons, staff maintained high standards of plant care in winter 2024. It requires daily attention from the LREC staff to maintain the research, the greenhouses, and the overall operation of the facility.

EXTENSION ACTIVITIES

Dr. Tim Holt presenting at the UW High Altitude Bull Test and Sale field day.

LREC hosts many events each year that include youth and adult education and training. This year, banner events included the Albany County 4-H sheep program, Wyoming Wool Growers Ram Test, Wyoming High Altitude Bull Test and Sale, UW Extension Sheep Task Force, 4-H and FFA wool judging at the 7220 National Wool Invitational and State Contest, collegiate wool judging at the 7220 National Contest and Cowboy Classic National Invitational, Extension Agriculture & Natural Resources (ANR) educator training, and the Wyoming Farm Bureau – Emerging Leaders program. Here we will highlight a few of these extension activities in greater detail.

Bull Test

The goals of the High Altitude Bull Test and Sale are to evaluate potential sires on their ability to serve producers at high altitudes; increase applied production agriculture experience available for students; and engage producers in research and education related to brisket disease and bull development. In the second year of the test, 11 producers consigned bulls in November 2023. Bulls went through a 45-day screening period to assess performance and risk for pulmonary hypertension. Bulls with pulmonary arterial pressure (PAP) scores considered high risk were removed from the test. The remaining 43 bulls continued on test and completed at 70-day feed efficiency test. Animals were weighed biweekly to monitor performance throughout the test. Bulls were evaluated using reproductive tests, ultrasound measurement to evaluate carcass characteristics, and PAP testing to assess the risk of pulmonary hypertension. The data collected on bulls in the test provided consignors and producers with valuable information to utilize when making management and sire selection decisions. Bulls performed well throughout the test, with an overall average daily gain of 3.18 lb/day across all bulls.

In the third year of the test, 12 producers consigned a total of 65 bulls in November 2024. The bull test format will remain the same with a 45-day screening period followed by a 70-day feed efficiency test in the spring and a live sale on March 21, 2025.

The High Altitude Bull Test culminated in an educational field day and private treaty sale on March 26, 2024. The field day aimed to provide producers with new educational opportunities to learn about brisket disease and bull development. Approximately 50 participants attended the event. The field day featured presentations from Chase Markel, UW graduate student, on high-altitude research at UW; Dr. Kacie McCarthy, assistant professor at University of Nebraska–Lincoln, on bull development; and Dr. Tim Holt, professor at Colorado State University, on pulmonary hypertension and PAP testing. The field day also featured a poster session highlighting current beef research being conducted at the University of Wyoming. A total of 43 bulls completed the test and went through a live sale, with an average sale price of $4,651.79.

Ram Test

The University of Wyoming's ram-testing program has established itself as a cornerstone for sheep ranchers nationwide, offering a comprehensive platform to evaluate and select premier sheep genetics. This unique program, celebrating its 64th year, stands as one of only two remaining tests in the nation that assess dual-purpose wool and meat sheep genetics. The program was held on April 13, 2024.

During the test, rams are consigned by producers from various parts of the country and managed at LREC over a span of 160 days. During this period, key metrics such as growth performance, feed conversion efficiency, and wool-quality traits are meticulously gathered on each ram. These metrics are then integrated into a selection index, enabling

Participants bidding on bulls during the sale.

the identification of genetically superior rams. The program utilizes two indices, namely the Rambouillet Index and the Wyoming Certified Index, to highlight the top-performing 30% of rams, ensuring that only the best genetics are recognized and promoted.

The 2023–2024 Wyoming Centralized Ram Performance Test saw 90 enrolled rams. Consignors represented 21 operations from 3 states and Canada, the first time in recent years where the program sought international appeal in its role in advancing sheep genetics across North America. For the 2024–2025 test, 102 rams were enrolled, representing 22 operations in 4 states and Canada. Breed types represented on the test are mainly registered Rambouillet rams, commercial Rambouillet rams, Targhees, Rambouillet x Merino, and Targhee x Rambouillet.

The conclusion of the testing period is marked by an educational field day and silent auction, an event that garners significant interest from industry stakeholders. This culmination not only provides an opportunity for attendees to engage with cutting-edge sheep genetics but also serves as an integral part of the ANSC 4230 Advanced Sheep Production course. Students in this course gain invaluable hands-on experience in managing rams and applying principles of genetic selection, further enriching their academic and practical understanding of sheep production.

The University of Wyoming's ram-testing program continues to be a pivotal resource for the sheep industry, driving innovation and excellence in sheep genetics through its comprehensive testing and educational initiatives.

Lamb-a-Year

The Lamb-a-Year program, launched in 2022, is designed to evaluate and enhance lamb quality by providing producers with valuable production data. For the 2024–2025 program, 26 producers from across the state contributed a total of 126 lambs. Traditionally, feeder lambs are sold in the fall, and crucial growth and carcass trait data often fail to reach the original producer. This occurs because lambs may be grouped into larger lots or change ownership multiple times. The Lamb-A-Year program addresses this gap by collecting and relaying production data directly to the producer. Lambs arrive at the beginning of October, at which point initial weights are recorded. They are then managed as a single cohort while transitioning onto a feedlot diet. This year, the program incorporated the Vytelle (formerly GrowSafe) feed intake system, allowing for the evaluation of feed efficiency in addition to other performance metrics. Through the Lamb-a-Year program, producers receive detailed production data, including average daily gain, loin eye area, backfat measurements, and closely trimmed retail cuts, among other key traits. While proceeds from the program help support sheep research and education efforts, the primary goal is to equip producers with data that can inform future breeding decisions and improve marketing opportunities, ultimately adding value to their operations.

National Meat Animal Evaluation Contest

The University of Wyoming hosted the National Meat Animal Evaluation Contest in 2024. This was the first time UW has hosted the contest. Only a small number of universities are able to host the contest given livestock costs, livestock availability, and facility needs. LREC played an integral role in the endeavor as all of the market animal and breeding livestock divisions were hosted at the Cliff and Martha Hansen Teaching Arena and multipurpose facilities. An attendee stated, "I had no idea UW had all of these facilities. I'm very impressed with the arena setup and hope that you'll continue to host events that collegiate judgers can attend." The contest hosted 143 students from 13 U.S. universities. The event is a three-day contest where students evaluate market livestock to estimate carcass traits, use provided production scenarios to evaluate breeding livestock, and evaluate carcasses for relevant meat industry value. This is the only collegiate contest of its kind. Most students who participate have judged competitively either as a collegiate livestock or meat judger. However, there are a number of students who have learned about meat animal and breeding livestock evaluation in their animal science curriculum and successfully apply this knowledge in a competitive setting for the first time. The University of Wyoming fielded a team of 11 students. The team finished sixth. Coordinated by McKensie Phillips and Landon Eldridge.

TEACHING

AGEC 4700: Economics of Range Resources: This course is taught by Leticia Henderson and included a tour of the LREC McGuire Ranch. The tour included an overview of the development of infrastructure, including fencing, a water well, and a pipeline, and led to class projects assessing net present value and other economic considerations of range development.

AGRI 4990: Controlled Environment Agriculture (CEA) Research and Internship: This was a summer pilot overview course that introduced the principles of controlled environment agriculture (CEA). This course was part of the Wyoming Innovation Partnership (WIP) program. CEA includes several indoor farming styles, from single-level greenhouses to more compact vertical farming and a variety of system technologies and media types. The course covers different types of controlled environments and their management. In this class/lab combination, students learned the environmental and cultural factors required for successful CEA production. This was a collaborative summer course. The class utilized the LREC greenhouse facility for one of the weeks. During this lecture/lab, students learned about sexual plant propagation through seeding and asexual plant propagation techniques. Students then conducted an asexual plant propagation lab exercise where they propagated plants through cuttings and observed the impact of different soil media in the success of rooting cuttings. Students also practiced the air-layering propagation technique. There were 10 students enrolled in this class. Taught by Elizabeth Moore, Department of Plant Sciences.

ANSC 1010: Introduction to Animal Science: Introduction to the field of animal science, including meat and dairy products, nutrition, reproduction, breeding and genetics, livestock selection, and diseases and health of domestic livestock species, with application to the management of beef cattle, sheep and wool, dairy cattle, swine, and horses. This course routinely uses LREC animal facilities for teaching. Taught by a team of faculty, Department of Animal Science.

ANSC 3535: Introduction to Wool Evaluation: This course teaches students how to objectively evaluate raw wool characteristics and quality-determining factors across various wool grades and breed types. Particular emphasis is given to how quality-determining factors influence replacement selection and the end product. Competitive wool judging format will be used to enhance organizational skills, wool judging terminology, and oral articulation skills. LREC provides the opportunity for students to look at a range of fleeces. Taught by Dylan Laverell, Department of Animal Science.

ANSC 3540: Collegiate Wool Judging: Students representing the university in regional and national intercollegiate wool contests are selected from this course and have the opportunity to judge at the 7220 National Wool Invitational (which includes 6 universities representing ~70 students and is hosted at LREC), the National Western Stock Show in Denver, the Black Hills Stock Show, Houston Livestock Show, and San Antonio Livestock Show, among others. Taught by Whit Stewart and Dylan Laverell, Department of Animal Science.

ANSC 4120: Principles of Mammalian Reproduction: In fall 2024, 50 students enrolled. Students enrolled in ANSC 4120 participated in 4 laboratories held at the LREC multipurpose building and wool classroom. Laboratories provided students with exposure to performing breeding soundness exams as well as techniques for semen collection, artificial insemination, and estrus synchronization. Taught by Jeremy Block, Department of Animal Science.

ANSC 4130: Management of Reproduction: In spring 2024, 10 students enrolled. Students enrolled in ANSC 4130 participated in 11 laboratories held at the LREC multipurpose building and wool classroom. Laboratories provided students with the opportunity to gain hands-on experience with rectal palpation, breeding soundness exams, semen handling and processing, artificial insemination, reproductive ultrasonography, pregnancy diagnosis, and fetal sexing. Laboratories also included demonstrations of techniques used for non-surgical embryo recovery and ovum pickup/in vitro fertilization. Taught by Jeremy Block, Department of Animal Science.

