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

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

**Period Covered:** 10/01/2014 to 09/30/2015

**Annual Meeting Date (s):** 08/17/2015 to 08/18/2015

**Administrative Advisor’s Authorization Code:**

**Participants:**

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**Students Present:**

Hannah Hamilton, University of Nebraska (Graduate student, hamiltonh1798@gmail.com)

Emily Hilburger, University of Nebraska (Graduate student, ehilburger@huskers.unl.edu)

Colt Knight, University of Arizona (Graduate student, coltwknight@email.arizona.edu)

**Unable to Attend:**

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

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

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

Dale ZoBell, Utah State University (dale.zobell@usu.edu)

**I. Minutes of the Annual Meeting** (held 8/17/15):

**A. Business Meeting** (*Dan Faulkner*, Chair)

Meeting began with election of new Secretary (Ron Lewis, with 2016 meeting in NE) and Secretary-elect (David Bohnert, with 2017 meeting in OR)

**1. Administrative update** (*Brett Hess*)

***Project status.*** The multi-state review committee appreciated the coordination within the group in developing the W-2012 project proposal. As the project moves forward, the team needs to focus on meeting project objectives. The carry-over balance for the project is $14,684.61. NIMSS is being redesigned at Clemson University with greater security and functionality, including clearer identification of scientific staff involvement in project reporting. Timely submission of annual reports is important. An impact statement writer has been hired who will consolidate project impact statements for reporting on the hill. Dr. Catherine Woteki and others react well to such information.

*Discussion:* Challenges in accessing the NIMSS website (www.nimss.org) were raised. Those issues should be redressed with the design effort underway.

***Federal budget.*** On July 16, the draft farm bill was completed followed by budgetary discussions. It is unlikely that a budget will be quickly passed by Congress. In the draft budget, capacity and extension dollars were maintained. President Obama added $100 million to the AFRI line. However, the House reduced and the Senate removed that addition. There likely will no change in the AFRI budget in the upcoming year.

***Forthcoming opportunities.*** A forthcoming funding opportunity is the Foundation for Food and Agriculture Research (FFAR), which is a farm research foundation for agriculture. The program involves an industry-match with government. The underpinning view is that animal agricultural research had been less well funded relative to the plant world, and this effort is to redress that balance by taking advantage of commodity/foundation matching. The priorities of FFAR are listed on their website (<http://www.far.foundation/research-priorities.html>). The FFAR Board has been set-up, and a call for proposals in forthcoming.

*Discussion.* Clarification was sought on the mechanism by which the FFAR Board will advertise the program. That process was still being developed.

**2. Grazing Livestock Nutrition Conference** (*Ken Olson*)

Plans for the upcoming Grazing Livestock Nutrition Conference (GLNC), scheduled for mid-July 2016, in Park City, UT, were discussed.

***Venue and administration.*** The proposed location for the conference is Park City, Utah. There will be considerable support by the American Society of Animal Science (ASAS), including registration and (online) publication of conference proceedings. The organizing committee includes Ken Olson, Joel Caton, Richard Waterman, and Eric Scholljegerdes. It was suggested that the W2012 financial account be used to handle the costs/revenues from the GLNC. It was recommended that the group coordinate invitation of, particularly, any international speakers with ASAS.

***Conference agenda***. A draft agenda for the conference was circulated.

*Discussion.* There was considerable discussion of the content of the GLNC, including possible plenary speakers. Topics raised included: (i) the importance of highlighting key contemporary challenges such as the global demand to double food production by 2050, climate change, and the use and management of public lands; and, (ii) balancing the number and length of talks to allow thorough coverage of each topic yet allow time for questions and discussion by participants (for instance, the idea of holding “bull pen” sessions in the evening focused on different themes raised during the various daytime sessions was suggested). Based on the conversation, Joel Caton agreed to develop and circulate a revised conference agenda, which is summarized below.

***GLNC tentative agenda***

*Sunday evening, July 17, 2016*

## Plenary Session I: Keynote lecture I. Understanding and enhancing the role of grazing livestock in meeting projected human food demands by 2050 (proposed speaker: Joyce Turk (Senior Livestock Advisor, USAID) or Clay Mathis (TAMUCK))

*Monday, July 18, 2016*

* Plenary Session II: Sustainability and efficiency (tentatively five invited talks)
* Plenary Session III (lunch session): Keynote Lecture II. Global sustainability (proposed speaker: Cameron Bruett (JBS); over lunch)
* Plenary Session IV: Energetics in grazing livestock: supply and demand considerations (tentatively five invited talks)

(Conference dinner)

* Plenary Session V: Keynote Lecture III. Legends and living legends: looking back and pressing forward (proposed speaker: Mark Petersen (USDA-ARS, Fort Keogh))

*Tuesday morning, July 19, 2016*

* Plenary Session VI: Genetic adaptation to the environment: can genomics speed up the search for efficient grazers? (tentatively three invited talks)
* Plenary Session VII: Bringing it all together (tentatively two invited talks)

***Posters.*** As part of a poster session, the notion of “invited” posters was introduced. Their aim would be to follow-up topics raised at the last GLNC and to link the upcoming conference to the objectives of W1012/2012.

*Discussion.* Two topics for invited posters were proposed: (i) the new NRC guidelines; and, (ii) the challenges of measuring food intake in grazing environments, highlighting the strengths and weaknesses of using alkanes for such predictions. Like invited talks, it was proposed that invited posters would contribute full papers to the conference proceedings.

**B. Station Reports**

**Montana State University**

*Rachel Endecott*

* Several new people were being hired including sheep and forage extension specialists. A considerable focus in extension work remained on answering questions about hay quality and other fairly routine animal nutritional issues.
* Considered impact of supplementing cattle diets with calcium propionate or rumensin (at 40 g/day). Such supplementation may improve cattle performance, including in rangeland systems, by impacting rumen fermentation and feed digestibility.

*Ligia Prezotto*

* Recently started at Montana State University and was in the process of setting up her lab.
* Interested in evaluating molecular mechanisms within the gastrointestinal and reproductive systems that impact animal growth and milk production, particularly the neural and hormonal controls of these systems. Also plans to concentrate her research on nutritional manipulations during gestation on fetal development (programming) and their impacts on the efficiency of animal performance later in life.

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

* One part of the program considered liver pathogens (pathogenic molecules) and their communication with the gastrointestinal system thereby impacting digestibility. Additionally, has focused on the rumen microbiome (metabolomics), and the relationship between the rumen microflora in the dam and calf performance. Calves are being tubed one week after birth to collect samples. There are some concerns with using oral gavage to collect particulate samples with better approaches being established. There is interest in studying the microbiome in drylot *versus* pasture-based cows. Efforts are use underway to retrofit feedlots to better handle cows.
* In describing Eric Scholljegerdes’ program mentioned his work in three areas: heifer development programs, strategic arginine supplementation, and repletion/depletion of minerals. With depletion of minerals, cattle may lose weight with concordant loss in liver size. This may have more general detrimental impacts on metabolism.

*Discussion.* Were slaughter data available on the mineral depleted cattle? At least currently, no.

* Joint interests in relationships of catecholamines and cortisol on intake. Catecholamines have been shown to impact the microbial population. Have supplemented cattle with different levels of cortisol. At larger doses, intake was reduced substantially. This suggested that impacts of stress confounds intake.

