

Project/Activity Number: NC1182,

Project/Activity Title: “Management and Environmental Factors Affecting Nitrogen Cycling and Use Efficiency in Forage-Based Livestock Production Systems”

Period Covered: July 2017 to July 2018

Date of This Report: August 25, 2018

Annual Meeting Date(s): July 17-18, 2018

Annual Meeting Participants:

Coffey, Ken (kcoffey@uark.edu) - University of Arkansas; Miller, Rhonda (rhonda.miller@usu.edu) - Utah State University; Franklin, Dorcas (dfrankln@uga.edu) – University of Georgia; Nave, Renata (rnave@utk.edu) - University of Tennessee; Norberg, Steve (s.norberg@wsu.edu) – Washington State University; Barker, David (barker169@osu.edu) - Ohio State University; McCulley, Rebecca (rebecca.mcculley@uky.edu) – University of Kentucky; Benfield, David (Benfield.2@osu.edu) – Administrative report via Zoom.

Brief summary of minutes of annual meeting:

A summary of the decision made is in the Business portion of the minutes below.

NC1182 Minutes

Management and Environmental Factors Affecting Nitrogen Cycling and
Use Efficiency in Forage-Based Livestock Production Systems

Pasco, WA

17-18, 2018

Present:

Chair: Steve Norberg, Ph.D. Regional Forage Specialist Washington State University

Secretary: Dorcas Franklin, Ph.D. Assoc. Professor Sustainable Agriculture and Nutrient Management,
Crop & Soil Sciences, University of Georgia

State Representatives:

Arkansas State Report – Ken Coffey

Kentucky State Report – Rebecca McCulley

Georgia State Report – Dorcas Franklin

Ohio State Report – David Barker

Utah State Report – Rhonda Miller

Washington State Report – Steve Norberg

July 17th MORNING:

The multistate meeting began with a tour of Washington State University’s new Viticulture and Science Center, Prosser, WA and overview/tour of Pasco irrigated research and Extension Center. For the remainder of the morning we toured and received 5 forage presentations:

“Teff Grass for forage: Nitrogen and irrigation requirements”

“Comparisons of Switchgrass and Corn for Biomass and Bioenergy under irrigation with same N application rates.”

“Dual-purpose winter canola in the pacific northwest: Silage production”

“Alfalfa productivity and quality with varied N and P application rates”

“Orchardgrass Hay Production for the Columbia Basin of Washington”

Discussion of results, similar studies in other states and possible other research techniques and collaborations continued into lunch for a working lunch.

July 17th, Afternoon:

Introductions, state reports and business meeting (Administrative items) were conducted into the early evening.

First Order of Business

Zoom meeting with David A. Benfield who informed us of that our report was due within 60 days of July 17, 2018 and that submission of renewal had several important deadlines to note. One member asked if it were possible to request a one-year extension on the project while we discern if and what our renewal or starting a new NC project. With the goodness that we could delay the renewal for one year we voted and decided to use the year to discern and determine an updated focus and new objectives which we could all participate we would submit either a renewal or new project.

Business item 2

State reports were given by each state listed above. Discussions, questions, and suggestions were positive and abundant. Research in reports was decidedly not redundant. While all were focused on N-cycling and N use efficiency, forage management and production reports ranged from application rate trials, rotations, split N applications and timing, strategic-rotational grazing to managing to prevent losses N to the atmosphere, surface runoff and leaching in both organic and conventional agronomic systems. The exchanges were very informative and engaging.

Dorcas Franklin was to write-up minutes, report, and set-up and dialog to determine future of NC-1182. First item was to be minutes. Second item of was to begin gathering ideas for renewal objectives.

Group voted to go to Georgia 2019, May 12-14. I work on renewal if set of objectives could be agreed upon.

July 18, Morning,

Tour Gaunt farm and Zen-Noh Hay Export facility

Respectfully submitted,

Dorcas H. Franklin
Crop & Soil Sciences
University of Georgia

Specific Accomplishments, Impacts and Dissemination of work shared at our annual meeting follow and are organized by Objective. Within each objective we have also listed specific accomplishments.

Accomplishments:

1. **OBJECTIVE 1:** Evaluate legume cultural and management strategies emphasizing legume establishment, N cycling and use efficiency, and GHG emissions. (AR, KY, NE, UT). Specific objectives: (i) Identify practices that optimize legume establishment and persistence. (ii) Compare N cycling and use efficiency of ruminants grazing pastures with and without forage legumes. (iii) Determine the impact of legumes on the GHG footprint of livestock production systems.

AR – nothing to report under this objective

Georgia: (Dorcas Franklin, Dennis Hancock, and Ali Missaoui)

In ten USA Southern Piedmont pastures of Georgia we have evaluated the impact of grazing animals on potential nitrogen mineralization and biological activity measured as CO₂-C respiration and N losses in runoff. We have presented talks and poster presentations of results at the American Society of Agronomy Meetings, and Soil and Water Conservation Society Meetings (Abstracts are located in Appendix). After understanding the distribution of N in pastures based on continuous grazing practices we implemented (spring 2016) Strategic-rotational grazing practices in five of the pastures. One of the practices was strategic placement of legumes (clovers and cowpeas depending on season) mixed with other forages to regenerate critical source areas (areas within pastures that are vulnerable to erosion and nutrient losses), which were compacted by grazing animals and have begun to show positive results in reduced N losses, improved soil biological activity and potential nitrogen mineralization See Abstract G1 in Appendix.

Kentucky: *Enhanced Efficiency N Fertilizer Formulation Effect on Warm Season Pasture Productivity* -

The use of nitrogen (N) fertilizer is generally restricted on mixed species forage systems due to its stimulatory effect on grasses that increases competition with legume species. Reduced legume growth from this competition can compromise the forage nutritive value and prospective yields. The controlled-release nature of several enhanced efficiency (EE) fertilizer N products holds the potential to improve legume persistence in mixed species pastures while providing the supplemental N required by the grass component. This study evaluated the effect of different EE N formulations (ESN, methylene urea, SuperU, and a 75% ESN: 25% urea blend) and untreated urea on yield, nutritive value, and legume persistence in a 'Wrangler' bermudagrass (*Cynodon dactylon*) and 'Durana' white clover (*Trifolium repens*) mixture. Nitrogen was applied at four rates (0, 112, 224, and 448 kg N ha⁻¹) in two equal applications. The study was conducted at the University of Kentucky Spindletop Research Farm in Lexington, KY using a randomized complete block design. During the establishment year, the encroachment of volunteer white clover plants resulted in only a small decline in the clover population of the highest N rate but became larger among all treatments in the second and third years. Averaged over the three years of the study, all EE N sources maintained white clover populations similar to the unfertilized grass/clover control, but only ESN kept clover composition greater than standard urea. Total forage yields linearly increased along N rates in all years, but dry weather conditions in the second year resulted in lower total yield. Forage nutritive value followed general trends throughout each growing season, but ESN's ability to maintain clover resulted in higher nutritive value.