ANSC 4220: Advanced Beef Production and Management: Nine students enrolled in 2024. The Advanced Beef Production and Management course is focused on enhancing student knowledge and skills related to the management and production of beef cattle, integrating concepts of animal breeding, nutrition, reproduction, and health. Students completed numerous labs at the Laramie Research and Extension Center, including those focused on bull selection, body condition scoring, artificial insemination, heifer selection, pregnancy detection, ultrasounding, calving, and pulmonary arterial pressure (PAP) testing. Students gained hands-on experience working with cattle throughout the semester, allowing them to build their animal handling and management skills. Taught by Shelby Rosasco, Department of Animal Science.

ANSC 4230: Advanced Sheep Production (Lecture and Lab Sections): This course integrates animal breeding, nutrition, and reproductive physiology in sheep production management schemes. Students get the opportunity to work through field study scenarios and work with managers at the LREC Sheep Unit. Taught by Whit Stewart and Dylan Laverell, Department of Animal Science.

ANSC 4500: Bull Test Enterprise: In spring 2024, 11 students enrolled; in fall 2024, 12 students enrolled. The High Altitude

Doctoral student Chase Markel teaches students in the ANSC 4500 High Altitude Bull Test course how to clip and torch bulls to prepare for picturing.

Bull Test Enterprise course is designed to provide students with experiential learning opportunities centered around the UW High Altitude Bull Test and Sale. The course is focused on enhancing student knowledge and skills related to bull growth, development, nutrition, reproduction, and health. The course also provides students with practical experience in the management, performance testing, and marketing of cattle. Students are directly involved in the management of bulls on test, collection of data, development of marketing materials, and organization of the bull sale and extension field day. Students spend extended periods of time managing the bulls at the Laramie Research and Extension Center, including daily health checks, doctoring bulls, weighing bulls, assisting with pulmonary arterial pressure (PAP) testing, clipping and picturing bulls, assisting with carcass ultrasound data collection, and helping with breeding soundness exams. Students in the course also learn the basics related to the development of marketing materials and assist in creating social media and print marketing materials. Taught by Shelby Rosasco, Department of Animal Science.

FDSC 2040: Principles of Meat Animal Evaluation: The Laramie Research and Extension Center provides facilities for teaching efforts within the Animal and Veterinary Sciences degree program. The FDSC 2040: Principles of Meat Animal Evaluation course is one of the courses in this program. Landon Eldridge, assistant lecturer and UW Livestock Judging Team coach, leads students through evaluation of market-ready cattle, hogs, and lambs, prioritizing the estimation of carcass characteristics. After the livestock are harvested at the UW Meat Lab, McKensie Phillips, associate lecturer and UW Meat Judging Team coordinator, helps students determine actual yield and quality of the carcasses so students can make connections between what they are evaluating in the coolers relative to what they evaluated in the barns. Forty-four students enrolled in the spring 2024 course. LREC facilities, specifically the confinement barn and multipurpose facilities, serve as the venue for the live-animal labs. LREC staff are integral to the facilitation of this course as they ensure facilities and livestock are available for labs. The LREC budget procures any livestock needed that are not raised on the farm.

FDSC 3060: Principles of Meat Science and Muscle Biology: This course teaches the principles of muscle, adipose, and connective tissue growth, structure, and metabolism; conversion of muscle into meat; fresh meat properties and quality; chemical properties of meat; meat microbiology, preservation, and storage; meat by-products; and HACCP. This course routinely uses LREC animal facilities for live-animal evaluation all the way through slaughter at the meat lab. Taught by Cody Gifford, Department of Animal Science.

PLNT 1000: Agroecology: Offered in both fall and spring semesters, this course utilizes LREC greenhouses to plant and maintain a living collection of diverse crops for students to learn from. This collection is used for plant identification and anatomy lessons. We also tour LREC with Ryan Pendleton so students can learn about greenhouse production and agricultural research. Students in 2024 numbered ~40 in the fall (taught by Elizabeth Moore, Department of Plant Sciences) and ~30 in the spring (taught by Randa Jabbour, Department of Plant Sciences).

PLNT 2026: Horticultural Sciences Laboratory: This course was taught during the fall semester in the LREC classroom/greenhouse. This class had an enrollment of 17 students and is the one-hour lab class that accompanies PLNT 2025: Horticultural Science. This class is required for all horticulture minors and agriculture education majors. In this class, we apply hands-on laboratory exercises to concepts taught in PLNT 2025. Our experiments include the study of plant anatomy, floral anatomy, fertilizer, potting media, floral design, seed propagation, asexual propagation through cuttings, organic versus conventional food products, light level impact on plant growth, transpiration rates of plants, and vase life of cut flowers. The students take data on each study and write detailed laboratory reports on their findings. Taught by Elizabeth Moore, Department of Plant Sciences.

PLNT 3300: Plant Propagation: This course was taught during the spring semester and had an enrollment of 13 students. This was a very hands-on class where students conducted 10 experiments over the course of the semester, collected data, and wrote detailed lab reports on each experiment. The experiments students conducted were (1) seed viability testing; (2) seed propagation comparing various scarification and stratification methods; (3) asexual propagation through cuttings of evergreen species; (4) asexual propagation through cuttings of deciduous species; (5) asexual propagation through cuttings of herbaceous species; (6) asexual propagation through grafting of scion to rootstock in tomato; (7) asexual propagation through budding techniques of deciduous trees; (8) asexual propagation through specialized reproductive structures; (9) asexual propagation through layering techniques; and (10) asexual propagation through micropropagation. In addition to the experiments, students took weekly quizzes on lecture material. Taught by Elizabeth Moore, Department of Plant Sciences.

PLNT 4970: Applied Plant Protection: This course was taught at the LREC Greenhouse during the 2024 fall semester for the second year in a row. This course is designed to give students hands-on training in pest management techniques. The LREC facility provides lab space for teaching, as well as greenhouse and field space for evaluating insects and crop plant injury. The course was taught by Randa Jabbour and Clint Beiermann, Department of Plant Sciences.

REWM 2400: Range Ecosystems and Plants: This course is designed to teach students about the ecology of rangeland ecosystems and to recognize common plants found throughout the western United States.

Students toured the McGuire Ranch to learn about sagebrush plant communities, with students in the laboratory attending the field trip. Taught by Brian Sebade, Department of Ecosystem Science and Management.

REWM 4330: Rangeland Ecosystem Assessment & Monitoring: This course focuses on measuring attributes of rangeland systems, including cover, biomass, and density, as well as characteristics of rangelands, including livestock utilization. Field measurements are in turn used by students in computer labs to analyze and interpret findings. Beginning in fall 2013, REWM 4330 classes have collected utilization and production data at the LREC McGuire Ranch. We use 1 x 1 meter grazing exclosures to estimate utilization based on the difference in weights of herbage inside versus outside exclosures. Production is estimated solely inside exclosures. We also estimate utilization around the exclosures with the modified Robel technique. We estimate these values in native sagebrush, seeded sagebrush, and the Plumbago Creek holding pasture. In 2024, we collected data on October 7. Production (lb/acre of dry matter) was 237 lb/acre in sagebrush in a rocky ridge in the north-central part of McGuire Ranch, 369 lb/acre in native sagebrush, 275 lb/acre in seeded sagebrush, and 1,117 lb/acre in the riparian zone along Plumbago Creek. Our estimates of utilization with the paired plot method ranged from 26.6% in the seeded sagebrush pasture to 44.1% in the Plumbago Creek riparian area, 44.9% in native sagebrush on a rocky ridge on the north end of the McGuire Ranch, and 59.3% in native sagebrush. Taught by Jeffrey Beck, Department of Ecosystem Science and Management.

RMAL 1010: Introduction to Ranch Management & Agricultural Leadership: This course serves as an overview of the Ranch Management & Agricultural Leadership (RMAL) program (and includes a lab). It discusses three of the major agricultural disciplines (animal science, agricultural business, and range management) that contribute to the overall program. It also establishes the foundation for developing the leadership skills necessary for today's industry. LREC provided tours of the sheep unit (covering sheep production, hoof trimming, and ram selection), the beef unit (covering low-stress livestock handling and live grading fat cattle), the greenhouse facility, and the McGuire Ranch (covering grazing systems and how to estimate forage). Taught by Randall Violett, Ranch Management & Agricultural Leadership Program.

ANIMAL SCIENCE RESEARCH

Effects of Choline Supplementation on Reproductive Performance of Ewe Lambs in the Breeding and Non-Breeding Seasons

AUTHORS: Jeremy Block,[1] Whit C. Stewart,[1] Cody L. Gifford,[1] Tom W. Murphy[2]

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PROBLEM: Despite the importance of fertility, current estimates of average number of lambs born per ewe are only slightly better compared to the 1970s.

EFFORT: A study was conducted to determine whether supplementation of choline during the early post-mating period could improve reproductive outcomes in ewe lambs. Rambouillet ewe lambs in the non-breeding (June; n=78) and breeding (October; n=52) seasons were randomly assigned to either control (no supplementation) or choline-supplemented treatment groups. Ewe lambs were submitted to an estrus synchronization protocol and then subsequently placed with rams for a six-day mating period. At the end of the synchronization protocol, ewe lambs in the choline treatment group were fed 5 g of rumen-protected choline loaded in gelatin-coated capsules per ewe for 12 days. Control animals were fed empty gelatin capsules each day for the 12-day treatment period. Pregnancy status was determined at 70 ± 3 days after initiation of the mating period.

RESULTS: Preliminary data for pregnancy rate are summarized below in Table 1. The project is still ongoing and will evaluate effects of choline supplementation on number of lambs born as well as their growth performance and carcass quality.

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Table 1. Effects of choline supplementation during the early post-mating period on pregnancy rates obtained during the non-breeding and breeding seasons.

