1171 Estrus: Association with productive parameters and implications to fertility. R. L. A. Cerri*[1], B. F. Silper[1], T. A. Burnett[1], A. M. L. Madureira[2], J. L. M. Vasconcelos[2], and L. Polsky[1], [1]*Applied Animal Biology, Faculty of Land and Food Systems, University of British Columbia, Vancouver, Canada,* [2]*Sao Paulo State University, Botucatu, Brazil.*

Comparison between the fertility of timed-AI protocols vs. AI based on spontaneous or induced estrus is often inadequate. Day post-partum at AI and the consequent grouping of animals with different cyclic status, BCS, and overall health status is a confounding factor caused by many experimental designs. Previous studies observing the effect of concentration of progesterone during diestrus, concentration of estradiol and length of proestrus and follicular dominance minimize or neglect the effect of the expression of estrus on parameters such as fertilization rate, embryo quality, and endometrium receptivity. In one study, the likelihood of ovulation was greater for high vs. low relative increase estrus, but a more detailed experiment also showed slight differences in the timing of ovulation. Expression of estrus near AI also modified the expression of genes related with the immune system, adhesion molecules and prostaglandin synthesis in the endometrium (*MX1*, *MX2*, *MYL12A*, *MMP19*, *CXCL10*, *IGLL1*, *SLPI, OTR*, and *COX-2*) and those related with apoptosis, P4 synthesis, and prostaglandin receptor (*CYP11A*, *BAX*, and *FPr*) in the CL. The expression of estrus was associated with increased P/AI for timed-AI (38.9 vs. 25.5%) and embryo transfer (46.2 vs. 32.7%) protocols. Moreover, there was a decrease in pregnancy loss in both programs. Data from other recent studies involving spontaneous and estradiol cypionate induced estrus have shown that greater relative increase and longer duration of estrus, captured by different activity monitors, have a significant impact on P/AI (over 12% points across different studies). Intensity and duration of estrus were correlated with BCS, parity, and secondary behavior signs as expected, but only weakly associated with milk production. Follicle diameter and concentration of estradiol at estrus were also weakly correlated with estrus expression. Collectively, ovulation could partly explain the observed reduction in fertility, but it is clear that the endometrium and the CL play an important role that is independent of parameters such as parity, BCS, and milk production. Quantitative information from estrus events could be used to improve estrus detection quality and develop decision-making strategies at the farm level. Further studies in this field should aim to 1) better understand ovarian, embryo and endometrium mechanisms associated with either the expression or intensity of estrus and, 2) refine the collection of phenotypes related to estrus (i.e., relative increase, absolute increase, baseline levels, duration, and repeatability within cow) to improve estrus detection and possibly genetic selection.

Key Words: dairy cow, estrus expression, fertility

PRODUCTION, MANAGEMENT, AND ENVIRONMENT

1172 Use of evaporative cooling systems and their effects on core body temperature and lying times in lactating dairy cattle. J. R. Johnson*[1], L. G. D. Mendonça[2], J. P. Harner[3], and M. J. Brouk[1], [1]*Department of Animal Sciences and Industry, Kansas State University, Manhattan,* [2]*Kansas State University, Manhattan,* [3]*Department of Biological and Agricultural Engineering, Kansas State University, Manhattan.*

A study was completed to assess the effect of an evaporative cooling system on respiration rates, rear udder skin temperature (T_u), core body temperature (CBT), and resting time in lactating dairy cows. There were two environmental treatments in this study: FAN (Cyclone fans only, no fog); and FANFOG (Cyclone fans and fog on). Cows exposed to these 2 environments were either housed in a bedded pack barn equipped with an evaporative cooling system (Cyclone fans, Chippewa Falls, WI) or a tie-stall barn equipped with cooling cells. Cows were divided into 2 treatment groups with 8 cows/treatment: TIE which spent 50% of the time in the tie-stall barn and 50% of the time in the bedded pack barn, and PACK which also spent 50% of the time in the tie-stall barn and 50% of the time in the bedded pack barn but opposite of TIE. Each cow was fitted with a vaginal temperature logger (HOBO U12, Onset Computer Corporation, Pocasset, MA), a neck collar that contained a sensor (HOBO Pro V2, Onset Computer Corporation, Pocasset, MA) to track temperature and relative humidity of the environment, and an electronic data logger (HOBO Pendant G Acceleration Data Logger, Onset Computer Corporation, Pocasset, MA) to track lying times. Ambient temperature and relative humidity (RH) were also collected and all devices recorded at 1 min intervals. During FANFOG, PACK cows had reduced ($P < 0.05$) respiration rates (breaths per minute) compared with TIE (69 vs. 76 ± 2.4 BPM). Breaths per minute also increased significantly throughout the day for TIE but this was not the case for PACK. No differences were found in T_u between treatments. CBT data were divided into the following categories: < 38.6°C, ≥ 38.6°C, and ≥ 39.0°C. When exposed to the FANFOG environment, cows spent decreased ($P = 0.05$) time above 39°C CBT when compared with FAN (9.2 vs. 14.6 h/d, respectively), while PACK cows during FAN and FANFOG spent fewer hours/day above 39°C CBT vs. TIE ($P < 0.05$). TIE showed numerically greater total daily lying times during FAN and FANFOG compared with PACK ($P > 0.10$). These results confirm that evaporative cooling systems (Cyclone fans and fog) are effective at decreasing respiration rates and CBT thus improving cow comfort, while having no

effect on T_u and lying times in lactating dairy cows.

Key Words: core body temperature, evaporative cooling, heat stress

1173 Relationship between blood parameters, physiological changes, and behavior pattern in Korean native steers under cold stress. W. S. Kim*, U. S. Jung, M. J. Kim, S. W. Jeon, D. Q. Peng, Y. S. Kim, M. H. Bae, J. S. Lee, S. R. Lee, and H. G. Lee, *Department of Animal Science and Technology, College of Animal Bioscience and Technology, Konkuk University, Seoul, Korea.*

The performance, health, and behavior of cattle are strongly affected by climate. The objective of this study was to investigate the relationship between blood parameters, rectal temperature, heart rate, and rumination time in Korean native steers under cold stress. Data were collected from four Korean native steers (331.6 ± 6.46 kg BW and 343.5 ± 3.48 d age), which were kept in three designated temperature levels based on ambient temperature: HCS; high cold stress (−15 to −10°C) period, MCS; medium cold stress (−10 to −5°C) period, and LCS; low cold stress (−5 to 2°C) period. According to the ambient temperature, blood was collected after 3h feeding (at 1100). The blood metabolites and hormone as stress-related indicators were analyzed using biochemical analyzer-T-BA-40FR. Complete Blood Count (CBC) test was conducted to determine the change in blood cells, and rectal temperature (RT) and heart rate (HR) were measured at the same time points. Feed and water intake were recorded daily (at 0900 h), and rumination time (RMT) was monitored through a video monitoring system. Data were analyzed using the JMP 5.0 procedures of SAS. The results showed that the level of serum cortisol ($P = 0.027$) as an indicator of stress steroid hormone was significantly increased in the HCS period compared with the LCS period. Also, RT ($P = 0.003$) and HR ($P = 0.01$) were significantly increased in the HCS period compared with the LCS period. However, RMT ($P = 0.011$) was decreased in the HCS period compared with the LCS period. Feed, water intake, and blood parameters were not associated with RT ($P > 0.10$). In contrast, RMT and HR influenced RT ($P < 0.01$). Serum cortisol, platelet, and RMT were affected in HR ($P < 0.05$). This means that the lower temperature is related to high stress in Korean native steers, and there were close correlations between RT, HR, and cortisol. In conclusion, HR and RT were very important stress indexes in cold season, which has a very close relationship with the concentration of cortisol and RMT. In addition, an increase in cortisol level probably activates the sympathetic nerve system to cause an increase in the heart rate of Korean native steers. This relationship with this physiological action explains that it would be an important factor to reduce stress.

Key Words: blood parameters, cold stress, Korean native steer

1174 Effects of exit-lane water drenching using showers on lactating dairy cow vaginal temperature. A. R. Lee*, S. M. Smith, D. L. Ray, J. D. Clark, and J. M. Bewley, *University of Kentucky, Lexington.*

Dairy producers can help mitigate the negative effects of high temperature and humidity by implementing cow cooling methods. The objective of this study was to quantify the changes in vaginal temperature after drenching cows with water using showers on parlor exit. Forty-five lactating Holstein cows (Parity = 1.89 ± 1.21, days in milk = 244.58 ± 127.58) at the University of Kentucky Coldstream Dairy were enrolled in a 4 wk crossover study from August 31 to September 24, 2013. Vaginal temperature measurements were recorded every 6 min for 7 d using Thermochrom iButtons (Embedded Data Systems, Lawrenceberg, KY) placed in a vaginally inserted blank CIDR (Zoetis, Florham Park, NJ). Vaginal temperature was used as a measure of core body temperature. Cooling Sense showers (Edstrom Industries, Waterford, WI) were installed in 2 parlor exit lanes and automatically activated at morning or afternoon milking when ambient air temperature was ≥ 18.3°C. Showers sensed approaching cows and drenched water for 5 s, as cows walked through each respective exit lane. Showers ran for 5 s, although cows may have received no, some, or all of the drench. Cows were randomly balanced by days in milk and parity into two pens. Cows in pen 1 received 4 d of showers and 3 d of washout during weeks 1 and 3. Cows in pen 2 received 4 d of showers and 3 d of washout during weeks 2 and 4. All other times, cows in pen 1 or pen 2 did not have showers. Shower time was characterized as the time before or after the cow entered the shower. The MIXED procedure of SAS (SAS 9.3, SAS Inst., Inc., Cary NC) was used to analyze the effects of shower time, shower use, and milking sessions on vaginal temperature. Stepwise backward elimination was used to remove nonsignificant interactions ($P \geq 0.05$). Vaginal temperature was lower ($P < 0.01$) 1 h and 2 h after drench than 1h and 2h before drench (LSMean ± SE; 39.1 ± 0.04°C vs. 39.2 ± 0.04°C) and (39.1 ± 0.03°C vs. 39.2 ± 0.04°C), respectively. Morning or afternoon milking had a significant effect on vaginal temperature at 5 min, 10 min, 30 min, 1 h, and 2 h after milking ($P < 0.01$). The use of showers on parlor exit reduced vaginal temperature by 0.1°C for up to 2 h following drenching with showers.

Key Words: cow cooling, shower, vaginal temperature

1175 The effects of zinc amino acid complex on biomarkers of gut integrity and metabolism in heat-stressed steers. M. Abuajamieh*[1], S. K. Kvidera[1], E. A. Horst[1], E. J. Mayorga[1], J. T. Seibert[1], J. S. Johnson[1], J. W. Ross[1], M. A. Al-Qaisi[1], P. J. Gorden[2], J. DeFrain[3], R. P. Rhoads[4], and L. H. Baumgard[1], *[1]Iowa State University, Ames, [2]Veterinary Diagnostic and Production Animal Medicine, Iowa State University, Ames, [3]Zinpro Corporation, Eden Prairie, MN, [4]Virginia Tech, Blacksburg.*

Supplemental Zn improves monogastric intestinal integrity during heat stress (HS), but its ability to improve ruminant gut health is unknown. Forty Holstein steers (173.6 ± 4.9 kg) were used in a replicated, incomplete 2 x 3 factorial design to determine the effect of Zn source ($ZnSO_4$ vs. Zn amino acid complex [CZ; Availa®Zn, Zinpro Corporation]) and environment (thermal neutral [TN] conditions or cyclical HS) on biomarkers of intestinal integrity and villi morphology. Steers were fed ad libitum (AL) one of two diets for 21 d: 1) 75 mg/kg of Zn from $ZnSO_4$ or 2) 35 mg/kg Zn from $ZnSO_4$ and 40 mg/kg Zn from of CZ. Steers remained on assigned diets and were then housed in environmental chambers. The experiment consisted of two periods (P): P1) 5 d of baseline in TN-AL conditions (20.2 ± 1.4°C, 30.4 ± 4.3% RH) and P2) 6 d of environment implementation followed by euthanasia. During P2, steers received one of five diets by environment combinations: 1) TN fed AL 75 mg/kg of Zn from $ZnSO_4$ (Ctrl; n = 8), 2) TN pair-fed (PF) 75 mg/kg of Zn from $ZnSO_4$ (0CZPF, n = 8), 3) HS (27.1 ± 1.5 to 35.0 ± 2.9°C, 19.3 ± 3.5% RH) and fed AL 75 mg/kg of Zn from $ZnSO_4$ (0CZHS; n = 8), 4) TN and PF 35 mg/kg of Zn from $ZnSO_4$ and 40 mg/kg of Zn from CZ (40CZPF, n = 8), and 5) HS and fed AL 35 mg/kg of Zn from $ZnSO_4$ and 40 mg/kg of Zn from CZ (40CZHS; n = 8). The Ctrl, 0CZPF, and 40CZPF steers remained in TN continuously. The 0CZPF and 40CZPF steers were fed to their 0CZHS and 40CZHS counterparts, respectively. Data were analyzed with repeated measures using PROC MIXED in SAS and P1 data used as a covariate. Preplanned contrasts evaluated Zn source and environment. Regardless of environment, 40CZ tended to increase DMI (10%; P = 0.09) relative to 0CZ (P < 0.01). Compared to TN, HS decreased NEFA, serum amyloid A and increased BUN, insulin:DMI, and L-lactate (P < 0.01). 40CZHS calves had reduced rectal temperature compared to 0CZHS (0.24°C; P < 0.01). Compared to PF, HS calves had increased (P < 0.01) goblet cell numbers in the duodenum, jejunum, ileum, and colon. 40CZHS decreased duodenum villi width and increased both jejunum villi height and villi height:crypt depth relative to 0CZHS (P < 0.01). Feeding CZ improved DMI, reduced rectal temperature, and altered intestinal morphology; changes indicative of improved intestinal barrier function during HS.

Key Words: gut health, heat stress, intestine, zinc

1176 Effect of OmniGen-AF® supplementation to heat stressed cows during late gestation on blood parameters and immune cells of their calves. A. L. Skibiel*[1], J. L. Powell[1], T. F. Fabris[1], Y. M. Torres[1], F. N. Corra[1], J. D. Chapman[2], D. J. McLean[2], D. Kirk[2], G. E. Dahl[1], and J. Laporta[1], *[1]Department of Animal Sciences, University of Florida, Gainesville, [2]Phibro Animal Health Corporation, Quincy, IL.*

Exposure to heat (HT) stress during the dry period negatively impacts cow immune status. Feeding OmniGen-AF® (OG) has been shown to improve the immune status of the HT cow, but the effect on the calf is unknown. We evaluated the effect of OG supplementation pre-calving (56 g/d, for approximately 105 d) to cows under HT (shade) or cooled (CL; shade, fans, soakers) environmental conditions during the dry period (~56 d) on the immune and stress response of their calves. The experimental design was a 2 x 2 factorial with four treatments: CL (n = 4), CLOG (n = 6), HT (n = 6), HTOG (n = 7). Data were analyzed with a one- or two-way ANOVA, d as a repeated measure. At birth, heifers were fed maternal colostrum (5.7 L, two meals the first 24h). Blood samples were collected at 0 h, 24 h, d 10, and d 28 to measure cortisol, haptoglobin, (HPT), and serum amyloid-A (SAA). Hematology parameters and immune cell counts were assessed in the circulation of calves at birth and at 24 h (before and after colostrum feeding). Total cortisol concentrations were elevated at birth, but markedly decreased after feeding colostrum and on d 10 (P < 0.01) for all groups. Calves born to OG fed cows tended to have increased circulating cortisol (P = 0.09). Haptoglobin and SAA levels were higher on d 10 for all groups except for the CL calves (P < 0.01). Calves born to OG fed cows, and those born to HT cows, had higher SAA on d 10 (P < 0.03). White blood cell counts were similar at birth, and increased at 24 h after colostrum feeding except in the calves born to CLOG cows. Red blood cell counts (RBC) were elevated at birth and decreased significantly at 24 h for all groups (P < 0.05), except for the CL calves. Calves born to OG fed cows had more RBC (P < 0.02). Neutrophil counts were similar for all groups at birth and increased, after colostrum feeding, only for the HT and CL calves. Calves born to OG fed cows had more lymphocytes at birth compared to those born to cows not fed OG (P < 0.05). Heifers born to HT cows had fewer lymphocytes compared to CL if they weren't fed OG, but if they were born to HTOG cows their lymphocyte count was similar to the CLOG. In summary, in-utero exposure to heat stress during late-gestation negatively affects the immune and stress responses of the calf ex-utero. OmniGen-AF® supplementation to the dam could potentially benefit the offspring.

Key Words: calves, immunity, OmniGen-AF, stress

1177 Effects of cooling and dietary zinc source on the inflammatory responses to an intra-mammary lipopolysaccharide challenge in lactating Holstein cows during summer. A. P. A. Monteiro*[1], X. Weng[1], J. Guo[1], J. K. Bernard[1], J. DeFrain[2], and S. Tao[1], *[1]University of Georgia, Tifton, [2]Zinpro Corporation, Eden Prairie, MN.*

Milk somatic cell count increases during summer and dietary zinc supplementation has been shown to improve mammary health. The objective was to determine the effect of active cooling and dietary zinc source on an intra-mammary lipopolysaccharide challenge during summer. Twenty lactating multiparous Holstein cows were randomly assigned to one of 4 treatments with a 2 × 2 factorial arrangement (n = 5/treatment), including two environments: cooled (CL) or not cooled (NC), and two sources of Zn: 75 ppm ZnCl, or 35 ppm ZnCl+40 ppm Zn-methionine complex. From d 0 to 84 of the trial, all cows were cooled (fans and misters over the freestall and feeding areas, temperature-humidity index = 73). Starting at d 85, NC cows were deprived of cooling (temperature-humidity index = 78). At d 118, cows received infusions of 10 μg of lipopolysaccharide and saline in the left (LQ) and right (control, CQ) rear quarters, respectively. Rectal temperature was assessed. Individual quarter milk samples were collected at −12, −4, 0, 6, 12, 24, 48, 72, 96, 120, 144, and 168 h relative to infusion and analyzed for composition. Plasma was collected at the same time points (with an additional sample at 3 h) for analyses of lactose and Zn, and complete blood count was performed for samples collected within the first 24 h. Treatments did not affect DMI, whereas milk yield tended to be greater for NC at d 6 than CL cows (environment × d, P < 0.10). CL cows tended to have higher somatic cell score at 96, 120, and 144 h in LQ, and at 24 h in CQ than NC cows (environment × h, P < 0.10). Compared with CL, NC cows had higher rectal temperature at 12 h and tended to have higher at 120 and 144 h (environment × h, P = 0.01). CL cows had higher milk protein percentage in CQ, but lower in LQ ($P \leq$ 0.05) than NC. Relative to CL, NC cows had higher milk urea nitrogen in CQ (P = 0.04). Solids-not-fat percent tended to be higher for CL than NC cows in CQ (P = 0.07). Relative to CL, NC cows had higher plasma lactose at 3 h (environment × h, P = 0.02) and lower plasma Zn at 6 and 12 h (environment × h, P < 0.01). NC cows had a greater reduction in blood neutrophils at 3 h (environment × h, P < 0.01) and lymphocytes at 3 and 6 h (P = 0.05) than CL. Active cooling mitigated the inflammatory responses to an intra-mammary lipopolysaccharide challenge; however, dietary Zn source had no impact.

Key Words: cooling, intra-mammary lipopolysaccharide challenge, zinc

1178 Survey of facility design and heat abatement strategies in progressive Central California dairies. A. H. Souza*[1], E. O. S. Batista[2], B. Gonzales[3], and F. Doricci[4], *[1]Ceva Animal Health, Libourne, France, [2]University of Sao Paulo, Pirassununga, Brazil, [3]Large Animal Veterinary Practitioner-Campestre Dairy, Sao Pedro, Brazil, [4]University of Sao Paulo, Sao Paulo, Brazil.*

An on-farm survey was performed to assess type of facilities and common practices used to mitigate heat stress in progressive Central California dairies. A total of 18 dairies (10 drylot, 8 free-stall herds) classified as in the top quartile in terms of milk production and reproduction performance according to DHIA benchmarking for herds in Central California agreed to participate in the on-farm data collection procedure, which consisted of ~1 h walk through on all facilities in the dairy plus a 20 min interview with herd managers. Data collection and recording were performed by the same trained technician and all herd visits were performed in the morning hours from June to October of 2014. Complete sanitization of clothes and rubber boots used during the visit occurred after all visits and an interval of at least 72 h between visits was respected for biosecurity reasons. All participating dairies purposely chosen to avoid breed-related facility variations milked predominantly (≥ 90% of the cows in the herd) Holstein cows with an average herd size of 1959 lactating cows (range 703 to 5987). In terms of heat abatement strategies, all herds had shade, soakers, and fans in their pre-milking holding areas. Most herds (15) had fans in the holding area positioned to the opposite side of the milking parlor, but 3 of them had fans positioned toward the milking parlor. In addition, 11 herds had functioning under-wash systems in their holding areas. However, only 6 herds had showers, 13 had water troughs, and 7 had rubber-mattress in the return alleys after milking time. Interestingly, only 1 herd had shade provided in the return alleys from milking parlor to all milking pens. Thirteen herds used dry-manure beddings, 3 had compost-manure beddings, and 2 used sand-based bedding systems. Out of the herds that used stalls in the bedding area (9), stall front width averaged 121.3 cm. All herds used head-locks instead of neck-rails in the feeding lane, all had shaded areas for resting in the yard, all had soakers, and only 12 herds had shaded feed-bunks. Interestingly, only 3 herds had fairly clean water troughs in their barns, and most herds should implement more frequent routines to improve water trough cleanness. In conclusion, top performing dairy herds in CA use several strategies to mitigate detrimental effects of heat stress and keep cows comfortable while housed in confined systems.

Key Words: dairy cow, facility design, heat stress

1179 The effect of vaginal temperature on expressed physical activity of lactating Holstein cows following induced estrus. L. Polsky*[1], A. M. L. Madureira[2], E. L. Drago Filho[2], J. L. M. Vasconcelos[2], and R. L. A. Cerri[1], *[1]Applied Animal Biology, Faculty of Land and Food Systems, University of British Columbia, Vancouver, Canada, [2]Departamento de Produção Animal-FMVZ-UNESP, Botucatu, Brazil.*

The objective of this study was to determine the effect of vaginal temperature on levels of physical activity expressed by lactating Holstein cows following induced estrus. Lactating Holstein cows (n = 641; 41.5 ± 9.4 kg milk/d) were fitted with a leg-mounted pedometer (AfiActII, Afimilk, Israel) resulting in 843 evaluated activity episodes of estrus. Vaginal temperature was monitored using thermometers (Thermochron iButton −40°C thru +85°C), attached to an intravaginal device (CIDR) as part of a timed-AI protocol (CIDR+estradiol benzoate+GnRH-7d-PGF-2d-CIDR out+PGF+ECP-2d-timed AI), which recorded vaginal temperature every 10 min for 3 d. Ambient temperature and relative humidity were monitored using an external thermometer placed in the center of each pen. Milk production and BCS were collected at time of thermometer insertion. All statistical analysis was performed in R and R Studio using GLM and ARM packages. Heat stress was calculated based on the percentage of time the cow spent with a vaginal temperature greater than 39.1°C (HS). The mean HS was 36.8 ± 24.5%, whereas the mean maximum (MaxVT) and minimum (MinVT) vaginal temperatures were 39.7 ± 0.5°C and 38.0 ± 0.8°C, respectively, with an average amplitude (AMP) 1.71 ± 0.9°C. Mean peak activity (PA) at estrus was 237.0 ± 160.0% relative increase. Increasing MaxVT negatively affected mean PA (ODDS = 0.67, $P < 0.01$). PA was significantly affected by parity as multiparous cows expressed lower PA compared to primiparous cows (ODDS = 0.76, $P < 0.01$). MinVT, AMP, and HS had no significant effects on mean PA, but cows displaying greater PA at estrus had greater P/AI compared with lower PA (28% vs. 18%$P < 0.003$). The P/AI at 32 d was significantly reduced by increasing MaxVT (ODDS = 0.67 $P < 0.05$); however HS, MinVT, and AMP did not significantly affect P/AI. Future research should aim to refine variables related to hyperthermia as well as further effects of body temperature on physical activity behaviors such as lying time, bout, rumination, and subsequent effects on estrous expression and pregnancy rates.

Key Words: estrus, heat stress, physical activity

1180 Partial carbon footprint of milk and interaction between enteric methane and nitrous oxide emissions in grazing dairy farms: The case of Costa Rica. M. A. Wattiaux*[1], J. P. Iñamagua-Uyaguari[2], F. Casasola-Coto[3], L. Guerra-Alarcón[4], and A. Jenet[3], *[1]University of Wisconsin-Madison, Madison, [2]Universidad de Cuenca, Cuenca, Ecuador, [3]Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica, [4]Université Laval, Québec, Canada.*

Pasture-based dairy production systems in Costa Rica vary considerably from the tropical coastal areas to the temperate highlands (1600 to 2400 m above sea level). The objective of this study was to identify indicators of on-farm partial carbon footprint (PCFP) of milk among 31 variables describing farm conditions (e.g., altitude, rainfall, temperature), farm structure (e.g., stocking rate, breed), feeding and housing management practices (e.g., concentrate fed, intake from pasture), and pasture management (e.g., fertilization rate, hours in pasture). A second objective was to explore the correlation between methane (CH_4) and nitrous oxide (N_2O) emissions. Farm records and face-to-face survey data from 104 farms of the Dos Pinos cooperative were collected to estimate PCFP based on enteric CH_4 of lactating cows and N_2O from commercial fertilizers applied to grazed pastures (Fertilizer-A), cut-and-carry pastures (Fertilizer-B), and estimated manure N deposited during grazing. The PCFP ranged from 0.378 to 1.054 with CH_4 ranging from 0.310 to 0.692, and N_2O ranging from 0.056 to 0.609 kg CO_2eq./kg of fat-and-protein corrected milk (FPCM). Contribution of enteric CH_4, Fertilizer-A, Fertilizer-B and manure N to PCFP averaged 69.5, 9.2, 0.7 and 20.7%, respectively. Forward regression analysis indicated that the three most important variables explaining the PCFP were (all $P < 0.001$) feed efficiency (FPCM (kg/d)/dry matter intake (kg/d)), which ranged from 0.49 to 1.36 (partial r^2 = 0.52), Fertilizer-A, which ranged from 0 to 1058 kg/ha per year (partial r^2 = 0.16), and estimated dry matter intake from pasture, which ranged from 0 to 15.6 kg/d (partial r^2 = 0.08). Pearson correlation between CH_4 and N_2O emissions was 0.41 ($P < 0.001$). The contribution of CH_4 to PCFP was determined primarily by feed efficiency and estimated dietary dry matter digestibility, whereas the contribution of N_2O to PCFP was determined primarily by Fertilizer-A, feed efficiency, stocking rate (lactating cows per ha), hours of the day that cows were in pasture, and cow N use efficiency (milk N (g/d)/intake N (g/d)). Thus feeding practices had a substantial impact on both CH_4 and N_2O emissions. The relationship between CH_4 and N_2O emission was mediated in part through hours of the day that cows are in pasture, estimates of pasture consumption and pasture digestibility. In some farms PCFP of milk could be reduced readily simply by reducing excess fertilizer application. However, the adoption of management practices aimed at reducing enteric CH_4 may substantially alter pasture

N_2O emission and possibly vice-versa.

Key Words: climate change, greenhouse gases, LCA

1181 WS Effects of dry and wet conditions during the pre-weaning phase on subsequent feedlot performance and carcass composition of beef cattle. G. A. Gatson[*1], B. L. Vander Ley[2], W. D. Busby[3], P. J. Gunn[4], and A. M. Meyer[1], *[1]Division of Animal Sciences, University of Missouri, Columbia, [2]College of Veterinary Medicine, University of Missouri, Columbia, [3]Tri-County Steer Carcass Futurity, Lewis, IA, [4]Department of Animal Science, Iowa State University, Ames.*

The objective of this study was to determine the effects of dry and wet conditions during the pre-weaning phase of beef cattle production on subsequent feedlot performance and carcass characteristics. Steers (n = 7439) and heifers (n = 2380) finished in 16 feedlots in southwestern Iowa through the Tri-County Steer Carcass Futurity Cooperative (Lewis, IA) were used for a retrospective analysis. Cattle originated in the Midwest, were born in February, March, or April, and were slaughtered between 2003 and 2014. Feedlot performance and carcass composition data were obtained for each animal. Palmer Drought Severity Index (PDSI) values were obtained for each animal for the pre-weaning forage growing season on a monthly basis. These values were used to classify conditions as dry (mean PDSI value ≤ -2.00), normal (mean PDSI value > -2.00 and < 2.00), or wet (mean PDSI value ≥ 2.00) for the cool season, warm season, and combined seasons. Mixed models were used to evaluate the effects of dry and wet conditions on subsequent performance. Birth year, feedlot, and sex were included as fixed effects. Average daily gain was greater ($P < 0.03$) for cattle from the dry class than those from the wet class during the cool season and the combined seasons. Cattle from the dry and normal classes for both the cool season and combined seasons had greater ($P < 0.02$) final BW than those from the wet class. During the cool season, HCW was greater ($P < 0.0001$) for the normal class than wet class, although HCW was greater ($P < 0.04$) for the dry class compared with normal and wet during the combined seasons. Calculated yield grade was improved ($P < 0.01$) for the normal class during the cool season compared with the dry and wet classes. For both the warm and combined seasons, the dry class had improved ($P < 0.02$) calculated yield grade compared with normal and wet classes. For the cool season, the dry and normal classes had greater ($P < 0.03$) marbling scores than the wet class. For marbling score in the warm season, the normal and wet classes were greater ($P < 0.02$) than the dry class. In conclusion, this study indicates that both dry and wet conditions during the pre-weaning phase may impact ultimate feedlot performance and carcass composition.

Key Words: carcass, drought, feedlot

1182 Predicting manure volatile solid output of lactating dairy cows. R. Appuhamy[*1], L. Moraes[1], C. Wagner-Riddle[2], D. P. Casper[3], and E. Kebreab[1], *[1]University of California, Davis, Davis, [2]University of Guelph, Guelph, Canada, [3]Dairy Science Department, South Dakota State University, Brookings.*

Organic matter (OM) in livestock manure consisting of biodegradable and non-biodegradable fractions are known as volatile solids (VS). According to Intergovernmental Panel on Climate Change Tier 2 (IPCC-Tier 2) guidelines, methane emissions from manure is determined based on VS. However, only biodegradable OM generates methane. So methane emissions should be based on biodegradable VS (dVS, dVS = VS – lignin). The objective of the study was to develop mathematical models for estimating VS and dVS outputs by lactating dairy cows. Dry matter intake, dietary nutrient contents, milk yield and composition, body weight, and days in milk were used as potential predictor variables. Multicollinearity, model simplicity, and random study effects were taken into account during model development that used 588 VS and dVS measurements (kg/cow/d) from 43 studies. New models and the IPCC-Tier 2 model [VS = {fecal energy (MJ/d) + urinary energy (MJ/d)} × fecal OM/18.45] were evaluated with an independent set of VS and dVS measurements (n = 244) made on Holstein cows in the United States. Dry matter intake (kg/d) and dietary CP and NDF contents (% of DM) were significantly associated ($P < 0.001$) with VS. A model including these variables [VS = 0.364 ± 0.007 × DMI + 0.026 ± 0.004 × NDF– 0.078 ± 0.008 × CP] fitted best to data. When evaluated with independent data, the new model had a root mean square prediction error, as a percentage of average observed value (RMSPE%), of 14.0%. More than 93% of the error was due to random variability of data. Under the assumptions that feed digestibility = 66%, energy intake partitioning to urine = 0.04, and fecal OM = 0.92, the IPCC-Tier 2 model also performed well on independent data and had a RMSPE of 14.5%. A model including DMI, and dietary CP and hemicellulose (HC, HC = NDF– ADF in % of DM) contents as predictor variables fitted best to dVS data [dVS = 0.334 ± 0.007 × DMI + 0.029 ± 0.006 × HC– 0.058 ± 0.008 × CP] and performed well, when evaluated with independent data (RMSPE = 13.9%). The majority of the error (95.7%) was due to random variability of data. The study offers empirical models that can predict VS. and dVS of lactating dairy cows accurately and thereby, could assist in determining methane emissions from manure successfully.

Key Words: dairy cow, manure, prediction model, volatile solid

1183 The effects of vermifiltration on gaseous emissions from dairy lagoon water. *E. Lai*, Y. Zhao, Y. Pan, and F. M. Mitloehner, University of California, Davis, Davis.*

Dairy lagoon water contains high concentrations of nitrogen (N), which has the potential to pollute groundwater and the atmosphere. To reduce N loading of an anaerobic lagoon at a commercial dairy, a pilot project vermifilter was installed, which used earthworms embedded in woodchips to enhance removal of solids and contaminants. The objective was to mitigate nitrogenous gases, greenhouse gases (GHGs), volatile organic compounds (VOCs), and criteria pollutants from lagoon water using this new technology. Specifically, emissions of ammonia (NH_3), nitrous oxide (N_2O), carbon dioxide (CO_2), methane (CH_4), hydrogen sulfide (H_2S), and ethanol (EtOH) were measured using Thermo analyzers (Franklin, MA) that were housed inside a Mobile Agricultural Air Quality Lab. To assess whole filter system performance, emissions were measured from the untreated dairy lagoon water (LAG), as well as from the vermifilter's influent (INF), effluent (EFF), the top (TOP), and bottom (BOT) of the filter. Gases were measured using a flux chamber approach for LAG, INF, and EFF, a triangle wind tunnel for the TOP, and an inlet threaded to the bottom of the filter for BOT. Results for EFF vs. INF showed a 90.2% reduction of NH_3 emissions without increasing emission of N_2O, CO_2, CH_4, H_2S, and EtOH from the rest of the vermifilter's system. The vermifilter's ability to reduce nutrient loading and subsequent NH_3 emissions without producing other detrimental gaseous emissions needs to be replicated across more dairy operations. However, this new technology has the potential to be a viable candidate for nitrogen removal particularly in regions like the San Joaquin Valley of California, where dairy air and water quality issues are most sensitive.

Key Words: dairy wastewater, emissions, nitrogen

1184 Trends in milk urea nitrogen, milk composition, and milk yield in dairy farms in the Northeast U.S. A. N. Hristov[*1], M. T. Harper[1], J. Oh[1], F. Giallongo[1], J. C. Lopes[1], G. Cudoc[2], J. Clay[3], and L. E. Chase[4], *[1]The Pennsylvania State University, University Park, [2]Dairy One Coop., Inc., Ithaca, NY, [3]Dairy Records Management Systems, Raleigh, NC, [4]Cornell University, Ithaca, NY.*

The main objective of this survey was to examine trends in milk urea nitrogen (MUN) in DHI herds (all dairy cattle breeds were included) in the Northeast U.S. Data for milk fat and true protein concentrations, milk yield, days in milk (DIM) on test day, and lactation number of the cows were also collected. Close to 11 million historical (2004 to 2015) records from the Dairy Records Management Systems (Raleigh, NC) for 14 states (CT, DE, MA, MD, ME, NC, NH, NJ, NY, PA, RI, VA, VT, and WV) were included in the analysis. Average (across states and years) MUN, milk fat, milk true protein, milk yield, DIM, and lactation number were (mean and SD): 13.3 (0.65) mg/dL, 3.85 (0.07)%, 3.13 (0.04)%, 31.6 (0.86) kg/d, 178 (19.2) d, and 2.3 (0.04) lactations. MUN was 13.3 mg/dL in 2004, decreased to 12.4–12.6 mg/dL in 2009–10, steadily increased to 14.6 mg/dL by 2013, and then decreased to 13.0 and 12.4 mg/dL in 2014 and 2015, respectively. Milk fat concentration steadily increased from 3.69 in 2004 to 3.92–3.93% in 2013–14 and decreased to 3.87% in 2015. Milk true protein was 3.01% in 2004, increased to 3.15–3.16% in 2008–09 and declined to 3.13–3.11% thereafter. Except for 2004 (33.5 kg/d), milk yield steadily increased from 30.7 in 2005 to 32.3–32.8 kg/d in 2014–15. The likely explanation for the higher average milk yield in 2004 was the lower average test day DIM (119 d) in that year vs. all other years (184 d, SD = 4.3). In an effort to explain the observed trends in MUN, we investigated variability in dairy feed cost in PA and the U.S. (Northeast data were not available). Average dairy feed cost in PA (for a cow producing 29.5 kg milk/d) increased from $3.08 in 2005 to $5.22 in 2008, declined to $4.01 by 2010, increased again to $6.03 in 2012, and then declined to $5.07/d in 2015. Dairy feed cost for the U.S. followed similar trends. It was apparent that high MUN coincided with high feed cost and vice versa. Therefore, our conclusion from this survey was that MUN in Northeast dairy herds fluctuated following trends in feed cost; however, ration data are not available to better define the reasons for the variations in MUN levels.

Key Words: dairy cow, milk composition, milk urea nitrogen, northeast U.S.

