Production, Management and the Environment: Dairy Production I

107 A meta-analysis of the impact of stocking rate on the productivity of pasture-based milk production systems. B. McCarthy*[1,2], L. Delaby[3], K. M. Pierce[2], F. Journot[1], and B. Horan[1], *[1]Animal and Grassland Research and Innovation Centre, Teagasc Moorepark, Fermoy, Co. Cork, Ireland, [2]School of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Belfield, Dublin, Ireland, [3]INRA, AgroCampus Ouest, UMR 1080, Production du Lait, Saint-Gilles, France.*

The objective of this paper is to quantify the milk production response per cow and per hectare (ha) for an incremental stocking rate (SR) change, based on a meta-analysis of published research papers. Suitable experiments for inclusion in the database required a comparison of at least 2 SRs under the same experimental conditions in addition to details on experimental length and milk production results per cow and per ha. Each additional increased SR treatment was also described in terms of the relative milk production change per cow and per ha compared with the lower base SR. A database containing 109 experiments of various lengths with 131 comparisons of SR was subdivided into: Type I experiments (common experimental lengths) and Type II experiments (variable experimental lengths). Actual and proportional changes in milk production according to SR change were analyzed using linear mixed model procedures with study included as a random effect in the model. Low residual standard errors indicated a good precision of the predictive equations with the exception of proportional change in milk production per cow. For all milk yield variables analyzed, the results illustrate that while production per cow is reduced, a strong positive relationship exists between SR and milk production per ha. A SR increase of one cow/ha resulted in a decrease in daily milk yield per cow of 7.4% and 8.7% for Type I and II data respectively, while milk yield per ha increased by 20.1% and 19.6%, respectively. Within the Type II data set, a one cow/ha increase in SR also resulted in a 15.1% reduction in lactation length (equivalent to 42 d). The low predictability of proportional change in milk production per cow according to the classical SR definition of cows/ha over a defined period suggests that SR may be more appropriately defined in terms of the change in available feed offered per animal within each treatment.

Key words: dairy cow, stocking rate, meta-analysis

108 Claw length and angle in lactating Jersey cattle, field measurements. D. J. Tomlinson*[1], L. Rodriguez[1], M. L. McGilliard[2], and K. Burgi[3], *[1]Zinpro Performance Minerals, Eden Prairie, MN, [2]Virginia Tech, Blacksburg, [3]Dairyland Hoof Care Institute Inc., Baraboo, WI.*

Low claw angle and/or long toe length may lead to development of claw lesions. Previous research and field observations indicate claws of Holstein cattle typically have an angle of 48 to 50 degrees and length of 75 to 85 mm. However, little information is available for Jersey cattle. The objective of this study was to determine length and angle of the dorsal wall of lateral claws of Jersey cows. Observations were made (n = 1654) on 7 Jersey dairy farms located in Hilmar, California. Measurement of dorsal wall angle and length were made on the lateral claw of the rear feet. Measures were made with a digital angle gauge and caliper in the milking parlor. All measures were made over the course of 3 d. Observations represented 56% first lactation cows, 20% second and 24% older animals. Mean lateral toe length of the rear claw was 71 mm with angle of 43 deg, for cows 121 d DIM and milk yield (MY; 27 kg/d). Toe length was correlated with angle −0.44, MY 0.30, and DIM 0.16. Stepwise regression of toe length, with farm and lactation number held in the model, eliminated non-significant dependent variables from a list of angle, DIM, MY, with their squares and cross-products. The model contained linear and quadratic angle, DIM and DIM*angle for an R2 = 0.49. The Glimmix procedure of SAS 9.2 indicated no interactions of these variables with farm. Our final model contained random effects of farm and residual (variances of 1.6 and 14.2), a lactation effect, and regressions on linear (−1.58) and quadratic (0.0129) foot angle, DIM (0.045) and DIM*angle (−0.00075). LSmeans for toe length were 68.6, 72.4, 74.5 mm for first through third+ lactation with SE of 0.50. Relative to average toe length, toe length at 50 DIM was 6 mm longer at 32 deg angle and 5 mm shorter at 56 degree angle, whereas toe length at 450 DIM was 15 mm longer at 32 deg angle and 4 mm shorter at 56 deg angle. There was a slight quadratic effect of angle and its interaction with DIM but no interaction with lactation number. This study demonstrated that Jersey cattle in these 7 CA dairies have a lower claw angle and shorter dorsal wall length than reported in Holstein cattle.

