PRODUCTION, MANAGEMENT, AND THE ENVIRONMENT: INFLUENCE OF DIET AND MANAGEMENT PRACTICES ON ENVIRONMENTAL FOOTPRINT

0547 Effect of breed type and pasture type on methane emissions from weaned lambs offered fresh grasses. M. D. Fraser, H. R. Fleming, V. J. Theobald, and J. M. Moorby*, *Aberystwyth University, Aberystwyth, UK.*

To investigate the extent to which enteric methane emissions from growing lambs are explained by simple body weight and diet characteristics, a 2 × 2 Latin square changeover design experiment was performed using 2 sheep breed types and 2 fresh pasture types. Weaned lambs of 2 sheep breed types were used: Welsh Mountain (a small, hardy hill breed; mean LW = 27 ± 3.6 kg) and Mule × Texel (prime lamb; 35 ± 2.5 kg; n = 8 per breed). The lambs were zero-grazed on material cut from contrasting high (ryegrass) and low (permanent pasture) digestibility pastures and fed fresh. In each experimental period, ad libitum DMI was determined individually indoors following an adaptation period of 2 wk, and methane emissions were measured individually in open-circuit respiration chambers over a period of 3 d. Mean pasture composition, as fed, for ryegrass and permanent pasture respectively, was: DM, 21.9 and 21.9%; CP, 12.4 and 11.1% DM; NDF, 41.2 and 53.3% DM; GE, 17.3 and 17.1 MJ/kg DM. Although total daily methane emissions were lower for the Welsh Mountain lambs than for the Mule × Texel lambs (13 vs. 16 g/d respectively; SED = 1.0; $P < 0.05$) when offered fresh forage, the yield of methane per unit DMI was similar for the 2 breed types (16.4 vs. 17.7 g methane/kg DMI; SED = 0.79; NS). Total output of methane per day was higher when lambs were offered ryegrass compared with permanent pasture (16 vs. 13 g/d respectively; SED = 0.49; $P < 0.001$) which was likely driven by differences in DMI (986 vs. 732 g/d; SED = 22.4; $P < 0.001$). Methane emissions per unit DMI (16.4 vs. 17.7 g methane/kg DMI; SED = 0.37; $P < 0.01$) and proportion of GE intake excreted as methane (4.9 vs. 5.3%; SED = 0.11; $P < 0.01$) were both higher on the permanent pasture. No forage × breed type interactions were identified. The results indicate that forage type had a greater impact than breed type on methane emissions from growing weaned lambs. It can be concluded that, when calculating methane emissions for inventory purposes, it would be more important to know what feeds growing lambs are consuming than to know what breeds they are.

Key Words: lambs, grass, methane

0548 Effects of dietary nitrate supplementation on enteric methane and nitrous oxide emissions from beef cattle. C. J. Neumeier*[1], Q. Wang[1], A. R. Castillo[2], Y. Zhao[1], Y. Pan[1], and F. M. Mitloehner[1], *[1]University of California-Davis, Davis, [2]University of California Cooperative Extension, Merced.*