1185 Effect of time and storage conditions on cow urine pH. M. C. Lewis*, S. A. Armstrong, J. P. Jarrett, and D. J. McLean, *Phibro Animal Health Corporation, Quincy, IL.*

Analysis of bovine urine pH is a common practice for dairy professionals wishing to evaluate the efficacy of a negative dietary cation anion difference (DCAD) diet in pre-fresh transitional dairy cows. However, immediate measurement of urine pH on collection is not always possible in an on-farm setting, and information regarding how storage conditions and time impact changes in urine pH is not available. The objective of this study was to analyze the effect of various storage conditions over time on the urine pH of dairy cows fed a fully-acidified and non-acidified diet. This information will be used to advise professionals on the best method of urine storage to consistently obtain accurate urine pH values. Urine from three randomly selected Jersey cows was collected and an initial time zero pH reading was taken with a pre-calibrated Milwaukee portable pH meter, model MW101. Samples were aliquoted and assigned for either 2, 4, 6, and 24 h of storage in triplicate, then placed at 4°C, 20°C, 37°C, and field conditions at temperatures ranging from 0.5°C to 7°C and 81% to 100%

humidity. Urine pH was measured at the indicated storage time intervals. Study one (S1) measured sampled urine from cows on a fully acidified diet, while study two (S2) measured sampled urine from cows without diet acidification. Data were analyzed as change in pH units from the pH value at initial collection (time = 0), using two way ANOVA procedure in graph pad Prism 6.03 with storage method and time as fixed effects. Significance was declared at $P < 0.05$. The urine pH values from the fully-acidified cows had a significant storage effect ($P < 0.0001$) as well as a significant time effect ($P < 0.0001$) while the interaction of storage and time was not significant. Urine pH values were not different across time when collected from non-acidified cows, however storage temperature conditions did significantly change sample pH values ($P < 0.0001$), and the interaction between time and storage was significant ($P < 0.0001$). Diet acidification influenced urine pH values for all storage methods ($P < 0.05$). In cows fed both fully-acidified and non-acidified diets, urine stored at a temperature closest to the animal's normal internal temperature of 38.5°C had the least amount of change in pH units from initial collection, indicating that keeping samples at 37°C or 20°C produces significantly less pH variation than at cooler temperatures.

Key Words: dairy cows, dietary cation anion difference, urine pH

1186 Farm gate environmental impacts of beef production in the Northern Plains and Midwest regions of the U.S. S. Asem-Hiablie, C. A. Rotz*, and R. C. Stout, *USDA-ARS Pasture Systems and Watershed Management Research Unit, University Park, PA.*

Cradle-to-farm gate environmental impacts of beef production in two cattle producing regions were assessed as part of an ongoing national sustainability study of the U.S. beef value chain launched by the Beef Checkoff. Region-specific data on common ranch and feedlot management practices were characterized from producer surveys and site visits in each of the 10 states within the Midwest and Northern Plains regions. This management information was used along with appropriate climate and soil data to simulate representative operations and predict environmental impacts with the Integrated Farm System Model (IFSM). The representative ranch and feedlot operations were then linked to form full production systems in each region. Weighted averages of the environmental footprints for the regions were determined using animal distribution data from both the producer survey and the National Agricultural Statistics Service. Preliminary results gave footprints of total carbon emission, reactive nitrogen loss, and energy and non-precipitation water use for the two regions as 19.7 ± 1.5 kg CO_{2e}, 158 ± 12.9 g N, 48 ± 4.3 MJ, and 1106 ± 154 L per kilogram of carcass weight produced, respectively. The carbon and reactive nitrogen footprints were greater in the Midwest than the Northern Plains, but water use was greater in the Northern Plains. These farm-gate results will be linked with post-farm gate impacts for each of seven study regions to provide the basis for a full national life cycle assessment of beef production and consumption.

Key Words: beef production, environmental footprint, sustainability

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118 Effect of temperature on ammonia emissions from feedlot cattle manure. K. M. Koenig* and S. M. McGinn*, Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, Canada.*

Livestock feeding operations are the largest contributor to anthropogenic ammonia emissions affecting air quality and terrestrial and aquatic ecosystems. Ammonia emissions are highly temperature dependent and can be expected to vary through the production cycle from the major cattle producing regions of Western Canada that experience environmental extremes of cold winters and hot, dry summers. A study was conducted to simulate and quantify the effects of temperature on ammonia emissions from manure of feedlot cattle. Fresh feces and urine were collected separately for 24 h from eight beef heifers fed high concentrate, barley grain-based diets (14.8% CP). Urine was collected using bladder catheters into collection vessels submerged in an ice-slurry. Feces and urine were each pooled, sampled for chemical composition, divided into subsamples, and frozen. Feces and urine were thawed, equilibrated to treatment temperatures, combined to constitute manure (1:1 wt/wt wet basis), and ~2.25 kg of the manure were incubated in each of four open flow-through chambers. Chambers were housed within a walk-in controlled environment room with a fresh air exchange rate to prevent build-up of gases. Air flow through the chambers was 1.5 m/s and was subsampled by pumping 200 mL/min through sorbent tubes fitted on the inlet and exhaust ports at 24, 48, 72, and 96 h at temperatures of 5, 10, 15, 20, and 25°C. Flux and cumulative NH_3–N emissions were analyzed with a mixed model with experimental temperature as a fixed effect and chamber as a random effect and the experimental unit. Orthogonal contrasts were applied to determine linear and quadratic effects of temperature on emissions. Manure contained 17.6% DM and 1.12% N (as-is basis) of which 54.2% was urea-N. Increasing the temperature from 5 to 25°C increased the NH_3–N flux (g N/m^2) and cumulative emissions (g N/96 h, % of total N, and % of urea-N; linear and quadratic, $P < 0.001$). Cumulative NH_3–N emissions expressed as a percentage of total manure N for the 96-h incubations were 6.3, 21.2, and 30.8% at temperatures of 5, 15, and 25°C, respectively. Cumulative NH_3–N emissions expressed as a percentage of manure urea-N were 20.3, 38.3, and 58.7% for 5, 15, and 25°C, respectively. Temperature had a marked effect on volatilization of NH_3–N from feedlot manure and was reduced by 75% as temperature decreased from 15 to 5°C and increased

by 50% as temperature increased from 15 to 25°C.

Key Words: ammonia emissions, feedlot cattle, temperature

1188 A novel method for collecting gas produced from the in vitro ANKOM gas production system.

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Enteric methane produced by ruminants is a source of greenhouse gas emissions. One method for investigating methane production from ruminants is the in vitro method which when compared with in vivo methods is faster and less expensive. The ANKOM™ system is an in vitro system that periodically releases excess gas during the incubation to prevent it from diffusing into the medium. For this reason, a gas sample taken from the module's headspace at the conclusion of the incubation period may not be representative of the gas produced during the entire fermentation period. This study tested two methods that enable the collection of released gases. Yeast and sugar were incubated for 24 h in 310 mL ANKOM™ bottles equipped with an ANKOM module to regulate headspace pressure through ventilation. Incubations were made with three different methods: vented gas not collected (NC); vented gas collected in gas bags through a 304 cm gas sample line with an internal diameter (ID) of 1.0 mm (C304); and vented gas collected in gas bags through a 22 cm extension tube with an ID of 4.0 mm (C22). Each method was conducted using four different venting pressures (0.4, 0.6, 0.8, and 1.0 psi). When total gas production was calculated from absolute pressure measurements made by the pressure transducer in the ANKOM module, the mean of total gas production (ml) for the C304 method was significantly ($P < 0.05$) greater (125.3 ± 1.9) than either the C22 method (114 ± 1.9) or the NC method (115 ± 1.7), while the C22 method was not different from the NC method. There was no effect of venting pressure across treatments on estimated total gas production. It is concluded that the C22 method for collecting gas can be used in gas production studies with the ANKOM system as it does not interfere with measurement of gas production.

Key Words: enteric methane, gas collection technique, in vitro gas production

1189 Effect of forage source of dairy cow diets on methane emission from enteric fermentation and manure storage.

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The aim of this study was to determine the effect of corn silage (CS), barley silage (BS), alfalfa silage (AS), and timothy silage (TS) on CH_4 emissions from enteric fermentation and manure storage of dairy cows. For this purpose, 3 experiments (9 cows; replicated 3 × 3 Latin square design; 32-d periods) were conducted. Forages included at 60% of diet DM were, in study 1: 100% CS (0% AS), 100% AS (0% CS), and 50:50 mix CS:AS; in study 2: 100% CS (0% BS), 100% BS (0% CS), and 50:50 mix CS:BS; and study 3: 100% AS (0% TS), 100% TS (0% AS), and 50:50 mix AS:TS. Cows were fed for ad libitum intake and enteric CH_4 emission was determined (3 d) using respiration chambers. Manure excretion was measured over 5 d. Manure CH_4 emissions were estimated using the Eq. [10].23 of the IPCC (2006). Total CH_4 emissions are the sum of enteric and manure CH_4 emissions. Data were analyzed using the MIXED procedure (SAS) and differences between treatments were declared significant at $P \leq 0.05$ using the Tukey multiple comparison test. Overall, 72% of total CH_4 emission was from enteric source and 28% was from manure storage. In study 1, enteric CH_4 emissions (17.7 vs. 20.5 g/kg DMI) and manure CH_4 emissions (6.78 vs. 7.50 g/kg DMI) were lower in cows fed 100% CS compared to cows fed 100% AS or 50:50 mix CS:AS. Consequently, total CH_4 emissions were also lower in cows fed 100% CS compared to cows fed 100% AS or 50:50 mix CS:AS (24.4 vs. 28.0 g/kg DMI). Similarly, in study 2, enteric (19.1 vs. 22.1 g/kg DMI), manure (7.59 vs. 9.04 g/kg DMI) and total (26.7 vs. 31.1 g/kg DMI) CH_4 emissions decreased in cows fed 100% CS compared to cows fed 100% BS or 50:50 mix CS:BS. In study 3, no treatment effect was observed on enteric CH_4 (19.8 g/kg DMI), manure CH_4 (7.16 g/kg DMI), and total (27.0 g/kg DMI) emissions. Results of this study show that replacing AS or BS with CS in dairy cow diets is expected to lower total CH_4 emissions (g/kg DMI) because of reduced enteric and manure CH_4 emissions. However, no effect on CH_4 emissions (enteric, manure, and total) can be expected by replacing TS with AS in dairy cow diets.

Key Words: enteric/manure, forage, methane

1190 Intake, milk production, and methane emission of dairy cows fed diets that differ in ruminal in vitro NDF digestibility. *M. J. Aguerre*[*1], M. J. Powell[2], A. R. Pelletier[1], and M. A. Wattiaux[1], [1]University of Wisconsin-Madison, Madison, [2]USDA-ARS, US Dairy Forage Research Center, Madison, WI.*

The objective of this study was to determine how feeding diets that differed in dietary ruminal in vitro NDF digestibility (IVNDFD) affected DMI, milk production, and CH_4 emission from lactating dairy cows. Twenty four multiparous Holstein cows (mean ± SD; 717 ± 67 kg of BW; 160 ± 49 d in milk) were randomly assigned to four dietary treatments in a randomized complete block design study. Four levels of dietary IVNDFD (digestibility determine after 30 h of incubation) were achieved by substituting corn stover (15% of dietary DM) with alkaline-treated corn stover (at 7.0% $Ca(OH)_2$ of stover DM; stover DM was 50%) in stepwise increments (0, 5, 10, and 15% of dietary DM). Following a 2-wk covariate adjustment period, cows were assigned to dietary treatments for 6 wk. Cows were fed a total mixed ration with (DM basis) 55% forage, 45% concentrate, 16.6% crude protein, 28.7% NDF, and 23.7% starch once daily. Replacing untreated corn stover with 5, 10, and 15% treated corn stover increased dietary IVNDFD by 2.2, 4.3, and 6.2% units, respectively. Performance and CH_4 emission measurements were conducted in four tie-stall emission chambers during three consecutive days the last week of the covariate and experimental periods. Treatment effects are presented as covariate-adjusted least squares means (± SEM). Increasing IVNDFD in the diet had no effect on DMI (21.3 ± 1.3 kg/d), milk yield (32.1 ± 2.2 kg/d), fat-and-protein corrected milk yield (FPCM; 29.9 ± 2.3 kg/d), FPCM/DMI (1.42 ± 0.1), CH_4 emission (524 ± 35 kg/d), and CH_4/FPCM (18.4 g/kg ± 1.7). However, with increasing levels of IVNDFD in the diet there was a linear decrease ($P = 0.02$) in CH_4/DMI from 26.4 to 23.3 (g/kg) and a tendency ($P = 0.06$) to reduce CH_4/milk from 18.8 to 14.4 (g/kg). Also, a tendency ($P = 0.08$) for a quadratic response was observed for CH_4/milk; increasing dietary IVNDFD by 2.2 and 6.2% units decreased CH_4/milk to 17.7 and 14.4 g/kg respectively, compared with 15% untreated corn stover diet (18.8 g/kg), but a 4.4% increase on IVNDFD resulted in the highest yield of CH_4/milk (20.0 g/kg). Under the conditions of this study increasing IVNDFD in the diet by as much as 6.2% units had little impact on performance or emission of CH_4 (g/d), but decrease CH_4 emission per unit of DMI by 12% and decreased CH_4 emission per unit milk by 23%.

Key Words: dairy, forage, greenhouse

1191 Life cycle energy and greenhouse gas comparison of co-located organic and conventional dairy systems. B. J. Heins*, M. Reese, J. Tallaksen, and E. Buchanan, *University of Minnesota West Central Research and Outreach Center, Morris.*

The objective of this study was to directly compare life cycle fossil energy use and greenhouse gas (GHG) emissions in an organic and conventional dairy system at a site that utilizes both systems. The study was conducted at the University of Minnesota's West Central Research and Outreach Center, Morris, MN with SimaPro software. Conveniently, the on-site conventional and organic cropping systems provide comparable feed sourcing data. The life cycle assessment (LCA) is a cradle to gate study, with a functional unit of 1 kg of energy and fat corrected milk (EFCM). In terms of GHG, as measured by equivalents of CO_2, the organic system is greater (1.36 kg CO_2 equivalent per kg EFCM) compared to the conventional system (0.975 kg CO_2 equivalent). The organic dairy had higher emissions (1.3 and 0.0596 kg CO_2 equivalent) for animal maintenance/feeding and milk harvesting compared to the conventional herd (0.94 and 0.0351 kg CO_2 equivalent), respectively. In terms of fossil energy use, the organic system required more of fossil energy (3.47 MJ/kg EFCM) than the conventional system (2.72 MJ/kg EFCM). Fossil energy use for animal/maintenance and milk harvesting was similar for greenhouse gases for the organic system (1.87 and 1.6 MJ) compared to the conventional system (1.78 and 0.941 MJ), respectively. The largest factor influencing these results is the relative productivity of the organic and conventional herd. The organic herd is a pasture based low maintenance system, whereas the conventional herd is a more confinement based system. The conventional herd (20.9 kg/d) had greater milk production compared to the organic herd (12.3 kg/d). Another key difference between these systems is the feed use, which is higher per kg of milk produced in the organic system because of the greater use of pasture and high forage diets. The conventional system is able to use co-products such as DDGS and beet pulp to fulfill dietary requirements. With co-products, GHG and fossil energy impacts are spread between the main product (i.e., ethanol or sugar), resulting in a lower impact feed. It is important to note that this is an ongoing study and that additional data analysis may likely change the findings as the study progresses.

Key Words: greenhouse gas emissions, LCA, organic

1192 Effects of canola meal and soybean meal as protein sources on methane and ammonia emissions of high producing dairy cows.

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Manipulating dietary ingredients may effect greenhouse gas emissions by dairy cows. The objective was to determine CH_4 and NH_3 emissions of lactating cows fed canola meal (CM) or soybean meal (SBM) as the main protein source at either a high (HI; 17.6%) or low (LO; 15.4%) CP concentration. Twenty-four multiparous Holstein cows (mean ± SD; 120.5 ± 3.24 DIM; 2.71 ± 0.81 parity) were assigned 1 of 4 treatment diets at calving in a randomized complete block design with a 2 x 2 factorial arrangement of treatments. After wk 16 of lactation, cows were randomly assigned to 1 of 4 air-flow controlled chambers. Cows remained in the chamber for 6 d. Performance and emission data were measured on the last 3 d of each block. Diets were formulated to contain 55.0% forage (39.6% corn silage, 15.4% alfalfa silage) and 45% concentrate on DM basis. CM was included at 19.4% and 11.9% DM and SBM was included at 14.5% and 8.9% DM for the HI and LO diets, respectively. Soyhulls were included to balance nutrients and alter CP concentration. All other ingredients were the same across diets. Data were analyzed using the MIXED procedure of SAS. Cows fed either source or CP concentration of protein did not differ in DMI (mean ± SEM; 26.67 ± 0.75) or 4% fat-corrected milk (FCM; 53.89 ± 2.04 kg/d). Milk yield (59.1 vs. 53.3 ± 2.48 kg/d; $P = 0.095$) and feed efficiency (FCM/DMI; 2.11 vs. 1.95 ± 0.09; $P = 0.082$) tended to be greater for cows consuming HI protein compared to LO protein diets. Milk urea N (MUN) was lower for cows fed LO protein compared to HI protein (9.14 vs. 12.93 mg/dL; $P < 0.001$). There was a source x CP concentration interaction for CH_4 emission. Cows fed HICM produced less CH_4 than those consuming HISBM and LOCM (465.7 vs. 528.5 and 537.9 ± 28.7 g/d; $P = 0.036$). CH_4 expressed per unit of DMI (19.3 ± 1.24) or FCM (9.23 ± 0.71) did not differ among treatments. NH_3 tended to be higher for cows fed HI protein compared to LO protein (29.5 vs. 24.6 ± 2.31 g/d; $P = 0.062$). Milk N (g/d) and NH_3 emission expressed per unit of milk N was not affected by diet. NH_3 tends to increase with added protein inclusion in the diet and CM may reduce methane under specific feeding strategies.

Key Words: canola meal, greenhouse gas, methane

1193 Optimizing nitrogen efficiency on commercial dairy farms: Impact on production performance and herd profitability.

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Nitrogen efficiency (milk N/dietary N; NE) can be used as a tool for the environmental management of dairy herds. The aim of this study was to identify factors affecting NE and assess its impact on herd profitability. One hundred dairy herds comprising 17 to 117 lactating cows and located in the province of Québec, Canada were visited from October 2015 to June 2016. Feed intake was measured over 24 h. Samples of each feedstuff were taken and sent to a commercial laboratory for analysis of chemical composition. Particle size distribution of silages and total mixed ration was determined using the Penn State Particle Separator. Feeding management and feed prices were recorded. Milk yield was recorded and milk samples were collected over two consecutive milkings. Fat, protein, lactose, and milk urea nitrogen (MUN) were analyzed. Farms were divided according to their NE as low NE (L-NE) and high NE (H-NE) by the 25th and 75th percentiles, respectively. Differences between these groups were analyzed with the GLIMMIX procedure of SAS. Metabolizable protein (MP supply–MP requirements) and rumen degradable N (RDP supply–RDP requirement) balances were calculated according to NRC (2001). Income over feed cost was also calculated. Milk production was higher for H-NE than for L-NE (32.5 vs. 29.4 kg/d; $P < 0.001$) whereas MUN was lower for H-NE (11.1 vs. 12.8 mg/dL; $P < 0.01$). Herds with H-NE received diets with higher non-fiber carbohydrate (NFC; 41.1 vs. 37.3; $P < 0.01$), physically effective NDF (6.9 vs. 3.7; $P < 0.05$) and TDN (74.0 vs. 71.0; $P < 0.01$), and lower CP (11.1 vs. 12.8; $P < 0.01$), NDF (36.5 vs. 40.0; $P < 0.001$), lignin (3.0 vs. 4.0; $P < 0.001$) and soluble protein (4.6 vs. 5.3; $P < 0.05$) than herds with L-NE. Metabolizable protein and RDP balances were lower for H-NE than L-NE (−320 vs. 206 g/d; $P < 0.001$ and 314 vs. 525 g/d; $P < 0.001$, respectively). Furthermore, the negative MP balance for H-NE herds indicates that NRC (2001) may have overestimated the MP requirements for this group. Finally, income over feed cost was higher for H-NE (0.56 vs. 0.50 $/kg; $P < 0.001$). In conclusion, herds with H-NE had lower MUN and less CP, but higher NFC contents in the diet, which suggest a greater energy availability allowing a better efficiency of N utilization. This strategy was shown to be economically profitable.

Key Words: lactating dairy cows, milk urea nitrogen, nitrogen efficiency

1194 Including corn in crop rotations is profitable for dairy farms and does not result in greater greenhouse gas emissions at the whole-farm level. V. Ouellet*[1], D. Pellerin[1], M. Chantigny[2], and E. Charbonneau[1], [1]*Département des sciences animales, Université Laval, Quebec, Canada,* [2]*Soils and Crops Research and Development Centre, Agriculture and Agri-Food Canada, Quebec, Canada,*

Corn silage is recognized as a palatable and digestible source of energy for dairy cows. On the other hand, corn silage production is widely criticized as it may carry more environmental risks than perennial forages. Our objective was to use the whole-farm model N-CyCLES to assess the effect of different crop rotations with varied levels of environmental risks on dairy farm profits, N and P balance, and greenhouse gas emissions, while optimizing the management practices required to achieve maximum profits. Adaptations made to the model included modification to rotations, adjustment in the optimization constraints, evaluation of crop production cost, evaluation of forage nutritive value, and update in fertilization requirements. Data representative of an average dairy farm from Centre-du-Quebec region in Quebec, Canada were used. Four crop rotation scenarios considered to have different environmental impact were built in the model, and compared: corn grain-soybean-corn silage-alfalfa-alfalfa (very high negative impact, +++); corn grain-soybean-corn silage-alfalfa/timothy-alfalfa/timothy-alfalfa/timothy (moderate negative impact, ++); cereal-alfalfa/timothy-alfalfa/timothy-alfalfa/timothy-naked oats (low negative, +); cereal-alfalfa/timothy-alfalfa/timothy-alfalfa/timothy-alfalfa/timothy-mixed grains (positive impact,-). Results showed that the highest dairy farm profits (0.12 $/kg of FPCM) were associated with the (++) rotation, whereas the lowest profits (0.05 $/kg of FPCM) were associated with the (-) rotation. The lowest farm-gate to farm-gate greenhouse gas emission allocated to milk production (0.98 CO_2 eq./kg of FPCM) was predicted for the (+++) rotation, whereas the highest value (1.03 CO_2 eq./kg of FPCM) was predicted for the (-) rotation. This result is mainly explained by the lack of cash crop sold and the lower NFC and higher N content in cow's diet for the farm with (-) rotation. The highest N and P balances (20.1 g/kg of FPCM and 1.185 g/kg of FPCM, respectively) were predicted for the (-) rotation since more corn grain was bought (156.5 t/yr) to compensate for the absence of corn grain and corn silage produced on the farm. Moreover, the lowest N and P balances (12.8 g/kg of FPCM, 0.465 g/kg of FPCM) were predicted for the (++) rotation. These results suggested that including corn silage in the crop rotation do not carry a greater environmental risk on the considered output than crop rotations without corn and that growing corn silage is profitable when the whole farm is considered as a single unit of decision. Sound practices still need to be developed to improve other environmental considerations such as soil structure and erosion.

Key Words: corn silage, crop rotation, whole-farm model

1195 Effect of baling or grazing of corn residue on the subsequent crop yields. K. M. Ulmer*[1], J. L. Cox[1], M. K. Rakkar[1], R. G. Bondurant[1], M. E. Drewnoski[1], J. C. MacDonald[1], H. Blanco-Canqui[2], and R. J. Rasby[1], [1]*University of Nebraska, Lincoln,* [2]*Department of Agronomy and Horticulture, University of Nebraska, Lincoln.*

The amount of corn residue in the Midwest has increased with the increased corn production. Producers have utilized this resource as a feedstuff for cattle for grazing in the fall and winter and as a baled feed resource for future feeding. The objective of this 2 yr study was to determine how grazing or baling of corn residue affects subsequent grain yield and harvest index in multiple regions across Nebraska. In year 1, there were three locations and in year 2, an additional two locations were added. At each location, there were 3 treatments: grazed (GZD), baled (BLD), and no graze-no bale (NGNB) with 2–3 reps per treatment per location. Hand harvest yield estimates were collected once the corn reached black layer stage of maturity. Corn plants were cut from 5.33 m rows (3 rows per rep), corn grain was removed, then the grain and remaining plant material were weighed separately and subsequently subsampled for dry matter analysis (60°C). Dry matter measurements from the grain and stover were used to calculate corn yield and stover (total biomass minus the grain) per ha. Harvest index was calculated based on the percentage of dry grain out of total biomass (grain plus stover). Data were analyzed using the MIXED procedure of SAS with yield, location (nested within year), and treatment as fixed effects. There were no interactions ($P \geq 0.15$) between location and treatment for all analyses, but location was significant ($P \leq 0.01$). No differences were observed among treatments for grain yield ($P = 0.137$) with BLD having yields of 14,918 kg grain DM/ha, GZD with 14,689 kg grain DM/ha and NGNB with 13,682 kg grain DM/ha (SEM = 306). Across location, grain yields ranged from 11,981 to 17,085 kg DM/ha across locations. There was no difference ($P = 0.87$) in stover yield among treatments (8974, 9137, and 8743 ± 237 kg/ha stover DM for BLD, GZD, and NGNB, respectively). Stover yield ranged from 7649 to 11,562 kg DM/ha across locations. There was no difference ($P > 0.40$) in harvest index among treatments (62.2, 61.5 and 61.0 ± 0.57% for BLD, GZD, and NGNB, respectively). Harvest index ranged from 55.1 to 63.0% across locations. Results indicate that in the short term, removing corn residue provides a potential feed resource with no negative impact on grain yield or harvest index.

Key Words: baling, corn residue, crop yields, grazing

1196 Use of a novel continuous culture fermentor system for in vitro determination of enteric methane output from ruminants. A. I. Roca-Fernandez*, S. L. Dillard, M. D. Rubano, R. J. Tillmann, and K. J. Soder, *USDA-Agricultural Research Service, University Park, PA.*

Continuous culture fermentor systems (CCFS) serve to evaluate the effect of diet on in vitro nutrient digestibility, fermentation, and microbial protein synthesis. Limitations of CCFS are: maintaining protozoa populations, and avoiding accumulation of undigested material in the vessels. Therefore, a 4-unit, 3-L bioreactor CCFS (Applikon Biotechnology Inc., Foster City, CA) was adapted to determine pH, DM, protozoa numbers, and enteric CH_4 output of a forage diet. Each unit was fed 82 g DM/d of 50% orchardgrass (*Dactylis glomerata*) + 50% alfalfa (*Medicago sativa*) in equal portions, 4 times daily (07:30, 10:30, 14:00, and 19:00 h) throughout 10-d periods ($n = 4$, 7 d adaptation and 3 d collection). The CCFS was programmed to maintain temperature = 39°C, stirrer = 255 rpm, and CO_2 flux = 1 mL/min. Temperature and pH were recorded every 2 min. On d 1 of each period, 1500 mL of rumen fluid + 32 g of digesta were collected from a fistulated cow and added to each fermentor. Vat volume was maintained at 1500 ± 200 mL during the 10 d. Solid mean retention time, solid dilution rate, and liquid dilution rate were adjusted daily to 24 h, 4%/h, and 11%/h, respectively, by regulation of buffer input and effluent removal. Effluent and fermentation vats were sampled daily to determine protozoa numbers and DM. Gas samples for CH_4 analysis were collected 6 times daily (07:25, 09:00, 10:00, 13:55, 15:30, 16:30 h) during the 3-d collection periods and analyzed by GC (Varian CP 3800, Agilent Technologies, Santa Clara, CA). Data were analyzed using PROC GLIMMIX (SAS Inst. Inc., Cary, NC). There were no differences ($P \geq 0.067$) in total buffer and effluent volume, effluent DM, and CH_4 output between periods or among days within a collection period. There were no differences in pH or vat DM ($P \geq 0.445$) between periods. However, pH was greater ($P < 0.001$) on d 10 than d 8 or d 9 (6.51, 6.43, and 6.45, respectively). Preliminary results show fewer ($P < 0.001$) protozoa during the adaptation vs. collection period ($11.5 \pm 2.82 \times 10^4$ and $34.0 \pm 3.95 \times 10^4$ cells/ml, respectively). There was no difference ($P = 0.786$) in protozoa during the 3 d of the collection period ($34.0 \pm 2.25 \times 10^4$cells/ml). This CCFS not only provides a stable fermentation environment, but also preserves protozoal populations, which better simulates in vivo ruminal fermentation conditions compared with previous CCFS methods.

Key Words: continuous culture fermentor, methane, ruminants

1197 Effect of introducing legumes containing condensed tannins in an orchardgrass diet on forage nutritive value and enteric methane output in continuous culture. A. I. Roca-Fernandez*, S. L. Dillard, M. D. Rubano, C. J. Dell, and K. J. Soder, *USDA-Agricultural Research Service, University Park, PA.*

Legumes containing condensed tannins (CT) have been shown to reduce enteric CH_4 in ruminants; however, research is lacking on how increased CT levels affect forage nutritive value and CH_4 output. A 4-unit, dual-flow continuous culture fermentor system was used to assess CH_4 output of CT legumes in an orchardgrass diet (*Dactylis glomerata*). Treatments included: alfalfa (ALF, *Medicago sativa*) used as control, birdsfoot trefoil (BFT, *Lotus corniculatus*) as a low CT legume (7% CT, DM basis), crown vetch (CV, *Coronilla varia*) as an intermediate CT legume (12% CT, DM basis), and sericea lespedeza (SL, *Lespedeza cuneata*) as a high CT legume (31% CT, DM basis). Treatments were randomly assigned to fermentors in a 4 × 4 Latin square design using 7 d for adaptation and 3 d for collection. Feedings (82 g DM/d) occurred 4 times daily (07:30, 10:30, 14:00, and 19:00 h) throughout 4, 10-d periods. Treatments consisted of 50% orchardgrass and 50% legume. Forage samples were analyzed for DM, OM, CP, soluble and degradable protein, fiber, lignin, and NE_L. Gas samples for CH_4 analysis were collected 6 times daily (07:25, 09:00, 10:00, 13:55, 15:30, 16:30 h) during the last 3 d of each period and analyzed by GC (Varian CP 3800, Agilent Technologies, Santa Clara, CA). Methane data were analyzed using the GLIMMIX procedure of SAS (SAS Inst. Inc., Cary, NC) with treatment and period as fixed effects and fermentor as random effect. Pearson correlation coefficients between CH_4 output and forage characteristics were determined using PROC CORR, and stepwise linear regression analysis was conducted according to PROC REG to detect predictive statistical associations between CH_4 output and forage characteristics. Methane output of SL was 60, 68, and 73% less ($P < 0.012$) compared to CV, BFT, and ALF, respectively. Crown vetch reduced ($P < 0.025$) CH_4 output by 33% compared to ALF. There were no differences ($P > 0.200$) in CH_4 output between BFT and ALF or BFT and CV. Correlation analysis revealed a positive relationship between CH_4 output and degradable protein ($r = 0.630$, $P = 0.009$). An inverse relationship was found between CH_4 output and OM ($r = -0.520$, $P = 0.039$). Stepwise regression analysis revealed that degradable protein explained 40% of the variation in CH_4 output across all CT legumes. In summary, inclusion of legumes containing CT reduces CH_4 output and was affected by nutrient content of the forage.

Key Words: condensed tannins, enteric methane, legumes

1198 Effect of summer annuals on ruminal fermentation and methane output in continuous culture. *S. L. Dillard*[*1], *A. I. Roca-Fernandez*[1], *A. N. Hafla*[1], *M. D. Rubano*[1], *A. F. Brito*[2], *and K. J. Soder*[1], [1]*USDA-Agricultural Research Service, University Park, PA,* [2]*University of New Hampshire, Durham.*

Summer annuals (SA) provide forage during the summer "forage slump", yet research on ruminal fermentation and CH_4 output of SA is lacking. A 4-unit, dual-flow continuous culture fermentor system was used to assess nutrient digestibility, VFA production, bacterial protein synthesis, and CH_4 output of SA. Treatments were randomly assigned to fermentors in a 4 × 4 Latin square design using 7 d for adaptation and 3 d for collection. Treatments were: 1) 100% orchardgrass (*Dactylis glomerata*) herbage (HERB), 2) 50% herbage + 50% Japanese millet (*Echinochloa esculenta*; MIL), 3) 50% herbage + 50% sorghum × sudangrass (*Sorghum bicolor* × *S. bicolor var. sudanense*; SSG), and 4) 50% herbage + 25% MIL + 25% SSG (MIX). Feedings (60 g DM/d) occurred 4 times throughout four, 10-d periods; fermentors were fed orchardgrass herbage at 730 and 1030 h. At 1400 and 1900 h, SA treatments received SA supplements while HERB received orchardgrass. Samples for CH_4 were collected 6 times daily (725, 0900, 1000, 1355, 1530, 1630 h) during d 8, 9, and 10; samples for NH_3–N, VFA, and pH were taken on d 8, 9, and 10. Samples were also analyzed for DM, OM, CP, and fiber fractions for determination of nutrient digestibility, and estimation of bacterial protein synthesis. Data were analyzed using MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). Apparent DM, NDF, and ADF, and true DM digestibilities were not different ($P > 0.062$) among treatments. True OM and CP digestibilities, and apparent OM digestibility, were not different ($P > 0.084$; 76 ± 2.3, 93 ± 2.4, and 66 ± 2.6%, respectively) among treatments. Total N intake was not different ($P = 0.389$) among treatments (2.3 ± 0.01 g N/d), but bacterial N was greater ($P = 0.013$) in MIL and MIX than HERB (0.33, 0.34, and 0.25 ± 0.020 g N/d). There was no difference ($P = 0.296$) in total VFA concentration among treatments (57.5 ± 1.16 mmol/L). There was no difference ($P > 0.178$) in daily CH_4 output (6.7 ± 2.14 mmol/d) or CH_4 per gram OM fed (1.9 ± 0.62 mg CH_4/g of OM fed). Addition of SA to an herbage-based diet provided similar nutrient digestibility, VFA production, and CH_4 output as HERB, suggesting SA would produce similar animal performance to that of HERB.

Key Words: methane, pasture, summer annuals

1199 Analysis and review of publicly available GreenFeed results. S. Zimmerman* and P. R. Zimmerman, *C-lock, Inc., Rapid City, SD.*

The GreenFeed is a novel tool for measurement of enteric methane (CH_4) from ruminant animals. The GreenFeed method uses repeated short-term measurement of CH_4 emitted from the animal in a feed trough while animals are receiving a feed reward. To date, over 50 papers, conference proceeding, and reports are available that have used GreenFeed. The research covers a wide range of applications including method comparisons, animal genetics and dietary studies, and on-farm use. In many studies, variability and repeatability of the GreenFeed data are reported. The objective of this study was to aggregate the public data, analyze the results for overall accuracy compared to reference methods, summarize variability and repeatability of CH_4 emissions across applications, and to determine the strength of individual animal ranking relationships. Overall, 22 method comparison trails ranging in herd averaged emission from 150–485 g/d have been completed comparing GreenFeed to either the Sulfur Hexafluoride tracer method (SF_6, 11 trials), respiration chambers (9 trials), or model predictions (2 trials). The herd averaged results for the reference method compared to GreenFeed showed no significant slope bias (Reference = 0.99 × *g*reenFeed, $R^2 = 0.99$) and the average absolute mean error for all trails was 6.4%. For individual animal CH_4 emissions, GreenFeed measured CH_4 emissions were positively and moderately-to highly correlated with respiration chamber, SF_6, or modeled CH_4 in all but 4 trials. In the 4 trials with less agreement for individual animals, the number of GreenFeed samples per animal was very low for some animals (4–10 samples) or there was no chamber replication. GreenFeed measured CH_4 for individual animals also showed moderate correlations with DMI in three studies ($r^2 = 0.73$, $r^2 = 0.61$, $r = 0.77$), and in other studies was found to be higher ($r^2 = 0.42$ and $r^2 = 0.47$) than for SF_6 ($r^2 = 0.17$, $r^2 = 0.08$). Between animal variation in GreenFeed CH_4 emissions were found to be the same, or lower than between animal variation in DMI, BW, or Respiration Chambers, or SF_6 in all but one trail. Long term repeatability (R) of GreenFeed CH_4 emissions on forage based diets was $R = 0.70$- 0.88 in 7 different trials. Overall, the GreenFeed method produced similar absolute CH_4emissions estimates to reference methods, demonstrated the ability to rank animals, produced low but accurate between animal variability, and was highly repeatable on forage diets.

