Multistate Project NC-1182

Nitrogen Cycling, Loading, and Use Efficiency in Forage-Based Livestock Production Systems

Annual Progress Report

October 1, 2010 to September 30, 2011

University of Arkansas
NC-1182 Progress Report
October 1, 2010 to September 30, 2011

Objective 1: Quantify N efficiency of forage-based ecosystems and determine the fate of excreta N.
Project: Legume establishment, persistence, and performance under grazing

Overall Objective: Identification of legume establishment strategies, species persistence, and legume performance under grazing.

Specific Objectives: 1) Determine successful establishment strategies; 2) Screen winter annual and perennial legumes regarding persistence under rotational stocking and mechanical harvest; 3) Evaluate the effects of overseeded annual and perennial clovers on animal performance in bermudagrass-based pastures.

Project 1: Legume establishment strategies; no-till drill establishment vs. broadcast on grazed-before and grazed-after pastures. **Project 2**: Persistence of annual and perennial legume species; **Project 3**: Performance of crimson clover and white clover in a bermudagrass-based grazing system.

Personnel: D. Philipp, K.P. Coffey, J. Jennings, M. Savin, D. Hubbell, III, Greg Montgomery.

Summary:

Project 1. Crimson clover (*Trifolium incarnatum* L.), and white clover (*Trifolium repens* L.) were no-till drilled and broadcast at a low and high seeding rate into an existing bermudagrass pasture. Additionally, half of the area was grazed before planting (low canopy), and the other half was grazed after planting (high canopy) to estimate the effects of cattle hoof action on establishment success. Results from the year 1 and 2 of the study suggested that no-till drill establishment of either species into a low canopy was unsurprisingly more successful than other treatments in terms of seedling counts per unit area. However, seedling counts of white clover broadcast and "grazed after" tended to be higher than "grazed before" during the first year of the study. Above-ground biomass measurement generally reflected seedling count results in both years.

In autumn of 2011, this experiment ended. In general, the no-till drill procedure appeared to result in higher numbers of seedlings than other methods. Grazing before or after planting had evidently no effect on the outcome. Therefore, enhanced seed-soil contact through hoof-action may occur anecdotally, but not in general.

Project 2: In October of 2007, four annual and four perennial legumes were drilled into an existing bermudagrass (*Cynodon dactylon* L.) sward at the University of Arkansas Batesville Livestock and Forestry Research Station in north-central Arkansas. Annual species used were arrowleaf clover (*Trifolium vesiculosum* Savi), crimson clover hairy vetch (*Vicia villosa* Roth), and subterranean clover (*Trifolium subterraneum* L.). Perennial species used were alfalfa (*Medicago sativa* L.), kura clover (*Trifolium ambiguum* Bieb.), red clover (*Trifolium pratense* L.), and white clover. Our objectives

were to monitor species composition, dry matter yield, and forage nutritive value under rotational grazing. Kura clover and subterranean clover did not establish and were excluded from the study. Species percent occupancy in the pasture based on photosynthetically active tissue was higher in hairy vetch and crimson clover compared with arrowleaf clover early in the growing season, but late vegetative growth in arrowleaf clover reversed this trend. In pastures oversown with perennial legumes, red clover and white clover had similar occupancies throughout the growing season, but both were higher than alfalfa. Dry matter yields ranged between 1.5 and 4.0 Mg ha^{-1} for plots with perennial legumes and 1.5 to 3 Mg ha^{-1} for plots with annual legumes. Forage nutritive value for perennial legumes ranged from a minimum of 10% crude protein (CP) in control plots (bermudagrass only) to 20% CP in red clover/bermudagrass mixes during 2008. Forage nutritive value analyses for 2009 are under way.

In summer of 2010, this project was finalized. Overall, white clover, red clover, and hairy vetch appeared to be adapted better than the other species to the environmental conditions of North-central Arkansas, but management of legume species remains challenging due to the soil conditions and relatively dry and hot summers there.

Project 3: In partnership with the University of Arkansas at Monticello, crimson clover and white clover were overseeded into bermudagrass pastures during the fall of 2008 and 2009 and compared with a bermudagrass pasture to which only commercial N fertilizer was applied (control). Additionally, annual ryegrass (*Lolium multiflorum* Lam.) was seeded into all treatments as winter annual forage. In 2009, spring grazing days in the legume treatments were reduced compared with the bermudagrass + N treatment as cattle were stocked on these paddocks earlier due to the application of commercial fertilizer. Therefore, weight gain was significantly lower in legume treatments than in the control treatment. During the summer grazing period however, some of the N fixed by the legume treatments was apparently carried over so that weight gain did not differ among treatments. The experiment was repeated during 2009-2010 and results are currently being evaluated.

This experiment also ended in 2011. No differences were observed between the control and legume treatments with regard to animal weight gain. There is some indication that forage production was increased in the control treatment plots compared with the legume treatments; therefore, stocking rate that was held similar across all treatments may have masked possible increased weight gains from the control (N-fertilized only) treatment.

Project: Use of legume banks for grazing cow-calf pairs.

Overall Objective: To enhance survival of legumes and improve N-use efficiency through the use of legume banks for cow-calf pairs.

Personnel: K.P. Coffey, D. Philipp, J. Jennings, M. Savin.

Summary: Both fall and spring calving cows will be grazed on the same pastures within replications to enhance forage use efficiency. We propose 3 treatments and 6 total groups.

1. N fertilization

2. High-degradable N legumes (red, white) and tannin-containing legumes (birdsfoot trefoil/ low-tannin sericea lespedeza) seeded in strips
3. High-degradable N legumes (red, white) and tannin-containing legumes (birdsfoot trefoil/ low-tannin sericea lespedeza) seeded in separately-fenced legume banks.

Individual legumes will be seeded in separate cells within a replication and will not be seeded together within a cell. The red and white clover were seeded in the fall of 2011 and the trefoil and sericea lespedeza will be seeded in the spring of 2012.

The forage base is toxic endophyte-infected tall fescue with a limited acreage of non-toxic, novel endophyte-infected fescue assigned to each replication.

Project: Use of legume banks for grazing weaned calves.

Overall Objective: To enhance improve post-weaning calf performance and N-use efficiency through the use of legume banks for weaned calves.

Personnel: K.P. Coffey, D. Philipp, J. Jennings, M. Savin, M. Popp.

Summary: After weaning, calves will graze pastures of predominantly bermudagrass (fall-born calves) or non-toxic, novel endophyte-infected tall fescue. These pastures will be allocated to one of three treatments:

1. N fertilization
2. High-degradable N legumes (red, white) seeded in banks
3. Tannin-containing legumes (birdsfoot trefoil/ low-tannin sericea lespedeza) seeded in banks.

   Individual legumes will be seeded in separate cells within a "bank" so that legume-specific management can be used.

Objective 2: Quantify the effect of dietary and animal factors on utilization and excretion of forage N by beef and dairy cattle.

Project: Intake, in situ disappearance, and ruminal fermentation of bermudagrass hay by lactating beef cows offered hominy feed or corn as supplements

Overall Objective: The objective of this study was to determine the effect of level of hominy feed supplementation on intake, in situ DM disappearance, and ruminal fermentation characteristics of medium quality bermudagrass hay.

