**REPORT**

**Multistate Project NC1181:** **Optimizing land use for beef cattle production**

**Period Covered: 10/1/19-9/30/20**

**Date: 10/13/20**

**Annual Meeting Date and Location: 8/13/20 meeting held virtually with Keith Harmoney (KSU) hosting.**

**Participants:**

Mitch Stephenson, John Guretzky, Walter Fick, Paul Beck, Jerry Volesky, Guogie Wang, Mary Drewnoski, Jim McDonald, Jaymelynn Farney, Daren Redfearn, Jay Parson, Karla Wilke, Keith Harmoney

Administrating Advisor, Shibu Jose, also joined and gave an introduction and emphasis for the project moving forward. Each participant highlighted accomplishments from the previous year and discussion focused on plans for the current year of the project. A summary of the meeting is presented below.

**Objectives**

* Enhance productivity and efficient use of pasture, rangeland, and other forage resources
* Create and evaluate opportunities to incorporate forage production within cropping systems
* Develop management strategies for cows/calf systems that use limited or no perennial pasture
* Assess economic performance, resiliency, and adaptability of the systems and management practices explored
* Improve stakeholder understanding of the systems and management practices evaluated

**Accomplishments**

*Short-term outcomes:*

* Objective 1: Enhance productivity and efficient use of pasture, rangeland, and other forage resources

In 2020, research was published in the Agronomy Journal (see Guretzky et al., 2020a) that evaluated interseeding annual warm-season grasses into pastureland dominated by perennial cool-season grasses may be a strategy to reduce shortage of forage on pasture in the central Great Plains. This multi-university study originated out of discussions at annual NC1181 meetings. Field trials were conducted at three Nebraska (Mead, North Platte, and Sidney) and two Kansas (Hays and Mound Valley) locations in 2015–2016 (10 environments).  Key findings of this research were that interseeding annual warm-season grasses presents an effective strategy to increase forage accumulation in humid pasturelands harvested once or twice after interseeding (Mead and Mound Valley). In semiarid pasturelands, forage responses to interseeding will vary from year-to-year depending on timing and amount of precipitation, but forage accumulation can be significant.

In September 2020, we submitted an additional manuscript to Agronomy Journal (Guretzky et al. In Review) that evaluated nutritive value of pastures interseeded with annual warm-season grasses and was developed within the NC1181 working group.  The research analyzed forage collected from five Nebraska and Kansas field trials in 2015-2016 (eight environments) for crude protein (CP), neutral detergent fiber (NDF), and in vitro organic matter digestibility (IVOMD).  Crude protein averaged 128 and 85 g kg-1 and IVOMD averaged 670 and 627 g kg-1 at 45 and 90 d, respectively, in sudangrass and sorghum-sudangrass interseeded pastures harvested twice after interseeding, indicating the pastures likely have sufficient nutritive value to support cattle weight gains throughout summer. Outcomes of these studies will provide a spatially robust data set that producers can compare their own operations with to determine efficacy of this type of management practice.

Evaluation of grazing strategies under different timing of grazing and stock densities continues to be important for understanding cattle production on range and pasturelands. Researchers accomplished substantial work towards proposed NC1181 studies and preliminary data was shared by a number of researchers. Stephenson and Volesky conducted two studies to evaluate 1) the effect of burning in the early spring to remove standing dead biomass and 2) the influence of grazing time and intensity on subsequent-year hay biomass and quality. Preliminary outcomes suggest that spring fire has minimal impacts to forage production and fall grazing is more detrimental to forage production than winter grazing after 2 years.

Gueretzky and others also finalized and published research on mob grazing impacts on trampling and litter deposition in Sandhills subirrigated meadows in Crop, Forage & Turfgrass Management (see Guretzky et al., 2020b).  In this research, aboveground vegetation production, standing live and dead mass before and after grazing, vegetation utilization, trampling, litter accumulation, and spring standing dead mass were measured across 2014 and 2015, comparing high [210,343 lb live weight (LW) acre–1] and low (7,011 lb LW acre–1) stocking densities.

Additionally, a long-term grazing strategy study (currently in year 10) on upland Sandhills Range was continued at the Barta Brothers Ranch in the Nebraska Sandhills. Harmoney and others in Kansas continued evaluation of early intensive stocking on rangelands. The outcomes of these necessarily long-term studies provide key insight into how different grazing strategies influence both livestock production (e.g., harvest efficiency and weight gains) and range and pasture ecology (e.g., shifts in species composition) in the central Great Plains.