Key Words: emissions, GreenFeed, methane

1200 Evaluation of an enteric methane emissions measurement system for cattle. E. M. Andreini*[1,2], M. S. Calvo-Lorenzo[1,3], C. J. Richards[1], J. E. White[1], and S. E. Place[1], [1]*Oklahoma State University, Stillwater,* [2]*University of California, Davis,* [3]*Elanco Animal Health, Fayetteville, AR.*

Growing concern about climate change and sustainability has increased societal pressures toward livestock production to quantify and reduce its environmental impact. Through enteric fermentation, ruminants produce the greenhouse gas methane (CH_4), and to improve emission inventories and evaluate mitigation techniques, several methods (i.e., whole animal and head chambers, SF_6 tracer technique) of measuring emissions have been developed. The objectives of this study were to evaluate a ventilated head box system capable of measuring CH_4 and carbon dioxide (CO_2) emissions, and oxygen (O_2) consumption from cattle and to compare emissions across ad libitum and restricted intake periods. An additional objective was to provide insight to animal comfort while housed in the head box system. Six Holstein heifers (n = 6), initial live weight between 364 and 430 kg, were used to measure CH_4 and CO_2 emissions and O_2 consumption from two ad libitum intake periods (ADAPT and ADLIB) and one period (RESTRICT) with intake restricted to 2% of body weight on a dry matter basis. In the head box system, ambient air was circulated around the animal's head, and expired air was collected. Emissions were determined by calculating the difference in gas concentrations between ambient and expired air. As a measure of comfort in the head box system, all cattle were assessed for lying time, and respiration rates and THI were evaluated for thermal comfort. During ADAPT and ADLIB, DMI in individual pens (10.40 ± 0.41 kg and 11.00 ± 0.41 kg, respectively) was higher ($P < 0.0001$) than DMI during gas measurement (9.20 ± 0.45 kg and 9.80 ± 0.45 kg, respectively). During RESTRICT, DMI in individual pens (8.40 ± 0.44 kg) did not differ ($P > 0.05$) from DMI during gas measurement (8.40 ± 0.45 kg). Methane and CO_2 emissions were lower ($P < 0.05$) during RESTRICT as compared to ADAPT and ADLIB (Table 1, next page). Oxygen consumption rates differed for each period (Table 1). Lying time while in the head box system was similar to lying behaviors of dairy

Table 1200.

Table 1. Least-squares means (n = 6) of heifer emissions and lying time[v] by period for periods ADAPT, ADLIB, and RESTRICT[+].

	Period					
	ADAPT		ADLIB		RESTRICT	
Item	LS mean	SE	LS Mean	SE	LS Mean	SE
CH_4 Production (L/day)	235.00[a]	6.19	228.26[a]	6.18	193.19[b]	8.88
CO_2 Production (L/day)	3627.47[a]	90.72	3632.35[a]	90.47	3183.95[b]	104.79
O_2 Consumption (L/day)	3390.59[a]	99.77	3453.90[b]	99.57	3001.81[c]	111.36
Lying Time (Min/day)	779.17[a]	31.19	768.79[a]	31.19	842.78[a]	31.19

[a, b, c] Least-squares means within row without common superscript letters differ ($P < 0.05$).

[+] For periods ADAPT and ADLIB heifers were fed *ad libitum* feed intake. For period RESTRICT, feed was restricted to 2% of body weight on a dry matter basis 4 days prior to and for the duration of the 3-day gas measurement.

[v] Lying time measurement refers to average time spent lying during the 3-day gas measurement at the end of each period.

heifers reported in previous literature. There was no difference ($P > 0.05$) in THI and respiration rate across all periods, and THI and respiration rate were positively correlated ($R^2 = 0.381$; $P < 0.0001$). The head box system evaluated will be useful in examining the effects of emissions mitigation strategies, and variation in emissions caused by different feeds and throughout the 24-hour cycle of a day.

Key Words: cattle, enteric methane, measurement

1201 Impact of corn or soybean in crops and lactating cow diets on estimated greenhouse gas emission from Wisconsin certified organic dairy farms.

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This study used a partial life cycle assessment approach to estimate the impact of feeding strategies and associated cropping systems on greenhouse gases emission intensity (GHG-EI, kg CO_2–eq/t energy corrected milk, ECM) from Wisconsin certified organic dairy farms. Gases and sources of emissions included in the study were: nitrous oxide (N_2O) from fields (row crop and pasture), enteric methane (CH_4), and manure management (N_2O and CH_4). An earlier study had identified four clusters from a survey dataset of 69 organic dairy farms. In cluster 1, 2, 3, and 4 daily DMI of lactating dairy cows was 22.1, 15.2, 20.9, and 18.1 kg/d, amount of concentrate fed was 8.0, 2.0, 6.0, and 6.0 kg/d, time grazing on pasture was 39.2, 53.5, 38.6, and 47.7% of the year, and ECM was 6657, 3857, 7666, and 5495 kg/yr per cow, respectively. Three combinations of corn grain (CG) and soybean (SB) as concentrate (100%CG, 75%CG+25%SB, and 50%CG+50%SB) were assigned to each cluster to study the substitution effect of protein vs. energy supplementation. Overall, GHG-EI was 1273 ± 235 kg CO2-eq/t ECM with contributions of 57.4, 34.1, and 8.5%, for enteric fermentation, manure management, and field emissions, respectively. There was a strong inverse relationship between level of production and GHG-EI, which averaged 1209, 1622, 996, and 1264 kg CO2-eq/t ECM for cluster 1, 2, 3, and 4, respectively. Grazing time was positively related with GHG-EI in part because longer grazing time was associated with lower ECM production and increased N_2O emission from manure deposited on pasture during grazing. The GHG-EI was the greatest in Cluster 2 with 50%CG+50%SB and the lowest in Cluster 3 with 100%CG (1635 vs. 983 kg CO_2–eq/t ECM). The GHG-EI was predicted to increase with increasing SB in all four clusters and on average GHG-EI was 1260, 1273, and 1285 kg CO_2–eq/t ECM for 100%CG, 75%CG+25%SB, and 50%CG+50%SB, respectively. Planting soybean decreased N_2O emission from cropland due to lower intensity of N fertilization and greater reliance on biological N-fixation compared with planting corn. Lowering CG for more SB in the diet reduced enteric CH_4 emission (because of greater fat content in the latter) but increased N_2O emission from manure (because of greater CP content of the latter). This study suggested that growing and feeding CG or SB might explain only a small fraction of the large differences in emission observed among clusters.

Key Words: carbon footprint, LCA, organic dairy farms

1202 Winter feeding systems and farm greenhouse gas emissions.

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Overwintering beef cows is a major cost in Canadian cow-calf production systems and swath grazing is a potential alternative to reduce winter feeding cost relative to the traditional drylot feeding systems. The objective was to estimate and compare greenhouse gas (GHG) emissions from winter feeding systems: i) swath grazing on triticale, ii) swath grazing on corn, and iii) conventional drylot feeding systems (control). Data were obtained from a study conducted over three production cycles (2008/2009, 2009/2010, 2010/2011) at the Lacombe Research Center in western Canada. Greenhouse gas emissions were estimated by calculating methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions from different sources using Intergovernmental Panel on Climate Change (IPCC) Tier 2 approach. Methane emissions were estimated from enteric fermentation and manure, N_2O emissions from fertilization and manure, and CO_2 emissions from energy use for farm activities related to feed production and processing, feed and bedding delivery and manure removal. Total emission expressed per kg of feed produced and fed were significantly ($P < 0.001$) lower for both the swath grazing treatments relative to the control treatment. Emissions per cow varied among treatments ($P < 0.001$), higher for control (12.3 kg CO_2e cow-d^{-1}) than corn (9.4 kg CO_2e cow-d^{-1}), with triticale (11.0 kg CO_2e cow-d^{-1}) intermediate. In all the treatments, the largest fraction of emissions was enteric CH_4 (69–76%), followed by N_2O (14–24%). The contribution of energy-derived CO_2 emissions for total GHG emissions was lower in swath grazing treatments (5–7%) compared to a traditional feeding system (11%) due to their minimal energy use. Farm activity related energy use was 9.4, 11.5, and 21.4 MJ cow-d^{-1} for triticale, corn, and conventional drylot feeding, respectively. This study indicated that swath grazing on triticale or corn can be an effective alternative winter feeding systems to reduce GHG emissions and increase energy use efficiency of Canadian beef cattle industry.

Key Words: greenhouse gas, swath grazing, winter feeding

1203 Grazing management and farm greenhouse gas emission intensity of beef production systems.
A. W. Alemu*[1], H. Janzen[1], S. Little[1], X. Hao[1], D. Thompson[1], V. Baron[2], A. D. Iwaasa[3], K. A. Beauchemin[1], and R. Kröbel[1], *[1]Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Lethbridge, Canada, [2]Lacombe Research and Development Centre, Agriculture and Agri-Food Canada, Lacombe, Canada, [3]Agriculture and Agri-Food Canada, Swift Current, Canada.*

The objective of the study was to evaluate the impact of grazing management on greenhouse gas (GHG) emission intensity at the farm-gate for beef production systems in western Canada using life cycle analysis. A life cycle analysis over an 8-yr period was conducted on a beef farm that managed 120 cows, 4 bulls, and their progeny. Calves were stocked on pasture and market cattle were finished on grain for 136 d. Four grazing management systems were evaluated: i) light continuous grazing (LC), ii) heavy continuous grazing (HC), iii) light continuous grazing for the cow-calf pairs and moderate deferred-rotational grazing for the stocker cattle (LCDR), and iv) heavy continuous grazing for the cow-calf pairs and moderate deferred-rotational grazing for the stocker cattle (HCDR). Primary data for pasture quality, animal performance and soil were from short- and long-term grazing studies. GHG emissions from different sources within the farm were estimated using the whole-farm model, Holos. Soil carbon change related to the different grazing managements was estimated using the Introductory Carbon Balance Model. Emissions intensity of beef varied among grazing management strategies and ranged between 14.4–15.9 kg CO_2e kg^{-1} live weight. Emissions intensity decreased with increasing stocking rate where the LC management had 9% greater GHG emission intensity than the HC treatment (14.4 kg CO_2e kg^{-1} live weight). There was no difference in emission intensity estimates between LC and LCDR or between HC and HCDR, indicating that the use of moderate deferred-rotational grazing for the stocker operation in LCDR and HCDR has no effect on emission intensity. However, the LCDR management had 7% greater emission intensity than HCDR (14.5 kg CO_2e kg^{-1} live weight). Regardless of the grazing management, methane emission from enteric fermentation was the major contributor (67–68%) followed by nitrous oxide from manure management (14–16%). Similarly, in all the grazing managements, emissions from the cow-calf herd were the major contributor (68–70%) for the total farm GHG emissions. When soil carbon sequestration was included into the total farm emissions, intensity estimate was reduced by 25–30% and were similar among the grazing management scenarios. Overall, the outcome from our study emphasizes the impact of grazing management on farm emissions as well as the importance of accounting for all the emission sources and sinks within the beef production system while estimating its environmental footprint.

Key Words: grazing management, life cycle analysis, soil carbon

1204 A life cycle assessment of a beef feedlot finishing ration supply chain in California.
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A life cycle assessment (LCA) was conducted for the feed supply chain (FSC) of a total mixed ration (TMR) typical of finishing feedlot cattle produced in California, USA. The goal was to determine the global warming potential (kg CO_2e kg^{-1} TMR) associated with the FSC along with the associated impacts of the FSC on the total life cycle of feedlot cattle produced in California. The methodology used followed the Livestock Environmental Assessment and Performance (LEAP) Partnership guidelines for FSC. System boundaries included feed production (crops and feed additives), transportation (from field or factory to feedmill), and TMR compound feed production (i.e., at the feedmill). Life cycle inventory data for a typical finishing TMR was collected. Given the scope of the study, primary data were limited. In accordance with LEAP guidelines, secondary data were sourced from national databases and Ecoinvent™ unit process data. Three scenarios were assessed as a result of allocation at the transportation step. Scenario A, B, and C assumed that once a feed ingredient was transported to the feedmill, 100%, 50%, and 0% of the empty return load would be allocated to TMR production, respectively. Additionally, the impacts of feed production in relation to the entire feedlot cattle production life cycle, for Scenario A, was determined. Total GHG emissions were determined to be 0.630 kg CO_2e/kg TMR for Scenario A, 0.576 kg CO_2e/kg TMR for Scenario B, and 0.521 kg CO_2e/kg TMR for Scenario C. Corn production, feed transportation, and liquid premix production were the main contributors to the life cycle impacts of the TMR. When assessing the entire feedlot life cycle for Scenario A, total GHG emissions were determined to be 0.824 CO_2e/kg TMR. Additionally, for scenario A, feed production in the Angus and Holstein feedlot scenarios was found to contribute approximately 76% and 58% of total feedlot emissions, respectively. The FSC is a major contributor of emissions to the total life cycle of feedlot cattle production and knowledge thereof is a first step in improving efficiencies and reducing emissions.

Key Words: feedmill, greenhouse gas, sustainability

1205 Estimating farm-gate ammonia emissions from Canadian beef production in 1981 as compared with 2011.

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The quantity of beef produced per animal in Canada over the past three decades has increased significantly as a result of improvements in production efficiency and increases in carcass weights. This resulted in a decline in greenhouse gas emissions per kilogram beef. As NH_3 volatilization from beef cattle manure is also a major environmental concern, the present study compared the NH_3 emissions of Canadian beef production in 1981 and 2011. A nation-wide mass balance approach based on total ammoniacal nitrogen (TAN) content in animal manure was used to estimate NH_3losses from housing, grazing, manure storage, and land spreading. Temporal and regional differences in cattle categories, feed types, and management systems, average daily gains and carcass weights were considered. On average, 21% to 22% of the total nitrogen (N) consumed by Canadian beef cattle was lost as NH_3–N in both years. Highest losses were observed in finished cattle where approximately 43% of the N consumed was lost as NH_3–N. Contribution of NH_3 from the various cattle classes differed between years and was mainly due to differences in the type of feeds used, and proportions of breeding stock and cattle finished in feedlots. Emission sources were generally consistent in both years, with average values of 12%, 40%, 28%, and 21% associated with animal housing, animal grazing, manure storage and land spreading, respectively. Total NH_3 emissions from the production of Canadian beef cattle (standardized on the basis of the size of the breeding herd within the reference year) was 27% higher in 2011 than they were 1981. The average emissions per animal in 1981 and 2011 were 14.2 and 15.7 kg NH_3/animal/yr, respectively. On an intensity basis, however, kilogram of NH_3 emitted per kilogram of beef decreased by 20%, from 0.17 in 1981 to 0.14 in 2011. The reduction in NH_3 intensity is mainly attributed to increase in reproductive efficiency, average daily gain and slaughter weights, and the resulting improvement in productivity per breeding herd over the study period. Differences in intensity may also be attributed to increased use of extended grazing (*e.g.*, swath, stockpiled and bale grazing) in 2011 compared to 1981. As management practices are altered in response to changes in profitability and policy, further studies are necessary to assess the impact of the beef industry on NH_3 emissions and air quality at the local, regional and national scale.

Key Words: ammonia emission intensity, beef, Canada.

1206 The effect of reduced crude protein, synthetic amino acid supplemented diets on nutrient excretion in wean to finish swine.

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Seven hundred twenty mixed-sex pigs were placed in 12 rooms at the Purdue University Swine Environmental Research Building to study the effect of reduced crude protein diets supplemented with synthetic amino acids on nutrient excretion from wean-finish. Pigs were blocked by BW and gender, and randomly assigned to a room and pen (10 pigs/pen). There were two deep pits per room and three pens over each pit. Each room was fed one of three diets: 1) control diet (Control) balanced to the first limiting amino acid with no synthetic amino acids, 2) a low crude protein (2X), high synthetic amino acid diet that balanced to the seventh limiting amino acid, and 3) an intermediate CP diet (1X) formulated to have a CP concentration intermediate to the Control and 2X diets, with a moderate level of synthetic amino acid inclusion. This resulted in approximately a 3 and 5%-unit reduction in CP, respectively for 1X and 2X diets. Pig BW, feed intake, and manure pit depths were determined at each diet phase change. Pit vacuum samples were collected at the end of each growth phase and frozen at −20°C for subsequent analyses. Data were analyzed using the GLM procedure in SAS. Reductions in dietary crude protein resulted in a linear reduction in ammoniated N excretion per kg of BW gain in both Nursery (Control = 8.6 g/kg gain, 1X = 7.2 g/kg gain, 2X = 5.5 g/kg gain; $P < 0.0001$) and Grow-Finish (Control = 18.0 g/kg gain, 1X = 14.3 kg/kg gain, 2X = 10.1 g/kg gain; $P < 0.0001$) phases. Reductions in dietary CP, with synthetic amino acid supplementation also resulted in a linear reduction in total N excreted per kg gain in the Grow-Finish phase (Control = 18.5 g/kg gain, 1X = 14.9 g/kg gain, 2X = 13.1 g/kg gain; $P < 0.0001$) and overall (Control = 17.4 g/kg gain, 1X = 15.4 g/kg gain, 2X = 13.1 g/kg gain; $P = 0.0009$). Total mineral excretion (Ash) per kg gain was reduced in the 1X and 2X diets compared to the control (Control = 39.6 g/kg gain, 1X = 36.0 g/kg gain, 2X = 33.4 g/kg gain; $P = 0.0046$). There was no effect of diet on total manure volume or P excreted per kg gain. These results indicate that reductions in dietary crude protein of ~3 and 5%-units from wean-finish result in reductions of total N excretion of 11.7 and 24.4%, respectively.

Key Words: crude protein, excretion, swine

1207 Oxalic acid production by *Aspergillus niger* when using whey permeate lactose as a carbon source.
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When manure is applied to crops on a nitrogen basis, it often creates a buildup of phosphorus (P) in the soil. Phosphorus recovery by struvite precipitation is one strategy to capture excess P before land application. However, daily operating costs are expensive due to chemical inputs. Dairy cow manure contains larger concentrations of calcium compared to other livestock manure, which requires an acid addition to break the calcium phosphate bonds. Oxalic acid is desirable because, in addition to breaking bonds, its anion (oxalate) binds the calcium. This study investigated the production of a dilute oxalic acid solution by the fungus *Aspergillus niger* (*A. niger*) using whey permeate as a substrate. This study was based on the work by Strasser et al., which found that *A. niger* exclusively produces oxalic acid when fermenting a lactose carbon source. Whey permeate is a desired substrate due to its high lactose content, and because it can be viewed as a by-product of the dairy industry. Oxalic acid production was evaluated by independently incubating two strains of *A. niger*, ATCC 9029 and ATCC 6275, at two concentrations: 11% lactose whey permeate (no lactose added) or a 20% lactose whey permeate (lactose added), to see if either strain could produce the 1–1.5% oxalic acid solution necessary for struvite formation. Fungi were grown in two-liter vessels for 6 d at 30°C and a pH of 6. Samples were collected each day and analyzed for oxalic acid content. The first study compared oxalic production between the two strains when fermenting a 20% lactose whey permeate solution, and found that *A. niger* 9029 produced a 125mM oxalic acid solution and *A. niger* 6275 produced a 200mM oxalic acid solution over a period of 6 d. The production data were fitted with polynomial regression lines of $y = -5.0x^2+41.17x+37.95$ ($R^2 = 0.72$) and $y = -2.80x^2+36.88x+68.98$ ($R^2 = 0.89$), respectively. The second study compared oxalic production between the two strains when fermenting an 11% lactose whey permeate solution (no added lactose), and found that *A. niger* 9029 produced a 350mM oxalic acid solution and *A. niger* 6275 produced a 150mM oxalic acid solution over a period of 6 d. The data were fitted with polynomial regression lines of $y = -17.4x^2+147.7x+57.26$ ($R^2 = 0.85$) and $y = -6.85x^2+58.23x+28.81$ ($R^2 = 0.75$), respectively. These data indicate that *A. niger* can produce the necessary concentration of oxalic acid for struvite production when fermenting whey permeate with no added lactose.

Key Words: *Aspergillus niger*, oxalic acid, whey permeate

1208 Effects of pre- and postpartum supplementation of ruminally protected polyunsaturated fatty acids on reproductive performance of suckled beef cows.
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To evaluate the effects of a ruminally protected PUFA supplement (M-R, Church & Dwight Co., Princeton, NJ) on reproductive performance of suckled beef cows, 66 multiparous cows (621 ± 70 kg of BW) were used in a completely randomized design. Cows were stratified by breed, BCS and the previous year's calving date and assigned to 1 of 2 treatments: Control (CTRL; 0.91 kg·d^{-1} of corn gluten feed (CGF) + 0.23 kg·d^{-1} of Megalac-E) and treatment (MEGR; 0.91 kg·d^{-1} of CGF + 0.23 kg·d^{-1} of Megalac-R). The experiment was designed for cows to receive treatments from 30 d prepartum to 30 d postpartum (mean d fed prepartum = 29.66; mean days fed postpartum = 29.34). Treatments were provided individually 5 d per wk. All cows had ad libitum access to bermudagrass hay (*Cynodon dactylon*), water and mineral supplement during supplementation period. After completion of supplementation, all cows grazed a mixed winter forage pasture of rye (*Secale cereale*) and ryegrass (*Lolium multiflorum*) during for the remainder of the study. Cow and calf BW and cow BCS were assessed weekly. Postpartum concentrations of progesterone were determined on a weekly basis to access resumption of postpartum estrous cycles. Cows were exposed to a 7-d CO-Synch+CIDR estrus synchronization protocol and fixed timed artificial insemination (TAI) was performed 60 ± 6 h after $PGF_{2\alpha}$. Cows where then exposed to fertile cleanup bulls for 70 d. Ultrasonography was performed 35 d after AI when pregnancy status and embryo size was assessed. Pregnant cows were monitored until calving and calf birth weight and calving distribution were determined. Data were analyzed using the Mixed procedure of SAS with cow as the experimental unit and treatment as fixed effects. There was no difference between treatments for mean cow BW ($P = 0.97$) or BCS ($P = 0.20$). In addition, weaning weights of calves among treatments did not differ ($P = 0.16$) and the percentage of cows resuming estrous cycles by initiation of the breeding season did not differ ($P = 84$). There was no effect of treatment on pregnancy percentage at d 35 ($P = 0.13$) and at the end of the breading season ($P = 0.56$). At d 35 postbreeding, there were no differences ($P = 0.26$) between treatments on fetus crown-rump length and no effect of treatment on birth weight ($P = 0.31$) and calving distribution ($P = 0.91$). We conclude that Megalac-R supplementation failed to improve reproductive performance of suckled beef cows when compared with Megalac-E.

Key Words: Beef cows, polyunsaturated fatty acids, reproduction

1209 The effect of straw bedding on dry matter intake and residual feed intake ranking in yearling bulls. J. B. Hall[1,2], M. C. Roberts Lew[*3], and W. K. Smith[3], *[1]University of Idaho Nancy M. Cummings Research, Extension Education Center, Carmen, [2]Department of Animal & Veterinary Sciences, University of Idaho, Moscow, [3]UI Nancy M. Cummings Research, Extension & Education Center, Carmen, ID.*

The objective of this study was to examine the effect of straw bedding on dry matter intake (DMI) and residual feed intake (RFI) ranking in bulls. For animal care purposes, cattle are commonly bedded with straw when being housed in pens where snow and rain are frequent. Over 2 yr, residual feed intake (RFI) was analyzed on Angus and Shorthorn bulls (n = 188) using the GrowSafe® system. The bulls were fed a total mixed ration (TMR) with 14.2% protein and 68.7% TDN. These bulls were divided into four pens based on bull owner. Daily feed intake was measured for 80 d and 47 d in 2014 and 2015, respectively. Straw bedding was added twice a week. Dry matter intake (DMI, kg), average daily gain (ADG, kg/d), feed to gain ratio (F:G) and residual feed intake (RFI) were calculated. For F:G and RFI, bulls were ranked numerically then DMI was excluded from days where straw bedding was included and the bulls were ranked again. The individual bull DMI decreased ($P < 0.001$) on days were straw bedding was added (Bedding = 11.3 ± 0.1 kg, No bedding = 11.6 ± 0.1 kg). The pen DMI decreased ($P < 0.02$) when straw bedding was added as well (Bedding = 267.1 ± 2.2 kg, No bedding = 273.1 ± 1.4 kg). Year was not significant for both individual and pen DMI. The majority of the bulls did not maintain the previous ranking. 86.4% (159/184) and 77.7% (146/188) of the bulls changed rank for RFI and F:G, respectively. Of those bulls that changed rank, 76.7% (122/159) of the RFI and 56.9% (83/146) of the F:G changed by more than 2 rankings. The average change in rank for RFI and F:G was 4.63 and 1.86, respectively. It can be concluded that adding straw bedding to pens with cattle decreases DMI in a GrowSafe® system. Reduced intake due to bedding caused a change in RFI and F:G rankings within bulls. Bulls on a RFI test should be given minimal straw bedding and those days bedding is added should be left out of the RFI calculation.

Key Words: Bulls, feed efficiency, residual feed intake, bedding

1210 Management of dairy bull calves on U.S. dairy operations. C. B. Shivley[*1,2], N. Urie[1,2], and J. E. Lombard[1], *[1]USDA:APHIS:VS:Center for Epidemiology and Animal Health, National Animal Health Monitoring System, Fort Collins, CO, [2]Colorado State University, Fort Collins.*

The objective of this study was to evaluate management practices of dairy bull calves and compare these practices to those used for dairy heifer calves in the United States. This study was conducted as part of the National Animal Health Monitoring System's Dairy 2014 study, and included 36 operations in 8 states. Overall, 7.9% (SE 0.7) of bull calves were stillborn. Stillbirth percentage for all calves on the 36 operations was 6.0% (SE 0.6). Regarding colostrum management, 95.6% (SE 2.8) of bull calves received colostrum; 94.9% (SE 2.1) received colostrum by hand feeding only, 3.3% (SE 1.5) received colostrum by hand feeding and suckling, and 1.8% (SE 1.0) received colostrum by suckling only. No heifer calves received colostrum by suckling only. Bull calves received colostrum 4.6 h (SE 0.5) after birth, compared with 3.0 h (SE 0.5) after birth for heifer calves. At the first feeding, bull calves received 3.3 L (SE 0.1) of colostrum, plus 1.7 L (SE 0.3) in all subsequent feedings for a total of 5.0 L (SE 0.3) of colostrum in the first 24 h, compared with a total of 5.4 L (SE 0.4) of colostrum in the first 24 h for heifer calves. On average, 2.3% (SE 0.5) of bull calves died before leaving the operation. Most operations did not dehorn bull calves (77.8%). Of the 22.2% of operations that did dehorn bull calves, 62.5% of operations dehorned using hot irons at an average age of 21.0 d (SE 7.6). Only 12.5% of operations used analgesics/anesthetics when dehorning bull calves. Heifer calves were dehorned on 91.4% of operations, with hot iron being the most commonly used method. Anesthetics/analgesics were used when dehorning heifer calves on 28.0% of operations. Most operations did not castrate bull calves (71.4%). Of the 28.6% of operations that did castrate bull calves, 30.0% used a knife, with an average age of 14.7 d (SE 4.8); no operations used analgesics/anesthetics. Bands were used by 70.0% of operations at an average age of 6.3 d (SE 0.9 d); 9.8% of operations (n = 1) used analgesics/anesthetics. Bull calves on these operations were managed differently from heifer calves. These results highlight the need to administer the appropriate volume of quality colostrum in a timely manner, and the value of using analgesics or anesthetics for painful procedures in bull calves.

Key Words: dairy bull calves; colostrum quality; dehorning practices

1211 Assessment of different bedding systems for lactating cows in freestall housing. H. Su[*1], N. M. Esser[2], W. K. Coblentz[3], M. A. Borchardt[3], W. Jokela[3], and M. Akins[1], *[1]University of Wisconsin, Madison, [2]University of Wisconsin, Marshfield, [3]US Dairy Forage Research Center, Marshfield, WI.*

The objective of this study was to compare different bedding systems for lactating cows in freestall housing. Bedding systems included new sand (NS), recycled byproducts of manure separation (organic solids [OS] and recycled sand [RS]), and foam-core mattresses with a shallow layer of OS (MS). The experimental barn contained 128 freestalls that were divided into 4 equal quadrants with 1 bedding system for each quadrant. All animals included in this study were first lactation cows, randomly assigned to different quadrants as cows calved. This experiment was conducted between January 2014 and December 2015 with 2 periods (1 calendar year for each period). Bedding systems were changed the last week of the first period. Milk yield data was recorded daily and milk samples were collected monthly for milk composition and somatic cell count (SCC). Cow's behavior, hygiene, and hock score were collected monthly. Clinical mastitis and hoof trimming cases were summarized based on veterinary records. Quadrant (pen) was considered the experimental unit with all data averaged by quadrant before analysis. Results represent 2 yr of data collection, and are presented as means ± SD (Table 1); Therefore, yearly comparisons of means are numerical only, and do not imply statistical significance. The OS and NS groups had greater milk yield compared with RS and MS groups, and the same responses were observed for energy-corrected (ECM) and fat-corrected milk (FCM). The SCC and somatic cell score (SCS) were greatest for the OS group. Cows housed in NS stalls had the greatest cow comfort and stall usage indexes. Cows in OS, NS and RS stalls were cleaner (lower flank score) than cows in MS stall. Cows in MS stalls had the most severe hock lesions (greater hock score). Greater incidence (total cases over 2 yr) of clinical mastitis was observed for cows with OS freestalls. Cows housed in NS and RS stalls needed fewer hoof trimmings than cows housed in OS and MS stalls. Based on the data thus far, NS seems to be the best bedding material for lactating cows based on milk performance, behavior, hygiene, and health data.

Key Words: lactating cow, bedding, freestall housing

1212 Management practices related to the welfare of dairy heifer calves on U.S. dairy operations. C. B. Shivley[*1,2], N. Urie[1,2], and J. E. Lombard[1], *[1]USDA:APHIS:VS:Center for Epidemiology and Animal Health, National Animal Health Monitoring System, Fort Collins, CO, [2]Colorado State University, Fort Collins.*

Animal welfare is a growing concern among the general public. The objective of this study was to evaluate dairy heifer welfare based on the results of the calf component of the National Animal Health Monitoring System's Dairy 2014 study. The 18-mo longitudinal calf study focused on dairy heifer calves from birth to weaning, and included 104 dairy operations in 13 states. Data were collected on 2,545 calves. Major risk factors for poor calf welfare were identified. Regarding calving management, 43.7% of births were unattended and 21.2% of calves did not have their navels disinfected. Concerning colostrum management, 22.7% of calves received poor quality colostrum (IgG < 50 g/L), and 13.0% of calves had failure of passive transfer with serum IgG < 10 g/L. Colostrum was primarily obtained via sucking for 22.1% of calves, with no control over quantity or quality. While the average timing after birth to colostrum feeding was within the recommended 4 h at 2.8 h (SE 0.05), 14.9% of calves received colostrum after 4 h, with the maximum 20 h after birth. An inadequate volume of colostrum (< 5.7 L) was administered to 67.5% of calves within the first 24 h. Of the 52.3% of all calves that were dehorned during the preweaning period, only 27.8% received any anesthetics or analgesics. Regarding milk feeding, restrictive feeding practices were common, with 29.6% of calves receiving less than 4.7 L of milk per day, and the average volume of milk per day fed was 5.7 L (SE 0.03). This restriction was reflected in the average daily gain of calves, with 35.5% of calves gaining less than 0.63 kg/day. The average age at weaning was 9.4 wk (SE 0.05), which was slightly higher than the recommended 6 to 8 wk of age. The most commonly used weaning criterion was age; only 4.6% of calves were weaned based on starter intake. Only 13.4% of calves were housed in groups, which has been shown to increase cognitive development but has increased disease risk. Bedding is important for calves to remain clean and comfortable but 12.6% of calves were bedded with sand or no bedding. Overall, 5.0% of calves died during the preweaning period, and most of these deaths had no reported cause, identifying an area for further investigation. Identifying risk factors for calf welfare is the first step toward finding solutions.

Key Words: dairy heifer calves; animal welfare; colostrum management

1213 Performance and health of calves pre- and post-weaning when fed pasteurized whole milk and whole milk supplemented with differing milk replacer protein sources. D. Ziegler[*1], H. Chester-Jones[1], D. L. Cook[2], J. L. Olson[2], and S. M. McCusker[2], *[1]University of Minnesota Southern Research and Outreach Center, Waseca, [2]Milk Products, Chilton, WI.*

The objectives of this study were to compare calf pre- (d 1 to 49) and postweaning performance (d 50 to 56) when fed pasteurized waste milk (PWM) or a combination of 67% PWM with 33% milk replacers (MR) formulated with similar crude protein (CP) to PWM with varying protein sources. One hundred-eight (2 to 5 d old) individually fed Holstein heifer calves (38.4 ± 0.64 kg) were randomly assigned to 1 of 4 milk treatments. Milk treatments included 1) PWM fed at 0.34 kg DM 2× daily from d 1 to 42 and 1× daily from d 43 to weaning at d 49 **(**WM); 2) PWM (67%) fed with 33% all-milk protein MR as in treatment 1 **(**AM); 3) PWM (67%) fed with 33% MR containing 50% all-milk and 50% blend of soy protein concentrate/wheat protein as in treatments 1 and 2 (SWP); 4) PWM (67%) with 33% MR containing 50% all-milk and 50% blend of hydrolyzed vegetable proteins and autolyzed yeast fed as in treatments 1, 2, and 3 (PP). Calf starter (CS;18%CP) and water were fed free choice d 1 to 56. Waste milk was collected 2× wk and pasteurized before each feeding. Total milk DMI was similar for all calf groups, averaging 29.9 kg. Pre-weaning ADG tended to be greater ($P = 0.09$) for WM (0.76 kg/d) and AM (0.73 kg/d) calves vs. those fed SWP (0.69 kg/d) and PP (0.70 kg/d). There were no postweaning ADG differences ($P > 0.05$) in the nursery. Pre- and postweaning CS DMI, were similar ($P > 0.05$) across treatments, averaging 21.8 and 15.5 kg, respectively. Hip height gain d 1 to 56 averaged 12.7 cm. Preweaning and overall d 1 to 56 gain/feed was highest for WM calves ($P < 0.05$). There were no differences ($P > 0.05$) in number of scouring days and treatment costs. From d 57 to d 84 there were no differences in ADG ($P > 0.05$) across calf groups when all calves were on a common diet in group pens. Under conditions of this study calves fed WM tended to have better pre-weaning performance parameters vs. those fed 2/3 WM and 1/3 MR containing varying protein sources.

Key Words: calf performance, pasteurized waste milk, milk replacers.

1214 Performance and health of calves pre- and post-weaning when fed milk replacers formulated with alternative protein sources. H. Chester-Jones[*1], D. Ziegler[1], R. Blome[2], and D. Wood[2], *[1]University of Minnesota Southern Research and Outreach Center, Waseca, MN, [2]Animix, Juneau, WI.*

The objectives of this study were to compare pre- (d 1 to 42) and postweaning performances of calves (d 43 to 56) when fed milk replacers (MR) with differing protein sources. One-hundred thirty (2 to 5 d old) individually fed Holstein heifer calves (38.4 ± 0.71 kg) were randomly assigned to 1 of 5 non-medicated 24% CP: 20% fat MR treatments (trt): 1) MR containing all-milk protein fed at 0.34 kg DM with 2.39 L water 2× daily for 35 d and once daily from d 36 to weaning at d 42 **(**AM), 2) MR fed as in trt 1 with 16% of the CP replaced by Manildra GemPro 7700 wheat (MG)**,** 3) MR fed as in trt 1 and 2 with 16% of the CP replaced by MG and 16.8% by plasma (Nutrapro B; MGNB), 4) MR fed as in trt 1, 2, and 3 with 17.1% of the CP replaced by Chamtour Nutrior wheat (CN), and 5) MR fed as in trt 1, 2, 3, and 4 with 16.8% of the CP replaced by NB. All diets were formulated to contain standardized 2.4% lysine, 0.8% methionine and 1.6% threonine. Calf starter (CS;18% CP as-fed) and water were fed free choice d 1 to 56. There were no differences in pre- and postweaning ADG ($P > 0.05$) which averaged 0.68 and 1.07 kg, respectively. Overall d 1 to 56 ADG averaged 0.78 kg. All calf groups doubled their initial BW by 56 d with 12.24 cm of HH gain average. Total MR was 24.9 kg across calf groups. There were no differences ($P > 0.05$) in pre- and postweaning CS intake which averaged 48.9 kg for the 56 d. Pre- (0.67 kg), postweaning (0.48 kg), and overall (0.63 kg) gain/feed were similar ($P > 0.05$) across calf groups. Serum protein averaged 5.9 mg/dl. There were no trt differences in scouring d and trt costs. Under the conditions of this study replacing milk protein in milk replacers with 2 different sources of wheat (approx.17%) with or without plasma (16.8%) resulted in very acceptable calf performances. Calf performance was not compromised by inclusion of wheat proteins in the milk replacers fed for 42 d.

Key Words: calf performance, milk replacers, protein sources.