Personnel: Z.Madzonga, A. Young, K. Coffey, D. Phillip, E. Kegley

Summary: Five ruminally cannulated lactating beef cows (BW= 596 kg, SE=13.9) were used in a 5 x 5 Latin square design. Treatments were low hominy (LH; 0.25% of BW), medium hominy (MH; 0.50% of BW), low corn (LC; 0.25% of BW), medium corn (MC; 0.50% of BW) and no supplement (Cont). Supplements were offered at 0800 daily and corn was offered as ground corn. Hay was offered to maintain 10% refusal and water was offered for ad libitum consumption. Five consecutive 16–d periods were used, each

consisting of 9 d for adaptation followed by a 6 d in situ period. Dacron bags containing approximately 5 g of ground (2-mm screen) bermudagrass hay were not incubated, or incubated for 4, 8, 12, 16, 24, 52, 76, 100, and 124 h to measure forage DM disappearance. Ruminal fluid was sampled on d-14 of each period at 0, 1, 3, 5, 7, 9, 11, and 13 h after the morning feeding and pH was measured. Hay DMI (% of BW) was greater ($P < 0.05$) for Cont and LC compared with MH, but total DMI (% of BW) was greater ($P < 0.05$) for MC and MH compared with the other treatments. Hay fraction B (potentially degradable DM) was greater ($P < 0.05$) for LH and MC compared with MH, whereas hay fraction U (undegradable DM) was greater ($P < 0.05$) for MH compared with MC and LH. Mean ruminal pH tended ($P = 0.07$) to be greater for LC and Cont (6.43 and 6.34 respectively), compared with LH (6.12). Therefore, hominy feed does not appear to have advantages over ground corn as a supplemental feedstuff for lactating beef cows offered bermudagrass hay.

Project: Chemical composition and longevity of sericea lespedeza subjected to different grazing management simulations.

Objective: To determine the impacts of forage management on yield, longevity, and chemical composition of sericea lespedeza.

Personnel: K. Coffey, D. Philipp, W. Coblentz, A. Young.

Summary: Four blocks were selected within an established mixture of sericea lespedeza and fescue that have the greatest % basal cover of sericea lespedeza. Each site was divided into 10 plots in a 3 × 3 + 1 factorial treatment arrangement of a randomized block design experiment with one extra treatment. The main effects are clipping the forage to heights of either 5, 10, or 15 cm at 3, 6, or 9-wk intervals. The extra treatment consists of plots that are not clipped during the entire experiment. Samples are separated into sericea lespedeza, fescue, and other forages. Sericea will be analyzed for tannin concentrations and in situ DM and N degradability. The study is in its second year. A severe drought occurred in year 2 and only 2 samplings were collected.

Publications:

Caldwell, J. D., K. P. Coffey, W. K. Coblentz, J. A. Jennings, D. S. Hubbell, III, D. L. Kreider, M. L. Looper, D. L. Galloway, E. B. Kegley, and C. F. Rosenkrans, Jr. 2011. Weaning and post-weaning performance by fall-born beef calves weaned on different dates in the spring from *Neotyphodium coenophialum*-infected tall fescue pastures. Livestock Sci. 135:44-52.

Sales, M. A., M. J. Larson, S. T. Reiter, A. H. Brown, Jr., M. A. Brown, M. L. Looper, **K. P. Coffey**, and C. F. Rosenkrans, Jr. 2011. Effects of bovine cytochrome P450 single nucleotide polymorphism, forage type, and body condition on production traits in cattle. J. Anim. Physiol.Nutr. (In Press).

Coffey, K., J. Caldwell, J. Jennings, D. Philipp, A. Young, J. Tucker, D. Hubbell, III, T. Hess, M. Looper, C. West, M. Savin, M. Popp, D. Kreider, and C. Rosenkrans, Jr. 2011. Performance by spring and fall-calving cows grazing with full access, limited access, or no access to toxic, wild-type endophyte -infected tall fescue – 3-year summary. Proc. Am. For. Grassl. Council. French Lick, IN.

Coffey, K., J. Caldwell, J. Jennings, D. Philipp, A. Young, J. Tucker, D. Hubbell, III, C. West, M. Savin, M. Popp, and C. Rosenkrans, Jr.. 2011. Forage quality, ergot alkaloid concentrations, and species composition from toxic wild-type and non-toxic, novel endophyte infected tall fescue pastures grazed by cow-calf pairs. Proc. Am. For. Grassl. Council. French Lick, IN.

Ata, M., K. P. Coffey, J. D. Caldwell, E. B. Kegley, M. L. Looper, A. N. Young, D. Philipp, D. S. Hubbell, III, and C. F. Rosenkrans, Jr. 2011. Relationship between polymorphisms in the prolactin promoter and cytochrome P450 genes, and feedlot performance by steers weaned from wild-type or non-toxic endophyte-infected tall fescue pastures. J. Anim. Sci. 89(E-Suppl. 2):153.

Boyer, A. R., M. L. Looper, K. P. Coffey, and C. F. Rosenkrans, Jr., 2011. Effects of forage and breed type on grazing behavior and temperament of beef heifers. J. Anim. Sci. 89(E-Suppl. 2):7.

Jennings, J. A., K. P. Coffey, K. J. Simon, and M. L. Looper New recommendations for improving cow/calf production using limited acreage of novel endophyte fescue in toxic fescue forage systems. Proc. 2011 Am. For Grassl. Conf., French Lick, IN.

O'Berg, S. A. J. G. Powell, K. P. Coffey, C. A. Tucker, M. P. Rowe, and J. L. Reynolds. 2011. Determining effects of two deworming protocols on fecal egg counts and growth performance in beef calves. J. Anim. Sci. 89(E-Suppl. 2):9.

Simon, K. J., J. A. Jennings, K. P. Coffey, B. L. Barham, R. Poling, J. Gunsaulis, and D. Henderson. Producer attitudes toward renovating toxic fescue with novel endophyte fescue. Proc. 2011 Am. For Grassl. Conf., French Lick, IN.

Williamson, B. C., M. L. Looper, J. D. Patterson, M. A. Sales, K. P. Coffey, M. Ata, and C. F. Rosenkrans, Jr.. 2011. Relationships among single nucleotide polymorphisms in the cytochrome P450 gene and the enhancer region of the prolactin gene, molecular breeding values, and steer performance. J. Anim. Sci. 89(E-Suppl. 2):8.

University of Kentucky
NC-1182 Annual Report
October 1, 2010 to September 30, 2011

"Nitrogen Cycling, Loading, and Use Efficiency in Forage-Based Livestock Production Systems"

Research Summaries:

1) "Endophyte infection increases carbon sequestration and alters nutrient and microbial communities of southeastern USA tall fescue pastures."

Participants: Dr. Javed Iqbal (postdoc), Jacob A. Siegrist (MS student), Jim A. Nelson (support scientist), Dr. Rebecca L. McCulley (PI)

Tall fescue (*Festuca arundinacea* Schreb.) can be infected with a common toxic fungal endophyte (*Neotyphodium coenophialum*) capable of producing alkaloids that affect grazing animal health, insect herbivory, plant production, and litter decomposition. The strength of these endophyte-associated effects is thought to be dependent on the abiotic and biotic conditions of a specific site. Prior work from a site in Georgia, USA, showed that fungal endophyte infection can increase soil carbon pools; however, for endophyte infection to contribute substantially to carbon sequestration, this result would have to be true across the broad range of environmental conditions that support tall fescue growth. In this study, we evaluated whether endophyte infection consistently alters various soil parameters of tall fescue stands located throughout the southeastern United States. Soil samples were collected from 9 sites with established paired high- and low- endophyte infected tall fescue stands. These samples were analyzed for basic soil parameters, soil organic carbon (SOC), soil total nitrogen (TN), particulate and non-particulate organic matter-C and -N (POM, n-POM), C and N mineralization rates, and microbial biomass and community composition. Averaged across all sites, endophyte infected (E+) tall fescue stands had 6% greater SOC and 5% greater TN pools in surface soil than adjacent endophyte free (E-) stands, and these results did not appear sensitive to age of stand, climate, or other site-specific environmental conditions. While POM C and POM N tended to be higher in E+ than E- stands, this result was not significant. However, significantly greater pools of n-POM C and N were observed in E+ vs. E- stands when averaged across all the sites, suggesting increased retention of recalcitrant substrates in response to fungal endophyte infection. During 76 days of soil incubation, C mineralization was 5.6% higher in E+ than E- stands when averaged across all sites. Total microbial biomass, measured as the sum of 74 identified fatty acid methyl esters (FAMEs) extracted via phospholipid fatty acid analysis (PLFA), was significantly greater in E+ than E- tall fescue when averaged across sites, reflecting the trends observed with SOC and TN. Microbial community composition shifted in response to fungal endophyte infections: significantly higher fungal to bacterial ratios were observed from E- compared to E+ stands. Ordinations of the FAME data separated microbial communities from E+ and E- stands at some sites but not others. Enhanced SOC, TN, recalcitrant POM C and N pools, and altered microbial biomass and communities suggest endophyte infection increases C sequestration capacity of tall fescue stands throughout the Southeastern USA.

