PRODUCTION, MANAGEMENT, AND THE ENVIRONMENT: **EFFECTS OF TEMPERATURE ON PERFORMANCE**

0578 Urine metabolomics of heat-stressed dairy goats supplemented with soybean oil. A. Salama[*1,2], N. Nayan[3], A. Contreras-Jodar[1], S. Hamzaoui[1], and G. Caja[1], *[1]Group of Ruminant Research (G2R), Universitat Autonoma de Barcelona, Bellaterra, Barcelona, Spain, [2]Animal Production Research Institute, Dokki, Giza, Egypt, [3]Dep. of Animal Science, Faculty of Agriculture, University Putra Malaysia, Serdang.*

Biofluids assessment by ^{1}H nuclear magnetic resonance (NMR) spectroscopy would highlight the physiological mechanisms that may have occurred in goats when exposed to different management and environmental conditions. Our objective was to detect metabolomic changes in the urine of heat-stressed goats supplemented with soybean oil (SBO) for alleviating fat depression. Murciano-Granadina dairy goats (n = 8; 42.8 ± 1.3 kg BW) kept in metabolic cages were used in a replicated 4 × 4 Latin square design with 4 periods, 19 d each (14 d adaptation, 5 d for measurements). Goats were allocated to one of four treatments in a 2 × 2 factorial arrangement. Factors were no oil (C) or 4% SBO, and thermal neutral (TN; 15 to 20°C) or heat stress (HS; 12 h/d at 37°C and 12 h/d at 30°C) conditions, resulting in four treatments: TN-C, TN-SBO, HS-C, and HS-SBO. Urine samples were collected and analyzed with ^{1}H NMR spectroscopy for a qualitative metabolomic study. Principal component analysis (PCA) and partial least square–discriminant analysis (PLS-DA) were used to detect possible outliers and to identify possible metabolite markers of HS and SBO. The PLS-DA revealed that there were two separated clusters corresponding to TN (TN-C + TN-SBO) and HS (HS-C + HS-SBO) groups. Metabolites increased (P < 0.01) by HS were: hippurate, isoleucine, acetate, glutamate, glycine, and 3-hydroxybutyrate. On the other hand, L-phenylalanine and creatinine decreased (P < 0.01) by HS. Changes in those metabolites could be related to physiological responses to HS, including increased harmful gut microbiota activity (hippurate), increased catecholamine activity (conversion of L-phenylalanine to catecholamines), neurotransmitter inhibition (glycine), and decreased degradation of energy-related metabolites (acetate, isoleucine and glutamate). No significant regression model was found for the effects of SBO supplementation. We conclude that urine metabolomics could help in understanding the responses to heat stress and establishment of new alleviation strategies.

Key Words: heat stress, metabolomics, multivariate analysis

0579 Bovine core body and scrotal temperature measured using surgically implanted temperature-sensitive radio-transmitters, iButtons, and infrared thermography. A. Wallage[*1], J. B. Gaughan[1], A. Lisle[1], L. Beard[2], A. J. Cawdell-Smith[1], C. W. Collins[1], and S. Johnston[1], *[1]The University of Queensland, Gatton, Australia, [2]The University of Queensland, St Lucia, Australia.*