1215 Performance and health of calves pre- and post-weaning when fed milk replacer supplemented with algae. D. Schimek*[1], B. Ziegler[1], D. Ziegler[2], and H. Chester-Jones[2], *[1]Hubbard Feeds Inc., Mankato, MN, [2]University of Minnesota Southern Research and Outreach Center, Waseca.*

The objectives of this study were to compare calf pre- (d 1 to 42) and postweaning performance (d 43 to 56) when fed milk replacer (MR) supplemented with microalgae meal *(All-G Rich™ Schizochytrium limacinum* CCAP 4087/2; Alltech, Inc.) in a dose titration study from August through November, 2015. One hundred-eight (2 to 5 d old) individually fed Holstein heifer calves (38.6 ± 0.61 kg) were randomly assigned to 1 of 4 treatments (trt); 1) Milk replacer, 24% CP:20% fat fed at 0.34 kg in 2.39 L water ×2 daily for 35 d and ×1 daily from d 36 to weaning at d 42 (CON); 2) Milk replacer as in trt 1 plus 2 g algae/calf daily (2 gA); 3) Milk replacer as in trt 1 with 4 g algae/calf daily (4 gA); 4) Milk replacer fed as in trt 1 supplemented with 6 g algae/calf daily (6 gA).Texturized calf starter (CS; 18% CP) and water were fed free choice d 1 to 56.There were no differences in pre- and postweaning total BW and daily gain ($P > 0.05$). Calves fed 6 g algae tended to have numerically higher preweaning gain (linear effect, $P = 0.11$). Average BW and HH after 56 d for all calf groups, met the suggested guidelines of double their initial BW and at least 10.2 cm of HH gain. Total MR intake was similar ($P > 0.05$) among all calf groups, averaging 24.7 kg. There were no CS intake differences among calf groups ($P > 0.05$). There was a trend for a linear increase in gain/feed preweaning ($P = 0.08$) with increasing levels of algae in the MR compared to CON. This numerical trend was also observed from d 1 to 56. There were no differences in scouring d (fecal score ≥ 3). There was a linear decrease ($P = 0.06$) in the number of scouring d when the fecal scores = 4 from calves fed CON compared to those fed increasing MR algae levels. There were no differences in treatment costs. Under conditions of this study, supplementing algae in MR from 2 to 6 g/calf daily was not detrimental to pre- and postweaning calf performance. There was an indication of a positive trend for supplementing 6 g algae for feed efficiency especially preweaning.

Key Words: calf performance, milk replacers, algae

1216 Evaluation of the efficacy of a copper sodium hypochlorite footbath and a 5% copper sulfate footbath on the control of digital dermatitis lesions. B. A. Wadsworth*, J. D. Clark, and J. M. Bewley, *University of Kentucky, Lexington.*

Digital dermatitis (DD) may be prevented using a 5% copper sulfate footbath. One alternative solution is a copper sodium hypochlorite solution (treatment; 2.5% copper sulfate footbath with 1.4 L of sodium hypochlorite solution added; GEA Farm Technologies, Naperville, IL). The objective of this study was to compare the copper sodium hypochlorite solution to a 5% copper sulfate footbath (positive control) on the frequency and severity of DD. This study was conducted at the University of Kentucky Coldstream Dairy from May 11, 2015 to June 26, 2015. Holstein cows ($n = 66$) were housed in 2 freestall barns (A and B) and cows were balanced for parity and days in milk. Footbath solutions were administered through 2 poly footbaths (J&D Manufacturing, Eau Claire, WI) in separate locations, measuring 15.24 cm × 81.28 cm × 198.12 cm and holding 94.64 L of solution each. Cows in barn A passed through the positive control footbath 5 d a week, 2 times per day. Cows in barn B passed through the treatment footbath 5 d a week, 2 times per day. The positive control footbath was refreshed every other day and the treatment footbath was refreshed every day. Rear feet DD lesions were scored weekly using a M0 to M4 scoring system: M0 indicates no lesion (non-active lesion); M1 represents an early growth < 2 cm in size (active lesion); M2 indicates an ulcerative lesion > 2 cm in size (active lesion); M3 represents a healing growth (non-active lesion); and M4 designates a chronic growth (non -active lesion). The DD lesions were further separated into active lesions or non-active lesions for statistical analysis. The GENMOD procedure of SAS (SAS Institute, Inc., Cary, NC) was used to analyze the probability of having an active lesion with each treatment. The probability of having left rear active lesions was 1.53 times greater ($P = 0.28$) than non-active lesions for the positive control compared to the treatment. The probability of having right rear active lesions was 1.87 ($P = 0.10$) times greater than non-active lesions for the positive control compared to the treatment. In conclusion, no significant differences were observed between the two footbaths, highlighting that copper sodium hypochlorite solution might be a viable alternative footbathing solution.

Key Words: digital dermatitis, footbath, copper sulfate, sodium hypochlorite

1217 Comparison of DX613 copper sulfate acidifier to a 5% copper sulfate footbath for prevention of digital dermatitis lesions in dairy cattle. H. B. Reichenbach*, B. A. Wadsworth, J. D. Clark, and J. M. Bewley, *University of Kentucky, Lexington.*

Digital dermatitis (DD) is an infectious disease seriously plaguing the dairy industry. The gold standard for prevention is a copper sulfate footbath. Although this method is effective, the large quantities of product required and the negative environmental impacts of bath waste necessitates a search for alternatives. The objective of this study was to compare a 2.2% copper sulfate footbath with 325.31 mL of DX613 Acidifier (treatment; GEA Farm Technologies, Naperville, IL) to a 5% copper sulfate footbath (positive control) on the frequency and severity of DD. Footbaths were delivered via a split footbath (Intra Care Foot Bath, Diamond Hoof Care LTD Alberta, Canada), measuring 32.5 cm wide by 233 cm

long, allowing for 80 L of solution per side. A metal coil separated the 2 footbaths to prevent cross contamination of solutions and decrease organic matter contamination. The left side of the bath served as the positive control and the right side served as the treatment. Baths were refreshed every 2 to 3 milkings, twice weekly. The study was conducted at the University of Kentucky Coldstream Dairy from November 11, 2015 to January 20, 2016. Holstein (n = 59) cows were housed in 2 freestall barns and balanced for parity and days in milk. The cows were exposed to the solutions on leaving the parlor after morning and afternoon milkings, 5 times per week. The DD lesions were scored biweekly using a M0 to M4 scoring system. A M0 score indicated no lesion (non-active lesions); M1 indicated small lesions (active lesions); M2 indicated large and potentially severe lesions (active lesions); M3 represented healing lesions (non-active lesions); and M4 represented chronic lesions (non-active lesions). The DD lesions were further separated into active lesions or non-active lesions for statistical analysis. A Chi-Square test calculated using the FREQUENCY procedure of SAS (SAS Institute, Inc., Cary, NC) indicated no-significant difference between the two solutions (chi-square = 1.18, P = 0.56). Eleven percent of treatment cows had active lesions and 9% of positive control cows had active lesions. A McNemar's test indicated significant differences in the prevalence of lesions from the beginning to end of the study (treatment: $P < 0.05$, positive control: $P < 0.01$; Table 1). This concludes a comparable effectiveness of both solutions. Given the potential for reduced environmental impact, the DX613 Acidifier may be a viable alternative for dairy producers.

Key Words: digital dermatitis, footbath, copper sulfate, acidifier, hoof care

Table 1217.

Table 1: Prevalence of lesions from beginning to end of study

Item	Positive Control	Treatment
No lesion at baseline and no lesion at end	46	42
No lesion at baseline and lesion at end	1	13
Lesion at baseline and no lesion at end	11	4
Lesion at baseline and lesion at end	1	0

1218 ortheast dairy herd characteristics: transition cow management strategies, performance, culling, and health. A. B. Lawton*[1], W. S. Burhans[1], D. V. Nydam[2], M. Tetreault[3], and T. R. Overton[1], *[1]Cornell University, Department of Animal Science and PRO-DAIRY, Ithaca, NY, [2]Cornell University, Department of Population Medicine and Diagnostic Sciences, Ithaca, NY, [3]Poulin Grain Inc., Newport, VT.*

A cross-sectional field study was conducted to describe transition cow management strategies and herd performance characteristics in high-producing dairies. A convenience sample of commercial Holstein herds (n = 72) in New York and Vermont were enrolled between November 2012 and August 2015. Data reported represent annual data at herd enrollment. Herd size range was 345 to 2,900 milk cows (mean ± SD; 935 ± 486) with a Dairy Herd Improvement herd milk average of 12,283 ± 1,051 kg (n = 50) and herd average milk yield/cow of 37.8 ± 3.8 kg/d (n = 69). Within the 40% of herds using recombinant bovine somatotropin (rbST) an average of 78% of eligible cows received rbST. Primiparous and multiparous animals had similar average days dry (56.5 ± 5.6) and herd reported voluntary waiting period (58.3 ± 9.4). All farms moved cows as parturition approached; 28% of herds moved animals to a maternity pen 0 to 3 d before calving; the other 72% used a calving pen, defined as animals moving to a pen when showing signs of calving. Eighteen percent of herds used separate calving locations for nulliparous and parous animals. Farms used a 1-group (9.7%) or 2-group (90.3%) dry cow system and 1-group (6.9%) or 2-group (93.1%) early lactation system for parous animals. Far-off and prefresh pens were either freestall (92.7%, 82.5%, respectively) or bedded packs (7.3%, 17.5%, respectively). Pens housing prefresh animals had animals moving in 1×/wk (71.6%) whereas 23.2% had animals moving in multiple times per week. From dry off until calving, number of pen moves for parous animals was either 2× (19.4%), 3× (69.4%), or 4× (11.1%) (n = 72 herds). From 60 d before due date until calving, nulliparous animals were moved 1× (4.2%), 2× (50.7%), 3× (40.3%), or 4× (4.2%) (n = 72 herds). Herd mean cull and death rate for animals $\leq$ 60 d in milk (DIM) was 5.9 ± 4.5% for primiparous animals and 8.4 ± 4.3% for multiparous animals (n = 71). Herd mean (SD) cull and death rate for animals overall was 20.6% (7.8%) for primiparous animals and 35.7% (7.2%) for multiparous animals (n = 71). Incidence of herd identified post-partum health

events (n = 71) were as follows; stillborn heifers: 5.9 ± 1.8%, twinning: 4.1 ± 1.4% (n = 72), RP: 6.5 ± 3.8%, metritis ≤ 30 DIM: 6.4 ± 8.5%, DA ≤ 60 DIM: 2.0 ± 1.6%, and ketosis ≤ 30 DIM: 6.6 ± 8.9%. These results demonstrate the variability in current practices and health related outcomes in large, progressive dairies in the Northeast.

Key Words: Transition cow, management, health outcomes

1219 Facilities, management, and animal factors associated with heifer culls in New York State dairy farms. B. D. Scott* and J. O. Giordano, *Department of Animal Science, Cornell University, Ithaca, NY.*

Objectives were to evaluate the rate of heifers leaving herds from 151 to 600 d of age relative to facilities, management practices, and individual animal factors. A survey was conducted on 55 commercial dairy farms in 2014 to assess and define herd factors for the prior and subsequent year. Dairy records from the on farm herd management software were collected approximately 1 yr later to analyze data for calves born in 2013 and 2014. Cull rates (P[mortality, dairy sales, or slaughter]) were established for a 151 to 360 (EXIT360) and 361 to 600 (EXIT600) days of age risk period. Risk ratios of EXIT360 and EXIT600 were analyzed using Poisson regression with PROC GENMOD of SAS. The heifer was the experimental unit within farm, utilizing an exchangeable correlation matrix. Variables of interest for both EXIT360 and EXIT600 were birth season (BIRTHSSN; cold = September through February and warm = March to August) and year, pneumonia or diarrhea events for the first 150 (ILLNESS150), 151 to 360 (ILLNESS360), and 361 to 600 (ILLNESS600) days of age, colostrum and milk feeding factors (quantity and duration), wean transition (methodology, age, and duration), number of pen moves, bunk space access, relative stocking density (heifers per stall), number of feedings and pushups per day, bedding amount and type, herd growth mode, culling style of herd manager (forgiving, moderate, aggressive), and number of lactating cows in the herd. Mortality and dairy sales were reported as 50% and 26% of all EXIT360 (6.2% of 33,168 heifers). Mortality and dairy sales were reported as 31% and 11% of all EXIT600 (10.6% of 9465 heifers). Birth season, birth year, ILLNESS150, and ILLNESS360, were all associated with EXIT360 (Table 1). Birth season and ILLNESS600 were associated with EXIT600 (Table 1). When ILLNESS and BIRTHSSN are considered, no facility or management factors were associated (P > 0.10) with EXIT360 or EXIT600 across these herds and their diversity of facilities and management in 2013 to 2014. We conclude that birth season and year as well as pneumonia and diarrhea events are associated with the probability of dairy heifers leaving herds between 151 and 600 d of age.

Key Words: replacements, mortality, illness

1220 Facilities, management, and animal factors associated with primiparous cows postpartum herd exit risk in New York state dairy farms. B. D. Scott* and J. O. Giordano, *Department of Animal Science, Cornell University, Ithaca, NY.*

Objectives were to evaluate the rate of primiparous cows leaving herds in the first 60 DIM relative to facilities, management practices, and individual animal factors. A survey was conducted on 55 commercial dairy farms in 2014 to assess and define herd factors for the prior and subsequent year. Dairy records from the on farm herd management software were collected approximately 1 yr later to analyze data for cows entering first lactation in 2013 and 2014. Cull rates (P[mortality, dairy sales, or slaughter]) were established for a 60 d eligible risk period (EXIT60). Risk ratios of EXIT60 were analyzed using Poisson regression with PROC GENMOD of SAS. The cow was the experimental unit within farm, utilizing an exchangeable correlation matrix. Cow level variables of interest for EXIT60 were calving season, age at first calving (AFC), maximum energy corrected milk produced in the first 60 DIM (MECM60), and maximum somatic cell linear score in the first 60 DIM (LSFresh). Peripartum facility and management variables analyzed were bunk space access, relative stocking density (animals per stall), bedding depth, bedding type, commingling with multiparous cows, herd growth mode, culling style of the herd manager (forgiving, moderate, aggressive), years of experience of the herd manager, lactating cow herd size, and whether heifers were all raised on-farm or some purchased. Final EXIT60 included 54 farms with

Table 1219.

Table 1. Estimates of relative risk (RR) for EXIT360 and EXIT600 within 52 farms, 2013-2014

	EXIT360				EXIT600			
	RR	95% CI		Pr > |Z|	RR	95% CI		Pr > |Z|
Birth Season (Cold vs. Warm)	1.27	0.97	1.68	0.09	1.55	1.15	2.11	<0.001
Birth Year (2013 vs. 2014*)	0.48	0.39	0.58	<0.01	-	-	-	-
ILLNESS150	1.49	1.17	1.89	<0.01	-	-	-	-
ILLNESS360	1.99	1.30	3.05	<0.01	-	-	-	-
ILLNESS600	-	-	-	-	4.59	3.05	6.91	<0.01

*No heifers born in 2014 had yet reached 600 days of age for EXIT600 analysis

Table 1220.

Table 1. Estimates of relative risk of 30,145 primiparous cows exiting the herd within 60 days in milk on 54 farms in New York State in 2013 and 2014

	RR	95% CI		Pr > |Z|
Calving Season (Cold vs. Mild)	1.30	1.02	1.65	0.033
Calving Season (Hot vs. Mild)	0.73	0.54	0.98	0.039
AFC (≤21 Months vs. 21-24.5)	0.69	0.50	0.95	0.022
AFC (≥24.5 Months vs. 21-24.5)	1.48	1.25	1.75	<0.001
Heifer Purchasing (None vs. Some)	1.48	0.96	2.26	0.073
MECM60 (Per 1 Kg Increase)	0.89	0.88	0.90	<0.001
LSFresh (Moderate[a] vs. Low)	1.20	1.03	1.41	0.022
LSFresh (High[a] vs. Low)	1.82	1.52	2.17	<0.001

[a]Low<4.0, 4.0≤Moderate≤6.0, High>6.0

adequate records for analysis and 30,145 cows. Mortality and dairy sales were reported to be 20% and 16% of all EXIT60, respectively, which totaled 6.6% of all cows at-risk. Table 1 summarizes differences and parameter estimates. Calving season, AFC, MECM60, LSFresh, and purchasing cows were associated with EXIT60. Conversely, no facilities or management factors were associated ($P > 0.10$) with EXIT60 across these herds and their diversity of facilities and management. We conclude that in years 2013 and 2014 calving season, age at first calving, milk production, and linear score were associated with the probability of a primiparous exiting the herd in the first 60 DIM across these 54 dairies in New York.

Key Words: culling, primiparous cow, dairy

1221 Facilities, management, and animal factors associated with calf losses in New York state dairy farms. B. D. Scott* and J. O. Giordano, *Department of Animal Science, Cornell University, Ithaca, NY.*

Objectives were to evaluate the rate of calves leaving herds in the first 150 d of age relative to facilities, management practices, and individual animal factors. A survey was conducted on 55 commercial dairy farms in 2014 to assess and define herd factors for the prior and subsequent year. Dairy records from the on-farm dairy management software were collected approximately 1 yr later to analyze data for calves born in 2013 and 2014. Cull rates (P[mortality, dairy sales, or slaughter]) were established for calves with a 150 d of age eligible risk period (EXIT150). Risk ratios of EXIT150 were analyzed using Poisson regression with PROC GENMOD of SAS. The calf was the experimental unit within farm, utilizing an exchangeable correlation matrix. Variables of interest were birth season (BIRTHSSN) and year, first colostrum administration (liters, type, and timeline), liters of colostrum (total) on the day of birth, number of milk feedings in a day, type of milk solution fed and quantity, weaning approach, weaning age and duration of process, pre-wean housing type, growth mode of the dairy, reported culling style of manager, experience level of calving supervisor, hours of calving area supervision, post wean ration, age at first exposure to fermented feeds, recorded pneumonia and/or diarrhea (ILLNESS) events, and relative scale of the dairy operation. The final regression model for EXIT150 retained 53 herds (n = 55,108 calves) after losses for inadequate records. Overall, mean EXIT150 was 4.91% (range = 0.53 to 22.0%). Reported mortality and dairy sales represented 59.9 and 16.3% of all EXIT150, respectively. Birth year of 2014 had higher ($P < 0.01$) EXIT150 (7.68%, n = 26,807) than 2013 (2.29%, n = 28,301). Colder BIRTHSSN (September through February) was associated with increased ($P < 0.01$) EXIT150 (RR = 1.58, 95%CI = 1.33–1.88) relative to other seasons. Reported ILLNESS data were available from 38 herds with 11.2% of the total calves having reported ILLNESS. Calves with reported ILLNESS had higher ($P < 0.01$) EXIT150 (RR = 1.43, 95%CI = 1.16–1.76). All other factors tested had no association with EXIT150 ($P > 0.10$) across the dairies included in the study and within their diversity of facility and management practices. We conclude that events of pneumonia and diarrhea, birth season, and birth year were associated with heifers leaving the herd and mortality within the dairies surveyed in 2013 and 2014.

Key Words: culling, survey, risk ratio, mortality

1222 Seasonal effects on milk yield and somatic cell score in organic dairy farms from the Northeast United States. J. G. B. Galvão Jr.*[1], A. F. Brito[2], A. H. N. Rangel[3], and J. B. A. Silva[4], *[1]Federal Institute of Science, Education,and Technology of Rio Grande do Norte, Ipanguaçu, Brazil, [2]University of New Hampshire, Durham, NH, [3]Federal University of Rio Grande do Norte, Natal, Brazil, [4]Universidade Federal do Semiarido, Mossoro, Brazil.*

The objective of this study was to evaluate the seasonal milk performance of organically-certified dairy farms in the Northeast region of the United States. Dairy Herd Improvement (DHI) records from May 2012 to May 2015 were obtained monthly from 7 herds in the states of New Hampshire (n = 2), Maine (n = 3), Vermont (n = 1), and New York (n = 1).

Table 1222.

Table 1. Least square means and SEM for the effects of season on milk yield and composition, and somatic cell score in Northeastern organic dairy farms

Season	Milk yield, kg/d	Protein, %	Fat, %	SCS	n
Fall	20.7 ± 0.34[b]	3.43 ± 0.01[a]	4.41 ± 0.02[ab]	2.47 ± 0.03[ab]	2,725
Spring	22.0 ± 0.34[a]	3.22 ± 0.01[c]	4.24 ± 0.02[c]	2.46 ± 0.03[b]	2,894
Summer	21.7 ± 0.32[a]	3.24 ± 0.01[c]	3.97 ± 0.02[d]	2.58 ± 0.03[a]	2,988
Winter	21.5 ± 0.35[a]	3.34 ± 0.01[b]	4.46 ± 0.02[a]	2.51 ± 0.03[ab]	2,837

[a,b,c]Values in the same column with different superscripts are significantly different at $P < 0.05$.

A total of 11,444 observations including milk yield, concentrations of milk fat and protein, and somatic cell score (SCS) were obtained and tested against the effects of season using the PROC GLM procedure of SAS. The herds averaged (mean ± SD) 166 ± 107 DIM, 21.5 ± 8.21 kg/d milk yield, 3.31 ± 0.52% milk protein, 4.27 ± 0.98% milk fat, and 2.51 ± 1.71 SCS. The seasonal effects on selected milk variables are shown in Table 1. All milk variables analyzed herein were affected by season. Milk yield was lower ($P < 0.05$) in the fall (mean = 20.7 ± 8.03 kg/d) compared with spring (mean = 22.0 ± 8.35 kg/d), summer (mean = 21.7 ± 7.88 kg/d), and winter (mean = 21.5 ± 8.48 kg/d), which did not differ from each other. The observed decrease in milk yield during the fall may be explained by limited pasture biomass production and changing of diets as cows transition from pasture- to winter-based rations. Milk protein and fat concentrations showed an inverse relationship with milk yield, thus suggesting a dilution effect caused by increased or decreased milk volume. The SCS was greatest during the summer (2.58 ± 1.74), intermediate during the fall and winter, and lowest during the spring (2.46 ± 1.71). Cows are susceptible to heat stress and nuisance flies during the summer, which can depress their immune system and increase intramammary infections. Somatic cell score is positively correlated with poor udder heath and a SCS over 4.0 possibly indicates the presence of intramammary infections and associated reduction in milk yield. However, the SCS across the 7 organic dairies used in our study ranged from 2.46 to 2.58, suggesting adequate milking procedures and preventative mastitis program. The use of annual forage crops can extend the grazing season potentially helping farmers mitigate milk yield losses during late fall, while management tools to reduce fly pressure and heat stress are likely needed to reduce SCS during the summer.

Key Words: milk composition, organic dairies, somatic cell score

1223 Argentina Veterinarian preferences to devise a mastitis control plan: A conjoint analysis approach.

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The rationale applied for veterinarians to propose the most suitable udder health plan to farmers is not well understood in Argentina. Objective: to quantify the preference of different technical and economic criteria considered by veterinarians when a mastitis control plan (MCP) is being devised to apply on farm. Methodology: During an annual meeting of the Argentinian Milk Quality Association, 45 veterinarians with at least 5 yr of experience working on milk quality participated in a choice experiment (CE). Six interventions were considered in the design of MCP: milking machine maintenance, milking routine, clinical mastitis management, dry cow therapy, culling of cows with persistent infection, and environmental hygiene. Four attributes were defined for MCP: operational costs, efficacy over bulk milk somatic cell count (BMSCC) reduction, efficacy on clinical mastitis (CM) reduction, and specific level of technical support needed to implement the MCP. The cost attribute had 3 levels (50, 40, and 30 US$ /day), the efficacy on BMSCC reduction had two levels (300,000 to 500,000 cells/mL or < 300,000 cells/mL), the efficacy in reducing CM cases had 3 levels (10 to 20%, 5 to 10% and < 5%) and technical support had three levels (3, 6, and 16 US$/day). The CE was framed using a fractional factorial design combining MCP attributes ($n = 4$) and their level ($n = 12$) in an orthogonal matrix (IBM SPSS Conjoint 20). Ten cards were randomly chosen from the matrix (48 combinations) to perform the CE. Each card contained a MCP (A to I) with its attributes and its specific

Table 1223.

Table 1: Relative importance (%) of the mastitis control plan attributes for two choice scenarios

	Cost	Efficacy on BMSCC reduction	Efficacy in reducing CM cases	Technical support
Completely confined dairy herd	22.5	23.2	42.2	12.1
Confined plus grazing dairy herd	26	24.4	38.3	11.3

level. The CE was conducted considering that the MCP would be applied in a 100 milking cows herd with a BMSCC around 500,000 to 600,000 cells/mL, during the last 12 mo. The veterinarians had to evaluate two scenarios; a completely confined and a confined plus grazing dairy herd. Participants ranked the MCP list from the best to the worst, for both herd scenarios. Such arrange was used to estimate the average utility (U) taking into account the preferences of the participants. The model was as follows, U = u(a1)+u(a2)+…+u(a4), where, U = total utility of MCP; a = attribute; $u(a_i)$ = unit of change of U for u. Results: The model showed that efficacy criteria prevailed over economic criteria; while the technical support had marginal influence in the decision (Table 1). An inverse relationship between cost and utility was found, which means that less costly intervention is preferred. In contrast, we found a direct relationship between efficacy and utility.

Key Words: conjoint analysis, mastitis control, choice experiment

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1224 A model to estimate losses due to bovine mastitis for Argentinian dairy herds. M. Richardet[1,2], H. Solari[3,4], C. Vissio[*1,2], J. Bartolome[5], G. Bo[6], P. Turiello[2], C. Bogni[7], and A. Larriestra[2], *[1]CONICET, Rio Cuarto, Argentina, [2]Facultad de Agronomia y Veterinaria, UNRC, Rio Cuarto, Argentina, [3]CONICET, Buenos Aires, Argentina, [4]Facultad de Ciencias Exactas, Fisicas y Naturales, UBA, Buenos Aires, Argentina, [5]Facultad de Ciencias Veterinarias, UNLPam, General Pico, Argentina, [6]IAP Ciencias Basicas y Aplicadas, UNVM, Villa Maria, Argentina, [7]Facultad de Ciencias Exactas, Físico-Químicas y Naturales, UNRC, Rio Cuarto, Argentina.*

A comprehensive economic evaluation of disease control implies developing models to capture the complexity and dynamics of the production system, especially for diseases like mastitis, which has multiples effects such as milk losses, increased risk of culling or a higher likelihood of reproductive failure. Objective: to describe preliminary results of estimated clinical (CM) and subclinical mastitis (SCM) frequency caused by *S. aureus* and their milk associated losses by a stochastic simulation model. Methodology: The model simulates discrete events overtime mimicking a real Holstein herd in terms of production and reproduction. The system has been divided into compartments involving reproduction, production, disease, feeding and culling/mortality events and their respective costs overtime. The model has been written in C language and its parameters have been gathered through a literature review. The model starts with a user defined herd in terms of demography and health status. From that point, the system projects the whole dynamics of the herd for a specific time horizon (e.g., 12 mo). The model focuses on *S. aureus* infections and drives the infection within the herd considering transition probabilities among different cows (uninfected or subclinically or clinically infected). The system updates the whole herd and disease information every 2 wk. As an example, the model has been run 100 times in a 200-cow herd. Results: The annual projection showed a median gross CM prevalence of 3% (q1 = 2%; q3 = 4%) and a median gross SCM prevalence of 21% (q1 = 17%; q3 = 25%). Estimated milk losses due to CM and SCM were 2.87 and 1.40 l/cow/day, respectively. All results are consistent with observational data recently published in Argentina. The model evaluation and verification on relevant assumptions need to be done. The model runs satisfactorily and it can be customized for the user. Further development will involve the inclusion of multiples contagious and environmental microorganisms.

Key Words: stochastic model, milk loss, mastitis

1225 Effects of oral calcium formate supplementation in peripartum dairy cows. E. W. Carneiro[1], E. E. Ichikawa[2], D. M. V. F. Carneiro[3], and R. D. Almeida[*1], *[1]Universidade Federal do Paraná, Curitiba, Brazil, [2]Bayer HealthCare, São Paulo, Brazil, [3]Instituto Federal Catarinense, Araquari, Brazil.*

The objective of the study was to evaluate the effects of oral calcium formate supplementation on serum total calcium (tCa), ionic calcium (iCa), β-hydroxybutyrate (BHBA), total cholesterol, and cortisol in early-lactation dairy cows. In 2 commercial dairy farms in Castro county, Paraná State, Southern Brazil, 242 Holstein cows (150 multiparous and 92 primiparous) were blocked by herd, parity, and tCa status 6 h after calving. Blood samples were analyzed for group allocation (normal and hypocalcemia groups) using 8.9 mg/dL as the cutpoint (IDEXX VetTest® Chemistry Analyzer, Inc., Westbrook, ME). Within each block, fresh cows were randomly allocated to treatment (T) and control (C) groups, with treated -cows being supplemented twice, 6 and 31 h after parturition, with 350 mL of 14.3% (w/w) calcium as a 48.6% aqueous suspension of calcium formate (Calfon Oral®, Bayer HealthCare). Six blood samples from each animal were collected (6, 12, 31, 54, 78, and 102 h after calving) for determination of tCa and iCa. Blood samples for cortisol and cholesterol analysis were collected 6 h and 5 d after calving, while for BHBA analysis, blood samples were collected on Days 3, 5, and 7. Data was analyzed using MIXED procedure of SAS with a model containing the effects of block, treatment, time, and treatment*time interaction as fixed effects and cow within treatment as a random effect. Hypocalcemia incidence rates were 43% using on-farm tCa from VetTest ($\leq$ 8.9 mg/dL), 78% using tCa ($\leq$ 8.0 mg/dL) and 76% using iCa (concentration $\leq$ 4.0 mg/dL), with the lowest iCa values being observed at 12 h postpartum. Serum iCa values were higher (P = 0.04) in oral Ca formate-treated cows; 3.62 vs. 3.55 ± 0.02 mg/dL for the controls. Subclinical ketosis (serum BHBA $\geq$ 1.2 mmol/L) incidence rate was 21.5% (52/242). Estimates

of BHBA on Day 5 were lower ($P = 0.03$) for treated cows; 0.70 vs. 0.87 ± 0.06 mmol/L for the non-treated ones. No differences were detected ($P > 0.05$) for tCa, cholesterol, and cortisol concentrations between T and C animals. During the experimental period, both farms had shown very high levels of subclinical hypocalcemia. The oral calcium formate supplementation had shown modest, but beneficial effects in early-lactation dairy cows, increasing ionic Ca and reducing BHBA concentrations, important goals to control metabolic disorders in dairy farms.

Key Words: milk fever; ketosis; subclinical hypocalcemia

1226 Effect of prenatal and lactating cow trace mineral source on Angus and Brangus calf acute phase protein response to a weaning stressor.

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Trace mineral (TM) source provided to gestating and lactating Angus and Brangus cows and its subsequent effect on acute phase protein (APP) response in like breeds of calves at weaning was examined during 2 yr. Treatments were inorganic (salt sulfates) or organic (Se-yeast and proteinates) TM supplementation of Co, Cu, Fe, I, Mn, Mo, Se and Zn (3 d/wk, 0.4 kg·$^{-1}$454 kg BW·$^{-1}$d·cow^{-1}·d^{-1}). Delivery of TM to cows was initiated 88 ± 2 d pre-calving in year 1 and from conception to weaning of year 2. In both years, calves (year 1, $n = 28$/sex, 7/treatment×breed of bulls, heifers, steers; year 2, $n = 48$/sex, 24/treatment×breed of heifers, steers) were physically separated from dams at weaning (d 0) and maintained in dry-lot pens from d 0– 7, and on bahiagrass pastures from d 7–14. Calf blood samples were collected for analysis of APP including acid soluble protein (ASP), ceruloplasmin and haptoglobin on d 0, 1, 3, 7, and 14 relative to weaning. Calf was the experimental unit with PROC MIXED repeated measures within each year for analysis. Models included fixed effects of TM treatment, breed, calf sex, day relative to weaning, and interactions. Treatment did not affect any APP in year 1 ($P > 0.05$) or year 2 ($P > 0.05$). Day affected ($P \leq 0.05$) all APP values within a year. In year 1, peak concentrations of all APP occurred on d 3. In year 2, peak concentrations of ASP and haptoglobin occurred on d 3, while ceruloplasmin concentrations peaked on d 7. Within a year, ASP concentrations were greater ($P \leq 0.01$) in Brangus (year 1 = 83.4 ± 3.5; year 2 = 84.9 ± 2.6 mg/dL) than Angus (year 1 = 68.0 ± 3.5; year 2 = 61.7 ± 2.6 mg/dL) calves. Haptoglobin concentrations were greater ($P \leq 0.05$) in year 1 and year 2 in Angus (1.8 ± 0.1 units) than Brangus (1.5 ± 0.1 units) calves within each year. For ceruloplasmin, heifers had greater ($P \leq 0.05$) concentrations (15.2 ± 0.5 mg/dL) than steers (13.6 ± 0.5 mg/dL) and bulls (12.9 ± 0.5 mg/dL) in year 1; whereas in year 2, heifers (16.7 ± 0.4 mg/dL) had greater ($P \leq 0.05$) ceruloplasmin concentrations than steers (15.5 ± 0.4 mg/dL). In conclusion, calf breed and sex had greater effects on APP response to weaning than TM source.

Key Words: trace minerals, weaning, acute phase response

1227 Factors associated with average daily gain in dairy heifer calves on U.S. dairy operations.

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The objective of this study was to evaluate average daily gain (ADG) in U.S. dairy heifer calves based on different health, feeding, and management practices, as well as environmental factors. This study was conducted as part of the calf component of the National Animal Health Monitoring System's Dairy 2014 study, which included 104 dairy operations in 13 states. The calf component was an 18-mo longitudinal study focused on dairy heifer calves from birth to weaning. This analysis included data from 1,331 Holstein calves. The mean ADG was 0.75 kg/day (SE = 0.007), and calves were fed liquid diets an average of 63.8 d (SE = 0.4). Backward elimination model selection in Proc Mixed of SAS® was used after univariate screening ($P < 0.2$) to determine which environmental factors, diet, and management practices significantly impacted ADG. The final model included disease Y/N ($P < 0.001$), kg protein fed in the liquid diet per day ($P < 0.001$), the average temperature and humidity index for the preweaning period ($P < 0.001$), dam lactation number ($P < 0.001$), bedding type ($P < 0.001$), and singleton vs. twin birth ($P = 0.006$). After controlling for other independent variables in the model, calves with no disease events gained on average 0.05 kg/d more than calves with one or more disease events. Every 1 kg of protein fed per day equated to 0.1 kg/day of gain. Each 10-unit decrease in THI equated to 0.02 kg/day of gain. Calves from third or higher lactation dams had the highest gains (0.68 kg/d), followed by second lactation dams, and last first lactation dams (0.63 kg/d). Calves bedded with a combination of bedding materials gained the most (0.72 kg/d), followed by those bedded with shavings, then straw or hay, and lastly no bedding or sand (0.52 kg/d). Single calves gained 0.08 kg/day more than twins. These results highlight the importance of feeding an appropriate quantity and quality of a liquid diet, keeping calves healthy, and mitigating the effects of temperature and humidity on ADG.

Key Words: dairy heifers, average daily gain, calf nutrition

1228 Factors associated with morbidity in dairy heifer calves on U.S. dairy operations.

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The objective of this study was to evaluate morbidity in U.S. dairy heifer calves based on different health, feeding, and management practices, as well as environmental factors. This study was conducted as part of the calf component of the National Animal Health Monitoring System's Dairy 2014 study, which included 104 dairy operations in 13 states. The calf component was an 18-mo longitudinal study focused on dairy heifer calves from birth to weaning; data were collected on 2,545 calves. The morbidity rate for all calves enrolled in the study was 34%, with 7% of calves experiencing more than one disease event. It is likely that some sick calves were neither identified nor recorded and morbidity is underreported. The majority of clinical signs reported were digestive (56%) and respiratory (34%). Almost all sick calves (90%) received treatment, with 81% of treated calves receiving antimicrobials. Of calves treated with antimicrobials, the most commonly used classes were fluoroquinolones (28% of calves) and sulfonamides (25% of calves). The mortality rate for the study was 5.2%. The primary causes of death were reported as unknown (35% of calves), digestive (31%), and respiratory (16%). Backward elimination model selection in Proc Genmod of SAS® was used after univariate screening ($P < 0.2$) to determine which environmental factors and management practices significantly impacted morbidity. The final model included serum IgG ($P = 0.024$), gender of the primary caretaker ($P = 0.031$), and number of calves housed together ($P = 0.049$). Calves with an increased serum IgG were less likely to have a reported a disease event. Calves that had a female or male as the primary caretaker were 1.2 times more likely to have a reported disease event compared with calves that had a male and female as the primary caretaker. As group size increased, the risk of reported disease also increased. Practices that weren't significant in the final model included the use of vaccines, the addition of antibiotics, coccidiostats, or direct fed microbials to milk, and pasteurization of milk. These results highlight the continued importance of ensuring a high level of passive transfer of immunoglobulins in calves via colostrum, the importance of vigilant caretakers, and the possible morbidity risks of group housing.

Key Words: dairy heifers, morbidity, mortality

1229 Factors associated with *Cryptosporidium* and *Giardia* infection in preweaned dairy heifer calves.

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The objective of this study was to evaluate the presence of *Cryptosporidium* (*Crypto*) and *Giardia* in U.S. dairy heifer calves based on different management practices and environmental factors. This study was conducted as part of the calf component of the National Animal Health Monitoring System's Dairy 2014 study, which included 104 dairy operations in 13 states. The calf component was an 18-mo longitudinal study focused on dairy heifer calves from birth to weaning. Fecal samples were collected from 2,009 calves: 1,258 calves in the East region (IA, MI, MN, MO, NY, OH, PA, VT, VA, WI) and 751 calves in the West region (CA, CO, WA). Calves were sampled from 3 to 66 d of age, with a mean of 22 d (SE = 0.13). Calves were evenly sampled throughout the spring ($n = 491$), summer ($n = 539$), fall ($n = 536$), and winter ($n = 443$) seasons. Overall, 43.6% of calves were infected with *Crypto* and 30.0% of calves were infected with *Giardia*. Backward elimination model selection in Proc Genmod of SAS® was used after univariate screening ($P < 0.2$) to determine which environmental factors and management practices significantly impacted the presence of *Crypto* or *Giardia*. The final *Crypto* model included days of age at fecal collection ($P < 0.001$), herd size ($P = 0.03$), and season ($P = 0.04$). Calves £28 d of age were 1.24 times more likely to be infected with *Crypto* compared with calves > 28 d of age. Large herds (500+ cows) were 1.12 times more likely to be infected with *Crypto* compared with small herds (30 to 99 cows). Calves sampled in the fall were 1.1 times more likely to be to be infected with *Crypto* than calves sampled in the spring. The final *Giardia* model included season ($P < 0.001$), region ($P = 0.001$), liquid diet additives ($P = 0.002$), and average daily gain (ADG; $P = 0.003$). Calves sampled in spring, summer, or fall were 1.14 times more likely to be infected with *Giardia* than calves sampled in the winter. Calves in the East region were 1.15 times more likely to be positive for *Giardia* than calves in the West region. Calves fed additives other than antibiotics and direct fed microbials, such as larvicides and coccidiostats, in their liquid diet were 1.12 times more likely to be infected with *Giardia.* Additionally, ADG had a negative association with *Giardia*. These results highlight the factors associated with the presence of *Crypto* and *Giardia* in preweaned dairy heifer calves.