Season	Treatment	Pregnant (%)
Non-Breeding	Control	14/37 = 37.8%
	Choline	18/41 = 44.0%
Breeding	Control	17/24 = 70.8%
	Choline	15/28 = 53.6%

Effects of Human Dietary Patterns on Indicators of Metabolic Health Using a Biomedical Swine Model: Live Animal Performance, Blood Metrics, and Fecal Microbiome

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PROBLEM: Previous studies have utilized swine as a biomedical model to evaluate the impact of diet on various metabolic indicators; however, none of these studies have been able to evaluate the impact of metabolic indices on health or gene expression in a crossover design. Because diet quality is related to timing, a crossover design will provide an understanding of the risk involved with poor-quality and high-quality diets at specific growth stages.

EFFORT: A total of 30 gilts (Yorkshire x Landrace x Duroc) were randomly assigned to either a high-protein diet or a Western-style diet (n=15 HP, n=15 WSD). Gilts were fed their respective diet for 8 weeks before a subsample (n=5) from each group was harvested. The remaining 20 gilts were then assigned to either stay on their respective diet or cross over to the opposite diet (n=5 HP, n=5 WSD, n=5 SP, n=5 PS). The gilts were fed for another 8 weeks before going to harvest. Weekly weights and ultrasound data were collected throughout the duration of the project, and fecal samples were collected at the beginning, middle, and end of the project to evaluate the gut microbiome. At harvest, tissue samples were collected from the duodenum, jejunum, and ileum, and all organ weights were recorded.

RESULTS: Data collected from this project is currently being processed to determine the effects of diet quality on gut microbiome and metabolic indicators.

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Effects of Human Dietary Patterns on Indicators of Metabolic Health Using a Biomedical Swine Model: Carcass Composition and Muscle Chemistry

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PROBLEM: The association between poor dietary quality and metabolic disease risk continues to detrimentally impact the U.S. The Western-style diet (WSD) is characterized by elevated sugar, sodium, and saturated fat, and is a common diet spanning across the U.S. To assess the effect of a WSD, biomedical swine models were utilized to evaluate the impact of human dietary patterns on physiology and to assess metabolic indicators. The objective of this project was to evaluate carcass characteristics, muscle chemistry, microbiome, performance data, blood assays, and intestinal tissue on treatment groups both high in sucrose (WSD) and high in protein (HP).

EFFORT: Thirty Landrace x York x Duroc gilts were randomly assigned to receive a higher protein (n=15) or Western-style diet (n=15) for 8 weeks. Following a subsample (n=5/treatment) harvested after 8 weeks, remaining gilts continued to receive a higher protein (n=5) or Western-style diet (n=5) for an additional 8 weeks or were provided the opposite diet for the remaining 8 weeks (n=5/crossover arrangement) prior to harvest. Swine diets were adapted to assess human dietary patterns fitting macronutrient and ingredient criteria for higher-protein and Western-style dietary patterns. After harvest, carcass metrics and muscle samples were evaluated for compositional changes and muscle samples were evaluated for nutrient and chemical compound changes.

RESULTS: Data collected from this project is currently being processed to determine the effects of dietary patterns on body composition and muscle chemistry changes.

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Addressing the Big Data Problem in Precision Agriculture: Developing Useful Production Tools and Analytics from Precision Cattle Trackers

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PROBLEM: Recent advancements in precision agriculture have led to the widespread use of GPS location ear tags that are used to monitor various livestock metrics such as location and feeding behaviors. The large quantities of high-resolution data that are generated from these biosensors make it difficult for producers to fully capitalize on their potential. A better understanding of how these data can be used to guide management decisions in an applied setting is necessary.

EFFORT: A total of 39 commercial cows from the University of Wyoming Beef Unit herd were first fitted with 701x (n = 26 xTPro tags; n = 13 xTLite tags) GPS-enabled smart ear tags before being turned out to pasture prior to calving. Calves (n = 40) were fitted with the 701x xTLite tags at the time of calving. Cow body weights and body condition scores were evaluated during the monitoring period (March – May) and calf weight was recorded at calving, branding, and weaning to provide production metrics to evaluate alongside location and behavior data.

RESULTS: Currently open-sourced R-based scripts are being developed to process the location data and conduct spatial statistical analysis to determine if this data is connected to production outcomes. This project addresses Production Agriculture Research Priorities I.16 and I.17.

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Comparison of Red Angus Sires Divergent in Genetic Potential for Growth on Calf Performance

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PROBLEM: Expected progeny differences (EPD) allow for comparison of genetic potential of animals within a breed for specific traits. Growth performance is an economically important trait in the cow-calf production system. The objective of this study was to compare growth performance of offspring sired by young unproven bulls divergent in genetic potential for growth.

EFFORT: Twenty-four calves were born to Angus cross-bred commercial cows randomly mated to two sires divergent in growth trait EPDs. Eleven calves were sired by the high-growth bull (Sire 1), and 13 calves were sired by the lower-growth sire (Sire 2). Both bulls were young and unproven, with zero progeny records entered into the Red Angus Association of America (RAAA) database. Both sires previously had DNA analysis conducted and had genomically enhanced EPDs available, improving the accuracy of the EPDs. Calves were weaned in early October and placed on a high-roughage post-weaning ration at the Laramie Research and Extension Center.

RESULTS: Calves born to the high-growth bull (Sire 1) had an increase in body weight at 328 days of age compared to calves born to the low-growth bull (Sire 2). On a steer equivalent, age-constant basis, calves by Sire 1 averaged 772 pounds, while the progeny of Sire 2 weighed 725 pounds at 328 days of age. Based on current market prices, the value difference between the two sire groups is approximately $125 per head. Genetic differences in EPDs for growth translated into phenotypic differences in progeny body weight. This comparison illustrates the values of utilizing genomically enhanced EPDs to improve growth performance and increase profitability. Additional performance and carcass data is being collected on calves from year 1 and progeny from year 2 will be weaned in fall 2025.

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Weaning Strategy Influence on Pulmonary Hypertension Risk and Respiratory Disease

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PROBLEM: Currently, bovine congestive heart failure (BCHF) presents a risk to the production and economic sustainability of beef operations. Data suggests a strong link between BCHF and bovine respiratory disease (BRD), which is often heightened during the weaning period. At weaning, calves undergo more stress, increasing the incidence of BRD and therefore impacting their risk of BCHF. The goal of this project is to evaluate weaning strategy impacts on BRD incidence and to inform decisions on managing risk of pulmonary hypertension and respiratory disease associated with weaning strategy.

EFFORT: A total of 109 commercial calves from the University of Wyoming Beef Unit Herd (n=56 steers, n=53 heifers) were placed into treatment groups: fence-line weaning (FW), preconditioned fence-line weaning (PC+FW), immediate weaning (IW), and preconditioned immediate weaning (PC+IW) (n=27 FW, n=28 PC+FW, n=27 IW, n=27 PC+IW). Calves were weaned in their respective groups and behavioral observations were taken at sunrise, midday, and sunset daily for the duration of the two-week weaning period. After this time, the calves were placed on a feed efficiency trial in which PAP testing, nasal swabs, and blood samples were collected at the beginning and end of the trial and biweekly weights were taken.

RESULTS: Currently the data is being processed to determine the impact of weaning strategy on BCHF risk. Collaboration with producers will allow for more data to be compiled. This project addresses Production Agriculture Research Priorities I.1 and I.19.

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Characterizing Heart Failure Risk and Carcass Characteristics in Beef Steers Fed to Achieve Different Rates of Gain

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PROBLEM: Historically, heart failure losses have been most common in cattle on cow-calf operations housed at higher elevations in the Rocky Mountain region. However, recent studies indicate a similar pattern of disease leading to heart failure in feedlot cattle housed at lower elevations. This study aims to evaluate heart failure risk in cattle fed to achieve different rates of gain.

EFFORT: Forty steers were separated into two even groups (n = 20) based on initial heart failure risk (low risk ≤ 42 mmHg; moderate/high risk > 42 mmHg). One group was fed to achieve an average daily gain (ADG) of 3.5 lb/day, while the other group was fed to achieve an ADG of 2.5 lb/day. Cattle were pulmonary arterial pressure (PAP) tested four times throughout the study to characterize the change in heart failure risk throughout the finishing phase in cattle fed to achieve different rates of gain. Weights were collected biweekly throughout the feeding period. Nasal swabs were collected prior to harvest in an effort to further the understanding of the respiratory microbiome that accompanies increased PAP risk. Feed efficiency data was collected using the Vytelle SENSE system through the final 68 days of feeding. Carcass characteristics were measured and tissues were collected following harvest.

RESULTS: Data analysis is currently ongoing to determine the impact of diet strategy on performance, economic implications, and carcass and sensory properties of beef produced from feedlot steers of variable initial pulmonary arterial pressure. This project addresses Production Agriculture Research Priorities I.1.

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Lamb Feeding Strategies and Meat Quality Assessment in the Katahdin Sheep Breed

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PROBLEM: The Katahdin hair sheep is an emerging breed within the U.S. in many different production systems. Since this sheep matures earlier compared to the well-known wool breeds, there are knowledge gaps from lamb management to optimal carcass endpoint. The goal of this project was to evaluate live animal and carcass performance.

EFFORT: Two studies are ongoing. In study 1, Katahdin lambs were fed to two live body weight targets (115 lb versus 130 lb) to assess the impact on carcass yield when feeding hair sheep to a heavier live body weight. In study 2, Katahdin lambs were fed according to the following 3 diet strategies: 1) textured feedlot diet, 2) 100 days of grazing followed by textured feedlot diet, and 3) 100 days of grazing followed by a forage-based dry lot diet. Live performance, carcass, sensory, and muscle chemistry data are currently being collected and analyzed.

RESULTS: Partial data has been collected and analyzed. During the upcoming year, these feeding trials and complete comprehensive data will be published. This project addresses Production Agriculture Research Priorities I.1, V.16, and V.17.