**North Dakota State University** (*Joel Caton*)

* Applied for a USDA Conference grant to support the upcoming 5th Grazing Livestock Nutrition Conference. (Subsequent to the project meeting, funding of conference was confirmed).
* Conducting a series of intake studies differing in grazing intensities: extreme, high, moderate (normal recommendations – 60 to 65% usage) and low. There were 3 pastures per treatment, with no rotation among pastures. Animals were removed from a grazing area once the target forage usage (residual) had been achieved, or due to snowfall. Among the measurement considered were diet composition, fermentation rate, and digestibility. Cannulated animals were being used. The work is an extension of a long term project (25 years), in which the same areas had been grazed although not at different intensities. Animals on the higher intensity grazing were losing weight.

*Discussion.* It was noted that similar outcomes in cattle performance had been observed on other stations with varying long term grazing intensities. Even with moderate grazing intensities, forage regrowth occurred.

**Oregon State University**

*Dave Bohnert*

* One focus of program at the Eastern Oregon Agricultural Research Center (EOARC) is the use of various supplement-types (protein, energy) combined with monensin to enhance utilization of low-quality forages in beef cattle.
* Habitats for fall migratory birds may be impacted by grazing strategies. Management strategies on public lands also need to consider fire history and mitigation. The interplay of grazing strategies on riparian areas is a central part of the research program.
* Other program areas include mineral supplementation, heifer development in pens *versus* pasture, animal movement (using Lotek GPS collars), and the effects of stress resulting from vaccination and/or shipping. Such stressors are known to reduce intake, and their predisposing causes and means for remediation are of interest.
* Described work by Dustin Johnson considering grazing practices following reseeding post-fire. An important question is how long areas should be rested before grazing is allowed. Even with a 2 year rest, cattle may pull plants out of the ground perhaps due to change in soil structure after fire. In addition, considering the impact of predation on cattle stress, and whether it results in longer and not only shorter term consequences.

*Discussion.* What measures were used to evaluate levels of stress? The measurements used included cortisol (blood, saliva), hemoglobin, regularly recorded rectal temperatures and intake.

*Tim DelCurto*

* Described research evaluating different grazing systems. Bunchgrass communities predominate into mountain areas and defining their optimum use remains challenging. Main plants are not tolerant to grazing with usage typically limited to 30-35%. If overgrazed, the deep rooted perennials are replaced with shallower rooted perennials with consequent degradation of the ecosystem. The distribution of cattle grazing therefore needs to be controlled with use of multiple-pasture grazing systems. Forages senesce before the end of the growing season (in 60 *versus* 90 days) due to limited rainfall. The program is considering animal performance when grazed in multiple pastures, including evaluating forage preferences across the grazing season. The relationship of rainfall patterns to herbage composition is also being assessed.
* In forested land on the Hall Ranch (2,200 acre property, which is part of EOARC) the relationship between overstory and understory vegetation is being evaluated. Have sampled 17 habitats, which reflects about 80% of the composition (diversity) of the land area. About 3,000 samples have been collected.
* With funding from Bonneville Power, a 10 year study focused on riparian grazing studies has started. The project is highly multidisciplinary with a large research team. The effort reflects legal pressures on Bonneville Power regarding the impact of hydroelectric power generation on riparian ecosystems. As part of the program, the impacts of grazing *versus* no grazing in such environments will be evaluated. Cattle movement will be monitored using GPS collars, with dietary choices assessed.
* In describing Chad Muellers’ program, focus on cow efficiency. Attributes of an efficient high index cow are being defined as remaining productive through 5-6 years-of-age with 4 lactations (calvings), with a high weight of calves produced relative to cow weight. Looking at time intervals between lactations, and calf growth rates. In collaboration with Washington State University, studying the impact of drought on alfalfa. Drought not only impacts yield but also quality measures. Also, investigating the prevalence of new invasive species in pine forests, which can become predominant in shallow soil sites.

*Discussion.* Are imaging techniques being used to determine botanical composition of diet as reflected in feces? Such work is underway at Washington State University. General consensus that new imaging tools, with automation, may provide a valuable mechanism for predicting diet composition.

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

* As part of AFRI Food Security grant, evaluating consequence of prairie dog densities on forage quality and availability, soil characteristics including nutrient profiles, and on cattle grazing opportunities on reservation land. GPS collars were used to track animal movement and grazing behaviors. Esophageal cannulated cattle were used to monitor dietary choices. Soil and range scientists using results from study to consider ways to recover land with dense prairie dog towns.

*Discussion:* What were the characteristics of the prairie dog town? In the core of colony, bare dirt with some weeds. Outside colony were short clipped grass. Although it impacted the rate of sampling of fistulated animals, cattle eventually ate weedy areas. The weedy material they ate were of higher quality (higher CP, lower NDF). How stocked: based on forage availability or equal? Pastures were stocked relative to prairie dog density, with similar performance levels observed across pastures. In future may stock at fixed level across different prairie dog densities.

* Collaborated in fetal programming study with meat scientists at South Dakota State University. Rather than global nutrient restrictions, looked at protein restrictive (isocaloric) diets fed in mid *versus* late gestation. Calves (progeny) fed using a GrowSafe system (collaboration with Rick Funston). No long terms consequences observed in pregnancy rates or milk production/composition in cows, or in birth weight or vigor, or weaning weight in calves.

**University of Arizona**

*Dan Faulkner*

* Collecting longer term data on growth patterns, fitness, live time productivity on at least 10 daughters of 40 Hereford bulls with genomic data (SNP panels) retained in the herd.
* Considered methods available commercially for geolocation of cattle. One product is Wandering Shepherd from Australia that used a bolus as tool for geo-positioning and at a competitive price.

*Jim Sprinkle*

* Described plans for upcoming program with move to the University of Idaho (UoI). At UoI, every replacement heifer runs through GrowSafe and evaluated for residual food intake (RFI). Plans to evaluate high and low RFI in 2-yr-old cows grazing a common rangeland. Attributes measured will be grazing behavior using relatively inexpensive “homemade” GPS collars (e.g., grazing time, bite rate, distance travelled), forage intake using a pulse-dose alkane procedure, and production efficiency (e.g., cow weight and condition score).

*Colt Knight*

* Described results from dissertation research. Low RFI intake cattle travelled more and used more extreme sites. Collecting fecal samples (DNA) on cattle throughout the grazing season as a means to assess their diet composition. Unsure if methods will delineate genus/species and/or composition. Additionally monitoring botanical composition of rangelands. Will describe construction of low-costs GPS unit as part of tours planned for the next day.

**University of Nebraska-Lincoln**

*Ron Lewis*

* In collaboration with Jerry Volesky at the University of Nebraska-Lincoln (UNL) West Central Research and Extension Center, prescribed cool (C3) and warm (C4) season forages, and the legume, had been sampled at their peak vegetative and dormant states. An additional plant of each type common to NE also was harvested. The *n*-alkane and long-chain alcohol profiles of these plants were evaluated, with variation in these profiles identified between plants, and between vegetative and dormant states of a plant.

*Discussion.* Forage sample collections were being organized at several of the participating stations. It was agreed that such sampling should be delayed until 2016 to allow plants within a growing season to be harvested at both their vegetative and dormant stages.

