Production, Management and the Environment: Surveys and Models

TH359 **Predicting methane and carbon dioxide emissions using the CNCPS.** R. J. Higgs*, K. L. Russomanno, T. F. Christoph, and M. E. Van Amburgh, *Cornell University, Ithaca, NY.*

Food production in the US has received increased consideration from policy makers for its role in greenhouse gas (GHG) emissions. Despite dairy farms contributing < 1% of the annual GHG emissions, future regulations are possible. Integrating prediction equations for GHG emissions into field usable models could provide a tool for farmers and nutritionist to consider GHG emissions during the ration formulation process. In this study, the Cornell Net Carbohydrate and Protein System (CNCPS) was updated to include equations that were derived to predict CO_2 and CH_4 production: CO_2 (g/d) = 821.3 + 126.0 × DMI (kg/d) − 1.18 × milk (kg/d) (Casper and Mertens, 2010); CH_4 (g/d) = 45.98 − (45.98 e(−1((−0.0011 × starch/ADF) + 0.0045) × ME intake)) /55 (Mills et al., 2003). Studies were compiled (n = 4; treatments = 22) that reported CO_2 and CH_4 production from animals in metabolic chambers that also had adequate dietary information to run an evaluation in the CNCPS. Data were analyzed using a mixed model where study was included as a random variable. Observed and model predicted (13,449 ± 1,228 and 12,306 ± 685; 503 ± 29 and 442 ± 37) CO_2 and CH_4 (mean g/d ± SD), respectively, were not significantly different ($P > 0.05$) indicating the equations used could provide reliable estimates of GHG production as long as adequate dietary information was available. Following this evaluation, a data set was compiled using information from commercial farms that represented significant regions of dairy production in the US. The data set included 91 diets from 70 different farms representing 10 states. The CNCPS was used to generate predictions of CO_2 and CH_4 at the cow level. Model predicted emissions (g GHG/kg milk) were regressed against milk yield (kg/cow/d). A negative relationship similar to other literature reports was observed where GHG emissions per unit of milk decreased as milk yield increased (R^2 = 0.81 and 0.89; Slope = −5.7 and −0.26 for CO_2 and CH_4, respectively). These data demonstrate the potential for nutritionists to consider GHG production as part of ration formulation in a field usable model to reduce the environmental impact of dairy production.

Key Words: greenhouse gas, dairy, modeling

TH360 **Risk measurement for technologies used in cow-calf production system.** J. O. Barcellos*[1], T. E. Oliveira[1], C. McManus[1], R. P. Pedroso[2], D. S. Freitas[1], and M. E. Canozzi[1], [1]*UFRGS, Porto Alegre, RS, Brazil,* [2]*UFPA, Belem, PA, Brazil.*

The selection of a technological innovation requires a decision-making promptly secure that combines the usual empirical selection technologies and a quantitative strategy to assist the rural manager. This association increases the consistency and reliability of choosing which technology will be more fitting for each production system. Therefore, this paper seeks to develop a simple method, capable of assisting rural managers in this decision-making process by indicating the risk of technologies used to increase the pregnancy rate in cow-calf systems. The perceptions of 18 experts were evaluated across 4 dimensions related to the risk of technologies (cost (C), technical knowledge (TK), operational complexity (OC) and flexibility (F)). The 4 dimensions, in addition to their definitions, were presented in questionnaires, in which 32 technologies were appraised in accordance with the dimensions on a 5-level Likert scale (1 = very low; 2 = low, 3 = average, 4 = high, 5 = very high). The experts estimated the risk (ER) or the probability that certain technology does not produce the expected result (pregnancy rate). The dimensions with greater influence on the ER were OC and C and the increase of one unit increased ER by 0.43 points (OC) and 0.28 points (C) (maximum value of 1 point). The values for ER and the risk calculated by the proposed equation were not significantly different from each other (G-test = 43.529; P = 0.07) and were correlated (r = 0.81), validating the method. Management practices were least risky when related to nutritional ($P < 0.0001$) and reproductive ($P < 0.0001$) technologies, which showed no difference between each other ($P = 0.13$). Technologies related to inputs showed greater risk than innovations in the production process ($P < 0.0001$) and consolidated practices had lower risk than innovative strategies ($P < 0.0001$). Despite their importance, the technical knowledge and flexibility are usually undervalued in the decision-making process in the rural environment. Therefore, studies able to provide clear information regarding technologies may contribute to disseminate those technologies and improve the system efficiency.

Key Words: efficiency, decision-making, livestock system

TH361 **The environmental and economic impact of steroid implant and β-adrenergic agonist use within US beef production.** J. L. Capper*, *Livestock Sustainability Consulting, Bozeman, MT.*

Consumers are increasingly aware of food production practices, yet this cogniscence is associated with concerns regarding technology use. This study quantified the effects of steroid implant (SI) and β-adrenergic agonist (βAA) use within US beef production upon environmental and economic metrics. A whole-system environmental model was used to quantify resource inputs and waste outputs per 363 kg of beef (US average hot carcass weight). System boundaries extended from cropping input manufacture to live animal delivery at the packing plant. Four production systems were compared: one system using SI; one system using βAA; one system using both technologies; and one system without technology. Systems were modeled using management practices and production data characteristic of US beef systems. The economic impact of technology use was derived from feed use metrics. The greatest opportunity to reduce environmental and economic metrics resulted from a combination of SI and βAA use (via increased carcass weight and improved growth rate) with SI having a greater effect than βAA alone. Technology use reduced the population size required to produce 363 kg beef from 3.08 (no technology) to 2.92 (βAA), 2.72 (SI) or 2.62 (SI+βAA) animals. Production systems using both SI and βAA used less land (2.71 ha) and water (563,543 L) to produce 363 kg beef compared with SI (2.83 ha and 586,219 L), βAA (2.97 ha and 616,588 L) or a system without technology (3.13 ha and 649,556 L). Carbon emissions per 363 kg beef were reduced from 6,738 kg (no technology), to 6,459 kg with βAA, 6,287 kg with SI and 6,072 kg with SI+βAA (reductions of 5.0%, 7.5% and 10.7% respectively). Economic costs of production followed similar patterns, with decreases of 3.8% (βAA), 7.5% (SI) and 9.9% (SI+βAA) compared with the system without technology. The extra beef produced on one single carcass from the SI+βAA system would supply 7 schoolchildren with their beef-containing school meals for one year. Use of technologies improves environmental and economic sustainability metrics, yet communication of these messages to the consumer will require further investigation.