Feeding nitrate has been proposed as a means to reduce enteric greenhouse gas emissions from ruminants. Nitrate can compete with methanogens for hydrogen in the rumen and therefore reduce methane from eructation. However, increasing the nitrate concentration in the rumen could induce enteric nitrous oxide emissions, potentially nullifying the greenhouse gas reduction achieved from lowering methane emissions. The present study investigated the effects 2% nitrate (on DM basis) vs. an isonitrogenous concentration of urea supplemented to finishing steers on enteric methane and nitrous oxide emissions. Sixteen steers were allocated to nitrate and urea treatments in a randomized complete block design (n = 8). Eructated emissions were collected using head chambers for 12 h following the morning feeding. Methane was measured using the TEI 55C direct methane analyzer and nitrous oxide using the 46i nitrous oxide analyzer (both were Thermo Environmental Instruments, Franklin, MA). All data was analyzed using the Proc Mixed Model in SAS (SAS Inst. Inc., Cary, NC). The nitrate vs. urea treatment lowered methane production at measurement h 1 and 2 ($P < 0.01$), but did not lower overall methane production during the 12-h measurement period. The nitrate vs. urea treatment increased nitrous oxide production at h 1, 2, and 3 ($P < 0.05$) of measurement, and the overall 12-h measurement period ($P < 0.0001$). Nitrous oxide was detected in both treatments at each time point, with a sixfold increase in production in the nitrate (~600 mg/12 h) vs. urea treatment (~100 mg/12 h). Overall, combined greenhouse gas production expressed as carbon dioxide equivalents was similar between treatments. This study indicates that nitrate supplementation in finishing beef cattle is effective at reducing eructated methane in the time immediately following feeding, and might need to be supplemented at a higher concentration and/or more frequently to achieve more optimal methane reduction. Furthermore, this study suggests that cattle could be a source of the potent greenhouse gas nitrous oxide, which is further stimulated by nitrate supplementation. Additional research is necessary to evaluate more effective means of reducing methane with nitrate in finishing beef cattle and the production of nitrous oxide with and without supplementation of nitrate.

Key Words: greenhouse gas, hydrogen sink, ruminant

0549 Comparison of active flux and passive concentration measurements of methane emissions from cattle. P. Huhtanen*[1], E. H. Cabezas Garcia[1], S. R. Zimmerman[2], and P. R. Zimmerman[2], *[1]Swedish University of Agricultural Sciences, Umea, Sweden, [2]C-Lock Inc., Rapid City, SD*.

There are 2 new measurement techniques to measure emitted CH_4 and CO_2 from cattle in production systems, the passive concentration measurement method (PCM) and the active gas capture method (AGC). Both systems estimate cattle muzzle CH_4 and CO_2 emissions for short-term periods (3 to 15 min) while cattle visit a feeding station multiple times daily. The objective was to determine if the 2 techniques yielded comparable results under farm conditions. A GreenFeed (GF) system was used (C-Lock Inc., Rapid City, SD) that measures individual animal emissions over a feed trough. For AGC, an active airflow (2000 L/min) was induced around the animal's muzzle that attracted emissions into a air collection pipe where airflow and CH_4 and CO_2 concentrations were measured and the average flux was calculated for each visit. For PCM, a concentration sampling intake (at 1 l/min) was placed inside the feed trough, no active airflow was used, and the average CH_4 and CO_2concentrations for each visit were calculated. 32 Swedish Red dairy cows (BW 664 ± 72 kg, MY 30.2 ± 6.3 kg/d, and DMI 20.1 ± 2.8 kg/d) housed in a free-stall barn had an access to 2 separate GF units. The diets were fed ad libitum as TMR (60% forages, 40% concentrates on DM basis). The GF were configured for 10-d sampling periods using PCM and AGC repeated twice. The data was analyzed with linear mixed models using the MIXED procedure in SAS (SAS Inst. Inc., Cary, NC). Repeatability (R) was calculated as $R = \delta^2_{Animal}/(\delta^2_{Ánimal} + \delta^2_{Residual})$. The cows visited GF on average 2.85 ± 0.95 times per day. For CH_4, the between animal coefficient of variation (CV) was greater (11.0 vs. 17.6%) with PMC compared with AGC. Comparing CH_4 results for individual animals to determine if ranking was consistent between AGC and PCM, a weak correlation was found between CH_4 concentration with PCM and CH_4 flux with AGC:CH_4 Flux (g/d) = 363 ± 30.5 + 0.058 ± 0.0214 × CH_4 (ppm; R^2 = 0.13; RMSE = 52.1). For CH_4/CO_2 ratio, CV values were similar (6.4 and 6.6%) but averaged CH_4/CO_2 ratio was greater (P = 0.001) with PMC (0.107) compared with AGC (0.094). The repeatability for AGC and PCM were high (0.72 to 0.74). It is concluded that PCM methods are not sufficient for ranking animal's emissions on farms. Measuring concentration passively is not the same as measuring fluxes.

