**Project/Activity Number:** W-2012

**Project/Activity Title:** Enhancing management, production, and sustainability of grazing ruminants in extensive landscapes

**Period Covered:** 10/1/2016 – 9/30/2017

**Annual Meeting Date (s); Location:** 08/08/2017 to 08/09/2017; Eastern Oregon Agricultural Research Center, Burns, Oregon

**Administrative Advisor’s Authorization Code:**

**Participants:**

Dave Bohnert, Oregon State University, Chair, (dave.bohnert@oregonstate.edu)

Tim DelCurto, Montana State University, (timothy.delcurto@montana.edu)

Brett Hess, University of Wyoming, Administrator Advisor, (BretHess@uwyo.edu)

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Shana Ivy, New Mexico State University, (sivey@nmsu.edu)

Alec Kollman, University of Nebraska-Lincoln, Research Technologist, (S-Akollma1@unl.edu)

Ron Lewis, University of Nebraska-Lincoln, (ron.lewis@unl.edu)

Travis Mulliniks, University of Nebraska-Lincoln, (Travis.Mulliniks@unl.edu); at UNL in 2 weeks

Ken Olson, South Dakota State University, (kenneth.olson@sdstate.edu)

Ligia Prezotto, Montana State University, (ligia.prezotto@montana.edu)

Jim Sprinkle, University of Idaho, Secretary, (sprinkle@uidaho.edu)

Jennifer Thorson, Montana State University, (Jennifer.thorson2@montana.edu)

Richard Waterman, USDA-ARS, Miles City, Montana, (richard.waterman@ars.usda.gov)

**Students Present:**

Alec Kollman, University of Nebraska-Lincoln, Graduate Student, (S-Akollma1@unl.edu)

**Unable to Attend:**

Craig Carr, Montana State University, (craig.carr@montana.edu)

Earl Creech, Utah State University, (earl.creech@usu.edu)

Joel Caton, North Dakota State University, (Joel.Caton@ndsu.edu)

Melinda Ellison, University of Idaho, (ellison@uidaho.edu); not enrolled yet

Rachel Endecott, Montana State University, (rachel.endecott@montana.edu)

Antonio Faciola, University of Nevada, Reno, (afaciola@cabnr.unr.edu); Moved to University of Florida

Matt Garcia, Utah State University, (matthew.garcia@usu.edu); new member who will enroll

Janna Kincheloe, North Dakota State University, (janna.kincheloe@ndsu.edu); not enrolled yet

Donald Llewellyn, Washington Coop. Extension, (don.llewellyn@wsu.edu); Can no longer participate

Allison Meyer, University of Missouri, (MeyerAll@missouri.edu)

Eric Scholljegerdes, New Mexico State University, (ejs@nmsu.edu)

Don Snyder, Utah State University, (don.snyder@usu.edu); Retired

Mitch Stephenson, University of Nebraska-Lincoln, (mstephenson@unl.edu)

Dale Zobell, Utah State University, (dale.zobell@usu.edu); Retired

**Minutes of the Annual Meeting**

A photo of W2012 attendees at the Roaring Springs field tour is available at:

<https://app.box.com/s/exh3683nvvb8t645nqom5mbdilfxhk65>

**August 8, 2017 (Business Meeting)**

The business meeting was held on August 8, 2017 at Eastern Oregon Ag Research Center (EOARC) with Dave Bohnert presiding as Chair. Introductions of those present. The 2016 Minutes were read and approved. Richard moved, Ron Seconded, passed.

1. ***Overview of the history and programs at EOARC***

Dr. Dave Bohnert gave an overview of the Oregon State University history of the station and its associated programs and research goals. Joint funding with USDA-ARS. Before giving report, appreciation award from OSU-EOARC given to Tim DelCurto for his years of service at Union.

Harney Branch Station was originally established to help homesteaders find crops that would grow here. Most homesteaders left Harney County by 1950’s due to difficulty of climate. Emphasis at Squaw Butte shifted to livestock and grazing. Closed cow herd since 1938. High density cow herd in Malhuer County (# 7 county in nation) and Harney County (# 10 county in nation). EOARC is in sagebrush steppe which is 100 million acres in US. 80 frost free days per year, no warm season grasses, 11 in precip per annum, 60% in winter. 8 to 15 A/AUM. A lot of new Extension focus is going to facilitation and collaboration, e.g. Candidate Conservation Agreement for sage grouse. Question asked about if EOARC Extension employees receive formal facilitation training; we don’t run meeting, just help get people there. More collaborative in nature. Reviewed nature of Malheur Wildlife Refuge occupation earlier this year.

Dr. Chad Boyd, USDA-ARS Research Leader, followed this with the program overview of the USDA-ARS Station at Burns. Have or will have 8 scientists and 8 technicians. There is a joint effort with EOARC with a couple of scientists from The Nature Conservancy. Help solve local problems but with an international and national application. Have customer driven research and outreach input. Conifer expansion, cheatgrass invasion, and fire are big research emphases in ecosystem dysfunction. Working on seed amendments to help native plants germinate such as seed pillows (nutrients) and herbicide protection pods. Charcoal deactivates herbicide in vicinity of desirable seed. Also working on hydrophobic coating to help protect seeds from winter freezing. Working on pre-positioning plant communities to be more resilient to wildfires; grazing is a key landscape tool.

1. ***Budget Overview (Bret Hess – Administrative Advisor)***

The carry-over balance for the project hasn’t changed. No draws on funds. University of Wyoming has changed financial management. Funds not budgeted placed in holding account. Got 20% back as contingency. We need to show flow of dollars. Haven’t seen invoices for alkane analyses. Bret has said this project has 20K dedicated. Call on these dollars. Need to plan budget for future as a group. If knew what startup costs are for GLNC, need to prepare budget. May want to consider electing a treasurer or a setting up a finance subcommittee. **Should prepare a budget for this fall**. Bret can make 20K available right now. Budgets are annual at UWyo. Ron Lewis: How far in depth do we want to go with alkane analyses, parts of plants vs whole plants? Talked about travel for invited speakers at next GLNC. Ken didn’t receive anything from national ASAS, ASAS goal is to keep at 40 to 45K for Western Section, American Society of Animal Science. Concern is national ASAS is sweeping funds from GLNC but they could also be contributing for expenses as well. Bottom line, we just didn’t receive a complete accounting of expenses. Joel Caton could provide some information on grant. At Estes Park, grant and registration paid for complete conference, sponsors were extra. If do a partnership with ASAS again, need to improve communication on grant.

*Federal budget.* Fortunate this year. Held line for capacity dollars like Hatch. 25 million increase for competitive grants for AFRI. However, occurred after 2018 budget put forward by agencies which didn’t have increase for AFRI. Both houses keeping things finally constant. Budget probably won’t get passed for awhile. Both sides support NIFA without decrease from last year. Educational institutions haven’t seen 2017 dollars yet.

There has not been chief scientist for agency appointed yet. Might gain an advocate for Research, Extension, & Education at highest level.

Farm Bill discussion still continuing. Might pass in a year. Considering having hearings in the West. Sonny Perdue, USDA Secretary, considering traveling in an RV and get views in the field.

ARS Report: (*report from Richard*) both House and Senate will not include Woodward and Miles City on chop block. Dubois not on block but no dollars allocated. Steve Gaines of MT is on ag appropriations and said need Dubois. Strong stakeholder support is key. Once Justin Derner leaves Cheyenne, retirement or otherwise, that position won’t be refilled.

1. ***Election of Secretary***

The 2018 meeting will be held in Idaho with Jim Sprinkle as Chair. Tim DelCurto was elected as new Secretary with the 2019 meeting in Montana. Tim will be in charge of the report and minutes for the 2018 meeting. New Mexico State has volunteered to host again in the future.

1. ***Report***

If you are listed in Appendix E and have not submitted a report yet, you need to do so.

1. ***Administrative E.***

Send list to Bret regarding those who are not active who are listed in Appendix E such as retirees and those who want to be removed. He may need to contact their station head. Sprinkle will send a list.

1. ***Status of Mid-Project Review and Administrative Update***

This project was reviewed this year; on nimss.org. We were listed as “Excellent” in all respects! We need to make sure have outputs for alkane work, such as poster that was done on Grazing Conference. Where are we? Next year’s report should highlight some alkane results. Ron mentioned that next year a Ph. D. student will contribute on mathematics.

Use GLNC topics to help address objectives of grant.

Next year needs to have a portion of the meeting be dedicated to a rewrite in 2018 meeting. We need to have renewal proposal completed by January 2019. Sprinkle suggested dedicating a day to the proposal and having it at a lodge in Salmon on the river. This will make it a little more pleasant to do.

***7. Establishment of Planning Committee for******Grazing Livestock Nutrition Conference (2020?)***

Where is 2020 ASAS meeting going to be? Sacramento? Still awaiting to hear from national ASAS.

Mark Petersen will not be on the GLNC committee next time, sent Ken an email to that effect. **Dave Bohnert, Eric Scholljegerdes, Tim DelCurto, Richard Waterman, Ron Lewis, Shanna Ivey, and Travis Mulliniks will be on the committee, with Eric S. as** **chair of committee and Richard will be historian of committee**. By spring of 2018, need to have topics, have speakers identified by one year out. This fall committee will have a general topic for meeting finalized by December. Finalize conference by W202 meeting of 2018. **May need an extra day for meeting next year**. We should consider putting together 100 copies of proceedings as spiral bound. Need a common invitation letter to speakers including responsibilities and proceedings deadline.