An ability to continuously and remotely monitor body (BT) and scrotal temperature (ST) without adverse or behavioral interference is fundamental to any study that investigates thermoregulation of the testis. Several methods for monitoring BT exist: loggers inserted into the rectum or vagina or placed in the ear close to the tympanic membrane, implantable radio-transmitters (RT), and rumen boluses. However, with all but RT and rumen boluses, data can only be collected for a few days. Previously, ST had only been measured via thermocouples for short durations (hours) or by manual scanning of microchips. This study compared the three most suitable technologies available for the coincident measurement of BT and ST: temperature sensitive RTs, data logging iButtons (IB), and infrared imaging (IRI). Bundles containing RT and IB were calibrated and surgically implanted in the abdominal muscle wall and scrotum of six bulls for between 29 and 49 d. IBs logged every 30 min, and RT pulse intervals were scanned every 15 min. Hourly IRI were taken of the body and scrotum of each bull for one 24 h period. Histology samples were obtained after castration at the conclusion of a series of heat-stress trials. IB were more reliable than the RT; all RT lost at least 11% of data, while 11 of the 12 IB had 100% data recovery. Pearson correlations between IB and RT were strong for both BT (r > 0.94, P < 0.001) and ST (r > 0.80, P < 0.001). Bland-Altman plots (limits of agreement) also showed stronger agreement with BT than ST, possibly due to the temperature gradient within the scrotum. The surgical procedure produced minor inflammation and hematoma in 2 animals immediately after the surgery. On castration, scar tissue was observed at all surgical sites but active spermatogenesis was evident in 10 of the 12 testicles. As all animals had been used in additional heat stress trials, it was impossible to determine the exact pathological effect of implant surgery. No significant correlation of IRI with either IB or RT existed, although sample size was small and, given that IRI measures surface temperature rather than BT, the usefulness of IRI is uncertain. IB provided a reliable, robust, and continuous BT and ST data set and can be successfully implanted in both the abdomen and scrotum of bovines.

Key Words: scrotal-temperature, iButton, radio-transmitter

0580 Rumen temperature of Brahman, Angus, and Charolais steers with and without access to shade. A. M. Lees*, J. B. Gaughan, M. L. Sullivan, J. C. Lees, and A. Lisle, *The University of Queensland, Gatton, Australia.*

Continuous measurement of body temperature (BT) is often difficult, and data collection is often restricted to short intervals. Remote assessment of BT through rumen boluses is a method of obtaining consistent BT over long periods of time without compromising animal comfort and potentially degrading carcass value. In this study, rumen temperature (T_{RUM}) of three cattle breeds, with and without access to shade, were assessed. 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 two treatments: un-shaded and shaded (3 m^2/animal; 90% solar block shade cloth). There were six steers (two/breed) per pen (162 m^2) and three pens/treatment. Ten-min T_{RUM} data were obtained over 130 d using rumen boluses. Individual T_{RUM} data were first converted to an hourly average, and then mean hourly T_{RUM} within breed x treatment were calculated. Rumen temperature was analyzed using a repeated measures model (PROC MIXED; SAS Inst. Inc. Cary, NC). The model analyzed the effect of breed ($P < 0.0001$), hour (h; $P < 0.0001$), breed x h ($P < 0.0001$), treatment x h ($P < 0.0001$), and breed x treatment x h ($P = 0.0036$). On average T_{RUM} of un-shaded Angus were greater ($P < 0.05$) than shaded and un-shaded Brahman's by 0.65 ± 0.05°C and 0.64 ± 0.05°C, respectively. Rumen temperature of shaded Angus were on average 0.46 ± 0.03°C ($P < 0.05$) lower than unshaded Angus between 1200 and 1600 h. Differences were observed between shaded and un-shaded Charolais between 1000 and 1700 h, with the shaded treatment on average 0.48 ± 0.02°C lower than unshaded. No h or treatment differences were detected between unshaded and shaded Brahman's, with a daily mean of 39.08 ± 0.08°C and 39.07 ± 0.08°C respectively, indicating that these animals may be utilizing breed specific behavioral and physiological mechanisms to regulate BT. These data suggest that providing feedlot cattle with shade during summer improves a non-heat-tolerant breed's ability to regulate BT. The relationship between rectal temperatures and T_{RUM} were also assessed ($r = 0.57$), with an average difference of 0.06 ± 0.06°C indicating that T_{RUM} is a robust measure of BT. Therefore, the assessment of an animal's thermal status can be undertaken through the remote assessment T_{RUM}.