Enhanced Efficiency N Fertilizer Formulation Effect on Cool Season Pasture Productivity -This study evaluated the effect of different enhanced efficiency (EE) N formulations [ESN, Agrotain treated urea (ATU), and a 75% ESN: 25% urea blend] and untreated urea on yield, nutritive value, and legume

persistence in a 'KY 31' tall fescue (*Festuca arundinacea*) and 'Kenland' red clover (*Trifolium pratense*) mixture. Nitrogen was applied at four rates (0, 112, 224, and 336 kg N ha⁻¹) in two equal applications. The study was conducted at the University of Kentucky Spindletop Research Farm in Lexington, KY using a randomized complete block design. During the first year, total seasonal yield increased with increasing N rates. There was no difference in forage yield among N rate or N source in the second growing season. Clover content declined with increasing N rates, ESN and the ESN+Urea blend maintained more clover than ATU and urea.

Impacts: We have also represented the research and demonstration results to producers throughout each state participating as well as shared results, regionally, nationally, and internationally. Researchers and farmers from all scales have requested guidance on implementing a similar approaches.

Georgia: Work with Stakeholders: Producers and the Natural Resource Conservation Service Technical teams have been closely involved in the above project, which is in collaboration with North Carolina State University. We have met to discuss sampling technique and analysis, results, and research that is needed, how to share results to date, and where all felt we should focus next. This was a research and demonstration project that started with Grazing land coalition. We are now working with other researchers in the Coastal Plains ecoregions. We did submit a proposal to USDA Conservation Innovation Grants that was highly rated but not funded in 2018. Farmers, Extension and Researchers are meeting again fall 2018 to adapt our approach and resubmit.

In the first year of implementation of strategic-rotational grazing (2016), we found that the addition of legumes and mixed forages helped reduce the number of hay bales (almost half) needed to maintain cattle during a drought year. This management practice could be a critical means to help producers resist and prevail over extreme weather events.

Missouri: Our main impacts occur with producers at field days and other Extension meetings. We have a strong framework with grazing schools and a client base that seeks information from our unbiased personnel. All meetings are well-attended by producers and stakeholders in search of the latest information to improve their vocation.

Ohio: One of the most destructive insect pests that threatens persistence of alfalfa is the potato leafhopper, *Empoasca fabae* Harris (Hemiptera: Cicadellidae). Loss estimates from this pest range from \$32-66/ha. There is evidence that climate change is associated with earlier appearance of the leafhopper by migration in alfalfa fields each year and that the severity of potato leafhopper damage increases with rising temperatures. Scientists at The Ohio State University, University of Maryland, and University of Wisconsin are collaborating in research that will be the basis for revising the economic action threshold for insecticide treatment of potato leafhopper in alfalfa in light of changes in cultivars (i.e. host resistance to this pest), and the potential tolerance by grass-alfalfa mixtures. In Maryland, scientists will also relate leafhopper injury to rates of nitrogen fixation, providing a test of whether resistant cultivars and alfalfa-grass mixtures are an effective means to reduce damage to nitrogen fixation of alfalfa. This is important because an insecticide application late in the growth cycle is not practical nor would it be perceived as necessary by producers since it would have limited to no effect on yield of the current growth cycle. Ohio experienced heavy potato leafhopper pressure in the trial in 2016. Mean number of leafhoppers (adults+nymphs) per sweep in unsprayed plots in three summer growth cycles ranged from 10 to 26 in the resistant cultivar, 39 to 118 in the susceptible cultivar, and 42 to 156 in the susceptible alfalfa cultivar and grass mixture. Data will be summarized once the study is completed in 2018. In addition to providing new guidelines to forage producers and consultants, the research will demonstrate the value of leafhopper resistant alfalfa and grass-alfalfa mixtures, which will increase adoption of those practices, leading to

more sustainable approaches to protect alfalfa from this key pest. The project is funded by the USDA-AFRI Alfalfa and Forage Research Program.

The Ohio State University is part of a six state collaboration (OH, PA, MI, WI, KS, CA) to evaluate a new transgenic alfalfa cultivar with reduced lignin (RL) content developed by scientists at Forage Genetics International, The Samuel Robert Noble Foundation and the U.S. Dairy Forage Research Center and released in commercially with Monsanto Co. under the brand of HarvXtra™ alfalfa. The purpose of this research was to 1) compare forage nutritive value and yield of a RL cultivar to non-RL cultivars and 2) to determine if a recalibration of the predictive equations for alfalfa quality (PEAQ) were necessary for adequate neutral detergent fiber (NDF) predictions for RL alfalfa. For Obj. 1, the overall linear model for cultivar response to harvest intervals was significant and all cultivars responded similarly across harvest intervals and events. 'HarvXtra-008' was always higher in nutritive value than non-RL cultivars. The NDF digestibility (NDFD) for 'HarvXtra-008' was greater ($P < 0.05$) by 4.0% to 10.4% than non-RL cultivars. NDF was lower ($P < 0.05$) for 'HarvXtra-008' by 5.4 to 8.3% than '54R02' and numerically lower but not significantly different than 'WL 355RR'. Differences in yield at individual harvests among cultivars and across harvest intervals were non-significant; however, 'HarvXtra-008' was significantly lower ($P < 0.05$) in annual total dry matter yield than non-RL cultivars. For Obj. 2, The PEAQ NDF prediction was calculated from the stage of the most mature stem (MAX) and the height of the tallest stem in each sample (MAXHT) during each regrowth period. The observed NIRS values were regressed on the estimated PEAQ values. Across both states and all cuttings, root mean square error (RMSE) for all three alfalfa cultivars ranged from 25.2 to 31.8. g kg⁻¹ for NDF and the coefficient of determination (r^2) ranged from 0.60 to 0.71. When regressions were conducted on cultivar means across four replicates, RMSE ranged from 17.2 to 27.5 g kg⁻¹; the coefficient of determination also improved ranging from 0.69 to 0.83. The slopes and intercepts were tested and were not significantly different among cultivars, but the Wisconsin regressions differed from Ohio regressions. Based on the results from these studies, 'HarvXtra-008' was always higher in nutritive value within any given harvest interval and yield within harvest interval was not different from non-RL alfalfa. Furthermore, it can be harvested 5-10 d later and still have similar to better nutritive value and similar yield as non-RL cultivars harvested earlier, suggesting that alfalfa producers have more flexibility with RL alfalfa when making harvest timing decisions. The original PEAQ equations were acceptable for predicting forage NDF in the RL alfalfa cultivar we tested. The project is funded in part by Forage Genetics.