Key Words: dairy heifers, *Cryptosporidium*, *Giardia*

1230 Factors associated with colostrum quality and passive transfer status of dairy heifer calves on U.S. dairy operations. J. E. Lombard[*1], C. B. Shivley[1,2], and N. Urie[1,2], *[1]USDA:APHIS:VS:Center for Epidemiology and Animal Health, National Animal Health Monitoring System, Fort Collins, CO, [2]Colorado State University, Fort Collins.*

Passive transfer of immunity is essential for the short- and long-term health of dairy calves. The objective of this study was to evaluate colostrum quality and passive transfer status of U.S. dairy heifer calves. This study was conducted as part of the calf component of the National Animal Health Monitoring System's Dairy 2014 study, which included 104 dairy operations in 13 states. This longitudinal study focused on dairy heifer calves from birth to weaning and was conducted over an 18-mo period. Data analysis included 1,972 Holstein calves. The mean colostrum IgG was 74.4 g/L (SE 0.72), with 77.4% of samples having colostrum IgG levels above 50 g/L. The mean serum IgG was 21.6 g/L (SE 0.25), and 73.3% of calves had serum IgG levels above 15 g/L. Backward elimination model selection in Proc Mixed of SAS® was used to determine which factors were most important ($P < 0.05$) for determining colostrum IgG levels. The final model for colostrum IgG included the source of the colostrum ($P < 0.001$) and the temperature and humidity index (THI) for the month before calving ($P < 0.001$). Colostrum IgG was highest for third or higher lactation dams (84.2 g/L) and lowest for commercial colostrum replacers (39.5 g/L). For every 10-unit increase in THI, the colostrum IgG increased 1.4 g/L. Factors most important for predicting serum IgG levels were also evaluated using a backward elimination model selection in Proc Mixed after univariate screening ($P < 0.2$). The final model for serum IgG included source of the colostrum ($P < 0.001$), timing to the first feeding ($P < 0.001$), total amount of colostrum fed in 24 h ($P = 0.010$), the age of the calf at blood sampling ($P < 0.001$), colostrum IgG ($P < 0.001$), and THI for birth month ($P = 0.026$). Serum IgG was highest for calves from first lactation dams (23.4 g/L) and lowest for commercial colostrum replacer (14.5 g/L). For every hour following birth that colostrum was administered, serum IgG decreased 0.37 g/L. For every 1 L of colostrum administered in the first 24 h after birth, the serum IgG increased 0.56 g/L. For every 10 g/L increase in colostrum IgG, serum IgG increased 1.1 g/L. For every 10-unit increase in birth month THI, the serum IgG increased 0.32 g/L. These results indicate that prompt feeding of high-quality colostrum in appropriate amounts following birth and THI are crucial to the passive transfer status of dairy calves.

Key Words: dairy heifer calves; colostrum quality; passive transfer

1231 Risk factors for calf mortality on farms using automated feeders in the Midwest USA. M. Jorgensen* and M. I. Endres, *University of Minnesota, St. Paul.*

Use of automated calf feeding systems is increasing across the USA, yet information regarding health and mortality outcomes is limited. The objective of this study was to investigate the association of various farm management practices, housing, and environmental factors with mortality in preweaned dairy calves. Twenty-three Midwestern dairy farms were included in this mortality analysis. Farms were visited approximately every 60 d for 18 mo. Housing and environmental factors were measured at the time of each visit. Management practices were collected using a questionnaire and mortality events were gathered from producer-kept records. Relationships between categorical factors of interest and mortality rate were calculated using the mixed procedure of SAS. Pearson's correlation was used for continuous variables. Average mortality of calves on farms using automated feeders was 3.85 ± 3.70%/yr and 57% of farms (13/23) reported mortality rates below 3%/yr. The maximum recorded mortality rate was 13.41%/yr and the minimum was 0.24%/yr. Farm average serum total protein concentration of calves < 5 d old was negatively associated with farm annual mortality rate ($R = -0.50$, $P = 0.02$; mean sTP = 5.4 g/dL ± 0.74). Farms that disinfect the navels of newborn calves had a lower ($P = 0.03$) mortality rate (mean ± SE, 2.97 ± 0.80%; 78% of farms) than farms that do not disinfect (7.32 ± 1.59%; 22% of farms). Farms that use the drinking speed of calves as an alarm had a lower ($P < 0.001$) annual mortality rate (2.37 ± 0.83%; 74% of farms) than those that do not (6.57 ± 1.13%; 36% of farms). Farms that disinfect the calf pens between groups had a lower ($P = 0.04$) annual mortality rate (2.55 ± 0.94; 59% of farms) than those that do not disinfect (5.78 ± 2.55%, 41% of farms). Trends were detected in the correlations between mortality rate and bacteria counts (standard plate count) of milk collected from the feeder hose ($R = 0.37$, $P = 0.08$; median = 435,000 cfu/mL, IQR = 3764,375 cfu/mL), size of the dairy (number of calves on site; $R = -0.41$, $P = 0.08$; mean = 82.18 ± 84.26 calves) and age difference in calf groups ($R = 0.41$, $P = 0.06$; mean = 3.07 ± 2.03 wk). Basic calf-care practices remain vital to ensuring calf survival in automated feeding systems. These data indicate that farms using automated feeders are able to achieve a very low rate of death loss in preweaned calves, but a high variability in mortality among farms indicates continued room for improvement in calf death losses.

Key Words: automated calf feeding, mortality, management

1232 Impact of milk-feeding programs on fecal bacteria population and antimicrobial resistance genes in *Escherichia coli* isolated from feces in preweaned calves. G. Maynou[*1], L. Migura-Garcia[2], J. Subirats[3], H. Chester-Jones[4], D. Ziegler[4], A. Bach[1,5], and M. Terré[1], *[1]IRTA, Caldes de Montbui, Spain, [2]CRESA, Cerdanyola del Vallès, Spain, [3]ICRA, Girona, Spain, [4]University of Minnesota Southern Research and Outreach Center, Waseca, MN, [5]ICREA, Barcelona, Spain.*

The objectives of this study were to characterize fecal bacteria communities and evaluate the presence of antimicrobial resistance genes isolated from fecal *Escherichia coli* of dairy calves fed two different milk feeding programs. Fifteen Holstein newborn female calves (38.4 ± 3.21 kg BW) were fed pasteurized waste milk (pWM) with β-lactam antimicrobials residues, and 10 calves (39.2 ± 4.89 kg BW) were fed milk replacer (MR) with similar nutrient composition (27.5% CP, 32.1% fat) to waste milk (28.6% CP, 30.0% fat) from birth to weaning at 49 d of age. Fecal samples of 8 calves fed MR and 11 calves fed pWM were obtained on d 42 to profile fecal bacteria populations. The DNA was extracted and amplified for Eubacteria sequencing using Illumina Miseq platforms. Samples were filtered and assigned to a reference taxonomy using the SILVA reference database. A first analysis was made to assess differences in α and β diversity between the 2 milk-feeding sources using QIIME. An ANOVA was used to identify differences at order level between feeding practices. Furthermore, 25 *E. coli* isolates from fecal swabs of all calves at 35 d of age were used to identify resistance genes. A total of 10 resistance genes corresponding to aminoglycosides (*aadA*, *strA/strB* and *aac(3)IV*), β-lactam (*bla*CMY-2), tetracyclines (*tetA*, *tetB* and *tetC*) and sulfonamides (*sul1*, *sul2* and *sul3*) were examined by PCR and analyzed using a binary logistic regression to assess differences between feeding practices. Chao1 and Shannon α diversity indexes were similar in calves regardless of the feeding program followed. The prevalence of Clostridiales order was greater ($P < 0.05$) whereas Bacteroidales tended ($P = 0.07$) to be lower in pWM calves (0.58 ± 0.029 and 0.33 ± 0.032, respectively) than in those fed MR (0.44 ± 0.034 and 0.46 ± 0.038, respectively). A high prevalence of *sul1*, *sul2*, *tetA*, *aadA*, *strA/strB* and *aac(3)IV* were found in both treatments (0.43 ± 0.142, 0.62 ± 0.137, 0.50 ± 0.141, 043 ± 0.142, 0.63 ± 0.138, 0.43 ± 0.149, respectively) whereas the prevalence of CMY-2 in pWM calves (0.67 ± 0.122) was greater ($P < 0.05$) than in MR fed calves (0.10 ± 0.095). In conclusion, milk feeding practices can cause shifts in calf gut bacteria populations. High prevalence of extended spectrum β-lactamase resistance genes has been found in fecal *E. coli* isolates from pWM fed calf.

Key Words: calf feeding programs, fecal bacteria population, resistance genes.

1233 A survey of management practices and producers' perceptions regarding manual and automated milk feeding systems for dairy calves. C. Medrano-Galarza[*1,2], J. Rushen[3], A. M. de Passillé[3], A. Jones-Bitton[1], T. J. DeVries[4,5], S. J. LeBlanc[1], and D. B. Haley[1,2], *[1]Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada, [2]Campbell Centre for the Study of Animal Welfare, University of Guelph, Guelph, ON, Canada, [3]Faculty of Land & Food Systems, University of British Columbia, Agassiz, BC, Canada, [4]Department of Animal Biosciences, University of Guelph, Guelph, ON, Canada, [5]University of Guelph, Guelph, ON, Canada.*

Dairy calves are commonly housed individually and fed by manual milk feeding (MMF) methods, with buckets or bottles. Automated milk feeders (AMF) allow for more natural milk feeding frequency and volume, with calves usually housed in groups. A national online survey was developed to determine management practices for the care of milk-fed calves in Canada, and factors that influence use of MMF or the switch to AMF. A total of 670 responses were received (5.7% of all dairy farms in Canada). Of respondents, 16% used AMF and 84% used MMF. Seventy percent of farms using AMF had free-stall barns compared to only 48% for those using MMF. Interestingly, 30% of AMF farms also had automatic milking systems (AMS), compared to 8% for MMF farms. Having a herd size > 80 milking cows (OR = 5.1; $P = 0.003$) and automated feed pushers (OR: 5.0; $P = 0.03$) were associated with having an AMF among tie-stall farms. For loose-housing farms (i.e., free-stall and bedded-pack), herd size > 80 milking cows (OR = 2.7; $P = 0.004$), having an AMS (OR = 2.4; $P = 0.01$), and use of cow-brushes (OR = 4.5; $P = 0.002$) were associated with having an AMF. Automated milk-fed calves were typically housed in groups of 10 to 15, while nearly 75% of the farms with MMF housed calves individually. Having group housing for milk-fed calves was associated with larger farms (> 80 milking cows; OR = 2.2; $P < 0.001$), having an AMS (OR = 1.8; $P = 0.03$), and having fewer personnel looking after the calves (1 vs. 2 people: OR = 1.8; $P = 0.009$; and 1 vs. ≥ 3 people: OR = 2.0: $P = 0.007$). Although both AMF and MMF farms fed similar amounts of milk the first week of life (a median of 6 L/d), the cumulative volume fed in the first 4 wk differed significantly ($P < 0.001$), with a median of 231 vs. 182 L, respectively. Median milk allowance for AMF also peaked higher than for MMF (10 vs. 8 L/d, respectively). The 4 most important producer-identified factors that motivated producers to switch to automation were to raise better calves, offer more milk to calves, reduce labor, and improve working conditions. For MMF farms, the investment in equipment and in group housing facilities, and farm size were the primary reasons given for maintaining manual feeding methods. To conclude, AMF farms were larger, provided more milk to calves, and use

more automation. These data provide insights into calf rearing practices across Canada, resulting in improved understanding of producers' uptake, and application of technology.

Key Words: calves, feeding practices, automation.

1234 Investigating the within-herd prevalence and risk factors of hyperketonemia of dairy cattle in Ontario as diagnosed by the test-day concentration of milk β-hydroxybutyrate.

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A large-scale observational study was conducted to estimate the within-herd prevalence and cow-level risk factors of hyperketonemia (HK) in dairy herds in Ontario that participate in a dairy herd improvement association (DHIA) program. Hyperketonemia was diagnosed as milk β-hydroxybutyrate ≥ 0.15 mmol/L (Ketoscreen test, MilkoScan FT600, Foss Analytical A/S, Hillerød, Denmark) at first DHIA test within the first 30 d in milk (DIM). Eight hundred and thirteen herds providing at least 61 first milk tests from June 2014 to December 2015 and were used to estimate the provincial within-herd prevalence with 95% confidence, 80% power and precision of 10%. All herds on DHIA in Ontario (n = 3,042) were used to construct multi-level logistic regression models to investigate the association of commonly measured variables with the odds of HK at first DHIA milk test at the cow-level. The overall HK prevalence in Ontario was 22% of cows at first test, with an average within-herd prevalence of 21% (SD = 10.6). The prevalence of HK had a distinct seasonality with the lowest prevalence occurring from July to November. Herds with automatic milking systems (AMS) (11%, n = 92) had higher within-herd prevalence than all other herds, as well as increased odds of HK in multiparous animals at first test (OR: 1.46; CI_{95}: 1.30 to 1.63). This association requires further study of causal factors. Both primiparous and multiparous Jersey cattle had 1.4 times higher odds of HK than Holstein cattle. After controlling for breed, a milk yield > 26 kg and milk fat > 4.8% at the last milk test of the previous lactation were associated with decreased odds of HK in the current lactation (OR_{yield}: 0.55; $OR_{fat\%}$: 0.83). Increased days dry and longer calving intervals, for multiparous animals, and older age at first calving for primiparous animals increased the odds of hyperketonemia at first test. This is the first report of associations of AMS, and milk yield and components late in the previous lactation with increased HK.

Key Words: prevalence hyperketonemia β-hydroxybutyrate

Table 1235.

Table 1. Effect of 8 wk milk replacer (kg) and calf starter (kg) intake on first-lactation 305-d milk, fat, and protein yield (kg) in all cows (n=2880).

Item	R^2	Variable	Estimate	SE	P-value
305-d milk	0.10	Milk Replacer	9.89	12.42	0.4261
		Calf Starter	8.21	2.53	0.0012
305-d fat	0.28	Milk Replacer	0.52	0.53	0.3332
		Calf Starter	0.36	0.10	0.0002
305-d protein	0.17	Milk Replacer	0.29	0.35	0.4115
		Calf Starter	0.33	0.07	<0.0001

1235 Relationships between early life milk replacer and starter intake and first lactation performance of Holstein dairy cows.

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The objective was to determine relationships between early life milk replacer and starter intake and first lactation performance of Holstein cows. Data were collected from birth yr of 2004 to 2012 for 2,880 Holstein animals. Calves were received from 3 commercial dairy farms and enrolled in 37 different calf research trials at SROC from 3 to 195 d. Upon trial completion, calves were returned to their respective farms. Milk replacer options included varying protein level and amounts fed but in the majority of studies calves were fed a 20% CP: 20% fat MR at 0.57 kg/calf daily. Most calves (93%) were weaned at 6 wk. Milk replacer DM intake, starter intake, ADG, and BW at 8 wk were (mean ± SD): 21.7 ± 2.5, 44.4 ± 12.0 kg, 0.63 ± 0.12 kg/d, and 75.8 ± 8.4 kg, respectively. Average age at first calving and first lactation 305-d milk yield were: 715 ± 46.5 d and 10,959 ± 1,527 kg, respectively. Mixed model analysis was conducted using the REML model fitting protocol of JMP (SAS) to determine the effect of 8 wk milk replacer and 8 wk calf starter intake on first-lactation 305-d milk, milk fat, and true protein yield. Birth season, calving season, calving yr, and calving yr nested within herd were included in the models with calf trial as a random effect. Eight-wk intake of calf starter had a significant positive effect on first lactation 305-d yield of milk and milk components (P < 0.01; Table 1). However, these improvements were modest and variation was high suggesting additional factors not accounted for in this analysis impact first lactation performance. Milk replacer intake, which varied very little in this dataset, had no effect on first

lactation 305-d yield of milk and milk components.

Key Words: calves, milk replacer, calf starter, first lactation.

1236 Feeding management strategies on large and smaller freestall dairy herds in Minnesota. L. Kloeckner* and M. I. Endres, *University of Minnesota, St. Paul.*

The objectives of this study were to evaluate feeding management practices on freestall dairy farms in Minnesota and compare practices between two dairy farm sizes. Eighty-two farms were randomly selected from a list provided by the Minnesota Department of Agriculture that included all dairies in the state. Farms were visited once between May and November to collect on farm measurements and observations and to inquire about management practices. Farms were blocked by size: large farms ($\geq$ 400 cows; n = 45) and smaller farms (> 150 and < 400 cows; n = 37). Data were analyzed using the MEANS, TTEST and FREQ procedures of SAS. Mean farm size for the large and smaller farms was 886 and 278 cows, respectively. Large farms had more separate lactating rations (mean ± SE, 2.98 ± 0.20) and non-lactating rations (1.71 ± 0.07) than smaller farms (1.81 ± 0.15 and 1.35 ± 0.08, respectively). Large farms had more frequent feed pushups (8.91 ± 0.63) and milkings (2.95 ± 0.05) per day than smaller farms (4.94 ± 0.45 and 2.36 ± 0.08, respectively). Bovine somatotropin was used on 75.6% of large farms vs. 43.2% of smaller farms (P = 0.004). The use of a feeding management software (57.8% vs. 2.7%, P < 0.001) and the use of other technologies (84.4% vs. 62.2%, P = 0.03) was greater on large farms compared to smaller farms. Large farms were more likely to use an on farm master mix (37.8% vs. 16.2%, P = 0.047) and less likely to use uprights silos (20.0% vs. 43.2%, P = 0.03) and Ag bags (17.8% vs. 43.2%, P = 0.02) than smaller farms. There were no differences in the usage of bulk bins, commodity bays, bunker silos, and forage piles between each farm size. There were no differences in the type of plastic used to cover forages. Other management practices where no differences were observed included number of feedings per day, target percent refusals, processing method of corn silage, own or hired chopping, corn silage hybrids, TMR mixer type, and an estimate of feed shrink. Results of the study indicate that some feeding management practices are influenced by farm size.

Key Words: feeding, herd size, management practices

1237 Evaluation of the CowVac for controlling flies on Minnesota organic dairy farms. M. A. Kienitz[1] and B. J. Heins*[2], [1]*University of Minnesota, Lakeville,* [2]*University of Minnesota West Central Research and Outreach Center, Morris.*

The objective of this study was to evaluate the efficacy of the CowVac (Spalding Laboratories, Reno, NV) in on-farm organic dairy production systems to control horn flies, stable flies, and face flies. The CowVac utilizes a chute apparatus and powerful vacuums to suction flies off the cows as they walk through the system. The study utilized eight organic dairy farms during the summer of 2015 in Minnesota, and herds ranged from 30 to 350 cows. The farms were divided into pairs by location and during the first period of the summer (June to July) the CowVac was set up on one farm and during the second period of the summer (August to September) the CowVac was sent to its paired farm. Farms were visited once per week to collect flies (or collect and count flies) from the CowVac, as well as count and record flies on cows. Bulk tank milk, fat, and protein production and SCC were collected on farms during the entire study period. Data were analyzed using the GLM procedure of SAS. Independent variables for analyses were the fixed effects of farm, CowVac presence, housing scenario, and period. Horn fly numbers on cows were reduced (P < 0.05) by 44% on farm in the presence of a CowVac (11.4 vs. 20.5 flies/side) compared to the absence of a CowVac. Stable fly (5.4 vs. 7.1 fly/leg) and face fly (1.0 vs. 1.0 fly/cow) numbers were similar (P > 0.05) on farm whether the CowVac was present or absent on farms, respectively. Milk production was similar (P > 0.05) for farms with the CowVac (15.5 kg/d) compared to without (15.3 kg/d) the CowVac. The presence of a CowVac on farm reduced (P < 0.05) horn fly population growth rates (−0.008 vs. 0.002 flies/d) compared to the absence of a CowVac. Cows on farms with no housing (100% pasture) tended (P = 0.07) to have reduced horn fly numbers (11.7 vs. 28.3 flies/side) in the presence of a CowVac compared to the absence of a CowVac on farm. Cows on farms with housing had similar (P > 0.60) horn fly numbers (11.2 vs. 14.8 flies/side) in the presence of a CowVac compared to the absence of a CowVac on farm. In summary, these results indicate the CowVac was effective in reducing horn fly numbers on cows and reduced horn fly growth rates during the pasture season in organic dairy production systems.

Key Words: organic, CowVac, fly control

Table 1239.

Table 1: Mean and variance components of DM content and particle size distribution in TMR (n=318)

Variable (%)*	Mean	Variance				
		Farm	Pen	Day	Feed bunk site	Sampling + analytical
DM	45.2	20.59	6.44	7.50	0.05	2.69
>19.0 mm	10.0	0.43	0.12	0.07	0.00	0.11
19.0 -8.0 mm	36.6	0.11	0.02	0.01	0.00	0.01
8.0-1.18 mm	36.6	0.02	0.01	0.01	0.00	0.01
<1.18 mm	11.0	0.32	0.03	0.07	0.00	0.06

*Variance estimates for particle size distribution were obtained from the logarithmically transformed variable

1238 Prediction of daily concentration of milk and milk components from single-milking values.
M. Duplessis[*1], L. Fadul-Pacheco[2], R. Lacroix[1], D. M. Lefebvre[1], D. E. Santschi[1], and D. Pellerin[3], *[1]Valacta, Ste-Anne-de-Bellevue, QC, Canada, [2]Département des sciences animales, Université Laval, Québec, QC, Canada, [3]Universite Laval, Quebec, QC, Canada.*

Alternate a.m.-p.m. milk testing has been introduced in many countries and is often used instead of collecting milk for 2 consecutive milkings. Models taking into account milking interval have been developed to predict 24-h yield and concentration from milk yield and fat concentration single-milking values. However, there is still a gap between the prediction and the reality. It has been hypothesized that feeding factors could help better estimating 24-h prediction. The purpose of this study was to evaluate feed-related management factors affecting a.m. and p.m. milk yield and milk fat, protein, lactose, urea, somatic cell count (SCC), and β-hydroxybutyrate (BHBA) concentrations as a single predictor of 24-h concentrations. Separate milk samples from a.m. and p.m. milkings were taken for each cow on 98 tiestall and 2 freestall barns. Milk samples were analyzed using Fourier transform infrared spectroscopy. Milk production weighted averages were calculated to obtain daily concentrations. Milking intervals, number of concentrate meals offered, feeding systems (conventional, individual concentrate feeding [ICF] and total mixed ration [TMR]), interval between milking and last concentrate meal were recorded and used as independent variables in the multiple regression analysis. Milk yield and component concentrations from a.m. or p.m. samples to calculated daily concentrations ratios were computed and considered as dependant variables. For analysis purposes, individual ratios were averaged by herd. Multiple regressions were performed with Proc GLMSELECT of SAS using stepwise selection and $P = 0.05$ as the cut-off point. Highest R-squares were obtained while predicting milk yield (a.m.: $r^2 = 0.63$; p.m.: $r^2 = 0.51$), followed by fat concentration (a.m.: $r^2 = 0.30$; p.m.: $r^2 = 0.26$), SCC (a.m.: $r^2 = 0.29$; p.m.: $r^2 = 0.26$), BHBA (a.m.: $r^2 = 0.15$; p.m.: $r^2 = 0.16$), protein (a.m.: $r^2 = 0.14$; p.m.: $r^2 = 0.10$), urea (a.m.: $r^2 = 0.13$; p.m.: $r^2 = 0.08$), and lactose (a.m.: $r^2 = 0.03$; p.m.: $r^2 = 0.00$). Milking interval affected daily prediction of a.m. and p.m. milk yield and a.m. and p.m. fat, SCC, and BHBA contents. Interval between milking and last concentrate meal affected 24-h prediction in all a.m. models except for BHBA. Feeding system had an impact on 24-h prediction of a.m. and p.m. protein and urea concentrations. Regarding lactose, results confirm that a.m. or p.m. concentrations without adjustment could predict 24-h lactose concentration as this component is relatively constant. In summary, feed-related management factors slightly improved 24-h prediction as compared with models adjusting only for milking interval as suggested by the low R-Square increment.

Key Words: single milking, milk yield, component

1239 Sources of variation in dry matter content and particle size distribution in total mixed rations in dairy farms in Argentina.
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Total mixed rations (TMR) composition variation has been associated with lower milk yield and higher health problems at herd level. Our objectives were to describe TMR DM percentage and particle size distribution, and to partition that variance into different sources of variation. Ten dairy farms in Southern Cordoba province, Argentina, were visited for 3 consecutive days during the summer. Fresh TMR offered in the morning to each lactating pen was sampled within 5 min after delivery, to assess DM percentage and particle size distribution with a

Penn State Particle Separator. Duplicate samples were taken at the beginning and at the end of the feed bunk (feed bunk site) in each pen. Number of pens ranged from 1 to 4. To estimate variances in physical and DM composition of TMR and to partition that variance into measurements components, random effects models including farm, pen within-farm, day within-pen and farm, place, and residual error, were fitted to the data (n = 318) using mixed procedures of InfoStat. Particles were assumed to be logarithmically normally distributed. Results are shown in Table 1. Mean DM content of TMR was 45.2% and it ranged from 22.8 to 56.9%. Particle retention on the top sieve (>19.0 mm) was higher than recommended (2 to 8%) for high producing cows. Because cows are expected to sort against large particles and that would change NDF and starch intake, it is important to follow the recommended proportion on the top sieve. Although mean particle percentage on the 19.0 to 8.0-mm sieve was according to the recommendation (30 to 50%), there is a wide range of values. More than 72% of the variation in particle size distribution and DM content was explained by farm and pen within-farm. Within-pen, daily variation accounted for half of the variation for particle size distribution (46 to 61%), which is demonstrating that procedures involved in ration preparation (including adjusting forage inclusion for moisture content) were not always the same. The rest of this variation was explained by sampling and analytical variance. For DM content, 73% of the within-pen variation was explained by day-to-day variation. Our data shows that day-to-day ration variation is an important source of variation within pen in a farm, particularly when DM content is determined, although attention should be paid to sampling and analytical effects to make appropriate decisions.

Key Words: variation, TMR, particle size distribution

1240 Growth measurements of crossbred dairy steers compared to Holstein dairy steers raised in an organic production system. H. N. Phillips* and B. J. Heins, *University of Minnesota West Central Research and Outreach Center, Morris.*

Bull calves (n = 30) were used to compare growth measurements of crossbred and Holstein dairy steers raised in an organic production system. Calves were born at the University of Minnesota West Central Research and Outreach Center organic dairy from March to May 2015 and assigned to 1 of 3 replicated breed groups at birth. Breed groups were: crossbreds comprised of Montbéliarde, Holstein, and Viking Red (MVH; n = 10), crossbreds comprised of Jersey, Normande, and Viking Red (NJV; n = 10), and purebred Holstein (HO; n = 10). Calves were group-housed by breed group (n = 5) and group-fed 6 L/d of 13% total solids organic milk once daily and were weaned when the group consumed an average of 0.91 kg of organic starter per calf per day for 3 consecutive days. Body measurements were recorded at birth, weekly during the pre-weaning period, at weaning, and monthly thereafter. After weaning, steer groups were fed a diet of organic corn, corn silage, alfalfa haylage and minerals. Diets were recorded daily with herd management software. Analysis was performed using PROC MIXED of SAS, independent variables for statistical analysis were the fixed effects of breed group, and replicate was a random effect. Analysis of variables was on a pen basis. Birth weight for calves was: HO: 40.2 kg, MVH: 46.4 kg, and NJV: 39.3 kg ($P > 0.05$). Weaning age was: HO: 69.1 d, MVH: 68.4 d, and NJV: 78.8 d; weaning weight was: HO: 91.7 kg, MVH: 106.0 kg, and NJV: 100.6 kg; and gain per day was: HO: 0.74 kg/d, MVH: 0.86 kg/d, NJV: 0.77 kg/d. Breed groups were not different ($P > 0.05$) for weaning age and weaning weight. However, the MVH calves tended ($P < 0.10$) to have greater gain per day than the HO calves. For the first 9 mo of age, gain per day for steers was: HO: 1.07 kg/d, MVH: 1.01 kg/d, and NJV: 0.98 kg/d ($P > 0.05$). Hip height (cm) (HO: 95.9; MVH: 97.8, and NJV: 94.9) and heart girth (cm) (HO: 107.7, MVH: 112.4, and NJV: 112.1) at weaning was not different ($P > 0.05$) for breed groups. In summary, no significant differences in growth measurements were found between breed groups for dairy steers in this organic production system.

Key Words: organic; dairy steers; growth; breeds

1241 Accuracy and precision of diets for high-producing dairy cows and their impacts on production and milk composition. J. H. Carneiro[1,2], J. F. Santos[2], P. Schmidt[1], T. J. DeVries[3], and R. D. Almeida*[1], *[1]Universidade Federal do Paraná, Curitiba, Brazil, [2]Castrolanda Cooperativa Agroindustrial, Castro, Brazil, [3]Department of Animal Biosciences, University of Guelph, Guelph, ON, Canada.*

The goal of this study was evaluate associated feeding management and nutritional accuracy with milk production and composition on commercial herds. Twenty high-producing dairy farms from Campos Gerais county, Paraná State, Southern Brazil, were visited for 3 consecutive days in the 2015 fall season. Feeding management and TMR preparation related variables, and the physical and chemical characteristics of the offered diets and orts were collected. Production performance and milk composition from the high-production group of cows were obtained from regular milk testing, performed on average 1 ± 5d before or after the data collection period. Pearson correlations were estimated among the management and diet variables with production, milk composition, and feed sorting estimates. Using the Penn State Particle Separator, the offered diets had on average 14.9, 41.8, 32.8, and 10.5% (DM) of long, medium, short, and fine particles, respectively. Long particles showed a daily refusal rate of 9.0%, whereas short and medium particles were preferentially consumed at 1.1 and 1.7%, respectively. A high proportion of long particles in the forage (78.2% of haylage and hay) was

associated with reduction in milk fat % (%MF) ($r = -0.50$; $P < 0.05$), and an increased proportion of cows with fat:protein ratio lower than 1 (FPR < 1) ($r = 0.50$; $P < 0.05$). Errors associated with loading an excess of concentrate ingredients in the TMR wagon were negatively associated with %MF ($r = -0.52$; $P = 0.05$) and milk production ($r = -0.47$; $P < 0.05$). By comparing the formulated diet with the one delivered to the cows, we noted, on a DM basis, a decrease in CP (−3.1%), fat (−7.0%), and ash contents (−10.5%), and an increase in NDF (+10.3%). The accuracy observed between formulated and delivered diets was not associated with the performance of the cows. However, daily variation of the DM content of the diet was associated with a greater proportion of cows with FPR < 1, and reduced FPR ($r = 0.40$; $P = 0.09$ and $r = -0.43$; $P = 0.07$, respectively). Low homogeneity (across 3 d) of the % of long particles in the diet was associated with greater selection against these particles ($r = -0.64$; $P < 0.05$), which showed a curvilinear association with %MF. These results demonstrated that the addition of more concentrate ingredients than expected, as well as the inconsistent intake of different particle sizes throughout the day, had a negative impact on milk production and composition of the studied herds.

Key Words: feed management, feed sorting, total mixed ration

1242 Health treatment costs of pure Holsteins in 8 high-performance Minnesota dairies. M. R. Donnelly*[1], A. R. Hazel[1], B. J. Heins[2], and L. B. Hansen[1], *[1]University of Minnesota, St. Paul, [2]University of Minnesota West Central Research and Outreach Center, Morris.*

Health treatment costs of pure Holstein cows (n = 4,997) were evaluated in 8 high-performance dairy herds in Minnesota. Cows calved from March 2008 to September 2015, and 17 types of health treatments were defined uniformly across herds. The cost for treatment of retained placenta, metritis, cystic ovary, miscellaneous reproduction, ketosis, displaced abomasum, milk fever, lameness, mastitis, digestive, respiratory, injury, California Mastitis Test/milk culture, and other treatments were summed within 6 stages of lactation for parities 1 to 5. Excluded from analysis were hoof trimming, palpation, and reproductive aid. The 6 stages of lactation were defined based on days in milk. The first 4 stages were 60 d each, stage 5 started on Day 241 and was variable in length and continued until the dry date, and stage 6 included the dry period only. Treatment costs were the mean cost of treatment protocols defined by the veterinarians used by the herds in addition to a fixed labor cost of $18/h reported by producers. Labor costs were applied based on time per treatment from a producer survey. Cows were grouped into 2 year-blocks of calving and year-blocks were defined as 2008 to 2010 and 2011 to 2015. Statistical analyses were conducted separately for each parity, and independent variables were the fixed effects of herd, year-block of calving, interaction of herd and year-block, stage of lactation, and interaction of stage of lactation and year-block. Year-blocks were combined for parities 3 to 5 because cows left the herds as they aged. For this reason, only the fixed effects of herd and stage of lactation were considered for parities 3 to 5. For all 5 parities, herd and stage of lactation were highly significant ($P < 0.01$). For parities 1 and 2, year-block and its interactions were highly significant ($P < 0.01$). As expected, treatment costs were largest during the first 60 d in milk, which is usually when cows experience high treatment costs for transition disorders. Least squares means of treatment costs (Table 1) for parities 1 and 2 decreased as year-block increased for most stages of lactation. The most dramatic decrease in treatment cost by year-block occurred within the first 60 d in milk, perhaps indicating an improvement in transition cow management among the herds during the years of the study.

Key Words: treatment costs, management, health

1243 Relationships between early life growth and first lactation performance of Holstein dairy cows. B. J. Heins*[1], H. Chester-Jones[2], D. Ziegler[2], M. B. De Ondarza[3], S. E. Schuling[4], B. Ziegler[4], D. Schimek[4], N. Broadwater[5], and C. J. Sniffen[6], *[1]University of Minnesota West Central Research and Outreach Center, Morris, [2]University of Minnesota Southern Research and Outreach Center, Waseca, [3]Paradox Nutrition, West Chazy, NY, [4]Hubbard Feeds Inc., Mankato, MN, [5]University of Minnesota Extension, Rochester, [6]Fencrest, LLC, Holderness, NH.*

The objective was to determine relationships between early life ADG and BW and first lactation performance of Holstein

Table 1243.

Table 1. Effect of 6 wk BW (kg) and ADG (kg/d on first-lactation 305-d milk, fat, and protein yield (kg; n=2,880).

Item	Variable	R^2	Estimate	SE	P-value
305-d milk	6 wk BW	0.11	20.11	4.41	< 0.0001
	6 wk ADG	0.10	543.71	248.80	0.0290
305-d fat	6 wk BW	0.28	0.84	0.17	< 0.0001
	6 wk ADG	0.28	21.04	9.46	0.0262
305-d protein	6 wk BW	0.17	0.70	0.12	< 0.0001
	6 wk ADG	0.16	22.98	6.70	0.0006

cows. Data were collected from birth yr of 2004 to 2012 for 2,880 Holstein animals. Calves were received from 3 commercial dairy farms and enrolled in 37 different calf research trials at SROC from 3 to 195 d. Upon trial completion, calves were returned to their respective farms. Milk replacer options included varying protein level and amounts fed but in the majority of studies calves were fed a 20% CP: 20% fat MR at 0.57 kg/calf daily. Most calves (93%) were weaned at 6 wk. Milk replacer DM intake, starter intake, ADG, and BW at 6 wk were: 21.5 ± 2.2 kg, 17.3 ± 7.3 kg, 0.53 ± 0.13 kg/d, and 62.4 ± 6.8 kg, respectively. Average age at first calving and first lactation 305-d milk yield were: 715 ± 46.5 d and 10959 ± 1527 kg, respectively. Separate mixed model analyses were conducted using the REML model fitting protocol of JMP (SAS) to determine the effect of 6 wk BW or ADG on first-lactation 305-d milk, fat, and true protein yield. Birth season and calving season, yr, and yr nested within herd were included in the models with calf trial as a random effect. Early life BW and ADG positively affected first-lactation 305-d yield of milk and components ($P < 0.03$; Table 1). Six-week ADG class (< 0.23, 0.23 to 0.33, 0.34 to 0.44, 0.45 to 0.56, 0.57 to 0.67, 0.68 to 0.80, and > 0.80 kg/d) also affected 305-d yield of milk and components ($P < 0.02$). Greater BW and ADG at 6 wk resulted in increased first lactation milk and milk component yields. However, these improvements were modest and variation was high suggesting additional factors not accounted for in this analysis impact first lactation performance.