Key Words: rumen temperature, body temperature, rectal temperature

0581 The effect of shade on vaginal temperature of cows housed outside under subtropical summer conditions. J. C. Lees*, J. B. Gaughan, A. M. Lees, and M. L. Sullivan, *The University of Queensland, Gatton, Australia.*

It is generally agreed that lactating dairy cows with access to shade have lower body temperatures than those without shade. The aim of this study was to determine the effect of shade on vaginal temperature (T_{VAG}) of cows housed outside in a sub-tropical environment. Holstein Friesian cows (n = 40) were paired based on milk yield and live-weight. Each pair was then allocated to either a shade (S) or a no shade (NS) treatment. Pairs were then randomly allocated to a T_{VAG} group (five pairs/group). Data were collected on one group per week, over 8 wk (two reps/group). A temperature logger was attached to a CIDR and inserted into the vagina for 5 d, logging every 10 min. Weather was monitored via an automated weather station (200 m from cows) and temperature humidity index [THI = 0.8 × ambient temperature + relative humidity x (ambient temperature – 14.3) + 46.3] was calculated using these data. Cows were milked twice daily at 0500 and 1500 h. Fans and sprinklers were used for 15 min before afternoon milking. Cows were placed within treatment from 0700 to 1445 h daily; fed a mixed ration twice daily, and turned out to improved pasture overnight. Averages for T_{VAG} and THI were obtained for each h over each 5-d period. Three data periods were examined: day (D), night (N), and evening (E); T_{VAG}_D and THI_D (0900 to 1500 h); T_{VAG}_N and THI_N (2200 to 0600 h); and T_{VAG}_E and THI_E (1700 to 2100 h). Pearsons correlations were performed on T_{VAG} against THI for each period. Overall, relationships were found between T_{VAG}_N and THI_N (r = -0.256; P = 0.041); T_{VAG}_D and THI_D (r = 0.34; P = 0.006); and T_{VAG}_D-N and THI_D-N (r = 0.61; $P < 0.000$) on the whole herd. Moderate correlations were determined for T_{VAG}_D-N and THI_D-N for S (r = 0.516; P = 0.003) and NS (r = 0.769; $P < 0.000$) cows. Shaded cows were better able to regulate T_{VAG} up to a THI of 76, after which T_{VAG} increased, whereas NS showed a positive, linear increase in T_{VAG} with increasing THI. It appears that S cows were better able to regulate body temperature than NS when THI_D-N was smaller than seven THI units. Above this point, the rate of increase in T_{VAG} against THI was greater in both treatments.

Key Words: vaginal temperature, shade, dairy cows

0582 Differences in panting score and shade usage between Brahman, Angus, and Charolais steers with and without access to shade during summer. J. B. Gaughan*, A. M. Lees, M. L. Sullivan, J. C. Lees, and N. B. Nquyen, *The University of Queensland, Gatton, Australia.*

The use of shade is largely a function of breed type and weather conditions. In this study the effect of breed on shade use and