Key Words: beef, environment, economic

TH362   The environmental and economic impact of withdrawing parasite control (Fenbendazole) from US beef production. J. L. Capper*, *Livestock Sustainability Consulting, Bozeman, MT.*

Consumer concern exists regarding the use of chemicals to control infective disease within livestock systems, yet as the global human population increases, ruminant productivity must be improved to fulfill beef demand. This study quantified the environmental and economic effects of withdrawing a parasite control compound (Fenbendazole) from US beef production. A whole-system environmental model (EM) was used to quantify resource inputs and waste outputs per 363 kg beef (US average hot carcass weight). System boundaries extended from cropping input manufacture to live animal delivery at the packing plant. Two production systems were compared, either with or without Fenbendazole use for parasite control in growing and mature cattle. Systems were modeled using characteristic management practices and production data from US beef systems. Productivity effects of parasite control were derived from peer-reviewed published literature. The economic impact of withdrawing parasite control was quantified from feed use within the EM. Withdrawing parasite control from US beef production reduced herd productivity through decreases in pregnancy rate (81% vs. 91%), weaning weight (227 kg vs. 248 kg) and growth rate from birth to slaughter (1.10 kg/d vs. 1.31 kg/d). A production system without parasite control required a total of 3.07 animals (supporting population plus slaughter animals) to produce one 363 kg carcass compared with 2.61 animals in a population with parasite control. An extra 1,180 kg of feed, 0.43 ha of land and 85,864 L of water were required to produce one 363 kg beef carcass in a system without parasite control. Carbon emissions were increased by 13.4% (6,883 kg per 363 kg beef) by withdrawing parasite control from the beef production system compared with the control (6,072 kg per 363 kg beef). Reduced productivity conferred by withdrawing parasite control incurred an increase of 11.8% in production costs per unit of beef. It is clear that parasite control has significant environmental and economic impacts on beef production; the challenge is to communicate these effects to the consumer, retailer and policy-maker.

Key Words: beef, economic, environment

TH363   The environmental and economic impact of calving rate within US beef production. J. L. Capper*, *Livestock Sustainability Consulting, Bozeman, MT.*

The proportion of cows bearing a live calf is a key productivity metric in cow-calf production. This study quantified the environmental and economic effects of calving rate within US beef production. A whole-system environmental model (EM) was used to quantify resource inputs and waste outputs per 363 kg of beef (average US hot carcass weight). System boundaries extended from cropping input manufacture to live animal delivery at the packing plant. Calving rate varied from the ideal of one live calf per cow per year (100%) to 60% (representative of many South American systems), with systems modeled using management practices and production data characteristic of US beef production. The economic impact of varying calving rate was quantified from feed use within the EM. As calving rate (x) within the cow-calf system decreased from 100% to 60%, the number of animals required to produce 363 kg of beef increased from 2.35 to 3.38 with a trend described by Animals (head) = $0.0047x^2 - 0.0238x + 2.475$ ($R^2 = 0.992$). Land and water use increased with a decrease in calving rate, with the quantity of land required (Land (ha) = $0.0143x^2 - 0.0718x + 6.204$; $R^2 = 0.992$) increasing at a greater rate than water use (Water (L) = $211x^2 - 1062x + 139843$; R = 0.992). At a 60% calving rate, land use was increased by 53.2% per unit of beef, whereas water use was increased by 34.1%. This was due to the differing proportions of land and water attributed to the cow-calf operation within the entire system. As calving rate decreased from 100% to 60%, carbon emissions increased from 5,459 kg per 363 kg beef to 7,945 kg per 363 kg beef, following a polynomial trend with the equation: Carbon (kg) = $11.45x^2 - 57.62x + 5762$. A decline in calving rate from 100% to 60% was associated with a 36.3% increase in production costs per unit of beef. Opportunities clearly exist to reduce environmental and economic impact per unit of beef by improving calving rate, with the greatest returns per unit increase occurring at lower calving rates. Further research should focus on quantifying the proportional contribution of other management practices, including calf mortality and weaning weight.

Key Words: beef, calving, environment

TH364   Comparison of traditional and modern systems for the individual identification of dromedary camels. G. Caja*[1], E. Diaz-Medina[2], S. Cabrera[2], O. Amann[2], O. H. Salama[3], M. H. El-Shafei[3], H. El-Sayed[3], A. A. K. Salama[1,3], R. S. Aljumaah[4], M. Ayadi[4], and M. A. Alshaikh[4], *[1]Grup of Ruminant Research (G2R), Universitat Autonoma de Barcelona, Bellaterra, Spain, [2]Oasis Park-Museo del Campo Majorero, Fuerteventura, Spain, [3]Animal Production Research Institute, Dokki, Giza, Egypt, [4]College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia.*

The use of traditional (red iron brands) and modern (plastic ear tags and low radiofrequency boluses) identification (ID) systems were compared in a study done in 477 camel dromedaries of different breeds, ages and exploitation conditions (stabulated and grazing) according to location: Egypt (Maghrebi, n = 83; 1 to 14 yr), Spain (Canarian, n = 304; 0 to 19 yr) and Saudi Arabia (Maghatir, n = 37; Majahim, n = 53; 1 to 15 yr). We evaluated the retention and readability of ID systems and camel health and wellbeing during 2 yr. Iron brands (3 digits, 20 cm) were applied in left flank of 45 Egyptian camels at yearling. Ear tags, made of polyurethane and consisting on double rectangular flaps (15 × 50 mm, 3 g; Egypt) or button tags (28.5 mm diameter, 3.5 g; Spain) were inserted in left ear of > 1 yr age camels at the start of the study. Moreover, 5 types of radiofrequency boluses, varying in specific gravity (SG, 1.5 to 3.6), volume (5.2 to 22.8 mL) and weight (12.7 to 82.1 g), were also orally administered by trained operators across camel ages and locations at the start of the study. Data were analyzed by the PROC MIXED of SAS v.9.1, using a Logit model with the method of maximum likelihood. Iron brands showed healing problems, only 38% brand digits being fully readable which misadvised on their use. Ear tag retention was lower in the rectangular vs. button ear tags (66.0 vs. 81.1%; $P < 0.01$). Administration of boluses was done safely at all ages, but 2 standard sized boluses (21 × 68 mm, 22.4 mL) were blocked at the diaphragmatic hiatus level in 2 camel calves (70 kg BW) and required the use of an esophageal probe to be unblocked. Bolus retention varied dramatically according to SG, the SG <2 being fully lost after 8 mo. On the contrary, despite their volume and weight, SG > 3 boluses were efficiently retained (99 to 100%) at all ages. Under practical conditions, > 99% camel ID at mid-term (>2 yr) can be obtained by administering high SG radiofrequency boluses. Bolus administration needs to be done by trained operators and the use of miniboluses (<15 mL) is hardly recommended in camel calves <90 kg BW.

