Production, Management and the Environment: Management and Methods II

518 Production traits of Montbéliarde-sired crossbreds compared to pure Holsteins in both high-input and low-input research herds. A. R. Hazel*, B. J. Heins, and L. B. Hansen, *University of Minnesota, St. Paul.*

Montbéliarde × Holstein crossbred cows (MH, n = 59) and Montbéliarde × Jersey/Holstein crossbred cows (MJH, n = 91) were compared with pure Holstein cows (HO, n = 163) for 305-d milk, fat, and protein production, and SCS during the first 5 lactations. Cows were in 2 research herds of the University of Minnesota, the high-input dairy at St. Paul and the low-input dairy at Morris, and calved from October 2005 to November 2012. Best Prediction was used to calculate production and SCS for 305-d lactations with adjustment for age at calving, and records less than 305 d were projected to 305 d. Independent variables for statistical analysis of all traits included the fixed effects of herd, parity group (first, second, or third through fifth), breed, interaction of herd and parity group, herd-year of calving nested within interaction of herd and parity group, interaction of herd and breed, interaction of parity group and breed, interaction of herd, parity group, and breed, and random cow nested within breed. The MH and HO, respectively, were not significantly different ($P > 0.05$) for fat plus protein production (CFP) during first (509 kg vs. 518 kg), second (603 kg vs. 596 kg), nor third through fifth parities (643 kg vs. 641 kg). However, the MJH had significantly less ($P < 0.05$) CFP in first parity (−22 kg) compared with HO. For the low-input herd, the MJH had similar ($P > 0.05$) CFP in first (−2 kg) and third through fifth (+1 kg) parities, and tended ($P < 0.10$) to have greater CFP in second parity (+31 kg) compared with HO. Across herds, the MH (2.37) had lower ($P < 0.05$) SCS than MJH (2.57) and HO (2.87) during second parity. For the low-input herd, MH (3.05) and MJH (3.08) had lower ($P < 0.05$) SCS than HO (3.72) during third through fifth parities. The CFP of MH was similar to HO in both research herds; however, production for the MJH was more competitive with HO and MH for low-input production than high-input production.

Key Words: crossbreeding, heterosis, Montbéliarde

519 Fertility, survival, and mortality of Montbéliarde-sired crossbreds compared to pure Holsteins in two research herds. A. R. Hazel, B. J. Heins, and L. B. Hansen*, *University of Minnesota, St. Paul.*

Montbéliarde × Holstein crossbred cows (MH, n = 57) and Montbéliarde × Jersey/Holstein crossbred cows (MJH, n = 86) were compared with pure Holstein cows (HO, n = 153) for days open (DO), survival, and mortality rate. Cows calved in one of 2 research herds of the University of Minnesota, the high-input dairy at St. Paul and the low-input dairy at Morris, from October 2005 to May 2010. Cows were required to have at least 250 DIM for DO, and cows with DO greater than 250 d were truncated to 250 d. Cows were required to have 5 yr of opportunity for herd life (HL), and HL greater than 1,826 d was truncated to 1,826 d. Independent variables for statistical analysis of DO included the fixed effects of herd, parity group (first, second, or third through fifth), breed, interaction of herd and parity group, herd-year of calving nested within interaction of herd and parity group, interaction of herd and breed, interaction of parity group and breed, interaction of herd, parity group, and breed, and random cow nested within breed. The analyses of survival to subsequent calving, HL, and mortality rate included the independent variables of herd, breed, and interaction of herd and breed. The MH and MJH had significantly lower ($P < 0.01$) DO than HO, respectively, in first (127 d, 115 d, 161 d), second (135 d, 132 d, and 178 d) and third through fifth (122 d, 124 d, and 161 d) parities. Across parity and breed groups, Montbéliarde-sired crossbred cows had 41 d fewer DO than HO. For survival to third, fourth, and fifth calving, respectively, MH (58%, 43%, and 27%) and MJH (51%, 35%, and 20%) were significantly greater ($P < 0.01$) than HO (31%, 14%, and 6%). The HL was significantly longer ($P < 0.05$) for MH (1,050 d) and MJH (1,078 d) compared with HO (837 d). Mortality rate was significantly lower ($P < 0.05$) for MH (5.1%) compared with HO (17.7%). Data suggest Montbéliarde-sired crossbreds have superior fertility, longer HL, and lower mortality compared with HO, which may result in greater profitability for dairying.