subsequent respiratory response to heat load were evaluated. Thirty-six steers (12 each of Angus, Charolais, and Brahman; initial BW of 318.5 ± 6.7 kg) were used in an 81-d feedlot study with two treatments: no shade and shade (3 m^2/animal; 90% solar block shade cloth). There were six steers (two/breed) per pen (162 m^2) and three pens/treatment. Individual panting scores (PS) were obtained daily at 2-h intervals from 0600 to 1800 h. The PS system uses a seven-point score (0, 1, 2, 2.5, 3, 3.5, and 4) where PS0 indicates no thermal stress and PS4 indicates severe thermal stress (open mouth, tongue extended, rapid labored breathing). Individual PS were collated (breed and treatment), and mean panting scores (MPS) for each observation time (h) calculated. A MPS of 0.8 to 1.2 indicates high heat load, and if > 1.2 extreme heat load. Analysis of variance of MPS and shade usage was performed using repeated measures. The model analyzed the effect of breed, treatment, h, and all interactions. Angus used the shade in greater numbers ($P < 0.05$) at all times except 0600 h. For all breeds < 1% were under shade at 0600 h. For Angus maximum shade usage occurred at 1200 h (81.5%); for Charolais and Brahman maximum use occurred at 1400 h (39.4% and 24.6%, respectively). Mean PS was affected ($P < 0.05$) by treatment, treatment × h, breed, and breed × treatment. At 0600 h unshaded Angus had a greater ($P < 0.05$) MPS (1.06 ± 0.04) compared with unshaded Brahman (0.10 ± 0.02) and unshaded Charolais (0.90 ± 0.04). At 1400 h, when maximum MPS occurred, the values for unshaded (shaded in brackets) Angus, Charolais, and Brahman steers were 1.77 (1.52), 1.37 (1.31), and 0.78 (0.69), respectively. The percentage increase in MPS (0600 to 1400 h) of unshaded Brahmans was 87% ($P < 0.05$) (97% for shaded); for unshaded Angus the increase was 40% (47% for shaded), for Charolais it was 34% for unshaded and 41% for shaded. The MPS for shaded cattle suggests that the provision of shade allows cattle to improve thermoregulation. The greater percentage rise in MPS of Brahmans indicates that this breed does use increased respiratory dynamics in thermoregulation.

Key Words: panting, shade, cattle

0583 Correlation between mean panting score and temperature humidity index in lactating dairy cows in a sub-tropical summer. M. L. Sullivan*, J. B. Gaughan, N. Son, J. Lees, and A. M. Lees, *The University of Queensland, Gatton, Australia.*

Climate directly influences production and physiological responses of lactating dairy cows. Panting score (PS) can assist in determining the level of heat stress within a herd, but there is little research in this area for dairy cows. Forty lactating Holstein-Friesian cows were used in a 103-d study investigating the influence of summer conditions on animal response to heat load. The cows were managed within a partial mixed ration system and were milked twice daily (0530 h, 1400 h). The cows were observed twice daily [1000 h (AM); 1400 h (PM)] by the same observer. Individual PS were obtained once at each observation. Panting score system uses a seven-point score (0, 1, 2, 2.5, 3, 3.5, and 4), with PS0 = no thermal stress and PS4 = severe thermal stress (open mouth, tongue extended, rapid labored breathing). Individual PS were collated and converted into mean PS (MPS) for 40 cows at AM and PM. A MPS of 0.8 to 1.2 = high heat load, MPS > 1.2 = extreme heat load. In both instances milk production and reproduction are adversely affected. Ambient temperature (T_A) and relative humidity (RH) were obtained at 10-min intervals from an automated on-site weather station. THI was calculated from these data (THI = 0.8 × T_A) + [(RH/100) × (T_A - 14.4)] + 46.4). Mean PS were analyzed using repeated measures model. Correlations between MPS and THI at time of observation (0 h; AM/PM) and for 2- and 1-h lags were determined using Pearson correlation analysis. The MPS of cows (0 h) at PM (1.3 ± 0.05; extreme heat load) was greater ($P < 0.01$) than AM (1.1 ± 0.05; high heat load). Overall, MPS and THI were moderately correlated ($P < 0.001$) for 0-, 1-, and 2-h lags for AM and PM. For AM the best correlation between MPS and THI was $r^2 = 0.50$ for 1-h lag. For PM the best correlation between MPS and THI was $r^2 = 0.69$ for no lag (0 h). Elevated PS during AM may be an attempt to reduce heat load while there is a positive temperature gradient between the cow and the environment.