Key Words: bolus, branding, ear tag

TH365   Prediction of body condition scores in dairy cattle from daily measurements of milk yield, milk composition and body weights. A. De Vries*[1], K. D. Gay[1], L. F. Barbosa[1], F. Du[1], K. Kaniya-mattam[1], and E. Maltz[2], *[1]University of Florida, Gainesville, [2]Institute*

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The objectives of this study were to develop and compare equations to predict body condition scores (BCS) in dairy cows during their lactation from body weight, milk yield and milk composition measurements obtained, for each cow, twice per day around milking. At the University of Florida Dairy Unit, 338 Holstein cows were scored weekly (1 to 5 scale) from calving until culling or dry off in 2011 and 2012 (n = 15,959). All cows were fed one total mixed ration and housed in freestalls. Body weights, milk yield, fat, protein, and lactose were obtained using commercial sensors (milk meters, on-line milk composition analyzers, and walk through scales). Weekly averages were calculated. The weekly BCS per cow were smoothed with a loess smoother. Thirty-four variables were constructed, including, but not limited to, energy in milk, milk yield, weight, metabolic weight, days in milk (DIM), and their logs, squares and reciprocals. SAS procedure glmselect was used to find the best fitting regression equations constrained to 3, 5, or 7 variables and their 2-way interactions. Results for mean ± SD of BCS at calving, 70, 140, 210, 280, 350 DIM were 3.46 ± 0.29, 2.99 ± 0.55, 3.16 ± 0.51, 3.43 ± 0.51, 3.65 ± 0.41, and 3.89 ± 0.43. The Root MSE of the 3, 5, and 7-variable equations were 0.34, 0.32 and 0.31 BCS. The R squared of the 3, 5, and 7-variable equations were 53%, 60%, and 63%. The 7-variable equation was BCS at t DIM = 3.65 + 0.238 × BCS at calving – 0.083 × Mcal in kg milk per kg metabolic body weight at t DIM × Mcal in milk at 7 DIM – 3.08 × kg milk yield at 70 DIM / Mcal in kg milk at 70 DIM + 2.68 × kg body weight at t DIM / kg body weight at 70 DIM – 0.204 × lactation number × kg body weight at t DIM / body weight at 70 DIM – 827 / kg body weight at t DIM. When the cow has not yet reached 70 DIM, estimates at 70 DIM should be provided. In conclusion, body weight, milk yield, and components were useful for predicting BCS during the course of the lactation. The predictions could be improved with new variables that have not been tested, and should be validated with other BCS data sets.

Key Words: body condition score, weight, milk component

TH366   Evaluating carbon fluxes variability in late lactation organic Jersey cows using a portable automated gas quantification system during the grazing season. A. B. D. Pereira*[1], A. F. Brito[1], S. Zimmerman[2], and N. Antaya[1], [1]*University of New Hampshire, Durham,* [2]*C-Lock Inc., Rapid City, SD.*

The objective of the current study was to determine methane and carbon dioxide fluxes (J_{CH4} and J_{CO2}, respectively), and carbon emissions variability from 7 primiparous and 3 multiparous lactating organic Jersey cows (200 ± 53 DIM and 13.3 ± 2.4 kg of milk yield). Measurements were taken from July to October 2012 yielding a total of 72 d of data collection. A portable, automated system [i.e., The GreenFeed (GF) system; C-Lock Inc., Rapid City, SD] consisting of air sampling and gas quantification modules powered by solar energy was mounted on a trailer for assessing breath carbon fluxes from grazing cows. The GF uses radio frequency identification and controlled release of pellet concentrates to reinforce voluntary visitations by individual animals several times throughout the day. Cows were moved to a new strip of fresh, cool-season grass-legume herbage mix (predominantly grass) after each milking (a.m. and p.m.) yielding about 17 h of access to pasture daily. Cows were supplemented with a TMR composed (DM basis) of 51% grass-legume baleage, 47% concentrate, and 2% liquid molasses fed via Calan doors. The GF was moved once daily to remain with the cows. Cows had no access to the pasture and the GF from 0430 to 0800 h and from 1400 to 1730 h, which coincided with milking times and TMR feeding. Number of animal visitations to the GF, J_{CH4} and J_{CO2}, within

animal J_{CH4} and J_{CO2} coefficient of variation (CV), and between animal CV of 3 d rolling average were calculated. Average herbage DMI (6.5 kg/cow/d) was calculated by subtracting estimated total DMI (14.6 kg/cow/d; NRC, 2001) from measured TMR intake (8.1 ± 2.9 kg/cow/d), yielding a J_{CH4} of 21 g/kg DMI. Each animal averaged 128 ± 30 total visits to the GF. Daily J_{CH4} and J_{CO2} averaged 308 ± 18 g/d and 8,716 ± 519 g/d, respectively. The within animal emissions CV averaged 11.1% ± 2.13 and 8% ± 2 for J_{CH4} and J_{CO2}, respectively, while the between animal emissions CV averaged 5.9% for both J_{CH4} and J_{CO2}. Results suggest that the J_{CH4} and J_{CO2} measurements appear to be reliable and repeatable as indicated by the relatively low CV.

