

Nonruminant Nutrition Are We Ready for Nutritional Genomics?

321 Microarray and proteomic technology for nutrition research. K. E. Webb, Jr.*¹, E. A. Wong, and H. Jiang, *Virginia Tech, Blacksburg, VA.*

For decades, biochemical and physiological and, more recently, molecular approaches have been employed exhaustively and effectively in the quest to better understand nutrient utilization. A greater understanding of gene regulation and the interactions among their encoded proteins will enable the further extension of knowledge concerning nutritional physiology. The same genes are present in all cells in the body, however, differential expression of a subset of genes determines a cell's function. Multiple genes are responsible for most physiological processes, including nutritional processes such as digestion and absorption. Interactions among gene products are complicated and highly orchestrated. Functional genomics, through microarray hybridization, allows the coordinated assessment of changes in mRNA abundance for thousands of genes simultaneously in a cell or tissue in relation to changing physiological status. Microarrays can be valuable in understanding transcriptional regulation across the genome. mRNA are essential for translation of proteins, however, the presence of the mRNA for a protein does not necessarily mean that the protein is expressed. Further, proteins can persist in cells long after their mRNA are no longer present. Therefore, besides abundance of steady-state mRNA, it is necessary to monitor changes in the expression of proteins. Functional proteomics, the global analysis of gene expression at the protein level, allows the simultaneous evaluation of expression of hundreds or thousands of proteins and possible post-translational modifications of these proteins in cells or tissues using high-resolution, two-dimensional gel electrophoresis. Individually, microarray and proteomic technologies can provide vast amounts of information about gene function in relation to nutritional physiology which can assist in understanding prevailing concepts, enable discover-

ies, and/or facilitate the development of new hypotheses. Combined, they can be immensely powerful. These are new paradigms for examining gene expression in food-producing animals.

Key Words: Microarrays, Proteomics, Nutritional physiology

322 How do these tools help study nutrient function? X. G. Lei*¹, *Cornell University.*

In a post-genome-sequencing era, gene-chip and proteomic tools are being increasingly applied to study nutrient function and metabolism. Our laboratory has studied in vivo antioxidant functions and signaling of selenium. Using the selenium-dependent glutathione peroxidase (GPX1) knockout mice, we found that minute hepatic GPX1 activity attenuated the pro-oxidant-induced apoptosis, a mixed form of cell death that shares apoptosis and necrosis. To illustrate the underlying signal pathways, we determined the impact of minute GPX1 activity on the time-course of the pro-oxidant-induced expression of 23 apoptosis-related signal molecules in livers of the GPX1 knockout mice and the wild-type mice. Total liver RNA was isolated using the RNAqueousTM kit (Ambion, Austin, TX), and detected using the Mouse Apoptosis-1 GEArray kit (Super Array, Inc., Bethesda, MD). A total of 11 out of the 23 genes in the Array gave distinct and reproducible signals. The largest difference in mRNA levels between the two groups of mice was the DNA damage-inducible GADD45, followed by consistent protein responses. Our results unveil a novel signal mechanism for the GPX1 protection against oxidative cell death, and exemplify the usefulness of the genomic tools in studying nutrient function.

Key Words: Selenium, Gene knockout, Microarray

Animal Behavior and Well-Being Influence of Production Practices on Behavior and Well-Being

323 Reaction of Holstein dairy cattle to a looming person as a temperament assessment tool. J. L. Lanier¹ and T. Grandin*¹, *Colorado State University.*

A population of registered, artificially inseminated Holstein dairy cows (n=263) was used to determine if temperament as measured by reaction to a looming person was associated with average milk production. Individual reaction to a looming person was assessed while the cow was restrained in outdoor head stanchion during the morning feeding. An unfamiliar observer stood 1 m (3 feet) directly in front of each cow's head, keeping the shoulder pointed towards the cow's head, waited 15 s, then calmly leaned sideways towards the cow allowing the inner arm to dangle. Reaction was rated as 1) non-reactive - no reaction, or stretched to sniff observer, 2) mildly reactive - pulled away from observer, did not pull against head stanchion, or 3) highly reactive - pulled against head stanchion or head remained pulled against stanchion throughout test. Milk production values from the current lactation were used. Results were expected a priori for more reactive cows to have lower productivity. One-way analysis of variance with a contrast was used to compare the average production yield of highly reactive cows to the combined average of the mildly and non-reactive cows. Very reactive cows had 47.3 kg less productivity mature equivalent fat compared to the non- and mildly reactive cow average (P = 0.05). No association was found for all other production values. The temperament assessment could have been improved by comparing the cows' reaction to a familiar looming person as well. The use of temperament assessment combined with current production traits could assist dairy producers in their herd management.