Key Words: crossbreeding, survival, Montbéliarde

520 Association between stall surface and some dairy welfare measurements on farms using automatic milking systems. J. A. Salfer* and M. I. Endres, *University of Minnesota, St.Paul.*

The objective of this study was to evaluate the association between stall surface and some animal welfare measurements on farms using automatic milking systems (AMS) in Minnesota and Wisconsin. Fifty-one farms using AMS were visited once from June to September 2012. A random sample of a minimum of 30% of the cows in each pen were scored for locomotion (1–5 scale, 1 = normal, 5 = severely lame) and hygiene (1–5 scale, 1 = very clean and 5 = very dirty), and severe (swollen or open sores) hock lesions were recorded. Lying surface and number of farms were: mattresses (M; 22), sand (S; 14), waterbeds (W; 7), mattress and pasture (P; 5) and bedded pack (BP; 3). Lameness prevalence (% locomotion score = >3) was higher for M (40.9) than P (21.5; $P < 0.001$), S (22.5; $P < 0.001$) and BP (19.0; $P = 0.006$), but similar to W (35.3). Lameness prevalence was similar for BP, P and S. Severe lameness prevalence (% locomotion score = >4) was lower for P (2.7) than M (8.5; $P < 0.05$) and W (10.2; $P = 0.03$). Severe lameness prevalence tended to be lower for S (4.3) than M and W ($P = 0.07$; $P = 0.06$) and also tended to be lower for BP (1.7) than M and W ($P = 0.09$; $P = 0.06$). Prevalence of dirty cows (hygiene score >3) was lower for S (16.8) than BP (45.3; $P < 0.05$), M (41.9; $P = 0.001$), P (39.5; $P < 0.03$) and W (46.3; $P = 0.004$). Mattress, S, W and P were all similar. Prevalence of severely dirty (hygiene score > 4) cows was lower for S (1.8) than BP (14.6; $P < 0.05$) and W (11.1; $P < 0.05$) and tended to be lower than M (8.5; $P = 0.06$) and P (10.6; $P = 0.06$). Severe hock lesion prevalence was greater for M (17.2) than S (3.8; $P < 0.001$), W (7.8; $P = 0.02$) and BP (1.7; $P = 0.006$), and tended ($P = 0.06$) to be greater than P (9.9). Sand, W, BP, and P were similar. Results indicate that compared with previous studies in the Midwest, cows on AMS farms had higher lameness prevalence than cows housed in similar stall surfaces in other types of barns. This could be due to reduced footbath use on these AMS farms. Results also showed that cows on mattresses had greater prevalence of hock lesions compared with other surfaces.

Key Words: automatic milking system, lameness, hygiene

521 Environmental bioburden attributable to super-shedders in freestall pens. S. S. Aly*[1,2], A. D. Glover[2], J. D. Champagne[2], R. H. Whitlock[3], R. Anderson[4], and J. M. Adaska[5], *[1]Department of Population Health and Reproduction, School of Veterinary Medicine, University of California-Davis, Davis, [2]Veterinary Medicine Teaching and Research Center, School of Veterinary Medicine, University of California-Davis, Tulare, [3]Johne's Research Laboratory, New Bolton*