Key Words: methane, carbon dioxide, pasture

TH367   Housing and management characteristics of 53 farms using automatic milking systems. J. A. Salfer*[1], M. I. Endres[1], and D. W. Kammel[2], [1]*University of Minnesota, St. Paul,* [2]*University of Wisconsin, Madison.*

The objective of this study was to describe housing and management characteristics of farms in Minnesota and Wisconsin using automatic milking systems (AMS). Fifty-three farms using AMS were visited from June to September 2012. Data were collected on facility layout and design. Farms had 2.6 ± 1.6 AMS/farm, with a range or 1 to 8 AMS/farm. Farms averaged 1.4 robots/pen with a range of 1 to 3 robots/pen. The average number of freestalls was 78 ± 31 freestalls/pen. Thirty-four farms built new cow housing facilities and 23 installed AMS units in retrofitted existing barns. Methods of manure removal and number of farms were: automatic alley scrapers (25), scrape manually (14), slatted floor (11) and bedded pack (3). Eleven of the farms had robotic feed pushers that pushed up the ration on a pre-determined schedule. Forty farms had exclusively free flow cow traffic, 12 farms had exclusively guided flow traffic and 1 farm had both a free flow and guided flow cow traffic system in separate barns. Guided flow traffic and number of farms were: freestall to AMS to feed (9), feed to AMS to feed (2), feed to AMS to freestall (2). The majority of the summer forage on 5 farms was pasture, with 4 farms being certified organic. Freestall surface on farms were: mattresses (23), sand (14), or waterbeds (7). Cows on 5 farms had access to pasture and freestalls and 3 farms had a bedded pack. Thirty-five of the farms were naturally ventilated, 11 were tunnel ventilated and 7 were cross-ventilated. Forty-five of the farms had mechanical rotating brushes. Average feed bunk space was 50.5 ± 13.5 cm/cow with a range of 25.9 to 106.7 cm/cow. Open area in front of the robot was 44.7 ± 29.4 m^2 and ranged from 11.1 to 187.3 m^2. Protected AMS exit lane was 3.1 ± 2.4 m and ranged from 0.3 to 8.5 m. Drinking space was 6 ± 2.8 cm/cow and ranged from 0.5 to 11.8 cm/cow. These results indicate that some aspects of AMS barn designs appear to be similar to other types of housing systems.

Key Words: automatic milk system, precision dairy, robotic milking

TH368   Factors affecting expression of estrus of lactating dairy cows using activity monitors. A. M. L. Madureira*, T. A. Burnett, B. F. Silper, N. Dinn, and R. L. A. Cerri, *University of British Columbia, Vancouver, BC, Canada.*

The objective of this study was to determine parameters related to increased physical activity as a result of estrous expression. Estrus expression (795 events) from lactating Holstein cows (n = 305) was recorded. Cows were monitored continuously by an activity monitoring system (Heatime, SCR Engineers) attached to the cow's neck 5 d after calving. Data was recorded in real time every 2 h. The threshold level

was set at SCR index = 35 or approximately 80% increase in physical activity. Upon detection, cows had blood samples and BCS immediately collected and their ovaries scanned by ultrasound (Aloka SSD-500, Aloka Co. Ltd.). Pregnancy per AI, health episodes and milk production data were collected and recorded for the entire experimental period. Data was analyzed using ANOVA logistic regression using procMIXED and GLIMMIX. Mean estrus duration was 11.3 ± 5.3 h with index activity peak of 72.8 ± 20.2 and a pre-ovulatory follicle diameter of 18.8 ± 0.3 mm. There was a positive correlation between duration and peak (r2 = 0.70), with estrus episodes with high peak (66–100) being longer (14.3 ± 0.2 vs 6.2 ± 0.2 h) than those with small peaks (35–65). Estrus duration was affected by parity as multiparous cows expressed it for a shorter period than primiparous (10.8 ± 0.3 vs 12.2 ± 0.3 h). Cows with moderate BCS (>3.00) had longer duration of estrus episodes than cows with low BCS (≤ 2.75), 13.0 ± 0.4 vs 11.5 ± 0.3 h, respectively. Follicle diameter was not correlated with peak of activity, duration, BCS or disease episodes. Pregnancy per AI was not influenced by parity, follicle diameter, peak of activity and duration of estrus. Estrus expression patterns were not affected by disease episodes during the transition period or by expression of secondary signs of estrus behavior. In conclusion, duration and peak of estrus episodes were quite variable and mainly influenced by parity and BCS. Follicle diameter was not correlated with estrus peak and duration, and no effect on pregnancy per AI was found. Further analyses are needed to define physical activity thresholds correlated with pregnancy per AI and efficiency of activity monitoring technologies.

Key Words: follicle, duration, heat

TH369 **Ammonia emissions and carbon and energy footprints of dairy farms in the Northeastern United States and Northern Europe estimated using DairyGEM.** A. N. Hristov*[1], A. Rotz[2], P. Huhtanen[3], M. Korhonen[4], and B. Isenberg[1], [1]Department of Animal Science, The Pennsylvania State University, University Park, [2]USDA-ARS-PSWMRU, University Park, PA, [3]Division of Animal Husbandry, Swedish University of Agricultural Sciences, Umea, Sweden, [4]Farm Services, Valio Ltd., Helsinki, Finland.

Production system, diet, geographic location, and climate affect the environmental footprint of dairy farms. The objective of this analysis was to estimate ammonia emissions and carbon and energy footprints of dairy farms in the Northeastern United States (US) and Northern Europe (NE). Sixteen US farms [average size 121 ha (SD = 19.7, min = 16 and max = 304 ha)] and 11 NE farms [93 ha (SD = 44.8, min = 26 and max = 201 ha)] were included in the analysis. Parameters were established to simulate all farms with the Dairy Gas Emission Model (DairyGEM). Important input data for each farm were the number of animals including replacement heifers, milk production and milk composition, feeds (forages and concentrates) fed and their nutrient contents, pasture use, crude protein concentration of the diets, housing type, and manure handling practices. Output data were analyzed using the MIXED procedure of SAS with farm as a random effect. Estimated ammonia emissions ranged from 5.1 to 13.6 g ammonia/kg fat- and protein-corrected milk (FPCM) with the emissions on NE farms averaging 36% less ($P < 0.001$) than the US farms (Table 1). Carbon footprints ranged from 0.77 to 1.47 kg CO_2 eq/kg FPCM with the NE farms averaging 17% greater than the US farms. Energy use ranged from 2.45 to 3.81 MJ/kg FPCM with the NE farms averaging 19% greater than the US farms. The lower ammonia emissions for the NE farms were attributed to cooler temperatures, lower dietary protein content, and faster incorporation of manure when applied to fields. Greater carbon and energy footprints of the NE farms were primarily due to an average 16% lower milk production per cow compared with the US farms.