Key Words: methane, cattle, emissions

0550 Methane emission intensities by Holstein and Holstein × Jersey crossbreed lactating cows in two Brazilian grazing systems. A. Berndt, A. P. Lemes, L. A. Romero, T. C. Alves, A. M. Pedroso*, A. D. F. Pedroso, and P. P. A. Oliveira, *EMBRAPA, São Carlos, Brazil.*

The aim of this study was the evaluation of methane emissions from pure Holstein and half Jersey, half Holstein high-producing lactating cows grazing 2 different forages. The study was conducted at EMBRAPA's (Brazilian Agricultural Research Corporation) experimental station located in São Carlos city, in the Southeast region of Brazil. Treatments were a combination of 2 factors: 2 breeds (Holstein, HOL; and 1/2half Jersey half Holstein, JH) and 2 grazing systems (extensively grazed pastures with low stocking rate, ELS, or irrigated pastures under intensive management and high stocking rate, IHS). A total of 24 dairy cows were used (2 breeds × 2 grazing systems × 3 animals per paddock × 2 replicates), grouped according to age, stage of lactation, and level of milk production. Cows were kept on pasture and supplemented with minerals and concentrates in accordance with milk yield (1 kg of concentrate/3 kg of milk produced). The IHS pasture was rotationally managed and both IHS and ELS were managed under variable stocking rates ("put-and-take"). Forage production and animal performance variables were measured to determine environmental, technical, and economic assessments. Methane emission evaluation took place in May 2013 using the SF6 tracer technique. Each animal received 2 permeation tubes (average load of 1431.0 ± 76.2 mg of SF6 with an average emission rate of 1.74 ± 0.18 mg/d) 5 d before collection. Samples were collected every 24 h for 5 consecutive days. Gases were measured on a Shimadzu GC 2014. Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) and averages were compared using Tukey's test with significant differences at $P < 0.05$. No interactions were observed between breed and grazing system. Crossbred JH presented lower ($P < 0.05$) methane emission intensity than pure Holstein (11.26 ± 1.11 vs. 14.62 ± 1.11 gCH_4/L milk) regardless of grazing system. Crossbreed JH cows emitted less ($P < 0.05$) methane per day than pure HOL (275.1 ± 20.8 vs. 337.2 ± 20.8 gCH_4/d) and produced the same amount of milk (25.11 ± 1.11 vs. 23.76 ± 1.11 L/d). Efficiency of milk production can be a mitigation strategy when less methane is emitted per liter of milk.

Key Words: dairy cows, emission intensity, methane emission

0551 Comparison between the sulfur hexafluoride tracer technique and the portable automated head chamber system for measurements of enteric methane fluxes in mid-lactation holstein cows.

A. B. D. Pereira*[1], C. D. Dorich[1], A. F. Brito[1], R. K. Varner[1], and R. Martineau[2], *[1]University of New Hampshire, Durham, [2]Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre, Sherbrooke, QC, Canada.*

The objective of this study was to evaluate the concordance correlation coefficient (CCC) and coefficient of variation (CV) of enteric methane flux (Q_{CH4}) between the sulfur hexafluoride tracer technique (SF_6) and the portable automated head chamber system (The GreenFeed [GF]; C-Lock Inc., Rapid City, SD). Eleven multiparous and 4 primiparous lactating Holstein cows housed in a tie-stall barn and averaging 176 ± 34 d in milk (DIM), 42.9 ± 6.8 kg of milk yield and 681 ± 48 kg of BW were blocked by DIM, parity, and DMI (as % of BW) and, within each block, randomly assigned to 1 of 2 treatments: ad libitum intake (AI) or restricted intake (RI) (90% DMI) according to a crossover design. Each experimental period lasted 22 d with 14 d for treatments adaptation and 8 d for data and samples collection. Diets contained (DM basis): 40% corn silage, 12% grass-legume haylage, and 48% concentrate. Five-minute measurements were taken from all animals with intervals of 12 h between the 2 daily samplings using the GF. Sampling points were advanced 2 h from 1 d to the next to yield 14 gas samplings/cow over 7 d to account for diurnal variation in Q_{CH4}. For the SF_6 method, sampling was done twice a day before milking times with canisters placed in 5 different locations inside the barn for measuring background gas concentration. Animal performance data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) while the comparison between methods was done using the CCC. Data inclusion criteria were a minimum of 5 measurements per animal per period and Q_{CH4} ranging from 150 to 800 g/d. There was a significant difference in DMI between treatments (23.7 vs. 22.3 kg/d for AI and RI, respectively) but no difference was found for milk yield and Q_{CH4} when using the GF system (471 vs. 458 g/d for AI and RI, respectively) or the SF_6 technique (406 vs. 409 g/d for AI and RI, respectively). Between animal Q_{CH4} CV averaged 14.5% (GF) and 36.5% (SF_6); within animal Q_{CH4} CV averaged 17.8% (GF) and 36.2% (SF_6). The CCC was 0.15 on 225 comparisons of 2 daily data points with error terms of 10% (central tendency), 17% (regression), and 73% (disturbance). Current results suggest that the SF_6 technique was twice more variable and yielded lower Q_{CH4} compared with the GF system. Poor concordance between these 2 methodologies warrants further investigations.