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The Effect of Pre-Conditioning and Weaning Strategy on Pulmonary Hypertension and Live Growth Performance in Beef Steers

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PROBLEM: Pulmonary hypertension, the underlying cause of brisket disease, poses a significant challenge for beef producers operating at elevations above 5,000 feet. Extended exposure to high altitudes, where oxygen density is reduced, can lead to elevated pulmonary arterial pressure and, eventually, right ventricular heart failure. This condition often results in reduced performance and, in severe cases, death loss, particularly in younger calves. Because of its close relationship to cardiopulmonary function, pulmonary hypertension may be worsened by bovine respiratory disease (BRD) complex, one of the most economically impactful diseases in the beef industry. Given the critical role of pre-weaning vaccination and weaning strategy in managing BRD risk, this study aimed to evaluate how these management factors influence pulmonary hypertension and post-weaning performance in backgrounded calves.

EFFORT: A total of 57 steer calves born and raised at the Laramie Research and Extension Center were enrolled in the study. Calves were randomly assigned to one of two pre-weaning vaccination treatments: 1) a modified live viral vaccine combined with a 7-way clostridial vaccine administered 45 days prior to weaning or 2) no pre-weaning vaccination. Within each vaccination group, calves were further stratified into two weaning strategies: immediate weaning or fence-line weaning. All calves were raised at the McGuire Ranch prior to weaning and sorted by treatment. Pre-vaccinated calves received their initial vaccine and were returned to their dams until weaning. At an average weaning age of 211 days, all calves were transported to the Laramie Research and Extension Center. Upon arrival, all calves received weaning vaccinations consisting of a modified live viral vaccine, 7-way clostridial vaccine, and anthelmintic. Pre-vaccinated calves received a booster dose, while calves with no pre-weaning vaccination received their first full vaccination since branding. Fence-line weaned calves were housed in a dry-lot pasture adjacent to their dams, with access to hay, water, and a mineral supplement. Immediately weaned calves were transported directly to the feedlot and provided the same nutritional access. Behavioral observations were conducted for 14 days following weaning, after which fence-line weaned calves were moved to the feedlot. All calves were then transitioned to a backgrounding total mixed ration and remained on feed for 85 days. During the backgrounding period, calves were weighed every two weeks. Pulmonary arterial pressure was measured on two separate occasions, and individual feed intake was monitored using the Vytelle SENSE system.

RESULTS: Data from this study will be analyzed to assess the influence of pre-weaning vaccination and weaning strategy on pulmonary hypertension and key production traits, including average daily gain and residual feed intake.

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Mating Efficiency: Ram Sexual and Aggressive Behavior and Its Influence on Ewes in Various Stages of Estrus

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PROBLEM: Animal value and anatomical constraints limit application of reproductive technologies in sheep; as a result, the vast majority of lambs are born due to natural mating. The expression of male sexual behavior varies among individuals and, in multi-sire production systems, ewes can express mate choice.

EFFORT: This study was designed to further investigate how male-to-male interaction and social dominance of the male influences mate choice of the female. Estrous cycles of 60 multi-parous flock ewes were synchronized using intra-vaginal progesterone-releasing devices (EAZI-BREED CIDR, Pfizer, NY). Matings were timed so ewes were in early, mid-, or late estrus. Prior to exposure to ewes, rams were paired by age and tested for social dominance. Rams were placed with ewes and behaviors recorded for 30 minutes. Blood samples for the analysis of testosterone and cortisol were collected prior to dominance testing, following dominance testing and before exposure to ewes, and after an hour of ewe exposure.

RESULTS: Recorded behaviors and blood samples are being analyzed. We look forward to sharing our results in the upcoming months. This study is a part of an undergraduate and graduate research project.

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Risk Factors, Serum Metabolite Profiles, and Productivity Associated with Periparturient Metabolic Stress in Semi-Prolific Rambouillet Ewes

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PROBLEM: Historic USDA census data suggest that docking percentages—often misquoted as lambing percentages in western states like Wyoming—have increased by more than 30% over the past 50 years. While increasing NLB (number of lambs born per ewe) and eventually lambs sold increases overall profitability for sheep operations, there has been an increase in metabolic disorders, like hypocalcemia (milk fever; low calcium) and hypoglycemia (pregnancy toxemia; low energy/glucose) due to this increase in prolificacy. The increase in lambs gestated induces the "pull effect," or the increase in demand in minerals and energy during gestation due to fetal formation. Our understanding of micromineral requirements in contemporary and highly prolific sheep populations is unknown.

EFFORT: Sixty LREC Rambouillet ewes (ages 2–5 yrs old; average NLB = 1.84) were sampled for serum energy metabolites (glucose, β-hydroxybutyrate [BHBA], non-esterified fatty acids [NEFA]), and macrominerals (calcium, potassium, magnesium, and phosphorous), in addition to back fat, body weight, and lamb performance. Laboratory analysis of pro-inflammatory cytokines and endocrine signals for calcium metabolism are ongoing.

RESULTS: Ewes that gave birth to multiple lambs had increased metabolic stress as observed by lower glucose and greater BHBA and NEFA than those that birthed a single lamb. Furthermore, ewes that had lower levels of glucose after lambing raised greater weight of lamb to weaning. Additionally, 4-year-old ewes with low glucose had lost more ADG than 4-year-old ewes with high glucose. Precision nutritional management strategies of maternal Western white-faced ewes in semi-extensive production systems should be considered to mitigate metabolic stress and body weight loss during the periparturient period.

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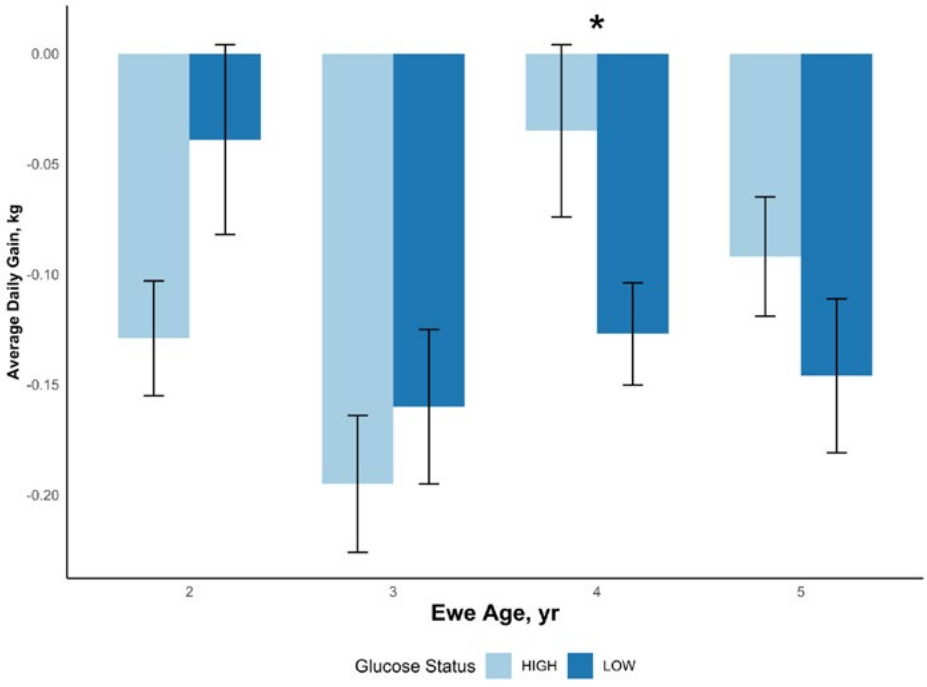

*Least-squares means (± SE) for the glucose status x age interaction effect on ewe $ADG_{7\text{-}WEAN}$. *Indicates a significant difference between NEFA status within ewe age ($P \leq 0.05$)*

Investigation of Fleece Trait Changes between Weaned Rambouillet Ram Lambs and Yearling Rams on Two Centralized Ram Performance Tests

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PROBLEM: Volatility in the global wool market, coupled with overall depressed prices, has underscored the importance of wool quality—particularly finer fiber diameter. As a result, commercial producers have placed greater emphasis on selecting rams with superior fiber traits. While wool characteristics are known to be highly heritable, environmental factors also play a role. Diets that are greater in caloric density increase staple length and grease fleece weights, but can also lead to an undesirable increase in fiber diameter compared to lower-caloric diets. Limited research exists on the extent of fiber diameter changes in contemporary populations of Rambouillet rams from weaning to yearling stages during centralized ram performance tests.

EFFORT: Wool samples were collected from rams participating in the Wyoming Centralized Ram Performance Test and the Dakota Fall Ram Test at the time of receiving in the fall of 2024. A second round of wool sampling will be conducted prior to spring shearing in 2025.

RESULTS: This research is still ongoing. However, we aim to determine whether wool samples taken at weaning can reliably predict fleece quality in rams. If successful, this could allow for earlier culling of rams with undesirable fleece traits, improving overall flock efficiency and wool quality.

GREENHOUSE RESEARCH

Native Bumble Bee Rearing and Undergraduate Learning Opportunities

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PROBLEM: Bumble bees are critically important native and commercial pollinators, particularly in colder areas like Wyoming. Research to understand how changing climates and anthropogenic factors are influencing bumble bee populations are generally performed on either Bombus terrestris or B. impatiens due to their commercial availability. However, neither species is native to the western U.S. and therefore inferences to our native species must be taken with a grain of salt. Unfortunately, it is notoriously difficult to get other species of bumble bees to start colonies in a laboratory setting.

EFFORT: We therefore used the greenhouse space to test rearing techniques of native bumble bees, particularly B. huntii, with the goal of ultimately addressing PARP I.10. Being able to rear native bumble bees would allow us to ask regionally relevant questions about how anthropogenic and climate changes will affect our local bee populations, and which management practices could be relevant for maintaining their populations.

RESULTS: We captured 350 queens from Laramie and the surrounding areas, resulting in 114 queens producing eggs and 18 colonies successfully hatching worker bees. Successful colonies were then used to test an RFID tracking system and understand more about native bumble bee foraging behaviors. This also served as an instructional activity for undergraduate students to learn more about the life cycle and behaviors of important local pollinators.

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A successful colony of B. huntii containing pupal cells, workers, and a queen.