Key Words: calves, early life, growth, first lactation

1244 Relationships between birth season versus early life starter intake and growth and first lactation performance of Holstein dairy cows.

B. J. Heins*[1], D. Ziegler[2], D. Schimek[3], S. E. Schuling[3], B. Ziegler[3], H. Chester-Jones[2], M. B. De Ondarza[4], C. J. Sniffen[5], and N. Broadwater[6], *[1]University of Minnesota West Central Research and Outreach Center, Morris, [2]University of Minnesota Southern Research and Outreach Center, Waseca, [3]Hubbard Feeds Inc., Mankato, MN, [4]Paradox Nutrition, West Chazy, NY, [5]Fencrest, LLC, Holderness, NH, [6]University of Minnesota Extension, Rochester.*

The objective was to determine the effect of birth season on early life starter intake, growth, and on first lactation performance of Holstein cows. Data was collected from birth yr of 2004 to 2012 for 2,880 Holstein cattle. Calves were received from 3 commercial dairy farms and enrolled in 37 different calf research trials at SROC from 3 to 195 d. Upon trial completion, calves were returned to their respective farms. Milk replacer options included varying protein level and amounts fed but in the majority of studies calves were fed a 20% CP: 20% fat MR at 0.57 kg/calf daily. Most calves (93%) were weaned at 6 wk. Milk replacer DM intake, starter DM intake, ADG, and BW at 8 wk were: 21.7 ± 2.5, 44.4 ± 12.0 kg, 0.63 ± 0.12 kg/d, and 75.8 ± 8.4 kg, respectively. Average age at first calving and first lactation 305-d milk yield were: 715 ± 46.5 d and 10,959 ± 1,527 kg, respectively. Separate mixed model analyses were conducted using the REML model fitting protocol of JMP (SAS) to determine the effect of birth season on 8 wk starter intake, BW, and ADG, and on first-lactation 305-d milk, milk fat, and true protein yield. Birth season, calving season, calving yr, and calving yr nested within herd were included in the models with calf trial as a random effect. Eight wk ADG and 8 wk ADG x birth season were also included when evaluating first-lactation performance. Calves born in fall and winter had greater ($P < 0.05$) starter intake (48.3 vs. 42.8 kg), BW (77.5 vs. 75.1 kg), and ADG (0.66 vs. 0.63 kg/d) at 8 wk. However, calves born in summer produced more 305-d milk during their first lactation than those born in the fall and winter ($P < 0.05$). There was no interaction between birth season and 8 wk ADG on first lactation performance.

Key Words: birth season, early life growth, first lactation

1245 ADSA®-EAAP Speaker Exchange Presentation: Comparing milk yield between cows with different dry period lengths over multiple lactations.

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To assess economic and environmental consequences of shortening the dry period (DP), we need to be able to compare milk yields of cows with different DP lengths, and to estimate effects on yield over multiple lactations. Milk yield is generally

Table 1244.

Table 1. Effect of birth season on first-lactation 305-d milk, fat, and protein yield.

Item	Birth season P-value	Spring	Summer	Fall	Winter
305-d milk (kg)	0.0206	11,033[ab]	11,145[a]	10,875[b]	10,863[b]
305-d fat (kg)	0.0508	401[ab]	409[a]	401[ab]	397[b]
305-d protein (kg)	0.0343	336[ab]	340[a]	333[ab]	332[b]

[ab]Values in the same row with different superscripts are different ($P < 0.05$)

compared using 305-d yields. This measure, however, does not account for additional yield before calving and potentially shorter calving intervals in case the DP is shortened. First, we aimed to develop a measure to compare milk yields between cows with different DP lengths. We defined an 'effective lactation yield' as kg of fat-and-protein-corrected milk (FPCM) per cow per day from 60 d before calving to 60 d before next calving. We applied this measure to 817 cows with a standard (49d to 90d), short (20d to 40d), or no DP before second calving, using first parity 305-d yield as a covariate. Compared with cows with a standard DP, 305-d yields were reduced by 2.3 kg FPCM d^{-1} for cows with a short DP ($P < 0.05$) and by 7.0 kg FPCM d^{-1} for cows with no DP ($P < 0.05$). Compared with cows with a standard DP, effective lactation yields were similar for cows with a short DP and reduced by 3.1 kg FPCM d^{-1} for cows with no DP ($P < 0.05$). Second, we aimed to assess the impact of shortening the DP over multiple lactations on effective lactation yield. Lactation data (2007 to 2015) of cows of 16 Dutch dairy farms that apply no or short DP were selected if effective lactation yield, current DP, and previous DP were known. Dry period categories were: no (0 to 2 wk), short (3 to 5 wk), standard (6 to 8 wk), and long (9 to 12 wk). A long, short, or no current DP reduced effective lactation yield, compared with a standard DP. Previous DP, however, did not affect effective lactation yield over multiple lactations. In conclusion, the effective yield enables comparison of yield when DP length and calving interval vary. Moreover, cows can be managed with short or no DP over multiple lactations without increasing yield losses.

Key Words: dairy cow, dry period length, long-term effects

1246 Economic impact of introducing automatic milking system on Canadian dairy farms.

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Adoption of automatic milking system (AMS) increased exponentially over the last years around the world. In 2014, 5% of Canadian dairy farms owned an AMS. The objective of this study was to evaluate the economic impact following AMS introduction in Canadian dairy herds. Data were first collected during a phone interview on 213 Canadian dairy farms having shifted to AMS (British-Colombia, $n = 8$; Alberta, $n = 42$; Saskatchewan, $n = 6$; Manitoba, $n = 12$; Ontario, $n = 73$; Québec, $n = 65$; and Atlantic provinces [New-Brunswick, Nova-Scotia, Prince-Edward-Island], $n = 7$). Second, 151 farms out of 213 have answered a more detailed online survey. After AMS adoption, herd size, milk production, and number of robots per herd averaged 100.2 ± 64.3 cows, 10,764 ± 1,663 kg, and 1.94 ± 1.36 robots, respectively. Milk production, reproduction, and culling data were provided by Valacta and CanWest DHI. Partial budgets were computed using an Excel spreadsheet; surveyed data were completed with literature data. Results of the partial budgets were divided by the respective number of cows after the AMS introduction to allow comparison regardless of herd size. Average parameter values were calculated for herds below percentile 25 and above percentile 75 for the net margin per cow and were compared with either a *t* test or a Wilcoxon signed-rank test. On average, after AMS introduction, herd size, milk production and culling rate were increased by 7.3 cows, 741.6 kg/cow/yr and 1.5%, respectively, and calving interval and labor requirement were decreased by 6.8 d and 15.1 h/cow/yr, respectively. Net margin per cow following AMS adoption was negative and averaged CAN $-1,204.41 ± 1,080.06. Introducing AMS resulted in increased costs of CAN $2,277.45 ± 1,362.21/cow mainly due to robot, barn construction or modifications and cow purchase amortizations (41.9% of total increased costs) and interest (27.8%). Increase in income averaging CAN $1,073.04 ± 1,739.10/cow was explained by milk production increase (55.1% of total increased income) and labor requirement decrease (29.8%). Highest net margin herds (P75) were characterized by having higher increased income (P75, CAN $2,331.76 and P25, CAN $-315.81; $P < 0.0001$) as compared with P25 herds. No difference was noted for increased costs ($P = 0.82$) between P25 and P75 herds. Difference in profitability between P75 and P25 herds was mainly due to milk production increase (CAN $524.47/cow; $P = 0.0004$). In summary, only 6% of dairy producers shifting to AMS have an expected payback less than 12 yr, which is the theoretical milking robot useful life.

Key Words: milking robot, partial budget, dairy

1247 Potential economic returns associated with weekly body condition scoring.

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The objective of this study was to estimate the potential economic returns from weekly recordings of body condition score (BCS) using a farm-level decision support tool. The feasibility of weekly BCS increases with the availability of automated BCS systems. To fully benefit from frequent BCS, the information must be used to make BCS-related cow, group, or herd management changes. These decisions may alter BCS distributions which can positively impact disease incidence, reproduction parameters, and feed efficiency. User inputs for the decision support tool included farm-specific herd demographics, financial data, disease incidences, and herd BCS distribution at calving. Differences between the current and goal BCS distributions were used to evaluate the economic returns from a potential improvement. The reported current disease incidences of metritis, milk fever, and ketosis were compared with the newly predicted disease incidences estimated from published odds ratios for effects of BCS on the

disease occurrence. Reproductive improvements were evaluated from a change in days open estimated from odd ratios describing BCS effects on conception rate. The lactation BCS curve was estimated using average herd BCS at calving and a sixth order polynomial regression equation. The average herd BCS before and after implementing regular scoring were used to compare differences in net energy costs across each lactation to compare the effects of BCS on feed efficiency. In an example scenario, input assumptions were sourced from 2015 DairyMetrics (DRMS, Raleigh, NC), USDA National Agriculture Statistics Service, and peer-reviewed literature. The inputs for current and herd BCS distributions are shown in Table 1. The increased revenue from improvements in disease incidence, reproduction, and feed efficiency estimated from this investment were $1,961.95/yr for a herd size of 183 cows. When the herd size was increased to 500 cows, with all other inputs held constant, financial improvements resulted in $3,692.12. Results from improvements in BCS are highly dependent on herd size, prior herd BCS, disease occurrence, and reproduction. This model can be used as a decision support tool to estimate farm-specific economic returns from improving BCS, potentially resulting from an investment in an automated BCS technology.

Key Words: body condition score, economics

1248 The influence of genetic potential on lactation curve and survival response of commercial dairy cattle to early lactation non-steroidal antiinflammatory (NSAID) drug administration.

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Previous research has indicated that the attenuation of inflammation in early lactation through the use of NSAID has a beneficial effect on whole-lactation milk production. Multiparous dairy cattle were blocked by breed, dystocia, and twin births, and assigned to 1 of 3 treatments at 12 to 36 h post-parturition (n = 153). Treatments were 1 placebo bolus on the first day of treatment and 3 consecutive daily drenches of sodium salicylate (125 g/cow/d; SAL); 1 bolus of meloxicam (675 mg/cow) and 3 drenches of an equal volume of water (MEL); and 1 placebo bolus and 3 daily drenches of water (CON). Daily milk production was averaged by week of lactation for statistical analysis. As reported previously, there was a significant increase in daily milk production and whole-lactation milk yield following NSAID administration, and a tendency for fewer cows receiving MEL to leave the herd up to 300 d in milk compared to CON. For all cows with at least 8 weekly milk observations reported (n = 130), lactation curves were fit to the MilkBot® model (DairySight LLC, Argyle, NY) to estimate decay, persistence, ramp, and scale. In brief, "decay" describes the rate of decline in daily milk production following peak, and it is used to mathematically derive persistence; "ramp" describes the rate of incline in daily milk production up to peak; and "scale" is a factor that is used to adjust the magnitude of the lactation curve without altering its shape. As a main effect, NSAID did not influence any of these parameters ($P \geq 0.15$); however, there was a significant interaction between the predicted transmitting ability for milk production (milk PTA) and NSAID treatment for decay of the lactation curve (P = 0.02; n = 121). A significant milk PTA and NSAID interaction was also detected for survival ($P < 0.01$). While milk PTA itself had a significant effect on risk of leaving the herd, such that lower milk PTA was associated with increased risk of leaving (P = 0.02), there was no evidence of this relationship in cows who had received either NSAID treatment. In conclusion, NSAID administration protected cattle with lower genetic potential from removal from the herd, possibly through an interaction with persistency of milk production in later lactation.

Key Words: lactation, persistence, inflammation, risk

Table 1247.

Table 1. Body condition score distributions in the before and after example scenario

BCS Score	Before	After
1.00 to 1.75	2.10%	1.20%
2.00 to 2.25	7.40%	4.80%
2.50 to 2.75	29.40%	38.00%
3.00 to 3.25	44.20%	48.00%
3.50 to 3.75	12.40%	6.80%
4.00 to 4.25	3.80%	1.20%
4.50 to 5.00	0.70%	0.00%

1249 Management practices and dietary physically effective fiber are related to bulk tank milk de novo fatty acid concentration on Holstein dairy farms. M. E. Woolpert*[1,2], H. M. Dann[1], K. W. Cotanch[1], C. Melilli[3], L. E. Chase[3], R. J. Grant[1], and D. M. Barbano[4], *[1]William H. Miner Agricultural Research Institute, Chazy, NY, [2]University of Vermont, Burlington, [3]Cornell University, Ithaca, NY, [4]Cornell University, Department of Food Science, Northeast Dairy Foods Research Center, Ithaca, NY.*

This study investigated the relationship of management and diet with de novo fatty acid (FA) concentration in bulk tank milk from commercial Holstein dairy farms. De novo FA are synthesized primarily from rumen fermentation products acetate and butyrate. It was hypothesized that farms with higher de novo FA concentrations would prioritize management that optimizes rumen conditions and cow comfort. Farms (n = 39) located in Vermont and northern New York were selected based on high (HDN; 24.5 ± 0.8 g/100 g FA; mean ± SD) or low (LDN; 22.9 ± 0.9 g/100 g FA) bulk tank de novo FA from the previous 6 mo. Milk FA were analyzed using mid infrared spectroscopy chemometric prediction models. Management was assessed during one visit per farm (February to April 2015). Total mixed ration samples were collected and analyzed for chemical composition using near infrared spectroscopy and for particle size distribution using a Penn State Particle Separator modified to include a 4-mm screen. Data were analyzed using the GLIMMIX procedure of SAS with de novo group as the fixed effect and farm as the random effect. In addition, data were categorized as above or below a defined threshold and odds ratios (OR) were calculated using a binary distribution with GLIMMIX. Milk fat (4.0 vs. 3.8%, SE < 0.1, P < 0.01), true protein (3.2 vs. 3.1%, SE < 0.1, P < 0.01), de novo FA concentration (26.0 vs. 23.8 g/100 g FA, SE = 0.2, P < 0.01) and de novo FA yield (315.6 vs. 276.2 g/d, SE = 9.5, P < 0.01) were greater for HDN than LDN farms. Milk (31.9 ± 4.1 kg/d; mean ± SD), fat (1.2 ± 0.2 kg/d), and true protein (1.0 ± 0.1 kg/d) yields and days in milk (173 ± 30 d) were not different (P > 0.25). Bunkspace (50.0 vs. 39.8 cm/cow; SE = 3.7, P = 0.06) tended to be greater for HDN than LDN freestalls. High de novo freestalls tended to be more likely to feed twice per day (OR = 5.0, 95% CL = 0.9 to 28.0, P = 0.07), have a stocking density ≤ 1.1 cows/stall (OR = 4.7, 95% CL = 0.8 to 27.2), P = 0.08) and ≥ 46 cm bunkspace per cow (OR = 10.1, 95% CL = 0.9 to 112.4, P = 0.06). Dry matter (42.6 ± 4.8%), crude protein (15.8 ± 1.5%), neutral detergent fiber (36.4 ± 4.0%), and starch (23.4 ± 4.5%) were not different (P > 0.20) between groups. Ether extract was lower (3.7 vs. 4.0%, SE = 0.1, P < 0.01) and physically effective neutral detergent fiber was higher (26.8 vs. 21.4%, SE = 1.1, P < 0.01) for HDN diets. Overcrowded freestalls, reduced feeding frequency, greater dietary ether extract and lower physically effective fiber were associated with lower milk fat, protein, and de novo FA content on commercial Holstein dairy farms.

Key Words: feed management, milk fat composition, stocking density

1250 Estimating the benefit:cost ratio of monensin supplementation. K. A. Dolecheck* and J. M. Bewley, *University of Kentucky, Lexington.*

The economic benefits of monensin supplementation have not been well documented. The objective of this study was to estimate the benefit:cost ratio of monensin supplementation. A deterministic, partial-budget model was used to estimate the effect of monensin supplementation in the lactating and dry cow rations of a dairy herd. Feed costs for lactating, far-off dry, and close-up dry rations were set at $227 per ton dry matter, $2.50 per cow per day, and $3.50 per cow per day, respectively. The non-supplemented herd level incidence rate of clinical mastitis, displaced abomasum, and clinical ketosis were set at 19.7%, 3.6%, and 6.3%, respectively. Milk price was determined using 5-yr (2011 to 2015) means of Federal Milk Marking Order product prices for butterfat ($4.50/kg), protein ($6.76/kg), and other solids ($0.73/kg). Monensin supplementation costs per cow per day were set at $0.050 and $0.035 in lactating and dry rations, respectively. The average response to monensin supplementation across lactation was established by a 2008 meta-analysis (2% decrease in dry matter intake, 2% increase in milk yield, 3% decrease in milk fat percentage, 1% decrease in milk protein percentage, decreased risk of ketosis [risk ratio = 0.75], decreased risk of displaced abomasum [risk ratio = 0.75], and decreased risk of mastitis [risk ratio = 0.91]). The model was run under 3 scenarios to estimate the sensitivity of monensin supplementation to pre-supplemented herd milk yield, milk fat percentage, and milk protein percentage. In scenario 1, milk yield was 31.8 kg/cow/d with 4.1% milk fat and 3.2% milk protein. In scenario 2, milk yield was 36.3 kg/cow/d with 3.8% milk fat and 3.1% milk protein. In scenario 3, milk yield was 40.8 kg/cow/d with 3.5% milk fat and 3.0% milk protein. All scenarios increased income over feed cost per cow per day ($0.29, $0.35, and $0.42, respectively) and resulted in a positive benefit:cost ratio (5.6:1, 6.8:1, and 8.0:1, respectively). The biggest factor influencing returns from monensin supplementation in all scenarios was increased income from milk sales ($5.63, $7.11, and $8.69 per cow per month, respectively). Other factors contributing to the positive benefit:cost ratio of monensin supplementation were reduced total feed costs (-$1.53,-$1.70, and-$1.85 per cow per month, respectively) and reduced losses from disease (-$0.95,-$0.99, and-$1.02 per cow per month, respectively). Future stochastic models should consider how variation in other factors affect the monensin supplementation benefit:cost ratio.

Key Words: monensin, benefit:cost, economic model

1251 TMR versus grazing supplemented with TMR out or into the grazing plot: Productive response. D. A. Mattiauda*[1], J. P. Marchelli[2], and P. Chilibroste[1], [1]*Facultad de Agronomia, Universidad de la Republica, Paysandu, Uruguay,* [2]*Facultad de Agronomia, Universidad de la Republica, Montevideo, Uruguay.*

An experiment was performed to study the effect of three contrasting feeding strategies involving TMR and grazing, during the first 60 d in milk of Holstein dairy cows. Thirty six multiparous dairy cows were blocked according to parity, expected calving date, body condition score (BCS; 2.9 ± 0.37) and BW (641 ± 49.2 kg) before calving, and were randomly allocated to follow one of three feeding treatments: TMR = total mix ratio (corn silage/concentrate mix 40/60; respectively), GR-one = one grazing session (AM: 0800 to 1400 h) supplemented with 50% of TMR out of the grazing plot and GR-two = two grazing sessions (AM: 0800 to 1400 h; PM: 1800 to 0400 h) supplemented with 50% of the TMR into the grazing plot. The three treatments were based on the same offer of energy (50 Mcal ENL/cow/d), differing in the source of feed (TMR vs. grazing plus TMR) and the synchrony or not between the access to pasture and to TMR (GR-one vs. GR-two). The cows were milked twice a day (04:30 and 15:00 h). Milk production was registered daily, milk composition weekly (samples from two consecutive milking) and BCS every 2 wk (scale 1 to 5). A fresh daily strip of a fescue based pasture (3,270 ± 758 kgDM/ha) was open to each grazing treatment with an herbage allowance (above 4 cm) enough to reach 25 Mcal ENL per cow/d. A mix model was used (Glimmix procedure, SAS 9.2, 2010) to analyze the results with treatment, week and their interaction as fix effects and block as a random effect. A first order autoregressive heterogeneous (AR1) covariance structure was selected. TMR cows produced more milk, energy, protein and lactose (Table 1) than grazing cows. Daily fat production was not different between treatments, since TMR cows produced milk with less ($P < 0.05$) or tendency for less ($P < 0.1$) fat content than GR-two and GR-one treatments, respectively. Grazing treatments did not differ except on the tendency ($P < 0.1$) for a higher milk fat content in GR-two than GR-one cows (Table 1). A reverse trend ($P < 0.1$) was observed for BCS (2.9 vs. 2.7 for GR-one and GR-two, respectively). The potential of GR-two cows to select a better mix of TMR and herbage than GR-one cows was not expressed in this trial. The long distance to the grazing plots (1.7 km) might have masked the potential benefits of GR-two feeding strategy.

Key Words: grazing, TMR, early lactation dairy cows, synchronizing

1252 Shearing during milking increases milk yield in dairy ewes. A. Elhadi[1], G. Caja*[2], A. A. K. Salama[1,3], X. Such[1], and E. Albanell[1], [1]*Universitat Autonoma de Barcelona, Bellaterra, Spain,* [2]*Group of Ruminant Research (G2R), Universitat Autonoma de Barcelona, Bellaterra, Spain,* [3]*Animal Production Research Institut, Giza, Egypt.*

The effect of shearing during lactation was investigated in 48 dairy ewes of 2 breeds (Manchega, MN; Lacaune, LC); 32 were multiparous (MN, n = 16, 69.5 ± 1.7 kg BW; LC, n = 16, 69.1 ± 1.9 kg BW) and 16 were primiparous (MN, n = 8, 59.4 ± 2.0 kg BW; LC, n = 8, 57.4 ± 2.4 kg BW). Ewes were permanently sheltered indoors and allocated in 4 groups by breed to which treatments were randomly applied in duplicate. Treatments were: US (unshorn) and SH (shorn) during mid lactation at mild winter conditions. Diets consisted of alfalfa hay ad-libitum and concentrate rationed individually at milking according to breed and requirements (MN, 0.45 kg/d; LC, 0.65 kg/d). Ewes were in straw-wood chips bedded pens and the ambient temperatures were mild before (12.6 ± 0.9°C) and after (13.0 ± 0.3°C) shearing. Fleece weight was greater in shorn MN than LC (1.04 ± 0.10 vs. 0.75 ± 0.09 kg/ewe). As a result of shearing, rectal temperature decreased in the MN-SH ewes, when compared to the MN-US (38.51 ± 0.11 vs. 38.88 ± 0.12°C, respectively), but did no vary in the LC ewes (38.57 ± 0.08°C). No differences were detected in the fill value of

Table 1251.

Table 1. Effect of feeding strategies on milk production and composition

Variables	TMR	GR-one	GR-two	SED	T	W	T*W
Milk yield (L/d)	35.9^{a}	30.8^{b}	29.7^{b}	0.816	P<0.01	P<0.01	P<0.01
Fat (%)	3.25^{b}	3.67^{ab}	3.72^{a}	0.175	P<0.05	P<0.05	NS
Fat yield (kg/d)	1.24	1.13	1.13	0.078	NS	NS	NS
Protein (%)	3.24	3.40	3.35	0.079	NS	P<0.001	NS
Protein yield (kg/d)	1.27^{a}	1.06^{b}	1.02^{b}	0.055	P<0.01	NS	NS
Lactose (%)	4.80	4.75	4.78	0.041	NS	P<0.01	P<0.01
Lactose yield (kg/d)	1.87^{a}	1.52^{b}	1.45^{b}	0.080	P<0.01	NS	NS
Energy (Mcal/d)	25.7^{a}	21.8^{b}	22.0^{b}	1.20	P<0.01	NS	NS

Mean within a row with different superscript differ (Tukey; $p < 0,05$)
TMR= No grazing; GR-one= one grazing session; GR-two= two grazing sessions; SED= SE of the difference; T= treatment; W= week; T*W= interaction T*W.
Energy= energy in milk: (0.0929*Fat (kg/d) + 0.0547*Protein (kg/d) + 0.0395*Lactose (kg/d)) * 100.

the alfalfa hay, expressed as French sheep fill units (SFU), between sheep breeds (0.97 ± 0.03 SFU/kg DM). Lactational responses to shearing during milking varied according to breed, the results in LC being more marked than in MN ewes. Feed intake increased 5% in the LC-SH, when compared to LC-US, but did not vary in the MN ewes. Moreover, the LC-SH ewes yielded 10% more milk than LC-US ewes, but no differences were detected in the MN ewes. There were no differences in milk composition between US and SH ewes in both breeds. The milk protein and lactose yields were higher for LC-SH than LC-US ewes (20% and 17%, respectively) agreeing with the milk yield increase. No effects of shearing were detected on metabolic (glucose, NEFA) and hormonal (cortisol, insulin) plasma values, as well as on BW and BCS changes. In conclusion, shearing lactating ewes during winter, under moderate cold conditions, is a suitable management option for improving feed intake and milk production of high-yielding dairy ewes, without deleterious effects neither on physiological indicators nor milk composition regardless their production level.

Key Words: dairy sheep, shearing, lactation, milk yield, milk composition

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1253 Evaluation of different synchronization and early pregnancy diagnosis methods in postpartum Holstein cows. A. H. Shahzad*[1], A. Sattar[2], I. Ahmad[3], A. Y. Qamar[3], and N. Ahmad[3], *[1]University of Veterinary and Animal Sciences, Lahore, LAHORE, Pakistan, [2]Department of Theriogenology, University of Veterinary and Animal Sciences, Lahore, Pakistan, [3]University of Veterinary and Animal Sciences, LAHORE, Pakistan.*

Objectives were to appraise the pregnancy rate (PR) after G7G-Ovsynch and Ovsynch protocol as well as accuracy of Pregnancy Associated Glycoproteins (PAGs) in milk, plasma, and plasma P4 in comparison with ultrasonography as gold standard pregnancy diagnosis (PD) method. In experiment 1, Holstein cows (n = 37) were bred by G7G-Ovsynch protocol (n = 19) or MG7G-Ovsynch (PG-8h-PG in Ovsynch). Pregnancy was evaluated by ultrasonography (US) at Days 31, 59, and 87 after breeding. Blood plasma and Milk samples were collected on Day 3 after insemination and at weekly intervals either 1) through Day 59 PTAI in open cows on d31 or 2) through Day 87 if the cow was found pregnant. The PAGs were measured by using ELISA and P4 by RIA. These PAGs classified samples either open or pregnant. In experiment 2, Lactating cows (n = 212) were bred by TAI following G7G-Ovsynch protocol (n = 110) or standard Ovsynch. Cows were subjected to PD on Day 30, 60, and 90 PTAI. Subset (n = 15 in each group) was subjected to blood plasma and milk samples on Day 30, 45, 60, 75, and 90 for PAGs and P4 profile. Pregnancy rate was compared by chi square. Effect of treatment on BCS, Plasma PAGs and P4 profiles were calculated by GLM procedures of SAS. Association of P4 with Plasma Milk PAGs was calculated using REG procedures of SAS (P < 0.05). In experiment 1, PR was 47% compared with 53% for G7G-Ovsynch versus MG7G-Ovsynch, respectively on d 31 post-TAI. On d 59 and 87, PR was recorded as 37% in G7G-Ovsynch group in comparison with MG7G-Ovsynch group (33%). In experiment 2, PR was 52% versus 42% (P = 0.159) on d 30,45% versus 37% (P = 0.226) on d 60, and 44% versus 36% on d 90 with overall pregnancy loss of 16% and 14% in G7G-Ovsynch and Ovsynch, respectively. In milk PAGs method sensitivity was 100%. Positive predictive value (PPV) was 92%. Negative predictive value (NPV) was 100% (P < 0.05). Sensitivity of plasma PAGs was recorded as 98% with 92% PPV and 83% NPV. Sensitivity of plasma P4 was 98% with 98% PPV and 89% NPV. There was positive correlation among P4 profile and PAGs concentration in both milk and plasma.Other parameters including BCS, cyclicity, and parity did not show any impact on pregnancy neither independently nor in interaction with treatment. In conclusion, although non-significant, increase in PR in G7G-Ovsynch makes it a protocol of choice in postpartum cows and PAGs as PD tool either in milk or plasma is as feasible as ultrasonography.

Key Words: G7G-Ovsynch, Pregnancy Associated Glycoproteins, milk sample, blood plasma, ultrasonography, pregnancy rate

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1254 WS Effects of octacosanol on non-seasonal spermatogenesis in ovine. J. W. Dickison*, *Angelo State University, San Angelo, TX.*

This study was conducted to understand the benefits of utilizing octacosanol as an additive to increase fertility of rams during the non-seasonal time of the year. Rams of Suffolk and Rambouillet influence were placed on a 60-d trial to determine the value of octocasanol as a feed supplement to promote semen production through the summer months. Rams were randomly divided into 2 groups of mixed breeds. Treatment group was fed a balanced ration containing 0.25% octocasanol per ton, while control rams were fed identical ration with no added octocasanol. Rams were fed at the rate of 6 lbs a day with alfalfa hay supplementation 3 times a week. Final collection was June 27 when ambient stress is generally at its highest point. Semen characteristics such as scrotal circumference, volume, concentration, and motility were used in the evaluation of the success of the product. Scrotal circumference (SC) measurements taken at onset of project to final showed no significant differences among control or treatment (P = 0.21) respectively although, the treatment group saw a larger increase in SC when compared to control (0.81 ± .01, 0.31 ± .01), respectively. Volume of ejaculate of both treatment and control also showed no significant difference from initial to final collection (P = 0.13) although as SC in the middle of summer the treatment group did show some increase when compared to control (0.32 ± .01, −0.60 ± .01 respectively). The same progressions were observed with concentration and motility of ejaculates

from beginning to final collection although again there was no significance ($P = 0.51$, $P = 0.34$ respectively). Concentration of ejaculate from treatment, again showed some increase from the control rams (2.32×10^9, -1.28×10^9 respectively). Like the previous measurements, motility also showed an increase from the treatment group when compared to the control rams (0.31×10^9, -0.27×10^9 respectively). Rams fed octacosanol for 60 d tended to have larger scrotal circumference, produced larger ejaculates with greater volume and sperm concentrations than control rams during the harshest period of the year for these parameters.

Key Words: Octacosanol, spermatogenesis, ovine

1255 WS Winter grazing or confinement feeding heifer development strategies differ in energetics as measured by 24 h heart rate and activity.

M. K. Petersen*[1], J. M. Muscha[2], and A. J. Roberts[1], *[1]USDA-ARS Fort Keogh Livestock and Range Research Laboratory, Miles City, MT, [2]Fort Keogh Livestock & Range Research Laboratory, Miles City, MT.*

The ability of a heifer to thrive is partially due to traits including behavioral/metabolic adaption and genetic background. Type of weaning and development program implemented creates an environment replacement heifers must adapt to flourish. This study was designed to determine if heifers developed in confinement or grazing native range use different adaption and coping processes by measuring activity such as distance traveled and percent resting time in 24 h along with resting heart rate and average heart rate per day. Spring-born, crossbred heifers were stratified to 1 of 2 treatments at weaning (start of Period 1): (1) fence-line weaning on native range (NR) with self-fed salt-mineral protein supplement ($n = 118$) and after weaning received a hand fed daily energy supplement or a self fed protein supplement, or (2) weaned into a dry lot (DL) and fed a corn silage diet formulated to gain 0.68 kg/d ($n = 53$). Ad libitum grass hay was made available in mid-December due to snow coverage resulting in range forage inaccessibility. Heifer BW were taken every 28 d from initiation of weaning. Each month (except February and June) a cohort of 7 heifers from each treatment were fitted with equine heart rate monitors (Polar Equine RS800CX) and QSTARZ CR-Q1100P GPS tracking recorder. Data were recorded for 48 h. On April 9, 2014 (Period 2) the two supplement groups grazing NR and DL heifers were combined into a common pasture. Heifers receiving DL had greater ($P < 0.01$) BW throughout the entire study. Resting heart rate was influenced ($P < 0.01$) by an interaction of period and weaning/development management. The rankings of resting heart rate were reversed from period 1 to period 2. Resting heart rate was also shown to influence BW. Resting heart rate relationship with BW was negative suggesting that lower resting heart rate is related greater BW. The analysis suggests that for every 2.2 decline in resting HR there is an additional 0.45 kg of BW. This study indicates that resting heart is negatively related to BW implying that animals with lower resting heart rate may have a production advantage.

Key Words: beef heifers, heart rate, heifer development

1256 WS Effects of dietary phytoestrogens on testicular growth and semen quality characteristics in developing Angus bulls.

S. C. Yurrita*, *Angelo State University, San Angelo, TX.*

This study investigated the impact of scrotal growth and semen quality parameters of bulls consuming dietary phytoestrogens versus bulls that are not exposed to phytoestrogen-containing diet ingredients. Angus bulls born in consecutive years were used in 2 independent trials. Bulls born in the spring of 2014 ($n = 39$) and 2015 ($n = 24$) were stratified by weaning weight, age of dam (AOD), and sire into a soybean meal diet group (SBMTRT) or a cottonseed meal diet group (CSMCON). At weaning (d −42), bulls were assigned to treatment and adapted to concentrate diets. At d 0, 21, 54, and 86 scrotal circumference measures were collected with semen collection and assessment also being conducted at d 86. Differences in scrotal circumference were detected due to the diet × day (year) interaction. On d 54 and 86, SBMTRT in 2014 exhibited larger scrotal measures than SBMTRT in 2015 ($P \leq 0.05$). At d 54, SBMTRT scrotal measures were also greater than the CSMCON scrotal measures in 2015 ($P = 0.05$). Scrotal growth from d 0 to 21 was greater for SBMTRT across both years ($P < 0.0001$). This pattern of larger teste growth was also observed from d 54 to d 86 ($P = 0.05$), and from d 0 through d 86 ($P < 0.0001$). Variation in semen concentration was due to the diet × AOD (year) interaction. The SBMTRT, produced from 2-yr old females, expelled higher concentrated semen samples in 2014 ($P = 0.026$) and 2015 ($P = 0.0006$), and this was inconsistent with the 2015 CSMCON out of 5+ year old cows who were higher for semen concentration ($P < 0.0001$). The diet × AOD (year) interaction was also a source of variation for motility. The 2014 bulls from 2 and 5+ year old cows ranked higher than the CSMCON cohorts of like aged cows ($P < .0001$). This trend was not evident in 2015 however, as the CSMCON mean was greater than the SBMTRT from 3 yr old cows only ($P = 0.0129$). Variation from the effect of diet for motility was also observed as well, as SBMTRT scored higher than CSMCON ($P = 0.0308$). These data suggest that dietary phytoestrogens at 10% soybean meal diet inclusion improves scrotal growth and semen quality and this is particularly evident in bulls produced by 2-yr old, first calf females.

Key Words: bull development, phytoestrogen, semen quality

1257 Reproductive performance of lactating dairy cows managed for first service with the Double-Ovsynch or Presynch-Ovsynch protocol and different duration of the voluntary waiting period.
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Our objective was to investigate time to pregnancy of dairy cows during lactation after submission for first AI service with three different treatments. Holstein cows (522 primiparous and 870 multiparous) from a commercial farm were stratified by parity and total milk production in their previous lactation (multiparous only) and randomly allocated to receive timed AI (TAI) after the Double-Ovsynch protocol (DO; GnRH-7d-P-GF-3d-GnRH-7d-GnRH-7d-PGF-56h-GnRH-16h-TAI) at 60 ± 3 DIM (DO60 = 476), TAI after DO at 88 ± 3 DIM (DO88 = 431), or a combination of insemination after detected estrus and TAI with the Presynch-Ovsynch protocol (PGF-14d-P-GF-12d-GnRH-7d-PGF-56h-GnRH-16h-TAI; PSOv = 485). Cows in the PSOv group received AI to estrus (AIE) after the second PGF treatment given at 50 ± 3 DIM or TAI at 72 ± 3 DIM. Subsequent AI services occurred through AIE or TAI after the Ovsynch protocol (32 ± 3 d after AI-GnRH-7d-PGF-56h-GnRH-16h-TAI). Pregnancy outcomes were determined using transrectal ultrasonography at 35 ± 3 and 94 ± 3 d after AI. Time to pregnancy up to 350 DIM was analyzed using Cox's regression whereas pregnancies per AI, pregnancy loss, and cows nonpregnant at 350 DIM were analyzed by logistic regression. Hazard of pregnancy was greater ($P < 0.01$) for DO60 [HR = 1.50 (95%CI = 1.29 to 1.74)] and PSOv [HR = 1.37 (95%CI = 1.18 to 1.59)] than for DO88 but it was similar ($P > 0.10$) for DO60 and PSOv [HR = 1.10 (95%CI = 0.95 to 1.26)]. Median days to pregnancy were 97, 117, and 98 for DO60, DO88, and PSOv, respectively. Hazard of pregnancy was greater ($P < 0.01$) for primiparous than multiparous cows [HR = 1.44 (95%CI = 1.27 to 1.62)]. The percentage of cows nonpregnant at 350 DIM was similar ($P = 0.16$) for the 3 groups (9.9, 13.8, and 12.6% for DO60, DO88, and PSOv). First service pregnancies per AI were similar ($P = 0.24$) for the 3 groups (DO60 = 41.4% [$n = 454$], DO88 = 44.1% [$n = 397$], PSOv = 38.2%; [$n = 461$]) but greater ($P < 0.01$) for cows that received TAI (45.2% [$n = 188$]) than AIE (33.3% [$n = 273$]) in the PSOv group. Pregnancy loss was similar ($P = 0.80$) among groups (DO60 = 5.9%, DO88 = 7.4%, and PSOv = 7.4%). We conclude that time to pregnancy was reduced when cows received TAI at 60 DIM after the Double-Ovsynch protocol or a combination of AIE after 50 DIM and TAI at 72 DIM with the Presynch-Ovsynch protocol than when cows received TAI at 88 DIM after the Double-Ovsynch protocol. Despite differences in time to pregnancy, the percentage of cows nonpregnant at 350 DIM was similar for the 3 groups. Supported by New York Farm Viability Institute project AOR13006.