Key Words: methane, sulfur hexafluoride tracer technique, GreenFeed

0552 Nitrogen use efficiency and carbon footprint by beef cattle limit-fed co-product feedstuffs.

W. B. Smith*[1], K. P. Coffey[2], R. T. Rhein[1], E. B. Kegley[1], D. Philipp[1], J. D. Caldwell[3], and A. N. Young[1], *[1]Department of Animal Science, University of Arkansas Division of Agriculture, Fayetteville, [2]University of Arkansas, Fayetteville, AR, [3]Department of Agriculture and Environmental Sciences, Lincoln University, Jefferson City, MO.*

In terms of energy density, the cost of importing hay is often not justified in years where adverse conditions limit local hay production. Coproduct feedstuffs could represent an alternative to feeding hay in these conditions. While the primary objective of our work was to determine if coproduct feedstuffs could be used to meet the energy demands for cows, also of interest was the N use efficiency of such a system, as well as the potential environmental impacts. Eight ruminally-fistulated cows (671 ± 32.0 kg BW) were stratified by BW and allocated randomly to 1 of 4 treatments in a 2-period study: (1) limit-fed soybean hulls (LSH), (2) limit-fed distillers' dried grains with solubles (LDG), (3) a limit-fed mixture of soybean hulls and distillers' dried grains with solubles (MIX), or (4) ad libitum mixed-grass hay (HAY; 10.6% CP, 71% NDF). Limit-fed diets were formulated to meet the ME requirements of an 11-mo postpartum mature beef cow. Diet amounts were increased over a 14-d period. Cows were then moved to indoor 3 × 4.3 m concrete pens fitted with rubber mats for a 14-d adaptation and 5-d total fecal collection period. Carbon footprint and emissions were predicted according to an IPCC (2006) model for cows housed on pasture. Excretion of total N, as well as percentage excreted in feces and urine, was not different ($P \geq 0.31$) among treatments. Concentration of ammonia-N in the urine was greater ($P = 0.02$), and concentration of urea-N tended to be greater ($P = 0.07$) from LDG than from other treatments. Both ammonia-N and urea-N, when expressed as a percentage of the total urinary N, were greater ($P \leq 0.04$) from LDG than other treatments. Predicted enteric CH_4, CH_4 from manure, direct loss of N_2O, as well as N_2O from volatilization and leaching were not different ($P \geq 0.12$) among treatments. Contribution of feedstuffs to total CO_2 load tended to be greatest ($P = 0.07$) from LDG and least from HAY, with MIX intermediate to LDG and LSH and LSH intermediate to MIX and HAY. However, total carbon footprint (kg CO_2 eq/d) was not different ($P = 0.55$) among treatments. Based on this information, coproduct feedstuffs may be used in lieu of hay to meet the energy requirements of cows without adverse effects on total N excretion or environmental impact.

Key Words: limit feeding, coproduct feedstuffs, carbon footprint