This group brought conference back after died briefly. Originated from this committee. The name of the conference was copyrighted and committee waited until copyright was retired. We need to make sure that each GLNC is prestigious. Proceedings of GLNC are available online. Looking at getting DOI on original conference.

Need this tight schedule to get conference grant submitted. Might want to have someone on planning committee who is an ASAS Director. Eric is an ASAS Editor.

1. ***Writing Committee for Renewal Prior to Next Meeting***

**Tim DelCurto, Jim Sprinkle, Ron Lewis, and Shanna Ivey will work on renewal and have a draft by the next meeting**. A writing day is proposed at a lodge the first day for everyone to finish this task.

Intake issue, Bolus, Markers may be items of inclusion in renewal.

***9. Impacts on Draft Annual Report***

Move Objective 1 to 3: As a result of training these students did we change behavior and contribute to society? Have you contributed to Knowledge, Skills, and Abilities? **Could you send Jim Sprinkle stuff on grad students, where they gained employment what they are doing by August 25th?** Recognition that grad students allow us meet objectives of this project.

Hurdles to be overcome with alkanes. Ron Lewis will provide a condensed bullet impact of two or three sentences for Objective 1.

Objective 2. What was the result of our activity?

Focus on scientific community: have advanced as a result # of papers. Where any of our citations or conclusion of 2014 ASAS conferences made in NRC 2016 Nutrient Requirements of Beef Cattle? Since the recent W2012 meeting, Sprinkle researched this more. The new NRC verified need for research into shortcomings for predicting intake. NRC didn’t feel they had enough information to change prediction equations for intake. The new NRC reference did cite one Journal of Animal Science journal article contributed as a result of this W2012 committee (see page 163), Coleman et al., 2014. This was a paper resulting from the 2014 ASAS symposia we organized. We did gain one concession in the new NRC, on page 2 of the summary: “*Equations for beef cows remain the same, however, additional guidance has been provided for predicting intake by beef cows, particularly those grazing forages*.” An example of this new guidance is presented on Page 168 of the new NRC with figures and formulas from the Coleman et al (2014) work, as well “rule of thumb guidelines from Lalman (2004). Galyean raised awareness of the difficulty in predicting intake when he presented at the last GLNC.

Is grazing more acceptable now as a result of participating collaboratively? E.g. CCA of Dave’s collaborative effort with sage grouse.

# citations

#**3 send specific examples of Extension changes of behavior to Sprinkle by Aug 25th**, e.g. taught mineral supplementation at state schools, xx% stated they would change mineral supplementation as a result of the information presented.

**Station Reports**

**Montana State University**

*Tim DelCurto*

* Strategic supplementation to optimize the use of low quality forages. Winters stay open in MT generally. Inadequacies related to averages of replicates, disturbance of grazing activity, cost. Looking at strategic use of supplements on distribution patterns, looking at cow age and rangeland use. Looking at cow size, percentage of BW weaned on supplement intake and grazing activity. Split plot with % of BW weaned as 1st plot and cow size as second plot. Using salt limited supplement (25%). Pelleted with bentonite as binder.
* Using Lotek collars monitor with Smart Feed Pro Feeders by C-lock. Can program intake of feeders. Avg. 2.75 kg of supplement/d and eat supplement from around 0800 to 1600 h. 264 cows used the 8 feeders. Generally eating more supplement when colder. Some cows didn’t eat every day. One cow would eat 6 lbs. of supplement in a feeding (including 25% salt) but not every day.
* Cow efficiency study high indexing cows supplement intake no differences due to great deal individual intake.
* UAV for characterizing rangelands, GIS maps. Surrogate for GPS collars.

*Discussion.* Takes a while to adapt to UAV at NMSU but not Union. Discussed the problem of individuality on supplementation. Best advice can give is sort out thin cows. Had a discussion on cow size and nutrient requirements.

*Ligia Prezotto & Jen Thorson*

* Nutritional programming and fibroblast growth factor 21 (**FGF21**) and energy status of hormones influence on production. At calving spikes, goes down in lactation cycle. Looking at this and its influence on weight gain and reproduction. Looking at FGF21 influence with Residual Feed Intake.
* Molecular role of hypothalamus neurons and influence on nutritional profile of animal. Alteration of blood brain barrier with nutrient restriction. Look at in utero influences (diet restriction or overfeeding of dam) that could be made on influence on fetus and how it may effect puberty, etc.

*Discussion.* What changes in blood brain barrier? Are you going to go look at progeny effects; one generation.

**New Mexico State University** (*Shanna Ivey*)

* Hiring ranch manager for College Ranch.
* Lots of Corona work, continuing arginine work. Cannulated cows with range cows, samples every month. Cows good at selecting.
* Antral follicle counts.
* Establishment of microbiome of calf. By day 7, NMSU calves more diverse compared to MARC.
* Milk components and effects of immunity?
* Corona cow families and AI fertility. Are there microbiome differences in cow tract?
* Water intake in range beef cattle.
* Mineral intake using same equipment.

**Oregon State University** (*Dave Bohnert)*

* 3rd of study on refuge, grazing reed canarygrass vs haying. Benefitting fall migratory bird habitat with grazing, more green.
* Horse grazing to see what level would impair sage grouse habitat. Doing this with ranch horses on Roaring Springs.
* Studies at Squaw Butte, season of use, early or after seedset grazing. Song bird habitat, sage grouse, long term potential species shifts. Clipping study with various levels of utilization, nesting habitat, visual obstruction. Discussed plant height and utilization.
* Meadow Creek study at Starkey and off site waters and utilization. GPS collared cows and small pastures. Bank alteration is the trigger that is the concern there; not stubble height.

**South Dakota State University** (*Ken Olson*)

• Field work has been completed for a 5-year prairie dog grazing study with yearling steers. Three pastures with level of prairie dog colonies ranging from 0 to 40% were compared. Lotek collars with activity sensors were used to determined whether grazing occurred off colony, on the shortgrass dominated portion of colonies, or in the annual forb dominated core of colonies. Cannulated steers were used for diet samples and to calculate rate of intake in grams/minute. Preliminary statistical analyses indicate little grazing time and low rate of intake on prairie dog colonies.

* To consider an alternative to patch burn grazing as conducted in southern Plains; patch winter grazing is being evaluated in SD to create a patch. 20% of each pasture gets patch grazed in mid-trimester, which is moved every year. Looking at livestock, vegetation, and bird populations and nesting access responses. Preliminary results indicate early in year, cattle love the patches. Wildfire took out portions of the study pastures in fall 2016 , so the study has been converted to comparison of patch burn to patch graze. GPS collars have been replaced with inexpensive homemade collars based on i-gotU GPS devices and activity sensors.

**University of Idaho** *(Jim Sprinkle)*

* Discussed collar data for efficient vs inefficient cows on rangeland.
* Also discussed importance replicate forage samples for selenium.

*Discussion.* Discussed the mechanisms that would contribute to differences of efficient cattle accessing slopes greater than inefficient on hot days including heat of fermentation, forage quality, etc. We also discussed pulse dose of alkanes that was done last year and validation trial. Also shared things about temperature, GPS data recovery rates.

**University of Nebraska-Lincoln**

*Ron Lewis and Alec Kollman*

* Discussed results of Nebraska & Montana alkane samples (2 yr) and some across technicians. Organized training procedures established in lab. Use lab standards based on two plant mixtures, with reliability assessed by regressing observed on actual composition. Alec Kollman achieved extremely reliable estimates (R2 > 0.99). Some techs cannot get good results. Due to lack of consistency, 2 out of 5 technicians at UNL did not continue with this procedure because they could not achieve predetermined standards. We need to have a round robin lab training/verification and certification for this technique. Forage samples should be dried at less than 60°C; freeze drying better. Anatomically/physiologically, cell wall alkanes should differ in legumes vs grasses. Concentrations of alkanes across years varied within species though generally similar profiles. Time of sampling within year has an impact on results, eg at maturity, Nebraska (still some green) vs Montana (dried out). We can’t develop a set alkane library for forages we can use, due to differences of phenology, etc. Forages would need to be collected at the same time as fecal samples to estimate diet compositions and intakes. Importance of knowing individual species composition is quite variable depending upon research objectives, for example, do you want to know how much cheatgrass they are eating or are you just interested in knowing how much they eat? Plant parts cause variation in alkane analyses, especially the reproductive parts of plant. Do we want to pay for cost of doing plant parts? Considering cost and time, at least initially, only whole plant. Committee agreed. With simpler pastures at USMARC (primarily smooth brome and Kentucky bluegrass), when sampling forages 3 times in two weeks, get reasonable estimates of intake. The cost of sampling is (running duplicates) $40 per sample. Takes four days to process 60 samples.

Proof of concept for NIRS?

* What do we need to do to wrap this up for Objective 1? **We need the samples from all the sites and all the plants for two years.** Could at least run data across one year. Need more description of sites.
* Know that variation exists across site, could run a greenhouse study to address.
* With alkanes alone, can distinguish 10% differences in diet composition for two plants mixed, but not likely for more complex diets.
* Do we need to broaden list of markers beyond alkanes to distinguish more plants? Could add alcohols for $5 more.
* For several of the committee, simple intake is the question we want to know about. The problem is being able to distinguish species with this techniques. We can’t delineate most C3 from C4 with this technique, although can distinguish some individual grasses (blue grama, needle-and-thread) and legumes.