Key Words: Double-Ovsynch, Presynch-Ovsynch, dairy cow

1258 Estrus detection intensity and accuracy, and optimal timing of insemination with automated activity monitors for dairy cows.
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The objectives were to assess: the ability of automated activity monitoring (AAM) to detect estrus for first insemination; the accuracy of detection; and the optimum interval from the onset of estrus to insemination. Four commercial farms were studied over 1 yr; 2 employed the AfiAct (Afikim) system and 2 the Heatime HR (SCR Inc.) system. Cows were inseminated between 55 and 80 DIM based on AAM only, then supplemented with timed AI (TAI). Blood progesterone was measured in 1,014 cows at weeks 5, 7, and 9 postpartum; purulent vaginal discharge (PVD) was assessed at week 5 and lameness and BCS at week 7. Overall, AAM detected 83% of cows in estrus by 80 DIM. Cows that had 3 serum P4 < 1 ng/mL, had PVD, or were both lame and had BCS $\leq$ 2.5 were less likely to be detected in estrus by 80 DIM (62, 68, 53%, respectively). Blood samples were collected on the day of 445 AI based on AAM and 323 TAI. The proportion of cows not in estrus (P4 > 1 ng/ml) on the day of AI was similar ($P = 0.35$) between AAM (4 ± 1.8%) and TAI (3 ± 1.2%). Activity data were extracted from AAM software for 1454 AI. Onset of estrus was calculated using the same (AfiAct) or similar (for the proprietary SCR algorithm) criteria as the AAM system. Producers recorded the time of AI. The interval from onset of estrus to AI was categorized as 0 to 8, 8 to 16, or > 16 h. There was no effect of AAM system on the probability of pregnancy per AI, but there was an interaction of interval with parity. For multiparous cows, the probability of pregnancy per AI was 31%, which did not differ ($P = 0.7$) with the interval to AI. For primiparous cows, the odds of pregnancy were greater if AI occurred 0 to 8 h (49%) than 8 to 16 h (36%) or > 16 h (31%) after the onset of estrus. AAM can detect estrus for first AI in just over the length of 1 estrus cycle for over 80% of cows, but the remainder would likely require intervention. For multiparous cows, performing AI based on AAM once per day would not affect pregnancy per AI, but for primiparous cows AI within 8 h of the onset of estrus may be advantageous.

Key Words: reproduction, management

1259 Beta-hydroxybutyrate concentration influences conception date in young beef cows in Tennessee.

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Selection for increased maternal traits like milk production in beef cattle may decrease reproductive efficiency due to increased metabolic load of lactation resulting in metabolic dysfunction. Therefore, our objective was to analyze the association of milk production, serum metabolites, cow BW change, and calf performance with time of conception in 183 spring-calving beef cows. Cows were classified by conception date as cows conceiving by timed-AI (TAI) or natural breeding (NAT). In addition, cows were grouped by age to represent young (3-and 4-yr-old), mature (5- and 6-yr-old), and old (7- to 9-yr-old) cows. Starting approximately d 30 postpartum, cow BW and BCS were recorded and blood samples were collected weekly through the end of breeding. Serum samples were aliquoted into pre-breeding and breeding composites then analyzed for metabolites. Cow BW and BCS did not influence ($P > 0.40$) conception date. Similarly, calf performance did not influence ($P > 0.30$) conception date. An age group × treatment interaction ($P < 0.01$) occurred for serum β-hydroxybutyrate (BHB). Serum BHB concentrations for mature and old cows were similar ($P > 0.05$) regardless of conception date. However, serum BHB concentrations for young NAT cows were greater ($P < 0.01$) than young cows conceiving at timed-AI. Serum non-esterified fatty acids (NEFA) exhibited ($P < 0.05$) a conception date × sampling period interaction. Pre-breeding serum NEFA concentrations were greater ($P < 0.05$) for NAT cows than TAI cows. Contrarily, serum NEFA concentrations during breeding were similar ($P > 0.05$) regardless of conception date. Serum glucose and urea N concentrations were not different ($P > 0.23$) between cows conceiving by timed-AI or natural service. Results from this study indicate that only the young, postpartum beef cows during early lactation were susceptible to metabolic dysfunctions and elevated blood BHB concentrations causing a delayed time to conception.

Key Words: beef cattle, β-hydroxybutyrate, conception time

1260 Heifer development using stockpiled, dormant native forages delays gain without altering reproductive performance.

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Winter grazing utilizing stockpiled forages is an economical alternative to feeding harvested feedstuffs during heifer development. However, development on stockpiled forages may have a negative impact on productivity due to restricted growth during a key physiological period. Therefore, our objective was to determine growth rate, nutritional status and reproductive performance of yearling heifers grazing differing stockpiled forages. Spring-born, crossbred heifers ($n = 155$) were stratified by BW at weaning to 1 of 3 stockpiled forage types: 1) endophyte-infected tall fescue (TF; 7.51% CP and 65.82% NDF, DM basis) 2) big bluestem and indiangrass combination (BI; 4.54% CP and 69.74% NDF, DM basis), or 3) switchgrass (SG; 4.23% CP and 75.77% NDF, DM basis). Each year, grazing began in January and was terminated in April at the onset of a 60-d breeding season. Heifers were fed twice per week at a rate of 0.18 kg·heifer^{-1}·d^{-1} of CP and were managed together before and after the grazing period. Heifer BW was obtained monthly from initiation of grazing until breeding and again at overall pregnancy diagnosis in September. Blood samples were collected 10 d prior and the day of timed-AI for serum metabolite analysis. Initial BW was not different ($P = 0.72$) among forage types. However, ADG from January to March was lower ($P < 0.01$) in heifers grazing BI and SG pastures. From March to April, ADG was not different ($P = 0.56$) among forage types. However, from April until September, heifers grazing both BI and SG pastures compensated and outgained ($P < 0.01$) heifers developed on stockpiled tall fescue pastures. Overall, heifers developed on TF pastures did have greater ($P < 0.01$) BW at final pregnancy detection. Circulating serum glucose concentration did not differ ($P = 0.19$) irrespective of forage type. Forage type × year interactions ($P < 0.05$) were exhibited for circulating NEFA and serum urea N concentrations. Serum β-hydroxybutyrate concentrations did not differ ($P = 0.15$) among forage types. Although BI and SG heifers exhibited restricted growth early in development, timed-AI pregnancy rates were 66, 51, and 59% for TF, BI, and SG heifers ($P = 0.40$), respectively. In addition, final pregnancy rates were 93, 92, and 87% for TF, BI, and SG heifers ($P = 0.56$), respectively. These results indicate that stockpiling native warm-season forages for winter grazing during heifer development delayed gain without reducing reproductive competence.

Key Words: beef heifers, heifer development, stockpiled forages

1261 Effect of pre- and postnatal trace mineral (TM) source on Angus and Brangus heifer growth and body composition. D. M. Price*[1], M. M. O'Neil[1], W. B. Watson III[1], R. West[2], D. O. Rae[2], D. M. Irsik[2], M. J. Hersom[1], and J. V. Yelich[1], *[1]Department of Animal Sciences, University of Florida, Gainesville, [2]College of Veterinary Medicine, University of Florida, Gainesville.*

A 2 by 2 factorial design evaluated growth and body composition in Angus (n = 40) and Brangus (n = 40) heifers born to cows supplemented with either inorganic (n = 40, 20/breed) or organic (n = 40, 20/breed) TM sources. The TM was initiated 82 ± 2 d pre-calving and resultant calves were weaned, and blocked by maternal TM source, age, sire, and weaning BW, and randomly assigned to 10 pens (5 pens/TM) for a 168 d development period. The TM supplement was pen fed 3 d/wk at 0.4 kg·454 kg BW-^{1}·heifer-^{1}·d-^{1}. Heifer BW and BCS (scale 1 to 9) were collected every 28 d. Ultrasound LM area (LMA), 12th rib back fat thickness (FAT), and LM intramuscular fat percentage (IMF) were recorded every 84 d. Statistical analysis used heifer as the experimental unit and repeated measures PROC MIXED to analyze BW, BCS, and ultrasound measurements. Fixed effects included TM, breed, day, and interactions. Results are presented as LSM ± pooled SE. At trial start, BW did not differ (P > 0.05) by TM or breed in inorganic, organic, Angus or Brangus (217, 224, 218, 223 ± 3 kg, respectively) heifers; however, organic and Brangus heifers had greater ($P \leq 0.01$; 4.6 ± 0.04) BCS than inorganic and Angus (4.4 ± 0.04). On d 84, organic (276 ± 4 kg) had greater ($P \leq 0.05$) BW than inorganic (261 ± 4 kg) heifers, while Angus and Brangus BW did not differ (P > 0.05). The BCS did not differ (P > 0.05) by TM or breed on d 84 (4.9 ± 0.04) and d 168 (5.4 ± 0.1). On d 168, BW did not differ (P > 0.05) by TM or breed in inorganic, organic, Angus, or Brangus (328, 338, 329, 337 ± 5 kg, respectively) heifers. No TM, breed, or interaction affected (P > 0.05) the 168 d ADG. The TM had no effect (P > 0.05) on IMF, FAT, or LMA. Breed did not affect (P > 0.05) FAT. Angus had greater ($P \leq 0.05$) IMF, but lesser LMA ($P \leq 0.01$) than Brangus (4.80 vs. 3.44 ± 0.12% and 43.99 vs. 49.67 ± 0.89 cm^2, respectively) when pooled across days. The TM source administered to cows during the last 1/3 of gestation did not affect heifer BW, BCS, or body composition over a 168 d post-weaning development period.

Key Words: heifers, trace minerals, performance, ultrasound

1262 Effect of pre- and postnatal trace mineral (TM) source on Angus and Brangus heifer growth and reproductive performance. D. M. Price*[1], M. M. O'Neil[1], W. B. Watson III[1], R. West[2], D. O. Rae[2], D. M. Irsik[2], M. J. Hersom[1], and J. V. Yelich[1], *[1]Department of Animal Sciences, University of Florida, Gainesville, [2]College of Veterinary Medicine, University of Florida, Gainesville.*

A 2 by 2 factorial design evaluated reproductive performance in Angus (n = 40) and Brangus (n = 40) heifers born to cows supplemented with either inorganic (n = 40, 20/breed) or organic (n = 40, 20/breed) TM sources. The TM was initiated 82 ± 2 d pre-calving and resultant calves were weaned, and blocked by maternal TM source, age, sire, and weaning BW, and randomly assigned to 10 pens (5 pens/TM) for a 168 d development period. On d 161 and 168, blood samples were collected to determine pubertal status (puberty = progesterone $\geq$ 1.5 ng/mL at one of two samples). A BW, BCS (Scale 1 to 9), and reproductive tract score (RTS, 1 to 5) were recorded and heifers were sorted by breed and TM source into 4 pastures (1 pasture/TM × breed) on d 168 for a 72 d natural service breeding season. Pregnancy was determined by ultrasound on d 51 of breeding season and 28 d after bull removal. The TM supplement was pen fed 3 d/wk at 0.4 kg·454 kg BW^{-1}·heifer^{-1}·d^{-1} as a pellet during development and as loose mineral during breeding (88.8 g·heifer^{-1}·d^{-1}). Heifer was the experimental unit and analysis utilized PROC MIXED for BW, BCS, and RTS data and PROC GLIMMIX for pregnancy and pubertal status. Fixed effects included TM, breed, and interaction. On d 168, inorganic (328 ± 5 kg) and organic (339 ± 5 kg) did not differ (P > 0.05) in BW or BCS (5.4 ± 0.1). Heifer RTS tended (P = 0.10) to be greater for organic (3.3 ± 0.1) than inorganic (3.0 ± 0.1) and greater ($P \leq 0.01$) in Brangus (3.4 ± 0.1) than Angus (2.9 ± 0.1) on d 168. Pubertal status did not differ (P > 0.05) on d 168 for TM (Inorganic, 20% = 4/20; Organic, 20% = 4/20) and breed (Angus, 20% = 4/20; Brangus, 20% = 4/20). On d 51 of breeding, pregnancy rates did not differ (P > 0.05) between inorganic (45% = 18/40) and organic (63% = 25/40) but were greater ($P \leq 0.05$) in Brangus (65% = 26/40) than Angus (43% = 17/40). Final breeding season pregnancy rates did not differ (P > 0.05) between inorganic (87.5% = 35/40) and organic (95% = 38/40), or between Angus (93% = 37/40) and Brangus (90% = 36/40). The TM source affected RTS but not pubertal status at the start of breeding season in yearling Angus and Brangus heifers. Additionally, TM source did not influence pregnancy rates to a natural breeding.

Key Words: trace minerals, heifers, pregnancy rate

1263 Impacts of zinc, manganese, and copper source on mature bull trace mineral status and spermatozoa characteristics. A. L. Zezeski*[1], M. Van Emon[2], R. C. Waterman[3], B. Eik[1], J. S. Heldt[4], and T. W. Geary[5], *[1]USDA-ARS Fort Keogh LARRL, Miles City, MT, [2]Montana State University, Bozeman, MT, [3]USDA-ARS Fort Keogh Livestock and Range Research Laboratory, Miles City, MT, [4]Micronutrients, Indianapolis, IN, [5]USDA ARS Fort Keogh, Miles City, MT.*

Our objective was to measure impacts of trace mineral source on liver mineral status and spermatozoa characteristics in mature bulls. Thirty-seven bulls (682 ± 147 kg) of mixed breeds, 2 to 4 yr of age were used in a 71 d trial. Bulls were blocked by length of time without trace mineral supplementation and stratified by initial liver Cu status to one of three dietary treatments (4 pens/treatment): 1) Supplement without Cu, Zn, and Mn; 2) Supplement with Cu, Zn, and Mn sulfate (sulfate); and 3) Supplement with basic Cu chloride, Zn and Mn hydroxychloride (hydroxy). Liver biopsies were collected on d −73, −24, and 71 to determine trace mineral status. Supplements containing Cu, Zn, and Mn were fed at 75% of NRC requirements as top dressing to a feedlot (corn silage) diet. Semen collection and scrotal circumference measurements were collected on d 0, 36, and 70. Ejaculates were evaluated for spermatozoa concentration, motility, and morphology as part of a standard breeding soundness examination. Acrosome integrity, sperm viability, and mitochondrial membrane potential were evaluated via flow cytometry counting at least 5,000 sperm per ejaculate. The mixed procedure of SAS was used for statistical analysis. On d 71, liver Cu concentrations of bulls receiving hydroxy minerals were greater ($P = 0.008$) than bulls receiving no mineral supplement or sulfate minerals. Liver Zn concentrations tended to be greater ($P = 0.08$) in bulls receiving hydroxy minerals compared to sulfate minerals. All other trace minerals (Co, Mn, Mo, and Fe) were not different ($P \geq 0.16$) due to dietary treatments. Liver concentration of Cu increased ($P = 0.04$) from the d −24 to 71 biopsy in bulls receiving hydroxy mineral. No differences ($P \geq 0.17$) were observed in any other trace mineral concentrations between treatments from the d −24 to 71 liver biopsies. Bulls with greater liver Zn concentrations on d 71 were correlated ($r = -0.39$, $P = 0.02$) with less acrosome damaged spermatozoa and tended to be correlated with greater spermatozoa concentrations ($r = 0.31$, $P = 0.06$). We conclude that basic Cu chloride and Zn hydroxychloride is more bioavailable and more readily stored in the liver compared with Cu and Zn sulfate. Increased liver Zn concentrations may also improve acrosome integrity of bull spermatozoa. However, diets deficient in trace mineral for > 170 d had no other detrimental effects on semen quality of mature bulls.

Key Words: trace mineral, bull, spermatozoa

1264 WS Effects of early or conventional weaning on beef cow and calf performance in pasture and drylot environments. G. W. Preedy*[1], J. R. Jaeger[2], J. W. Waggoner[3], and K. C. Olson[1], *[1]Kansas State University, Manhattan, [2]Western Kansas Agricultural Research Center, Kansas State University, Hays, [3]Western Kansas Agricultural Research Center, Kansas State University, Garden City.*

Spring-calving beef cows (initial BW = 599 ± 54.5 kg; initial BCS = 5.5 ± 0.54) and calves (initial BW = 204 ± 26.7 kg; 153 ± 15 d of age) were assigned randomly to 1 of 4 weaning treatments: weaning at 153 d of age followed by 56 d of limit feeding in confinement (E-D), confinement of cow and calf together for a 56-d period of limit feeding followed by weaning at 209 d of age (C-D), weaning at 153 d of age followed by a 56-d grazing period (E-P), and a 56-d grazing period with cow and calf together followed by weaning at 209 d of age (C-P). Calves assigned to E-D and C-D were fed a concentrate-based diet at 2.5% of BW, whereas cows assigned to E-D were fed a forage-based diet at 1.6% of BW. Cows assigned to C-D were offered the diet fed to E-D cows at 2.0% of BW. All cows and calves were limit fed common diets for 7 d at the end of our study to equalize gut fill. Calves ADG were influenced by diet and weaning treatments ($P \leq 0.03$). In general, calves managed in confinement and fed concentrate-based diets (i.e., E-D and C-D) had greater ADG than unsupplemented calves maintained on pasture (i.e., E-P and C-P). Cow BW and BCS change (d 0 to 63) were influenced by diet and weaning status ($P \leq 0.05$). Non-lactating cows maintained on pasture had lesser BW loss than other treatments, whereas non-lactating cows fed in confinement had lesser BCS on d 63 and greater BCS loss from d 0 to 63 than other treatments. Conversely, rump-fat depth on d 63 was greater ($P < 0.01$) for non-lactating cows maintained on pasture than for lactating cows in either pasture or drylot environments. Similarly, change in rump-fat depth was greatest ($P < 0.01$) for non-lactating cows on pasture and least for lactating cows in both pasture and drylot environments. Results were interpreted to indicate that weaning at 153 d of calf age spared cow BW and rump fat compared to weaning at 209 d of calf age. Performance of cows appeared to be similar when either limit-fed under drylot conditions or pastured without supplement. Conversely, calf performance was greater in confinement than on pasture.

Key Words: beef cows, concentrate, early weaning, pasture

1265 Association between management practices and reproductive performance of lactating dairy cows.
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It is common to observe great variation in reproductive performance among dairy herds; which ultimately impacts profitability. The objective was to assess the association of pre- and post-partum management practices with the annual average 21-d pregnancy rate (PR) in lactating dairy cows. A survey instrument was developed to collect information on herd demographics (e.g., breed, size, facilities), management practices for replacements and cows (e.g., housing, feeding, criteria to initiate breeding), reproductive program and performance (e.g., PR), health management (e.g., written protocols), and personnel (e.g., training, frequency, turnover). Multivariable regression and CORR models were performed using SAS. Information was collected from approximately 17,008 lactating dairy cows distributed in 41 herds in Argentina. The most predominant breed of cows was Holstein (> 85%) with an average herd size of 414 cows (ranged from 78 to 2,300). The average PR was 17% (ranged from 5 to 31.5%) and the voluntary waiting period (VWP) was 54 d (ranged from 40 to 70 d). The reproductive programs utilized (estrus detection, timed-AI, or bull) were not significantly associated with PR. The 21-d PR was positively correlated with prevention of hypocalcemia in prepartum cows (r = 0.36, P = 0.03), personnel training (primarily on reproductive program and AI technique; r = 0.57, P = 0.0006), an established VWP $\geq$ 50 d (r = 0.59, P = 0.0001), defined criteria (body weight, age, and reproductive tract score) to initiate breeding in replacement heifers (r = 0.47, P = 0.002), and availability of written protocols at the farm (yes vs. no; r = 0.37, P = 0.01). These management practices accounted for more than 52% of the observed variation in PR. There was considerable variation in PR (about 26.5% points) that could be attributed, at least in part, to pre- and post-partum management practices among herds. The most important reasons for increased annual PR were associated with a program for replacement heifers (4.6% points increase), prevention of metabolic diseases early in lactation (4.2% points increase), and training of dairy personnel responsible for breeding cows (5.6% points increase).

Key Words: dairy, management, reproduction

1266 Association between management practices and dairy herd performance.
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It is common to observe large variation in milk yield among herds; which ultimately impacts profitability. The objective was to assess the association of pre- and post-partum management practices with average milk yield (kg/cow/d) of 41 dairy herds in Argentina. A survey instrument was developed to collect information on herd demographics (e.g., breed, size, facilities), management practices for replacements and lactating cows (e.g., housing, feeding, milking frequency), reproductive management of replacements and lactating cows (e.g., breeding methods, criteria to initiate breeding), herd performance (e.g., milk yield) and health management (e.g., written protocols), and personnel (e.g., training, turnover). Multivariable regression and CORR models were performed using SAS. Information from approximately 17,008 lactating dairy cows distributed in 41 herds was collected. The most predominant breed of cows was Holstein (> 85%) with an average herd size of 414 cows (ranged from 78 to 2,300). The average milk yield per cow was 29.5 kg/d (ranged from 12.6 to 33.8 kg/d). The average daily milk yield was positively correlated with housing (confinement vs. grazing) for lactating cows (r = 0.46, P = 0.02), milking frequency (2 vs. 3 times per d; r = 0.67, P = 0.0003), availability of written protocols at the farm (yes vs. no; r = 0.52, P = 0.008), personnel training (yes vs. no; r = 0.54, P = 0.006), water analysis (yes vs. no; r = 0.68, P = 0.0002), and defined criteria (body weight, age, and reproductive tract score) to initiate breeding in replacement heifers (r = 0.50, P = 0.01). These management practices accounted for more than 54% of the observed variation in the average daily milk yield of lactating cows. There was a considerable variation in milk yield (about 21.2 kg/cow/d) that could be attributed to different diets and management practices among herds. The most important reasons for increased milk production were associated with training of dairy personnel (primarily on TMR and feed bunk management; ~5.5 kg/cow/d) and defined criteria (~5.4 kg/cow/d) to initiate breeding in replacement heifers.

Key Words: dairy, management, milk yield

1267 Impacts of early lactation hyperketonemia on reproduction and 305-d milk production.
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Hyperketonemia is a common early lactation disorder. Analysis of β-hydroxybutyrate (BHBA) by Fourier transform infrared spectroscopy in DHI milk samples provides a rapid and low-cost herd-level monitoring tool to evaluate the prevalence of hyperketonemia. The objective of this study was to evaluate the impact of elevated BHBA concentrations in early lactation DHI samples on reproduction and 305-d milk and component yields. Test-day and lactation records from 220,939 Holstein cows (114,267 primiparous and 106,672 multiparous) were used. All cows in the dataset had BHBA concentration on first test-day between 5 and 35 DIM. The following thresholds were used to classify cows based on milk BHBA concentration in early lactation: < 0.15 mmol/L = Negative (NEG); 0.15 to 0.19 mmol/L = Suspect (SUSP); and ≥ 0.20 mmol/L = Positive (POS), based on a previously published trial comparing milk and blood BHB concentrations. The MIXED procedure of SAS was used to evaluate the impact of BHBA classification on reproduction and production outcome. Cows with high BHBA concentration in early lactation had longer calving to first service and first service to conception intervals, increased days open, more services per conception, and lower 56d nonreturn rate. Cows with high BHBA concentration in early lactation produced higher 305-d milk and fat yields, but lower 305-d protein yields. Overall, trends were similar for primiparous and multiparous cows. Results indicate that hyperketonemia negatively impacts reproduction, but suggest higher producing cows are more affected. Monitoring and prevention strategies to reduce the prevalence of hyperketonemia in early lactation could result in improved reproduction and potential benefits on lactation milk yield.

Key Words: BHB, DHI, Reproduction

1268 Reproductive performance and culling dynamics of lactating dairy cows with detected pregnancy loss.
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Our objective was to evaluate the reproductive performance and culling dynamics of dairy cows that lose their pregnancy after an initial pregnancy examination. Individual cow records (AI dates, AI outcomes, and date of sale or death) were collected from five commercial farms. In all farms cows received AI after detected estrus and timed AI. Pregnancy outcomes after AI were determined using transrectal ultrasonography or rectal palpation at 32 ± 3 (*n* = 3 farms) or 39 ± 3 d (*n* = 2 farms) after AI. Pregnancy reconfirmation was conducted at 63 ± 3 (*n* = 1 farm), 90 ± 3 (*n* = 3 farms), or 100 ± 3 d (*n* = 1 farm) after AI. Cows with at least one pregnancy loss (PL) event were included in the PL group (PLG; *n* = 893) and cows with no PL recorded were included in the no PL group (NoPLG; *n* = 7856). Pregnancies per AI (P/AI) and PL were determined for inseminations preceded (*n* = 627) or not (*n* = 14,619) by a PL event for cows in the PLG and NoPLG combined. Dichotomous and time to event outcomes were analyzed using logistic regression and Cox's regression, respectively. Only cows that reached 150 d of gestation were considered pregnant for the analysis of time to pregnancy and P/AI. Hazard of pregnancy until 400 DIM was greater ($P < 0.001$) for NoPLG than PLG (HR = 4.2; 95%CI = 3.8 to 4.6). Median time to pregnancy was 114 and 324 d for NoPLG and PLG, respectively. Hazard of pregnancy was also greater ($P < 0.001$) for primiparous than multiparous cows (HR = 1.3; 95%CI = 1.2 to 1.4). The percentage of cows pregnant by 400 DIM was greater ($P < 0.001$) for the NoPLG (72.3%) than PLG (47.6%) and for primiparous (79.5%) than multiparous (64.3%) cows ($P < 0.001$). Pregnancies per AI were greater ($P < 0.001$) for AI services preceded (35.6%) than not preceded by PL (29.1%). Nevertheless, more cows ($P < 0.001$) underwent PL for AI services preceded (21.9%) than not preceded by PL (11.6%). Hazard of leaving the herd tended to be greater ($P = 0.08$) for the PLG than NoPLG (HR = 1.1; 95%CI = 0.9 to 1.2). More cows left the herd ($P < 0.001$) by 400 DIM for the PLG (39.5%) than NoPLG (30.9%) and the multiparous (46.7%) than the primiparous (20.5%) group ($P < 0.001$). We conclude that cows that underwent PL had delayed time to pregnancy and were more likely to leave the herd. Also, P/AI and PL for AI services preceded by PL were greater than for AI services not preceded by PL. Supported by USDA NIFA Multistate project NYC-127813.

Key Words: Pregnancy loss, reproductive performance, culling dynamics

1269 Profitability of dairy cows receiving first service timed artificial insemination after the Double-Ovsynch protocol with a voluntary waiting period of 60 or 88 d.
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Our objective was to evaluate the profitability of dairy cows receiving first service timed artificial insemination (TAI) after a voluntary waiting period (VWP) of 60 or 88 d. Holstein cows from 3 commercial farms received TAI after the Double-Ovsynch protocol (GnRH-7d-PGF-3d-GnRH-7d-GnRH-7d-PGF-56h-GnRH-16h-TAI) at 60 ± 3 (SVWP = 1,365) or 88 ± 3 DIM (LVWP = 1275). Subsequent AI services were conducted after detected estrus or TAI (32 ± 3 d after AI-GnRH-7d-PGF-56h-GnRH-16h-TAI). Individual cow production and reproduction data was collected for an 18 mo period

(18MP) after calving. Only cows that calved ≥ 18 mo before the day of data collection for the current analysis were included in the 18MP evaluation (SVWP = 523 and LVWP = 520). Total profitability (TPROF; $/cow) for the experimental lactation (EL) and the 18MP was the aggregation of: income over feed cost (IOFC), reproductive cost (RPRC; EL only), replacement cost (REPLC), calf value (CF; 18MP only), and fixed cost (FXC). Time to pregnancy was analyzed using Cox's regression, whereas continuous and binomial outcomes were analyzed by linear or logistic regression, respectively. Hazard of pregnancy up to 350 DIM for the EL was greater ($P < 0.01$) for SVWP than for LVWP [HR = 1.35 (95%CI = 1.24 to 1.48)] with median days to pregnancy of 102 and 128 for SVWP and LVWP, respectively. During the EL, lactation length was greater ($P < 0.01$) for LVWP (308 ± 3 d) than for SVWP (297 ± 2 d) and the same proportion ($P = 0.14$) of cows were culled (SWVP = 29% vs. LVWP = 32%). During the EL, similar TPROF (SVWP = $1,982 ± 36 vs. LVWP = $2,051 ± 38; $P = 0.12$) and profitability per day of lactation (SVWP = $5.5 ± 0.2 vs. LVWP = $5.3 ± 0.2; $P = 0.71$) was observed. Specifically, IOFC was greater ($P = 0.01$) for LVWP ($3,146 ± 37) than SVWP ($3,033 ± 35), FXC was greater ($P < 0.01$) for LVWP ($770 ± 7) than SVWP ($743 ± 6). Conversely, RPRC was greater ($P < 0.01$) for SVWP ($66.1 ± 0.9) than LVWP ($61.6 ± 0.9) and REPLC was similar ($P = 0.25$) for SVWP ($242 ± 12) and LVWP ($270 ± 13). For the 18MP, similar TPROF (SVWP = $2,885 ± 77 vs. LVWP = $2,764 ± 78; $P = 0.31$) and profitability per day (SVWP = $5.4 ± 0.2 vs. LVWP = $5.1 ± 0.3; $P = 0.45$) was observed. Specifically, no differences were observed for IOFC ($4,353 ± 76 vs. $4,227 ± 79; $P = 0.26$), REPLC ($373 ± 23 vs. $408 ± 24; $P = 0.45$), CF ($81.6 ± 2.8 vs. $80.8 ± 2.8; $P = 0.96$), and FXC ($1,112 ± 16 vs. $1,073 ± 17; $P = 0.16$). Percentage of cows culled during the 18MP was similar ($P = 0.57$) for SVWP (48%) and LVWP (50%). We conclude that despite differences in reproductive performance and individual factors that affect profitability, there were no differences in profitability during the EL or an 18 mo period after calving for cows that received TAI after a VWP of 60 or 88 d.

Key Words: Profitability, Double-Ovsynch, dairy cow

1270 Profitability of dairy cows managed for first service with the Double-Ovsynch or Presynch-Ovsynch protocol and different duration of the voluntary waiting period. M. L. Stangaferro*, R. Wijma, M. Masello, G. E. Granados, and J. O. Giordano, *Department of Animal Science, Cornell University, Ithaca, NY.*

Our objective was to evaluate the profitability of dairy cows managed with 3 different strategies for first service. Holstein cows from a commercial farm were randomly allocated to receive timed AI (TAI) after the Double-Ovsynch protocol (DO; GnRH-7d-PGF-3d-GnRH-7d-GnRH-7d-PGF-56h-GnRH-16h-TAI) at 60 ± 3 DIM (DO60 = 476), TAI after DO at 88 ± 3 DIM (DO88 = 431), or a combination of insemination after detected estrus (starting at 50 DIM) and TAI with the Presynch-Ovsynch protocol (PGF-14d-PGF-12d-GnRH-7d-PGF-56h-GnRH-16h-TAI;PSOv = 485). Subsequent AI services were conducted after detected estrus or TAI (32 ± 3 d after AI-GnRH-7d-PGF-56h-GnRH-16h-TAI). Data was collected for an 18 mo period (18MP) after calving. Only cows that calved ≥ 18 mo before the day of data collection for the current data analysis were included for the 18MP evaluation (DO60 = 218, DO88 = 208 and PSOv = 217). Total profitability (TPROF; $/cow) for the experimental lactation (EL; all cows included) and the 18MP was the aggregation of: income over feed cost (IOFC), reproductive cost (RPRC; EL only), replacement cost (REPLC), calf value (CF; 18MP only), and fixed cost (FXC). Time to pregnancy was analyzed using Cox's regression, whereas continuous and binomial outcomes were analyzed by linear or logistic regression, respectively. Hazard of pregnancy up to 350 DIM was greater ($P < 0.01$) for DO60 [HR = 1.50 (95%CI = 1.29 to 1.74)] and PSOv [HR = 1.37 (95%CI = 1.18 to 1.59)] than for DO88. Median days to pregnancy were 97, 117, and 98 for DO60, DO88, and PSOv, respectively. During the EL, lactation length was greater ($P = 0.03$) for DO88 (302 ± 4 d) than for DO60 (293 ± 5 d) and PSOv (289 ± 4 d). During the EL, similar TPROF (DO60 = $1,884 ± 55, DO88 = $1,893 ± 59 and PSOv = $1,860 ± 56; $P = 0.78$) and profitability per day (DO60 = $5.5 ± 0.3, DO88 = $5.1 ± 0.3 and PSOv = $5.5 ± 0.2; $P = 0.58$) was observed. Specifically, RPRC was greater ($P < 0.01$) for DO60 ($64.2 ± 1.4) and DO88 ($61.4 ± 1.5) than for PSOv ($55.3 ± 1.3), whereas FXC was greater ($P = 0.03$) for DO88 ($756 ± 11) than for DO60 ($733 ± 9) and PSOv ($723 ± 10). No differences were observed for IOFC (DO60 = $2,905 ± 53, DO88 = $2,989 ± 59 and PSOv = $2,926 ± 52; $P = 0.31$) and REPLC cost (DO60 = $225 ± 18, DO88 = $279 ± 20 and PSOv = $288 ± 22; $P = 0.11$). For the 18MP, similar TPROF (DO60 = $2,925 ± 119, DO88 = $2,627 ± 123 and PSOv = $2,708 ± 125; $P = 0.28$) and profitability per day (DO60 = $5.3 ± 0.4, DO88 = $6.1 ± 0.4 and PSOv = $5.1 ± 0.3; $P = 0.49$) was observed. Specifically, no differences were observed for IOFC (DO60 = $4,363 ± 117, DO88 = $4,073 ± 126 and PSOv = $4,175 ± 122; $P = 0.31$), REPLC (DO60 = $373 ± 31, DO88 = $408 ± 35 and PSOv = $417 ± 38; $P = 0.18$), CF (DO60 = $88.1 ± 4.3, DO88 = $81.3 ± 4.8 PSOv = $83.4 ± 4.8; $P = 0.69$), and FXC (DO60 = $1,136 ± 24 DO88 = $1,062 ± 27 and PSOv = 1078 ± 26; $P = 0.17$). We conclude that despite differences in reproductive performance and individual factors that affect profitability, there were no differences in profitability during the experimental lactation or an 18 mo period after calving.

Key Words: Profitability, Double-Ovsynch, Presynch-Ovsynch, dairy cow

1271 Economic evaluation of a milk test for pregnancy confirmation in dairy cows. E. M. Wynands[*1], M. von Massow[2], S. J. LeBlanc[1], and D. F. Kelton[1], [1]*Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada,* [2]*School of Hospitality, Food & Tourism Management, University of Guelph, Guelph, ON, Canada.*

Timely diagnosis of pregnancy and pregnancy loss is economically important. A commercially available pregnancy-associated glycoprotein milk assay is offered through routine Dairy Herd Improvement (DHI) testing for diagnosis of pregnancy. The objective was to complete a cost-benefit analysis of the milk pregnancy test for confirmation of pregnancy. The test can be used to complement, or as an alternative to, veterinary diagnosis by palpation or ultrasound. CanWest DHI currently recommends using the test for confirmation of pregnancy $\geq$ 60 d in gestation. Therefore, for this analysis it was assumed cows had been previously diagnosed pregnant. The model included 4 simulated pregnancy confirmation strategies: 1) no confirmatory testing, 2) confirmation by milk PAG test, 3) confirmatory examination by a veterinarian, and 4) confirmation using a combination of the milk test and veterinary exam. The analysis was done by simulations of economic outcomes using a cow-level stochastic model (with @Risk for Excel) with uniform distributions for additional days open due to testing frequency. Model assumptions were that cows became eligible for testing at 60 d in gestation, the herd had biweekly veterinary visits, and was enrolled in DHI milk recording with a milk test every 5 wk. Data from the current literature were used to model input variables associated with losses due to days open (for cows eligible to be re-inseminated after pregnancy loss) and culling after pregnancy loss for cows too late in lactation to re-inseminate. The base cost of veterinary exam was $2 and the milk test was $6. For each scenario, 1,000 simulations were run generating a minimum, maximum, and mean value. The most costly option was no confirmatory testing. The benefit of confirmatory testing compared to no confirmatory testing was between $11.80 and $17.90 per cow. On average, the milk test was $6.10 more costly per cow tested than veterinary confirmation. Under the assumed inputs, milk testing would have to cost < $1.00 or occur weekly to have a lower cost than veterinary confirmation. Sensitivity analysis indicated that the models were most sensitive to the proportion of cows found open and the proportion of open cows eligible to re-inseminate. Models were found to be less sensitive to the cost of a day open, additional days open due to testing frequency, and the cost of the test. Pregnancy loss is a costly event but the cost can be limited by pregnancy confirmation testing.