Key words: claw angle, claw length, lameness

109 A ranking system based on stochastic modeling to identify efficient dairy farms using farm-level inputs. A. S. Atzori*[1], A. Cannas[1], and L. O. Tedeschi[2], *[1]Dipartimento di Scienze Zootecniche, Università di Sassari, Sassari, Italy, [2]Department of Animal Science, Texas A&M University, College Station.*

A ranking system to classify dairy cow farms based on their production efficiency and profit using on-farm measurements was developed. A development database (dDB) containing 135 dairy farm from Sardinia, Italy, was gathered from Oct 09 to Sep 10. Input variables (IV, n = 18) were collected monthly either by the farmers' association (e.g., physiological stages (PS), #of lactating, dry, and culled cows, 305-d equivalent milk yield, age at first calving and culling, #of calves, and d open) or from a milk processing plant (e.g., milk sold (MkS), milk quality and price). Revenue was milk revenue plus $70/calf sold and feeding costs were based on NEl requirement and $0.195/Mcal of the diet. Income over feeding cost (IOFC, $/L) was revenue minus feeding costs. The annual average of IV for each farm was used. The distributions and correlations of IV from the dDB were used to obtain data (n = 5000) via Monte Carlo technique and stored into a database (sDB). The sDB data were used to obtain the standardized eigenvalues using the principal component analysis. Two regressions were obtained: selected principal components (PC) were regressed on the observed IOFC (REG1) and eigenvectors of the selected PC were used to compute PC values for each farm in the dDB (REG2). This computed PC values were then used with REG1 coefficients to predict IOFC, which was the ranking index (RI). Four PC were identified for milk efficiency (PS and MkS), milk quality and payment (milk quality and price), management (longevity, genetic level, SCC), and reproduction; and explained 37.4, 20.2, 15.6, and 4.4% of the sDB variance, respectively. The RI had a β distribution (mean = 0.119, SD = 0.0187) and explained 72% of the IOFC variance in the sDB. Farm allocation based on RI was 20 farms in [<-1SD], 30 in]-1SD, 0], 70 in]0, 1SD[, and 15 in [>1SD]. RI explained 79% of the IOFC variance in the dDB (root of mean square error = 0.012 $/L and 90% random errors). This approach provided a broad ranking system because it accounts for possible variability of the input variables and different weights can be used for each PC depending on the long-term goal of the dairy farm.

Key words: profitability, simulation, Monte Carlo

110 Predictors of primiparous and multiparous transition cow success from an automatic milking system. R. F. Leuer*, J. K. Reneau, J. M. Lukas, and M. I. Endres, *University of Minnesota, St. Paul*.

Analysis of performance early in lactation gives insight to future success. The objective of this retrospective study was to identify best indicators of transition success by parity and week. Lactation records (n = 191) from a Holstein dairy herd in Minnesota with a voluntary milking system were collected to identify factors associated with the success or failure of the primiparous (n = 51) and multiparous (n = 140) transition period. Metrics available were lactation number (LAC), milk production (MP), moving average production (MA), milk production average to week (MW), daily milkings (DM), milking refusals (REF), milking failures (FAI), concentrate feed consumed (CF), unconsumed concentrate feed (UCF), activity (ACT), rumination minutes (RM), and body weight (WT). Daily totals of each metric were used to calculate weekly averages. Total milk produced by 100 d was used to evaluate success of the transition period. To identify key metrics that indicate a successful transition period, best subsets regression was used to identify the combination of predictor variables for the first, second, and third week in the lactation. Fit was assessed with Mallows' Cp. Predictor variables for first week in lactation for primiparous cows ($R^2 = 0.60$), were mean MP and maximum UCF and ACT. Predictors for first week for multiparous cows($R^2 = 0.49$) were mean REF, maximum MP, CF, and UCF, and standard deviation REF and UCF. Predictor variables for second week for primiparous cows ($R^2 = 0.77$) were minimum UCF, mean MA, REF, and ACT, maximum MA, REF, FAI, and ACT, and standard deviation FAI and RM. Predictors for second week for multiparous cows ($R^2 = 0.54$) were LAC, minimum MA, maximum MA, and standard deviation of MA and DM. Finally, predictors for the third week for primiparious cows ($R^2 = 0.85$) were MW, minimum MP and RM, mean of MA and UCF, and maximum MA and RM whereas predictors for multiparous cows ($R^2 = 0.75$) were minimum WT, mean MA and UCF, maximum MA, MP, and UCF, and standard deviation of MP and UCF. Significant predictors changed week to week and between primiparous and multiparous cows.