The Ohio State University is part of a three state (TN, NC, OH) collaborative study to characterize nutritive value and forage yield of alfalfa grown in monoculture and in mixtures with tall fescue and bermudagrass under four harvest frequencies (21, 28, 35, and 42-day cutting intervals). The study was established in TN and OH in 2015 and data was collected in and is being collected in 2017. Plots were established at NC in 2016. In Ohio in 2016, there was no species treatment x cutting interval interaction. Pure stands of alfalfa yielded 4.7 and 5.6 Mg ha⁻¹ more ($P < 0.05$) than alfalfa with bermudagrass and tall fescue, respectively, over the 2016 growing season. The 21-day interval had the lowest seasonal forage (8.8 Mg ha⁻¹), the 35-day interval was had the highest forage yield (12.5 Mg ha⁻¹) and while the 28-day (11.6 Mg ha⁻¹) and 42-day (11.1 Mg ha⁻¹) were intermediate. The data collected will serve as a basis for grazing and harvest management recommendations that can optimize forage availability and forage nutritive value, according to region and livestock requirements. Extension programming will be developed to share results and train producers and advisors about alfalfa production and management alternatives. The project is funded by the USDA-AFRI Alfalfa and Forage Research Program.

The Ohio State University has collaborated with the Ohio Department of Natural Resources (ODNR), US Fish and Wildlife Service (USFWS), and Great Parks of Hamilton County (City of Cincinnati) to collect and propagate running buffalo clover (RBC) (*Trifolium stoloniferum*) plants from natural sites in Ohio. Running buffalo clover is a federally protected, endangered legume species. Studies to date have found RBC has high shade tolerance, readily propagates by stolons, and has excellent nutritive value. Its potential as a forage species in native pastures is not known, however, insufficient plant material is available for the conduct of research studies. During 2017, we procured 20-25 RBC stolons from each of three sites in Ohio, and successfully cloned 914 plantlets from these stolons. Some of these plants (628) were replanted back to the original sites from which the germplasm was obtained. The experimental design for the replanting included the effects: i) season (fall-17 vs spring-18), ii) plant size (small vs large), iii) fertilizer (+ vs none), iv) genotype, and v) location, and the associated interactions. In a second study, 131 plants from the three Ohio populations were stratified over winter, and during spring were placed adjacent to three beehives, and seed harvested. Plants produced 14-20 flowers per plant, and an average of 16 seed/flower. In a third study, 156 plants for Ohio were used to characterize three Ohio populations, and 5 accessions originated from Kentucky.

Impact: Results of a six-state collaborative study evaluating alfalfa with reduced lignin concentrations demonstrated that this trait improves the fiber digestibility of the harvested forage compared with standard cultivars, which will lead to improved ruminant livestock productivity. The reduced lignin trait will widen the period of time when it is possible to harvest the crop with adequate nutritive value to support high animal productivity, thus reducing losses in animal gains due to poor forage quality and potentially improving the economic sustainability of alfalfa-based forage systems.

Utah: ii. *Nitrogen cycling and use efficiency of pastures with and without legumes.* Research currently examines the impacts of grasses (tall fescue, meadow brome, orchard grass, and a high-carbohydrate perennial ryegrass) with varying carbohydrate levels as grass monocultures versus grass-legume (birdsfoot trefoil) mixtures, which contain tannins. Yield, rate of gain, plant, soil, and leachate samples are being collected to determine the impact of tannins and high carbohydrate forages on nutrient cycling. Preliminary results show the highest rates of gain with the grass-legume mixtures, with the perennial ryegrass mixture having the highest rate of gain followed by the orchardgrass, meadow brome, and tall fescue mixtures, respectively.

2. **OBJECTIVE 2:** *Assess the efficacy of secondary plant metabolites in legume species for increasing N retention and improving N-cycling in forage-livestock systems. (AR, KY, MI, UT) Specific objectives: (i) Evaluate effects of birdsfoot trefoil, a tannin-containing legumes, on N partitioning in dung and urine excretions. (ii) Determine soluble phenolic and genotypic effects on forage legume protein fractionation and nitrogen availability. (iii) Evaluate effects of genetic variability in tannin concentration on soil N availability in mixed birdsfoot trefoil/tall fescue swards.*

Arkansas: Received a NIFA grant.

M.C. Savin, K.P. Coffey, J. Zhao, and D. Philipp Enhancing sustainability of forage-based ruminant production systems by improving N-use efficiency and decreasing N emissions. USDA-NIFA-AFRI - Bioenergy, Natural Resources and Environment. \$499,471

GA - Nothing to report.

KY - Nothing to report.

Michigan: Evaluated the effects of genetic variability in tannin concentration on soil N availability in mixed birdsfoot trefoil/tall fescue swards. Major activities completed/experiments conducted: Increasing Legume Grazing for Higher Beef Gain on Pastures: An Improved High-Tannin Birdsfoot Trefoil Cultivar with Trans- Regional Potential. Data collected: Final data were collected on vigor, flowering date, and persistence/survival of birdsfoot trefoil accessions and varieties. In 2018, winter survival, vigor, flowering date, and seed pod rating were recorded for surviving individual trefoil plants in a selection nursery. Final spring stand density data were collected for birdsfoot trefoil varieties managed under grazing. Summary statistics and discussion of results: Final data are currently being analyzed. Key Outcomes and other accomplishments realized: The best accessions and commercial varieties survived up to four years in Michigan.

Impact: Birdsfoot trefoil accessions and commercial varieties were able to persist for up to four years in

Missouri: Found that 1) ensiling characteristics of Sunn hemp, not the nutritive value, contributed to reduced animal performance compared to tall fescue, likely due to an unfavorable environment for rumen microbes; 2) Interseeded Sunn hemp can be managed in Tall fescue pasture for improved DM yield and nutritive value during the summer; and 3) Nutritive value of an experimental striate lespedeza (MU 3993) and Korean lespedeza may be more desirable than 'Legend' lespedeza based on greater dNDF and lesser concentrations of biologically active polyphenolic compounds. However, Legend is superior if the objective is to exploit condensed tannins and their protein binding ability for potential benefits of rumen bypass protein.