Table 1. Milk production, ammonia emissions, and carbon and energy footprints of US and NE dairy farms

Item	US	NE	SEM	P-value
No. of farms	16	11	—	—
No. of cows	195	60	52.4	0.02
No. of heifers	164	55	45.7	0.03
FPCM, kg/yr	10,180	8,569	352.0	<0.001
Ammonia emissions, g/kg FPCM	10.3	6.6	0.64	<0.001
Carbon footprint, CO_2 eq g/kg FPCM	1.03	1.21	0.064	0.03
Energy footprint, MJ/kg FPCM	2.98	3.54	0.137	<0.001

Key Words: carbon footprint, ammonia emission, dairy farm

TH370 **Potential impact of climate change on crop yield and nutritive value of dairy farms in Quebec.** J. M. Moreno*[1], G. Bélanger[2], H. Côté[3], D. Pellerin[1], V. Bélanger[1], G. Allard[1], R. Audet[2], D. Chaumont[3], and E. Charbonneau[1], [1]Universite Laval, Quebec, QC, Canada, [2]Agriculture and Agri-Food Canada, Quebec, QC, Canada, [3]Ouranos, Montreal, QC, Canada.

The projected climate change will likely affect the yield and nutritive value of crops grown in Quebec but their effect on dairy farms has not yet been investigated. Our objective was to determine the effect of climate change on the yield and nutritive value of the major crops used on Quebec dairy farms as the first step of a more comprehensive study at the farm level. Our study was conducted for 2 regions [Centre-du-Quebec (CQ; corn heat unit: 2700) and Bas-St-Laurent (BSL; corn heat unit: 2045)]. Currently used agroclimatic indicators were calculated for the current conditions and projected for 2041–2070 using 2 scenarios of greenhouse gas emissions (SRES A1B and SRES B1). Published results were used along with the agroclimatic indicators to estimate the potential effect of climate change on crop yield and nutritive value, followed by a validation in a focus group of 10 experts in dairy and crop production. The projected climate change is expected to result in increased yields of grain corn (6.1 to 10.2 ton/ha) and soybeans (1.9 to 2.5 ton/ha) in CQ, and the possibility to grow those 2 crops in BSL with yields similar to those in CQ under current climatic conditions. Yields of wheat (2.1 ton/ha) and barley (2.0 ton/ha) are not expected to change with climate change in the 2 regions. An increase in yield is expected for alfalfa (CQ: 5.3 to 9.3 ton/ha; BSL: 3.9 to 6.8 ton/ha) and corn silage (CQ: 13.8 to 16.1 ton/ha; BSL: 11.1 to 13.8 ton/ha) but no changes are expected for timothy (CQ: 4.3 ton/ha; BSL: 3.1 ton/ha). Forage nutritive value is expected to be affected by climate change with a decrease in crude protein concentration of alfalfa (19.3 to 18.5%) and timothy (11.8 to 11.4%) and an increase in fiber concentration for alfalfa (NDF: 44.7 to 46.6%; ADF: 32.8 to 34.3%; ADL: 6.9 to 7.4%). In Quebec, a northern agricultural region, mostly positive variations in crop yields and negative changes in the nutritive value of forages are expected with climate change.

Key Words: climate change, dairy farm, crop production

TH371 **Potential impact of climate change on dairy farm profitability and management practices in Quebec.** J. M. Moreno*[1], D. Pellerin[1], G. Bélanger[2], V. Bélanger[1], H. Côté[3], G. Allard[1], R. Audet[3], D. Chaumont[3], and E. Charbonneau[1], [1]Universite Laval, Quebec, QC, Canada, [2]Agriculture and Agri-Food Canada, Quebec, QC, Canada, [3]Ouranos, Montreal, QC, Canada.

Modifications to crop yield and forage nutritive value with the projected climate change will likely affect management practices and profitability of dairy farms. Our objective was to evaluate the potential effect of

climate change on dairy farm profits and management practices, considering the farm as a single unit of management. The whole-farm model N-CyCLES was adapted and used to evaluate changes in the economic performance of a dairy farm and to optimize the management practices required to maximize profits. Data representative of an average dairy farm from the Centre-du-Quebec region in Quebec were used along with expected modifications to crop yield and forage nutritive value associated with climate change projections (greenhouse gas emission scenarios SRES B1 and A1B; 2041–2070 and assessed with a combination of agro-climatic indices, literature review, and focus groups). For both scenarios, projected higher crop yields and variations in forage nutritive value are likely to result in increased in the proportion of income from crop sales (3.0% to 6.3% and 7.4% for B1 and A1B respectively) and a decrease in purchased grains. The farm profit is projected to increase by $0.38/hL (±2668 $/farm) for A1B. The projected yield increase is less with the B1 scenario with a resulting lower farm profit than under the current situation (−0.06 $/hL). For both scenarios, no modifications in crop rotations were made by the model. To meet the requirements of lactating cows using forages with a lower nutritive value, the proportion of corn silage in the diets was increased. Climate change is expected to result in an increased farm P balance (201 and 197 kg/y with B1 and A1B respectively) but results for N balance variation are different for B1 (1236 kg/y) and A1B (−310 kg/y). These results, as well as sensitivity analysis performed on crop yields, confirm that the effect of climate change can be beneficial for Quebec dairy farms as long as the increase in crop income compensate for higher costs related to crop production and the lower forage nutritive value.