Key Words: Dairy cattle, Milk production, Temperament

324 Orientation of beef cattle grazing foothill winter range in Montana. B. Olson*¹, *Montana State University.*

Cattle may graze foothill winter range in northern areas as an alternative to feeding hay, although this exposes them to potential thermal stress. Consequently, cattle may orient to maximize heat gain or to minimize heat loss depending on ambient weather. Our objective was

to determine how mature cattle orient while grazing winter range. During two winters (Winter 1 1996-1997; Winter 2 1997-1998), we recorded orientation of cattle (n = 32) at 30-min intervals from dawn to dusk 3d each wk for approximately 7 wk. Circular statistics, including mean vector (body orientation relative to direction) and vector length (variation around mean vector), were used to characterize orientation. Stepwise multiple regression was used with mean vector and vector length as response variables, and solar radiation, net radiation, temperature, relative humidity, wind velocity, and wind direction as predictor variables. Mean vector was approximately east-west (Winter 1, 80°, Winter 2, 100°; body perpendicular to the sun low in the winter sky), although coefficients of determination were low, especially in the second winter (Winter 1, R² = 0.14; Winter 2, R² = 0.03). Vector lengths increased with increasing solar radiation, especially at cold temperatures (Winter 1, R² = 0.24; Winter 2 R² = 0.17), indicating more cattle were assuming the same orientation under these conditions. Cattle oriented perpendicular to the sun's rays intercept about 80% more direct radiation than cattle facing the sun. On relatively warm, sunny days, radiation absorbed by cattle can range from 4 to 6x (280-420 W m⁻²) basal metabolic heat production (70 W m⁻²). A simple thermal balance model, including net radiation, ambient temperature, cattle surface temperature, latent and sensible heat loss, conduction, storage, and metabolic heat, indicates that net radiation can greatly affect thermal energy gains and losses under different weather conditions.

Key Words: winter, thermal balance, behavior

325 Relationships between daily feed intake and feeding behaviours in feedlot steers. J.A. Basarab*¹, E.K. Okine², and K.L. Lyle¹, *¹Western Forage Beef Group, Lacombe Research Centre, Lacombe, Alberta, Canada, ²University of Alberta, Edmonton, Alberta, Canada.*

This study was conducted to quantify the relationship between daily feed intake and feeding behaviors in feedlot steers. Seventy-five spring born steer calves (330 kg; SD=40 kg), 15 from each of the M1, M2, M3, M4 and TX BeefBooster strains, were adjusted to a high-barley diet (22.0%

barley silage, 78.0% steam rolled barley and supplement) and intensively monitored for individual animal feed intake using the GrowSafe® System. Daily feed intake averaged 10.7 kg d⁻¹ (SD = 2.6). This level of feed intake was accomplished in just over eight feeding events daily (8.2 events d⁻¹, SD = 3.7) and over an average feeding duration of 81.4 min d⁻¹ (SD = 25.3). Head-down time averaged 33.8 min d⁻¹ (SD = 33.8). The relationship between feed intake and feeding duration was curvilinear and accounted for 59.9% ($P < 0.0001$) of the variation in feed intake. Each 10 minute increase in feeding duration resulted in an increase of 1.9 kg d⁻¹ in feed intake between feeding durations of 10 and 90 min d⁻¹. Feed intake reached a plateau after a feeding duration of 110 min d⁻¹, indicating that most feeding activity after 110 min was associated with socialization and rumination. The relationship between feeding head-down time and feed intake was also curvilinear and accounted for 48.5% ($P < 0.0001$) of the variation in feed intake. Feeding frequency was poorly related to feed intake ($r = 0.310$, $P < 0.0001$). These relationships may be useful in converting feeding behaviours to estimates of individual animal feed intake and understanding why low levels of feeding behaviour early in a feeding period are associated with poor growth performance in feedlot cattle.