Utah: Fecal and urine samples have been collected from Jersey heifers grazing grasses (tall fescue, meadow brome, orchard grass, and a high-carbohydrate perennial ryegrass) with varying carbohydrate levels as grass monocultures versus grass-legume (birdsfoot trefoil) mixtures, which contain tannins. Sample analysis is underway.

3. *OBJECTIVE 3: Quantify effects of pasture management strategies on N use efficiency by ruminant animals and N cycling in herbage and soils of grassland agro-ecosystems. (AR, NE, MI, OK) Specific objectives: (i) Investigate effects of management strategies that alter spatiotemporal distribution of grazing and nutritive value of forage on ruminant performance and N harvest efficiency. (ii) Evaluate effects of management strategies on herbage mass and accumulation, nutritive value, botanical composition, and N use efficiency across growing seasons and pasture landscapes. (iii) Determine N pool and cycling responses to management strategies across variable soil environments and climatic conditions.*

Arkansas: Annual ryegrass (*Lolium multiflorum*) was baled when it reached either 74% moisture (WET) or 30% moisture (DRY), and then wrapped either the day of bailing (D0) or 1 (D1), 2 (D2), or 3 d (D3) after bailing to produce round-bale silage. The silages were then offered to lambs to determine how the treatments affected forage intake and digestibility. Dry matter intake and intake of digestible dry matter were greater for DRY than WET silage. Generally intake of dry matter and digestible dry matter was greatest from silage wrapped the day of baling and declined thereafter.

Impact: A greater number of producers are attempting to make round bale silage rather than hay. This information along with previous work provides producer with information to help them understand which factors are the most important and have the greatest impact on animal preference and performance when making round bale silage from different forages.

Georgia: In ten USA Southern Piedmont pastures (approx.. 17 ha each) of Georgia, we have evaluated the impact of grazing animals on plant available nitrogen ($\text{NO}_3 + \text{NH}_4$) distribution. Our first manuscript titled: “Spatial distribution of inorganic nitrogen in pastures: as affected by management and landscape, and Cattle locus” has been accepted, revisions submitted and may be published in the September 2018 volume of Journal of Environmental Quality. We will also present results at the 2018 American society of Agronomy Annual meeting in Baltimore, MD Nov. 2018.

Impact: We have also presented research and demonstration results to producers throughout Georgia at grazing schools and on-farm demonstrations. Several farmers have requested soil sampling on their farms to better understand impact of their grazing management on soil N distribution. We have sampled, analyzed and compiled N distribution maps with four producers in Piedmont Georgia. A Field Day with results is scheduled for September.

Kentucky: *Enhanced Efficiency N Fertilizer Formulation Effect on Stockpiled Tall Fescue* -This study evaluated the effect of different enhanced efficiency N formulations [ESN, Agrotain treated urea (ATU), and SuperU] and untreated urea on yield and nutritive value in a ‘KY 31’ tall fescue (*Festuca arundinacea*) stockpiled pasture. Nitrogen was applied at four rates (0, 45, 90, and 135 kg N ha⁻¹) in one fall application. The study was conducted at the University of Kentucky Spindletop Research Farm in Lexington, KY using a randomized complete block design. Data are currently being analyzed.

Missouri: 1) Intercropping sunn hemp in tall fescue pastures during the summer resulted in greater crude protein concentration through the late summer and fall growth compared to an unfertilized tall fescue system. Biological-nitrogen fixation from the sunn hemp may have contributed to greater forage nutritive value, however no significant difference in system yield was observed. Sunn hemp intercropped system resulted in greater stocking density but we measured no significant difference in stocker cattle average daily gain. Sunn hemp is a viable option to intercrop within tall fescue systems to increase forage nutritive value during the summer and fall. 2) Program was awarded a USDA/NRCS CIG grant to fund development of a Bluetooth smartphone-GIS integrated system to measure forage availability in pastures. It allows for on-farm demonstrations and research to monitor forage production in various management regimens. An ultrasonic sensor collects data, Bluetooth transmits to the smartphone, and uploads to a server where it is processed/parsed; then users view the output tools on a website

(www.grazingwedge.missouri.edu) to provide data-driven decisions about pasture management.

3) Sourcing ammonium nitrate continues to be difficult in the Midwest. Urea is risky to use in pasture situations at certain times of the year. We evaluated different ratios of Agrium’s ESN product with urea to protect against nitrogen loss from pasture systems. From a cumulative yield and one time *spread-it-and-forget-it* standpoint, 100% ESN showed the most value over urea when applied in early October; while treatment effects were nonexistent in the autumn after application, apparently plants used 100% ESN readily into July of the next summer. If fertilization occurs in late August, at least 50% ESN should be included in mixtures with urea to protect N through the following spring. Preliminarily, these application timings would leverage the benefits of ESN to grass production in pasture systems.

KY - Nothing to report.

4. *Objective 4: Evaluate byproduct supplementation as a source of N for annual forages in integrated cropping livestock systems.*

Georgia: No work done in this objective.

Arkansas: Growing lambs were offered diets with either 8% or 13% crude protein for 9 weeks. Lambs offered the high crude protein diet had greater final body weight, intake, daily gain, and more efficient feed conversion than those offered the low protein diet. However, color characteristics of lamb carcasses were more desirable from lambs offered the low protein diet.

Impact: Results were presented at a scientific meeting along with more basic data on how protein levels impacted muscle development. Based on this information, producers can be educated about the importance of adequate protein for more efficient use of nitrogen by growing lambs. Improved efficiency will result in greater profitability by lamb producers.

5. *Objective 5: Disseminate research results through coordinated extension/education activities, including extension publications, university course material, and regional and state conferences on nitrogen cycling and use efficiency and management of grass-legume mixtures. (AR, KY, MI, NE, OK, UT)*

Arkansas:

Information derived from Arkansas research and that from other states is used routinely in multiple courses at the University of Arkansas. This information is particularly useful and routinely presented in courses taught by Ken Coffey including “Forage-Ruminant Relations” a graduate-level class and “Applied Animal Nutrition” and “Stocker/Feedlot Cattle Production”, both undergraduate courses.

Impact: Undergraduate and graduate students are given information about the most recent findings about how various management practices impact nitrogen efficiency throughout the nitrogen cycle. This gives them tools to better educate producers on their current or future jobs.

Publications

Clark, J. K, K. P. Coffey, W. K. Coblenz, B. C. Shanks, J. D. Caldwell, R. E. Muck, D. Philipp, M. A.

