in warm climates even with decreased silo integrity.

**Key Words:** corn silage, aerobic stability, sodium benzoate

**0685 Effects of chemical additives on fermentation characteristics of high-moisture alfalfa silage.**

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Alfalfa is sometimes harvested with a high moisture content that increases the chances for undesirable fermentations. The objective of these experiments were to determine the effectiveness of Safesil (SF; active ingredients: 10% potassium sorbate, 20% sodium benzoate, and 5% sodium nitrite) and Safesil Challenge (SC; active ingredients: 7.5% potassium sorbate, 15% sodium benzoate, and 10% sodium nitrite) from Salinity, Sweden, on improving the fermentation of high-moisture alfalfa silage. Alfalfa was directly chopped at 23% DM and used in two experiments. In Experiment 1, we evaluated the effect of SF on the characteristics of early fermentation. Four individual 1-kg replicates of untreated alfalfa or alfalfa treated with 4 L/t of SF were ensiled in vacuumed and heat-sealed, nylon–polyethylene bags for 1, 2, 4, and 7 d. Data were analyzed as a 2 × 4 factorial arrangement of treatments, with main factors of treatment, days of ensiling, and their interaction. In Experiment 2, the long term effects of SF or SC with and without air stress during storage were determined. Replicated silos (7.5 L) were packed (density of 224 kg of DM/$m^3$) with the same forage described above and were untreated or treated with SF (3 and 4 L/t) or SC (2 and 3 L/t). Half of the silos were submitted to a 2-h weekly air stress. Data were analyzed by ANOVA as a 2 × 5 factorial arrangement of treatments with main factors of air stress, treatment, and their interaction. In Experiment 1, pH decreased and acids and ethanol similarly increased for untreated and treated silages as ensiling progressed. Compared with untreated silage, treated silages had fewer yeasts ($P < 0.01$) at 4 d of ensiling (4.52 vs. 2.96 log cfu/g) and less enterobacteria after 1 d (6.79 vs. 5.81 log cfu/g). Ethanol concentration was numerically lower for treated silages at all time points. In Experiment 2, for silos submitted to air stress, the DM recovery after 100 d was higher ($P = 0.04$) for SF- and SC-treated silage than for untreated silage. After 100 d, numbers of yeasts and molds were less than 2.00 log cfu/g for all treatments. These experiments showed that Safesil can quickly reduce harmful microorganisms, such as yeasts and enterobacteria, in high-moisture alfalfa and that Safesil and Safesil Challenge can improve DM recovery in silage submitted to air stress.

**Key Words:** alfalfa, silage, Safesil

## FORAGES AND PASTURES SYMPOSIUM: GREENHOUSE GAS EMISSIONS IN PASTURE-BASED DAIRY AND BEEF CATTLE SYSTEMS

**0686 Comprehensive national assessment on the sustainability of beef production.**

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To develop better scientific understanding of the sustainability of beef in the United States, a national assessment is being conducted by the National Cattlemen's Beef Association, a contractor to the beef checkoff. This includes a life cycle assessment (LCA) of greenhouse gas emissions along with other environmental, social, and economic impacts. Assessments are being made for representative cattle operations in each of seven geographic regions to form the national total. Producer surveys and visits are used to characterize region-specific production systems, and the information gathered provides a basis for system simulation and a farm-gate LCA. Assessments have been completed for the central plains and midwestern regions and are in progress for the western and eastern regions of the country. Results thus far show farm-gate carbon footprints of representative production systems vary from 16 to 28 kg $CO_2$e/kg of carcass weight (CW) with a mean around 20 kg $CO_2$e/kg CW. The cow–calf operation is the source of 67 to 77% of this footprint and stocker operations contribute up to 18% of the footprint. Therefore, depending on whether cattle are backgrounded on pasture or in a feedlot, the grassland-based portion of the system can contribute 67 to 85% of the farm-gate carbon footprint of finished beef cattle. Enteric methane emission is the source of about 60% of the total greenhouse gas emissions from cow–calf and stocker operations and 35% of that from feedlot finishing operations. Nitrous oxide emissions contribute about 20% of the carbon footprint of grazing cattle. Considering post-farm gate sources (harvest, retail, restaurant, and consumer), the full carbon footprint is about 45 kg $CO_2$e/kg of consumed beef. Of this total, 58 to 73% can be attributed to emissions from grazing cattle and the inputs required to maintain them. A similar result is found for environmental impacts such as total reactive nitrogen loss, where 50 to 70% of the farm-gate footprint is attributed to grazing cattle. Therefore, to make substantial reductions in the environmental impacts of beef production, our analysis to this point indicates that mitigation strategies are needed to reduce greenhouse gas and nitrogen emissions from grassland systems. This provides a major challenge for beef cattle research because practical technologies or strategies for reducing these emissions are

essentially unknown.