* Objective 2: Create and evaluate opportunities to incorporate forage production within cropping systems

Previous research from this group has shown that winter grazing of corn residue has minimal impacts on soil physical properties and can be a sustainable source of winter feed. One concern voiced by some farmers was that cattle grazing during the spring (March) with high stocking densities would result in compaction and have negative impacts on subsequent crop yields. We have conducted a two year study, evaluating the effects of stocking density during spring grazing. The results suggest that stocking density does not matter when stocking rate is similar, meaning fewer animals for a period of time vs. more animals for a shorter period of time is similar. The results also suggest that spring grazing has minimal effects on soil physical properties. Thus, spring grazing should not be considered detrimental and potentially increases the window of opportunity for corn residue grazing as traditionally most farmers dictate that cows need to be removed by mid-February.

In 2020, Stephenson, Volesky, and Redfearn published research evaluating the efficacy of including different oat and legume mixtures into cropping systems in diverse environments across Nebraska (see Pflueger et al. 2020). Outcomes of the study suggested that there was limitied benefit to adding a legume in dry climates. An additional outcome of this study was discussions at the NC1181 meetings in 2019 on appropriate seeding and fertilization rates for spring and fall planted cereal grains for forages. In 2020, a multi-university (KSU and UNL) study was initiated to evaluate the effect of seeding rate and fertilizer on oat production in the spring and fall. Newer varieties of oats for forage have not been extensively evaluated in the central Great Plains and with increased opportunities to incorporate forage within established cropping systems, oats provide a potentially valuable alternative crop. Research was conducted at four locations across diverse environments. Preliminary results were shared at the NC1181 meeting in 2020 and research will be conducted in 2021 and include an economic evaluation of the most appropriate management at the different environments.

In Kansas, seventeen annual forages were planted and evaluated as a forage option whether grazed, hayed, or ensiled. The forages that yielded the greatest biomass were ones that included sorghum-sudan in the mixture. Silage harvesting resulted in the greatest biomass, followed by grazing, and hay was the lowest (there is still another anticipated hay harvest and at least one more grazing event to harvest). Within these combinations of plant species biomass was the greater when the mixture of all 5-plant species was included or when there were only 2 plant species, especially as compared to single species forages (*P* < 0.01). The 3 plant species blends were intermediate. When evaluating the single species, grasses produced twice as much biomass as the legumes and broadleaves (*P* < 0.001).

Lastly, research we published in Agrosystems, Geosciences and Environment (La Vallie et al., 2020) indicted that use of annual forages like sorghum sudangrass as companion crops would greatly increase total forage yields during alfalfa establishment while reducing weeds compared to alfalfa establishment without weed control.  Producers would get better establishment of alfalfa when established without a companion crop, though, if effective weed management practices are in place.  Weed control will impose costs including that for herbicide application.  Alternatively, producers could adopt organic methods of establishing alfalfa, but this would likely require greater knowledge, understanding, and skills of cultural methods of weed control and alfalfa management. Collectively, outcomes of all these projects offer stakeholders valuable information on both the types of forages and specific management practices that will contribute to incorporating forages into established cropping systems.

* Objective 3: Develop management strategies for cows/calf systems that use limited or no perennial pasture

We completed two years of the integrated cow/calf and cropping system project. Similar to year 1, conception rates and calving rates were similar between the integrated treatment and the control. Both weaning rate and calves weaned per cow exposed were similar between the two treatments. However, the integrated system resulted in lighter weaning weights, and fewer pounds of calf weaning weight per cow exposed. We hypothesize that this is related to calving date with calves in the integrated system being younger during the winter months. Interestingly, the twinning rate is greater for the integrated system and the cause in unclear. Calves in the integrated system compensate during the backgrounding period, but still require more days on feed to achieve similar fat composition at the time of slaughter. Carcass weights are similar between the two treatments. Outcomes of this study will guide alternative management strategies for raising cattle in confined and integrated cropland systems.