Key Words: dairy farm, whole-farm model, climate change

TH372   Survey of milk production, and feeding and reproduction management on pasture based dairy farms in Florida and Georgia. F. Du*[1], K. Gay[1], M. Sowerby[1], Y. Newman[1], C. Staples[1], C. Lacy[2], and A. De Vries[1], [1]*University of Florida, Gainesville,* [2]*University of Georgia, Tifton.*

Objective of this study was to document milk production, and feeding and reproduction management on pasture based dairy farms in Florida and Georgia. The survey consisted of 62 questions and covered 7 areas, which included farm business structure, young stock, herd management, pasture and crop management, feeding management, manure and nutrient management and environment and sustainability. The survey focused on the year 2011–2012. Data were collected by personal interview in the fall of 2012. This survey was conducted on 15 dairy farms that were responsible for approximately 12,000 cows and 5,000 heifers. Grazing rotation and pasture management was employed by 10 (67%) respondents. The average milk production was 58 ± 16 lbs/cow/day during the winter and 41 ± 14 lbs/cow/day during the summer. The average rolling herd average was 15,766 ± 4,719 lbs/cow/year. The average somatic cell count was 253,286 ± 73,676 cells/ml during the winter, and 381,467 ± 85,891 cells/ml during the summer. For cows, 4 farms (27%) utilized a year around breeding strategy, while the remaining farms practiced various seasonal breeding strategies. Three farms (20%) employed 100% seasonal breeding. The greatest number of calvings were reported for October (8 farms, 53%) while 13 farms (87%) reported the fewest calvings during the summer. Non-breeding periods were reported by 13 farms (87%). Summer breeding was avoided due to lower pregnancy rates (7 farms, 47%), or breeding during October to November was avoided (10 farms, 67%) to avoid calving during the summer. Feeding from grazing varied widely in different seasons, and the intake from stored feed was high. For lactating cows, the average dry matter intake from stored feed was 33 ± 16 lbs/cow/day during the winter, and 21 ± 19 lbs/cow/day

during the summer. For dry cows, the average dry matter intake from stored feed was 12 ± 10 lbs/cow/day during the winter, and 6 ± 11 lbs/cow/day during the summer. Findings from this study will be used to design programs that focus on optimization of reproduction strategies for pasture based dairy farms in the Southeastern United States.

Key Words: pasture, seasonality, survey

TH373   Breeding for polled dairy cows versus dehorning: Preliminary cost assessments and discussion. N. J. O. Widmar*[1], M. M. Schutz[1], and J. B. Cole[2], [1]*Purdue University, West Lafayette, IN,* [2]*Animal Improvement Programs Laboratory, ARS, USDA, Beltsville, MD.*

Dairy producers today face labor, equipment, and medical costs associated with dehorning heifers. Further, complications requiring veterinary intervention occur with some probability. The objective of this work is to develop preliminary cost estimates of selecting for polled dairy heifers. Stochastic budgets were developed to analyze the expected costs (EC) associated with polled dairy genetics. Triangular distributions, commonly used to represent distributions with limited data, were used to represent costs for dehorning, added semen costs of polled genetics, the likelihood of treatment of calf, and the cost of veterinary treatment (should it be needed). The minimum, most likely, and maximum costs used for dehorning were $5.00, $7.00, and $15.00; additional polled genetics $0.00, $8.00, $20.00; probability of treatment with dehorning 0.01, 0.03, and 0.08; probability of treatment with polled 0.01, 0.02, and 0.03; and the cost of treatment, held constant across all scenarios, was parameterized by $10.00, $50.00, and $150.00. A total of 10,000 iterations were run using @Risk v 5.7. The minimum expected cost of dehorning and polled breeding, using these simplified parameters, was $5.84 and $0.47, respectively. The maximum EC of dehorning and polled breeding, using these simplified parameters, was $22.89 and $22.50, respectively. Mean EC of $11.79 and $10.73 were found for dehorning and polled genetics, respectively; given the parameters outlined here, sensitivity to individual farms' semen and dehorning costs are likely to outweigh these differences. Beyond on-farm costs, industry-wide discussion may be warranted surrounding the public acceptance and attitude toward polled genetics versus dehorning calves. The value of avoiding dehorning may be (much) larger for the industry, and perhaps some individual farms, than initially suggested if additional value is put on calf comfort, potentially decreased rates of gain if calves are stressed at dehorning, and possible worker aversion to the dehorning process.

Key Words: dairy breeding, polled, cost-benefit

TH374   Environmental impact estimate of dairy cows treated for mastitis. F. M. Goncalves*[1,2], P. A. S. Silveira[1,3], M. E. Lima[1,3], G. N. Bolzan[1,3], J. Halfen[1,3], A. Schneider[1,3], E. G. Xavier[1,4], and M. N. Correa[1,3], [1]*Federal University of Pelotas, Pelotas, RS, Brazil,* [2]*Nucleo GAPA - Research Group in Environmental management in livestock, MERCOSUL Center, Pelotas, RS, Brazil,* [3]*NUPEEC - Research, Teaching and Animal Husbandry Extension Center, Veterinary Clinic Dep., Pelotas, RS, Brazil,* [4]*Granja 4 Irmaos, Rio Grande, RS, Brazil.*

Mastitis is one of the major causes of quality and quantity deficiency in milk production. Brazil has the largest commercial cattle herd in the world using tropical forage as their main diet; due to this, the country has been dubbed "the major methane producer in the world." The aim of this study was to estimate the environmental impact on a dairy herd presenting mastitis episodes. Data collected along 781 d on a dairy farm located in southern Brazil was analyzed using descriptive statistics. The

average number of lactating dairy cows kept under semi-confinement management (concentrate and pasture fed) during this period was 873 animals. Average milk production was 22.5 ± 7.6 kg/cow/day. One thousand three hundred and twenty-seven mastitis episodes distributed between recidivist and new cases were observed but only the number of total episodes was used. Mastitis treatment was performed following a Veterinarian antibiotic protocol and averaged 2.36 ± 1.66 d. Milk discard days were estimated by adding days of treatment to the withholding period. Milk discard averaged 5.36 ± 1.66 d per episode. Upon considering the methane emission estimate proposed by Robertson and Waghorn (2002), the cows emitted 22.5g of methane/kg milk. Milk discard was 120.7 ± 37.5 kg per mastitis episode, corresponding to a total of 159,772.5 kg milk discarded in the period observed. This amount contributed to 3,594.88t of methane emission due to discarded milk. Parameters such as diet metabolizable energy (ME), days of lactation and feeding regimens have been the research focus in methane emission reduction. However, this study showed that the sanitary status of cattle must be taken into account. It was concluded that disease prevention in dairy cattle is a very important measure to reduce the use of therapies that imply milk disposal, which generates an environmental impact without any social or economic benefit to the farmer.

