(SFZ) plus 1/2 partially delinted CS fed at 3) 100% (SFC100) or 4) 90% of WCS (SFC90). Sixty cows averaging 105 DIM were fed the WCS diet for 2 wk and then assigned to one of the 4 diets for 12 wk. In a 5 x 5 Latin square with 3-wk periods (Trial 2), 5 rumen-cannulated cows were fed: 1) control with CS hulls and CS meal plus tallow and Ca soaps of FA, 2) WCS, 3) SFZ, 4) LFZ, or 5) SFC100. Diets contained 39.6% concentrate, 14.4% CS, and 46% forage (40:60, alfalfa hay:corn silage) on a DM basis. Unless stated, $P \leq 0.05$. For Trial 1, milk production trended to progressively increase for SFC100 and SFC90 than WCS or LFZ (diet x time, $P=0.07$). Milk fat was lower for LFZ (2.74%) and SFC90 (2.85%) than WCS or SFC100 (3.07 and 3.08%). 3.5%FCM was lower for LFZ than WCS, SFC100, and SFC90 (31.2, 35.0, 37.3, and 34.5 kg/d). In trial 2, NDF digestibility was unaffected, but N digestibility was lowest for SFC. FA digestibility was higher for WCS, SFZ, and LFZ (81.1, 82.6, and 82.3%) than control or SFC treatments (78.8 and 75.3%). The 18:1 *trans*-11 in milk from cows fed SFZ and LFZ (7.10 and 6.73%) was greater than control, WCS, and SFC (1.65, 4.13, and 3.78%). The % 18:1 *trans*-10 in milk from control (.36), SFZ (.27), and LFZ (.36) were higher than those in WCS and SFC (.04, .05). Based on estimated passage rates from NRC, fat disappearance in situ was 27.8, 65.7, 52.6, and 44.7% for WCS, SFZ, LFZ, and SFC. Although having a lower FA digestibility, SFC100 appeared to minimize negative effects of free oil in the rumen from SFZ, explaining higher DMI and milk production than WCS or LFZ.

Key Words: Cottonseed, Fatty Acid, Lactating Dairy Cows

629 Effect of feeding whole fuzzy cottonseed with elevated concentrations of free fatty acids on production of lactating dairy cows.

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Twenty-four lactating Holstein cows were used in an 8 wk randomized block trial to examine the effects of feeding whole cottonseed (WCS) with elevated concentrations of free fatty acids in the oil (FFA) on intake and performance. Treatments included a control WCS with normal concentrations of FFA (6.8%) and two lots of WCS with elevated FFA; HFFA1 (24.1%) or HFFA2 (22.3%). Compared with control and HFFA1, the HFFA2 contained slightly more moisture (9.4, 10.6, and 11.9 %, respectively) and less oil (18.4, 17.1, and 15.9 %, respectively) and were visibly discolored. There were no differences in concentrations of ADF, NDF, or minerals among WCS treatments. Cows were trained to eat behind Calan doors and individually fed once daily. The WCS composed 14% of the total DM of the ration. Dry matter intake was highest ($P = 0.06$) for cows fed HFFA2 (23.5 kg/d) compared with control and HFFA1 (21.6 and 22.0 kg/d, respectively). No differences in milk yield (average 34.7 kg/d) were observed among treatments. Milk fat percent was lower ($P = 0.007$) for HFFA1 (3.64%) and HFFA2 (3.58 %) compared with control (4.22%). Percentage of milk protein, lactose, and SNF was similar among treatments. No differences were observed in concentrations of MUN although values were numerically higher ($P = 0.15$) for diets containing WCS with elevated FFA. While molar proportions of butyrate and isobutyrate were higher for HFFA1 and HFFA2 compared with control ($P = 0.08$ and $P = 0.0004$, respectively), no differences were observed in concentrations of acetate or propionate. Results of this trial indicate that feeding WCS with high concentrations of FFA may slightly increase DMI and decreases milk fat percentage but does not alter milk yield. The decrease in milk fat percentage is apparently not due to changes in proportions of individual VFA.

Key Words: Cottonseed, Free Fatty Acids

Animal Behavior and Well-being: Dairy Cattle Housing, Management, and Stress

630 The use of animal-based measures to evaluate tie stall design on dairy farms in Ontario.

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Poor tie stall design can cause injury, lameness and mastitis. These problems affect cattle welfare and increase the probability of premature culling, lost production and negative public attitudes toward the dairy industry. The objective of this study was to describe the prevalence of animal-based measures of cow comfort and associations among measures of cow comfort, tie stall dimensions, milk production and milk quality.