**Key Words:** beef, cattle, carbon footprint

**0687 Screening for forages and foraging managements that reduce nitrogen excretion and methane emissions while maintaining or increasing animal production.** P. Gregorini*, P. C. Beukes, and A. J. Romera, *DairyNZ Ltd., Hamilton, New Zealand*.

Farmers face complex decisions at the time to feed animals, trying to achieve their production goals while contemplating social and environmental constraints. Our purpose was facilitating such decision-making for pastoral dairy farmers, aiming to reduce urinary N (UN) and methane ($CH_4$) emissions while maintaining or increasing milk production (MP). There are a considerable number of forages the farmers can choose from and combine. First, we used three grasses, three legumes, and two herbs combined in 72 mixed swards. Then, 50 feeds (forages and grains) were systematically combined in different proportions producing 11,526 binary diets. Swards and binary diets were screened, using an a posteriori approach and a Pareto front (PF) analysis of model (Molly-DairyNZ) outputs. The objective was identifying combinations with the best possible compromise (i.e., frontier) between UN, $CH_4$, and MP. All PF solutions are considered optimal and equally good. Using MP and low UN as objective functions, PF included seven optimal swards, with fescue, alfalfa, and plantain as key species. Adding $CH_4$ emissions as objective function increased the number to 23. For binary diets, the MP–UN frontier included 10, 14, 12, and 50 for nonlactating and early, mid, and late lactation periods, respectively, with cereals and beets featuring strongly. Using the same objective functions but including ryegrass as dietary base, PF included 2, 4, 8, and 4 diets for those periods. These results suggest that from a wide range of diverse diets, farmers could choose from a handful of mixed swards and binary diets to reduce UN while maintaining or increasing production. If the criterion is maintaining pasture-based systems, there are fewer suitable options. Reducing UN will simply require dilution of N supplied by pasture by either supplementing low-N forages or strategic foraging managements. The results also indicate that reducing UN may imply increments in $CH_4$ emission and vice versa, that is, pollution swapping. Although there is no perfect sward or diet that optimizes all the objectives at once, there are feeding options to offset pollution swapping, if the current diet is not in the frontier. Ultimately, it is up to the farmers to choose the best options, according to their farming context.

**Key Words:** forages, ruminant nutrition, environmental footprint

**0688 Outcomes and future directions from the National Livestock Methane Program in Australia.** T. M. Davison*, *Meat and Livestock Australia, Brisbane, Australia*.

The National Livestock Methane Program (NLMP) was a collaborative and coordinated research effort run by Meat and Livestock Australia. The investment in methane research was initiated by a federal government program, filling the Research Gap. This overall initiative also included other national programs of work in soil carbon, nitrous oxide, and manure management. The program aims were to provide Australian livestock producers with practical strategies and tools to help them increase productivity and profitability and at the same time lower methane emissions. The NLMP was a $33.5 million investment over 3 yr and consisted of 17 projects in 5 themes of work: 1) forages, 2) supplements, 3) beef genetics, 4) rumen microbiology, and 5) measurement. Three overarching themes linked the program of work within NLMP. First, to develop a greater understanding of the underlying mechanisms in the production and control of methanogenesis; second, to identify methods or farming practices that might apply to the federal government Carbon Farming Initiative (a scheme that offers income opportunities for carbon abatement), and third, communication products for use by partners. A variety of outcomes included knowledge of the relationship between productivity and methane emissions, identification of methane abatement from various forages, the role of supplements such as red algae and grape marc, the role of wheat in dairy diets, identification of potential plant bioactives, new bacterial species, and knowledge of rumen methane pathways. A national needs and gaps analysis that included a marginal abatement cost curve analysis was conducted to determined future priorities for research based on a range of investment criteria.

**Key Words:** methane research, forages, supplements, carbon schemes

**0689 Greenhouse gas emissions and mitigation in the West African subregion: Challenges and opportunities.** C. Antwi*, *Kwame Nkrumah University of Science & Technology, Kumasi, Ghana*.

Animal agriculture contributes to about 18% of the global greenhouse gasses (GHG), of which 3% is generated by all ruminants in sub-Saharan Africa. The methane emissions from these ruminants represent about 12% of the GE intake, which could otherwise be used as energy for maintenance. In an attempt, therefore, to reduce emissions, researchers in the West African subregion have initiated profiling GHG emissions of feed resources and selection feed with less methane emission potential. Some common feedstuffs in the subregion were assayed for their methane production using either the in vitro systems or hand-held methane analyzer. In vitro assessment of shea nut (*Butyrospermum parkii*) for methane