* Napo Vargas, a Ph.D. student, developed a more precise method for predicting the composition of a forage mixture using a normal compositional model, which involves a Bayesian approaches. With this technique, differences in both the mean and variance of plant-wax markers can be incorporated into predictions. Such is not the case with the typically employed least-squares methodology.
* In collaboration with Harvey Freetly at the U.S. Meat Animal Research Center, an indoor (controlled) and a series of outdoor (smooth brome dominant pastures) studies were conducted with beef heifers to validate the utility of using plant waxes to estimate food intakes and dietary choices. The plant-wax profiles of the feed/forage and fecal samples collected were being analyzed using gas chromatography. The work contributes to M.S. thesis projects of Hannah Hamilton and Emily Hilburger.

*Mitch Stephenson*

* Recently joined UNL Panhandle Research and Extension Center in Scottsbluff as forage specialist.
* Interested in evaluating grazing distribution of cattle in sandhills region including return to and reutilization of grazing areas. Will use GPS collars on herds calving in March and May to monitor grazing behaviors.
* Plans for testing the value of mowing cool season pastures and seeding with warm season plants to produce extra forage.

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

* Summarizing Andy Roberts’ program, considered impact of ad libitum and 20% restrictive feeding during heifer development, including during pregnancy, on their own and on their daughter’s lifetime performance. Concluded that restrictive feeding in utero and in early life had little long term impact on performance, with such cows weaning calves at similar body weights those not restricted.
* Summarizing collaborative work with Tom Geary, evaluated flow cytometry as a means to augment bull fertility/soundness testing. A focus is on the consequence of mineral restriction/deficiency on spermatogenesis. There was no clear impact in mature bulls but may be of more consequence in young bulls.
* A focus of own program was changes in the mineral content (salinity) in water sources relative to season and year, which was of particular interest to producers wishing to monitor water quality.

**C. Project Overview** (*Shanna Ivey*)

**Objective 1**

* Committee membership was discussed. Currently there is no member from CO, and perhaps a member should be sought from that state. Jim Sprinkle asked to be added to this objective for ID.
* Eric Scholljegerdes developed a common data sheet to be used to characterize the forage samples collected at the individual stations. Shanna Ivey and Eric would develop and circulate data recording form and SOP. (Subsequent to the project meeting, such materials were completed and circulated to project participants. The form is included as Appendix I.)
* If a limited number of labs were to develop the expertise in conducting *n*-alkane analyses, there was a need to identify those specific labs and a costing structure for conducting the analyses. (Subsequent to the formal meeting, Hannah Hamilton calculated the cost for determining the *n*-alkane profile of a sample in the lab at the University of Nebraska-Lincoln. Including consumables and lab technician time, but not equipment set-up/purchase, the approximate cost was $32 per sample.)
* The possibility of using project funds to support the costs of lab analyses was raised. A possible approach would be to contact experiment station directors for additional funds to support project efforts, although seeking supplementary funds should likely should be restricted to either the Grazing Livestock Nutrition Conference or the lab analyses but not both.
* In certain states, some of plants chosen for sampling (e.g., certain C4) may not be readily available. It was agreed that flexibility may well be needed to address the pasture and/or rangeland characteristics of individual states.
* Joel Caton suggested that as a collaborative effort the possible use of automated imaging techniques to histologically delineate plant components in fecal samples could be explored as another method to predict dietary choices.

**Objective 2**

* Dan Faulkner noted that heifer development was a consistent theme across stations. He suggested that common procedures be established across states for evaluating heifer development programs.

**E. Other Business**

**Project report**

* Project members will need to prepare their individual station reports focusing on project objectives, impacts and outcomes. Ron Lewis will then prepare Minutes from the meeting, and combine the station reports into a project report to send to Bret Hess for further editing and submission.
* Dan Faulkner and Shanna Ivey will provide Ron with the instructions and a copy of the previous year’s report as guidelines to follow.

**Project meeting in 2016**

* Ron Lewis and Mitch Stephenson will plan the project meeting for 2016 in NE.
* Dave Bohnert will take on the role of project secretary at that meeting.

Meeting adjourned: 4:52 p.m.

**D. 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 during the 2016 grazing season. 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** (*Eric* *Scholljegerdes)*

* Field sampling had commenced on forages.

**Oregon State University** *(David Bohnert & Tim DelCurto)*

* Oregon State University’s contribution will be completed in 2016.

**University of Missouri** (*Allison Meyer*)

* Tall fescue samples (stockpiled fall growth, November-March) had been collected.

**University of Nebraska-Lincoln** (*Ron Lewis*)

* Laboratory protocols were developed and implemented at the University of Nebraska-Lincoln to ensure reliable assessment of plant waxes (*n*-alkanes, long-chain alcohols) of forage 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.
* Cool and warm season grasses, and legumes, were sampled at their peak vegetative and dormant states in the central region of NE, which is typified by mixedgrass prarie and sandhills. Beyond the forages to be collected at all stations, needle-and-thread (C3), little bluestem (C4) and lead plant (legume) also were sampled. The *n*-alkane and long-chain alcohol contents of the forages were evaluated with variation among plants, and within plant based on their phenological status (maturity), were identified.

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

* Steps made to collect samples early next year.

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

**New Mexico State University**

*Shanna Ivey*

* Invited speaker International Conference on Algal Biomass", San Diego CA., Presented an invited talk dealing with the use of lipid extracted algae in production animal diets.

*Eric Scholljegerdes*

* Invited Speaker, NMSU, (2 presentations) Cattle and wildlife interactions; Cow/Calf nutrition, Clayton Livestock Research Center Field Day, September, 2015 (80 ranchers and feedlot operators, and industry).
* Invited Speaker, Applied Reproductive Strategies in Beef Cattle, Nutritional management of heifers during drought, Davis CA, August, 2015. (220 attendees).
* Invited Speaker, NMSU, Corona Range and Livestock, Beyond the Roundtable Symposium, Cow/Calf Nutrition, August, 2015 (48 ranchers and land managers).
* Invited Speaker, NMSU, Corona Range and Livestock, Beyond the Roundtable Symposium, Ruminant Nutrition, July, 2015 (50 ranchers and land managers).
* US Beef Academy, (3 presentations) Structure and function of the ruminant digestive system; Feeding and supplementing for reproduction; Body condition Scoring, July, 2015. (8 high school students).
* Invited speaker, New Mexico Youth Ranch Camp, Range cow nutrition, June, 2015 (30 high school students).
* Invited Speaker, NM Indian Livestock Days, Goat nutrition, health, and management. May, 2015. (120 ranchers and land managers).
* Invited Speaker, Zinpro Corporation, Influence of trace mineral level and source on cattle performance and mineral status. February, 2015. (5 attendees).

**North Dakota State University** *(Joel Caton)*

* Functioned as a member of the Grazing Livestock Nutrition Conference (GLNC) organizing committee and assisted with development of the GLNC program to be presented at the GLNC symposium in the summer of 2016 (collaborative effort across stations).
* Secured USDA competitive conference grant funding in support of the GLNC (collaborative effort across stations).