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Environmental sampling can be used to reliably quantify *Mycobacterium avium* ssp. *paratuberculosis* (MAP) in fecal slurry from freestall pens. The amount of MAP in a pen's environment attributable to super-shedders (SS) is not known. In addition, it is not known whether the MAP bioburden in pens housing super-shedders significantly differs from those without SS or how movement of SS into and out of pens affects pen MAP bioburden. The objective of this study was to estimate the MAP bioburden in fecal slurry from freestall pens using quantitative real-time polymerase chain reaction (qrt PCR). MAP SS identified from a whole herd test were moved between 2 pens in a double crossover study design. Environmental samples were collected daily for 15 d with SS cows introduced to the first pen at d 4 through d 6 and in the second pen at d 9 through d 12 allowing for a washout period of 3 d in between and while holding pen population otherwise fixed. MAP bioburden of environmental slurry before introducing SS was not significantly different compared with after the washout period following removal of the SS (P value 0.13 and 0.59, pens 1 and 2 respectively). Map bioburden significantly increased upon introduction of SS cows ($P < 0.001$) with an estimated decrease of 9.1 cycles-to-threshold of qrt-PCR. Results of this study show that SS cows introduced to freestall pens can contribute significantly to pen MAP bioburden and within as short a time period as 3 d from introduction.

Key Words: Johne's, environmental bioburden, PCR

522 Influence of breed, milk yield, and temperature humidity index on dairy cow reticulorumen temperature, lying time, and rumination behavior. A. E. Sterrett*, B. A. Wadsworth, J. D. Clark, and J. M. Bewley, *University of Kentucky, Department of Animal and Food Sciences, Lexington.*

The objective of this study, conducted from October 8, 2012 to January 23, 2013 at the University of Kentucky Coldstream Dairy, was to compare daily lying time (LT), reticulorumen temperature (RT), and rumination time (RU) between 3 breed groups. Cows (n = 36; 12 Holstein (H), 12 crossbred (C), and 12 Jersey (J)) were matched by parity group (PG, 1 or ≥2 lactations), DIM, and milk yield (MY). Lying time, RU, RT, MY, and maximum temperature-humidity index (THI) were recorded and summarized for each cow day. At least 75 d per cow of recorded LT, RU, and RT data was required for study inclusion. The MIXED Procedure of SAS (Cary, NC) was used to evaluate fixed effects of breed, MY, PG, THI, and their interactions on LT, RT, and RU, with cow within breed as subject. Mean (±SD) daily DIM, LT, MY, RT, RU, THI were 198 ± 106 d, 11 ± 2 h, 28 ± 8 kg, 39 ± 1°C, 369 ± 99 min, and 63 ± 17, respectively. Breed × PG, breed × MY, and THI were significant predictors of LT ($P < 0.01$). Primiparous H cow LT was 1.28 ± 0.24 h lower than multiparous H cow LT ($P < 0.01$). Breed × PG and MY were significant predictors of RU ($P < 0.01$). Primiparous H cows ruminated 27.19 ± 9.97 ($P = 0.04$) and 33.00 ± 11.20 ($P < 0.01$) minutes longer than primiparous J and C cows, respectively. Milk yield × THI, THI × PG, and breed × PG were significant predictors of RT ($P < 0.01$). Reticulorumen temperatures for primiparous H cows were 0.94 ± 0.01 and 0.28 ± 0.09°C higher than primiparous J and C cows, respectively ($P < 0.01$), suggesting that J and C cows may be more heat-tolerant. Rumination time was highly correlated with MY (r = 0.90, $P < 0.01$), but weakly correlated with THI (r = 0.03, $P < 0.01$). Lying time was moderately correlated with MY and THI (r = −0.32 and −0.21, respectively, $P < 0.01$). Reticulorumen temperature was moderately correlated with THI (r = 0.30, $P < 0.01$). The physiological and behavioral differences between H, J, and C cows observed in this study provide new insight into breed differences that can be useful for interpreting LT, RT, and RU data in future studies.