Key words: precision dairy farming, automatic milking system, transition cow success

111 Effects of sodium bicarbonate or calcium magnesium carbonate on intake, digestibility and milk yield and composition of high producing dairy cows. R. E. Rauch*[1,2], P. H. Robinson[2], D. D. Simms[3], and L. J. Erasmus[1], *[1]University of Pretoria, Pretoria, South Africa, [2]University of California, Davis, [3]MIN-AD, Amarillo, TX.*

The rumen buffer sodium bicarbonate (SB) is a common dairy feed supplement, although recent research of its efficacy in modern low starch diets is limited. In California, new environmental regulations limit salt (including sodium) discharge from dairies. Our aim was to determine effects of SB or calcium magnesium carbonate (CMC; a potential alternative not classed as a salt), on performance of early lactation high producing Holstein cows. The study was a Latin square design with 3 periods of 28 d, 3 treatments (i.e., control (C), SB, CMC) and 3 pens of ~310 cows. The total mixed ration was supplemented with 0.8% dry matter SB or CMC, and contained 51.9% DM and 15.8% CP, 33.4% aNDF and 16.0% starch (all DM basis). Dietary cation anion difference (DCAD) for the C, SB and CMC diet was 195, 276 and 202 mEq (Na^+K-Cl^-S)/kg DM, respectively. Dry matter intake for C, SB and CMC did not differ (28.2, 28.5, 28.6 kg/d, respectively), and feed intake patterns during early (07:00–08:50 h) and late (08:50–11:00 h) morning were similar between treatments (time*treatment interaction: $P = 0.18$). The SB diet tended ($P = 0.053$) to reduce DM digestibility (63.7 vs. 65.6%) and increase ($P = 0.09$) fecal pH (6.65 vs. 6.60) compared with C. CMC cows had a higher ($P < 0.0001$) fecal pH than C cows (6.76 vs. 6.60), but digestibility did not differ. SB cows had lower ($P < 0.01$) milk yield (45.2 vs. 46.2 kg/d) and higher ($P < 0.01$) milk fat % (3.56 vs. 3.43%), but milk fat yield did not differ (1.60 vs. 1.58 kg/d) compared with C. CMC and C cows did not differ in milk yield (45.7 vs. 46.2 kg/d) or composition. Changes in body condition score were similar for C, SB and CMC (−0.08, −0.08, −0.04 units/30 d), and net energy (NEl) output (41.1, 40.9, 41.3 Mcal/d) and diet NEl concentration (1.46, 1.44, 1.44 Mcal/kg DM) for C, SB and CMC did not differ. Results suggest that SB buffered the rumen and/or improved acid base balance by increased DCAD, and that CMC buffered the abomasum and lower gastrointestinal tract. However, for diets and conditions comparable to this study, use of neither supplement is supported.