Key Words: environmental impact, mastitis, dairy cow

TH375   Trends in noncompliance with milk quality standards for dairy herd improvement herds in the United States. H. D. Norman* and J. R. Wright, *Animal Improvement Programs Laboratory, USDA-ARS, Beltsville, MD.*

Frequency of herd noncompliance for somatic cell count (SCC) based on current US and European Union (EU) standards as well as for standards proposed by the National Milk Producers Federation (NMPF) was examined for US Dairy Herd Improvement (DHI) herds. For current US standards, regulatory action is taken if bulk-tank SCC (BTSCC) for 3 of 5 consecutive monthly shipments is >750,000 cells/mL. For EU standards, a herd is SCC noncompliant after 4 consecutive rolling 3-test geometric means of >400,000 cells/mL. For proposed NMPF standards, a herd would be SCC noncompliant if 3 of 5 consecutive BTSCC were >600,000 cells/mL (January 2014) or >400,000 cells/mL (January 2015). The SCC for individual cows are derived from somatic cell scores, where $SCC = 2^{(\text{somatic cell score} - 3)}(100,000)$. As a BTSCC proxy for determining which herds and milk were SCC noncompliant, herd test-day SCC (HTSCC) were derived by weighting each cow's SCC by her test-day milk yield. Based on HTSCC, noncompliance rates were examined for various milk quality standards, with a focus on trends during the last 2 yr, as the EU standards have been imposed upon many US dairies producing for export. Data were from about 13,000 DHI herds monthly and represented about 50% of US milk produced. Herds included had DHI tests with ≥ 10 cows from April 2009 through October 2010 or from April 2011 through October 2012. Mean monthly herd noncompliance based on current US standards dropped from 0.9 to 0.4% over the last 2 yr. For NMPF proposed standards, herd noncompliance would have dropped from 2.7 to 1.4% for a limit of 600,000 cells/mL or from 14.1 to 9.0% for 400,000 cells/mL. For the EU standard, herd noncompliance would have been reduced from 7.8 to 5.0%. The percentage of milk affected by noncompliance is considerably less than the percentage of herds; only 0.1 and 1.4% of US milk failed current US and EU SCC standards, respectively. Trends indicate a continued improvement in US SCC compliance levels but to satisfy stricter milk standards, US producers will need to continue to emphasize sound milking practices more and cull on SCC more intensively.

Key Words: somatic cell count, milk quality, standard

TH376   Management and outcomes of Sicilian dairy farms enrolled in a team-based milk quality improvement project. G. Azzaro[1], M. Caccamo*[1], P. L. Ruegg[2], J. D. Ferguson[3], M. Gambina[1], and G. Licitra[1,4], [1]*CoRFiLaC, Regione Siciliana, Ragusa, Italy, [2]University of Wisconsin, Madison, [3]School of Veterinary Medicine, University of Pennsylvania, Philadelphia, [4]DISPA, University of Catania, Catania, Italy.*

Sicilian dairy farms (n = 138) were enrolled in a team-based milk quality improvement project funded by Sicilian Region. The aim of the project was to identify and improve management practices mostly affecting milk quality to control and reduce mastitis incidence. At the first milk quality team meeting, a survey was submitted to gather management and financial information from dairy farms and a bulk tank milk sample was collected. Farms were ranked according to their bulk tank milk somatic cell (SCC) and total bacteria counts (TBC). Although not statistically significant, an inverse relationship between milk yield and SCC class was found. Economic loss per liter of milk ranged between 3.4 and 5.1 € cents with increasing SCC class ($P = 0.065$). Adoption of standardized best management practices such as maintaining appropriate vacuum reserve, use of milking gloves, pre and post milking teat disinfection, and dry cow therapy were associated with herds having lower bulk milk SCC. Every 2 mo, each team met, analyzed herd performance and identified milk quality goals, set target dates to reach the goals, created an action plan, and assigned responsibility for specific tasks. Bulk tank milk was also sampled and cows were scored for body condition, teat end, and udder hygiene. After 2 meetings, 31 farms were left out of the project based on their willingness to continue and their ability to achieve the assigned goals. No overall difference was detected in the selection of milk quality goals and actions by breed and bulk milk SCC and TBC at enrollment ($P > 0.05$). However, team members working with herds having very high bulk milk SCC and TBC were more likely to list milking as action areas than were team members with herds having medium or low bulk milk SCC. In general, herds completing the fourth meeting of the milk quality program reported reduced bulk tank milk TBC ($P < 0.10$), and rates of teat end and udder hygiene ($P < 0.001$) scored above 3 compared with the beginning of the program. These preliminary results confirm the effectiveness of such programs in improving milk quality.

Key Words: milk quality, team-based program

TH377   Effect of delaying breeding during the summer on profitability of dairy cows. M. Gobikrushanth*, A. De Vries, C. A. Risco, J. E. Santos, and K. N. Galvão, *University of Florida, Gainesville.*

The objective was to evaluate the effect of delaying breeding during the summer on profitability. Holstein cows (n = 676) that calved between June and September of 2007 and 2008 were used. Cows that calved between Jun 1 and Jul 21 were AI upon estrus detection (ED) after the second PGF of the Presynch between 57 and 63 DIM, or were timed AI using the Ovsynch protocol (TAI) if not detected in estrus. Cows that calved between Jul 22 and Sept 18 were AI after the first or second PGF starting Nov 14 or Nov 21 or were TAI if not detected in estrus. Following this scheme, cows could have a regular (REG; 57–63 DIM; n = 288) or extended voluntary waiting period (VWP; 64–115 DIM), which was divided into medium (MED; 64–84 DIM; n = 224) or long (LONG; 85–115 DIM; n = 164). Overall and daily net return was calculated by subtracting the costs with replacement heifers ($1,850/heifer), feeding costs ($0.30/kg lactating cow diet; $0.25/kg dry cow diet), breeding costs ($2.65/dose PGF; $2.40/dose GnRH; $0.25/injection administration; $10.0/semen straw; $5.0/AI; $3.0/pregnancy diagnosis), and other costs ($3.0/d) from the daily income with milk sales ($0.44/kg milk), cow sales ($1.76/kg live weight), and calf sales ($140/calf). Data was

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analyzed using the MIXED procedures of SAS. Models included the effect of VWP group, parity and its interaction. VWP group did not affect ($P > 0.5$) overall or daily net return. Overall/daily net return per cow was \$2079/\$5.3, \$1952/\$5.1, and \$2033/5.2 for REG, MED and LONG, respectively. With the exception of milk income, VWP group affected ($P < 0.05$) all costs and incomes. Feeding/other cost was higher for LONG (\$1162/\$1120) and REG (\$1148/\$1108) than MED (\$1073/\$1043). Replacement cost was higher for MED (\$463) than REG (\$304), while LONG was intermediate (\$379). Breeding cost was higher for REG (\$48) than for MED (\$38) and LONG (\$37). Calf sales income was higher for REG (\$117) than MED (\$105), while LONG was intermediate (\$111). On the other hand, cow sales income was lower for REG (\$123) than MED (\$214), while LONG was intermediate (\$193). Although extending the VWP affected most costs and incomes, it did not affect profitability.