Key Words: reticulorumen temperature, rumination, lying time

523 Effect of milking frequency on the behavior and productivity of lactating dairy cows. K. D. Hart*[1], B. W. McBride[2], T. F. Duffield[3], and T. J. DeVries[1], *[1]Dept. of Animal and Poultry Science, University of Guelph, Kemptville Campus, Kemptville, ON, Canada, [2]Dept. of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada, [3]Dept. of Population Medicine, University of Guelph, Guelph, ON, Canada.*

The objective of this study was to determine the effect of milking frequency on the behavioral patterns and productivity of lactating dairy cows. Twelve free-stall housed, lactating Holstein dairy cows, including 7 primiparous (PP) and 5 multiparous (MP), were exposed to each of 2 treatments (over 21-d periods) in a replicated crossover design. Treatments were milking frequency: (1) 2×/d (at 0600 and 1800 h) and (2) 3×/d (at 0600, 1400, and 2200 h). Milk production, feeding, lying, and rumination behavior were electronically monitored for each animal for the last 7 d of each treatment period. Milk samples were collected for the last 3 d of each period for milk component analysis. Data were analyzed in a general linear mixed model. Cows produced more milk when milked 3×/d compared with 2×/d (37.7 vs. 34.9 kg/d; SE = 1.2; $P = 0.002$). Primiparous cows produced less milk (32.1 vs. 40.3 kg/d; SE = 1.7; $P = 0.004$) and consumed less DM (24.2 vs. 28.0 kg/d; SE = 0.5; $P < 0.001$) than MP cows. The extra time required for milking 3×/d altered the distribution of cow behavioral activity throughout the day. While this did not affect total daily lying (694.7 min/d) or rumination (506.1 min/d) time, there was a tendency for cows milked 2×/d to spend less time (224.6 vs. 237.5 min/d; SE = 17.6; $P = 0.1$) feeding and, thus, consume their feed at a faster rate (0.13 vs. 0.12 kg DM/min; SE = 0.02; $P = 0.07$) than cows milked 3×/d. For MP cows, the increase in feeding activity was facilitated through having longer (40.1 vs. 36.8 min/meal; SE = 3.3; $P = 0.004$), and slightly larger meals (4.8 vs. 4.6 kg DM/meal; SE = 0.7; $P = 0.05$) when milked 3×/d. Alternatively, PP cows consumed smaller (2.9 vs. 3.2 kg DM/meal; SE = 0.7; $P = 0.05$), more frequent meals (9.1 vs. 7.7 meals/d; SE = 1.1; $P = 0.04$) throughout the day when milked 3×/d, resulting in a tendency for greater DMI (24.7 vs. 23.6 kg/d; SE = 0.5; $P = 0.08$). These results indicate that under 3×/d milking schedules, PP cows will positively adjust their feeding behavior to achieve similar production increases as MP cows.

Key Words: milking frequency, behavior, parity

524 Periconceptional heat stress of Holstein cows affects subsequent milk production and composition. B. Brown*, J. Stallings, and M. Rhoads, *Virginia Polytechnic Institute and State University, Blacksburg.*

The fertility of lactating Holstein cows is severely reduced during periods of heat stress (HS). Of course, some inseminations conducted during HS result in successful pregnancies from which heifer calves are born; many of these heifer calves are retained and raised to enter the milking herd as replacements. We hypothesized that the HS experienced by these females around the time they were conceived conferred long-lasting effects that could potentially alter milk production and composition during adulthood. Therefore, the objective of the current study was to examine the relationship between periconceptional HS and