2) "Cool season, mixed species, forage response to nutrient additions."

Participants: Dr. Rebecca L. McCulley (PI), Jim A. Nelson (support scientist), and Glade B. Brosi (MS student)

Nutrient availability is a key determinant of plant biomass and species composition in forage systems, and is commonly manipulated via fertilizer applications. Therefore, understanding forage species responses to micro- and macro-nutrient applications is necessary to predict changes in species assemblages and forage production associated with altering nutrient regimes. To explore the relationships between forage species composition and production and nutrient availability we performed a full factorial design of N, P, and K plus micronutrient applications on a mixed tall fescue, orchardgrass, Kentucky bluegrass, clover, and vetch hay pasture in central Kentucky. We collected biomass by functional group (graminoids, forbs, legumes, and dead litter) and species cover data for two consecutive years (2008 and 2009) of fertilizer applications. Nitrogen additions favored grass species, promoting grass production and cover, and negatively impacted forbs. Phosphorus additions had little impact on the vegetation parameters measured, presumably because of the high phosphorus soils prevalent at the site. However, the K plus micronutrient treatment significantly increased production and cover of Big Flowered Vetch, a legume, which resulted in significant declines in grass production in these plots over time. Additional testing revealed that K was the nutrient the Big Flowered Vetch was responding to. In this central Kentucky hay field, total forage production was most stimulated by N additions increasing grass biomass; however, K additions most affected the species composition of the site by promoting legumes (specifically Big Flowered Vetch). This alteration in species composition was immediate and appears likely to have long-lasting effects on the vegetative community.

3) "Fungal endophyte presence and genotype affect plant diversity and soil-to-atmosphere trace gas fluxes."

Participants: Dr. Javed Iqbal (postdoc), Jim A. Nelson (support scientist), Dr. Rebecca L. McCulley (PI)

Novel endophyte (*Neotyphodium coenophialum*) genotypes in symbiosis with tall fescue (*Lolium arundinaceum*) have been recently introduced to agricultural seed markets. These novel endophytes do not produce the full suite of toxins that the 'common toxic' form does, and therefore, may not have the same consequences on plant and soil processes. Here, we evaluated the effects of novel endophyte presence and genotype on ecosystem processes of tall fescue stands. We quantified the effects of the presence of the common toxic endophyte (CT), two novel endophyte genotypes (AR-542, AR-584), no endophyte (endophyte free, E-), and a mixture of all endophyte statuses (mix) within a single genotype of tall fescue (PDF) on various soil and plant parameters. Endophyte presence and genotype affected tall fescue cover and plant species richness: cover – CT, AR-542, AR -584, mix > E- and species richness – E-, mix > AR-542, AR -584 > CT. Most measured soil parameters had significant endophyte effects. For example, higher fluxes of soil CO_2 and N_2O were measured from stands of AR-542 than the other endophyte treatments. These results indicate that endophyte presence and genetic identity are important in understanding the ecosystem-scale effects of this agronomically important grass-fungal symbiosis.

Related Publications:

Refereed Journal Articles/Book Chapters:

1) Iqbal, J., J.A. Siegrist, J.A. Nelson, and R.L. McCulley. In Press. Fungal endophyte infection increases carbon sequestration potential of southeastern USA tall fescue stands. Soil Biology & Biochemistry 44:81-92.

2) Brosi, G.B., R.L. McCulley, L.P. Bush, J.A. Nelson, A.T. Classen, and R.J. Norby. 2011. Effects of multiple climate change factors on the tall fescue – fungal endophyte symbiosis: infection frequency and tissue chemistry. New Phytologist 189:797-805.

3) McNear, Jr., D.H. and R.L. McCulley. In Press. Influence of the *Neotyphodium* – tall fescue symbiosis on belowground processes. Proceedings of the 7th International Symposium on Fungal Endophytes of Grasses, Noble Foundation, Ardmore, OK.

Published Abstracts:

1) McCulley, R.L., J.A. Nelson, and A.E. Carlisle. 2011. Effects of elevated temperature and additional growing season precipitation on managed grassland carbon storage and flux. *Ecological Society of America Annual Meeting*, Austin, TX.

2) Cooke, A.L., G.B. Brosi, J.A. Nelson, and R.L. McCulley. 2011. Climate change effects on forage quality of Kentucky hay fields. *American Forage and Grassland Council Annual Meeting*, French Licks, IN.

3) Iqbal, J. , J.A. Nelson, A.E. Carlisle, and R.L. McCulley. 2011. Influence of fungal endophyte genotypes on plant diversity and soil-atmospheric trace gas fluxes. *Soil Science Society of America Annual Meeting*, San Antonio, TX.

University of Nebraska-Lincoln
NC-1182 Progress Report
October 1, 2010 to September 30, 2011

Objective: Quantify N harvest efficiency of grassland agroecosystems by determining N inputs such as fertilizer, manure, atmospheric deposition, and leguminous fixation and calculating N takeoff as food, fuel, or fiber.

Principal Investigators:
Walter Schacht, Dept. of Agronomy and Horticulture
Terry Klopfenstein, Dept. of Animal Science
John Guretzky, Dept. of Agronomy and Horticulture

Project 1: Nitrogen harvest efficiency in perennial grassland cropping systems.

This project tested the hypothesis that P and K fertilization application improves N harvest efficiency of switchgrass managed as a cellulosic biomass energy crop. To evaluate this hypothesis, the N harvest efficiency in switchgrass cropping systems managed for cellulosic biofuels and fertilized with different combinations of N, phosphorus (P), and potassium (K) were compared. The 3-year field study was initiated in May 2009 at the Agricultural Research and Development Center on an established, dryland stand of switchgrass. Treatments were applied to 2 by 3-m plots arranged in a randomized complete block, split-split-plot design with three replications. The whole plot treatment was the level of N fertilization (0, 56, and 112 kg N/ha). The split plot treatment was level of P fertilization (0, 22, and 44 kg P/ha). The split-split plot treatment was level of K fertilization (0, 11, and 22 kg K/ha). Plots were harvested at a 10-cm cutting height on August 1 of each year. Three years of field data have been collected and will be analyzed in the next several months.

