Forages and Pastures Symposium: Implications of climate change on the resiliency of forage and pasture production systems

416 Managed grassland resiliency to climate change: Shifting species composition buffers climate change effects on plant production and forage quality. Rebecca L. McCulley*[1], A. Elizabeth Carlisle[1], Allison L. Cooke[2], Matthew M. Conley[3], Bruce A. Kimball[3], and Jim A. Nelson[1], *[1]University of Kentucky, Lexington, KY, [2]Metabolic Disease Institute, University of Cincinnati, Cincinnati, OH, [3]US Arid-Land Agricultural Research Center, USDA-ARS, Maricopa, AZ.*

Managed grasslands cover significant acreage in the eastern half of the United States, and are dominated by non-native grass species that may or may not respond to climate change similarly to native species. It is important to understand how plant species composition, plant production, and forage quality will respond to predicted warming and alterations in precipitation because managed grasslands can improve environmental quality and provide the forage base for animal production in the region. We hypothesized that warming would cause species shifts (increased relative abundance of C_4 vs. C_3 species) and would reduce plant production and forage quality, but increases in precipitation would ameliorate these effects. We tested this hypothesis using a field-based, climate manipulation, located in central Kentucky. In a mixed species pasture, we established 5 replicate plots of 4 climate treatments: an ambient control, increased temperature, increased precipitation, and the combination of increased temperature and precipitation. Treatments were applied for 5 consecutive years (2009–2013), and species composition, plant biomass, and forage quality were measured seasonally in all years. Warming significantly increased the relative abundance of C_4 grasses, especially in summer and fall. However, in the spring, C_3 grasses remained the dominant plant functional type in all plots. Climate treatment effects on production varied by year, but when harvested biomass was summed across the 5-year experiment, no significant effect was observed. Effects of climate treatments on forage quality metrics (% crude protein and lignin) also varied by year and season, but were less dramatic than effects on plant production and species composition. Increased temperature and precipitation did not substantially alter plant production or forage quality, but did promote C_4 vs. C_3 grass dominance, illustrating the potential of species compositional changes to buffer ecosystem response to climate change. This result suggests that although dominant plants will differ, managed grasslands of the eastern United States will continue, from an animal forage production perspective, to function similarly to today.

Key Words: pasture, climate change, forage production

417 Carbon sequestration potential for forage and pasture systems . Vern S. Baron*[1], R. Howard Skinner[2], and Gilles Bélanger[3], *[1]Agriculture and Agri-Food Canada, Lacombe, AB, Canada, [2]USDA-ARS, University Park, PA, [3]Agriculture and Agri-Food Canada, Quebec City, QC, Canada.*

Grassland soils are a reservoir of organic and inorganic carbon. Regionally, grasslands are CO_2 sources or sinks depending on management, soil organic carbon (SOC) concentration and climate. Land management changes (LMC) affect SOC sequestration rate, duration and C-store at steady state. A common hypothesis is that higher grassland productivity increases SOC sequestration to a higher steady state. High SOC-sequestration rates occur for 5 to 10 yr after LMC, but continue slowly up to 50 yr. Permanent grasslands are at steady state for CO_2 exchange. The most significant LMC for SOC accumulation is conversion from cropland to grassland where C-inputs from perennial roots and residues are higher than annual crops. Residue- and root-C inputs for Alberta perennial forage systems were 2.3 to 3 times greater, than barley silage. SOC sequestration rates for improved pastures on degraded soils in South-Eastern US were up to 1.4 Mg SOC ha^{-1} yr^{-1}. Applications of fertilizer-N, manure and using legumes increased SOC through higher root-C inputs, but not always permanently, due to the increased degradable-C fraction. Manure-C application effectively replaces surface soil-C on Quebec dairy farms. But, micro-meteorological studies on net ecosystem exchange (NEE) on old pastures in Pennsylvania, and Alberta (>6% soil organic matter), indicated that when harvested forage-C was removed from NEE, net Biome-C loss occurred in 90% of the years. Increasing productivity through N-application in Pennsylvania resulted in lost SOC, but a 5-species forage mixture increased productivity and sequestered more SOC than a 2-species mixture. Specific LMC in this grassland was less important to sequestration rate than initial SOC content. Quebec studies show that grass and legume species respond differently to increased atmospheric temperature and CO_2 concentration. Elevated temperature and CO_2 caused a higher root C: N ratio, resulting in a lower in vitro degradation rate, indicating that reduced SOC-degradation rates under future climates might be possible. How a concomitant change in species mixture affects SOC and what effects changing moisture and temperature regimens have on potential SOC-sequestration at a regional level can only be speculated.