measurements of milk production and composition. National Dairy Herd Improvement Association data was obtained from Dairy Records Management Systems. Records (n = 704,419) included Holstein cows born between 2000 and 2011 in FL, GA, SC, MS, LA, AL, and TX. Conception dates were calculated by subtracting 276 d from the recorded birth date. Records for cows conceived within the months of June, July, and August were retained as "HS-conceived" (HSC) cows; cows conceived within the months of December, January, and February were retained as contemporaries. Adjusted 305-d mature equivalent milk, protein, and fat yields were evaluated by ANOVA using PROC HPMIXED of SAS. Heat stress-conceived cows produced less milk than contemporaries in the following states: FL ($P < 0.01$), GA ($P < 0.01$), MS ($P = 0.02$), LA ($P < 0.01$), AL ($P < 0.01$), and TX ($P < 0.01$). Periconceptional HS reduced fat yield in FL ($P < 0.01$), GA ($P < 0.01$), MS ($P < 0.01$), LA ($P < 0.01$), AL ($P < 0.01$), and TX ($P < 0.01$) and tended to decrease fat yield in SC ($P = 0.08$). Protein yield was significantly reduced in FL ($P < 0.01$), SC ($P < 0.05$), LA ($P < 0.01$), AL ($P < 0.01$), MS ($P = 0.05$), and TX ($P < 0.01$). The relationship between HSC and adjusted 305-d mature equivalent milk production variables suggests that HS at the time of conception and during early pregnancy impairs cow performance throughout her lifetime. Further studies are needed to explore the mechanisms responsible for this relationship and resulting effect on dairy production efficiency.

Key Words: milk, dairy cow, heat stress

525 Use of urine as a diagnostic tool for subacute ruminal acidosis (SARA) in lactating Holstein and Jersey cows. S. Luan*, M. R. Murphy, F. C. Cardoso, and J. K. Drackley, *University of Illinois, Urbana.*

Subacute ruminal acidosis (SARA) is a common digestive disorder in high producing dairy cows that decreases production efficiency. Methods for early diagnosis of SARA could help prevent potential losses. To investigate the association between SARA and urine pH (UPH) and rumen pH (RPH), 6 Holstein cows (HOL, BW = 717 kg; 258 ± 16 d in milk), 6 rumen-cannulated Holstein cows (CAN, BW = 762 kg; 287 ± 45 d in milk), and 6 Jersey cows (JER, BW = 470 kg; 190 ± 86 d in milk) were used in a replicated 3 × 3 Latin square design balanced to measure carry-over effects. Periods (10 d) were divided into 4 stages (S): S1, baseline, d 1–3, ad libitum TMR; S2, restricted feeding, d 4, cows fed for 50% of S1 DMI; S3, challenge, d 5, treatments applied; S4, recovery, d 6–10, all cows fed ad libitum TMR. Treatments were CON, no top dress; MOD, 10% of S1 DMI as top dress (pelleted mixture of 50:50 of wheat:barley); and HIG, 20% of S1 DMI as top dress. Rumen pH (CAN) and UPH (all cows) were recorded at −2 to 22 h relative to feeding during S3. No treatment carry-over effect was observed for any outcome variable ($P > 0.30$). Mean RPH was lower ($P < 0.001$) for HIG (6.25 ± 0.09) than for CON (6.44 ± 0.09). Nadir time (h) for RPH below 6 was 3, 5, and 7 h for CON, MOD, and HIG, respectively. The linear effect among CON, MOD, and HIG was significant for RPH ($P < 0.001$) and UPH ($P < 0.007$). During S3, UPH was lower ($P < 0.05$) for HIG (8.43 ± 0.08) than for CON (8.49 ± 0.08) in Holsteins, but did not differ for JER. The DMI was lower for during S2 as designed, but did not differ among S1, S3, and S4. The quadratic effect among CON, MOD, and HIG was significant ($P < 0.007$) for DMI. Holstein cows had higher ($P < 0.001$) DMI than JER (17.0 ± 0.48 vs. 12.1 ± 0.68 kg/d, respectively). In conclusion, cows receiving HIG had lower RPH and UPH than cows receiving CON. The UPH of Jersey cows was not as affected by SARA as UPH of HOL. Linear effects for both UPH and RPH with increasing challenge suggest a relationship that might be useful as a diagnostic tool for SARA.