Project 2: Strategies of supplementing dried distillers grains to yearling steers on smooth bromegrass pastures

The study was initiated as an extension of a five-year project that compared N-use efficiency on fertilized and non-fertilized pastures grazed by supplemented (dried distillers grains) or non-supplemented yearling cattle during the growing season. Original treatments included were (1) smooth bromegrass paddocks fertilized with 90 kg of N/ha and stocked at 9.9 AUM/ha (FERT); (2) non-fertilized smooth bromegrass paddocks stocked at 9.9 AUM/ha and supplemented with DDGS at 0.6% BW daily (SUPP); (3) non-fertilized smooth bromegrass pasture stocked at 69% of FERT and SUPP. In 2010, two additional treatments (4 and 5) were added for increased replication and addition of a strategic supplementation treatment and included (4) non-fertilized pasture stocked at 4 AUM/acre strategically supplemented with DDGS (DM) at incremental levels of (STRAT). Incremental levels were based on declining forage quality with smooth bromegrass maturation. At the start of the grazing season, steers on strategic supplementation received 0.91 kg/day DDGS to meet MP requirements; thereafter, supplement incrementally increased to 3.24 kg/day/head. The STRAT and SUPP treatments were designed to receive the same overall average amount of DDGS over the grazing season. Results from 2010 showed that steers supplemented with dried distillers grains with solubles (DDGS) daily on nonfertilized

smooth bromegrass pastures gained 0.25 kg/day more than cattle on nonsupplemented treatments. Steers supplemented at 0.6% BW DDGS gained 1.17 kg/day compared to 1.07 kg/day for steers fed a similar total amount of DDGS at increasing levels over the grazing season.

Project 3: Litter accumulation and decomposition in smooth bromegrass pastures

Litter is important to soil quality, hydrology, and nutrient cycling of grasslands. Our objectives were to evaluate how N inputs affect litter accumulation and decomposition rates in smooth bromegrass pastures. From 2010-2011, we measured forage mass, litter mass, litter accumulation rates, and litter decomposition rates within an ongoing (6-yr) grazing experiment with (1) fertilized (90 kg N ha^{-1}) pastures (FERT); (2) unfertilized pastures where cattle were supplemented with a N-rich ethanol co-product, dry distillers grains plus solubles (DDGS); and (3) unfertilized pastures (CONT). Forage mass varied with pasture treatment and sampling date. During spring, forage mass averaged 4734, 3685, and 2699 kg DM ha^{-1} in FERT, DDGS, and CONT pastures, respectively. By late summer, forage mass averaged 1907 kg DM ha^{-1} across treatments. Across the season, forage N concentration averaged 18.4, 17.1, and 16.8 g kg^{-1} within FERT, DDGS, and CONT pastures, respectively. Despite these differences, N addition to the pastures did not affect litter mass, litter accumulation, or litter decomposition. Pastures contained on average 2000 kg DM ha^{-1} of litter; litter accumulation averaged 10 kg ha^{-1} d^{-1}; and 30% of litter DM was lost through decomposition from mid-summer to spring the next year. Although litter may constitute an important organic matter pool in grasslands, results showed that N inputs from fertilization and supplemental feeds has limited effects on litter in pastures where increases in forage mass from the added N is lost through animal consumption.

Project 4: Nitrous oxide emissions from smooth bromegrass pasture under nitrogen fertilizer and bovine urine application in eastern Nebraska

Nitrous oxide (N_2O) is a greenhouse gas primarily produced in soils by denitrifying and nitrifying organisms. In terms of global warming potential (GWP), N_2O has 310 times the GWP of carbon dioxide (CO_2). Atmospheric N_2O concentrations have increased by 18% since the industrial revolution with agricultural soils responsible for 70% of emissions in the United States. Tracking N_2O emissions in the United States prepares the country for future legislation and carbon budgeting. Although the measurement of N_2O has become more focused in the last 20 years, little data has been collected in pasture ecosystems. This study focused on the production of N_2O in smooth brome (*Bromus inermis* Leyss.) pastures in eastern Nebraska. Thirty smooth brome plots were treated with five different fertilizer treatments (0, 45, 90, 135, and 180 kg/ha) and two urine treatments (urine and no urine). N_2O emissions were recorded biweekly from March to October using the Hutchinson and Mosier (1981) vented chamber method. Preliminary findings revealed a significant interaction between N fertilizer rate ($p<0.005$), urine application ($p <0.001$), and sampling date ($p<0.0001$). Both treatments resulted in higher N_2O emissions compared to control plots. In this study, ideal conditions for denitrifying and nitrifying activity occurred at 15.5^{o}C with 55% soil moisture which resulted in N_2O emissions up to 297.22 ng N/cm2/h. N_2O emissions in this study were higher than cited in previous studies and significant daily losses raise questions about timing of sampling and further research.

Project 5: Nitrogen dynamics as affected by grazing management and supplementation strategies.

This study is being implemented to address the hypothesis that supplementation and management strategies can be used on smooth bromegrass pasture grazed by yearling beef cattle to increase N capture and N use efficiency. The study was inititated as a continuation of the NC-1021 project that compared N-use efficiency on fertilized and non-fertilized pastures grazed by supplemented (dried distillers grains) or non-supplemented yearling cattle during the growing season. Treatments were (1) smooth bromegrass pasture stocked with yearling cattle at the recommended rate (about 9.9 AUM/ha) and fertilized with 90 kg of N/ha (FERT), (2) non-fertilized smooth bromegrass pasture stocked at 70% of the control, and (3) non-fertilized smooth bromegrass pasture stocked at the same rate as the control and the cattle supplemented with DDGS, (4) non-fertilized smooth bromegrass pasture stocked at twice the rate of the control and the cattle supplemented with a mixture of 60% wheat straw and 40% wet distillers grains, (5) non-fertilized smooth bromegrass pasture stocked at twice the rate of the control and the cattle supplemented with a mixture of 60% wheat straw and 40% solubles, and (6) non-fertilized smooth bromegrass pasture stocked at twice the rate of the control and the cattle supplemented with a mixture of 65% wheat straw and 35% solubles.

Project 6: Nitrogen dynamics as affected by grazing management and supplementation strategies.

The initiation of the study was delayed because the principle investigator (Walter Schacht) is on faculty development leave in Namibia for all of 2011. Beginning in June 2012, however, the study will evaluate whether range condition of native Sandhills rangeland affects N capture and N use efficiencyat the Gudmundsen Sandhills Laboratory (GSL). Treatments are (1) rotational grazing of sands ecological site in fair range condition and (2) rotational grazing of sands ecological site in high-good to low-excellent range condition. There are two replications of each treatment arranged in a randomized complete block design. Each treatment replication is comprised of five pastures rotationally grazed from mid-June to mid-August. The pastures in fair range condition (treatment 1) have a recent history of being stocked at two times the recommended stocking rate (1.5 AUM/ha) and are characterized by lower seral stage grasses and forbs and lower herbage production. The pastures in high-good to low-excellent range condition have been grazed at the recommended stocking rate for several years and are characterized by climax dominant grasses and forbs and higher herbage production. The pastures in fair condition will be stocked at the recommended stocking rate for fair-conditioned sands sites (0.85 AUM/ha) and the high-good to low-excellent pastures will be stocked at the stocking rate recommended for sands sites in high-good condition (1.5 AUM/ha).

Grants:

Greenhouse Gas Emissions and Nitrogen Cycling from Beef Production Systems: Effect of Climate, Season, Production System, Diet and Management. Grant Period: 11/01/2010 - 10/31/2011; Grant Type: Research/Creative Activity, Extension; Total Amount: $50000 Granting Agency: USDA-NIFA-AFRI Scope: National

Nitrogen cycling and greenhouse gas emissions in pasture and feedlot production systems. Grant Period: 04/01/2010 - 06/30/2012; Grant Type: Research/Creative Activity; Total Amount: $189468; Granting Agency Name: IANR Strategic Investments; Scope: Regional (Multi-state)

Publications:

Watson, A. K., T. J. Klopfenstein, G. E. Erickson, W. H. Schacht, and D. R. Mark. 2011. Economic analysis of smooth bromegrass pasture beef growing systems. J. Anim. Sci. Midwest ASAS Abstract 85.

Pruitt, S. K., K. M. Rolfe, B. L. Nuttelman, A. K. Watson, W. A. Griffin, T. J. Klopfenstein, G. E. Erickson, and W. H. Schacht. 2011. Strategies of supplementing dried distillers grains to yearling steers grazing smooth bromegrass pastures. J. Anim. Sci. Midwest ASAS Abstract: 297.