Key Words: Beef Cattle, Remote sensing, feeding behaviour

326 Effect of timing and uniformity of feed delivery on feeding behavior, ruminal pH and growth performance of feedlot cattle. K.S. SchwartzkopfGenswein^{*1}, T.A. McAllister², D.J. Gibb², K.A. Beauchemin², and M. Streeter³, ¹Alberta Agriculture, Food and Rural Development, Lethbridge, AB, ²Agriculture and Agri-Food Canada, Lethbridge, AB, ³Alpharma Inc., Fort Lee, NJ.

The effects of programmed (P) vs fluctuating (F) feed delivery on ruminal pH were assessed in a crossover experiment (two 28-d periods) involving six mature, ruminally cannulated steers consuming an average of 10.32 kg/d of a barley grain/barley silage-based finishing diet. Steers in group P were fed for ad libitum intake, whereas steers in group F were fed 10% above or below their ad libitum intake on a rotating 3-d schedule. Ruminal pH of each steer was measured continuously via an indwelling electrode placed in the rumen during the last 6 d of each period. Mean pH was 0.10 units lower ($P = 0.15$) for F than P steers (5.63 vs 5.73), and ruminal pH of F steers remained below 6.2 ($P = 0.15$), 5.8 ($P = 0.03$) or 5.5 ($P = 0.14$) for greater proportions of the day than with steers in group P. Inconsistent delivery of feed may lower ruminal pH and increase risk factors associated with acidosis. In Exp. 2, the effects of fluctuation (P vs F) and timing (0800 vs 2100 daily) of feed delivery on feeding behavior and performance during backgrounding and finishing were assessed in a 209-d trial using 240 crossbred beef steers (310 ± 23 kg) in 16 pens, with treatments arranged in a 2 × 2 factorial ($n = 4$). One pen per treatment was equipped with a radio frequency identification (GrowSafe Systems Ltd.) system that monitored bunk attendance by each steer throughout the trial. Feeding regime did not affect ($P > 0.05$) DMI (7.36 kg/d), ADG (1.23 kg/d), feed/gain (6.23), or time spent at the bunk (109 min/d), nor were fluctuation × timing interactions observed ($P > 0.05$). Late feeding increased ($P < 0.05$) daily DMI (7.48 vs 7.26 kg) but this difference was not reflected in ADG, feed conversion or time at the bunk. These studies indicate that the risk of ruminal acidosis was increased with fluctuating delivery of feed, but increased risk of acidosis did not impair animal performance.

Key Words: Feed delivery, Feeding behavior, Cattle performance

327 The effects of ractopamine on behavior and physiology of finishing pigs. J.N. Marchant-Forde^{*2}, D.C. Lay Jr.², B.T. Richert¹, and E.A. Pajor¹, ¹Dept of Animal Sciences, Purdue University, 1151 Lilly Hall, West Lafayette, IN 47907, ²USDA-ARS, Livestock Behavior Research Unit, Purdue University, West Lafayette, IN 47907.

This study aimed to examine the effects of ractopamine (RAC) on behavior and physiology of pigs during handling and transport. Twenty-four groups of 3 finishing pigs were randomly assigned to one of two treatments, four weeks prior to slaughter; 1) finishing feed plus RAC (10ppm), 2) finishing feed alone. Pigs were housed in adjacent pens with fully-slatted floors and access to feed and water ad lib. Behavioral time budgets were determined in half the pens over a single 24-hour period during each week. Behavioral responses to routine handling and weighing were determined at the start of the trial and weekly. Heart-rate (HR) responses to unfamiliar human presence were measured in all