Key Words: subacute ruminal acidosis, urine pH, rumen pH

526 Potential of mid-infrared spectrum of milk to detect changes in the physiological status of dairy cows. A. Laine*[1], A. Goubau[1], H. Hammami[1,2], C. Bastin[1], and N. Gengler[1], *[1]University of Liege, Gembloux Agro-Bio Tech, Animal Science Unit, Gembloux, Belgium, [2]National Fund for Scientific Research, Brussels, Belgium.*

Fertility and health problems are causing large economic losses to the dairy industry. Early identification of pregnant cows and early detection of mastitis are key elements to improve reproductive, health, and animal welfare and reduce costs for the farmer. The mid-infrared (MIR) spectrum obtained from milk recording routines measure the absorbance over a large number of wavelengths. Two studies, based on spectral data and extra phenotypes (pregnancy diagnosis and mastitis) from Luxembourg and Wallonia (Belgium) milk recordings, were conducted to investigate the potential use of the entire spectrum in the identification of animal status. In the first study, a total of 9,717 spectral records coupled with pregnancy status coming from milk recording in Luxembourg were used. A subset of MIR spectrum from non-pregnant cows was retained and a multivariate mixed model was applied to obtain predicted MIR spectral values for all test-days, prediction errors (residuals) representing the factors not present in the model (reproductive status, unaccounted factors, and error). A quadratic discriminant function was then constructed on the residual spectra to predict the pregnancy status. Leave one out cross-validation showed promising results with an error rate of cross-validation equal to 3.1% for non-pregnant cow and an error rate of cross-validation equal to 7.4% for pregnant cow. In the second study, a total of 4,126 test-days from cows with at least one mastitis detected during its lactation and coming from the Walloon milk recording were used. Significant differences ($P < 0.05$) were observed between milk MIR spectra considered related to mastitis (in an interval of 10 d around this test-day) and the other spectra for 23.8% of the analyzed MIR spectral data points. Results from both studies showed that MIR milk spectrum could be very useful to detect changes in the physiological status of dairy cows and could be potentially used in routine management decision tools.

Key Words: milk MIR spectrum, pregnancy diagnosis, mastitis

527 Evaluation of a novel system to measure enteric methane emissions from beef cattle on pasture. S. Zimmerman*[1], J. J. Michal[2], R. White[2], K. A. Johnson[2], A. Guerouali[3], and P. Zimmerman[1], *[1]C-Lock Incorperated, Rapid City, SD, [2]Washington State University, Pullman, [3]Hassan II Agronomic and Veterinary Institute, Rabat, Morocco.*

The GreenFeed system (GF; patent 8,307,785, C-Lock Inc., Rapid City, SD) is a new system to quantitatively measure CH_4 mass fluxes (emissions) from cattle while individual animals visit GF to receive a small feed reward several times per day. The objectives of this study were to determine how beef cattle adapt to using GF, determine the consistency of GF CH_4 emissions measures, and compare CH_4 emissions with those obtained using the sulfur hexafluoride tracer technique (SF_6). Over 20 wk, cattle were fed 4 diets: good quality pasture (P1), low quality pasture (P2), low quality pasture plus bluegrass straw (BGS) (P3), and BGS (P4). Seven Angus cows (BW = 706 ± 51 kg) and 1 Angus heifer were introduced to GF in staggered groups to test GF adoption rates. In P2 and P3, CH_4 emissions with SF_6 were simultaneously measured with 51 12-h canister samples from 6 cows. Individual animal ranking stability of GF measured CH_4 emissions across diets was determined by calculating the correlation coefficient (r) of individual animal averaged