**Oregon State University***(David Bohnert & Tim DelCurto)*

* Evaluated the influence of supplement type and monensin addition on utilization of low-quality, cool-season forage by beef cattle. A digestibility/ruminal fermentation study and a cow performance study have been completed. Samples/data are currently being analyzed.
* Physiological responses associated with beef cows supplemented with protein infrequently were evaluated. Decreasing frequency of protein supplementation did not reduce uterine flushing pH or plasma P4 concentrations, which are known to impact reproduction in beef cows.
* Beef cow supplemented during late gestation with organic or inorganic Co, Cu, Zn, and Mn increased concentrations of these trace minerals in the placental cotyledon as well as maternal and newborn calf liver. However, calf body weight (BW) and calf value upon weaning and following a 45-d preconditioning were only increased when late-gestating cows were supplemented with an organic source of Co, Cu, Zn, and Mn.
* In two experiments, low-quality cool-season forages were supplemented based on protein or energy ingredients. The influence of supplement composition on ruminal forage disappearance, performance, and physiological responses of Angus × Hereford cattle were evaluated. The cattle equally used and benefitted, in terms of forage digestibility, performance and physiological parameters, from supplements based on protein or energy ingredients provided as 0.5% of BW/d at isocaloric and isonitrogenous rates.
* Knapweed hay was tested as a nutritional supplement for beef cows fed low-quality forage. Russian knapweed is comparable to alfalfa as a protein supplement for beef cows consuming low-quality forage. Using Russian knapweed as a nutritional supplement can help solve two major production problems: managing an invasive weed and providing a feedstuff that reduces an impediment in livestock production systems.
* Influence of supplement composition on intake and digestibility of a low-quality (< 6% CP), cool-season forage, as well as on cow performance, was evaluated in two studies. Results suggest that a corn-urea based supplement can be utilized as effectively as soybean meal by ruminants consuming low-quality, cool-season forages as long as the 2 supplements provide comparable intake of CP and energy.
* Influence of cattle grazing on forested rangelands with respect to climate change and vegetation change models were evaluated. This long term study was recently completed and looked at the impact of domestic cattle grazing and wild herbivores (deer and elk) on vegetation change with two scenarios of climate change. This effort has led to a predictive model that can be used by forest managers/researchers in evaluating the long-term impact of herbivores in the rangeland ecosystem. In addition, this information may provide valuable information about using domestic cattle to manage fuels on the landscape and, as a result, be used to mitigate against large catastrophic wildfires.
* A model was developed to predict beef cattle distribution and use on mixed-conifer forested rangelands, which will help forest service land managers as well as beef cattle producers in the western U.S. predict beef cattle distribution and use on large allotment pastures. Model will use precipitation and temperature to predict beef cattle distribution patterns, habitat selection and use on diverse forested rangelands.
* The composition and quality of diet across season of use was determined in beef cattle. Dominant bunchgrass vegetation in the Great Basin and Intermountain West contain cool season forages that are not particularly tolerant of defoliation. As a result, most land managers are encouraged to rotate season of use to avoid grazing during the growing season every year. These ongoing projects look at how diet composition and diet quality change as a function of season of use. Results of this research seem to confirm the value of deferred rotation systems for sustainable use of the forage base and help livestock managers define when supplemental nutrition is needed based on forage quality estimates.
* Influence of cattle grazing on riparian areas and the use of riparian vegetation within riparian areas were assessed. Riparian areas are focal points of range management and become the focus of conflict when the streams contain threatened and endangered fish species. This research is designed to evaluate beef cattle management strategies to reduce the impact on riparian vegetation and, as a result, maintain or enhance vegetation necessary for optimal riparian structure and function. This research has evaluated beef cattle diets in riparian pastures, season of use impacts on cattle diets, and management strategies to reduce beef cattle impacts.
* Presentations included: “Nutritional Management Strategies for Efficient Beef Production in Rangeland Environments” at the Malheur County Cattlemen’s Meeting, Ontario, OR (February 11, 2015; approximately 120 participants); “Supplementation of Beef Cattle on Pasture” at the Oregon Forage and Grasslands Council Spring Conference, Corvallis, OR (March 14, 2015; approximately 50 participants).

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

* Conducted beefSD, an educational program for beginning cow-calf producers in South Dakota. It is a 2-yr program with an intensive curriculum that includes classroom instruction, case studies of established, successful ranches to evaluate alternative beef cattle production systems, mentoring by established ranchers and other agriculture professionals, post-weaning calf performance evaluation of participant’s cattle, travel study trips to visit other sectors and aspects of the US beef cattle industry, and interactive web-based learning, including webinars, podcasts, a managed forum, and computer apps. We will finish the 2nd class of participants in October 2015, with 16 participants completed the curriculum.
* Collaborated in the Range Beef Cow Symposium (RBCS) is a jointly sponsored program by Colorado State University, University of Wyoming, University of Nebraska, and South Dakota State University. It is held biennially in odd years with the next symposium to be held November 17-19, 2015 at Loveland, Colorado. Participant registration has exceeded 700 at past RBCS.
* Conducted the South Dakota Grazing School, an annual 2½-day workshop held in September each year. Thirty-three participants completed the 2015 Grazing School.

**University of Arizona**

*Dan Faulkner*

* Conducted two range cow nutrition workshops focused on improving range cow reproduction. Ninety-five individuals participated, representing 25% of the cows in AZ. Survey results indicated that over 80% would implement recommendations which could result in a 10% improvement in reproduction and $100 per cow represented (total = $500,000).
* Collecting longer term data on growth patterns, fitness, live time productivity on at least 10 daughters of 40 Hereford bulls with genomic data (SNP panels) retained in the herd.

*Jim Sprinkle*

* With Extension Committee of Western Section, American Society of Animal Science, convened a regional Extension Symposium on *Value of Low Stress Livestock Handling in Livestock Production Practices* for 125 clientele, Extension agents and specialists, and scientists from across the West at Ruidoso, NM. Collaborators included faculty, practitioners, industry sponsors, and scientists from New Mexico, Idaho, Colorado, Montana, South Dakota, and Texas.
* Presented an invited talk to the winter meeting of the Arizona Section, Society for Range Management on *Change on the Range: People, Places and Perspectives* at Tucson, AZ to 100 people from a broad representation of managers and ranchers in Arizona.
* Organized a workshop and a follow up training on *Using VGS Range Monitoring Database Software to Help Develop Proposed Actions for NEPA* to range managers and grazing permit holders from all ranger districts on the Tonto National Forest in central Arizona. Attendance at both workshops was 55 people and participants learned how to use software with field tablets for collecting and generating reports for grazing management.
* As part of a NOAA grant team led by Mitch McClaran at the University of Arizona, helped with implementation of a co-development process between agency employees and grazing permit holders (including two participatory workshops; 30 people each time) on the Tonto National Forest related to improving livestock management during drought. This is a two year project that has both regional and local support from the US Forest Service and the Gila County Cattle Growers.