Management systems for calves born and raised in confined settings are being evaluated. Results from one year of data suggest that calves who share a wet distillers and residue based diet with their dams as their only feed source gain less (*P* < 0.003) than calves early weaned (120 d) and given a diet of hay, corn, and wet distillers grains. The early weaned calves gained less than calves nursing the cow and given access to the early weaned calf diet in a separate creep area (1.62, 2.2, and 2.8 lb/d, respectively). After all calves were approximately 180 days of age, they were weaned and fed a common growing ration. Calves previously offered only their mother’s diet and early weaned calves had similar (*P* > 0.67) gain (2.49 and 2.42 lb/d, respectively) but both groups gained more than the calves who previously nursed and were offered creep (2.03 lb/d) (*P* < 0.05) resulting in compensatory gain. Dry matter intake and efficiency are being evaluated and finishing performance, carcass characteristics, and economics of the systems will be evaluated.

* Objective 4: Assess economic performance, resiliency, and adaptability of the systems and management practices explored

Data collected from the studies in objective 3 are being evaluated to determine the economic viability of alternative management strategies. In a partial budget analysis, a proposed change (experimental treatment) is compared to a base case (control treatment) by subtracting the negative economic effects (added costs and decreased revenue) from the positive economic effects (increased revenue and reduced costs) associated with change compared to the base case. This provides a nimble economic comparison of management practices that can easily be combined with stochastic tools for sensitivity analysis to test the robustness of the economic results. As more data is collected and analyzed outcomes of objective 4 will be further reported.

* Objective 5: Improve stakeholder understanding of the systems and management practices evaluated

Data from the above studies has been shared in UNL BeefWatch and CropWatch article, other extension outlets, and in research station bulletins. As stated in the proposed objective, researchers at UNL developed a “train the trainer” program virtually with five events being hosted in 2020. The main objective of these meetings was to deliver information to Nebraska Extension Educators on several projects being conducted as part of collaborations with the NC1181. Topics for these meetings include confined cattle, integrating crop and livestock systems with annual forages and crop residues, different management for cattle reproductive success, management and economics of cull cows. Outcomes of this effort were improved communication with regionally-based Extension Educators, better information dissemination opportunities, and improved responses to questions posed by livestock producers.

Activities

* Objective 1: Enhance productivity and efficient use of pasture, rangeland, and other forage resources
* Completed year 1 of a fall and winter season grazing study on Sandhills subirrigated meadows. This study will increase understanding of the influence of timing and intensity of cattle grazing hay regrowth on subsequent year plant biomass and forage quality within integrated hay and grazing systems.
* Finalized a 3-year study evaluating the influence of early spring burning on hay production later in the growing season on subirrigated Sandhill meadows. Analyzed data in preparation for a MS Student thesis defense that will take place in October 2020.
* In 2020, the grazing treatments and plant data collection were completed for a long-term study evaluating the effects of grazing period length and stocking density. This grazing study is being conducted on upland Sandhills rangeland at UNL’s Barta Brothers Ranch.  A grant proposal to examine grazing treatment effects on several soil components is pending.
* Completed first year of project evaluating establishment of summer annual warm-season grasses into smooth bromegrass pasture using different rates of herbicide suppression at the Eastern Nebraska Research and Extension Center, University of Nebraska-Lincoln.
* Completed first year of a project evaluating seeding rate and species effects on establishment of annual warm-season grasses into perennial cool-season grass pasture at the Eastern Nebraska Research and Extension Center, University of Nebraska-Lincoln and the Agricultural Research Center-Hays, Kansas State University.
* Objective 2: Create and evaluate opportunities to incorporate forage production within cropping systems
* The first year of a two year project to investigate the grazing potential of cereal rye, triticale and winter wheat for early spring use in the NCR, including the timing of the start of grazing and nutritive value of forage as measured by cattle gain was completed.
* The first year of a study to compare cereal rye, triticale and winter wheat for spring silage production in the NCR was completed. To better understand how each species may fit into a crop rotation the relative timing of maturation of each species coupled with the yield and nutritive value at various stages was evaluated.
* A multi-location (North Platte, NE, Sidney, NE, Lincoln, NE, and Hays, KS) experiment was initiated to evaluate the effects of seeding rate and nitrogen fertilizer rate on oat forage yield and quality.  This is done for both a spring and late summer planting date.  Data analysis for the spring planting date is in progress and data from the late summer planting will be collected in late October.
* Completed first year of research evaluating forage mass and weight gains of cattle grazing nitrogen-fertilized, legume-mixed, and unfertilized stands of triticale at the Eastern Nebraska Research and Extension Center, University of Nebraska-Lincoln.
* Objective 3: Develop management strategies for cows/calf systems that use limited or no perennial pasture
* The second year of replicated study in which late summer calving cows are managed using cropland grazing and summer confinement compared to a perennial forage based system was completed.
* The first year of a study to evaluate the nutritional management of the young calf when cow/calf pairs are managed in drylot was completed.
* Objective 4: Assess economic performance, resiliency, and adaptability of the systems and management practices explored
* Objective 5: Improve stakeholder understanding of the systems and management practices evaluated
* Research results were translated for use by producers and disseminated through electronic newsletters, podcasts, extension publications, and distributed through social media.
* Results from studies associated with Objective 1 have been presented at multiple on-line producer workshops.  Results from the meadow grazing studies were presented at multiple extension events including the Nebraska Section of the Society for Range Management (80 participants) and the Gudmundsen Sandhills Lab open house (100 participants) by Stephenson and Volesky.
* Results from annual forage trials (including oat seeding rates) were presented at the UNL Crop Production Clinics (greater than 900 participants across Nebraska), at the UNL western Nebraska Soil Health Workshop in Bridgeport, NE (35 participants) by Redfearn and Stephenson. Other workshops provided education in annual forages to over 500 participants by Drewnoski and Wilke.
* “Train-the-Trainer” workshops were hosted in five meetings by Wilke and Drewnoski to extension educators in Nebraska with approximately 30 participants in each meeting.
* In Kansas, ten extension presentations were given to over 2,000 participants.