Key Words: panting, heat stress, temperature humidity index

0584 Correlation between milk production, days in milk, and temperature humidity index in lactating dairy cows in a sub-tropical summer. M. L. Sullivan*, J. B. Gaughan, N. Son, J. Lees, and A. M. Lees, *The University of Queensland, Gatton, Australia.*

Heat load is a significant factor that contributes to reductions in milk production in sub-tropical dairy cows. Forty lactating Holstein-Friesian cows were used in a 103-d study investigating the influence of summer conditions on animal responses. The cows were managed within a partial mixed ration system (70% total mixed ration and 30% pasture) and were milked twice daily at 0530 h and 1400 h. Individual milk production (MP) was recorded at each milking. Ambient temperature (T_A) and relative humidity (RH), were obtained at 10-min intervals from an automated on-site weather station, and temperature humidity index (THI) was calculated based on these data: (THI = 0.8 x T_A) + [(RH/100) x (T_A - 14.4)] + 46.4. Individual MP were collated and converted into mean MP for the 40 cows. Correlations between MP and mean THI for -1, -2, and -3-d lags were examined using Pearson correlation analysis. The mean MP over the duration of the study was 23.3 kg/cow.d^{-1} (range 18.9 to 28.3 kg/cow.d^{-1}), and DIM was < 50 d at the commencement of the study. The mean monthly THI for the duration of the study progressively increased: December, 71.0 ± 0.07 (range 51.5 to 84.7); January, 73.2 ± 0.07 (range 60.2 to 86.4); February, 74.1 ± 0.09 (range 59.7 to 87.1). Milk production was negatively correlated with THI ($P < 0.01$) for

1-, 2-, and 3-d lags. The correlation between MP for the 1-, 2-, and 3-d lags and THI on d 0 were -0.57, -0.55, and -0.53. Fluctuations in MP during summer are generally attributed to changes in THI, and this is supported by the current study. However, there was a negative correlation (r = -0.72, P < 0.001) between MP and DIM. During the study, increasing heat load corresponded with increasing DIM. Reductions in MP due to increasing DIM need to be accounted for so as not to confound the reductions in MP due to heat load. This study suggests that there is a strong negative correlation between the THI, MP, and DIM and that the effects are cumulative.

Key Words: heat stress, milk production, temperature humidity index

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0585 Effects of metabolizable energy intake on tympanic temperature and ADG of steers finished in southern Chile during wintertime. R. A. Arias[*1], T. Brown-Brandl[2], and T. L. Mader[3], *[1]Universidad Católica de Temuco, Núcleo de Investigación en Producción Alimentaria, Temuco, Chile, [2]ARS-USDA, Clay Center, NE, [3]Mader Consulting, LLC, Gretna, NE.*

A total of 24 Angus x Hereford steers (BW = 479.8 ± 4.48) were used to assess the effect of ME intake (MEI) on ADG and tympanic temperature (TT) during the wintertime in southern Chile. The study was conducted at the experimental field of the UC Temuco and included a period of 21 d for adaptation to diet and facilities. Steers were randomly allocated in four pens (six/pen) equipped with a Calan Feeding System. Steers were sorted by BW, assigned to block (lighter or heavier), and then allocated into one of two treatments: T1 = 1.85x or T2 = 2.72 x MEI for maintenance. All steers were fed 1x/day with the same diet; treatments were applied by controlling DMI. Subsequently, five animals/treatment received a device to collect TT; those were retrieved 10 d later. Climatic data were obtained from a weather station located 5 km southeast from the research site. All data were analyzed under a complete randomized block experimental design (α = 0.05), and each steer was considered an experimental and observational unit. The steers fed with higher MEI showed higher TT than those fed with lesser MEI (P < 0.0001) through all days. In addition, both groups followed the same TT pattern throughout the TT collection period. This could be explained by changes in precipitations (PP) and wind speed (WS). The highest TT was observed in those days without PP and low WS. On the other hand, the lowest TT was observed when WS and PP were higher. Thus, in adult animals it appears that WS has an important role in the thermal balance during the wintertime. Similarly, steers fed with less MEI showed lesser TT when compared with those fed high MEI (P < 0.0001) through every hour of the day, even when both groups had theoretically enough energy to cover maintenance requirements. Following the same trend, observed ADG was higher (P = 0.0004) for those steers fed the high MEI compared with those fed the less MEI (0.54 vs. 0.17 ± 0.06 kg/d, respectively). This represents a performance of 3.18 times better for T2; however, MEI was only 1.47 times higher in this treatment. In conclusion, based on the data collected so far, it can be said that MEI has a direct effect on the TT and ADG of steers finished during the winter period in an open feedlot. In addition, both variables are directly affected by climatic conditions.