**University of Missouri** (*Allison Meyer*)

Producer/Allied industry presentations

* Meyer, A. M. 2015. Cow nutritional management after a wet summer. Presented at the Thompson Research Center Field Day in Spickard, MO. September 2014. (80 producers and students in attendance)
* Meyer, A. M. 2015. Supplementing low quality forages. Presented at Kent Nutrition Group Dealer Training Meeting in Columbia, MO. August 2015. (40 sales staff in attendance)
* Meyer, A. M. 2015. Role of gestational nutrition in fetal development. Presented at the Merial Veterinarian and Client Meeting in Columbia, MO. February 2015. (40 veterinarians and sales staff in attendance)
* Meyer, A. M. 2015. Role of nutrition during pregnancy on calf performance. Presented at the Santa Fe Agri-Leaders Meeting in Alma, MO. January 2015. (15 producers in attendance)

Contributed to popular press producer articles

* “Stockpiled fescue beats bad hay for cows” by Duane Dailey, run in Missouri Ruralist (Farm Progress): results of late pregnancy nutritional management study currently on-going in our lab.
* “Momma matters: Cowherd care impacts calves and their future calves” by Miranda Reiman (Certified Angus Beef), run in Feedlot Magazine, Western Farmer-Stockman, Agri-view, yourcattle.com, and others.
* “Maintaining Nutrition” by Gary Digiuseppe, run in Ozark Farm and Neighbor.

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

Research

* Demand for new and suitable plant materials is a long-term issue and is increasing continuously especially in the Intermountain West regions. 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 - 2014 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.

Extension

* Islam, M.A. 2014. WERA 1014 Regional Project Report: On-going/Completed Research. University Inn, Utah State University, October 27-28 2014. Logan, UT.
* Islam, M.A. 2014. Grass-Legume Mixtures. Tear Down the Walls Annual Meeting at Western Nebraska Community College, August 13-14 2014. Sidney, NE.
* Islam, M.A. 2014. Wyoming NCCC-31 Report-Ecophysiological Aspects of Forage Management. Kellogg Biological Station, June 17-19 2014. Hickory Corners, MI.
* Islam, M.A. 2014. Wyoming Chapter Gamma Sigma Delta. GSD Conclave at University of Nebraska-Lincoln, June 2-4 2014. Lincoln, NE.
* Islam, M.A. 2014. Annual Forages: Species, Varieties, and Importance. Wyoming Beef Production Convention, November 18, 2014. Torrington, WY.
* Islam, M.A. 2014. Forage Crop Trials in Wyoming. LREC Field Day, August 28, 2014. Laramie, WY.
* Islam, M.A. 2014. Roundup Ready Alfalfa and Forage Trials: An Update. SAREC Field Day, August 21, 2014. Lingle, WY.
* Islam, M.A. 2014. Economics of Tall Fescue Forage and Seed Production. PREC Field Day, July 17, 2014. Powell, WY.
* Islam, M.A. 2014. Forage Establishment: Factors to Consider. Wyoming Forage Field Day, July 10, 2014. Eden Valley Community Center, Farson, WY.
* Islam, M.A. 2014. Grass-Legume Mixtures and Grass Hay Production Studies. ShREC Field Day, June 14, 2014. Sheridan, WY.
* Islam, M.A. 2014. Forage Variety Selection. Master Hay Grower, February 3, 2014. Agriculture Resource and Learning Center, Casper, WY.
* Islam, M.A. 2014. Forage Crops Under Irrigation in Wyoming. Cattleman’s Update, February 3, 2014. Albany County Fairgrounds, Laramie, WY.
* Islam, M.A. 2014. Nutrient Management in Forage Crops. 2014 Wyoming Certification Rendezvous, January 22, 2014. Casper, WY.

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

**New Mexico State University**

*Shanna Ivey*

Graduate students (Advised and completed since last report)

* Katelin Marchetti, MS. Quorum sensing by ruminal bacteria on differing sources of carbohydrate

Undergraduate projects

* Anna Garza, Howard Hughes Medical Institute Undergraduate Researcher. Quorum sensing by ruminal bacteria on differing sources of carbohydrate

*Eric Scholljegerdes*

Graduate Students (Advised and completed since last report)

* Margaret Garcia, M.S., *Effects of supplemental trace mineral level and source on liver and serum trace mineral concentrations, health, and performance of newly received calves from New Mexico ranches.*
* Colleen Buck, M.S., *Effects of ad libitum supplement containing increasing levels of microalgae Scenedesmus sp., on site and extent of digestion and evaluation of microbial diversity in the rumen of beef heifers consuming a forage based diet.*
* Whitney Stewart, Ph.D., *Utilization of ground juniper in small ruminant livestock diets.* (Collaborative program between Texas A&M AgriLife Research Station, San Angelo, TX and Dr. Travis Whitney)
* Leah Schmitz, M. S., *Replacement heifer development: alternative management strategies that impact heifer productivity.*
* Clayton Gardner, M.S., *Effects of rumen protected arginine on livestock performance.*
* James Graves, M.S., *Relationship of serum antibody titers to the bovine respiratory disease complex and feedlot morbidity and performance.*

Undergraduate student projects

* Nicole Rodriguez, USDA-HSI Leaders grant, Undergraduate Research Program, Project title: *Effects of supplemental microalgae, Scenedesmus Sp., on ruminal fatty acid metabolism.*
* Brandon Meyerhoff, Howard Hughes Medical Institute, Undergraduate Research Program, Project title: *Development of a novel rumen protected dextrose*.

**North Dakota State University** *(Joel Caton)*

* Co-advising a M.S. student with Dr. Bryan Neville at the Central Grasslands Research and Extension Center (CGREC).
* Mentored a M.S. student during her program and coached on Grant writing and successful securing of grant funds to support portions of her M.S. project at CGREC.

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

* Advised 2 Ph.D. students, Janna Kincheloe and Megan Webb, and three undergraduate interns, Kelsey Ducheneaux, Cady Olson and Andrea Collins, on project areas related to W2012.

**University of Arizona**

*Dan Faulkner*

* Colt Knight participated in the W2012 committee meeting. He gave a presentation on making GPS collars for cows, which relates to his dissertation research entitled *The Influence of Cow Intake on Grazing Behavior and Performance*.

*Jim Sprinkle*

* Member of graduate committee for a Ph. D. student (Colt Knight) from the University of Arizona School of Animal and Comparative Biomedical Sciences who has been doing range cow research related to the work of W2012.
* Assisted Dan Faulkner and Doug Tolleson of Arizona in hosting the field tour for the W2012 summer meeting. Demonstrated the solar powered data acquisition equipment we developed at the University of Arizona to determine individual mineral intake by range cows in a rangeland environment.