Borchardt, R. T. Rhein, W. E. Jokela, E. A. Backes, M. G. Bertram, and W. B. Smith. 2018. Voluntary intake and digestibility by sheep of alfalfa ensiled at different moisture concentrations following fertilization with dairy slurry J. Anim. Sci.96:964-974.

Hays, M. A., K. P. Coffey, P. A. Beck, W. K. Coblenz, C. P. Weiss, T. S. Crook, and D. Philipp. 2018. Effects of delayed wrapping and moisture content on intake and digestibility of ryegrass silage by growing lambs. J. Anim. Sci. 96(Suppl. 1):31-32 (Abstr.) <https://doi.org/10.1093/jas/sky027.059>.

Huang, Y., S. Shelby, X. Wang, J. Apple, and K. Coffey. 2018. Effect of two dietary crude protein levels on finishing performance, carcass characteristics, and meat quality of lambs. J. Anim. Sci. 96(Suppl. 1):29-30 (Abstr.) <https://doi.org/10.1093/jas/sky027.055>.

Georgia:

Recent news articles relevant to the subject:

- Fertilizer Prices: The Game Has Changed, Again - Progressive Forage Grower Magazine - April 2016

- Soil Organic Matter: The Secret to Successful Farming - Progressive Forage Grower Magazine - March 2016
- Poultry litter: Black gold or black plague? - Progressive Forage Grower Magazine - January 2016

Talks

Hayfield management (discussing economical N fertilization strategies) 8-29-18 Monroe Co.
 Hayfield management (discussing economical N fertilization strategies) 8-30-18 Greene Co.
 Forage management techniques of master cattlemen (discussing economical N fertilization strategies) 1-17-17; 9-5-17; 2-13-18
 Alfalfa in bermudagrass (N replacement; Lillington, NC) 8-23-18
 Are Clovers Worth It? (AL Farmers Alliance meeting, Montgomery, AL) 2-7-18
 Sustainable Grass-Grazing Rain, Sunlight, and Soil (Roane Co. TN) 2-23-17
 Producing high quality harvested forage (affects of fertility on hay quality; Auburn, AL) 6-21-18
 Alfalfa in bermudagrass (N replacement; New Iberia, LA) 6-14-18
 Tried and True Approaches to Using Clovers in the Southern United States in Forage and Cover Crop Mixtures (Portland, OR) 2-7-18
 Hayfield management (discussing economical N fertilization strategies) 9-7-17 Turner Co.
 Sustainable Grass-Grazing Rain, Sunlight, and Soil (GA Farm Bureau Young Farmers Convention; Jekyll Island) 7-20-17
 Alfalfa and nitrogen fixation - Alfalfa Intensive Training Seminar 12-14-17 Cuyahoga Falls, OH
 Legume nitrogen fixation - GA Grazing School 9-20-17 Athens, GA
 Fertilization Outlook for Hay Producers - SE Hay Convention 3-14-17 Moultrie, GA
 Management Recommendations to Minimize or Eliminate Fescue Toxicosis (Use of Legumes, moderation of N rates) 2-16-17 Athens, GA
 Management Recommendations to Minimize or Eliminate Fescue Toxicosis (Use of Legumes, moderation of N rates) 3-23-17 Rock Springs, GA

Scientific papers

Cyle, K.T., N. Hill, K. Young, T. Jenkins, D. Hancock, P.A. Schroeder, and A. Thompson. 2016. Substrate quality influences organic matter accumulation in the soil silt and clay fraction. *Soil Biology and Biochemistry* 103:138-148.

Hancock, D., K. Saha, J. Tucker, and R. Stewart, Jr. 2016. Observations of high nitrate concentrations in forage bermudagrass during severe to exceptional drought years. *American Journal of Plant Sciences*. 7:695-701. doi: 10.4236/ajps.2016.74062.

Payne, K.M., B.M. Goff, S.R. Smith, J.H. Grove, M.S. Coyne, J.W. Lehmkuhler. 2018. Enhanced efficiency nitrogen fertilizer effect on pasture productivity. KFGC Eastern Field Day, Morehead, KY. 6 Sept.

Payne, K.M., B.M. Goff, S.R. Smith, J.H. Grove, M.S. Coyne, J.W. Lehmkuhler. 2018. Enhanced efficiency nitrogen fertilizer effect on pasture productivity. Donald Sparks IPSS Graduate Research Symposium, Lexington, KY. 23 March.

Kentucky:

Forage News Articles (distributed electronically and available online):

- 31 Aug 2018, Featured Publication: Forage Establishment
- 31 Aug 2018, Forage Timely Tips: September
- 31 Aug 2018, New Crimson Clover Available: Kentucky Pride
- 30 Jul 2018, Forage Timely Tips: August

- 29 March 2018, Featured Publication: Alfalfa Management Guide
- 31 Jan 2018, Frost Seeding Red and Ladino White Clover Soon
- 19 Dec 2017, Maximizing Success with Frost Seedings of Clover
- 1 Dec 2017, Don't Trip on Triple-19

Michigan:

Extension presentations in Michigan over the past year included seventeen programs that incorporated aspects of nitrogen management. Material was also incorporated into an undergraduate Forage Management class at MSU. Data collected: Participants completed program evaluations that were incorporated into extension impact summaries. Summary statistics and discussion of results: Participants responded positively to research results. Key outcomes or other accomplishments realized: Outreach education improved farmer knowledge of nitrogen management in forage crops.

Abstracts and Posters

*Renz, M.J., W.R. Osterholz, J.H. Grabber, K.A. Cassida, E.E. Burns, J.A. Williamson, and D.L. Bjornberg. 2018. Identifying factors to optimize establishment of alfalfa interseeded in corn. 2018 Joint Conference of NAAIC, Trifolium, and Grass Breeders, June 4-6, 2018. Logan Utah.

https://www.naaic.org/Meetingsa/National/2018meeting/13_Grabber_Abstract.pdf

*Rojas -Downing, M.M., A.P. Nejadhashemi, B. Elahi, K.A. Cassida, F. Aneshvar, J. S. Hernandez-Suarez, M. Abouali, M.R. Herman, S.A. Al Masraf, and T. Harrigan. 2017. A Systems Approach to Address Sustainability in Dairy Production. The National Systems Conference. December 1-3, 2017, Agra, India. (oral presentation)

Sulc, M., A. Parker, K. Albrecht, K. Cassida, M. Hall, D.H. Min, S. Orloff, D. Undersander, X. Xu, and E. van Santen. 2017. Reduced lignin alfalfa: research update & implications to harvest management. Western Alfalfa & Forage Symposium, Nov. 28-30, 2017, Reno, NV. (invited)

Cassida, K.A. 2017. Potential of Alternative Legumes in Michigan Forage and Cover Crop Systems. Annual Meeting of ASA/CSSA/SSSA, Tampa, FL, Oct. 22-25, 2017.