Key Words: tympanic temperature, thermal comfort, climate

0586 Conductive cooling as an alternative to cool down dairy cows. X. A. Ortiz[*1], J. F. Smith[1], F. Rojano[1], C. Y. Choi[2], J. Bruer[3], T. Steele[3], N. Schuring[4], J. D. Allen[5], and R. J. Collier[6], *[1]University of Arizona, Tucson, [2]University of Wisconsin-Madison, Madison, [3]Conco Technology Inc., Phoenix, AZ, [4]GEA Farm Technologies, Naperville, IL, [5]Northwest Missouri State, Maryville, [6]The University of Arizona, Tucson.*

The typical cooling system utilized to reduce heat stress in dairy operations requires high energy and/or water usage. With the steady increase in electricity costs and reduction of water availability and increase in water usage regulations, passive cooling systems need to be investigated as ways to cool cows and reduce the utilization of water and electricity. An experiment was designed to investigate the use of heat exchangers buried 25 cm below the surface as components in a conductive system for cooling cows. Six cows were housed in environmentally controlled rooms with tie-stall beds that were equipped with a heat exchanger and filled with 25 cm of either sand or dried manure. Beds were connected to supply and return lines and individually controlled. Two beds (one per each kind of bedding material) constituted a control group (water OFF), and the other four (two sand and two dried manure) used water at 7°C passing through the heat exchangers (water ON). The experiment was divided in two periods of 40 d, and each period involved three repetitions of three different climates (hot dry, thermo neutral, and hot humid). Sand bedding remained cooler than dried manure bedding in all environments and at all levels of cooling (water ON or OFF). Bed temperatures were lower and heat flux higher during the Sand ON bed treatment. We also detected a reduction in the core body temperatures (CBT), the respiration rates (RR), rectal temperatures, and skin temperatures of those cows heat-stressed during the Sand ON treatment. Dry matter intake and milk yield numerically increased during the Sand ON bed treatment for all climates. No major changes were observed in the lying time of cows or the composition of the milk produced. We concluded that use of heat exchangers is a viable alternative to systems that employ fans, misters, and the evaporative cooling methods to mitigate the effects of heat stress in dairy cows. Sand was a better bedding material to use in combination with heat exchangers. Additional research is needed to investigate alternative ways to increase the ex-

change of heat through conduction. Future studies should investigate the benefits of placing the heat exchanger closer to the skin surface and further reducing the water temperature through mechanical cooling.

Key Words: conductive cooling, heat stress and dairy cow

0587 Comparison of winter feeding systems for the evaluation of beef cow performance, reproductive efficiency, and system costs. D. Jose[*1], G. B. Penner[1], J. J. McKinnon[1], K. Larson[2], and B. Lardner[1,2], *[1]University of Saskatchewan, Saskatoon, Canada, [2]Western Beef Development Centre, Humboldt, SK, Canada.*