**Impacts**

From Oct 1, 2019 to Sept 30, 2020, progress was made to develop and continue proposed research projects evaluating rangeland and pasture management strategies, opportunities for forage production on croplands, and cow-calf management strategies with limited pasture.

Additionally, significant contributions were made to finalizing research from previous NC1181 projects. This included publication of several research papers that focused on important collaborations and work across the participants in the NC1181 project. For example, one paper published and one in review finalized a study evaluating interseeding of annual forages within perennial introduced pastures. Another example is research published on the benefits of incorporating cereal/legume forage mixtures on cropland in diverse environments.

Research developed within the NC1181 group, have been a focal point of multiple extension outreach efforts and have resulted in the better understanding beef production systems and how these systems can be managed for greater economic and environmental success. Research was presented to over 3,500 participants in extension workshops and trainings. Additionally, outreach through extension articles, websites, podcast, and other media outreach has further extended the impact of the projects developed through the NC1181.

**Outputs**

***Abstracts/Posters/Professional Presentations (Bold = authors from multiple states)***

**1.** Widder, E.K., D. Redfearn, R. Mitchell, M. Schmer, V. Jin, J. Parsons, and M. Drewnoski. 2020. Economic sustainability of a perennial grass system grazed by stocker cattle. In Annual Meetings Abstracts Society for Range Management, Littleton, CO.

2.       Tonon Rosa, A., S. Koeshall, C. Creech, K. L. Glewen, D. D. Redfearn, M. E. Drewnoski, R. Werle, and S. Stepanovic. 2019. Double Cropping Field Pea with Short Season Crops, Forages, and Cover Crops in Eastern Nebraska. ASA-CSSA-SSSA.

3.       D. D. Redfearn, M. E. Drewnoski, A. Johnson and J. Parsons. 2019. Seeding Rates for Oats and Brassica Mixtures. ASA-CSSA-SSSA.

4.       Widder, E., D. D. Redfearn, R. B. Mitchell, M. R. Schmer, V. L. Jin, J. Parsons, and M. E. Drewnoski. 2019. Evaluating the Economic Sustainability of Grazing Stocker Cattle on Marginally Productive Cropland. ASA-CSSA-SSSA.

5.       Proctor, C. A., L. E. L. E. Haramoto, A. J. McMechan, C. Sciarresi, W. Looker, J. Wehrbein, S. R. Everhart, M. S. Cortasa, D. D. Redfearn, M. Drewnoski, and R. W. Elmore. 2019. Impact of Planting Date on Fall Seeding Cover Crops Biomass Production in the Midwest and Upper Midsouth. ASA-CSSA-SSSA.