pigs and blood samples were taken from a single pig in each pen on different days during week 4. At the end of week 4, pigs were transported for 20 min to slaughter. HR was recorded from at least one pig per pen during transport and a further post-slaughter blood sample was taken from pigs previously sampled. During weeks 1 and 2, RAC pigs spent less time inactive (week 1, 75±2% vs 81±1%, $p < 0.05$; week 2, 76±1% vs 81±1%, $p < 0.01$) and less time lying laterally (week 1, 55±2% vs 65±2%, $p < 0.01$; week 2, 58±3% vs 68±1%, $p < 0.05$). There were no differences in time budgets during weeks 3 and 4. Initially, there were no differences in responses to handling. However, over each of the next 4 weeks, fewer RAC pigs exited the home pen voluntarily, they took longer to be removed from the home pen, longer to handle into the weighing scale and needed more interactions from the handler to enter the scales. At the end of week 4, RAC pigs had higher HR in the presence of an unfamiliar human (144.6±3.2 bpm vs 136.4±2.7 bpm, $p < 0.05$) and during transport (151.6±4.1 bpm vs 140.7±3.3 bpm, $p < 0.05$), but not during loading and unloading, and had higher circulating epinephrine (253.0±55.0 pg/ml vs 101.5±15.0 pg/ml, $p < 0.05$) and norepinephrine (991±150 pg/ml vs 480±58 pg/ml, $p < 0.01$) than control pigs. Circulating cortisol concentrations and cortisol responses to transport did not differ between treatments. The results show that ractopamine does affect the behavior and physiology of finishing pigs and may make them more difficult to handle and more susceptible to handling and transport stress.

Key Words: Swine, Behavior, Well-being

328 Modulation of health and production by oral beta-glucan and ascorbic acid after transport. S. D. Eicher^{*1} and T. R. Johnson², ¹USDA-ARS, ²Purdue.

Objective of this study was to determine production and health differences in Holstein calves, following transport, given an oral yeast cell-wall derivative, purified β-glucan from yeast cell-walls, or a positive control. Calves ($n=39$) were blocked by sex and assigned to treatments; (IG) 113 g of a yeast cell wall derivative (Energy-plus, Natural Chem Industries, LTD) and 250 mg of an ascorbic acid product (Stay-C, Roche Vitamins), (BG) 150 mg of a β-glucan fraction from yeast cell-walls that is equivalent to that contained in Energy-plus (Biopolymer Engineering) plus 250 mg Stay-C, or (Con) a positive control with no supplements, but subcutaneous electrolytes. Calves were fed an all milk, milk replacer at 4.45 kg/d in 2 equal feedings with supplements in the milk replacer. A grain based dry feed was offered beginning on d 3. Calves, 3 to 10 d-of-age, were transported for 4 h, after being weighed and sampled by jugular venipuncture, then calves began treatments in outdoor hutches. Weights were taken weekly for 4 wk and feed weighed back every other day. Fecal and clinical scores, and nasal and ocular discharge occurrences were recorded 3 times per wk. Blood samples were collected 0 h then d 3, 7, 10, 14, 21, and 28 post-transport. Data were analyzed as a repeated measures design using GLM procedures of SAS. Although weights were not different among calves, intake at week 4 was less for IG than for Con ($P < .05$). Feed efficiency was improved for IG ($P < .05$) and tended to improve for BG ($P < .10$) at wk 4. Plasma IgG, fecal and clinical scores, serotonin, and tryptophan were not different ($P > .10$). Ocular and nasal discharge scores were greater for BG than for IG during wk 2 ($P < .05$). This coincided with peripheral blood mononuclear cell counts that were least for BG compared to IG and Con (d 10) but IG was greater than Con (d 3), and than BG (d 21 and 28) ($P < .05$). Plasma fibrinogen tended ($P < .10$) to be greater for IG than Con (d 7) and than BG (d21). Both β-glucan products were beneficial for feed efficiency by wk 4. However, it appears the mechanisms may be different because many of the health and immune measures were different between IG and BG at d 10 to 28.

Key Words: Dietary Immunomodulators, Dairy Calves, Transport

329 The effect of holding pen time on milk production and blood components in Holstein dairy cows. A. G. Fahey^{*1}, M. M. Schutz¹, E. A. Pajor¹, S. D. Eicher², S. J. Larkin¹, and K. A. Scott², ¹Purdue University, West Lafayette, IN, ²USDA-ARS, West Lafayette, IN.