production indicated that including 10% of shea nut cake in finishing feedlot *Bos taurus* diets reduced 24-h in vitro methane production by approximately 20% without any significant reduction in total and individual VFA production. Methane output was also reduced during in vitro ruminal fermentation of *Brachiaria ruziziensis* when the in vitro mixture was supplemented with 20% of leaves of the browse plant *Securinega virosa*. Different fractions of Napier grass were evaluated in Ghana for methane production using a hand-held methane analyzer. The stem fraction was 2.5 times higher than that of the leaves, and as the grass advanced in age, the methane production increased. Emissions directly associated with animal production have globally increased partly because of the high demand for animal products. It is envisaged that emission intensity from animal agriculture in the West African subregion will increase due to the nature of feed they feed on. In an attempt to reduce emissions from animals, scientists adopt in vitro method of screening and selection of feed for ruminants. This, however, fails to estimate emission per feed intake, making it impossible to advance the best practices that result in GHG mitigation without any adverse effect on animal productivity. Although the global research alliance suggests to its member countries, of which Ghana is one, to focus on activities that reduce emissions intensity of livestock while increasing productivity, little is seen in terms of investment in developing research activities that reduces emissions. Several agro-byproducts including palm kennel cake and other cakes of leguminous crop exist in the subregion. Owing to their high lipids content, when supplemented to the high fibrous diet consumed by ruminants, it is certain that not only will methane emissions be reduced but that productivity will also increase.

**Key Words:** methane, mitigation, Africa

**0690 Effects of native and tame grassland species reintroduction on carbon sequestration potential on the Canadian Prairies.** A. D. Iwaasa*, B. McConkey, and H. Wang, *Agriculture and Agri-Food Canada, Swift Current, SK, Canada*.

Rising concentration of carbon dioxide in the atmosphere has prompted interest in implementing improved grassland management practices that could lead to a net accumulation of carbon in grassland soils. Converting cropland into native or tame perennial grasslands may result in substantial increase in soil C sequestration. Two studies were started in southern Saskatchewan where semiarid cropland was converted to perennial grasslands: Study 1 (2000–2014) seeded two different native pasture mixes (Simple, 7 species, and Diverse, 12 species) and Study 2 (2006–2011) seeded four different pasture types (meadow bromegrass + alfalfa [A], native grass mix [NG], NG + A, and NG + native legume). The objective of the studies was to determine the change in soil organic carbon (SOC) levels as affected by type of forage pasture mix and form of disturbance (grazing and nongrazing). In Study 1, the disturbance treatments were continuous, rotational, and nongrazing and the stocking rates were 0.8 and 1.9 animal unit (AU) $ha^{-1}$, respectively. In Study 2, continuous grazing occurred and the stocking rate ranged from 2.0 to 4.0 AU $ha^{-1}$ depending on which pasture treatment was used. All pastures were grazed to a utilization rate of 50 to 60%. Soil samples from each pasture were collected from three locations and at each location, a five radial (star pattern) sampling pattern occurred. From each of the five microsites, core samples were taken at five depths (0–7.5, 7.5–15, 15–30, 30–45, and 45–60 cm). Soil sampling for study 1 occurred in 2000, 2004, 2008, 2011, and 2014, whereas in study 2, it occurred in 2008 and 2011. In study 1, no SOC level (0–15 cm) differences were observed between disturbance and pasture mix combinations and interaction after 14 production years. Soil organic C levels were affected by year ($P < 0.0001$), which was expected with the different environmental conditions experienced among the different soil sampling years. In study 2, no SOC level (0–15 cm) differences were observed for interaction or main effects after three production years. Our studies did not support our hypothesis that a more diverse native mix (higher species richness) and tame grass + alfalfa would have higher SOC level than other treatments. Detecting small SOC change is difficult due to spatial heterogeneity in initial SOC, soil texture, bulk density, and plant productivity. Using our results, we develop criteria for measurement systems to detect changes design to detect SOC change.

**Key Words:** grazing, soil organic carbon, native and tame forages

## GENOMICS SYMPOSIUM: TRANSLATIONAL GENOMICS TO IMPROVE FERTILITY OF ANIMALS

**0691 Translational genomics for improving sow reproductive longevity.** D. C. Ciobanu*[1], S. D. Kachman[1], S. Olson[1], M. L. Spangler[1], M. D. Trenhaile[1], H. Wijesena[1], P. S. Miller[1], J. J. Riethoven[1], C. A. Lents[2], J. F. Thorson[2], R. Massey[3], and T. J. Safranski[3], *[1]University of Nebraska – Lincoln, Lincoln, [2]USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE, [3]University of Missouri, Columbia*.

Approximately 50% of sows are culled annually with more than one-third due to poor fertility. Age at puberty, the earliest prebreeding indicator of reproductive longevity, can be measured early in life and has a moderate heritability. Selection for age at puberty is challenging due to labor-intensive phenotyping. Genomic selection for this trait would be a more viable option because it could increase accuracy and selection response. This study aims to identify DNA markers that