6.       Brinton, M. M., B. H. Hansen, K. M. Ulmer, Z. E. Carlson, F. H. Hilscher, M. E. Drewnoski., and J. C. MacDonald. 2019. Forage production and calf gains when grazing oats following corn harvest. TAS. 3 (Suppl 1): 1641–1645. <https://doi.org/10.1093/tas/txz046>

7.      George, B., H. Hillhouse, B.E. Anderson, and J.A. Guretzky. 2018. Establishment of interseeded annual warm-season grasses in smooth bromegrass pastures. In 2018 ASA and CSSA Meeting Abstracts [Online]. Available at <https://scisoc.confex.com/scisoc/2018am/meetingapp.cgi/Paper/113271> (verified 14 Feb. 2020).

8.    Guretzky, J. Volesky, M. Stephenson, K.R. Harmoney, and J.L. Moyer. 2019. Interseeding annual forage grasses into pastureland – forage production. Abstract [Online]. 2019 ASA-CSSA-SSSA International Annual Meeting, 10-13 Nov., San Antonio, TX. Available at <https://scisoc.confex.com/scisoc/2019am/meetingapp.cgi/Paper/121803> (verified 9 Oct. 2020).

9. Harms, T, J. Volesky, M. Stephenson. 2020. Influence of early-season burning and grazing on subirrigated Sandhill meadow forage production. Abstracts of the 2020 Society for Range Management Annual Meetings. Denver, CO.

10.  Dunn, Cheryl, Jessica Milby, Walt Schacht, and Jerry D. Volesky. 2020. Effect of Grazing Strategies on Botanical Composition in the Nebraska Sandhills. P. 51. Proc.: 73rd Annual Meeting, Society for Range Management, Denver, CO.

* + 1. Farney, J. K. 2020. Effects of feeding spices on heifer gains and potential as tick management. Midwest ASAS. <https://www.eventscribe.com/2020/ASASMidwest/searchGlobal.asp>
    2. Toothaker, E. and J. K. Farney. 2020. Evaluation of two burning dates and addition of spices on stocker cattle gains on tallgrass native range. Midwest ASAS. <https://www.eventscribe.com/2020/ASASMidwest/searchGlobal.asp>

***Journal Articles (Bold = authors from multiple states)***

**Guretzky, J.A, J.D. Volesky, M.B. Stephenson, K.R. Harmoney, and J.L. Moyer. 2020a. Interseeding Annual Warm-Season Grasses into Temperate Pasturelands – Forage Accumulation and Composition. Agronomy Journal.** [**https://DOI.org/10.1002/agj2.20250**](https://doi.org/10.1002/agj2.20250)

**Guretzky, J.A, J.D. Volesky, M.B. Stephenson, K.R. Harmoney, and J.L. Moyer. 2020. Interseeding Annual Warm-Season Grasses into Temperate Pasturelands – Forage Quality. In review with Agronomy Journal.**

**Lenz, M.E., J. K. Farney, R. J. Kern, C. E. Orvis and M. E. Drewnoski. 2019. Nitrate toxicity in annual forages: survey of beef producer perspectives and samples submitted to a commercial testing laboratory in Nebraska. Applied Animal Science. 35:455-463.** [**https://doi.org/10.15232/aas.2019-01865**](https://doi.org/10.15232/aas.2019-01865)

Blanco-Canqui, H., S.J. Ruis, C.A. Proctor, C.F. Creech, M.E. Drewnoski, and D.D. Redfearn. 2020. Harvesting cover crops for biofuel and livestock production: Another ecosystems service? Agronomy Journal https://doi.org/10.1002/agj2.20165.

Conway, A. C., Z. Carlson, F. Hilscher, J. C. MacDonald, T. J. Klopfenstein, M. E. Drewnoski. 2020. Effect of ammoniation and harvest method on waste and consumption of corn residue bales fed to cows in a round bale feeder. Translational Animal Science. 4: 901-909. https://doi.org/10.1093/tas/txaa047

Pflueger, N., D. D. Redfearn, J. D. Volesky, R. Bolze, M. B. Stephenson. 2020. Influence of oat and spring pea mixtures on forage characteristics in different environments. Agronomy Journal 112:1911-1920.