**University of Tennessee**

*Travis Mulliniks*

* Milk production work. No correlation MP and calf weaning weight. Followed offspring of low MP and they were more efficient on GrowSafe. Calves that have access to forage gain better.
* Heifer development work on native forages January to April with 4% of crude protein. Some compensatory gain. No difference in preg rates of calving interval when compared to heifers grazing on stockpiled on tall fescue.

**University of Wyoming** *(Anowar Islam)*

* Evaluating annual legume (fuengreek), alfalfa, grass-legume mixes, cool season grass yield response to irrigation, drought, and planting time, irrigation and N rates corn silage, WY bred winter peas, quinoa, harvest yield conventional and low lignin alfalfa, forage sorghums.
* Discussed birdsfoot trefoil research, non-bloating legume. Reduces N in cattle urine. Don’t plant birdsfoot trefoil in standing crop of wheat; also important control weeds. Clean till method of establishment leads to better establishment. All cultivars similar. Yield and nutritive quality similar to alfalfa.

**USDA-ARS, Fort Keogh** (*Richard Waterman*)

* Mineral study with prepubertal bulls. Using flow cytometer to refine results on Breeding Soundness Examination and acrosomes, etc. Liver biopsy and looking Cu and Zn or alone. 100 day trial. Flow cytometer every 28 days. Liver biopsy at end. No deficiencies in baseline biopsies; had mineral when with cows.
* Drought issues on rangeland. Paddocks grazed May/June and October by cannulated cows. Artificial water application. One treatment 70% use vs 50%. After 4 years, starting to see some plant community shifts. Heavier grazed, more Japanese brome coming in. How hard can we graze dormant forage? 3 pastures graze 50%, 3 heavy. Developing heifers on these treatments.

*Discussion.* At EOARC have to go without a year without mineral to see deficiencies even with low mineral concentrations of Cu and Zn. Poorly drained forages that get plowed can contribute to high Mo. Winter kill effects with removing more forage before winter vs not?

**Project meeting in 2018**

* Jim Sprinkle will plan the project meeting for 2018 in ID.
* Tim DelCurto will take on the role of project secretary at that meeting.

**August 8, 2016 (Tour to Northern Great Basin Experimental Range)**

**Northern Great Basin Experimental Range, Dr. Chad Boyd**

Tropical 30 million years ago with 30” rainfall annually. Cascades uplifted and dried out. Radiocarbon dating for pack rat midden to sample pollen and also use fossils to help determine plants long ago. Little Ice Age late 1850’s. Would see different vegetation in 1700’s.

Tragedy of Commons discussed with lots of sheep on Steen Mt. Marvin Klemme helped establish Experiment Station. Grazing enclosures have been in place since 1939. Grazing with light to moderate stocking rates and rotate use, not much effect of grazing.

Have rainout shelters. Biggest change in climate has been here with C02 in atmosphere. Favors annual, & woody vegetation. Causes water efficiency to go up.

No surface water, catchments & wells with pipelines; OSU cattle here during summer.

Problem with cheat grass is that it changes the abiotic community around it.

Discussed GRSG Table 2-2. Sage Grouse. Can’t manage for 7” or 9” plant height. Trying to come up with a system mapping veg so can determine what state we are in. Greg Simmonds is mapping large acreages to determine what large spatial scale we are at.

**August 9, 2016 (Tour to Roaring Spring Ranch)**

**Roaring Springs Ranch**

Bob Sanders is owner and bought in 1992. Stacy Davies, Mgr hosted us. He has managed this ranch 21 years.

Started tour with introductions and what we would like to learn today.

Historic cattle barons from CA. Pete French was an earlier settler. 3 million acres he controlled.

Historically, this ranch had been self sustaining for a long time with food resources and supplies. 3500 momma cows when Stacy arrived to take over management; 10,000 today. 250,000 deeded acres + million acres BLM. Cattle in several western States: OR Natural Country beef Coop is used to market beef. He manages the Coop.

*Range Vale Project BLM* –Range restoration BLM planted 100,000 acres of crested wheatgrass. 70 years of uncontrolled grazing had preceded this, especially on Steen Mt. Dr. Griffiths documented degraded conditions in 1901. Vale Project seedings giving out. Renovation has been double disked & no till planted Siberian Wheatgrass & forage kochia. Also seed crested wheatgrass. Improved cattle gains with yeanlings up to 2 lb/d.

Andrew, wildlife Biologist for ranch. 100 sage grouse using pivots right now. Have collared some. Wintering 10 miles W in desert. Mosaic & diversity is important for wildlife. What should scale of mosaic be? BLM guidelines are pretty small (25 A for sage grouse), hard to do that in this type operation.

Problems of preservation attitude vs building habitat for wildlife, including sage grouse. Need to look at past history, e.g. old homesteads & loss of plant community then reseeding crested wheatgrass, then stand going out and needing replacement. Forage kochia is occupying more bare ground spots in seedings. Also out competes annuals. So expands some but could take out with 2,4-D. This seeding does help with fire control.

*Winter Range Stop*

Have put in some fences, especially so could use winter range more. Effectively stays fairly open during winter. When Stacy arrived to manage the ranch, cows were walking 7 miles to find winterfat and leaving squirreltail alone. Looked at plant reproduction. Use to be a lot of winterfat in this Valley. Set up 30 exclosures to test effect of no grazing with OSU Range Dept. Soil crust increasing rapidly in exclosures. Not much difference recruitment & production inside and outside. It has been 15 years. Big exclosure, if rototilled & planted winterfat could get to grow. Looked at ripping also minimum till, minimum tillage could get squirreltail to grow. Soil here has a Ca hardpan I which is conducive to winterfat. Reproduction of winterfat more apparent where soil has Ca closer to surface.

Tested cows if meeting nutritional requirements by Body Condition Scoring (**BCS**) plus veg analysis. Using tubs mostly for mineral req. Mid-age cows meeting requirements pretty well & young & older cows need mere help. When came, calving in February, now in April. Not having BCS crash like did before.

*Riparian Stop*

Talked about TMDL effort and water quality. FDA wouldn’t cooperate with effects made. In Bailey’s work showed some behavioral aspects of problem. Use water gap concept to help prevent bacterial loading. Look at managing from uplands dom. Putting in catchments as treat juniper. Also put in collection area on terrace in riparian area and pumping water up to uplands.

*Skull Creek*

Talked about Candidate Conservation Agreement (USFWS) and fish agreement. Rerouted road up canyon where fish stream was. Due to these and other efforts helped recover red band trout and prevented listing. Discussed aspen recovery. Talked about timing of grazing and moving through country. This year not grazing higher up because of fire control.

*Uplands*

Aspen regenerating from burns. Controversy about stream drying up in some of stream reaches due to beaver. Willows came in during 2002. Tamzem Stringham did some treatment with 100 yds of jumper Iaid over steam then 100 yds no juniper over stream. Purpose was to shade stream for a while while willows regenerate.

Over time, they have increased cowherd to 10,000 cows from beginning herd of 3,500 cows when arrived while increasing wildlife habitat. Prevented some wildlife issues with regeneration of riparian trees by treating more acres, so 50 acres treated/elk.

10 acres life on juniper cut and 20 years life on burn.

Sage grouse summer range up to 8,500 ft. Winter range moving 30 miles away. Lek counts increasing on ranch, some due to precip but some due to private land management.

Over 5 years, 50,000 A prescribed fire. Good results when dealing with this type of scale for treatments.

**Progress Toward Project Objectives**

***Objective 1:* Assess variation across space and time for n-alkane composition in unique classes of forages common to the Western United States, which is necessary for predicting feed intakes and diet choices of grazing ruminant animals.**

**General**

* Plans reviewed for collecting forage samples. Each research station will select a sampling date when forages will be at their peak vegetative and dormant state. At each sampling, the location and, where possible, soil properties will be recorded. Approximately 500 g of dry plant matter will be collected. About 100 g of each sample will be retained as the entire plant. The remainder will be subdivided into plant parts as appropriate (i.e., leaf, stem, flower, and seed head). These samples will be dried at 55 °C. Samples will then be ground through a 1 mm screen using a mill (Wiley Mill). Samples will then be stored at room temperature until analysis.
* The forages sampled will be:
	+ Cool-season grasses (C3): Western Wheatgrass (Agropyron smithii), Cheatgrass (Bromus tectorum);
	+ Warm-season grasses (C4): Blue grama (Bouteloua gracilis), sideoats grama (Bouteloua curtpendula);
	+ Legume: Sweet Clover (Melilotus officinalis); and,
	+ As many as two additional C3 and C4 grasses and a legume specific to a station

**New Mexico State University**

*Shanna Ivey & Eric Scholljegerdes*

* Field sampling has commenced on forages. Cheat grass, Blue Grama, and Side Oats Grama
* Samples from stations being sent to NMSU lab
* Lab analysis is underway

**North Dakota State University**

*Joel Caton*

* Analyzed forage masticate samples across differing grazing intensities for future use in address Objective 1.

**South Dakota State University**

*Ken Olson*

* In 2016, South Dakota State University collected growing season samples of western wheatgrass, annual brome, and sweet clover. Summer drought severely limited production of warm-season grasses, precluding collection of sideoats and blue grama. Additionally, the study area burned in October 2016, eliminating the possibility to collect subsequent dormant samples.
* In 2017, we collected growing season samples of western wheatgrass, annual brome, sweet clover, and blue grama. Sideoats grama is a rare species at the Cottonwood Research Station, precluding collection of an adequate sample.