Restoring Native Plants for Forest and Rangeland Resilience

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PROBLEM: Native seed availability has limited reclamation and restoration since the 1970s and is now considered a global challenge in land management. Surprisingly little is known about revegetation requirements for many native plant species. In addition, commercial seeds of native plant species are often scarce, resulting in a focus on relatively few species available through cultivation.

EFFORT: In 2024, we continued greenhouse and laboratory studies to identify seed sources and germination and establishment requirements of several native species in Wyoming, including native legumes. Additional funding was received and will allow seed-harvesting studies to examine the potential for commercial sale of native species to achieve land management and horticultural goals.

RESULTS: New funding was received to begin studies of commercial seed-harvesting impacts on native plant populations through field and greenhouse-based population viability studies. Wild seed collections are crucial to meet goals in ecological restoration and directly benefit the public through the recovery of ecosystem services and land uses such as wildlife habitat, recreation, and livestock grazing. Research to resolve questions about the risks of wildland seed harvesting contributes to both policies and practices necessary for the sustainable management of public lands.

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Far-Red Light Timing and Its Effect on Strawberry Nutrient Uptake, Phenology, and Yield

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PROBLEM: Several plant species, including strawberries, have successfully shown that additional far-red (FR) light can induce earlier flowering. However, our understanding of the optimal plant growth phase for applying FR light remains incomplete.

EFFORT: To optimize the appropriate time of FR light application, the June-bearing strawberry (Fragaria ananassa) 'Keepsake' was irradiated at different growth phases with supplemental FR light at 43.2 µmol/m²/s at a peak wavelength of 730 nm. Treatments were 1) FR light applied from transplanting to harvest (FR++); 2) FR light applied for the first 40 days after transplanting (FR+-); 3) FR light applied from 40 days after transplanting to harvest (FR-+); and 4) natural light only (FR--).

RESULTS: Plants receiving FR light during the initial growth phase showed a reduction in leaf area compared to those receiving no FR light or FR light 40 days after transplanting. Supplemental FR light caused early flowering and fruit output, but a reduced fruit diameter outweighed this advantage. Far-red light timing affected nutrient uptake in plant foliage. Plants subjected to FR light in their early growth phase had lower calcium and magnesium levels while demonstrating elevated iron levels. Manganese concentration was lower in plants exposed to continuous FR light. Therefore, supplemental FR light during the latter growth phase under natural light conditions may be advantageous in some June-bearing strawberries. This project aligned with objective X.5 outlined in the Wyoming Production Agriculture Research Priorities (2018).

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Strawberry 'Keepsake' response to supplementary far-red light in terms of flowering and plant morphology 40 days after plug transplantation. Treatments were a) FR applied from transplanting to harvest (FR++); b) FR applied for the first 40 days after transplanting (FR+-); c) FR applied from 40 days after transplanting to harvest (FR-+); and d) no FR applied (FR--).

Screening the Suitable Tomato and Pepper Varieties for Wyoming Environmental Conditions

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PROBLEM: Promoting local production for local consumption is essential and it has become more possible with many varieties hardy to cold climates introduced in recent years. Research on introducing suitable tomato and pepper cultivars for optimal yield has been lacking in Wyoming for an extended period.

EFFORT: To address the concerns of growers, a variety screening field trial was conducted in the summer of 2024 at the Laramie Research and Extension Center in Laramie, Wyoming, aimed at optimizing the growth and yield of two significant Solanaceae crops—pepper and tomato—in cool climates. The trial involved 15 tomato varieties and 8 pepper varieties.

RESULTS: Among the tomatoes, 'Northern Delight', 'Golden Bison', and 'Bounty' yielded a higher number of ripe fruits, with 'Northern Delight' also producing the most total fruits. The weight of ripe fruits was greatest in 'Mountain Fresh Plus,' followed by 'Bounty' and 'Mountain Spring,' with 'Mountain Fresh Plus' achieving the highest total weight (ripe + unripe fruits). Additionally, 'Mountain Delight' demonstrated superior plant fresh biomass.

In the pepper category, 'Omnicolor' led in ripe fruit production, followed closely by 'Rico', which also had the highest total fruit weight. A golden tomatillo variety, 'Chupon de Malinalco', from the 2023 screening trial at the Montana State University College of Agriculture, was included and performed exceptionally well. These promising results suggest the potential for extending this project by exploring different growing methods, comparing protected and unprotected production systems, and incorporating a broader range of varieties in future research programs. Nearly 500 kilograms of the project's output were generously shared with the Laramie community, as well as with colleagues and students. This project is in alignment with objectives I.12 and X.1 as outlined in the Wyoming Production Agriculture Research Priorities (2018).

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Images from a field trial of 15 varieties of tomatoes and 8 varieties of peppers, including a golden variety of tomatillo, carried out at the Laramie Research and Extension Center in summer 2024.

Determining Supplemental Light Spectra for Enhanced Growth and Development of Everbearing Strawberry cv. Ozark Beauty Under a Soilless Vertical Growing System

AUTHORS: Fraidoon Karimi[1]

AFFILIATIONS: [1]Department of Plant Sciences, University of Wyoming, Laramie, WY

PROBLEM: Indoor vertical farming is one of the most inventive techniques in contemporary horticulture production, applicable for both on-season and off-season cultivation. Effectively regulating the blooming process in fruit-bearing crops, such as strawberries, necessitates precise modifications to the light spectrum composition. Moreover, optimizing space utilization is crucial for enhancing the production output of expensive protected growing facilities.

EFFORT: The experiment was carried out at the Laramie Research and Extension Center greenhouses. This study aimed to optimize the duration of supplemental blue light, with or without far-red light, under natural daylight circumstances to improve the flowering and fruiting of the strawberry variety 'Ozark Beauty' (Fragaria ananassa Duch.) in a vertical growing system.

RESULTS: In March 2024, a vertical soilless cultivation system was planned and erected, along with the installation of an automated irrigation system. The current project is anticipated to be finished by autumn 2025. This project corresponds with target X.5 specified in the Wyoming Production Agriculture Research Priorities (2018).

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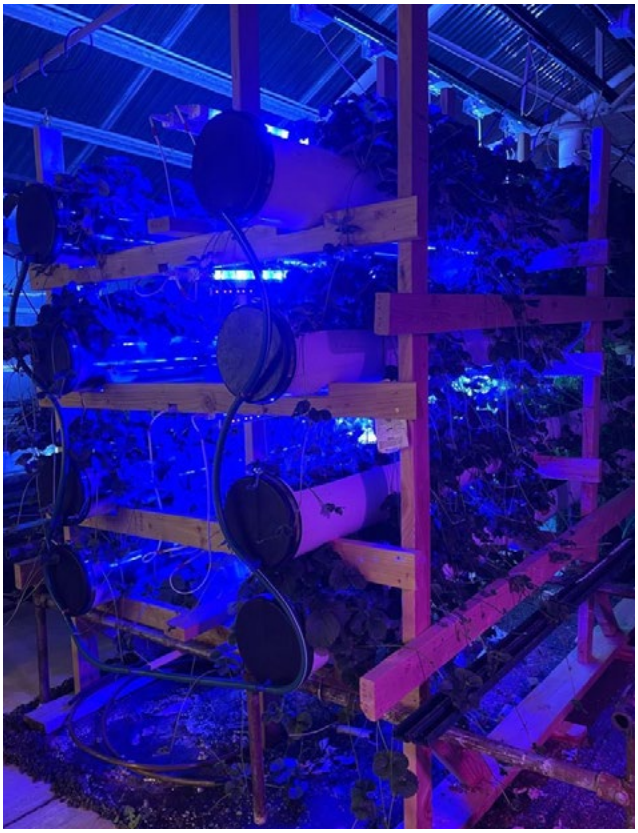

The vertical soilless growing system depicted was designed to investigate the effects of varying durations of supplemental blue light, both with and without the inclusion of far-red light, on the growth and production of the strawberry variety 'Ozark Beauty.'

Morphophysiology Response of Strawberry to Direction of Far-Red Lighting

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PROBLEM: Lighting direction is a novel concept distinct from light quality and intensity that influences plant morphophysiology. Reports indicate that differences in illumination direction influence plant morphophysiology. It mitigates the adverse effects of improper concentrations of plant growth regulators (PGRs) and solely modifies illumination angles, which simplifies control, lowers economic expenses, and does not hurt the plant. Far-red light has been found to enhance early flowering and fruit production in strawberries.

EFFORT: This study examines the response of strawberries to lateral far-red lighting compared to overhead far-red lighting to optimize the growth environment for improved strawberry production in protected farming systems. Moreover, our work elucidates the significant impact of lighting direction on the morphophysiology of strawberries and illustrates how side lighting visibly encourages runner development. These findings will also yield new insights into the propagation of the most widely farmed strawberries.

RESULTS: This project is currently in progress and is scheduled to be completed in the summer of 2025. This project corresponds with objective X.5 specified in the Wyoming Production Agriculture Research Priorities (2018).

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Experimental setup for studying morphophysiology response of strawberry to the direction of far-red lighting at the Laramie Research and Extension Center greenhouses.

Growth and Physiological Responses of Three Culturally Significant Native Edible Berry Species to Controlled-Release Fertilizer in Greenhouse Conditions

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PROBLEM: Native edible berry plants hold significant importance for Indigenous communities' food sovereignty and cultural preservation. However, their wild populations are threatened by extreme weather conditions and invasive species, necessitating greenhouse cultivation methods to ensure their survival. While controlled-release fertilizers (CRFs) are widely used in horticultural production, their optimal application rates for native edible berry plants remain understudied. While overfertilization can lead to excessive nitrogen (N) leaching, nutrient deficiency can limit plant growth.

EFFORT: The objectives of this research were to determine the effects of elevated CRF rates ranging from 0 to 0.96 g·L $^{-1}$ N on the growth, morphology, and physiology of three native edible berry species: Elaeagnus commutata (silverberry), Rhus trilobata (skunkbrush), and Shepherdia argentea (silver buffaloberry).