Guretzky, J., M. Mamo, W. Schacht, J. Volesky, and A. Wingeyer. 2020b. Mob grazing increases trampling but not litter deposition on a Nebraska Sandhills meadow. Crop, Forage and Turfgrass Management.<https://doi.org/10.1002/cft2.20047>

Blanco-Canqui, H., M. Drewnoski, J, MacDonald, D, Redfearn, J. Parsons, G. Lesoing, and T. Williams. 2020. Does cover crop grazing damage soils and reduce crop yield? Agrosystems, Geosystems, and Environment 2020; e20102. https://doi.org/10.1002/agg2-20102

Koehler-Cole, K., S.E. Everhart, Y. Gu, C.A. Proctor, M. Marroquin-Guzman, D.D. Redfearn, and R.E. Elmore. 2020. Is allelopathy from winter cover crops impacting row crops? Agriculture and Environmental Letters 2020; 5:e20015. https://doi.org/10.1002/ael2.20015

La Vallie, M., J.A. Guretzky, W.H. Schacht, and D.D. Redfearn. 2020. Alfalfa establishment with sorghum-sudangrass as a companion crop. Agrosystems, Geosystems, and Environment 2020; 3:e20044. https://doi.org/10.1002/agg2.20044

Smart, A.J., D. Redfearn, R. Mitchell, T. Wang, C. Zilverberg, P.J. Bauman, J.D. Derner, J. Walker, and C. Wright. 2020. Integration of crop-livestock systems: An opportunity to protect grasslands from conversion to cropland in the US Great Plains. Rangeland Ecology & Management.<https://doi.org/10.1016/j.rama.2019.12.007>

Smart, A. J., K. Harmoney, J. D. Scasta, M. B. Stephenson, J. D. Volesky, L. T. Vermeire, J. C. Mosley, K. Sedivec, M. Meehan, T. Haigh, J. D. Derner, M. P. McClaran. 2019. Critical decision dates for drought management in the central and northern Great Plains rangelands. Rangeland Ecology and Management. https://www.sciencedirect.com/science/article/pii/S1550742419300739

***Extension Research Reports/Publications***

Brinton, M. M., B. H. Hansen, K. M. Ulmer, Z. E. Carlson, F. H. Hilscher, M. E. Drewnoski and J. C. MacDonald. 2020. Forage Production and Calf Gains When Grazing Oats Following Corn Harvest. MP107: 35-37.

Klopfenstein, T., J. Parsons, M. Drewnoski, J. MacDonald and A. Watson. Economics of Yearling Systems. 2020. MP107:31-34.

Stephenson, M. and N. Pflueger. Grazing Annual Forage and Cover Crops in Nebraska. 2020. <https://nebraskagrazinglands.org/Programs/Grazing-Cover-Crops-Project>

Stephenson, M. and K. Mollet. What should my pastures look like: Interpreting rangeland monitoring data. 2020. <https://spark.adobe.com/page/EkDaaEdOVwCXG/>

Harmoney, Keith R. and Jaeger, John R. (2020) "An Efficient Stocking Strategy for Grazing Replacement Heifers," *Kansas Agricultural Experiment Station Research Reports*: Vol. 6: Iss. 3. <https://doi.org/10.4148/2378-5977.7898>

Harmoney, Keith R. and Jaeger, John R. (2020) "Using Modified Intensive Early Stocking for Cow/Calf Production," *Kansas Agricultural Experiment Station Research Reports*: Vol. 6: Iss. 3. <https://doi.org/10.4148/2378-5977.7899>

Farney, J. K. 2020. Spices fed to growing heifers on bromegrass result in increased gains with some effects on tick populations. Kansas Ag. Exp. Stat. Res. Report. Vol. 6: Iss. 4. <https://doi.org/10.4148/2378-5977.7907>

Farney, J. K. (2020) "Evaluating Stocker Steer Gains on Tallgrass Native Range with Two Burn Dates and Spices in Mineral," Kansas Agricultural Experiment Station Research Reports: Vol. 6: Iss. 2. <https://doi.org/10.4148/2378-5977.7885>

***Extension publications (peer-reviewed)***

Drewnoski. M. 2019. Frequently Asked Questions about Grazing Corn Residue Fields with Excessive Downed Corn. BeefWatch Electronic Newsletter. [November](https://beef.unl.edu/beefwatch/frequently-asked-questions-about-grazing-corn-residue-fields-excessive-downed-corn).