**University of Missouri** (*Allison Meyer*)

Graduate students

* Katlyn Neiderecker, M.S. completed August 2015, Thesis title: Impacts of late gestational tall fescue forage systems on preweaning calves
* Jill Larson, M.S. currently underway, Thesis topic: Metabolic changes in late pregnant cows and neonatal calves
* Natalie Duncan, M.S. currently underway, Thesis topic: Nutrition during pregnancy in ruminants
* Samantha Bolen, M.S. currently underway, Thesis topic: Nutritional management of late gestation cows in the Fescue Belt

Undergraduate research

* Ashton Smith, B.S. completed December 2014, Undergraduate research project: Effects of maternal energy source on small intestinal proliferation of the late gestation ewe and fetal lamb
* Kimberly Pearl, B.S. currently underway, Undergraduate research project: Changes in circulating metabolites during first 72 hours in neonatal beef calves
* Garth Gatson, B.S. currently underway, Undergraduate research project: Impacts of drought during the preweaning period on feedlot performance and carcass characteristics

Other undergraduate students involved in research

* Kenneth Roberts
* David Clizer
* Abigail Rathert
* Michael York
* Conner Locke
* Laura Wente
* Taylor Forsythe

**University of Nebraska-Lincoln** (*Ron Lewis*)

* In a collaboration with the Statistics Department at the University of Nebraska-Lincoln, Napoleón Vargas Jurado, a Ph.D. student, gained skills to develop computational methods (based on a normal compositional model under Bayesian inference) to more reliably predict dietary choices in free-grazing herbivores using plant wax markers. As an outcome, he presented his initial results as an oral presentation at the 2015 Joint Annual Meeting of the American Dairy Science Association and American Society of Animal Science in Orlando, Florida.
* In a collaboration with the U.S. Meat Animal Research Center, Hannah Hamilton and Emily Hilburger, both M.S. students, and Ashley Buescher, an undergraduate student, were involved in the design and conduct of a series of experiments to test the utility of using plant wax markers to predict dietary choices and intakes in cattle in controlled (pen) and in grazing conditions. Beyond field work, this effort has involved their training in experimental design and in the requisite laboratory skills (e.g., gas chromatography) to analyze the samples collected.
* Hannah Hamilton and Emily Hilburger participated in the annual multi-state project meeting.

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

Three students (one Ph.D. and 2 M.S.) graduated from forage agronomy programs:

* Dhruba Dhakal, Ph.D., Agronomy, Department of Plant Sciences, University of Wyoming. Spring 2015. Forage Grass-legume Mixture for Improved Forage Yield, Forage Quality, Stand Persistence, Soil Properties, and Economics.
* Albert Adjesiwor, M.S., Agronomy, Department of Plant Sciences, University of Wyoming. Spring 2015. Profitability and environmental benefits of irrigated grass-legume mixtures in comparison with synthetic fertilizer use in Wyoming.
* Parmeshwor Aryal, M.S., Agronomy, Department of Plant Sciences, University of Wyoming. Spring 2015. Potential of Forage Kochia to Establish and Improve Degraded Areas of Wyoming.

**E. Accomplishments and Impacts**

**1. Accomplishments**

***Objective 1***

* A key factor for predicting feed intakes and diet choices of grazing ruminant animals in the Western United States is assessing variation across space and time in the *n*-alkane composition of unique classes of forages common across this region. Protocols for collecting and storing forage samples on cool (C3) and warm (C4) plants, and on legumes, were agreed. Where possible, environmental measures (e.g., elevation; soil description; precipitation) corresponding with the plant sampling will be recorded.
* Across-lab consistency in measurement of the *n*-alkane contents of samples, both plant and fecal, is central to the reliability and general applicability of the plant-wax marker methodology. Protocols were shared, and defined mixtures of forages had been distributed for a ‘blind’ across-lab validation study. The laboratory analyses of those samples were still underway but an outcome of that effort will be establishment of consistent procedures for routine evaluation of *n*-alkanes among a network of labs.

***Objective 2***

* The agenda and tentative speakers for the 5th Grazing Livestock Nutrition Conference (GLNC) were determined. The conference will be held in Park City, UT, in July 2016. The meeting will be held in conjunction with ASAS-ADSA-CSAS-WSASAS Joint Animal Meeting (JAM) 2016. A USDA Conference proposal had been submitted to facilitate hosting the GLNC. (Subsequent to the project meeting, notification from USDA of the success of the Conference proposal was received).

***Objective 3***

* Through engagement of 36 graduate and 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 38 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.

**2. Impacts**

***Objective 1***

* Established protocols for collecting and storing forage samples across-stations, agreeing a common format for recording plant phenology and concordant environmental descriptors.
* Determined a consistent process for assessing the *n*-alkane profile of plants, and agreed that a subset of labs develop expertise for conducting those analyses.

***Objective 2***

* Developed a collaborative plan for 5th Grazing Livestock Nutrition Conference and secured USDA competitive conference grant funding to support that conference
* Promoted the broad exchange of ideas, information and data to promote advancements in nutritional technologies though:
  + 27 referred journal articles;
  + 38 abstracts and conference proceedings;
  + 7 book chapters;
  + 33 extension publications; and,
  + 12 popular press articles.

***Objective 3***

* Provided professional development and mentoring opportunities to young scientists and graduate students through
* 23 graduate student mentees, with 8 completed dissertations and theses during the reporting period; and,
* 13 undergraduate research opportunities.
* Provided outreach and training to nearly 2,000 ranchers and other industry professionals, including 38 high school students, through regional and state extension meetings and short-courses.

**F. Publications**

**1. Referred Journals**

***New Mexico State University***

*Shanna Ivey*

* Anderson, D. M., R. E. Estell, J. Holechek, S. L. Ivey, and G. Smith. 2014. Virtual Herding for Flexible Livestock Management – a Review. Rangeland J. 36:205-221. http://www.publish.csiro.au/paper/RJ13092.htm
* Ivey, S., P. H. Sanchez, L. N. Tracey, and M. K. Petersen. 2014. Propionibacterium acidipropionici P169 and glucogenic precursors improve rumen fermentation of low-quality forage in beef cattle. Journal of Animal Science, 4, 1738-1746.,
* Ivey, S. L., Tracey, L. N., Salazar, A., et al. 2014. Ruminant nutrition symposium: The utility of lipid extracted algae as a protein source in forage or starch-based ruminant diets. J. Anim. Sci. 92:1331-1342.

*Eric Scholljegerdes*

* Kronberg, S. L., E. J. Scholljegerdes, R. J. Maddock, G. Barcelo-Coblijn, and E. J. Murphy. 2015. Lean ground beef as a potentially significant and popular source of n-3 fatty acids for many people. Lipids (Submitted)
* Scholljegerdes, E. J., L. A. Lekatz, and K. A. Vonnahme. 2014. Effects of short-term oilseed supplementation on plasma fatty acid composition, progesterone, and prostaglandin F metabolite in lactating beef cows. Animal 7: 777-785.
* Stewart, W. C., T. R. Whitney, E. J. Scholljegerdes, R. P. Adams, H. D. Naumann, N. M Cherry, K. D. Welch, and D. R. Gardner. 2014. Effects of *Juniperus* species and stage of maturity on nutritional, in vitro digestibility, and plant secondary compound characteristics J. Anim. Sci. 93:4034-4047.
* Van Emon, M. L., A. F. Schultz, P. J. Gunn, M. K. Neary, R. P. Lemenager, E. J. Scholljegerdes, and S. L. Lake. 2015. Effects of added dietary protein and fat on subcutaneous adipose tissue and longissimus muscle fatty acid profiles of finishing lambs when fed differing levels of dried distillers grains with solubles. Sheep and Goat Res. 29: (In Revision).