**University of Idaho**

*Jim Sprinkle*

* With Carmen Willmore, Ph. D. student, conducted a 4 day total fecal collection and alkane pulse dose validation trial in a controlled pen experiment (*n* = 4 cows). This research will accompany pulse dose alkane field experiments for forage intake on rangeland pastures which were conducted last summer.

**University of Missouri**

*Allison Meyer*

* Tall fescue hay samples have been collected

**University of Nebraska-Lincoln**

*Ron Lewis*

* Variation in the n-alkane composition of forages common to the Western United States were evaluated across years (Nebraska) and locations (Nebraska; Montana). Three cool- and 3 warm-season grasses, and 2 legumes, were harvested at 2 phenologies (vegetative; mature). Across years, locations and phenologies, legumes were generally distinct from grasses. The n-alkane profile of a warm-season grass (blue grama) also appeared unique. However, discriminating individual grasses based on their n-alkane concentrations alone would be difficult. This work was in collaboration with Dr. Jerry Volesky (University of Nebraska-Lincoln) and Dr. Richard Waterman (USDA-ARS Fort Keogh, Montana).
* Methodological aspects of using n-alkanes to estimate intakes in heifers were investigated in 2 indoor experiments. Observed intakes were measured using a Calan Broadbent Feeding System. The robustness of the estimates depended on (i) accurate evaluation of diet composition, (ii) consistent level of dosing of an internal n-alkane marker, and (iii) pooling fecal samples collected over several consecutive days. With such procedures, cattle could be reliably ranked for observed intakes. This study was in partnership with Dr. Harvey Freetly (US Meat Animal Research Center, Nebraska).
* The diet compositions and intakes of heifers were estimated using n-alkanes in a sequence of 3 (year one) or 4 (year two) grazing studies conducted on smooth bromegrass dominant pastures. Although individual heifers expressed some selectivity, estimated diet composition aligned with the botanical composition of the pastures (82 to 95% smooth broomegrass). Estimated forage intakes were relatively consistent across the grazing season (on average 2% body weight on a dry matter basis). Despite the lack of fine demarcations among heifers, sensible intakes were obtained in a grazing setting using n-alkanes. This research involved collaboration with Dr. Harvey Freetly (US Meat Animal Research Center, Nebraska).
* The reliability of using plant waxes to estimate diet composition partly depends on the efficiency of the statistical methodology used to determine the content of a botanical mixture or diet. Using simulation, a traditional predictive approach (least squares) was compared with an alternative method (Bayesian linear unmixing) considered more efficient. The newer approach outperformed the traditional one for all of the botanical mixtures tested. However, estimates were considerably worse when the complexity of the mixture increases (contained 5 or more plants).
* Collaborations were established with Dr. James Sprinkle (University of Idaho) and Dr. Michael Undi (North Dakota State University) to provide laboratory support to evaluate the n-alkane concentrations of forages and feces collected during forage intake studies based on pulse dosing protocols.

**USDA-ARS Fort Keogh, Miles City, MT**

*Richard Waterman & Mark Petersen*

* Forage alkane samples collected in spring and fall of 2016 sent to Ron Lewis and Eric Scholljegerdes for crested wheatgrass, western wheatgrass, blue grama, needle-and-thread, prairie sandreed, cheatgrass, sweet clover, and lupine.

**University of Wyoming**

*Anowar Islam*

• Plant samples from the above list have been collected and stored properly. Plant samples will be ground according to the instructions and ground samples will be sent to the specific location(s)/lab for analyses.

***Objective 2:* Coordinate research and extension activities in extensive livestock production systems.**

**Montana State University**

*Tim DelCurto*

* Work closely with the Nancy Cameron Endowment advisory committee to set research and teaching goals for my position as they relate to the needs of the Montana beef cattle industry. Active participant with the Montana Stockgrowers Association with presentations at the “T-Bone” classic mid-summer board meeting in Big Sky (August, 2016; attendance of 30 producers/board members), presentation at the annual meeting in Billings (December, 2016; attendance of 500 members) and the summer mid-year / ag summit meeting in Great Falls (May, 2017). Discuss ongoing and future research with feedback from the Montana beef cattle industry.
* Outreach activities have included presentations to the Sweetwater Range Association (Bozeman, 20 attendees), Crazy Mountain Stockgrowers Association (30 attendees), MSU Northern Agriculture Research Center advisory meeting (February, 2017; 30 attendees) and Field-Day (300 attendees). In addition, I have presented at and/or coordinated the following events:
	+ Gallatin Valley 4H Beef Project Seminars (November, 2016; 40 attendees)
	+ Montana Farm Bureau tour of the MSU BART Farm (April, 2017; 20 attendees)
	+ Ag & Natural Resource Class from Clemson University tour of department of Animal & Range Sciences (June, 2017; 20 attendees)
* Invited Speaker at the Montana Nutrition and Livestock Forum (April, 2017; 150 attendees) and participated in a MSU Agent Training Program at the MSU Northern Agricultural Research Center (30 MSU Extension Faculty).

*Ligia Prezotto & Jennifer Thorson*

* Characterization of changes in temporal concentrations of fibroblast growth factor 21 (FGF21) in beef heifers and cows has had three experiments finalized and analyses completed for two with the third being completed before the end of this year. Results were presented in a poster at Fargo during the Western Section of the American Society of Animal Science. So far results have shown that FGF21 is a good candidate for a biomarker indicating energy and reproductive status in mature beef cows during early lactation.
* The nutritionally-induced plasticity of the blood-brain barrier in adult ewes project was conducted on previously harvested brain tissue from animals being feed low, control, and high plane of nutrition. We were able to observe several structural changes in the blood-brain barrier and reported this as a late breaking abstract at the Endocrine Society meeting in Orlando. A manuscript is ready for submission.
* Maternal nutritionally-induced plasticity of the blood-brain barrier in offspring is a project is close to being finalized to analyze how maternal nutrition throughout gestation affects the formation of the blood-brain barrier of the offspring.
* A project has been conducted with the objective to characterize the distribution of net wrap in the digestive tract of beef cattle when offered mixed with chopped forage. The project demonstrated a large accumulation of the plastic in the area of the reticulum + rumen. The project also demonstrated that a majority of the net wrap is not cleared from the digestive tract. An extension report has been reviewed and accepted.
* Data from the projects above have been presented in the following events:
* Invited presentation at the University of Sao Paulo - Brazil: 40 people
* Presentation at the Northern Ag Research Center during field day - attendance: 300 people
* Presentation at the Northern Ag Research Center during Advisory Council Meeting - attendance: 30 people

**New Mexico State University**

*Shanna Ivey & Eric Scholljegerdes*

* Invited Speaker, Corona Range and Livestock Research Center, Let’s Talk: Breakfast at the Ranch – Mineral nutrition, July 2017
* Invited Speaker, Corona Range and Livestock Research Center, Let’s Talk: Breakfast at the Ranch – Water quality, June 2017
* Invited Speaker, Southwest Beef Symposium, Fetal Programming: What is it. January, 2017
* Invited Speaker, Zoetis Cattlemen’s College, New Mexico Cattlegrowers Association, December, 2016
* Invited speaker, Corona Ranchers Roundtable, Timing of supplementation, November, 2016.
* Invited speaker, ADM Veterinary Educational Program, Influence of roughages/fiber on weaning and feedlot health, October, 2016
* Invited speaker, New Mexico Youth Ranch Camp, Range cow nutrition, June, 2016
* Invited Speaker, Grazing Livestock Nutrition Conference, Salt Lake City, UT, July, 2016.
* Invited Speaker, NCBA National Meeting, Cattleman’s College, San Diego, CA, January, 2016.
* Invited Speaker, NMSU, Corona Range and Livestock, Beyond the Roundtable Symposium, Ruminant Nutrition, (10 ranchers and land managers; Eric Scholljegerdes and Shanna Ivey).
* US Beef Academy, (4 presentations) Structure and function of the ruminant digestive system; Feeding and supplementing for reproduction; Body condition Scoring; Rumen Microbiology, July, 2017. (15 high school, undergraduate, graduate and veterinary students; Eric Scholljegerdes and Shanna Ivey)

**North Dakota State University**

*Joel Caton*

* Conducted collaborative research at the Central Grasslands Research and Extension Center in the Missouri Coteau region of North Dakota. This mixed-grass prairie region of ND represents over 50% of the ND cow herd.
* Provided face-to-face presentations and interactions with producers at field day meetings and met and discussed research emphasis and directions with the research center advisory committee.