Pruitt, S.K., Rolfe, K.M., Nuttleman, B., Klopfenstein, T.J. Erickson, G.E., Griffin, W.A., and W.H. Schacht. 2011. Strategies of supplementing dried distillers grains to yearling steers on smooth bromegrass pastures. 2012 Nebraska Beef Cattle Report MP95:49-50. University of Nebraska-Lincoln, Lincoln, NE.

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Greenquist, M.A., A.K. Swartz, T.J. Klopfenstein, W.H. Schacht, G.E. Erickson, K.J. Vander Pol, M.K. Lueffe, K.R. Brink, and L.B. Baleseng. 2010. Effects of nitrogen fertilization and dried distillers grains supplementation: nitrogen use efficiency. Journal of Animal Science. 89:1146-1152

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Guretzky, J.A. 2011. Litter Accumulation and Decomposition in Pastures. Center for Grassland Studies Report. Institute of Agriculture and Natural Resources. University of Nebraska-Lincoln. 17:1.

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Snell, L., J. Guretzky, V. Jin, R. Drijber, and M. Mamo. 2011. Nitrous oxide emissions from smooth bromegrass pasture under nitrogen fertilizer and bovine urine application in eastern Nebraska. Nebraska Section of the Society of Range Management Annual Meeting Abstract, Sidney, Nebraska. 4-6 Oct. 2011

Guretzky, J.A., W.H. Schacht, and T.J. Klopfenstein. 2011. Litter accumulation and decomposition in smooth bromegrass (Bromus inermis Leyss.) pastures. Society for Range Management 65th Annual Meeting Abstract. Spokane, WA. 29 Jan. - 3 Feb. 2012.

Guretzky, J.A., T.J. Klopfenstein, and W.H. Schacht. 2011. Litter deposition and decomposition in smooth bromegrass pastures. ASA, CSSA and SSSA 2011 International Annual Meetings Abstract. San Antonio, TX 16-19 Oct. 2011.

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Guretzky, J.A. Litter Deposition and Decomposition in Smooth Bromegrass Pastures. ASA-CSSA-SSSA 2011 International Annual Meetings. San Antonio, TX, 17 Oct. 2011.

Guretzky, J.A. Ethanol Co-Product Utilization and Fertilization Effects on Carbon and Nitrogen Cycling in Pastures. Climate, Water, and Ecosystems-Shaping the Great Plains. University of Nebraska-Lincoln, Lincoln, NE, 13 Oct 2011.

Guretzky, J.A. Effects of Nitrogen Input on Litter Accumulation and Decomposition in Pastures. Center for Grassland Studies Fall 2011 Seminar Series, Lincoln, NE, 26 Sep 2011.

Guretzky, J.A. Ethanol Co-Product Utilization and Fertilization Effects on Carbon and Nitrogen Cycling in Pastures. UNL Range and Forage Graduate Student Seminar, 24 Jan 2011.

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Oklahoma State University
NC-1182 Progress Report
October 1, 2010 to September 30, 2011

NC-1182 Objective 1. ***Quantify N harvest efficiency of grassland agroecosystems by determining N inputs such as fertilizer, manure, atmospheric deposition, and leguminous fixation and calculating N takeoff as food, fuel, or fiber.***

Nitrogen Use Efficiency and Environmental Impact of Stocker Cattle Production Systems Utilizing Warm-Season Perennial Grass Pasture

Objective: Determine the effect of N fertilization or dried distiller's grains plus solubles supplementation on N use efficiency and environmental impacts of stocker cattle production systems utilizing warm season perennial grass pasture

Personnel: Gerald Horn (Animal Science)
Phillip Lancaster (Animal Science)
Brody Wallis (Graduate Research Assistant)
Brian Arnall (Plant and Soil Science)
Jason Warren (Plant and Soil Science)
Tyson Ochsner (Plant and Soil Science)
Sarah Lancaster (Plant and Soil Science)

Summary of Research (2011): The Crosstimbers-Bluestem Stocker Range located 11 km southwest of Stillwater was used for this study. The site consists of 105 ha (12 paddocks; 4 to 10 ha) of warm-season perennial grasses: Plains Old World Bluestem (*Bothriochloa ischaemum* L. Keng) and Bermudagrass (*Cynodon dactylon* L. Pers.). Soils consist primarily of Zaneis-Huska complex (21%; 1 to 5% slopes), Stephenville-Darnell complex (15%; 3 to 8% slopes), Coyle-Lucien complex (13%; 1 to 5% slopes), Grainola-Lucien complex (10%; 5 to 12% slopes), and Stephenville fine sandy loam (9%; 3 to 5% slopes). Nitrogen (90 kg/ha) and phosphorus (39 kg/ha) fertilizer were applied at the start of the growing season to each pasture based on treatment designation (Table 1). Steers (arrival BW = 238 ± 23 kg) were randomly allotted to 4 treatments with 3 pasture replicates per treatment. Steers assigned to receive dried distiller's grains plus solubles (DDGS) supplement were fed 5 d per wk at 0.75% of BW, and feed amount adjusted based on expected rate of gain throughout the grazing season. Due to drought conditions and lack of forage steers only grazed from May 17 to July 19, 2011. Body weight measurements were collected at the start and end of the grazing period. Forage standing crop was measured monthly during the grazing season. Nitrogen recovery was computed as nitrogen removed from the grazing system in steer weight gain divided by nitrogen inputs to the system (i.e, fertilizer, feed, and atmospheric deposition).

Large grazing exclosures (15 m x 15 m) were established in 3 of the non-fertilized pastures. Within the grazing exclosures, small plots (1.8 m x 1.8 m) were established to determine the relationship between nitrogen fertilization rate (0, 22, 45, 67, 90, 112, and 135 kg/ha) and forage biomass using GreenSeeker® Sensor technology (Model 505; NTech Industries, Inc., Ukiah, CA). Measurements of nitrous oxide emissions were also collected from nitrogen fertilizer rate plots using the vented chamber technique at 0, 15, and 30 minutes weekly or biweekly during the summer grazing season. Water use efficiency was determined using beginning and ending soil moisture and meteorological data collected

by the Oklahoma Mesonet. Plant species composition was determined at the end of the grazing period to evaluate changes in forage stand persistence.

Results indicate that forage standing crop was not different among treatments (Table 2). Steers in NPFERT and DDGS treatments had greater ($P < 0.05$) ADG than CONTROL and NFERT steers. However, NPFERT and DDGS steers had greater ($P < 0.05$) gain per ha than NFERT steers, and NFERT steers were greater than CONTROL steers. Thus, supplementation with DDGS provided similar or improved ADG and gain per ha compared with the other treatments while maintaining a high stocking rate. Nitrogen inputs were greatest for treatments receiving nitrogen fertilizer, NFERT and NPFERT, and DDGS was greater ($P < 0.05$) than CONTROL (Table 3). Nitrogen retention in BW gain followed a similar trend as BW gain per ha. Nitrogen recovery was greatest for the CONTROL due to very low nitrogen inputs (atmospheric deposition only), but due to high rate of gain and lower nitrogen inputs DDGS had greater ($P < 0.05$) nitrogen recovery than NFERT and NPFERT. These results are slightly different than year 1 of this project where DDGS steers had greater ADG and BW gain per ha than NFERT and NPFERT. The reason for this may be due to differences in environmental conditions where in year 1 precipitation during the spring and early summer was adequate to above average compared to year 2 where precipitation was well below average. It appears that during year 2, possibly due to drought conditions, phosphorus availability in forage was limiting animal performance of CONTROL and NFERT. Providing phosphorus as fertilizer or supplemental feed (i.e., NPFERT or DDGS) increased animal performance. Mineral analysis of forage and feed samples to determine phosphorus content is still ongoing.