***Oregon State University*** *(David Bohnert & Tim DelCurto)*

* Bohnert, D. W., R. L. Sheley, S. J. Falck, and A. A. Nyman. 2014. Knapweed as a nutritional supplement for beef cows fed low-quality forage. Rangeland Ecol. Manage 67:219-223.
* Cappellozza, B. I., R. F. Cooke, T. A. Guarnieri Filho, and D. W. Bohnert. 2014. Supplementation based on protein or energy ingredients to beef cattle consuming low-quality cool-season forages: I. Forage disappearance parameters in rumen-fistulated steers and physiological responses in pregnant heifers. J. Anim. Sci. 92:2716-2724.
* Cappellozza, B. I., R. F. Cooke, M. M. Reis, R. S. Marques, T. A. Guarnieri Filho, G. A. Perry, D. B. Jump. K A. Lytle, and D. W. Bohnert. 2015. Effects of protein supplementation frequency on physiological responses associated with reproduction in beef cows. J. Anim. Sci. 93:386-394.
* Cappellozza, B. I., R. F. Cooke, M. M. Reis, P. Moriel, D. H. Keisler, and D. W. Bohnert. 2014. Supplementation based on protein or energy ingredients to beef cattle consuming low-quality cool-season forages: II. Performance, reproductive, and metabolic responses of replacement heifers. J. Anim. Sci. 92:2725-2734.
* Darambazar, E., T. DelCurto, and D. Damiran. 2014. The Influence of Cow Age on Botanical Composition of Diets in Mountain Riparian Areas in Eastern Oregon of United States. Sustainable Agriculture Research. 3:1-9.
* Peterson, M. K., C. J. Mueller, J. T. Mulliniks, A. J. Roberts, T. DelCurto, and R. C. Waterman. 2014. Potential limitations of NRC in predicting energetic requirements of beef females within western U.S. grazing systems. J. Anim. Sci. 92:2800-2808.
* Riggs, R. A., R. E. Keane, M. Cimon, R. Cook, L. Holsinger, J. Cook, T. DelCurto, L. S. Baggett, D. Justice, D. Powell, M. Vavra, B. Naylor. 2015. Biomass and fire dynamics in a temperate forest-grassland mosaic: Integrating multi-species herbivory, climate, and fire with the FireBGGv2/GrazeBGC system. Ecological Modelling. 296:57-78.
* Roever, C. L., T. DelCurto, M. Rowland, M. Vavra and M. Wisdom. 2015. Cattle grazing in semiarid forestlands: Habitat selection during periods of drought. J. Anim. Sci. 93: 3212-3225.
* Roever, C. L., M. Wisdom, M. Rowland, M. Vavra, and T. DelCurto. 2015. Integrating temporal dynamics in habitat selection models. Ecological Modelling. Submitted
* Vavra, M., T. DelCurto, N. Rimbey, and R. Kay. 2015. Ecological impacts of season of use on Sagebrush-Steppe Grasslands. J. Rangeland Applications. (In press).

***University of Arizona*** *(Jim Sprinkle)*

* Bernau, C. R., J. Sprinkle, R. Tanner, J. A. Kava, C. Thiel, V. Prileson, and D. Tolleson. 2014. Twenty years after the Dude Fire: Targeted cattle grazing of weeping lovegrass through the use of protein supplementation. Rangelands 36:15-21.
* Chapple W. P., M. J. Cecava, D. B. Faulkner and T. L. Felix. **2015. Effects of feeding processed corn stover and distillers grains on growth performance and metabolism of beef cattle.** J. Anim. Sci. 93:4002-4011.
* Wilson T. B., A. R. Schroeder, F. A. Ireland, D. B. Faulkner and D. W. Shike. **2015. Effects of late gestation distillers grains supplementation on fall-calving beef cow performance and steer calf growth and carcass characteristics. J**. Anim. Sci. (in press).

***University of Nebraska-Lincoln*** *(Ron Lewis)*

* Vargas Jurado, N., A. E. Tanner, S. R. Blevins, H. M. McNair, R. W. Mayes, and R. M. Lewis. 2015. Long-chain alcohols did not improve predictions of the composition of fescue and red clover mixtures over n-alkanes alone. Grass Forage Sci. 70:499-506.
* Vargas Jurado, N., A. E. Tanner, S. R. Blevins, J. Rich, R. W. Mayes, D. Fiske, W. S. Swecker, Jr., and R. M. Lewis. 2015. Feed intake and diet selection in Angus-cross heifers of two frame sizes at two stages of growth. J. Anim. Sci. 93:1565–1572.

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

* Johnson, P. S., R. N. Gates, H. H. Patterson, M. Hubert, D. Landblom, K. C. Olson, J. J. Kincheloe, H. A. Richter, and A. V. Grove. 2015. Early weaning reduces rangeland herbage disappearance. Forage and Grazinglands (in press).
* Kincheloe, J. J., L. G. Wood, D. R. Zobell, and K. C. Olson. 2014. Influence of monensin fed with a starch-based energy supplement on forage digestibility and intake by range cows during drought. Prof. Anim. Sci. 30:444-450. doi: 10.15232/pas.2013-01303.

**University of Missouri** (Allison Meyer)

* Meyer, A. M. and P. J. Gunn. 2015. BEEF SPECIES SYMPOSIUM: Making more but using less: The future of the U.S. beef industry with a reduced cow herd and the challenge to feed the United States and world. J. Anim. Sci. 93:4223-4226.
* Vonnahme, K. A., C. O. Lemley, J. S. Caton, and A. M. Meyer. 2015. Impacts of maternal nutrition on vascularity of nutrient transferring tissues during gestation and lactation. Nutrients. 7:3497-3523. (Invited review)
* Meyer, A. M., R. A. Vraspir, M. J. Ellison, and K. M. Cammack. 2015. The relationship of residual feed intake and visceral organ size in growing lambs fed a concentrate- or forage-based diet. Livest. Sci. 176:85-90.

**2. Abstracts and Proceedings**

***New Mexico State University*** *(Shanna Ivey & Eric Scholljegerdes)*

* Garcia, M. E., E. Oosthuysen, J. R. Graves, M. E. Hubbert, M. E. Branine, C. A. Löest, and E. J. Scholljegerdes. 2014. The effect of mineral source and level on growth performance of newly-received feedlot cattle. Plains Nutrition Conf. San Antonio, April 10th, 2014.
* Garcia, M. E., E. R. Oosthuysen, M. E. Hubbert, M. E. Branine, C. K. Larson, C. A. Löest, and E. J. Scholljegerdes. 2015. Assessment of supplemental trace mineral level and source on liver and serum mineral concentrations after feeding cattle a diet deficient in trace minerals. Proc. West. Sec. Am. Soc. Anim. Sci. 66:235-239.
* Glasscock, J. L., T. R. Whitney, J. R. Roper, A. R. Holmes, S. G. mars, N. M. Cherry, J. P. Muir, W. C. Stewart, and E. J. Scholljegerdes. 2015. Effects of using ground woody plants in kid goat feedlot diets on growth performance. Proc. West. Sec. Am. Soc. Anim. Sci. 66:204-212.
* Kronberg, S. L., and E. J. Scholljegerdes. 2015. In vitro evaluation of a treatment to flaxseed for reducing biohydrogenation of the n-3 fatty acid alpha-linolenic acid. J. Anim. Sci. (Suppl. 1): (Abstr.).
* Marchetti, K. H., A. Garza, E. J. Scholljegerdes, and S. L. Lodge-Ivey. 2015. Effects of supplementation of acyl-homoserine lactones on in vitro true digestibility of a forage diet. Proc. West. Sec. Am. Soc. Anim. Sci. 66:5-9.
* Morgan, T. D., A. L. Salazar, E. J. Scholljegerdes, C. A. Löest, L. M. White, F. R. Melgar, S. A. Soto-Navarro, and S. L. Ivey. 2015. Comparison of titanium dioxide vs. Chromic oxide as an external marker t estimate fecal output in horses. Proc. West. Sec. Am. Soc. Anim. Sci. 66:85-87.
* Owensby, L. R., L. M. White, B. Housewright, E. J. Scholljegerdes and K. W. Walter. 2015. Effects of arginine supplementation in adult exercising horses on heart rate and blood metabolites. Proc. West. Sec. Am. Soc. Anim. Sci. 66:277-281.
* Scholljegerdes, E. J. 2015. Drought: Devastating natural event or a wake-up call for better cattle management. Applied Reproductive Strategies Meeting. Pp. 157-171.
* Smythe, B. G., M. E. Wise, E. J. Scholljegerdes, and M. Fletcher. 2015. Performance of beef cattle as influenced by controlled and uncontrolled opulations of horn flies (*Diptera Muscidae*). Proc. West. Sec. Am. Soc. Anim. Sci. 66:72-76.
* Stewart, W. C., T. R. Whitney, E. J. Scholljegerdes, D. M. Hallford, S. A. Soto-Navarro, and H. D. Naumann. 2015. Effects of feeding ground juniper to gestationg ewes on pre- and psotartum ewe performance, serum metabolites, and progeny preweaning performance. Proc. West. Sec. Am. Soc. Anim. Sci. 66:10-16.