<https://scisoc.confex.com/scisoc/2017am/webprogram/Paper109156.html>

MacAdam, J.W., K. Cassida, and E. van Santen. 2017. Location of growth influenced birdsfoot trefoil tannin accumulation, but few accessions differed in tannin concentration. Annual Meeting of ASA/CSSA/SSSA, Tampa, FL, Oct. 22-25, 2017.

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Proceedings

Cassida, K.A., R.M. Martin, J.E. Rowntree, and J. Schwehofer. 2018. Finishing forages for grass-fed beef. Online. In: Proc. American Forage & Grassland Council, Jan. 14-16, 2018, Louisville, KY. AFGC, Berea, KY. http://www.afgc.org/proceedings/2018/Kim_Cassida_CassidaK_018_POST.pdf

Cassida, K.A., R.M. Sulc, A. Parker, K. Albrecht, M. Hall, D. Min, S. Orloff, and D. Undersander. 2018. Yield and quality of reduced lignin alfalfa across six states. In: Proc. American Forage & Grassland Council, Jan. 14-16, 2018, Louisville, KY. AFGC, Berea, KY.

Extension Bulletins

Cassida, K., J. Paling, and C. Kapp. 2018. *2017 Michigan Forage Variety Test Report*. MSU Forage Factsheet 18-01, 37 pages. Published Feb. 1, 2018. <https://forage.msu.edu/publications/> (Online.)

https://forage.msu.edu/wp-content/uploads/2018/02/149374-MSU-Forage-Varieties-Printed-Bulletin-January-2018-corrected_v4.pdf

Cassida, K., and J. Lindquist. 2018. *Frost-Seeding – an Effective Forage Establishment Practice for Michigan*. MSUE #E2125. <https://forage.msu.edu/wp-content/uploads/2018/08/E2185-FrostSeedingAnEffectiveForageEstablishmentPracticeForMichigan-2018.pdf>

Other Creative Works

Cassida, K.A. (webmaster). MSU Forage Connection. <http://forage.msu.edu/> (website)

Cassida, K. 2018. Manage alfalfa autotoxicity for healthier stands. Michigan Farmer online. https://www.michiganfarmer.com/alfalfa/manage-alfalfa-autotoxicity-healthier-stands?NL=FP-009&Issue=FP-009_20180815_FP-009_987&sfvc4enews=42&cl=article_1_b&utm_rid=CPG02000000283296&utm_campaign=30360&utm_medium=email&elq2=caf0564f51d5490ca97bde6f774ad2ae. Accessed 8/16/18.

Cassida, K. 2017. Grass-finished beef need high-energy forages. *Hay & Forage Grower*, April/May pp 8-9.

Scientific and Outreach Oral Presentations.

Aug. 21, 2018 – Michigan Forage Council Bus Tour, Alfalfa Management. Michigan Thumb area. (Audience: 40)

July 26, 2018. Forage Genetics International Alfalfa Field Day, East Lansing, MI. (Invited) (Audience: 36)

June 13, 2018 – Forage Walk, Upper Peninsula Research & Extension Center, Chatham, Michigan. (Audience: 36)

May 17, 2018 Alfalfa Harvest Scheduling – MSUE Field Crops Virtual Breakfast Meeting, 6:30-7:00 am.

May 8, 2018 - Doubling Up: Forages as Cover Crops, St. Joseph County 2018 Breakfast Meeting,

Mar. 27, 2018. “Alfalfa & Grass Mixes for Higher Income & Quality” at MSU Winter Forage Meetings – Optimizing Forage Profitability in 2018. Coldwater, Michigan.

Mar. 22, 2018. “Alfalfa & Grass Mixes for Higher Income & Quality” at MSU Winter Forage Meetings – Optimizing Forage Profitability in 2018. Shepherd, Michigan.

Mar. 13, 2018. “Alfalfa & Grass Mixes for Higher Income & Quality” at MSU Winter Forage Meetings – Optimizing Forage Profitability in 2018. Bad Axe, Michigan.

Mar. 7, 2018. “Forage Research Update.” Great Lakes Forage and Grazing Conference. St. Johns, MI.

Mar. 5. 2018. “Interseeding Alfalfa into Corn” MSUE Field Crops Webinar Series.

Feb. 27, 2018. “Forage Species for Grassfed Beef Systems.” Grass-fed Beef School. Audience: 45. (Invited)

Jan. 10, 2018. “Meeting Forage Demand.” MABA Conference, Lansing, MI. Audience: 14 (Invited)

Dec. 30, 2017. “Grazing Cover Crops.” Cover Crop Services, LLC. Shipshewana, IN. Audience: ~25 (Invited)

Dec. 20, 2017. “Forage Research Update.” Agronomy Update. East Lansing, MI. Audience: 150.

Nov. 14-16, 2017. “Alfalfa Establishment,” “Soil Fertility,” and “Value of alfalfa in crop rotations.” Alfalfa Intensive Training Seminar, Boise, ID. Audience: 25 (Invited)

Nov. 3, 2017. “Grazing cover crops.” KBS Cover Crop Field Day. Audience: 150.

Sept. 21-22, 2018. “Introduction to grazing management,” Understanding Forage plants and Their Response to Grazing,” “Pasture establishment & Renovation.” MSU Beginner Grazing School. Students: 19.

Missouri:

Lepcha, I., *Naumann, H.D., Fritschi, F., and Kallenbach, R. Partitioning of dry matter and forage nutritive value in sunn hemp plant components. Submitted 2018. Crop Science.

Lepcha, I., H.D. Naumann, F.B. Fritschi, and R.L. Kallenbach. 2018. Yield, nutritive value and regrowth potential of Sunn hemp at different harvest regimen and maturity. Crop Sci. *In Review*.

Kiniry, J.R., S. Kim, A.S. Williams, T.R. Lock, and R.L. Kallenbach. 2018. Simulating biomodal tall fescue growth with a degree-day based process oriented plant model. Grass & Forage Sci. *In Press*.

Kallenbach, R.L., C.A. Roberts, J.A. Lory, and S.A. Hamilton. 2017. Nitrogen fertilization rates influence stockpiled tall fescue forage through winter. Crop Sci. 57:1732-1741.