Key words: buffer, dietary cation anion difference, sodium

112 Withdrawn

113 Quantification of phytate in dairy digesta and feces using alkaline extraction and high performance ion chromatography. P. P. Ray*, C. Shang, J. P. Jarrett, and K. F. Knowlton, *Virginia Polytechnic Institute and State University, Blacksburg.*

The quantification of phytate in feed, digesta, and feces from dairy cows is important in nutrition and environmental research. Development of accurate, sensitive, robust, and inexpensive quantification methods for undigested phytate in ruminant feces and digesta samples is essential to advance knowledge of phytate degradation and phosphorus (P) excretion in ruminants. Established quantification methods give satisfactory results for feedstuffs and nonruminants manures but recovery of phytate is incomplete for ruminant feces and digesta samples because of complex sample matrix and low ratio of phytate to inorganic P. The objective was to develop a robust, accurate, sensitive, and inexpensive method to analyze phytate in wide variety of samples including ruminant feces and digesta. Diets varying in phytate content were fed to dairy heifers, dry cows and lactating cows to generate digesta and feces samples of widely varying composition to challenge extraction and quantification methods. Samples were extracted with 0.5 M HCl and 0.25 M $NaOH^+$0.05 M EDTA, independently. Acid extracts were mixed with a 20% NaCl solution, alkaline extracts were acidified to final acidity of 0.35 M and then both extracts were clarified via elution through C_{18} cartridges. High performance ion chromatography (HPIC) was used to quantify phytate. In feed samples, phytate in alkaline extracts was comparable to that in acid extracts (2965 vs 3085 μg/g DM). In digesta and feces samples, alkaline extraction yielded greater estimates of phytate content than in acid extracts (40.7 vs 33.6 and 202.9 vs 144.4 μg/g DM). Acidification and C_{18}–cartridge elution of alkaline extracts overcame the interference from sample matrix allowing HPIC analysis. Pure phytate added to dry samples before extraction was almost complete recovered (88 to 105%). This indicates higher extraction efficiency, no adverse effect of pretreatment and accurate quantification of phytate. The proposed method is rapid, inexpensive, and robust and allows more accurate phytate quantification in ruminant feces and digesta samples.

Key words: high performance ion chromatography, dairy feces, phytate

114 Use of rumen fluid to inoculate dairy excrement for bio-fuel production by anaerobic digestion. C. L. Ross*, K. C. Das, and M. A. Froetschel, *University of Georgia, Athens.*

A series of in vitro fermentations were conducted to test the viability of rumen fluid inoculations for anaerobic digestion utilizing different sources of rumen fluid, different sources of dairy excrement, and activated charcoal in buffered and un-buffered systems. To test the viability of rumen fluid to inoculate anaerobic digestion, rumen fluid from dairy cattle and fresh excrement were tested using a 3x3 factorial design. Three dilutions (w/v, H2O) of excrement were inoculated with 3 mixtures of viable and nonviable (heated to 80°C) rumen fluid (100% viable, 50:50 viable-nonviable, and 100% nonviable). A phosphate-carbonate buffer was used in buffered systems. Dry matter and gross energy digestion, volatile fatty acids, pH, and methane (CH4) production were measured after 2d and 7d incubations. All measurements were corrected for rumen fluid contributions. Results of the un-buffered system were highly variable but the effects of rumen fluid inoculation were still evident. After 2d fermentations the viable rumen fluid had 34% to 47.4% greater acetate ($P = 0.0001$) tended to produce more CH4 (67%; $P = 0.21$) than fermentations inoculated with nonviable ($P = 0.21$). 7d fermentations inoculated with viable rumen fluid produced 137.6% more CH4 when un-buffered and 182.2% more CH4 when buffered compared with fermentations inoculated with nonviable ($P = 0.07$). Another in vitro experiment using different sources of rumen fluid and activated charcoal vs. buffer to enhance anaerobic digestion was conducted. Rumen fluid inoculants from feedlot, grazing, and dairy cattle were incubated with dried dairy excrement as substrate using a 3x2 factorial design with 3 levels of activated charcoal (0%, 1.5%, and 15%) and 2 levels of buffer in 2d fermentations. Measurements were conducted as described previously. Final pH of all fermentations were above 6.0 and digestion, VFA, and CH4 were unaffected by buffer or activated charcoal indicating dried excrement was not as fermentable and as suited a substrate for modeling anaerobic digestion as fresh excrement. These results provide evidence that inoculation and buffering conditions can stimulate methane production for anaerobic digestion of dairy excrement.

Key words: anaerobic digestion, biofuel production, rumen fluid inoculation