***Oregon State University*** *(David Bohnert & Tim DelCurto)*

* Cappellozza, B. I., R. F. Cooke, M. M. Reis, P. Moriel, D. H. Keisler, and D. W. Bohnert. 2014. Supplementation based on protein or energy ingredients to beef cattle consuming low-quality cool-season forages: I. Performance, reproductive, and metabolic responses of replacement heifers. Proc. West. Sec. Am. Soc. Anim. Sci. 65:30.34.
* Cappellozza, B. I., R. F. Cooke, T. Guarnieri Filho, and D. W. Bohnert. 2014. Supplementation based on protein or energy ingredients to beef cattle consuming low-quality cool-season forages: II. Forage disappearance parameters in rumen-fistulated steers and physiological responses in pregnant heifers. Proc. West. Sec. Am. Soc. Anim. Sci. 65:141-145.
* Marques, R., R. Cooke, M. Rodrigues, B. Cappellozza, and D. Bohnert. 2015. Effect of cow BCS during gestation on performance variables of the offspring. J. Anim. Sci. 93:101 (Suppl. S3).
* Marques, R., R. F. Cooke, M. C. Rodrigues, T. Guarnieri Filho, B. I. Cappellozza, P. Moriel, and D. W. Bohnert. 2015. Effects of organic or inorganic Co, Cu, Mn, and Zn supplementation to late-gestating beef cows on productive and physiological responses of the offspring. Proc. West. Sec. Am. Soc. Anim. Sci. 66:17-21.
* McGuire, D. L., D. W. Bohnert, B. I. Cappellozza, M. M. Reis, R. S. Marques, K. C. Swanson, S. J. Falck, and R. F. Cooke. 2014. Influence of supplement composition on utilization of low-quality cool-season forages by beef cattle. Proc. West. Sec. Am. Soc. Anim. Sci. 65:129-133.
* Reis, M. M., R. F. Cooke, B. I. Cappellozza, R. S. Marques, T. Guarnieri Filho, G. A. Perry, and D. W. Bohnert. 2014. Effects of protein supplementation frequency on metabolic responses associated with reproduction of beef cows. J. Anim. Sci. 92(E-Suppl. 2):258.

**University of Arizona***(Jim Sprinkle)*

* Davis, B., J. Sprinkle, R. Tanner, and G. Weller. 2015. The response of a blue grama-pinyon pine-juniper rangeland to juniper grinding in central Arizona. Brigham Young University- Idaho Research Forum.
* Hawkes, K. L., M. P. McClaran, J. Brugger, M. A. Crimmins, L. D. Howery , G. B. Ruyle, J. E. Sprinkle, and D. R. Tolleson. 2015. Using co-development to improve livestock management during drought on national forests. Society for Range Management. Submitted.
* Sprinkle, J. 2015. Reading the Range: VGS facilitates collaborative range monitoring. Society for Range Management. (Submitted).

**University of Missouri** (Allison *Meyer*)

* Cunningham, H. C., K. J. Austin, K. M. Cammack, M. A. Berg, A. E. Radunz, and A. M. Meyer. 2015. Effect of maternal mid- to late gestational energy source on expression of angiogenic factors in fetal lamb jejunal tissue. Proc. West. Sec. Amer. Soc. Anim. Sci. In press.
* Geppert, T. C., A. M. Meyer, G. A. Perry, and P. J. Gunn. 2015. Relationship between plasma amino acid profile and ovarian function around the time of ovulation in beef cows. Accepted for the Joint Annual Meeting of ASAS-ADSA in Orlando, FL. July 2015.
* Geppert, T. C., A. M. Meyer, and P. J. Gunn. 2015. Effect of excess MP supplementation from corn gluten meal or soybean meal on plasma amino acid concentrations of beef cows consuming low quality forage. Presented at for the Joint Annual Meeting of ASAS-ADSA in Orlando, FL. July 2015.
* Geppert, J., T. C., A. M. Meyer, and P. J. Gunn. 2015. Effects of increasing supplementation of rumen undegradable protein on plasma essential amino acid concentrations in beef cows consuming low quality forage. Presented at the Midwestern Section ADSA-ASAS Meetings in Des Moines, IA. March 2015.
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*Shanna Ivey*

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*Eric Scholljegerdes*

Dissertation

* Utilization of ground juniper in small ruminant livestock diets.

Thesis

* Effects of supplemental trace mineral level and source on liver and serum trace mineral concentrations, health, and performance of newly received calves from New Mexico ranches.
* Effects of ad libitum supplement containing increasing levels of microalgae Scenedesmus sp., on site and extent of digestion and evaluation of microbial diversity in the rumen of beef heifers consuming a forage based diet.
* Replacement heifer development: alternative management strategies that impact heifer productivity.
* Effects of rumen protected arginine on livestock performance.
* Relationship of serum antibody titers to the bovine respiratory disease complex and feedlot morbidity and performance.

**University of Missouri** (*Allison Meyer*)

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**Appendix I**

**W-2012 Range Plant Alkane Composition Study**

**Station Name:**

**Site name:**

**Date collected:**

**Plant name:**

**Plant part (whole plant, vegetative part):**

**GPS coordinates:**

**Elevation:**

**Soil description:**

**Phenology of plant:**

**Climatic trend for previous 30 d:**

**Precipitation for month collected:**

**Instructions:**

1. Fill out sheet above to the best of your ability.
2. Collect plants in both vegetative and dormant stages.
3. Dry plants at 55 to 60 °C.
4. Plants needed are:
   1. Cool season (C3): Western Wheatgrass, Cheatgrass.
   2. Warm season (C4): Blue grama, Sideoats gramma.
   3. Legume: Sweet Clover.
   4. Additional C3 and C4 and a legume that might be specific to a station.