During dairy farm expansion, cows frequently spend more time standing in the holding pen before milking and are away longer from food, water and stalls. Thus, the objective of this study was to investigate the effect of time spent in the holding pen on milk production and blood parameters in Holsteins. Thirty-five cows were randomly assigned to

two groups. During period 1 (wk 1 and 2), cows in group A (n=17) were kept in a holding pen for 40 min before milking and cows in group B (n=18) were kept in the same holding pen for 120 min before milking. Both groups of cows were off the study for 12 d between period 1 and 2 in order to reduce any carryover effects. During period 2 (wk 3 and 4), cows in group A were kept in the holding pen for 120 min and cows in group B were kept in the holding pen for 40 min. During this time, milk weights were measured daily and milk composition and post-milking blood samples were taken from each cow 4 times during each period. Milk composition data included protein, fat, lactose, and somatic cell scores (SCS). Blood components measured included fibrinogen, white blood cells, peripheral blood mononuclear cells, granulocytes (GRAN%), and hematocrit (HCT%), which were examined as indicators of stress or dehydration. Weekly means of weights, SCS, and blood components were obtained, as were differences between means for the two weeks in each period. Statistical models used to analyze production and blood records included the effects of treatment, period and cow. Cow had a highly significant ($P < .01$) effect on all traits except for GRAN and HCT%, but not on differences from wk 1 to 2 within time period. The effect of period was highly significant ($P < .01$) for differences in milk component weights from wk 1 to 2 in each period and significant for milk ($P < .01$), fat ($P < .10$), lactose ($P < .05$), HCT% ($P < .05$), and difference in GRAN% from wk 1 to 2 ($P < .05$). Length of time in the holding pen affected only protein yield ($P < .10$), with cows held longer producing 0.03 kg more protein per day. Results indicate that exposure of cows for short times to increased stays in a holding pen does not significantly affect production or stress indicators in the short term.

Key Words: Holding pen, Milk production, Blood components

330 Weaning age impairs spatial learning in pigs at increased but not basal levels of stress. K. Laughlin* and A.J. Zanella, *Animal Behavior and Welfare Group, Department of Animal Science, Michigan State University.*

The cognitive abilities of domestic animals and how these are affected by environmental factors and the animal's own internal state, have been the focus of a number of recent applied ethology studies. Previous research has shown that domestic pigs have accurate spatial memory abilities, which can be impaired when animals are presented with relatively mild disturbance treatments. It is hypothesized that the practice of early weaning in pigs subjects the animals to increased levels of stress hormones which may have a detrimental effect on their subsequent cognitive development, perhaps through modulation of glucocorticoid receptor activity within the regions of the brain responsible for learning and memory. We adapted the Morris water maze to examine cognitive abilities in young female pigs, comparing the performances of early-weaned pigs (EW=12 d of age) with conventionally weaned (CW=21 d of age) littermates at basal and increased levels of stress. A circular pool was filled with opaque water containing a hidden platform. Spatial learning was measured by a decrease in latency to reach the platform across 7 exposures separated by 10-min intervals. Performances of EW (n=12) was compared to those of CW (n=12) pigs when tested at d14 and d23. We found no significant differences between the groups during normal undisturbed trials (ANOVA; $F_{1,22} = 1.58$, NS). We then socially isolated EW (n=6) and CW (n=6) pigs for 15-min prior to testing, which resulted in a significant increase in salivary cortisol in these animals (paired t-test; $N=12$, $t=7.82$, $p < 0.001$) and compared their performances in the maze to those of non-isolated control groups. We found no significant effect of isolation on the performances of CW pigs (ANOVA, $F_{1,10} = 1.28$, NS). However, isolated EW pigs did not appear to learn the task, showing no decrease in latency to reach the platform across successive visits to the pool, and their performance was significantly poorer than the EW control group (ANOVA; $F_{1,10} = 9.59$, $p = 0.01$). Cognitive impairment under stressful situations may compromise the adaptive response of pigs leading to potential management and welfare problems.