Key Words: pregnancy confirmation, economics

1272 Effect of synchronizing, access to supplement, and grazing session on grazing behavior of early lactating dairy cows. P. Chilibroste[1], J. P. Marchelli[2], and D. A. Mattiauda[*1], [1]*Facultad de Agronomia, Universidad de la Republica, Paysandu, Uruguay,* [2]*Facultad de Agronomia, Universidad de la Republica, Montevideo, Uruguay.*

An experiment was performed to study the effect of two contrasting feeding strategies involving TMR and grazing, during the first 60 d in milk of Holstein dairy cows. Twenty four multiparous dairy cows were blocked according to parity, expected calving date, body condition score (BCS; 3.2 ± 0.35) and BW (688 ± 60.7 kg) before calving, and were randomly allocated to follow 1 of 2 feeding strategies: GR-one = 1 grazing session (AM: 800 to 1400 h) supplemented with a total mixed ratio (TMR corn silage/concentrate mix 40/60; respectively) out of the grazing plot orGR-two = 2 grazing sessions (AM: 0800 to 1400 h; PM: 1800 to 400 h) supplemented with TMR into the grazing plot. The 2 treatments were based on the same offer of energy (50 Mcal ENL/cow/d), differing in the synchrony or not between the access to pasture and to TMR (50% each of the total energy on offer). In both treatments TMR supplementation was offered once a day at 1700 h on feed troughs (0.6 m lineal access per cow). On Days 10, 13, 30, and 33 of the experiment the number of cows grazing or idling were determined every 15 min during the first 4 h of the AM and 3 h of the PM grazing session. The PROC GLIMMIX of SAS (SAS 9.2, 2010) with a binomial response distribution and with Logit as a link function was used to determine the probability of the different events. A first order autoregressive heterogeneous (AR1) covariance structure was selected. The probability of cows grazing (approximately 0.5) during the AM grazing session was not different between treatments. There was a significant effect of time with higher probability of grazing during the first hour than in the following ones (0.84^{a}, 0.32^{b}, 0.36^{b} and 0.41^{b} for the first, second, third and fourth h, respectively; $p < 0.01$). A significant interaction between treatment and time was detected: GR-one cows grazed longer than GR-two cows during the first h (0.89 vs. 0.75; $p < 0.05$) but shorter during the third hour (0.26 vs. 0.47; $p < 0.05$) of the grazing session. During the PM grazing session the GR-two cows expended a large proportion of time either around the feed troughs (0.83, 0.57 and 0.50) or idling (0.10, 0.19 and 0.17) during the first, second and 3rdh, respectively. The changes observed on grazing behavior were no reflected on productive performance (companion abstract).

Key Words: early lactation dairy cows, grazing behavior, grazing, TMR

1273 Profitability of reproductive management strategies for second and greater artificial insemination service in dairy cows.

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Our objective was to evaluate the profitability of dairy cows managed with two different resynchronization protocols. Individual cow production and reproduction data was collected for an 18 mo period after calving for cows that completed a study aimed at evaluating two management strategies for second and greater AI services (Giordano et al., 2015; J Dairy Sci. 98:2488–2501). Briefly, cows enrolled in the control group (CON; n = 634) received insemination based on increased physical activity (AIACT) any time after a previous AI and timed AI (TAI) after the Ovsynch protocol (GnRH-7d-PGF2α-56h-GnRH-16h-TAI) initiated 32 ± 3 d after AI. Cows enrolled in the treatment group (TRT; n = 616) diagnosed non-pregnant 32 ± 3 d after AI with a corpus luteum (CL) ≥ 20 mm received a PGF2α treatment to induce estrus. Cows not AIACT within 9 d of the PGF2α received TAI after a 5d-CIDR-Ovsynch protocol (GnRH+CIDR-5d-PGF2α+CIDR-removal-24h-PGF2α-32h-GnRH-16h-TAI). Cows in TRT with no CL received a GnRH treatment for presynchronization and if not AIACT within 7 d were enrolled in the 5d-CIDR-Ovsynch protocol to receive TAI. Total profitability (TPROF; $/cow) during the 18 mo period of evaluation was the aggregation of: income over feed cost (IOFC) during lactation and the dry period, reproductive program cost (RPRC), replacement cost (REPLC), calf value (CF), and fixed cost per day (FXC). Time to pregnancy was analyzed using Cox's regression whereas, continuous and binomial outcomes were analyzed by linear or logistic regression, respectively. The hazard of pregnancy up to 270 DIM was similar for cows in the CON and TRT group (HR = 1.07; 95%CI = 0.95 to 1.21) with median days to pregnancy of 111 and 110 d for the CON and TRT group, respectively. Total days in lactation were similar (P = 0.57) for CON (417 ± 5 d) and TRT (420 ± 6 d) and the same proportion (P = 0.79) of cows were culled for both groups (CON = 57% vs. TRT = 55%). Similar TPROF (CON = $3,563 ± 71 vs. TRT = $3,498 ± 69; P = 0.71) and profitability per day of lactation (CON = $8.2 ± 0.2 vs. TRT = $8.1 ± 0.2; P = 0.89) was observed. Among individual factors used to calculate profitability, there were no differences between groups for IOFC (CON = $4,771 ± 68 vs. TRT = $4,724 ± 66; P = 0.80), FXC (CON = $1,041 ± 14 vs. TRT = 1049 ± 14; P = 0.57), REPLC (CON = $468 ± 19 vs. TRT = $449 ± 18; P = 0.82), and CF (CON = 86.2 ± 2.6 vs. TRT = 85.2 ± 2.7). Conversely, RPRC was greater (P < 0.01) for TRT ($68.8 ± 2.1) than for CON ($59.4 ± 1.7). We conclude that despite a greater reproductive program cost for TRT than CON, overall profitability for an 18 mo period after calving was similar for both strategies.

Key Words: profitability, resynchronization, dairy cow

1274 Pre-weaning injections of bovine somatotropin enhanced puberty attainment of bos indicus-influenced beef heifers.

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A 2-yr study evaluated the effects of three pre-weaning 14-d apart injections of bovine somatotropin (bST) on growth and puberty of beef heifers. On d 0 of each yr, Angus × Brangus heifers (n = 15 heifers/treatment/yr; BW = 153 ± 21 kg; age = 135 ± 12 d) were stratified by BW and age, and randomly assigned to receive s.c. injections of saline (SAL; 5 mL; 0.9% saline) or half-dose of bST (250 mg of sometribove zinc; Posilac, Elanco, Greenfield, IN) on d 0, 14, and 28. Cow-calf pairs were allocated to 4 bahiagrass (*Paspalum notatum*) pastures (7 to 8 pairs/pasture/yr) from d 0 until weaning (d 127). Unshrunk BW and blood samples were collected on d 0, 14, 28, and 127. From d 127 to 346, heifers were pooled by treatment and allocated to bahiagrass pastures (1 pasture/treatment/yr) and fed blackstrap molasses-based concentrate at 1.1% BW (DM basis). Unshrunk post-weaning BW was obtained every 28 d, and blood samples every 9 to 10 d to determine plasma progesterone (P4) concentrations. Heifers were considered pubertal when 2 consecutive plasma samples had P4 ≥ 1.5 ng/mL. Each group of heifers was placed with 1 Brangus bull from d 282 to 346. Effects of treatment × yr and treatment × yr × time were not detected for any variable measured in the study (P ≥ 0.11). During pre-weaning phase, bST heifers had greater mean plasma IGF-1 concentrations (115 vs. 102 ± 3.8 ng/mL; P = 0.02) and ADG from d 0 to 42 (1.17 vs. 1.06 ± 0.035 kg/d; P = 0.01), but tended to have less ADG from d 42 to 127 than SAL heifers (0.77 vs. 0.84 ± 0.029 kg/d; P ≥ 0.06). Hence, BW at weaning did not differ between bST and SAL heifers (267 vs. 270 ± 1.70 kg, respectively; P = 0.58). During post-weaning phase, bST heifers had similar ADG from d 127 to 347 (0.17 vs. 0.12 ± 0.07 kg/d; P = 0.11), BW and age at puberty (290 vs. 291 ± 6.9 kg and 395 vs. 419 ± 14 d, respectively; P ≥ 0.15), but greater puberty achievement at start of breeding season (63 vs. 44 ± 7.9%; P = 0.02) than SAL heifers. Hence, three half-dose injections of bST administered to suckling beef heifers at 14-d intervals may be a feasible management practice to enhance puberty attainment at the start of the breeding season.

Key Words: somatotropin, heifers, puberty

1275 Effects of temperament on physiological and reproductive responses of Bos Indicus beef cows.

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This experiment evaluated the effects of temperament on physiological and reproductive responses of *Bos indicus* cows. A total of 954 lactating, multiparous, non-pregnant Nelore cows (age = 99 ± 1.6 mo; days post-partum = 51.4 ± 0.3 d; BCS = 5.34 ± 0.04; BW = 430 ± 2 kg), allocated into 8 groups of approximately 120 cows each, were utilized. Groups were assigned to an estrus synchronization + timed-AI protocol from d 0 to 11. On 11, cows were inseminated, blood samples were collected, and cow temperament was evaluated via chute score and exit velocity. Individual exit score was calculated by dividing exit velocity results into quintiles and assigning cows with a score from 1 to 5 (exit score: 1 = slowest; 5 = fastest cow). Temperament scores were calculated by averaging cow chute score and exit score, and cow temperament type was defined according to temperament score (≤ 3 = adequate temperament, ADQ, > 3 = excitable temperament, EXC). Pregnancy status was verified 30 d after timed-AI via transrectal ultrasonography. Cows not pregnant to AI were assigned to a second timed-AI protocol. Cows that still remained non-pregnant were exposed to natural breeding for 60 d. Cow age, BW, BCS, and days post-partum on d 0 were similar ($P \geq 0.27$) between ADQ and EXC cows. On d 11, EXC had greater ($P < 0.01$) plasma cortisol but similar ($P = 0.89$) plasma haptoglobin concentrations compared with ADQ cows (48.9 vs. 38.4 ng/mL of cortisol, SEM = 1.0). Pregnancy rate to the first timed-AI tended ($P = 0.10$) to be less in EXC vs. ADQ cows (41.0 vs. 47.2%; SEM = 3.5), whereas pregnancy rates to the second timed-AI, natural breeding, and final pregnancy rates (AI + natural breeding) were similar ($P \geq 0.23$) between ADQ and EXC cows. However, calving rate was less ($P = 0.02$) in EXC vs. ADQ cows (66.9 vs. 74.9%; SEM = 2.5), which can be associated with the greater ($P = 0.04$) pregnancy loss (based on final pregnancy status and actual calving) detected in EXC vs. ADQ cows (11.3 vs. 6.4%; SEM = 1.6). Results from this experiment indicate that *B. indicus* cows with excitable temperament have impaired reproductive performance during a breeding season based on timed-AI + natural breeding compared to cohorts with adequate temperament.

Key Words: beef cows, reproduction, temperament

1276 Carcass quality of primiparous cows managed under a single-calf heifer model combined with use of sexed semen and early weaning.

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The single-calf heifer model (SCHM) harvests females after early-weaning their first calf, reducing average age and maintenance requirements of the herd, hence increasing biological efficiency of beef production. However, pregnancy estrogens accelerate bone ossification, which might affect carcass value of SCHM females. This study evaluated: overall maturity (OM), bone maturity (BM), lean maturity (LE), marbling (MA), Warner-Bratzler (WBSF) and slice shear force (SSF), and cooking loss (CL) of carcasses of SCHM females. Fifty-three Angus-based yearling heifers (BW = 353 ± 38.8 kg) and a second set of 58 (BW = 307 ± 29.9 kg), were synchronized and inseminated with sexed semen during first and second year of the project, respectively, to calve at approximately 24 mo of age. At weaning, average age of calves was 106 ± 22 and 120 ± 21 d, and first-calf heifers (43 each year) were fed for 88 and 90 d at a feedlot, for years 1 and 2, respectively. At harvest, carcasses were scored for LE, BM, and MA (slight = 300, small = 400, and modest = 500); OM was estimated from BM and LE (A^{00}, $B^{00}$and C^{00} maturities corresponded to scores of 100, 200, and 300, respectively). One LM sample was removed for SSF, WBSF and CL measurements. Carcasses were sorted by OM as < 300 or $\geq$ 300, and the resulting means for carcass traits were compared with a *t* test. Data were combined across years, since same significant differences ($P < 0.05$) between OM groups were obtained for both years. Means ± SD for the 66% of the carcasses classified as < 300 OM were: 192 ± 39.3 OM, 211 ± 53 BM, 165 ± 29 LE, 446 ± 84 MA, 25.4 ± 8.6 kg SSF, 4.94 ± 1.19 kg WBSF, and 25.4 ± 4.1% CL. Remaining carcasses ($\geq$ 300 OM) were 305 ± 18 OM, 346 ± 46 BM, 167 ± 27 LE, 462 ± 78 MA, 27.6 ± 9.1 kg SSF, 4.96 ± 0.84 kg WBSF, and 26.1 ± 4.2% CL. Significant differences between the 2 OM groups were found for BM ($P < 0.001$). However, no differences were detected for LE ($P = 0.81$), MA ($P = 0.39$), WBSF ($P = 0.96$), SSF ($P = 0.29$) or CL ($P = 0.47$). Therefore, differences in OM and BM did not affect palatability characteristics of carcasses of primiparous SCHM females approximately 30 mo of age.

Key Words: bone ossification, shear force

1277 Milk metabolomics of dairy goats with mammary inflammation under heat stress conditions.
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The objective was to test whether mammary gland response to bacterial endotoxin could be conditioned by heat stress, and to detect biomarkers for heat stress and inflammation in milk. Eight multiparous Murciano-Granadina dairy (2.2 ± 0.1 L/d; 100 ± 5 DIM, 42 ± 2 kg BW) goats were maintained under 2 environmental conditions varying in temperature, relative humidity (RH) and temperature humidity index (THI): 1) 4 goats under thermoneutral (TN; 15 to 20°C, RH = 50 ± 5%, THI = 59 to 65), and 2) 4 goats under heat stress conditions (HS; 35°C from 0900 to 2100 and 28°C from 2100 to 0900, RH = 45 ± 5%, THI = 75 to 83). Adaptation of 11 d to the experimental treatments was allowed. On d 12 each animal had 1 udder half infused with 10 µg *E. Coli* lipopolysaccharide (LPS) and the other udder half as the control with 0.9% saline (CON). This resulted in 4 treatment combination: TN-CON, TN-LPS, HS-CON, and HS-LPS. Milk samples (0, 4, 6, 12, and 24 h) were collected and analyzed by ^{1}H NMR spectroscopy operating at 600 MHz. Data were processed by the ChemoSpec package of R program and further analyzed by the web-based MetaboAnalyst program. Principal component analysis and partial least square–discriminant analysis were used to identify possible metabolite markers in milk. Citrate, glucose-1-phosphate, pyruvate and malonic acid increased in milk of HS goats. The increment in milk citrate might explain the previously observed deteriorated coagulation properties during the cheese making from the milk of heat-stressed animals. On the other hand, the LPS challenge resulted in an increment in milk lactate, acetate, butyrate, and capric acid. In conclusion, the metabolomic profile of milk was dramatically affected by environmental temperature and udder health status. Milk citrate and lactate were detected as good markers for heat stress and udder inflammation, respectively. Acknowledgment: Project AGL-2013–44061-R (Plan Nacional, MINECO, Spain).

Key Words: metabolomics, mastitis, heat stress, dairy goats

1278 Winter climate variables and their effect on feed intake in *Bos taurus* bulls.
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In beef cattle, there are numerous factors that influence feed intake such as breed composition, ration formulation, and body size. Additionally, an animal's intake could be influenced by many different environmental factors such as weather and climate factors. It is hypothesized that animal intake is influenced by weather events, specifically daily temperature difference (TDIFF) and average daily wind speed (WSPD), experienced prior and up to a feeding event, however there is limited research on the affects of these variables on feed intake. Therefore the objective of this study was to determine if average daily pen DMI (ADMI) were significantly influenced by changes in weather during winter months. Feed intake observations were collected from a total of 158 *Bos taurus* bulls from 3 different sources that were separated into pens ($n = 5$), with pen allocation based on source and BW. Feed intake observations were collected for approximately 70 d from December through February. Climate and feed intake data were obtained from the Colorado State University Agricultural Research, Development and Education Center. The distance between the weather station and the feed intake unit was approximately 5 km. The independent variable TDIFF was defined as the difference between the daily maximum temperature and minimum temperature. The effects of pen, WSPD, and TDIFF were evaluated for their influence on ADMI using a generalized linear model. This regression was performed for the intake observation day (d0), as well as every day up to 4 d before d0. Pen was included in the model to account for differences in cattle's breed, size and pen location. The model results suggested that TDIFF was significant ($P < 0.0001$) on d0, as well as 1, 2, and 3 d before d0. WSPD was shown to be significant 2 ($P < 0.0003$) and 4 ($P < 0.0001$) days before d0. Model R2 was shown to be the greatest 2 d before d0 (0.55). These results suggest that differences in a bull's DMI are influenced by weather changes occurring 2 d before the intake day during winter months. Better understanding of climate variables effect on feed intake in beef cattle could potentially lead to more accurate evaluations of differences of feed efficiency in beef cattle in the future.

Key Words: beef cattle, feed intake, winter climate

1279 Maternal heat stress reduces body and organ growth in calves: relationship to immune tissue development.
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Maternal heat stress (HT) not only reduces fetal growth but also influences postnatal performance and immune function of the offspring. The objective was to evaluate the effect of in utero HT on overall fetal growth and organ development, particularly those associated with immune function. Dams were dried off 45 d before expected calving and randomly assigned to one of two treatments: HT or cooling (CL). During the dry period, all cows were housed under shade in a freestall barn, where the pen for CL cows was equipped with active cooling including water soakers and fans whereas the pen for HT cows had no soakers and fans. Based on rectal temperature (RT) and

respiration rate (RR), heat stress was severe. Average RT in HT cows was 39.3°C compared with 38.9°C for CL cows, and HT cows had 66.7 breath/min respiration rate and 43.2 for CL cows. After birth all bull calves were immediately separated from their dams and weighed. Bull calves (n = 30) were sacrificed at birth without colostrum feeding (5/trt) and 1 and 2 d of age (DOA, following colostrum feeding, 5/trt). Pooled colostrum (3.8 L) was fed within 4 h after birth to bulls slaughtered on 1 and 2 DOA. After slaughter, the small intestine was removed, weighed (1.0 to 1.4 kg), and dissected into duodenal, jejunal and ileal segments, and tissue samples from each section were fixed in 4% neutral formalin and then transferred to 70% ethanol for immunohistochemistry. Bull birth weight from HT dams was lower than bulls from CL dams (HT: 39.3; CL: 43.8 SEM = 1.1 kg; $P < 0.01$). The thymus, spleen, and heart weight of HT bulls was lower compared with the CL bulls (Thymus, HT: 107.7; CL: 138.0, SEM = 14.4 g; $P = 0.02$; Spleen, HT: 75.5; CL: 93.7, SEM = 6.9 g; $P < 0.01$; Heart, HT: 292.4; CL: 329.4, SEM = 19.6 g; $P = 0.03$). The liver weight of HT bulls tended to be lower compared with the CL bulls (HT: 811.4; CL: 914.0, SEM = 70.4 g; $P = 0.09$). We conclude that the acute difference in heat strain on HT and CL cows during the dry period has significant impact on general fetal growth and on immune tissue development, which may be associated with reduced immune function in early life.

Key Words: heat stress, bull, immune tissue

1280 Liver proteomic analysis of cows exposed to heat stress or cooling conditions during the dry period.

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Heat stress negatively impacts cow performance, compromises immune function and increases susceptibility to metabolic disorders, particularly during the transition period. Metabolic adaptations of the liver are critical for successful transition from gestation to lactation, yet it is unclear how heat stress impacts metabolic pathways within the liver at the molecular level. The objective of this study was to investigate the liver proteome of cooled and heat stressed dry cows to gain insight into how molecular pathways are altered by heat stress and may contribute to poor performance and transition-related disorders. The experiment was conducted at the University of Florida Dairy Unit. During the dry period, cows were either housed in shaded barns with fans and soakers (cooled group [CL]; n = 5) or in shaded barns lacking these cooling devices (heat stressed group [HT]; n = 5). Liver biopsies were collected +2 d relative to calving. Proteins were analyzed by quantitative shotgun proteomics at the Weizmann Institute of Science (Rehovot, Israel). Proteins were extracted and subjected to in-solution tryptic digestion followed by nanoflow liquid chromatography coupled to high-resolution tandem mass spectrometry. Quantitative data was extracted using the Genedata Expressionist data analysis package and proteins identified using the Mascot search engine. Proteomics data, after logarithmic transformation, were analyzed by t test to examine effect of treatment (CL vs. HT). Proteins were regarded as differential at $P \leq 0.05$ and fold change ± 1.2. Differentially expressed proteins were analyzed by Ingenuity Pathway Analysis. A total of 3270 proteins were identified, 65 of which were differentially expressed between treatments. The most relevant pathways identified were hepatic oxidative phosphorylation and mitochondrial dysfunction. The abundance of several proteins related to these pathways was lower in the liver of HT cows relative to CL cows, including cytochrome c oxidase subunit 4 isoform 1(COX4I1, $P < 0.04$), NADH dehydrogenase 1 α subcomplex subunits 10, 11, and 12 (NDUFA10, $P < 0.002$; NDUFA11, $P < 0.01$; NDUFA12, $P < 0.04$), and thioredoxin-dependent peroxide reductase (PRDX3, $P < 0.04$). NADH dehydrogenase and cytochrome c oxidase are 2 of the 4 enzyme complexes in the inner mitochondrial membrane involved in the redox reactions that create the proton gradient necessary to power ATP synthesis. Thioredoxin-dependent peroxide reductase is an antioxidant and as such protects enzymes from oxidative damage. These results suggest that cooling late gestation cows improves liver function during early lactation.

Key Words: oxidative phosphorylation, heat stress, mitochondrial dysfunction

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1281 A rumen bolus is a useful tool to monitor core body temperature in lactating dairy cows in a sub-tropical summer.

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The ability to vary body temperature is a common thermoregulatory response in mammals and rumen boluses may allow frequent monitoring of such variations during heat stress episodes. Twenty four Holstein Friesian lactating dairy cows were fed either a total mixed ration plus wheat (TMRW), TMR plus Bioprotect, a starch binding agent (TMRB), or TMR plus Corn (TMRC). The only difference between diets was the type of grain contained in the TMR. Cows had ad libitum access to water and feed in shaded pens at the University of Queensland, Gatton Campus, Dairy research facilities, 27.4986°S, 153.0155°E, 89 m elevation during 29 d in summer 2015. Rumen temperature (RuT) was recorded over 15 d at 20 min interval using transponder rumen boluses (RFID

transmitters; Smartstock, USA) placed in the ventral sac of the rumen. Rectal temperature (RT) was measured once every 4 d in the morning (0700 to 1000 h) and the temperature humidity index (THI) was calculated from an on-site weather station. Data were analyzed using the restricted maximum likelihood (REML) and Pearson correlation analysis procedure for GenStat V15. Treatment groups were considered statistically different at $P \leq 0.05$. Average THI during the experimental days was 72.4 ± 2.0 (mean ± SD) with 76% of the days having THI $\geq$ 72 which is the critical THI threshold for dairy cows. TMRC fed cows had lower RT than TMRW and TMRB (38.8 vs. 39.1 and 39.1°C respectively; $P < 0.001$) and RT was directly correlated to THI and RuT in all diets ($P < 0.001$). Diet had no significant effect on RuT (39.6, 39.7, 39.5°C for cows fed TMRB, TMRC and TMRW respectively; $P > 0.05$). Cows had large variations in RuT during the day that weren't associated with THI. For example, RuT was higher overnight (2000 to 0500 h) than during the day with the maximum occurring between 2100 and 0300 h. The minimum RuT occurred around the AM feeding (0600 to 1000 h) after which RuT gradually increased during the day. There was a positive association between RuT and mean daily THI during the bolus data collection period ($P < 0.001$). The data obtained from our study demonstrated that the variation in RuT follows daily THI and that the association between RT and RuT is positive. Therefore, RuT enables a sensitive prediction of RT when cows are exposed to high ambient temperatures.

Key Words: dairy cows, heat stress, rumen temperature

1282 Activity and rumination in an organic vs. a conventional grazing herd.

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The objectives of this study were to evaluate activity and rumination of organic and conventional Holstein and crossbred cows during the grazing and winter months and to investigate the correlation between ambient air temperature and daily rumination and activity. The study was conducted for 2 yr (March 2014 to March 2016) at the University of Minnesota West Central Research and Outreach Center, Morris grazing dairy. During the grazing season (May to October) organic cows were on pasture and supplemented with 2.72 kg of corn per cow per day whereas conventional cows were supplemented with a TMR of corn silage, alfalfa haylage, corn, soybean meal, and minerals. During the winter season, both organic cows and conventional cows were supplemented with a TMR. Activity and rumination time (daily and 2-h periods) were monitored electronically using HR-LD Tags (SCR Engineers Ltd., Netanya, Israel) for the 2-yr period. Activity is reported in "activity units" from SCR DataFlow II software. The PROC MIXED of SAS was used for statistical analysis, and independent variables were herd (conventional or organic), month (January to December), year and their interactions, and date was a random effect. Daily activity was greater ($P < 0.05$) for the organic herd compared to the conventional herd (544 vs. 533), respectively. Daily rumination (min/d) was also greater ($P < 0.05$) for the organic herd (553 min/d) compared to the conventional (538 min/d) herd. Daily activity was greatest ($P < 0.05$) during July (791) and least during January (334) for the organic herd, and greatest ($P < 0.05$) during July (752) and least during January (289) for the conventional herd. Daily rumination was greater ($P < 0.05$) during December (592 min/d) compared to July (482 min/d) for the organic herd, and was greater ($P < 0.05$) during December (563 min/d) compared to March (496 min/d) for the conventional herd. Greater daily rumination of cows on a herd basis was negatively correlated (−0.39) with increased ($P < 0.01$) ambient air temperature in the organic herd, and there was a slight negative correlation (−0.10, $P < 0.01$) of daily rumination and air temperature in the conventional herd. In summary, organic cows had greater daily activity, and greater daily rumination compared to conventional grazing cows. Monthly activity and rumination patterns of grazing organic and conventional dairy cattle in this study were influenced by the weather.

Key Words: rumination, organic, activity

1283 Understanding behavior patterns of cattle adaptation to heat stress.

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Changes in climate may have negative effect on livestock that will have to adapt to more extreme environment in the near future. Therefore understanding how different breeds developed mechanisms to thrive under extreme conditions may help livestock production. This research compared the movement, ruminating time and weight gain between 2 breeds, Nellore (indicine, n = 24, 210 ± 15 kg) and Angus (taurine, n = 24, 227 ± 25kg) aging 10 mo and kept for 80 d at pasture during tropical spring (average temperature 26°C, maximum 32.2°C, minimum 21.5°C). Animals were sons of the same bull (Nellore or Angus) to minimize genetic variation. Concentrate supplement was provided twice a day (1.5% LW/day), netted shade was available (80% sun block, 10 m^2/animal). Animal motility (using an accelerometer, measured

relative movement-RM) and rumination time (minutes/day, using a sound sensitive sensor) were evaluated through a collar-sensor (SCR, Systems Heat time) by radio telemetry. Live weight (kg) was measured with a chute scale every 15 d. Data were compared by unpaired *t* test, two-way ANOVA and Pearson correlation analysis. We observed that Angus remained under the netted shade during daytime and grazed after sunset, Nellore on the other hand stayed on the sun despite the available shade. Nellore (781 ± 16 RM) moved less ($P < 0.001$) than Angus (919 ± 17 RM) but ruminated for longer periods ($P < 0.0001$; Nellore: 496 ± 9 min/day) compared to Angus (370 ± 8 min/day). Nellore (268 ± 27 kg) were lighter ($P = 0.0003$) than Angus 303 ± 24 kg) at the end of the 80 d period, average daily gain was lower ($P = 0.029$) in Nellore (0.65 ± 0.04 kg/day) compared to Angus (0.85 ± 0.05 kg/day). In summary Nellore moved less and ruminated more compared to Angus. It is possible that a reduction on movement is part of the Nellore adaptation to heat stress. By being less active Nellore produces a lower amount of heat to be dispersed but to move less, it selects the grass ingested in a worst way. The consequence is a need to ruminate more that can be done without much muscle activity and less heat production. Despite of moving more and ruminating less, Angus animals were more efficient than Nellore considering average daily gain. Samples from blood, muscle, skin, liver and semen were collected to be evaluated for metabolic, gene expression and epigenetic modifications induced by heat stress.

Key Words: Nellore, Angus, time ruminating

1284 Plasma insulin and glucose concentrations of feedlot cattle during summer.

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Periods of heat stress are typically associated with an increase in basal insulin (INS) concentration and a decrease in basal glucose (GLU) concentration, thereby altering energy metabolism. The purpose of this study was to investigate circulating INS and GLU of shaded and un-shaded *Bos indicus* and *Bos taurus* feedlot cattle during summer. Thirty-six steers (12 Angus, Charolais and Brahman) with an initial BW of 318.5 ± 6.7 kg were used in a 180 d feedlot study with 2 treatments: un-shaded and shaded (3 m^2/animal; 90% solar block shade cloth). There were 6 steers (2/breed) per pen (162 m^2) and 3 pens/treatment. Blood samples were collected via jugular venepuncture on 5 occasions (period 1 to period 5). Plasma concentrations of INS and GLU were analyzed using a repeated measures model (PROC MIXED; SAS Inst. Inc. Cary, NC). Plasma INS were highly variable across breed × treatment groups, therefore concentrations were Log_{10} transformed analysis. The model included breed ($P = 0.03$; $P = 0.03$), treatment ($P = 0.81$; $P = 0.97$), period ($P < 0.0001$; $P = 0.0003$), treatment × breed ($P = 0.38$; $P = 0.39$), treatment × period ($P = 0.06$; $P = 0.09$), breed × period ($P = 0.03$; $P < 0.0001$) and treatment × breed × period ($P = 0.50$; $P = 0.48$) as fixed effects for Log_{10} INS and GLU (mmol/L), repectively. Pen nested within treatment and treatment × breed × animal ID nested within pen were included as random effects. Overall the Brahmans had higher plasma GLU than Angus, particularly during periods 1 ($P < 0.0001$) and 2 ($P = 0.003$). However as days on feed increased, the variability of GLU on a breed × treatment group basis decreased. There was a trend for increasing INS and GLU over time, which can be partly explained by the high starch, high energy diet that was fed. In other species, feeding diets with a high glycaemic index is known to be associated with insulin resistance characterized by persistent hyperglycemia despite increased insulin secretion. In the current study, plasma GLU concentrations increased but GLU homeostasis was maintained but with a marked increase in circulating INS. Together these results may indicate the development of insulin sensitivity in feedlot cattle during summer on a diet designed for weight gain and fat deposition.

Key Words: feedlot cattle, glucose, heat stress, insulin

1285 Impact of heat stress on immune status of sheep.

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The objective of this study was to examine the effects of heat stress on sheep physiology. Australian Merino wethers (n = 144; 44.02 ± 0.32 kg) were randomly allocated to treatment in a climate controlled facility (CCF: 4 rooms; 3 pens/room; 6 sheep/pen; pen = 2.32 m^2). The treatments were: hot (HOT) and thermoneutral (TN). Treatment were replicated 4 times and each replication ran for 29 d. Dry bulb temperature (DBT) and relative humidity was obtained every 10 min. From these data a temperature humidity index (THI) was calculated: THI = DBT– {(0.31– 0.31× RH/100) × (DBT– 14.4)}. During HOT means for DBT, RH and THI were: 32.5 ± 0.40°C, 62.5 ± 7.22% and 30.5 ± 0.55, respectively. During TN the values were 19.7 ± 0.40°C, 79.9 ± 7.22% and 19.4 ± 0.55. Respiration rate (RR) were obtained 3 hly between 0800 and 1700 h. Rumen temperature (TRUM) was recorded at 10 min intervals using RFID rumen temperature boluses. Blood (2 × 10 mL) was collected by jugular venipuncture on entry and then every 7 d. Plasma concentrations of interleukin-1β (IL-1β), interferon-γ, tumor necrosis factor α, lipopolysaccharides (LPS), haptoglobin, alkaline phosphate (ALP), γ-glutamyl transpeptidase (GGT), creatine kinase (CK) and creatinine were determined. The MIXED procedure (SAS Inst. Inc. Cary, NC) was used. The model fitted included terms for replicate and treatment, a term for collection and a collection × treatment interaction. Mean RR of HOT was greater ($P < 0.01$)

at 140.0 ± 3.55 breaths per minute (bpm) compared with TN at 74.9 ± 3.55 bpm. The HOT group had a greater ($P < 0.05$) TRUM (40.4 ± 0.03°C) than the TN group (39.9 ± 0.04°C). ALP ($P = 0.0003$), GGT ($P = 0.0158$) and IL-1β ($P < 0.05$) were all lower in the HOT sheep. Creatinine concentration ($P = 0.0038$) and CK ($P > 0.05$) were higher in the HOT sheep. LPS concentration was greater ($P < 0.05$) in HOT compared with TN. The remaining parameters were not affected ($P > 0.05$) by treatment. Elevated CK, creatinine and TRUM suggest that the HOT sheep were heat stressed. There is some evidence pointing to impaired immune status. However, the data is equivocal, and in some cases confounding (e.g., greater IL-1β expression in TN, but greater LPS in HOT).

Key Words: sheep, heat stress, blood parameters

1286 Stocking rates and parasite load in yearling steers grazed season long in the Northern Great Plains.

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Intestinal parasitism of grazing ruminants can result in poor performance and compromised systems, especially in younger animals. Twelve pastures (12.9 ± 0.8 ha) were stocked at four stocking rates: light 1.83 ± 0.38 AUM · ha^{-1}, moderate 3.26 ± 0.30 AUM· ha^{-1}, heavy 4.98 ± 0.78 AUM · ha^{-1}, and extreme 6.18 ± 0.68 AUM · ha^{-1}. Yearling steers (317 ± 32 kg) were grazed on the pastures from mid-May to mid-September, 2015. Before turnout, the steers were dewormed with an injectable dewormer, as well as implanted with Revalor GTM to maximize live weight gains. The steers were also supplemented with dry distillers grains with solubles at 0.3% of body weight. Steers were weighed monthly during which time fecal grab samples were collected. Results demonstrated that initially the worming treatment before turnout proved effective in the early part of the grazing season as there was no difference ($P > 0.05$) among treatments in egg counts per gram (epg) in June, with corresponding low epg. However, a significant difference ($P < 0.05$) in epg was detected between the light and extreme treatment groups in July, with low levels in the light treatment, and higher levels in the extreme treatment. Egg counts over 35 epg, which has been proved as a performance threshold in grazing yearling cattle, were noted in individual animals on all treatments except the lightly grazed treatment in August and September. This study demonstrates an association between high stocking rates and increases in detectable parasite load, and supports the conclusion that individual yearling cattle that are susceptible to parasitism may be negatively impacted by season long systems that are stocked from moderate to extreme levels in the northern Great Plains.

Key Words: parasitism, northern Great Plains, yearling cattle, season long grazing

PRODUCTION, MANAGEMENT AND THE ENVIRONMENT SYMPOSIUM: IMPACTS OF LIVESTOCK PRODUCTION ON ENVIRONMENTAL REACTIVE NITROGEN

1287 The world's nitrogen cycle and human impacts.

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Perhaps 40% of the people alive today are sustained from increased grain yields attributed to the use of synthetic nitrogen fertilizer. While the Haber-Bosch process of converting atmospheric nitrogen to ammonia (i.e., fertilizer) has transformed agricultural production, it has also caused an unprecedented shift in the global nitrogen balance. Despite many improvements in nitrogen use efficiency in both crop and livestock systems, a large fraction of agricultural nitrogen inputs are lost to the environment. This "fugitive" nitrogen is causing a host of environmental problems at local and global scales. Excess nitrogen has been shown to alter biogeochemical processes and ecosystem function across the globe. Because nitrogen can be easily transported in water or air through natural processes, or by the transport of grain and livestock; the impacts of agriculture nitrogen are often observed far from where the nitrogen was initially used. A good example of this process is the observed increases in the atmospheric deposition of reactive nitrogen across many areas, including many pristine ecosystems. Nitrogen deposition is often linked to ammonia-derived aerosols, compounds that can travel hundreds of kilometers from the source before being redeposited back to the surface. Because livestock account for over 50% of all ammonia emissions in many regions; beef feedlots, dairies, and swine and poultry operations are often linked to this air quality issue. While there is no question that livestock ammonia emissions are large, quantifying the actual impact of reactive nitrogen on the environment is a complex question. One must consider atmospheric transport at both local and regional scales, chemical reactions with pollutants from other industries, and other non-livestock sources and forms of nitrogen. Perhaps nowhere has this issue been more investigated than along the Front Range of Colorado, where a mature cattle feeding industry is located relatively close to the pristine ecosystems in Rocky Mountain National park. This presentation will begin with the role of livestock in the global and U.S. nitrogen cycle, and then narrow the scope to specific issues facing livestock producers in Colorado regarding atmospheric ammonia. Summary comments will suggest how animal scientists and industry leaders might respond to these growing concerns.

Key Words: Colorado producers, atmospheric ammonia, nitrogen