**Oregon State University**

*David Bohnert*

* Presented 8 invited talks on livestock nutrition or beef cattle nutritional management in rangelands systems to 316 people.
* PI on a research project on “Horse Impacts on Sage-Grouse Habitat Structure and Composition on grazed Rangelands”. This research will be conducted in cooperation with the ARS group at EOARC Burns and a private landowner. Given that feral horse numbers are at an all-time high nationally, and that horse density in most publically managed Herd Management Areas is above the Allowable Management Level, quantifying the impacts of feral horses on sage-grouse habitat is of critical importance. This research will provide baseline information on the effects of free-ranging horses on habitats used by sage-grouse for nesting purposes.
* Co-PI on a research project titled “Grazing Season of Use Effects on Sagebrush Obligate Avian Habitat. This research will fill important knowledge gaps that currently exist around the short- and long-term effects of different grazing regimes on plant community and habitat characteristics of sagebrush rangelands”. This research will also fill a sizeable knowledge gap related to the influence of grazing on sagebrush-obligate songbird abundance and nest success. This is the kind of information that is desperately needed to help rangeland owners and managers identify and implement management practices that are sustainable for both grazing and sagebrush obligate avian species in the sagebrush ecosystem.
* Collaborator on a study titled “Testing the Compatibility of Innovative Cattle Grazing Practices with Salmonid Restoration: Meadow Creek Experiment, Starkey Experimental Forest and Range, Northeast Oregon”. Cattle grazing is the dominant land use on public allotments in the western United States that contain salmonid-bearing streams, and where recovery of salmonids under the Endangered Species Act has become a primary objective. Testing of innovative grazing practices compatible with salmonid recovery, however, has received little research attention, and represents a major knowledge gap and source of controversy in management. To address this knowledge gap, we are testing a set of grazing practices designed to minimize grazing time by cattle in riparian areas and the potential for detrimental grazing effects on salmonids. These practices include the use of small pastures, upland water, upland nutritional supplementation, short grazing periods, real-time forage monitoring, moderate stocking rates, deferred rotation, early-season grazing, compressed late-season grazing, and regular monitoring and herding of cattle, all of which are intended to maintain cattle distribution in uplands. These practices are not new, but their integration is novel and untested at practical scales of public allotments. The logistical and economic feasibility of these practices, which require more intensive herd management and infrastructure investments, also is a key research focus. Social acceptance of the practices found to be ecologically and economically effective is an additional focus of critical importance.
* Outreach is a critical component of these research projects and will be essential in the success of incorporation and acceptance of the resulting management recommendations.

**South Dakota State University**

*Ken Olson*

* South Dakota State University is conducting the 3rd, two-year class of beefSD, an educational program for beginning beef producers. Fifty-two participants interact with 19 peer mentors (alumni of past beefSD classes) to complete this program. beefSD is funded by a USDA Beginning Farmer and Rancher Development Program grant. The goal of beefSD is to increase the capacity of beginning beef producers to succeed as Equip beginning ranchers to make wise management decisions that lead to economic, ecological and sociological sustainability, thus contributing to future ongoing beef production, land stewardship, and rural community viability.
* Two classes of South Dakota Grazing School were conducted in 2016, with 61 individuals completing the course. Grazing school is a collaborative effort of SDSU Extension and the South Dakota Grassland Coalition. Two classes of grazing school are planned in September 2017, and registration exceeds the 60-seat maximum enrollment.

**University of Idaho**

*Jim Sprinkle*

* Presented 11 invited talks on range livestock nutrition or range livestock research at 6 locations in Idaho and 1 location in Oregon to approximately 251 people.
* Presented 3 invited talks and 1 demonstration on range management and range monitoring topics to approximately 65 people at 2 locations in Idaho.
* With Ken Olson of SDSU and Mitch Stephenson of UNL, we organized a 1.5 day Grazing Behavior Inservice in Springdale Utah attended by 31 scientists from across the United States, Europe, and Africa. Presented a talk on *Building and Testing a Homemade Grazing Halter.*
* **Beef Cow Efficiency on Rangeland**: A series of studies have been undertaken by faculty from the University of Idaho Nancy M. Cummings Research, Extension & Education Center to characterize cows that fit a rangeland environment. Using efficient and inefficient cows previously classified via residual food intake (RFI), cows have *grazing behavior* (locations, distance traveled, slope, elevation, walking time, resting time, grazing time, and bite rate), *forage intake*, and *production efficiency* (e.g., fertility, cow weight, and condition score) evaluated during mid- and late lactation as well as post weaning in a rangeland environment. Selection pressure on RFI is being applied by the cattle industry for bull purchases but very limited scientific studies have considered the impact of replacement heifers with divergent RFI in a limited range environment. Early results indicate that efficiently ranked cattle may utilize rugged rangeland more sustainably when summer temperatures increase.
* **Mineral Status for Forages in Idaho**: In conjunction with 7 Extension Educators in Idaho, mineral status in nine counties in Idaho for both irrigated and rangeland forages was measured during peak growing and dormancy seasons. Replicate samples demonstrated that commercial lab analyses for selenium were problematic and required more rigorous laboratory techniques. Results were presented at the Idaho Range Livestock Symposium in January, in county Extension meetings and newsletters, and in the June Line Rider magazine.
* **Protein Supplementation on Late Season Rangeland**: Due to loss of performance that occurs for range cows on cool season grass rangelands during late fall, a 2 yr joint study has been undertaken at the ARS Dubois Sheep Expt. Sta. to evaluate performance and grazing behavior for supplemented vs non-supplemented cows in both rotated and continuously grazed pastures.

**University of Nebraska-Lincoln**

*Mitch Stephenson*

* Presented 8 invited talks on range livestock grazing management or range livestock research to approximately 350 people. These talks included presentations to producers in Wyoming and Nebraska on grazing distribution, grazing strategies to optimize harvest efficiency, integration of crop and livestock systems, and livestock behavior. These included producers field days the the University of Nebraska Barta Brothers Ranch and High Plains Ag Lab.
* Collaborated with Jim Sprinkle and Ken Olson to develop, host, and present research at a grazing behavior inservice prior to the 2017 Society for Range Management annual meetings in St. George, UT. This 2 day inservice brought together a community of researchers that conduct research using GPS technology.
* Entered into the 2nd year of an evaluation looking at the influence of an internal parasiticide treatment on cattle behavior of rangelands. This study is also looking at changes in behavior as time within the pasture increases at different times during the growing season. Further analysis will evaluate how horn fly counts affect some of the distribution patterns of cattle.
* Began research with the USDA-ARS evaluating diet botanical composition of heifers grazing on pastures with a mixture of cheatgrass and perennial cool-season grasses early in the growing season. We are using fecal samples that will be analyzed for DNA of different plant species to assist in diet reconstruction with the lab Jonah Ventures based out of Fort Collins, CO.

**University of Tennessee**

*Travis Mulliniks*

* Invited Speaker, University of Tennessee, Matching Cow type with environment, University of Tennessee’s Beef and Forage Center’s Research and Recommendation Annual Meeting, December, 2016 (80 county extension agents and livestock producers).
* Invited Speaker, *6° Foro Ganadera de la Asociacion Ganadero local de Cusihuiriachic – Cuauhtemoc. October 28-29, 2016, Cuauhtémoc, Chihuahua, Mexico. (2 presentations; 100 livestock producers)*.

**University of Wyoming**

*Anowar Islam*

• In the western US, especially in the Intermountain West regions, demand for new and suitable plant materials is a long-term issue and is increasing continuously. The objective of this study is to evaluate different advanced lines of C3 grasses with the inclusion of some local checks in relation to their growth, yield, and quality response to irrigation, drought, and planting time. Species used in this study include tall fescue (seven lines), tall wheatgrass (three lines), western wheatgrass (five lines), and wildrye (two lines). Fall planting was made in late August 2008 whereas spring planting was in early May 2009. Data collected on different growth parameters, persistence, and forage quality from 2009 - 2016 for both plantings seems to be different among species and lines. Long-term data collection will help select and develop superior and well- adapted cultivars for the region.

* Islam, M.A. 2016. Grazing Alfalfa without a Fear of Bloat: A Seminar on Sabbatical Work in Canada. Department of Plant Sciences Seminar, October 28, 2016. UW, WY. Attendance: 33.
* Islam, M.A. 2016. Summer Experience in Japan: People, Culture, Education, and Research. Department of Plant Sciences Seminar, February 19, 2016. UW, WY. Attendance: 31.
* Islam, M.A. 2016. Grass-legume Mixture for Forage Yield and Economic Benefits. Wyoming Forage Field Day, June 14, 2016. ShREC, WY. Attendance: 95.
* Islam, M.A. 2016. Quinoa: A Potential Specialty Crop for Wyoming. Wyoming Master Gardener Association and Wyoming Farmers Market Association State Conference. April 1, 2016. Riverton, WY. Attendance: 23.
* Islam, M.A. 2016. Fenugreek – A Specialty Crop: Some Pros and Cons. Wyoming Master Gardener Association and Wyoming Farmers Market Association State Conference. April 1, 2016. Riverton, WY. Attendance: 21.
* Islam, M.A. 2016. Forage Variety Selection. Master Hay Grower, March 3, 2016. Cokeville, WY. Attendance: 27.
* Islam, M.A. 2016. Agronomy in Alfalfa. Alfalfa U – Loveland CO High Plains Journal, February 25, 2016. Loveland, CO. Attendance: 54.

**USDA-ARS Fort Keogh, Miles City, MT**

*Richard Waterman & Mark Petersen*

* Conducting research in areas of:
	+ Seasonal changes in water quality
	+ Range raised heifer development and management
	+ Mineral supplementation on spermatogenesis
	+ Drought impacts on forage production and grazing
	+ Impact on dormant forage utilization on subsequent year annual primary production

**Utah State University**

*Earl Creech*

* One M.S. student under my direction (Joseph Sagers) completed a project in the past year to characterize forage kochia response to salinity. Three new MS students (Jacob Briscoe, John Mortensen, and Marcus Rose) were recruited and began work on thesis projects to generate additional data for new Extension initiatives. Highlighted research and demonstration plots on grass/legume mixtures at a major field days in Panguitch and Lewiston, UT.