A spike in nitrous oxide emissions was evident following rain events early in the grazing season which was shortly after nitrogen fertilizer application, but not later in the grazing season. Following the first 21 days, nitrous oxide emissions were minimal from the nitrogen fertilizer plots. Interestingly, nitrous oxide emissions did not increase above 0 kg N/ha except at the highest level of nitrogen application (135 kg N/ha) suggesting that forage N uptake was maximized between 67 and 135 kg N/ha.

Application of Results: Supplementation of stocker cattle with DDGS adequately replaced forage without resulting in overgrazing and maintained stocking rate and cattle performance compared with nitrogen fertilizer. In addition, replacing nitrogen fertilizer with DDGS supplementation increased the nitrogen recovery in animal products 5-fold potentially reducing nitrogen lost to the environment. Therefore, supplementation of stocker cattle with DDGS may allow replacement of N fertilizer during times of relatively high fertilizer prices. However, further research is necessary to determine long term consequences of reduce N application on stand persistence and forage production. In addition, results will provide knowledge regarding the impact of pasture fertilization and feed supplementation on the environmental and economic sustainability of forage-based livestock systems.

Table 1. Treatments utilized to evaluate N use efficiency and environmental impact of stocker production systems.

Treatment	N fertilizer[1]	P fertilizer[2]	Stocking Rate	DDGS Supp[3]
Control	No	No	335 kg BW/ha	No
NFERT	Yes	No	675 kg BW/ha	No
NPFERT	Yes	Yes	675 kg BW/ha	No
DDGS	No	No	675 kg BW/ha	Yes

[1]Nitrogen fertilizer was applied at a rate of 0 or 90 kg N/ha.
[2]Phosphorus fertilizer was applied at a rate of 0 or 39 kg P/ha.
[3]Dried distiller's grains plus solubles was fed at a rate of 0 or 0.75% of BW.

Table 2. Effect of stocker production system on forage standing crop and cattle performance during the grazing season

Item	Control[1]	NFERT	NPFERT	DDGS	SEM[2]	*P*-value
Avg. forage standing crop, kg DM/ha	8666	7227	7849	7285	874	0.54
Initial BW, kg	237.6	239.0	239.6	235.6	1.6	0.38
Final BW, kg	306.7^{a}	306.4^{a}	320.1^{b}	321.8^{b}	2.5	0.01
ADG, kg·hd^{-1}·d^{-1}	1.10^{a}	1.07^{a}	1.28^{b}	1.37^{b}	0.04	0.01
BW gain, kg/ha	97.8^{a}	186.8^{b}	224.0^{c}	239.1^{c}	5.3	0.01

[1]Control = no N or P fertilizer, no DDGS, low stocking rate; NFERT = 90 kg N/ha, no P fertilizer, no DDGS, high stocking rate; NPFERT = 90 kg N/ha, 39 kg P/ha, no DDGS, high stocking rate; DDGS = no N or P fertilizer, 0.75% BW dried distiller's grains plus solubles, high stocking rate.
[2]SEM = Standard error of the mean.
[abc]Within a row, means without a common superscript letter differ ($P < 0.05$).

Table 3. Effect of stocker production system on nitrogen use efficiency

Item	Control[1]	NFERT	NPFERT	DDGS	SEM[2]	*P*-value
Nitrogen inputs, kg/ha	5.6^{a}	95.2^{b}	95.2^{b}	21.4^{c}	0.1	0.01
Nitrogen retention, kg/ha	2.7^{a}	5.1^{b}	6.0^{c}	6.5^{c}	0.1	0.01
Nitrogen recovery, %	48.3^{a}	5.4^{b}	6.4^{b}	30.3^{c}	0.6	0.01

[1]Control = no N or P fertilizer, no DDGS, low stocking rate; NFERT = 90 kg N/ha, no P fertilizer, no DDGS, high stocking rate; NPFERT = 90 kg N/ha, 39 kg P/ha, no DDGS, high stocking rate; DDGS = no N or P fertilizer, 0.75% BW dried distiller's grains plus solubles, high stocking rate.
[2]SEM = Standard error of the mean.
[abc]Within a row, means without a common superscript letter differ ($P < 0.05$).

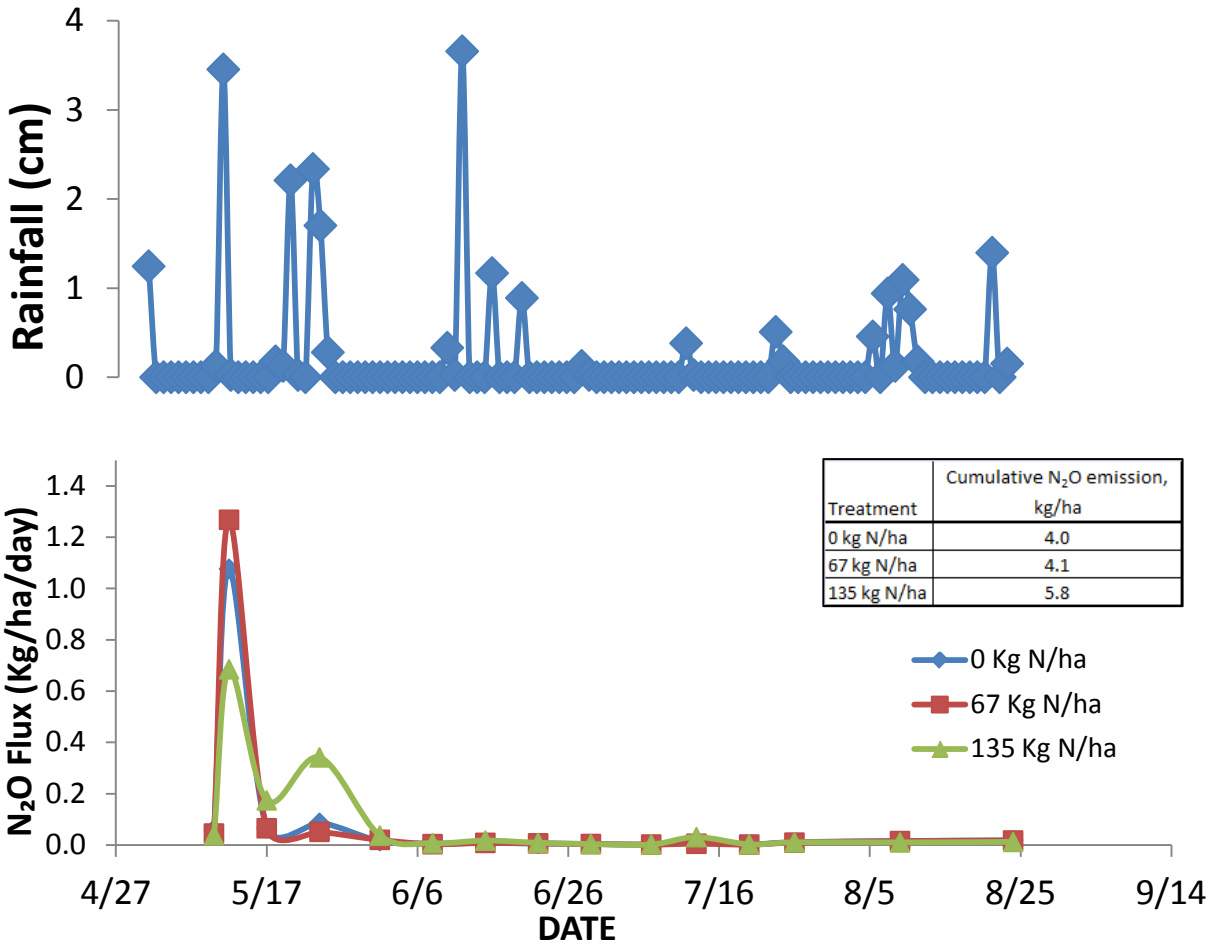

Figure 1. Precipitation and nitrous oxide flux during the grazing season at three levels of nitrogen fertilizer application. The inset table shows cumulative nitrous oxide emissions during the grazing season.