RESULTS: Decreased CRF rates led to reduced chlorophyll content, photosystem II efficiency, and leaf nitrogen content in E. commutata and R. trilobata, but root-to-shoot ratios were higher for those rates. Physiological parameters, such as photosynthesis and stomatal conductance, showed no significant increases above 0.12 g·L $^{-1}$ N CRF rate, while growth parameters remained statistically similar at CRF rates exceeding 0.24 g·L $^{-1}$ N. The results of this research indicate that CRF application rates lower than the manufacturer's recommendation were sufficient to maintain growth and physiology of the three native edible berry species.

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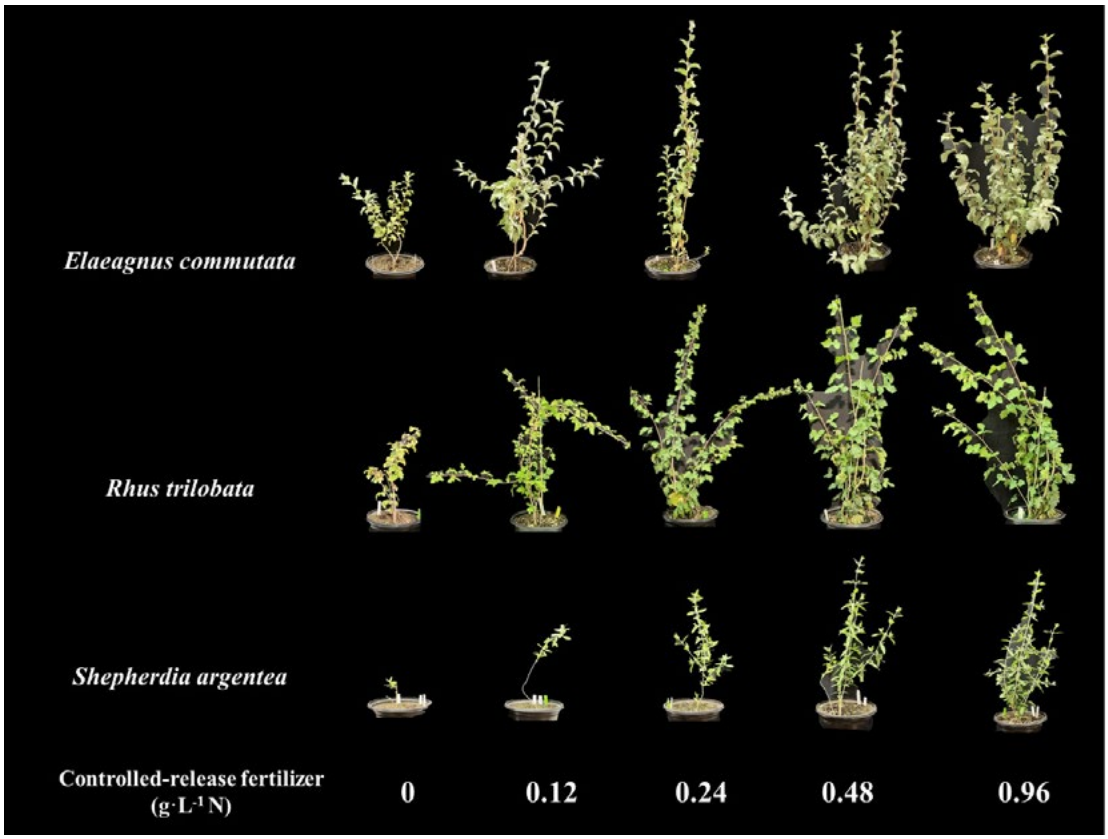

RANGELAND, PASTURE, AND NATURAL RESOURCES RESEARCH

Targeted Disturbance for Improved Nitrogen Mineralization and Forage Production in Meadows

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PROBLEM: Irrigated hay meadow soils of the Laramie Basin are unique. Due to long-term flood irrigation in cold environments, meadow soils have developed an organic "thatch" horizon at the surface that stores up to 1,500 lb of nitrogen per acre. If only a small portion of this nitrogen were made available to plants each growing season, producers could eliminate the need to apply fertilizer on their meadows while maintaining acceptable yield.

EFFORT: To stimulate nitrogen release for plant growth, we applied targeted grazing and light tillage to the flood-irrigated meadow south of the Hansen Arena at LREC. Targeted grazing was applied in October 2021 through 2023 using 1,200-lb dry cows for 24 hours at rates of 375 and 100 head/acre. Tillage was performed in October 2021 using a rototiller to 2-inch depth.

RESULTS: Although the heavy grazing and tillage treatments stimulated nitrogen release from the soil, disturbance to the plant community led to poor or unchanged yields the first two seasons following disturbance. In summer 2022, no treatment outperformed the untreated control. In summer 2023, both grazing treatments yielded less than the untreated control and tillage was not different than the control. However, in 2024, the rototilled treatment had recovered and yielded significantly higher than the control. Results indicate disturbing flood-irrigated meadows initially decreases yields but may provide increased yield potential 3 years following disturbance. Final measurements are scheduled for 2025 to confirm or refute this observation. PARP: I.2, II.5, II.8.

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Table shows hay yield (ton/acre) for four treatments to stimulate nitrogen release and hay growth in flood-irrigated meadows in 2022–2024. Yields followed by different letters were significantly different at p = 0.05.

Treatment	2022 Hay yield (ton/acre)	2023 Hay yield (ton/acre)	2024 Hay yield (ton/acre)
Control	2.09 A	1.71 AB	2.20 A
100 head/acre graze	1.83 A	1.37 AB	1.92 A
375 head/acre graze	1.34 AB	1.00 B	2.23 AB
Rototill	0.64 B	1.85 A	2.77 B

Microbial Inoculants: Potential Alternative for Improved Nitrogen Cycling and Forage Yield in Hay Meadows

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PROBLEM: Irrigated meadows are important for raising livestock in the Rocky Mountain West. However, flood irrigation and cool temperatures have resulted in a thick layer of organic material (thatch) buildup at the soil surface, as these conditions slow the breakdown and release of nutrients by soil microorganisms and thus affect forage yield. Using microbes to boost nutrient cycling and forage yield while reducing the need for chemical fertilizers could be a valuable solution.

EFFORT: Biofertilizers contain beneficial microbes that can improve nutrient cycling, increase the breakdown of the thick thatch layer, and improve soil fertility. To test this, we applied biofertilizers to a flood-irrigated meadow located south of the Hansen Arena at LREC in spring 2024. Treatments included Azospirillum (nitrogen-fixing bacteria); arbuscular mycorrhizal fungi (AMF), which helps plants absorb nutrients; Azospirillum + AMF; Hypergrow, a commercial biofertilizer; urea; and control.

RESULTS: Though there were no significant differences in yield between treatments, the Azospirillum (4.01 tons acre^{-1}) closely followed the urea treatment (4.13 tons acre ^{1}), suggesting that traditional nitrogen fertilization (urea) and nitrogen-fixing bacteria (Azospirillum) may enhance biomass production. The AMF treatment had the highest soil microbial biomass (559 mg kg^{-1}), suggesting that mycorrhizal inoculation enhances microbial biomass, likely due to increased root-associated microbial activity. Urea enhanced yield but did not improve microbial biomass, indicating that while it supports plant growth, it may not contribute to long-term microbial soil health. AMF increased soil microbial biomass, suggesting a more active microbial system that may contribute to long-term soil fertility.

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Table 1: Response of forage yield (ton/acre, dry matter) and total microbial biomass carbon (MBC) to seven treatments to stimulate nitrogen cycling and yield in flood irrigated hay meadows.

Treatment	Yield (tons acre^{-1})	MBC (mg kg^{-1})
Urea	4.13 ± 1.14	517 ± 107
AMF	3.66 ± 0.28	559 ± 38
Azospirillum	4.01 ± 0.89	419 ± 33
Azospirillum+AMF	3.67 ± 1.04	508 ± 124
Hypergrow high rate	3.52 ± 0.83	520 ± 71
Hypergrow low rate	3.25 ± 0.39	428 ± 54
Control	3.33 ± 0.53	499 ± 166

Evaluation of Forage Resources Favored by Climate Change Scenario in the Northern Mixed Grass Prairies

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PROBLEM: Events related to climate change should lead to shifts in forage production in grasslands worldwide, including the rangelands of the western U.S. These changes should occur in terms of forage species, biomass production, and nutritional quality, threatening the success and sustainability of grazing operations. Amongst these changes, it is expected that undesired forage species should be expanded in the northern mixed-grass prairies region, favoring invasive forages such as Bromus tectorum (cheatgrass) and Linaria dalmatica ssp. dalmatica (Dalmatian toadflax) and woody species, such as shrubs and sub-shrubs, at the expense of native grass species.

EFFORT: Based on the fact that sheep, as compared to cattle, are capable of grazing a wider range of forage species, including woodier materials and forages containing significant levels of secondary bioactive compounds, we decided to evaluate the aforementioned invasive forages and shrub species found in the state of Wyoming as a way to estimate the impact of forage species favored by climate change on sheep production systems. Chemical composition analyses were completed and in vitro gas production trials are being carried out; however, results of the latter are still in processing stages. Our group also plans on conducting in vivo grazing trials with the objective of having a more thorough evaluation of such plants.

RESULTS: Chemical composition analysis (Table 1) indicated that the forages selected have a chemical composition that indicated that they can be compatible with sheep operations, suggesting that competitive production levels can be met when these forages comprise more of the animals' diet. PARPS 2.V.3 and 2.X.1.

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Table shows chemical composition analysis of different forages used in our project. Values expressed in g/kg on dry matter basis (except for the dry matter content).