Key Words: Pig cognition, Water- maze, Early-weaning

331 Sexual behaviour of male New Zealand white rabbits in an intensive production unit. V. Fuentes*, C. Villagran, and J. Navarro, ¹*Centro Universitario de los Altos Universidad de Guadalajara, México.*

Sexual behaviour in the male New Zealand White Rabbit in intensive production units is not fully documented. Therefore the objective of this work is to provide further information about the sexual behaviour

of this species under intensive production. Fourteen, 6- to 12-mo old male rabbits were studied, housed individually under natural photoperiod (19 Latitude North). Mating was carried out twice a week. When mated a non-pregnant female was introduced to their cages for a time period of 6 min. During this time the number of mounts, latency between mounts, number and latency of ejaculations, enuresis (urination), grasping and kicking were observed and recorded. In total, 222 mounts were observed and recorded. Males mated one to five times. There was a relation between sexual behaviour and aggressiveness. Enuresis (urination) was observed only in one occasion. Grasping was noted in 142 mounts and kicking observed in 133 matings. For the first five matings, male rabbits mounted and ejaculated within 4.20 minutes. In addition, the minimum time taken from the moment of ejaculation and the beginning of next mounting was 17 s; the longest time noted was 5 minutes, 33 seconds. During the statistical analysis of the results it was observed that there was a significant difference between rabbits using a one factor ANOVA ($F = 11.51333$; 13,208 df ; $P < 0.05$). The sexual behaviour of white New Zealand male rabbits is regularly maintained through time, and environmental temperature and photoperiod did not influence their sexual behaviour.

Key Words: sexual behaviour, Rabbits, Mating

332 Effect of dehydration on some behavioral aspects of camels. H Abdel Rahman*¹, M.A. El Sherif², M.A. El Sayed¹, S.S. Omar¹, and N.M. Ibrahim², ¹*Minufiya University,* ²*Desert Research Center.*

Four she camels (*Camelus dromedaries*), aged 12 yrs and weighing 558.6 kg on average, were kept in 15 x 11 m open yard and fed ad libitum on fresh acacia and clover hay. They were exposed during summer and winter to 5 dehydration cycles (7 d each), preceded by 2 wk control period (CP). Fresh drinking water was available ad lib during CP. Behavioral patterns were recorded 3 times/ season (on last 2 d of CP, d 6 and 7 of 5th dehydration (DH)cycle and first (RH1) and second (RH2) rehydration days. Dehydrated animals lost 105.5 and 76.8 kg in summer and winter ($P < 0.01$), but they restored 85 and 60% on RH1 mounted to 128 and 105 % of body weight (BW) loss on RH2, respectively. Summer and winter water intake (WI) increased ($P < 0.01$) on RH1 to be 236 and 197% of control WI, equal to 20.3 and 14.4 % of DH live BW, respectively. On RH2, the corresponding values were 78, 81, 6.7 and 5.9% ($P < 0.01$), respectively. Time spent feeding, ruminating and idling was 29.6, 30.4 and 39.7 % of daily activities in summer CP vs. 6.8, 20.2 and 73.0% in DH period, being 34.3, 38.9 and 26.6% vs. 21.6, 32.0 and 46.4 % in winter, respectively. Both dehydration and season effects on such traits were highly significant ($P < 0.01$). RH camels still spent greater time idling (45.5 and 50.1% of daily activities on DH1 and DH2 in summer vs. 41.3 and 39.3% on DH1 and DH2 in winter, respectively, ($P < 0.01$). Combination effect of DH and hot climate on feeding behavior delayed recovery more than 2 d RH, while WI was recovered from long thirst period (7 days) within 1 day only. To face dehydration, camels alter their daily behavioral activities through reducing time spent feeding and ruminating and increased that idling.

Key Words: Dehydration, Behavior, Camel

333 Sexual performance of Awassi and Awassi x Romanov yearling rams. R. T. Kridli*¹, M. Momani Shaker², A. Y. Abdullah¹, and I. Sada², ¹*Jordan University of Science and Technology, Irbid/Jordan,* ²*Czech University of Agriculture, Prague/Czech Republic.*

This study was designed to compare libido and biological parameters of Awassi (A) with F1 Awassi x Romanov (AR) yearling rams. Romanov rams were imported to Jordan to improve fertility of Awassi sheep. In September, eight sexually nave, 10-mo old rams (four from each genotype) were evaluated for BW, body condition score (BCS) and scrotal circumference (SC) every 2 wk for 2 mo. Sexual performance was recorded on four occasions, each 2 d apart. During each occasion, rams were individually exposed to two estrous Awassi ewes for 20 min during which sexual behavior was monitored. Body weight and BCS were similar ($P > 0.05$) for both genotypes, however, AR had greater ($P < 0.001$) SC than A rams (30.6 0.2 cm and 27.4 0.2 cm for AR and A rams, respectively). Body weight for both A and AR rams increased with each test day. No correlations were detected ($P > 0.05$) among BW, BCS and SC. Bouts of leg kicking, anogenital sniffing and mount attempts were similar ($P > 0.05$) for both A and AR rams. There was a tendency