***Objective 3:* Provide professional development and mentoring opportunities for committee participants, young scientists, stakeholders, and graduate students.**

**Montana State University**

*Tim DelCurto*

* Major Professor for masters student, Alyson Williams, studying the influence of cow size and weaning weight ratio on grazing behavior and landscape distribution patterns. Project will also evaluate total DM intake, milk production and composition during the early post-partum period.
* Co-major Professor (with Dr. Megan Van Eman) for masters student, Hayley White, studying the influence of pelleting on intake behavior of yearling heifers consuming a 25% salt pasture supplement. Hayley will also study the impact of amount and frequency of salt intake on ruminal fermentation, microbial populations and digesta kinetics.
* Co-major Professor (with Dr. Darrin Boss) for Doctorate student, Cory Parsons, who will study sustainable beef production systems for northern mixed grass rangelands.
* Major Professor for masters student, Tyrell McClean, who will be studying strategic alfalfa supplementation of beef cattle winter grazing mixed grass rangelands.
* Three additional students (one Doctorate and two masters) will be joining our research group in 2018. Specific projects have not been determined.
* We also routinely use undergraduate students as research technicians for research projects throughout the year. Over the past year, I have utilized three undergraduate students and one will begin a master’s program in 2018.

*Ligia Prezotto & Jennifer Thorson*

* A day long tour was provided to the 7th grade students from Havre-MT. During the tour we spoke about the importance of STEM and gave several presentations related to STEM. The topic chosen for my lab was the importance of the mitochondria. Approximately 150 students participated.
* An undergraduate student from University of Sao Paulo has finalized an internship under our program. He has been involved in activities related to the aforementioned projects.
* An undergraduate student from Montana State University participated on a summer internship in our program. This student was involved in activities related to the aforementioned projects and completed an independent experiment evaluation ovarian development.
* An undergraduate student from Montana State University – Northern has initiated a cooperative project in our program in order to gain hands on experience for veterinary school admittance, laboratory skills, and receive credit for his undergraduate degree.

**New Mexico State University**

*Shanna Ivey & Eric Scholljegerdes*

* Kathryn Smith M.S. Impact of environment of the establishment of the rumen microbiome in beef calves
* Brandon Meyerhoff M.S. Effects of supplemental rumen protected arginine on progeny performance and tissue development and metabolism.
* Kacie McCarthy M.S. The effects of administering Ralgro to Holstein calves in the hutch period and fed to finish on growth performance and carcass characteristics (*Completed*)
* Joslyn Beard M.S. Effects of supplemental ruminally undegradable protein during late gestation on progeny performance
* Eben Oosthuysen PhD. Effects of management procedures on health and performance of newly-received calves
* Caitlin Hebbert M.S. Effects of source of zinc on growth and reproduction performance of Holstein Heifers
* Jorge Rodela M.S. Effects of fish meal supplementation on characteristics of digestion and metabolizable protein of cattle grazing wheat pasture
* Ulises Alejandro Sanchez M.S. Effects of monensin on microbial protein synthesis of cattle grazing wheat pasture

**North Dakota State University**

*Joel Caton*

* Provided training opportunities for two graduate students and three undergraduates in association with this collaborative project.
* One graduate M.S. student (Kayla Chilcoat) has completed their field work at the research center and is in the process of writing their thesis.
* Completed organizational support for the Grazing Livestock Nutrition Conference in held in July 2016.

**Oregon State University**

*David Bohnert*

* Member of graduate committee for 2 graduate students (1 M.S. & 1 Ph.D.) who graduated from OSU; currently serve on the graduate committee for 3 Ph.D. students (2 from OSU; 1 from UI)
* Helped train 6 interns who assisted with beef cattle research and outreach programs.

**South Dakota State University**

*Ken Olson*

* Served as major professor for Janna Kincheloe, who graduated with a PhD in Ruminant Nutrition in December 2016. Her dissertation title was “Influence of maternal protein restriction in primiparous heifers during mid- and/or late gestation on dam performance and progeny growth, carcass characteristics, and gene expression”.
* Serve on graduate committee for Megan Webb, PhD student in Meat Science. Her dissertation topic is “Identifying consumer label preferences to improve marketing of beef produced with different levels of growth promotant technology”.
* Serve on graduate committee for Jameson Brennan, PhD student in Natural Resource Management. His dissertation topic is “Comparing cattle grazing preference of plant communities on and off prairie dog colonies”.

**University of Idaho**

*Jim Sprinkle*

* Trained an undergraduate intern from BYU-Idaho, Tyler Covey, in data collection for rangeland monitoring and range livestock nutrition for 10 weeks. Also provided training for processing GPS data.
* Member of Graduate Committee, James Vinyard, M. S., Animal & Veterinary Science, 2016-present.
* Member of Graduate Committee, Carmen Willmore, Ph. D., Animal & Veterinary Science, 2015-present.

*Melinda Ellison*

* Major professor for Keri York who is doing a M.S. project on differing levels of cattle forage utilization and their effect on sage grouse brood rearing habitat in riparian meadows.
* Trained an undergraduate intern from University of Idaho, Kassidy Dunham, who worked on forage research.

**University of Missouri**

*Allison Meyer*

* Graduate students
* Natalie Duncan, M.S. currently underway, Thesis topic: Factors affecting neonatal calf and foal metabolism
* Emma Stephenson, M.S. currently underway, Thesis topic: Effects of trace mineral supplementation during late pregnancy
* Undergraduate research
* Katy Stoecklein, B.S. underway, Undergrad research project: Relationship of placental wet and dry mass with calf characteristics
* Abbey Rathert, B.S. underway, Undergrad research project: Effects of trace mineral supplementation during late pregnancy on colostrum quality and calf health
* Other undergraduate students involved in research:
* Ashleigh Redman
* Bailey Kemp

**University of Nebraska-Lincoln**

*Ron Lewis*

* Served as the chair of the graduate committee for a Ph.D. (Napoleón Vargas Jurado) at the University of Nebraska-Lincoln. The student submitted a journal paper entitled *Using a Bayesian hierarchical linear mixing model to estimate botanical mixtures* to the Journal of Agricultural, Biological, and Environmental Statistics, which has been accepted with revisions.
* Served as the chair of the graduate committee for a M.S. student (Emily Hilburger) at the University of Nebraska-Lincoln. The student completed her thesis (August 2017) entitled *Analysis strategies for calculating intake for cattle with plant waxes*. She also presented her research at the 2017 ASAS-CSAS Annual Meeting & Trade Show (July 8-12, 2017, Baltimore, Maryland).
* Hired a research technician (Alec Kollman) to develop and manage a state of the art laboratory to evaluate the plant wax compositions of plant and animal (fecal) samples. A key aspect of the current year’s activities was to establish procedures for quality assurance and laboratory standardization.
* Assisted 2 undergraduate students (Ashley Buescher; Riley Hahn) in developing and refining their laboratory skills to analyze the plant wax concentrations of samples collected in a variety of studies.

*Mitch Stephenson*

* Advisor for 2 M.S. students at the University of Nebraska - Lincoln,
	+ Jace Stott – Influence of an internal parasiticide treatment on cattle behavior in the Nebraska Sandhills.
	+ Nathan Pflueger – Use of annual forages in a dryland crop/livestock system to increase livestock production

**University of Tennessee**

*Travis Mulliniks*

* Jeremy Hobbs, M.S. completed December 2016. Thesis title: *Nutritional and metabolic factors influencing cow-calf efficiency in Tennessee*.

**University of Wyoming**

*Anowar Islam*

* Four students (2 PhD and 2 MS) are currently working on forage agronomy programs.
* Two students (one PhD and one MS) graduated from forage agronomy programs:
	+ Abdelaziz Nilahyane, Ph.D., Agronomy, Department of Plant Sciences, University of Wyoming. Spring 2016. Effect of irrigation water and nitrogen on physiological traits, yield, and quality of silage corn.
	+ Sayantan Sarkar, M.S., Agronomy, Department of Plant Sciences, University of Wyoming. Spring 2016. Effects of planting method, harvesting frequency, and cultivar on growth, yield, and nutritive value of birdsfoot trefoil.