Species	Big sagebrush[1]	Rabbitbrush[2]	Shadscale saltbush[3]	Cheatgrass[4]	Dalmatian toadflex[5]
Dry matter	879	888	910	942	945
Crude protein	116	69	66	58	116
NDF[6]	287	445	478	572	331
ADF	221	308	280	319	254
Ash	42	57	23	56	57
TDN	773	675	707	662	736

1 - Artemisia tridentata
2 - Ericameria nauseosa (Pall. ex Pursh)
3 - Atriplex confertifolia
4 - Bromus tectorum
5 - Linaria dalmatica ssp. dalmatica
6 - NDF – neutral detergent fiber; ADF – acid detergent fiber; TDN – total digestible nutrients

Estimating Forage and Visual Obstruction on LREC's McGuire Ranch

AUTHORS: Nicki Nimlos,[1] Timm Gergeni,[1] Amanda Norton,[1] Derek Scasta[1]

AFFILIATIONS: [1]Department of Ecosystem Science and Management, University of Wyoming, Laramie, WY

PROBLEM: The Robel Pole technique is commonly used to estimate standing plant biomass and assess residual herbage after grazing. However, its accuracy on Wyoming's heterogenous rangelands remains uncertain and warrants further investigation.

EFFORT: During the 2023 and 2024 growing seasons (May – August), we clipped 6 transects and recorded 60 Robel pole readings each month on 10 pastures at the McGuire Ranch, resulting in 240 forage clippings and 2,400 visual obstruction readings annually.

RESULTS: We identified 7 functional groups and 45 plant species. Graminoids (grasses) and shrubs were the dominant functional groups, with prairie Junegrass (Koeleria macrantha), muttongrass (Poa fendleriana), Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis), and western wheatgrass (Pascopyrum smithii) as the dominant species. Average forage production was 221 pounds per acre in 2023 and 342 pounds per acre in 2024. Forage biomass was significantly higher in 2024 than in 2023 ($p<0.001$). Across both years, July had significantly less biomass than May, June, and August ($p<0.001$), while we found no differences between May, June, and August. Mean visual obstruction height measured with the Robel pole was 7.2 inches (ranging from 0–48 inches) and was not normally distributed ($p<0.001$). Shrubs had the highest visual obstruction, followed by graminoids. Forbs and litter did not differ from one another, nor did lichens and litter. As expected, bare ground provided the least visual obstruction. These results suggest that the Robel Pole's estimates of vertical cover vary depending on the dominant functional group present, suggesting that the Robel pole's utility may be limited in heterogenous landscapes. PARPS addressed VI.3 and VI.6.

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Evaluating Soil Organic Carbon at the LREC McGuire Ranch

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AFFILIATION: [1]Department of Ecosystem Science and Management, University of Wyoming, Laramie, WY; [2]Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO

PROBLEM: There is limited understanding of how grazing management impacts soil organic carbon (SOC) in Wyoming rangelands. With emerging carbon market opportunities for ranchers, it is increasingly important to understand how SOC responds to different grazing management strategies across temporal and geographic scales.

EFFORT: As part of a $19-million, 5-year research initiative called the 3M Project: Metrics, Management, and Monitoring, the McGuire Ranch serves as an experimental ranch. In summer 2022, the University of Wyoming partnered with the Noble Research Institute and Colorado State University to collect soil samples. Led by Drs. Paige Stanley and Francesca Cotrufo, 480 soil samples were collected from 10 pastures receiving two different grazing management treatments. Five pastures are "prescriptively" grazed using a set stocking rate and rotation schedule, while the other five are "adaptively" grazed only once per year until a target utilization is reached.

RESULTS: SOC stocks varied by depth (0–15 cm, 15–30 cm, 30–50 cm, and 50–100 cm). Topsoil contained the greatest SOC stock, though deeper soil also contained significant amounts of SOC. This is likely due to the deep, extensive root systems of sagebrush and perennial grasses, along with minimal historical crop production. On average, the McGuire Ranch stored 52 tons of SOC per acre down to 1 meter (10.26, 8.12, 10.71, and 21.0 tons of SOC per acre in the 0–15, 15–30, 30–50, and 50–100 cm depths, respectively). In 2026, we will repeat soil sampling at the McGuire Ranch to assess how SOC and broader soil health metrics are changing over time in relation to grazing management and climate stressors such as drought. Estimating changes in SOC over time will also provide insights into potential financial opportunities for Wyoming ranchers through participation in the carbon market. PARPs addressed I.15; VI.5; VI.6.

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Nesting Success of Sagebrush-Obligate and Ground-Nesting Songbirds Within an Adaptive Rotational and Prescriptive Cattle Grazing System

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PROBLEM: As songbird populations continue to decline annually across various habitats, the impact of grazing type, intensity, and duration on nesting success has rarely been understood. An adaptive rotational grazing system is often thought to be positively associated with nest success, based on the assumption that this system will reduce competition between native forage and sagebrush while also allowing pastures to rest for longer periods, thereby promoting growth and rejuvenation.

EFFORT: We investigated the nesting success of three focal songbird species in Wyoming during the 2024 grazing season. The nests of these species—Brewer's sparrow (43%; Spizella breweri), horned lark (33%; Eremophila alpestris), and vesper sparrow (17%; Pooecetes gramineus)—were extensively monitored across 10 pastures to determine nest outcomes. The pastures were divided into two grazing treatments, one utilizing an adaptive rotational grazing system and the other employing a traditional season-long grazing system. Nests were located during the breeding season (June – August) using several established searching methods and were monitored every two to three days to track egg and nestling progression, as well as to ascertain the fate of each nest.

RESULTS: A total of 108 nests were found across the pastures. Using a Fisher exact test, the variation in nest success and failure was shown to be not significantly different ($p < 0.556$) between the two grazing treatments. The primary cause of failure was likely predation, as determined through an intensive investigation at the nesting site. Only two trampling events were observed, both associated with the red-winged blackbird (1%; Agelaius phoeniceus).

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A sagebrush-obligate songbird, the Brewer's Sparrow, carrying food for a fledgling.

Evaluating Open Gates During the Winter Months for Increasing the Permeability of Landscapes for Pronghorn When Livestock Are Not Present

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PROBLEM: Pronghorn (Antilocapra americana), commonly referred to as the "antelope," are a staple of North American big game that occupy the grasslands, intermountain valleys, and warm deserts of the American West. Endemic to North America, pronghorn evolved fleeing the North American cheetah (Miracinonyx trumani) in open plains where they developed their primary means of self-defense of vision and speed. However, due to their evolutionary history, pronghorn did not develop an instinct to jump vertically (despite their ability) and they typically cross under the bottom wire of fences. This behavior makes them especially susceptible to the risks involved with crossing fences. With the increasing presence of fences in the American West, pronghorn face declining populations and great limitations to their movement strategies.

EFFORT: We evaluated the utilization of open gates by pronghorn when cattle were not present. The study was conducted on LREC pastures, which are mainly composed of traditional woven wire sheep fencing topped with one or more strands of barbed wire, the deadliest design for pronghorn. We deployed 15 trail cameras at randomly selected gates on interior fences and monitored pronghorn crossings from December to May.

RESULTS: As we continue to collect data from the trail cameras, we have noticed that the pronghorn readily utilize open gates. Interestingly, we also found that there is a predation interaction between coyotes and pronghorn. Coyotes appear to be utilizing the woven wire fences to entrap pronghorn. When data collection is complete, videos will be analyzed with the Timelapse and AddaxAI programs to extract quantitative data. PARPS addressed I.17; VI.9; IX.8.

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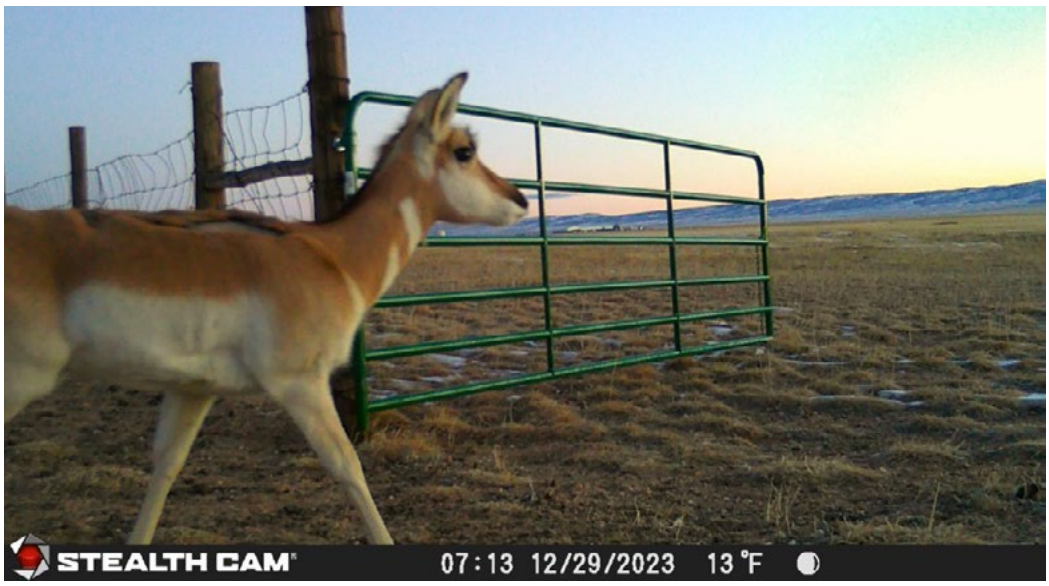

Game camera image of a young pronghorn doe using an intentionally open gate for movement.

Wyoming Production Agriculture Research Priorities (PARPs)

Updated June 2018

GRAND CHALLENGE—Enhance the competitiveness, profitability, and sustainability of Wyoming agricultural systems.