($P = 0.10$) for AR rams to have greater mounting frequency compared with A rams (20.9 ± 2.8 mounts/20 min and 14.5 ± 2.8 mounts/20 min for AR and A rams, respectively). The frequency of raising the fat tail of females, however, was greater ($P = 0.06$) in A than AR rams. Neither A nor AR rams managed to service the ewes. Significant correlation existed ($P < 0.05$) between bouts of leg kicking and mounting frequency

($r = 0.42$) and between mounting frequency and tail-raising ($r = 0.62$). Results indicate that A and AR rams have similar sexual performance. Awassi rams managed to raise the fat tail of females more frequently thus predicting a greater advantage in natural mating over AR rams.

Key Words: Sheep, Libido, Behavior

Animal Health Mastitis and Management

334 Infrared thermography to evaluate milking induced alterations in teat tissue fluid circulation. C. O. Paulrud^{*1}, S. Clausen², P. E. Andersen², M. Bjerring³, and M.D Rasmussen³, ¹Danish Dairy Board, ²Risoe National Laboratory, ³Danish Institute of Agricultural Sciences.

Machine milking may influence the defense mechanisms of the teat by altering teat tissue fluid-dynamics. The skin temperature reflects the underlying circulation and tissue metabolism. Use of thermography can focus, collect and transform the infrared range of the electromagnetic spectrum that is emitted from any body in a heat dependant fashion. Thermography images a pictorial summary of the heat gradients generated and can thereby visualize the thermal patterns of the skin resulting in useful mapping of the underlying circulation. Two healthy cows and one heifer with moderate teat oedema were milked with a conventional liner and a very soft experimental liner in a split udder design mode. Thermographic pictures were taken before teat preparation with a wet cloth, immediately after preparation, and successively after milking for 10 min. Skin temperatures were measured approximately 5 mm from the teat apex, at the mid, and at the base of the teat. The thermographic patterns were visually different between teats milked with different liners. During preparation, teat apex-, mid teat- and teat base-temperature fell 3.61.4, 3.41.6 and 1.70.9 C respectively. The decrease at mid teat and teat base temperature were however less distinct among teats with moderate oedema. Immediately after milking, all teats milked with the soft liner were colder at the teat apex (mean 2.10.4C) and slightly warmer at the middle (1.10.6C). During milking, temperature at the teat base decreased of teats without oedema and milked with the conventional liner but did however rise among teats milked with the soft liner and among teats with moderate oedema. Present findings may be explained by the soft liner having a relatively low ability to massage the teat apex combined with a relatively good capacity to massage the teat sinus and maintain fluid circulation at the teat base. We conclude that thermography is useful for study and evaluating the effects of different milking techniques on teat fluid dynamics.

Key Words: Milking, Teat, Thermography

335 Bedding amendments for environmental mastitis control in dairy cattle. E. K. Kupprion, J. D. Toth^{*}, Z. Dou, H. W. Aceto, and J. D. Ferguson, *University of Pennsylvania, Kennett Square, PA/USA.*

Coliform bacteria are environmental mastitis pathogens that thrive in manure and bedding and are often responsible for transient peracute and acute mastitis. The purpose of this experiment was to investigate if acid and alkaline amendments added to dairy cow bedding are effective in controlling mastitis-causing bacteria populations. Alum, fluidized bed combustion coal flyash (FBC), flue gas desulfurization flyash (FGD), or hydrated lime were added to kiln-dried sawdust bedding material (1:10 amendment:bedding, DM basis) overlying mattresses in dairy tie-stalls with no-amendment control included for comparison. Each treatment was replicated three times. Bacteria counts were made by plating samples of bedding, mattress swab, and teat end swab, collected on day 1, 2, 3; colonies were identified as total Gram-negative bacteria, *E. coli*, and *Klebsiella* spp. pH was also determined on bedding samples. All amendments but FGD exhibited antibacterial effect. Flyash FBC appeared to be most effective on day 1; the hydrated lime treatment suppressed bacteria growth on day 1 and 2 with the antibacterial effect diminished on day 3. Alum was able to suppress bacteria populations throughout the 3-day sampling period. The antibacterial effect of the amendments was apparently related to pH alteration of the bedding material. Hydrated lime raised pH by about 5 units during day 1 and 2, FBC by nearly 5