Publications:

Wallis, B.D., P.A. Lancaster, E.D. Sharman, D.B. Arnall, J.G. Warren, T.E. Ochsner, S.R. Lancaster, and G.W. Horn. 2011. Stocker production systems utilizing warm-season perennial grass pasture: Cattle performance and nitrogen use efficiency. J. Anim. Sci. 89 (E-Suppl. 1):172-173.

Utah State University
NC-1182 Progress Report
October 1, 2010 to September 30, 2011

Nitrogen Cycling, Loading, and Use Efficiency in Forage-Based Livestock Production Systems

Reporting Scientist

Rhonda Miller, Ph.D.
Agricultural Systems Technology and Education Dept.
Utah State University

Progress of Work and Principle Accomplishments

OBJECTIVE 4: *Determine the fate of excess N in grassland agroecosystems by estimating key components of nutrient cycles including aqueous and gaseous N losses.*

This study examines the effect of grazing on nitrogen cycling in both a traditional management intensive grazing system, and in a deferred grazing system. To replicate a system producers would use for maximum forage production, tall fescue was planted in the fall of 2005. The paddocks were in the establishment phase during 2006. In 2006, after the grass was growing well, soil cores measuring 38.1 cm in diameter and 111.8 cm in length were extracted using PVC pipe and a hollow-core drill. The soil cores were utilized to make zero-tension lysimeters which were then placed back in the ground. The top 40 cm of the PVC pipe was removed to allow for as much unrestricted plant growth as possible. Data collection began in the spring of 2007.

Usefulness of Findings

Economic Impact versus Environmental Impact:
Feed is one of the greatest costs a livestock producer faces. Grazing systems that extend the grazing season beyond the standard growing season, such as deferred or stockpiled grazing, reduce the need for harvested feed resulting in great reductions in machinery and labor costs. However, with the economic benefits of extending the grazing season come additional environmental concerns. Plant growth is minimal in the late fall and early spring which severely limits utilization of nutrients in the animal waste. In addition, snow melt and early spring rainfall events may "flush" many of the nutrients past the root zone. Excess nitrogen can result in groundwater contamination and eutrophication.

Future Regulations for Grazing Systems:
The Environmental Protection Agency (EPA) recently implemented new rules for Animal Feeding Operations. Although grazing operations are currently exempt from these regulations, initial discussions with EPA for the development of the Utah Strategy included grazing operations in the regulations. Little data on the environmental impacts

of livestock in grazing systems exists. In a study at the Caine Dairy, tall fescue was the best at utilizing nutrients and produced leachate with the lowest nitrogen concentrations. This study compares the environmental impacts of tall fescue in a traditional management intensive grazing system, an extended-season grazing system, and under mechanical harvest (hay production). This study will provide scientific data that can be used in the decision-making process when/if grazing systems are regulated.

Additional Work Planned

Complete soil profile samples (to a depth of 150 cm) were collected at the beginning and end of each grazing season to monitor any nutrient movement and buildup for each treatment. A composite sample of five subsamples were collected from each plot. The soil samples were analyzed for N and P at six depths (0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm, 90-120 cm, and 120-150 cm). The plots were fertilized, based on the soil tests, to maintain adequate forage production. Herbage dry matter samples were collected before and after each grazing event to determine the nutrients removed by grazing. Leachate samples were collected every two weeks during the grazing season, and as often as possible during the winter months. Leachate samples were analyzed for nitrate-nitrite on a Lachat auto-analyzer using a cadmium reduction method. Climatic data was recorded from a weather station located just outside of treatment plots. Ammonia emission measurements were made using dynamic chambers and the equilibrium concentration technique developed by JTI, Sweden (Svensson, 1994). Dynamic chambers were placed in the field immediately after each grazing event with emission measurements continuing for each plot for five days following.

Data analysis is currently underway. All data will be analyzed using PROC Mixed with Repeated Measures. To document the effects of grazing on nutrient cycling, determination of the nutrients in each phase (plant, soil, and soil water) will be made. The nitrogen balance technique will be used to estimate nitrogen losses due to volatilization. This will be done by comparing total nitrogen outputs (recovery in the plant, soil, and soil water phases) against the total amount of nitrogen inputs (fertilizer and legume nitrogen fixation).

Publications

Miller, R. L., B. Jensen, and L. Trinca. 2011. Effect of Grazing on Compaction and Nitrogen Cycling. In 2011 Agronomy Abstracts. Madison, WI: American Society of Agronomy.

Miller, R. L. 2010. Using zero-tension lysimeters to determine the effect of grazing on nutrient cycling. In 2010 Agronomy Abstracts. Madison, WI: American Society of Agronomy.

US Dairy Forage Research Center
NC-1182 Progress Report
September 9, 2010 to September 22, 2011

OBJECTIVE 2: ***Quantify the effect of dietary and animal factors on utilization and excretion of forage N by beef and dairy cattle.***

Effects of a Propionic Acid-Based Preservative on Storage Characteristics, Nutritive Value, and Energy Content for Alfalfa Hays Packaged in Large-Round Bales

Objective: Evaluate the effects of a propionic acid-based preservative on the storage characteristics and nutritive value of alfalfa hays stored as large-round bales.

Personnel: W. K. Coblentz (USDFRC)
Michael G. Bertram (University of Wisconsin)

Summary of Research: During 2009 and 2010, alfalfa hays from 2 cuttings harvested from the same field site were used to evaluate the effects of a propionic acid-based preservative on the storage characteristics and nutritive value of alfalfa hays stored as large-round bales. A total of 87 large-round bales (diameter = 1.5 m) were included in the study; of these, 45 bales served as controls, while 42 were treated with a commercial propionic acid-based preservative at mean application rates of 0.5 ± 0.14 and 0.7 ± 0.19% of bale weight, expressed on a wet (as is) or dry matter basis, respectively. Initial bale moisture concentrations ranged from 10.2 to 40.4%. Internal bale temperatures were monitored daily during an outdoor storage period, and heating characteristics were summarized for each bale as heating degree days > 30°C (HDD). For acid-treated bales, the regression relationship between HDD and initial bale moisture was best fitted to a quadratic model in which the linear term was dropped to improve fit ($Y = 2.02\ x^2 - 401$; $R^2 = 0.77$); control hays were best fitted to a nonlinear model in which the independent variable was squared [$Y = 4112 - (4549 * e^{-0.000559x*x})$; $R^2 = 0.77$]. Based on these regressions, acid-treated bales accumulated more HDD than control hays when the initial bale moisture was > 27.7%; this occurred largely because acid treatment tended to prolong active heating relative to control hays. Linear regressions of recoveries of dry matter on HDD did not differ ($P \geq 0.23$) on the basis of treatment, yielding a common linear relationship of $Y = -0.0066\ x + 96.3$ ($r^2 = 0.75$). Regressions relating changes (poststorage – prestorage) in concentrations of neutral-detergent insoluble CP (ΔNDICP) and acid-detergent insoluble CP (ΔADICP) with HDD for acid-treated and control hays are illustrated in Figure 1 and 2. Although slowed somewhat in response to acid treatment, ΔNDICP increased rapidly with only modest heating in all hays, and reached asymptotically defined limits at about 360 and 967 HDD for control and acid-treated hays, respectively. In contrast, ΔADICP increased more slowly, especially with minimal heating, but exceeded 25 percentage units of CP within severely heated hays. The accelerated response forΔADICP with greater HDD coincided with the apparent reactivity of hemicellulose. Presumably, hemicellulose concentrations decrease in response to severe heating because it becomes a reactive carbohydrate, playing an important role in Maillard reactions; subsequently, it is no longer recovered as hemicellulose, but it is recovered as artifact lignin.