- **Goal 1. Improve agricultural productivity considering economic viability and stewardship of natural resources.**
- **Goal 2. Develop new plant and animal production systems, products, and uses to increase economic return to producers.**

Producer recommendations developed from statewide listening sessions

I. Production Systems Objectives

1. Develop and maintain baseline agriculture production systems to evaluate effects of innovations on the natural resource base, sustainability, and profitability. (2014)
2. Develop best-agronomic management practices for alternative crops such as sunflower seed production and various forages (e.g., perennial and annual legumes, grasses, and legume-grass mixtures) and other oilseed crops. (2014)
3. Identify synergistic effects among crops to improve crop rotation systems. (2014)
4. Develop methods to deal with residue when establishing new stands in crop rotation systems. (2014)
5. Evaluate effects of legumes in dryland wheat production systems. (2014)
6. Evaluate incorporating crops and crop aftermath into livestock production systems. (2014)
7. Evaluate and compare no-till versus tillage techniques. (2014)
8. Identify improved harvesting techniques. (2014)
9. Evaluate the use of legumes in rotational cropping systems. (2014)
10. Identify causes for annual losses of bees and other pollinators and develop management procedures that minimize their loss. (2015)
11. Develop best management practices to control diseases in crops. (2015)
12. Conduct crop variety trials to identify varieties best suited to Wyoming localities. (2015)
13. Identify optimal crop rotations for sugar beet producers. (2015)
14. Identify seed treatments that optimize sugar beet and dry bean production. (2015)
15. Devise integrated cropping/grazing systems that optimize crop and livestock production with soil health. (2015)
16. Assistance in how to use drone and precision agriculture data to make management decisions. (2018)
17. Evaluate how all of the different specialties of researchers can be combined to benefit producers. (2018)
18. Assist producers in learning what their peers are doing. (2018)
19. Develop better collaboration between researchers and producers with on-farm projects.

II. Soil Fertility Management Objectives

1. Develop methods to ameliorate poor soil pH for crop production. (2014)
2. Investigate effects of fertilizer type, placement, and timing on crop production (e.g., sugar beets, cereal grains, dry beans, and forages). (2014)
3. Evaluate the efficacy of managing soil nitrogen applied by pivot irrigation. (2014)
4. Determine and categorize nitrogen release times for varied forms of nitrogen. (2014)
5. Discover methods to reduce dependence on commercial fertilizers. (2014)
6. Develop tillage systems that minimize soil disturbance. (2014)
7. Develop cheaper alternatives to commercial fertilizer (e.g., cover crops, legumes). (2014)
8. Test the ability of compost and manure to enhance soil fertility. (2014)
9. Identify plants such as legumes that enhance soil fertility. (2014)
10. Identify crops and varieties that perform best in varied soil types and elevations. (2015)
11. Evaluate effects of aerators on soil productivity. (2015)
12. Identify soils best suited for farming or grazing. (2015)

III. Weed Control Objectives

1. Develop control methods for weeds resistant to glyphosate (e.g., Roundup) or other herbicides, especially in sugar beet and dry bean production. (2014, revised 2015)
2. Develop methods to control weed emergence that can be applied in the fall.
3. Improve procedures to control noxious weeds, especially milkweed, knapweed, whitetop, curly dock (aka sour dock), and thistle. (2014, revised 2015)
4. Evaluate the efficacy of weed-control chemicals applied before planting in dry bean fields. (2014)
5. Develop chemical and non-chemical methods to control cheatgrass and other noxious weeds. (2014)
6. Coordinate application of glyphosate with precision agriculture. (2014)
7. Optimize use of herbicides economically and environmentally. (2014)
8. Facilitate access to chemicals needed for special uses. (2015)
9. Discover viable alternatives to pesticides. (2015)
10. Determine chemical carryover in no-till production. (2015)
11. Continually monitor unintended consequences of weed control on plants and animals. (2015)

IV. Irrigation Objectives

1. Test and develop surge, pivot, and drip irrigation techniques for specific crops, especially alfalfa, alfalfa seed, dry beans, and sugar beets. (2014, revised 2015)
2. Test the ability and reliability of moisture monitors to indicate timing of irrigation. (2014)
3. Conduct irrigation management studies to optimize water use for specific crops (e.g., alfalfa seed, dry beans, and sugar beets) and soils. (2014, revised 2015)
4. Develop methods to maximize (optimize) production with less water. (2014)
5. Improve irrigated pasture production at high elevations. (2014)
6. Test the ability of soil additives (e.g., surfactants) to affect water absorption and retention. (2015)

V. Livestock Objectives

1. Develop strategies to enhance the efficiency of feed utilization. (2014)
2. Evaluate effects of additives or chemicals to feeds to influence forage and/or weed consumption. (2014)
3. Train livestock to consume alternative feeds such as brush and weeds. (2014)
4. Determine heifer development strategies that optimize reproduction, foraging ability, and cow longevity to maximize profitability. (2014)
5. Identify strategic supplementation protocols that optimize animal production traits with costs of production. (2014)
6. Develop improved methods to control flies. (2014)
7. Determine how to minimize feed costs and maximize profit per unit of production. (2014)
8. Develop genetic markers for feed efficiency and determine their ramifications on important production traits such as reproduction, milk production, pounds of calves produced, and carcass characteristics. (2014, revised 2015)
9. Develop practical estrous synchronization methods for commercial producers.
10. Determine cumulative effects of minerals, ionophores, worming, and implants on animal productivity. (2014)
11. Provide cost/benefit information on grazing of irrigated pastures. (2014)
12. Determine direct and indirect effects of disease and predators on livestock production. (2015)
13. Develop best methods to ameliorate existing and emerging diseases in livestock. (2015)
14. Optimize breeding of first-calf and re-breeding of second-calf heifers. (2015)
15. Develop breeding strategies that maximize the beneficial effects of heterosis in livestock. (2015)
16. Develop criteria for lamb carcasses to decrease variability and increase consumer satisfaction. (2015)
17. Identify and eliminate causes for consumers having poor eating experiences with lamb. (2015)

VI. Grazing Management Objectives

1. Develop improved forage (e.g., grass/legume mixtures) based livestock production systems. (2014, revised 2015)
2. Demonstrate and evaluate benefits of strip grazing corn stalks. (2014)
3. Increase the carrying capacity of range and pastureland. (2014)
4. Evaluate effects of multi-species grazing on forage utilization and range health and productivity. (2014)
5. Develop alternative grazing strategies to enhance rangeland health. (2014)
6. Evaluate management intensive and rotational grazing strategies in dry environments. (2014)
7. Identify optimum grazing height for alfalfa aftermath and effects of grazing on stand longevity. (2014)
8. Develop forage species that are drought resistant. (2014)
9. Investigate ways to optimize wildlife-livestock interactions and receipt of value for hunting and tourism. (2014, revised 2015)
10. Provide new information on meadow management and irrigated pasture grazing in higher elevations. (2014)
11. Develop economically feasible methods to control sagebrush and greasewood. (2015)

VII. Production Economics Objectives

1. Determine the cost-effectiveness of fertilizer alternatives. (2014)
2. Determine the economics of alternative grazing systems. (2014)
3. Determine the cost-effectiveness of vaccines, mineral supplements, and pour-ons in livestock production systems. (2014)
4. Develop practical methods to assign economic values to ecological management procedures. (2014)
5. Identify obstacles and evaluate options and opportunities for marketing. (2014)
6. Identify obstacles and evaluate options and opportunities for marketing Wyoming- produced meat and other products to consumers. (2014, revised 2015)
7. Determine impacts of alternative management strategies on whole-ranch/farm economics. (2014)
8. Provide information on costs per unit of production. (2014)
9. Identify capital management alternatives for new and expanding producers. (2015)
10. Provide tools to facilitate record keeping. (2015)
11. Determine economic potentials for alternative crops (e.g., soybeans, oil crops, forage beets) and varied crop production methods (i.e., organic, no-till, and conventional) in specific Wyoming localities. (2015)
12. Determine economic impacts of grazing vs. harvesting of alfalfa and winter wheat in the fall. (2015)

VIII. Crop and Animal Genetics and Biotechnology Objectives

1. Improve marker-assisted selection procedures to identify plants and animals with desired production traits. (2014)
2. Develop and evaluate genetically modified organisms that enhance desired production traits. (2014)
3. Identify optimum cow size for Wyoming environments. (2014)
4. Increase longevity and production persistence of forage legumes. (2014)
5. Develop viable alternatives for legumes (especially alfalfa) at high elevations. (2015)
6. Develop methods to identify cattle and sheep seed stock that possess desired economic traits. (2015)

IX. Rural Prosperity, Consumer and Industry Outreach, Policy, Markets, and Trade Objectives

1. Analyze economic impacts of farming/ranching management decisions. (2014)
2. Consider input costs, budgets, and market risks by region and crop. (2014)
3. Conduct applied research studies with producers and develop demonstration trials with cooperators to facilitate adoption of new or changing technologies. (2014)
4. Increase dissemination of research results (e.g., Wyoming Livestock Roundup, radio programs). (2014)
5. Work with commodity groups to enhance adoption of new technologies. (2014)
6. Conduct hands-on classes at R&E centers or with cooperators for young/new producers. (2014)
7. Provide science-based information needed by policymakers to make informed decisions. (2015)

8. Educate the public about the impacts of agricultural practices. (2015)
9. Develop alternative markets and uses for agricultural by-products. (2015)
10. Investigate methods for, and impacts of, local food production. (2015)
11. Develop local processing and marketing opportunities for Wyoming livestock and crops. (2015)
12. Form venues to sell Wyoming products in international markets. (2015)
13. Enhance communication between producers, research entities, and regulatory agencies. (2015)

X. Responding to Climate Variability Objectives

1. Consider regionally unique environmental conditions when designing research studies. (2014)
2. Conduct integrated agricultural systems research that links environment and conservation to production and profitability. (2014)
3. Develop drought-resistant plants that fit the extreme environmental conditions of Wyoming. (2014)
4. Devise drought management strategies that minimize detrimental effects of grazing. (2015)
5. Determine effects of climate variability (e.g., lack of freeze vs. a hard winter) on plant and livestock diseases and production. (2015)

XI. Sustainable Energy

1. Conduct research on bioenergy/biofuels and bio-based products that are suitable to Wyoming's environment. (2014)

XII. Landscape-Scale Conservation and Management

1. Develop improved methods to reclaim disturbed lands. (2014)
2. Evaluate water, soil, and environmental quality using appropriate organisms as indicator species. (2014)
3. Present educational programs on environmental and societal impacts of agricultural innovations. (2015)
4. Develop methods to ameliorate the detrimental effects of poor-quality water on crop and livestock production. (2015)

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