units on day 1, whereas alum reduced pH by about 3 units throughout the 3-day period. Bedding pH was not changed by the FGD treatment.

Key Words: Environmental Mastitis, Mastitis Control, Bedding Amendments

336 Impact of two coliform mastitis vaccination schedules on milk yield, dry matter feed intake and intramammary infections of dairy cattle. C.S. Petersson^{*1}, K.E. Leslie¹, D.F. Kelton¹, and B.A. Mallard², ¹Department of Population Medicine, ²Department of Pathobiology, *University of Guelph, Ontario, Canada.*

Late lactation cows and springing heifers from two research herds were enrolled two weeks prior to drying off and randomly assigned to one of two vaccination protocols. Group A involved vaccination at dry-off, three weeks before expected calving, and 2 to 9 days in milk (DIM). Group B cows were vaccinated two weeks before dry-off, at dry-off, and at three weeks before expected calving. Daily milk weights were recorded from enrolment until the day of drying off, as well as for the first 30 days of the next lactation. Quarter milk samples were aseptically collected once from day 2 to 9 DIM for bacteriological culture. After calving, dry matter intakes (DMI) were recorded for all cows during the period from the day before to the two days after the Group A vaccination date. Descriptive data from the first 141 cows that have completed the trial are summarized. The mean decline in milk production over the two-week period prior to drying off was -11.8 kg and -13.6 kg for Group A and Group B cows, respectively. This difference was not statistically significant. Milk production on the day prior to dry-off in Groups A and B was 12.0 kg and 12.2 kg, respectively. After calving, the average milk production at 30 DIM was 37.5 kg and 37.8 kg cows in Groups A and B, respectively. On the day of vaccination for Group A after calving, DMI values were 11.8 kg and 13.0 kg for group A and B, respectively ($P=0.07$). Daily milk production on this date was found to be 26.5 kg and 27.5 kg for Groups A and B, respectively. Results of milk bacteriology from 656 quarter samples have isolated major pathogens from 29 and 14 quarters in groups A and B respectively. *E. coli*, *Klebsiella* and environmental *Streptococci* were found in 12, 3, and 10 versus 3, 1 and 5 of the quarters from animals in Groups A versus B, respectively. Preliminary results favor coliform mastitis vaccination at two weeks before, at dry-off and at transition.

Key Words: Vaccination, Mastitis, Coliform

337 Multiple boosters of J5 vaccine elicit strong lactational antibody responses in dairy cows. R.A. Darch^{*1}, L. Nielsen¹, P. Saama¹, R.J. Erskine², A.P. Belschner³, and J.L. Burton¹, ¹Animal Science, *Michigan State University*, ²Large Animal Clinical Sciences, *Michigan State University*, ³Pharmacia Animal Health.

J5 *E. coli* vaccines have done well to protect cows from coliform mastitis in early lactation. However, data from our group show that peak rates of coliform mastitis occur between 3 and 5 months of lactation, even in J5 vaccinated herds, suggesting that protective antibody responses wear off quickly after the final dose of vaccine is administered. The objective of this study was to determine if multiple boosters of J5 vaccine maintain strong anti-coliform antibody responses throughout lactation. Commercial J5 bacterin was used to immunize two groups of cows ($n = 4$ multiparous, 2 primiparous per group); control cows received the recommended 3 doses of J5 vaccine (at dry off, 30 days dry, and 14 days postpartum) while treated cows received 12 doses (the recommended 3 doses plus 9 additional doses at 30-day intervals). Weekly blood samples were collected from all cows throughout the trial for ELISA assay of serum anti-J5 *E. coli* IgM, IgG1, and IgG2 antibody responses. ELISA test data were normalized against negative control values and resulting