**USDA-ARS Fort Keogh, Miles City, MT**

*Richard Waterman & Mark Petersen*

* July 21, 2017: Scientists and staff meet and discuss current research objectives and status with MT Representative, Greg Gianforte.
* July 12-15, 2017: Mark Petersen attended the National Cattlemen’s Beef Association meeting in Denver, CO.
* July 6-11, 2017: El Hamidi Hay and Mark Petersen attended the American Society of Animal Science scientific and board meeting in Baltimore, MD.
* June 12, 2017: Students from Clemson University are given a tour of the range ecology research sites, practiced sample collect and visited with scientists about current research.
* June 7-9, 2017: Location Research Scientists presented accomplishments and discussed future research with USDA-ARS National Program Leader for Animal Production & Protection Dr Jeff Valet.
* May 30 – June 5, 2017: Mark Petersen participates in Montana Stockgrowers Association convention and Ag Summit in Great Falls, MT.
* May 15-17, 2017: Mark Petersen, Andy Roberts and El Hamidi Hay met with peers from Clay Center, El Reno and Cheyenne in Fort Collins for the USDA ARS Beef Grand Challenge brainstorming and planning.
* May 11, 2017: Mark Petersen presents overview of Fort Keogh Research Goals to 15 students of the Miles City Area Economic Development Leadership class.
* May 2-4, 2017: Mark Petersen, Tom Geary, Richard Waterman, Lance Vermeire, Sue Reil, Dustin Strong, Cheryl Murphy, Bernie Garber, Luke Shurtliff, and Travis Helm presented information tours and demonstrations to a total of 388 first and fifth graders from Eastern Montana.
* April 26, 2017: FFA Livestock Judging competition is held at Fort Keogh. 25 Future Farmers were provided the experience of judging various types of livestock.
* April 19-20, 2017: Mark Petersen, Research Leader, of the Livestock and Range Research Laboratory in Miles City, MT hosted Director and Scientists from the US Dairy and Forage Research Center in Madison, WI. The purpose is to conduct a workshop to share research goals in order to develop highly effective collaborative research programs between the two units.
* March 31, 2017: ARS Animal Researcher, Andy Roberts and Mark Petersen, of the Livestock and Range Research Laboratory in Miles City, MT, met with Burt Rutherford of BEEF Magazine to discuss Andy’s research in heifer development. Three blog’s resulted from this discussion. <http://www.beefmagazine.com/nutrition/how-much-feed-heifer-question> & <http://www.beefmagazine.com/nutrition/how-much-feed-heifer-part-ii> & <http://www.beefmagazine.com/breeding/how-manage-your-heifers-part-iii>
* February 5-7, 2017: Agricultural Research Service (ARS) Research Leader Mark Petersen, of the Livestock and Research Laboratory in Miles City, MT, met with numerous individuals and groups at the ARS Headquarters in Beltsville, MD.
* On February 3-5, Agricultural Research Service (ARS) Research Leader Mark Petersen, of the Livestock and Research Laboratory in Miles City, MT, attended the Animal Society of Animal Science Board of Directors meeting to participate in meetings in Braselton, GA.
* February 1-3, 2017: Agricultural Research Service (ARS) Research Leader Mark Petersen, of the Livestock and Research Laboratory in Miles City, MT, participated in Cattle Industry Convention and National Cattleman’s Beef Association (NCBA) Trade Show to participate in committee meetings in Nashville, TN.
* January 29 – February 1 2017: Agricultural Research Service (ARS) Research Leader Mark Petersen of the Livestock and Research Laboratory in Miles City, MT, presented the followings talks: “Effects of Supplementation Strategy on Heifer Resource Utilization and Dormant Vegetation use of Montana Rangelands,” “Vegetation Changes Over 5 Years on Clayey and Loamy Ecological Sites in Northern Great Plains,” “Russian Olive Invasion: How Soil Properties Affect Invasion Dynamics and Succession Following Management Inputs,” and “Change in Catchment Reservoir Stock Water TDS Concentrations” to the Society of Rangeland Management in Saint George, UT.
* January 27, 2017: Mark Petersen and Andrew Roberts conducted a roundtable discussion with the owners of the Harding Ranch (Terry, MT) and management to discuss genetic anomaly in their herd. A cooperative research project was designed in hopes of discovering the genetic problem.
* January 19-20, 2017: Agricultural Research Service (ARS) Research Leader Mark Petersen, Research Animal Scientist Andrew Roberts, and Rangeland Ecologist Lance Vermeire of the Livestock and Research Laboratory in Miles City, MT, gave the following presentations: (Mark P.) “Water Quality and Impacts on Mineral Supplements, Mostly Water Quality with a Touch on Minerals,” (Andrew R.) “Cow-calf Production Efficiency, Looking at Longevity and Heifer Development,” and (Lance V.) “Fire Ecology – Season of Fire and Return Interval Effects on Bud Bank Dynamics of Perennial Grasses” during Fort Keogh on the Road in Havre, MT and Great Falls, MT.
* January 19, 2017: Andrew Roberts and Mark Petersen discussed management implications with Rich Roth (CEO IX Ranch) of the current winter conditions, heifer management, herd reproduction and bull selection.
* January 18, 2017: Agricultural Research Service (ARS) Research Leader Mark Petersen, of the Livestock and Research Laboratory in Miles City, MT, gave the presentation, “Do Your Cows Eat the Expected Amount of Mineral or Supplement and Drink Similar Amounts of Water?” to the Winter Grazing seminar in Glasgow, MT.
* October 8, 2016: Hoofin it for Hunger Race a co-sponsored trail run with the Montana Farm Bureau providing for a community 5K, 10K and half marathon to expose non ag participants to ranchers and research.

**Utah State University**

*Earl Creech*

* John Mortensen, 2016-present, M.S. in Plant Science. Thesis title (proposed): Genetic mapping of grass-legume mixture compatibility QTLs in intermediate wheatgrass.
* Jacob Briscoe, 2016-present, M.S. in Plant Science. Thesis title (proposed): Grass-legume mixtures to improve forage quantity and quality.
* Joseph Sagers, 2015-2016, M.S. in Plant Science. Thesis title: Characterizing forage kochia response to salinity.
* Marcus Rose, 2017-present, M.S. in Plant Science. Thesis title (proposed): Plant and animal performance in grass/birdsfoot trefoil pastures.

**Accomplishments Related to Project Objectives**

Objective 1:

* Laboratory protocols were developed and implemented at the University of Nebraska-Lincoln to ensure reliable and repeatable assessment of plant wax concentrations of forage and fecal samples using gas chromatography. This involved designing test samples with known contents of plant waxes, and establishing a training program to allow staff and students to develop the requisite laboratory skills to consistently measure these compounds. These measurements are central to using plant waxes to estimate diet composition and feed intake in grazing ruminants.
* Key methodological and statistical procedures for using n-alkanes to estimate diet composition and feed intake were tested experimental in controlled (indoor) and simple pasture settings. Although there were inaccuracies, intakes were sufficiently well estimated to reliably rank animals. Since genetic selection can loosely be thought of as choosing animals based on ranks, plant-waxes may contribute to breeding programs designed to improve efficiency.
* Three cool- and 3 warm-season grasses, and 2 legumes, typical of western rangelands were harvested at 2 stages of growth in 2 years and 2 locations. The n-alkane profiles of several of these forages were unique. However, in a mixed diet, the contributions of the individual plants could not be well estimated. Refinements in the methodology are needed if plant waxes are to be used as reliable dietary markers for cattle grazing complex western rangelands.

Objective 2:

* Provided outreach and training to at least 3,600 stakeholders through state, regional, national, and international meetings and short-courses.
* Montana State University has begun to evaluate strategic supplementation strategies for beef cattle winter grazing northern mixed grass prairies. Optimal supplementation delivery systems that optimize beef cattle production with distribution and use of native vegetation during the winter season will be studied. The research will utilize SmartFeed Pro Supplement delivery technology with GPS collars to identify best management practices for western beef producers.
* Working with industry partners, Montana State University is evaluating self-limited intake of supplements with the appropriate additional of salt. A series of studies is underway that will characterize variation in intake, the influence of pelleting on intake variation, and the impact of amount and frequency of salt intake on ruminal fermentation and digesta kinetics.
* With support from the Bair Ranch Foundation, Montana State University is evaluating the use of UAV to monitor livestock and wildlife distribution patterns as well as map habitat characteristics of native rangelands.
* The University of Nebraska-Lincoln is collaborating with the High Plains USDA-ARS to evaluate the diet selection of cattle grazed early in the growing season on cheatgrass invaded pastures using fecal DNA technology
* Scientists at the University of Nebraska – Lincoln are evaluating diet quality differences between NUTBAL fecal samples, hand clipped forage samples, and esophageal fistulated cow samples for producer decision making on supplementation in the Nebraska Sandhills.
* Montana State University is continuing the work to characterize and validate fibroblast growth factor 21 (**FGF21**) as a biomarker for energy status and ovarian activity in the beef cow.
* Montana State University initiated a collaborative effort with Federal Rural University of Amazon with the objective to investigate the efficacy of selection methods used in the region for beef cattle production.
* Montana State University and Mississippi State University are analyzing changes in liver metabolism in response to seasonal changes of day length, and quality and quantity of forage availability.
* The University of Idaho has successfully constructed grazing halters that will collect and store both GPS and grazing activity data on rangeland cattle at a fraction (≈ 16%) of the cost of commercially available collars.
* Replicate sampling for forage selenium status is essential to ensure accurate laboratory results.
* Studies on determining cost effectiveness of establishing sole grass (fertilized with N), sole legumes, and grass-legume mixtures and how efficient these practices are utilizing irrigation water have positive impacts. Results will help recommend the best grass-legume mixture ratios that will be profitable to Wyoming producers by reducing production cost significantly.

Objective 3:

* Through engagement of 41 graduate and 23 undergraduate students in research activities underway within this Multistate Research Project, young scientists have been provided opportunities to develop skills in the design and conduct of successful research programs, and experience with publication and grantsmanship.
* Through participation in regional and statewide meetings, workshops and short courses, expertise in extensive livestock systems across the Multistate Project team was leveraged to impact ranching and farming practices through the Western region.

**Impacts Related to Project Objectives**

Objective 1:

* The utility of using n-alkanes as dietary markers depends on their precise and accurate measurement in forage and fecal samples. Such reliability only comes with use of standardized protocols and methodical training. To ensure the dependable use of this tool, a lab certification program should be established based on a common training program and analytical procedures. Using an agreed rubric, technicians should demonstrate a prescribed level of skill with the technique as part of the lab certification process. Routine re-testing of technicians also should be implemented for a lab to remain certified.
* The n-alkane profiles of individual forages found commonly in the Western U.S. vary with the geographic location, year, and phenology from which they were sampled. Furthermore, classes of grasses (C3; C4) could not be discriminated based on their n-alkane profiles. Given the complexity of the botanical makeup of Western rangelands, the use of n-alkanes alone as dietary markers is inadequate to estimate diet composition and intake of grazing ruminants. Given the importance of enhancing feed utilization in grazing environments, the investigation of a broader set of plant-wax markers (e.g., long chain alcohols; fatty acids) is needed if this methodology is to be considered as a potential tool to estimate diet composition in extensive systems.