Kallenbach, R.L., T.R. Lock, S.A. Hamilton, and J.A. Lory. 2018. Measure, monitor, and manage grazing systems using Paddocktrac. AFGC, Louisville, KY.

Hamilton, S.A. 2018. Use of Irrigation on Pasture-Based Dairies to Determine Forage and Irrigation Type Efficiencies. <https://projects.sare.org/project-reports/onc16-014/>

Ohio:Extension and Education Activities.

Extension presentations in Ohio over the past year included 16 extension articles and presentations; half of which specifically addressed aspects of legume and alfalfa management. Material was also used with a graduate/undergraduate Forage Management class at OSU (HCS5412).

Utah:

Two field days were held at the Lewiston Intermountain Irrigated Pasture Facility in 2018. The first field day was held as part of the North American Alfalfa Improvement Conference and targeted forage breeders and other agricultural professionals throughout the United States. The second field day targeted producers and demonstrated the potential of grazing using grass-legume mixtures, and the impact of tannins.

Publications

Cox, S., M. D. Peel, J. E. Creech, B. L. Waldron, J. S. Eun, D. Zobell, R. L. Miller, and D. L. Snyder. 2017. Forage production of grass-legume binary mixtures on Intermountain Western USA irrigation pastures. Crop Science 57:1-12.

Miller, R. L., J. Long, and M. Jensen. 2017. Using tannins to alter nitrogen cycling in a grazing system. In 2017 Agronomy Abstracts. Madison, WI: American Society of Agronomy.

Miller, R. L., J. Long, and M. Jensen. 2017. Impact of tannins on nitrogen cycling and the potential to reduce ammonia and greenhouse gas emissions. ASABE Presentation No. 1701035. St. Joseph, MI: American Society of Agricultural and Biological Engineers.

Appendix:

Georgia:

The 2018 Soil and Water Conservation Society Meeting Albuquerque, New Mexico,

Same authors for both presentation and poster: Dahal Subash^{1,3}; Dorcas H Franklin, PhD^{1,4}; Miguel L Cabrera, PhD¹; Dennis Hancock, PhD¹; Lawton Stewart; PhD²

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Topic: Soil Health Resources, Indicators, Assessment and Management

(G1)Title: Strategic Rotational Grazing for Improving Soil Health, Water Quality and Forage Productivity in Beef Pastures

A study was conducted in 10 beef-pastures of Georgia Southern Piedmont to develop a grazing management system which will improve soil health, water quality and forage productivity. In 2015, in-situ soil respiration and potentially mineralizable nitrogen were measured in 18% of randomly selected locations of a 50-m grid (“matrix”) of the pastures, as well as specific areas with high cattle activity (“AOIs”). Runoff collectors were installed in dominant watersheds of all pastures. In 2016, “Strategic-rotational” grazing was devised and implemented, in 5 of the pastures, which consisted of several better grazing techniques. During the baseline study, soil respiration was significantly higher in the “matrix” (1256.98 mg CO₂/day/m²) as compared to the “AOIs” (1047.58 mg CO₂/day/m²) suggesting an uneven spatial distribution of microbial activity. In 2017, the over seeded exclusions (1417.22 mg CO₂/day/m²) and non-excluded areas (1333.88 mg CO₂/day/m²) were not significantly different in terms of soil respiration suggesting an improvement in soil respiration in the excluded “AOIs”. In the baseline, potentially mineralizable nitrogen was significantly higher in the “AOIs” as compared to the “matrix”. We expect to see a uniform distribution of potentially mineralizable nitrogen in the “strategic-rotational” pastures. In 2016, in one of the study sites, significantly less hay (17 bales) was required in the “strategic-rotational” pastures as compared to (45 bales) “conventional” pastures. Also, the NDVI images created from satellites data (Sentinel-2) also demonstrated significantly higher overall-biomass of forages in the “strategic-rotational” pastures. We expect to have cleaner water (in terms of nitrate and ammonium) in the “strategic-rotational” pastures as compared to “conventional pastures”. While it is still early stage of our research, strategic-rotational grazing practice appears to be rapidly improving the soil health and forage productivity in beef-pastures.

Topic: Conservation Models Tools and Technologies

Title: Spatial Distribution of Plant Available Nitrogen in Conventionally Managed Beef-Pastures of Southern Piedmont, Georgia

Conventionally managed beef pastures are prone to non-uniform spatial distribution of nitrogen in soil. This study aims to determine the spatial distribution of plant available nitrogen (NH₄⁺ and NO₃⁻) and factors responsible for such distribution. An extensive soil sampling was conducted in 10 beef-pastures (9.31-21.62 hectares) of Georgia Southern Piedmont. Soil samples were taken at 0-5cm, 5-10cm and 10-20cm depths in a 50m grid (“Matrix”) as well as specific areas with high cattle activity (“AOI”). Plant available nitrogen was measured using cold KCL extraction procedure. Different pasture management factors (distance to nearest hay, water and tree/shade) and landscape parameters (curvature, slope, aspect,

flow direction) were measured using GIS technology. Cow locations were measured using LOTEK GPS collars every 5 minutes. Results suggested significant spatial autocorrelation ($p=0.05$) in the distribution of plant available nitrogen, at all three soil depths, suggesting uneven spatial distribution. Stepwise variable selection was used to identify the parameters responsible for the uneven distribution of plant available nitrogen. Plant available nitrogen decreased significantly with distance from hay, water or trees at all three depths. Cattle density and the lay of the land also had a significant impact on the distribution. Recursive Partitioning technique was used to select a threshold distance (for Distances to Shade, Water and Hay individually) within which the plant available nitrogen was different than the rest of the sampling locations. In general, plant available nitrogen was significantly higher within 100 m of the hay, shade and water. These results put light on the importance of management factors for uniform distribution of nitrogen in beef-pastures. Although landscape parameters cannot be manipulated easily, strategic placement of hay, portable shades, and waterers can be useful tools for achieving optimum land use for sustainable productivity.