All lactating cows on 317 randomly selected tie stall dairy farms across Ontario were included in this cross sectional study. Each cow was scored for the presence of the animal measures listed in Table 1. Using multivariate negative binomial regression techniques, these measures were analyzed for their associations with stall length, stall width, tie rail height, chain length and the presence of an electric trainer. The proportion of the herd affected with each problem and the farms tie stall dimensions were also analyzed for associations with the volume of milk shipped and bulk tank somatic cell count (BTSCC). The prevalence of open hock wounds was 36% greater for cows housed in stalls with electric trainers compared to stalls without (p=0.05). For each inch increase in tie chain length there is a 1.4% decrease in the prevalence of cows with dirty hind limbs (p=0.05). A 1% increase in the percent dirty cows was associated with an increase in BTSCC, of 1100 cells per ml (p=0.003).

Benchmarking the prevalence of lameness, cleanliness and injuries allows individual farms to assess their own herd scores and thereby to determine their farms strengths and weaknesses.

Table 1. The proportion of cows affected with each animal measure ranked from the lowest to highest scoring farms in each category.

Variable	Best 20% (%)	2nd Best 20% (%)	Middle 20% (%)	2nd Worst 20% (%)	Worst 20% (%)
Swollen hocks	0-4	5-9	10-15	16-26	27-61
Hock hair loss	0-15	16-27	28-42	43-53	54-81
Hock wounds	0-1	2-3	4-7	8-12	13-100
Neck lesions	0	0	0-1	2-4	5-48
Broken tails	0	0	0-1	2-5	6-50
Rotated hind claws	0-7	8-15	16-22	23-34	35-74
Arched backs	0	0-1	2-3	4-6	7-21
Dirty udders	0	0-1	2-3	4-7	8-48
Dirty hind limbs	0-3	4-9	10-18	19-36	37-94

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Key Words: Tie-Stall, Injuries, Dairy Cows

631 The comparison between cow behavior to free stall and straw bedding system.

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Free stall systems are increasing on dairy farms in Iran as an alternative to straw bedding. The objective of this study was to compare cows' responses to free stall and straw bedding systems, in different seasons. This experiment was conducted during 2004, in a dairy farm in north of Iran near the Caspian sea, with humid and hot weather in summer, annual rain fall of 450mm and minimum

and maximum of annual temperature and humidity of -3 to 42 C°, 30 to 100%, respectively. The herd size was 800 head with 300 cows milked daily and producing about 9 ton over the experiment. Two open sheds (60m x 32m) were used with 80 dairy cows in each. The average milk production of each barn was 36±1.5 Kg and average days in milk were 105±5. In one barn there were 80 free stalls and whilst the other was an open system with a concrete floor covered with wheat straw up to 10cm depth. Over 12 months, the location, posture and behavior of cows in each barn were considered at different times of day(4 AM, 9 AM, 2 PM and 8 PM). Data were analyzed using General Linear Models procedure of SAS V6.12 for ANOVA to evaluate differences among experimental groups, the design was split plot in time, means compared with Duncan test. In four seasons, the number of cows that were lying and eating in the straw bedding system was more than free stall system and the differences were significant (p≤0.05). So, data showed that cows prefer straw bedding in comparison with free stall system.

The effect of season on cow preference

	Lying in straw (%)	Lying in free stall (%	SEM
spring	35.96[a]	14.03[b]	0.013
summer	33[a]	14[b]	0.006
autumn	46.72[a]	15.88[b]	0.0001
winter	51.82[a]	35.88[b]	0.002
	Eating in straw (%)	Eating in free stall (%)	SEM
spring	31.57[a]	18.42[b]	0.011
summer	27[a]	26[b]	0.009
autumn	18.69	18.69	0.005
winter	7.4[a]	5.5[b]	0.05

Key Words: Free Stall, Straw Bedding, Dairy Cows

632 Immune function and oxidative stress vary by management and lactation stage for dairy cows in pasture-based production systems. K. Saker*[1], J. Fike[1], S. Washburn[2], and A. Meir[3], [1]*Virginia Polytechnic Institute and State University*, *Blacksburg*, [2]*North Carolina State University*, *Raleigh*,, [3]*Center for Environmental Farming Systems*, *Goldsboro, NC*.