Objective 2:

* Completed organizational support of the 5th Grazing Livestock Nutrition Conference. This conference attracted individuals from around the world to share their work in the area of grazing livestock nutrition. Peer reviewed invited papers were published as a part of the proceedings and for the first time have DOI searchable identifiers, which greatly increases long-term impact.
* The new NRC 2016 Nutrient Requirements of Beef Cattle verified the need for research into the shortcomings for predicting intake. We did gain one concession in the new NRC, on page 2 of the summary: “*Equations for beef cows remain the same, however, additional guidance has been provided for predicting intake by beef cows, particularly those grazing forages*.” An example of this new guidance is presented on Page 168 of the new NRC with figures and formulas from the Coleman et al (2014) work, as well “rule of thumb guidelines” from Lalman (2004). The Coleman et al., 2014 paper resulted from the 2014 ASAS symposia organized by W2012.
* Promoted the broad exchange of ideas, information and data to promote advancements in nutritional technologies though:
	+ 2 book chapters
	+ 58 referred journal articles;
	+ 31 abstracts
	+ 19 conference proceedings;
	+ 42 extension publications; and,
	+ 22 popular press articles.

Objective 3:

* On the sagebrush steppe, grazing is more acceptable in sage grouse habitat partially due to involvement of the Eastern Oregon Agricultural Research Center and Oregon State University and USDA-ARS scientists in helping construct the USFWS Candidate Conservation Agreement for the greater sage grouse. Stakeholders across multiple states have benefitted from this effort which is partially responsible for preventing the sage grouse from being listed.
* 90% of participants in the multistate (OR, ID, NV) program, Fine Fuels Management Field Day, stated that they intended to apply fuel management practices taught and demonstrated at this workshop.
* Helped teach the Oregon Master Naturalist Program – Northern Basin and Range Ecoregion Course. The Oregon Master Naturalist Program is for people interested in Oregon’s natural history and natural resources management who want to dedicate their time as volunteers. The Mission of the Oregon Master Naturalist Program is to develop a statewide corps of knowledgeable, skilled, and dedicated volunteers who enrich their communities and enhance public awareness of Oregon’s natural resources through conservation education, scientific inquiry, and stewardship activities. Dave Bohnert provided 9 hours of instruction/field tours related to livestock production/grazing/history in the Great Basin Region to 10 students who became certified and went back to their communities to provide educational information related to livestock production and grazing in the Great Basin.
* Provided instruction/lecture to 41 college students from around the great basin in a 3-day experiential learning experience for undergraduate college students studying rangeland and/or natural resource management. It involves a number of interactive learning modules designed to improve the students understanding of principles used in developing rangeland management plans. The program concludes with students preparing a management plan based on knowledge learned, a problem/issue outlined at the beginning of the program, and interaction with instructors/organizers. This program helps students in their preparation to become managers and stewards of rangelands. Personal responsibility is` a module focused on balancing profit and resource use on working landscapes utilizing grazing in sagebrush steppe systems.
* Participants in each class of beefSD have completed pre-, mid-term, and final evaluations of the program. These evaluations have allowed tracking of short-term (knowledge gain), medium-term (ranch business plans written and implemented), and long-term outcomes (improved management leading to ranch success). All participants demonstrate knowledge gain, the majority of participants have implemented business plans, and some participants have reported production and management improvements such as herd expansion or improved marketing practices. In addition, some participants have reported that knowledge gained through beefSD has allowed them to deal with catastrophic events such as the Atlas Blizzard or the market crash of 2016.
* South Dakota Grazing School has been conducted annually for 14 years. An evaluation has been administered at the end of each school. Virtually all participants have indicated intentions to apply improved grazing management practices learned from the school. Through informal contact with many past participants, Grazing School staff members are aware that many participants actually implemented some form of improved grazing management.
* Provided information via presentation to 316 people related to livestock nutrition and beef cattle nutritional management in rangelands systems. An estimated 25% of these individuals stated that they would alter their management practices based on the information presented and the potential economic and/or environmental benefits.
* The research programs in University of Wyoming have made selection for well-adapted high performing accessions/lines which resulted in development of cultivars that are suitable for Wyoming and neighboring states. This contributed to the improvement of productivity of local and regional producers and in the long-run, would provide economic benefits.
* Training of graduate and undergraduate students in various techniques associated with grazing livestock nutrition impacts both the current and future generations through applications based scientific data. Specific examples are listed immediately below.
* Though this project Hannah Hamilton developed requisite laboratory skills for nutrition-based studies, including the evaluation of plant-wax markers by gas chromatography, which contributed to her hiring as the manager of the nutrition lab at the University of Nebraska-Lincoln, and her continuation as a Ph.D. student in the Animal Science Department. By preparing Hannah for her staff position, and motivating her additional graduate studies, this project will contribute to expertise within the U.S. in the nutritional and rangeland sciences.
* Through his engagement in this project, Napoleon Vargas Jurado, a Ph.D. student, evaluated new statistical (mathematical) approaches to more robustly estimate diet composition in cattle grazing pastures of varying complexity. His excitement for this endeavor led to his enrolling in a dual animal science and statistics doctoral program at the University of Nebraska-Lincoln. Individuals with strong quantitative and computational skills are in tremendous demand in both academia and industry, and an outcome of this project is contributing to filling that demand.
* With involvement in this project, two students from Oregon State University have continued their involvement with programs that support beef production in extensive environments, one as a Ph.D. student at Oregon State University and one as a post-doc at OSU.
* Undergraduate students receiving training in nutritional and reproductive physiology at the Northern Agricultural Research Center in Havre, Montana have been prepared for graduate school (*n* =2) and veterinary programs (*n* = 1).
* Through a rigorous training program, Alec Kollman, a staff member at the University of Nebraska-Lincoln (UNL), has developed requisite skills to reliably analyze plant-waxes in forage and fecal samples. At least within the U.S., such expertise is rare. As an outcome of this project, Alec and UNL will be able to provide laboratory support to research initiatives using plant-waxes as markers to estimate diet composition and intakes in grazing ruminant livestock.
* Janna Kincheloe completed a PhD in Ruminant Nutrition with a focus on grazing livestock. Upon completion, she was employed by North Dakota State University as an Extension Livestock Specialist at the Hettinger Research Extension Center in southwest North Dakota. Her training equipped her to provide science-based education and advice to livestock producers and conduct applied research to provide answers for producer needs.
* Jameson Brennan is currently being trained as a PhD student with a focus on grazing livestock behavior. As a result of his expertise, he was invited to speak at a grazing behavior in-service training in January 2017.
* Over two days, 26 undergraduate students in the University of Idaho AVS 474 Beef Production class learned how to (1) estimate forage intake on late season rangeland and express maintenance requirements as kilocalories/unit metabolic body weight; (2) account for and calculate body weight loss or gain and partition maintenance requirements gained from stored body fat when losing weight on late season rangeland; (3) predict animal performance with or without protein supplement with nutritional analyses of late season rangeland; and (4) calculate differences in animal performance on late season rangeland with the added impact of lactation. Students who go into production agriculture will be able to refer back to this knowledge base and apply it to beef cattle production on rangeland. Students who go into academia will find these calculations helpful for designing range nutrition experiments and in advising producers.
* This project provided professional development and mentoring opportunities to young scientists and graduate students through:
* 41 graduate students
	+ 5 completed dissertations and theses
* 23 undergraduate research opportunities

**Publications**

**Book Chapters**

Montana State University

Reijo-Pera RA; **Prezotto LD**. 2016. Species-specific variation among mammals. Current Topics in Developmental Biology; 120:401-420.

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**Stephenson, M.** **B.** 2017. *Challenges facing rangelands in western Nebraska*. Panhandle Perspectives News Release. Scottsbluff Star Herald, 4/30/2017

**Stephenson, M. B**. 2017. *Understanding cattle behavior with GPS technology*. Plants, Pots, and Plots, UNL Agron/Hort Newsletter.

**Grant Support (Partial for Reported Grants)**

Oregon State University

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Funding Source** | **Role** | **Date** | **Amount Requested** | **Amount Funded** |
| USDA-ARS | PI; **D. W. Bohnert** | 2017-2020 | $224,000 | $224,000 |
| *Title: Horse Impacts on Sage-Grouse Habitat Structure and Composition on Grazed Rangelands* |
|  |  |  |  |  |
| U.S. Fish & Wildlife Service | Co-PI; D. D. Johnson, V. Schroeder, **D. Bohnert**, J. Dinkins, and C. Boyd | 2017 | $35,603 | $35,603 |
| *Title: Grazing Season of Use Effects on Sagebrush Obligate Avian Habitat* |
|  |
| Oregon Beef Council | Co-PI; B. A. Endress & **D. W. Bohnert** | 2017-2018 | $10,000 | $10,000 |
| *Title: Evaluation of Stubble Height Relationship to Riparian Health and Function* |
|  |  |  |  |  |
| Oregon Department of Fish & Wildlife | PI: A. Svejcar, Oregon State University; Collaborator: **D. W. Bohnert** | 2016-2017 | $161,925 | $161,925 *($16,000 Administered by D. W. Bohnert)* |
| *Title: Seed Delivery Research* |
|  |  |  |  |  |

University of Nebraska-Lincoln

* Lewis, R. M. (project director). 2015, 4-year duration (October 2015 – September 2019). Predicting diet selection and feed intake in cattle in a pasture system. Source: Nebraska Agricultural Experiment Station, Hatch Multistate Research capacity funding, U.S. Department of Agriculture, National Institute of Food and Agriculture (Accession Number 1006754). Amount: $40,000.