Key Words: C-sequestration, forage management

418 Climate-related risk management in agriculture: Its importance for coping with current and future climate changes in the southeastern United States. B. V. Ortiz*[1], C. Fraisse[2], D. Dourte[2], W. Bartels[2], D. Zierden[3], and P. Knox[4], *[1]Auburn University, Auburn, AL, [2]University of Florida, Gainesville, FL, [3]Center for Ocean-Atmospheric Prediction Studies, Tallahassee, FL, [4]University of Georgia, Athens, GA.*

Agricultural food and feed production is extremely important to the southeastern (SE) United States, because it not only provides quality food and feed for residents but also contributes to the region's economy. However, the stability and sustainability of the SE agriculture is affected by the interannual and seasonal variability of the climate, and could be at much higher risk under the projected future climate. Currently, El Niño Southern Oscillation (ENSO), especially El Niño and La Niña phases, makes important contributions to the year-to-year variations in conditions. ENSO has the strongest influence in the SE climate during the winter and spring months. During those months El Niño phase brings wet and cold conditions and La Niña phase results on dry and warm conditions. Several research studies have shown the relationship of ENSO phases and changes in row crops and forages yield, pest, and diseases; therefore the importance of the use of the ENSO forecast as a risk management strategy. The impact of weather and climate conditions on livestock farming (e.g., milk yield and composition, beef productivity) and, especially extreme events have been also documented. The current US National Climate Assessment released in 2014 report data of the effect of future climate scenarios on rainfall, ambient temperature, extreme events, among other variables. By 2050 in the SE, compared with the period 1971–2000, SE summer rainfall is expected to decline

up to 20%, the number of days per year with maximum temperature above 95°F, heat waves, is expected to be in the range of 25 to 35 d, summer ambient temperature could increase in the range of 4°F to 8°F. Projections of future precipitation patterns are less certain than projections for temperature increases; however, tropical storms are projected to be to be fewer in number globally, but stronger in force, and extreme precipitation events are expected to increase in number. Several climate research, education, and extension regional projects funded by USDA-NIFA are currently implemented to help stakeholders with adoption of new or adaptation of current management strategies to increase resilience and reduce potential impacts. The Southeast Climate Extension project (http://www.agroclimate.org/seclimate/), a multi-state and multi-institution project, is using a participatory approach toward engaging producers, extension specialists and agents, and farmers associations on the identification, development and evaluation of climate adaptation strategies. Hand-on workshops on the use of and awareness of web-based climate decision support tools hosted in www.Agroclimate.org are also very popular among the SE clientele. Awareness of the future climate projections and potential adaptation strategies should be considered into the risk management package.

Key Words: adaptive capacity, climate variability, climate change

876 Intensive grazing systems can enhance carcass production with the same methane emissions. A. Berndt*[1], L. S. Sakamoto[2], A. P. Lemes[3], A. F. Pedroso[1], J. R. M. Pezzopane[1], T. C. Alves[1], D. F. Vilas Boas[4], R. Ruegger[5], P. P. A. Oliveira[1], [1]*Embrapa Southeast Livestock, Sao Carlos, Brazil,* [2]*Animal Productivity and Quality Program, FZEA/USP, Pirassununga, Brazil,* [3]*Veterinarian Medicine, FCAV/UNESP, Jaboticabal, Brazil,* [4]*FAPED, Brazil,* [5]*CAPES/EMBRAPA, Brazil.*

Enteric methane emissions are significant from countries with considerable livestock production, including Brazil. Various strategies exist for the mitigation of greenhouse gas emissions and, in general, the intensification of production systems reduces emissions intensity; that is, emissions of CO_2 equivalents per unit of product (meat or milk). The objective of this trial was to measure CH_4 emissions and animal performance in beef cattle in 4 Brazilian grazing systems with different levels of intensification. The study was conducted at EMBRAPA Southeast Livestock, in São Paulo State, Brazil. Twenty-four Nellore steers were distributed across 4 representative grazing systems: (1) irrigated pasture with high stocking rate (IHS); (2) dryland pasture with high stocking rate (DHS), planted with *Panicum maximum*; (3) dryland pasture with moderate stocking rate (DMS); and (4) degraded pasture (DP), planted with *Brachiaria decumbens*. The HIS and DHS systems were composed of 12 paddocks each, and the DMS system consisted of 6 paddocks, all under rotational grazing. The DP system was managed under continuous stocking. Animals were kept in the same grazing systems from weaning until slaughter. Methane measurements were taken during 4 seasons using the SF_6 tracer technique and gases were analyzed by Shimadzu GC 2014. Data were analyzed using the SAS MIXED procedure and averages were compared using the Tukey test and considered significant at $P < 0.05$. The animals finished in the DP system presented the lowest ($P < 0.01$) carcass weights (265.5 ± 15.6 kg), whereas those finished in the IHS system presented the highest (328.3 ± 10.2 kg). The average daily methane emissions were similar at 202.7 ± 38.6 g/d, as were emissions per kilogram of live weight at 409.1 ± 59.7 (g of CH_4/kg of live weight). At the end of the experimental period, total methane emissions were similar at 66.9 ± 12.7 kg, whereas carcass gain over the period was significantly lower ($P = 0.0234$) for the DP group at 73.2 ± 18.0 kg, versus 105.8 ± 25.0 kg in the other intensified systems. The use of technologies that permit increased production favors animal performance, increases carcass production, and dilutes the emissions per kilogram of carcass produced.

Key Words: intensive grazing, Brazil, methane