Key Words: delayed breeding, profitability, dairy cow

TH378 Impact of feeding strategies on milk production and profitability on Wisconsin organic dairy farms. C. A. Hardie[*1], M. Dutreuil[1], R. Gildersleeve[2], M. Wattiaux[1], N. S. Keuler[1], and V. E. Cabrera[1], [1]*University of Wisconsin-Madison, Madison,* [2]*University of Wisconsin-Extension, Lancaster.*

The purpose of this study was to group and compare certified organic Wisconsin dairy farms based on general farm characteristics and their feeding regimens during the course of 2010 and evaluate their productivity and profitability. An on-site survey containing sections on farm demographics, feeding, pasturing, and economics was conducted on 69 organic dairy farms. A non-hierarchical clustering method using 9 variables related to general farm characteristics, feed supplementation, and grazing was applied to partition the farms into clusters. A scree plot was used to determine the most appropriate number of clusters. Farm production and profitability were evaluated using reported milk rolling herd averages (RHA) and calculated monthly milk income minus feed costs (IOFC), respectively. The farms in Clusters 1 (n = 8) and 3 (n = 32), the large and small high-input farms, respectively, had the largest RHA and IOFC (Table 1). Cluster 2 (n = 5), the completely seasonal, extremely low-input farms had the lowest RHA and IOFC. Cluster 4 (n = 24), the semi-seasonal, moderate-input cluster, was third for RHA and IOFC. Results indicate that Wisconsin organic dairy farms differed tremendously in structure and feeding strategies, and farms that supplemented more feed had larger RHA and higher IOFC. Evaluation of other farm costs needs to be conducted before assessing profitability at the whole-farm level.

Table 1. Cluster medians (interquartile ranges) for milk rolling herd average (RHA) and milk income minus feed costs (IOFC)

	Cluster (n=8)	Cluster 2 (n=5)	Cluster 3 (n=32)	Cluster 4 (n=24)
RHA, kg/cow per yr	6,878[a] (1,038)	3,632[b] (783)	7,457[a] (1,754)	5,417[c] (1,760)
IOFC,[1] \$/cow per d	10.17[a] (2.99)	5.07[ab] (2.62)	8.59[a] (4.68)	5.83[b] (2.66)

[a–c]Kruskal-Wallis test ($P \leq 0.001$); Wilcoxon test with Bonferroni correction ($P < 0.05$).
[1]IOFC for lactating cows for Jan–Nov. (clusters 1, 3, 4) and May–Nov (cluster 2).

Key Words: organic, supplementation, cluster analysis

TH379 Whole-farm balance of nitrogen and phosphorous on Costa Rican dairy farms. J. A. Elizondo-Salazar[*1], J. P. Jimenez-Castro[1], and Z. Wu[2], [1]*Estacion Experimental Alfredo Volio Mata, Facultad de Ciencias Agroalimentarias, Universidad de Costa Rica,* [2]*University of Pennsylvania, New Bolton Center.*

With the objective to determine the whole-farm nitrogen (N) and phosphorous (P) balances; to assess the efficiencies of imported N and P on Costa Rican dairy farms, 11 commercial herds were monitored for 12 mo. Farms differed in land area (1,0 to 116 ha), herd size (106 ± 46 animals), housing (tie-stall, free-stall, outdoors), feeding system (grazing, confinement, semi-confinement), production (19 ± 6 kg/day) and feed source (e.g., grasses, agricultural sub products, citrus pulp, concentrate). The import of N and P was mainly in the form of feeds, animals, inorganic fertilizers, and mineral supplements, and the export was through milk and culled animals. On average, feed, inorganic fertilizer, and mineral supplements accounted for 70 (±19), 16 (±14) and 14% (±8) of the total P imports, respectively. Likewise, 75% (±21) of the N imports was through feeds and 25% (±21) in inorganic fertilizers. The balance (import-export) of N and P varied substantially among farms, but was in excess for all farms. Only 33.0% of the N and 23.0% of the P imported was removed from the farm through milk and animals, with the remaining 67 and 77% staying on farm land for recycling through forages. However, surplus nutrientes may also lead to disturbances of environmental ecosystems. The exports through milk and animals averaged 92 and 8% for P and 94 and 6% for N. As the largest imports of P and N occur in feed, controlling dietary P and N to the requirement level, thus limiting feed purchase is fundamentally important for reducing nutrient losses as well as feed cost.

Key Words: nutrient management, environment, nutrition

TH380 Agreement of dairy cattle replacement policies by two models: Optimization and simulation. A. S. Kalantari[*] and V. E. Cabrera, *University of Wisconsin-Madison, Madison.*

The objective of this study was to compare proposed replacement decisions of a dynamic programming as an optimization model and a Markov chain as a simulation model. Lactation, month in milk, and pregnancy status were used to describe cow states in a herd in both models. The same economic and management parameters were used in both models. To compare models results the cow value calculated by the Markov chain model and the retention pay-off calculated by the dynamic programming model were used to rank all the animals in a sample herd. Then, the rank correlation (Spearman's correlation) was calculated between results of both models. The overall correlation was 89% (df = 998, P-value <0.0001), which evidenced a strong linear relationship between value ranking of animals from the 2 models. By considering only 10% of lowest ranking cows from both models the correlation increased to 98%. Cows with lower values are the main interest for replacement decisions. Therefore, based on this higher correlation for cows with lower values, we concluded that the final replacement decisions with both models were similar. A post optimality analysis was used to explore the effect of the optimal replacement decisions on the herd dynamics and herd net return. A net return was improved \$6/cow per year by using replacement decisions of both the dynamic programming model and the Markov chain cow value model.

Key Words: optimum replacement policy, optimization, simulation

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