Title: Strategic-Rotational Grazing to Reduce Inorganic N losses in Runoff from Beef Pastures

Nitrogen in surface runoff from conventionally managed pastures has disadvantages (i) loss of expensive Nitrogen from the field, and (ii) stream contamination accelerating eutrophication. In August 2015, pour-point collectors were established (in 3-5 sub-watersheds in each pasture) to collect surface runoff in eight “Conventionally” managed beef-pastures in Southern Piedmont, Georgia, USA. Runoff samples were collected immediately after each rainfall event and filtered (within 48 hours; 0.45 μm filter) and analyzed for nitrate (NO_3^-) and ammonium (NH_4^+). To reduce nitrogen in surface runoff, in May 2016, a novel grazing system (“Strategic-Rotational Grazing”) was devised and implemented in four pastures. The remaining four pastures were conventionally managed to allow comparison with “Strategic-Rotational Grazing”. The “Strategic-Rotational Grazing” includes excluding and over seeding vulnerable areas, strategic placement of shade, hay, and water, and moderate rotational grazing. A total of 60 runoff events, 28 before treatments and 32 events after treatments were recorded. Before treatment, the runoff NO_3^- was not significantly different between Strategic pastures (0.64 mg L^{-1}) as compared to Conventional pastures (0.93 mg L^{-1}). After treatment, NO_3^- was significantly lower (0.07 mg L^{-1}) in the Strategic pastures as compared to the Conventional pastures (0.29 mg L^{-1}). There was a significant increase in NH_4^+ after treatments in both Strategic and Conventional pastures, however, there was no significant difference between strategic rotational (0.83 mg L^{-1}) pastures and conventional pastures (0.65 mg L^{-1}). The results indicated that “Strategic-Rotational Grazing” could be a useful management tool to reduce NO_3^- loss in runoff from pastures.

Missouri:

Nutritive Value and Ensiling Characteristics of Sunn Hemp (*Crotalaria juncea* L.) Baleage Impact Animal Response

In fescue-based forage-livestock systems, tall fescue (TF; *Lolium arundinaceum*

(Schreb.) S.J. Darbyshire) is commonly harvested for stored forage at later stages of maturity when its nutritive value is less than optimum. Sunn hemp (SH; *Crotalaria juncea* L.) is a high yielding and high nutritive value warm-season legume that may be used as a suitable alternative stored forage. Our objectives were to compare ensiling characteristics and nutritive values of SH and TF, as well as animal performance when fed over winter. SH and TF baleage were analyzed for ammonia and total VFA, as well as nutritive value (CP, NDF, ADF, IVTD) in each bale during feedout. Stored forage was allocated to weaned steers at 3.5% of body weight to ensure no limit-feeding occurred. Forage refusals were weighed and removed daily. Cattle were weighed every 20 days for a 80-d period to determine ADG.

Total VFA and ammonia concentrations for SH were 51.5 and 27.1 g/kg DM, respectively; those of TF were 19.8 and 11.3 g/kg DM. We observed a species x period interaction ($P \leq 0.05$) for NDF and CP. NDF was greater in TF compared to SH for all feeding periods. Crude protein was greater in SH than TF through all periods except for period 1. Compounded average daily gain were greater ($P < 0.05$) in TF (0.71 kg/d) compared to SH (0.27 kg/d). However, a species by period interaction ($P < 0.05$) was observed such that ADG was greatest for TF during period 2 (0.83 kg/d) and least for SH in period 3 and 4 (0.12 and -0.27 kg/d, respectively). Animal performance was greater for TF but the nutritive value of SH was greater or equal to TF. Our results suggest that the ensiling characteristics of SH, not the nutritive value, contributed to reduced animal performance, likely due to an unfavorable environment for rumen microbes.

Interseeding Sunn Hemp (*Crotalaria juncea* L.) into Tall Fescue Pasture for Summer Forage Production

Warm-season legumes in tall fescue (TF) pasture can improve productivity and nutritive value when TF becomes dormant and less productive during summer. Our objectives were to evaluate *Crotalaria juncea* L. (Sunnhemp; SH) as potential species for interseeding into TF pasture with different interseeding systems (Mow-drill: MD, Strip-kill drill: SKD, TF, SH) and nitrogen (N) rates (0 and 50 lbs. /acre) on forage yield and nutritive values during summer. Yield and nutritive values were determined on data collected at 45, 55 and 65 days after planting (DAP) during the summer of 2016. Forage yield for SKD (3.1 Mg ha⁻¹) and MD (2.7 Mg ha⁻¹) were similar but SKD yielded greater ($P < 0.05$) than TF (2.5 Mg ha⁻¹) and SH (2.0 Mg ha⁻¹) at 65 DAP. Forage yield increased with maturity and N rates ($P < 0.05$). Crude protein concentrations were similar between SKD, MD and SH (153, 157, 155 g kg⁻¹ respectively) but greater ($P < 0.05$) than TF (135 g kg⁻¹) at 45 DAP. Crude protein was greater for MD than TF but similar to SH, and SKD at both N rates. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were greatest ($P < 0.05$) for TF (600, 320 g kg⁻¹ respectively) followed by SKD, MD and SH (503, 494 and 384 g kg⁻¹ NDF, and 299, 296 and 288 g kg⁻¹ ADF respectively). Interseeding systems produced lower NDF than TF but similar ADF at both N rates. In vitro true digestibility was greatest ($P < 0.05$) for SH (856 g kg⁻¹) followed by MD and SKD (833 and 824 g kg⁻¹ respectively) and lowest ($P < 0.05$) for TF (806 g kg⁻¹) at 45 DAP. Digestibility was greater for MD than TF at both N rates ($P < 0.05$). Our results suggest that both MD and SKD systems of interseeding SH can be managed in TF pasture for improved DM yield and nutritive value during the summer.

Yield, Nutritive Value and Condensed Tannins are Affected by Cultivar of Annual Lespedeza

‘Marion’ lespedeza was once the predominant summer-annual legume in Missouri and other parts of the Southeast due to its persistence in low fertility acidic soils. It is now virtually unavailable. Other varieties have not been widely evaluated in replicated trials.

An experimental cultivar of annual lespedeza, *Kummerowia striata* (Thunb.) Schindl., (MU 3993) has been selected for its characteristic tolerance to heat- and water-stress. MU 3993 may prove to be a valuable resource during the summer months in cool-season forage-livestock systems.

We evaluated the annual DM yield, nutritive value, and polyphenolic characteristics (condensed tannins, CT; protein-precipitable phenolics, PPP; total phenolics, TP; and protein bound by protein-precipitable phenolics, PB) of an experimental striate cultivar of annual lespedeza (MU 3993) compared with ‘Legend’, a striate type, and with a Korean type.

Nutritive value of MU 3993 and Korean lespedeza may be more desirable than Legend lespedeza based on greater dNDF and lesser concentrations of biologically active polyphenolic compounds. However, Legend is superior if the objective is to exploit condensed tannins and their protein binding ability for potential benefits of rumen bypass protein.