CH_4 emissions between each of the diets. Then the P-value was determined based on r and number of animals. A similar correlation analysis was completed for time of day ranking stability. P-values of differences between GF and SF_6 were determined using the 2-tailed student *t*-test. All cattle used GF an average of 2.5 $\pm$ 1.1 times/d and received 1.2 ± 0.5 kg/d of alfalfa-based pellets. Herd averaged GF CH_4 emissions were 300 ± 2.0, 292 $\pm$ 1.4, 309 $\pm$ 1.0, and 297 ± 1.0 g/d in P1, P2, P3, and P4, respectively. The overall between-animal coefficient of variation (CV) of CH_4 emissions was 9.1%; the weekly within-animal CV was 6.5%. The relative CH_4 emission ranking for the 8 animals was consistent and significant ($P < 0.05$) across diets and across the day. GF and SF_6 herd averaged CH_4 emissions were not significantly different in P2 or P3 ($P = 0.41$ and $P = 0.27$, respectively) and not significantly different ($P < 0.05$) for 9 of 12 individual animal comparisons. Overall, GF CH_4 emissions for outdoor-grazing animals were consistent, repeatable and in general, agreed with CH_4 emissions estimated with the SF_6 technique.

Key Words: methane, GreenFeed, beef cattle

528 Pasture-derived greenhouse gases emissions in cow-calf production systems. M. B. Chiavegato*, W. Powers, S. A. Utsumi, and J. Rowntree, *Michigan State University, East Lansing.*

The effects of stocking rates on pasture-derived greenhouse gas (GHG) flux are rarely reported for cow-calf production systems. This study aimed to compare GHG fluxes from cow-calf herds grazing under different stocking rates. During 2011 and 2012, methane (CH_4) and nitrous oxide (N_2O) fluxes from grazed pastures were quantified. Pastures were grazed with cow-calf herds at high stocking rate (2.5 cow/ha; 520 ± 50.4 kg, 30 d grazing return; HI), low stocking rate (1 cow/ha; 521 ± 40.4 kg, 60–90 d grazing return; LO), or excluded from grazing for several years (Control). Each year, 10 randomly deployed static chambers per paddock (750 m^2; n = 3 paddocks/treatment) were used to determine daily CH_4 and N_2O fluxes over 14-d post-grazing in early (May–June) and late (August–September) growing seasons. Soil (ST) and ambient temperature (AT) and soil water content (SWC) were monitored. Gas flux was analyzed using ANOVA for a completely randomized design ($\alpha = 0.05$) although restrictions to randomization existed due to farm logistics and management. In early season, negative CH_4 flux (i.e., sink) was detected for Control and HI (−20.3 ± 6.1 and −13.3 ± 3.8 g C-CH_4 ha^{-1} d^{-1}, respectively), however LO was a source of CH_4 (4.2 ± 5.8 g C-CH_4 ha^{-1} d^{-1}; $P < 0.01$). In late season, HI and LO were sources (10.1 ± 2.7 and 5.7 ± 4.1 g C-CH_4 ha^{-1} d^{-1}, respectively) and Control remained a sink (−7.1 ± 4.0 g C-CH_4 ha^{-1} d^{-1}; $P = 0.02$). Soil temperature, AT and SWC did not influence CH_4 fluxes ($P = 0.11$, $P = 0.08$ and $P = 0.82$, respectively). Nitrous oxide flux did not change from early to late season ($P = 0.11$). Fluxes from HI, LO and Control were not significantly different (6.8 ± 0.5, 6.6 ± 0.8 and 5.7 ± 0.8 g N-N_2O ha^{-1} d^{-1}, respectively; $P = 0.47$). Soil temperature, AT and SWC influenced N_2O fluxes ($P < 0.01$). The net flux of C-equivalent for HI, LO and Control were 0.86 ± 0.06, 0.91 ± 0.1 and 0.64 ± 0.1 kg C ha^{-1} d^{-1}, respectively and were not significantly different ($P = 0.08$). Although grazed pastures are net sources of GHG, our results indicate potential opportunities to reduce GHG fluxes by CH_4 consumption in pastures soils grazed at high stocking rates.

Key Words: methane, mitigation, nitrous oxide