This research focused on immune response to management and lactation stage in grazing dairy cows. Fall-calving first lactation and multiparous mixed breed dairy cattle (n=64) were maintained on pasture year-round. Pastures were a mix of cool- and warm-season perennial and annual grasses. Experimental treatments were high (3.7 cows/ha; HSR) vs. low (2.47 cow/ha; LSR) stocking rate management. A corn-cottonseed-based supplement was fed to both groups but at a greater rate for HSR cows (11 vs. 7 kg·cow d^{-1}). Stocking and supplementation rates were intentionally linked (confounding) to compare animal immune responses to differences in system management. Average milk production between the groups was similar (6100 kg/lactation), suggesting additional supplement adequately offset lower forage availability for HSR cows. Select immune function and oxidative stress measures were assessed 5 times per production year: calving (C), early lactation (EL), peak lactation/breeding (PL/B), summer heat stress (SHS), and late gestation (LG). In general, cows had lowest innate immune response during the PL/B and C periods, in that order. Phagocytic cell activity (% cells responding) of HSR cows was significantly lower than LSR cows during C (9.4 vs. 14.7%; $P < 0.01$), PL/B (9.3 vs. 18.6%; $P = 0.01$), and SHS (25.1 vs. 33.8%; $P < 0.01$) periods. Antioxidant activity in all cows closely paralleled phagocytic activity during specific times of physiological and environmental stress. Activity was lowest when oxidative stress was most pronounced. Cows at the LSR appeared to have greater protection against oxidative stress based on lower lipid hydroperoxide production (64.3 vs. 104.6 µM; $P < 0.01$) and higher antioxidant (SOD/GSH-Px) activities (36.0 vs. 15.5 and 94.4 vs. 81.2 mU/mg protein, respectively; $P < 0.05$). Somatic cell score of HSR cows were higher compared to the LSR group (3.5 vs. 2.5; $P = 0.05$). Stocking rate along with associated supplement:forage ratios in pasture-based dairy systems can influence immunological and physiological responses to management and environmental stressors.

Key Words: Antioxidant Activity, Immune Function

633 Infrared thermography as a non-invasive measure of stress in dairy cows. M. Stewart*[1], J. Webster[1], G. Verkerk[2], J. Colyn[3], and A. Schaefer[3], [1]*AgResearch*, *Hamilton, New Zealand*, [2]*Dexcel*, *Hamilton, New Zealand*, [3]*Agriculture and Agri-Food Canada*, *Lacombe, Alberta, Canada*.

Infrared thermography of the eye (ET), to detect heat produced by stress, may be a useful non-invasive way to measure the welfare impact of husbandry practices on domestic livestock. This study examined the ET of dairy cows during stimulation of the stress axis by intravenous hormonal administration or social isolation. Six cows, acclimated to handling, were each given six treatments in a random Latin-square design: 1) 5ml saline 2) ACTH (0.05 mg Synacthen) 3) bCRH (20 µg) 4) bCRH (40 µg) 5) epinephrine (1.4 µg /kg liveweight) and 6) isolation (I). Treatments were administered at time 0 and blood was sampled via jugular catheter while standing beside each cow at -30, -15, 0, 5, 10, 15, 20, 30, 40, 50, 60, 75, 90, 120, 180 and 240 min except for epinephrine which was sampled at -30, -15, -10, -5, 0, 2, 5, 10, 15, 20, 30, 45, 60, 90 and 120 min. Body temperature was recorded every 10 min and ET was recorded approximately every 2 min from 30 min pre-treatment (ThermaCam S60). Plasma samples were assayed for ACTH, cortisol and non-esterified fatty acids (NEFA). ACTH increased after bCRH, and cortisol increased after ACTH and bCRH ($P<0.001$). Neither cortisol nor ACTH changed after epinephrine or I. NEFA increased after epinephrine ($P<0.01$). ET increased prior to treatment in many cases. Compared to pre-treatment, ET was higher 30 and 60 min after saline and ACTH ($P<0.001$), but not after other treatments. ET tended to drop rapidly by the first sample after I ($P=0.057$) and then increase again (by 30 min, $P<0.001$). Body temperature was not affected by any treatment. Increases in cortisol, ACTH and NEFA confirmed stress axis activation. Pre-treatment increases in ET, possibly due to prior activity or handling stress, confounded post-treatment effects. The changes in ET found after I are novel, suggestive of an acute sympathetic response and may reflect psychological stress which was unique to social isolation.

Key Words: Infrared Thermography, Stress, Welfare

Animal Behavior and Well-being: Cattle, Pain Stress and Welfare

634 Does ketoprofen alleviate acute pain during dehorning? S. Millman*, T. Duffield, K. Lissemore, S. James, and L. Misch, *University of Guelph*, *Guelph, ON, Canada*.

Research shows that dehorning is painful to calves and that local anaesthetic, such as a lidocaine block, alleviates acute pain responses. Currently, the vast majority of dairy producers in North America dehorn their own calves, and rarely use lidocaine for this procedure. Effective in reducing post-surgical pain from dehorning, we examined if ketoprofen, an over-the-counter non-steroidal anti-inflammatory drug, is effective in alleviating pain when calves are dehorned at very young ages. Dairy calves (n=27) were dehorned when less than one month of age. All calves received corneal (IC) and intramuscular (IM) injections immediately prior to the dehorning procedure, with calves randomized among three treatments: L (lidocaine IC, saline IM), K (saline IM, ketoprofen IM) or C (saline IC, saline IM). Persons dehorning and collecting data were blind to the treatments. Behaviour data was collected during dehorning. Physiologic data was collected immediately prior to and following dehorning. Analysis of variance was used to analyse heart rate, respiratory rate, stamping and