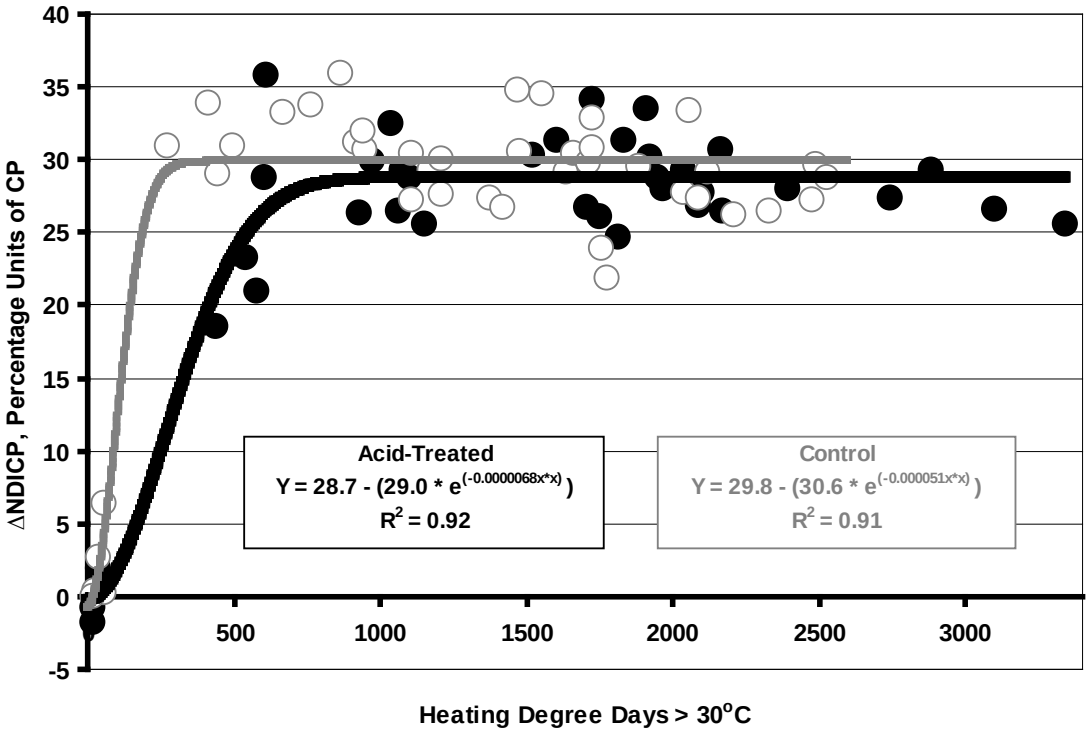

Figure 1. Changes in concentrations of neutral-detergent insoluble CP (poststorage – prestorage; ΔNDICP) as affected by heating degree days > 30°C for acid-treated (●, ▬) or control (○, ▬) alfalfa hays packaged as large-round bales. The mean prestorage concentration of NDICP (weighted on the basis of the number of bales from 2009 and 2010 harvests) was 15.1% of CP (3.4% of DM), which corresponds generally to ΔNDICP = 0 on the y-axis. Data are pooled over two harvests, and each data point represents an individual bale.

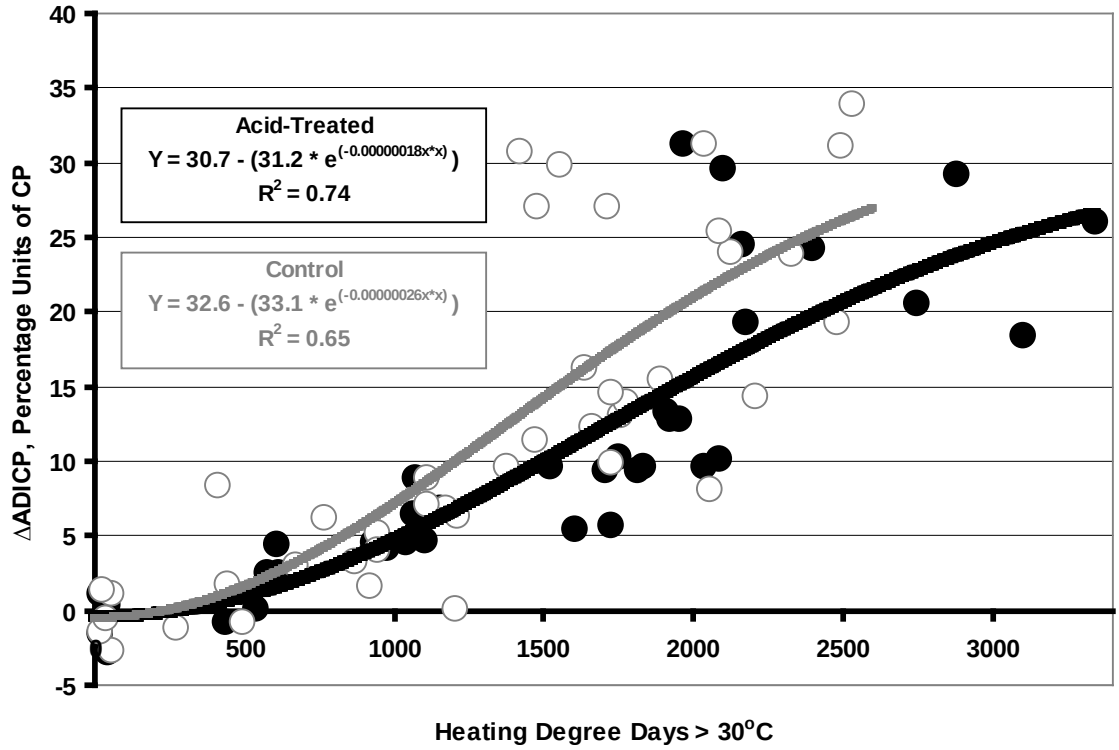

Figure 2. Changes in concentrations of acid-detergent insoluble CP (poststorage – prestorage; ΔADICP) as affected by heating degree days > 30°C for acid-treated (●, ▬) or control (○, ▬) alfalfa hays packaged as large-round bales. The mean prestorage concentration of ADICP (weighted on the basis of the number of bales from 2009 and 2010 harvests) was 6.9% of CP (1.57% of DM), which corresponds generally to ΔADICP = 0 on the y-axis. Data are pooled over two harvests, and each data point represents an individual bale.

Application of Results: Past studies have demonstrated clear benefits from application of propionic acid-based preservatives during packaging of small-square bales of alfalfa hay, and similar responses also have been observed recently at our station within (275-kg) large-square bales. However, results obtained from this study with large-round bales were much less favorable. This could be related to the greater size of the bale packages, differences in application methodologies between round and square (plunger-type) balers, or other factors. It also remains unclear whether results might have been more favorable if bale diameter had been reduced. Regardless, the potential for improving nutritive value relative to cost for these very large (1.5-m diameter) round-bale packages was not especially favorable. Producers may find that diligence to achieve adequate field desiccation prior to baling (~15% bale moisture), or use of oxygen-exclusion methods, such as wrapping in plastic, may be better alternatives for preserving moist hays baled in large round-bale packages.

Publications:

Coblentz, W. K., and M. G. Bertram. 2011. Effects of a propionic acid-based preservative on storage characteristics, nutritive value, and energy content for alfalfa hays packaged in large-round bales. J. Dairy Sci. (accepted 9/16/2011).