George, B., H. Hillhouse, B. Anderson, and J. Guretzky. 2019. Variables affecting establishment of sorghum-sudangrass in smooth bromegrass pastures. Cropwatch [Online]. UNL Institute of Agriculture and Natural Resources. IANR Media. Available at <https://cropwatch.unl.edu/2019/variables-affecting-establishment-sorghum-sudangrass-smooth-bromegrass-pastures> (verified 14 Feb. 2020).

Wilke, K. 2020. Managing Cows through dry conditions. Beefwatch electronic newsletter (Objective 4,5). <https://beef.unl.edu/beefwatch/2020/managing-cows-through-dry-conditions>

Wilke, K. 2020. Sugar beet pulp shortage and alternative energy sources for beef cattle. Beefwatch electronic newsletter (Objective 4,5). <https://beef.unl.edu/beefwatch/2020/sugar-beet-pulp-shortage-and-alternative-energy-sources-beef-cattle>

Wilke, K. 2020. Will feeding silage to my lactating cows give my calves scours? Beefwatch electronic newsletter (Objective 4,5). <https://beef.unl.edu/beefwatch/2020/will-feeding-silage-lactating-cows-give-my-calves-scours>

Redfearn, D., J. Parsons, and M. Drewnoski. 2020. Market your Crop residue using the Crop rResidue Exchange. CropWatch Electronic Newsletter, University of Nebraska-Lincoln (September 24, 2020).<https://cropwatch.unl.edu/tags/crop-residue-exchange>

Redfearn, D., N. Mueller, and M. Drewnoski. 2020. Harvesting soybeans for hay or silage. CropWatch Electronic Newsletter, University of Nebraska-Lincoln (September 4, 2020).<https://cropwatch.unl.edu/2020/harvesting-soybeans-hay-or-silage>

Parsons, J., D. Redfearn, M. Drewnoski, and R. Tigner. 2020. Estimating a fair value for standing forage. CropWatch Electronic Newsletter, University of Nebraska-Lincoln (July 31, 2020).<https://cropwatch.unl.edu/2020/estimating-fair-value-standing-forage>

Parsons, J., D. Redfearn, M. Drewnoski, and R. Tigner. 2020. Estimating a fair value for standing forage. Cornhusker Economics, University of Nebraska-Lincoln (July 29, 2020).<https://agecon.unl.edu/cornhusker-economics/2020/Estimating-Fair-Value-Standing-Forage>

Drewnoski, M., and D. Redfearn. 2020. Reducing nitrate concerns when grazing forage cover crops. CropWatch Electronic Newsletter, University of Nebraska-Lincoln (July 22, 2020).<https://cropwatch.unl.edu/2018/reducing-nitrate-concerns-when-grazing-forage-cover-crops>

Mueller, N., G. Lesoing, M. Taylor, J. Rees, D. Redfearn, and B. Anderson. 2020. Freeze damage to alfalfa. CropWatch Electronic Newsletter, University of Nebraska-Lincoln (April 15, 2020).<https://cropwatch.unl.edu/2020/freeze-damage-alfalfa>

Mollet, K., J. Milby, **M. Stephenson**. 2020. Pollinators and Nebraska Rangelands. UNL BeefWatch. July 2020. <https://beef.unl.edu/beefwatch/2020/pollinators-and-nebraska-rangelands>

**Stephenson, M.,**B. Beckman, J. Volesky. 2020. Flooded Sandhills subirrigated meadows and upland sites. UNL BeefWatch. May 2020. <https://beef.unl.edu/beefwatch/2020/flooded-sandhills-subirrigated-meadows-and-upland-sites>

Beckman, B., **M. Stephenson**. 2020. Targeted grazing to manage cheatgrass. UNL BeefWatch. April 2020. <https://beef.unl.edu/beefwatch/2020/targeted-grazing-manage-cheatgrass>

Harms, T., **M. Stephenson**. 2020. Early season burning and grazing on subirrigated Sandhills meadows. “The Researcher” Gudmundsen Sandhills Lab Newsletter. April 2020. <https://extension.unl.edu/statewide/westcentral/highlighted-research/>

**Stephenson, M.**, K. Mollet. 2020. What should my pastures look like? Interpreting rangeland monitoring data. UNL BeefWatch. April 2020. <https://beef.unl.edu/beefwatch/2020/what-should-my-pastures-look-interpreting-rangeland-monitoring-data>

***Webinars/Videos and URL for online access***

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