Extensive winter grazing has been proven as a successful strategy to reduce production and labor costs in a cow-calf operation without much adverse effects on animal health and performance. Two experiments were conducted during the winter of 2012–13, to evaluate three winter feeding systems: 1) field grazing standing whole plant corn (SC; TD*N* = 59.5%, CP = 7.8%), 2) field grazing swathed barley hay (SB; TD*N* = 66.2%, CP = 8.5%), and 3) barley hay bales fed in drylot pens (DL; TD*N* = 60.1%, CP = 12.7%). The specific objectives were to compare beef cow performance, reproductive efficiency, and system costs in experiment 1 (EXP 1), and ruminal pH parameters in experiment 2 (EXP 2). In EXP 1, dry pregnant Angus cows (n = 60, body weight (BW) = 651.2 ± 7 kg), stratified by body weight and days pregnant, were randomly allocated to one of three replicated (n = 2) winter grazing treatments for 77 d. Cow BW, body condition score (BCS), and rib and rump fats were measured at the start and end of the trial. Increases in rump fat were greater (P = 0.002) for SC cows compared to DL cows (1.90 mm vs. 0.55 mm, respectively). Calves born to cows on SC were heavier (P < 0.001) at birth compared to calves from SB cows (42 vs. 40 kg respectively). In EXP 2, nine cannulated beef heifers were cycled through the three winter systems concurrently within EXP 1 in a replicated 3 × 3 Latin square design for 63 d to evaluate effect of forage type on rumen pH. Results from EXP 2 indicated that SB heifers had the lowest (P < 0.003) mean, minimum, and maximum rumen pH and greatest duration and area under pH < 5.8 (P < 0.001) compared to heifers on SC and DL winter systems. Economic analysis revealed that total costs were greatest for the DL ($2.29/head/d) compared to SC ($1.78/head/d) and SB ($1.65/head/d) systems. Results suggest that both SC and SB systems are cost-effective alternatives to DL system and do not negatively affect cow body weight or reproductive performance in winter.

Key Words: winter grazing, corn grazing, swath grazing, reproductive performance

0588 Effect of two winter housing systems on production, body weight, somatic cell count, BCS, and dry matter intake of organic dairy cows. L. S. Sjostrom[*1], B. J. Heins[1], M. I. Endres[2], R. D. Moon[2], and U. S. Sorge[3], *[1]University of Minnesota, West Central Research and Outreach Center, Morris, [2]University of Minnesota, St. Paul, [3]University of Minnesota, Dep. of Veterinary Population Medicine, St. Paul.*

Organic cows (n = 83) were used to evaluate the effect of two winter housing systems (December 2012 to May 2013) on production, SCC, body weight, BCS, and DMI. Cows were assigned to one of two treatments (two replicates per group): 1) outdoor (straw pack, n = 42) or 2) indoor (compost-bedded pack barn, n = 41). There were 21 cows per replicate for the outdoor housing and 21 and 20 cows per replicate for the indoor housing. Cows calved during two seasons (March to May 2012 and September to December 2012) at the University of Minnesota West Central Research and Outreach Center, Morris, MN, organic dairy. Organic wheat straw was used as bedding for the two outdoor bedded packs, which were 12 m wide by 27 m long, and maintained by farm management to keep cows dry and absorb manure throughout the winter. The open-front compost-bedded pack barn (two pens in the barn) was bedded with organic-approved sawdust, and the bedding material was stirred twice per day with a small chisel plow. Cows were fed a TMR that included organic corn silage, alfalfa silage, corn, expelled soybean meal, vitamins, and minerals. Milk, fat, and protein production and SCC were recorded from monthly DHIA testing. Body weight and BCS were recorded bi-weekly as cows exited the milking parlor. The PROC MIXED of SAS was used for statistical analysis, and independent variables were fixed effects of season of calving (fall or spring), parity (1, 2, 3+), breed group, housing system, with replicate and cow nested within the interaction of housing system and season as a random effect. Energy-corrected milk and SCC was not different for the outdoor (15.5 kg/d, 206,000 mL) and indoor (16.1 kg/d, 357,000 mL) housing systems, respectively. In addition, outdoor and indoor housing systems were not different for body weight (523 vs. 538 kg) and BCS (3.15 vs. 3.08), respectively. Daily DMI was 17.8 kg/d for indoor cows and 17.6 kg/d for the outdoor cows (P = 0.47). Total bedding costs during the winter was $8,275 for the outdoor system and $9,248 for the indoor system. In summary, cows housed outdoors on straw-bedded packs did not differ from cows housed in an indoor compost-bedded pack barn for production and SCC, as well as body weight, BCS, or DMI.

Key Words: organic, outwintering, compost barn