W263 Technical and economic performance on beef cattle in the Livestock Low Carbon Integrated Project-ICV. Fabiano Alvim Barbosa*[1], Vando Telles Oliveira[2], Filipe Lage Bicalho[3], Luciano Bastos Lopes[4], Juliana Mergh Leão[1], and Lucas Luz Emerick[1], *[1]Universidade Federal de Minas Gerais, UFMG, Belo Horizonte, Minas Gerais, Brazil, [2]Instituto Centro de Vida, ICV, Alta Floresta, Mato Grosso, Brazil, [3]Soluções Integradas ao Agronegócio, SIGA, Alta Floresta, Mato Grosso, Brazil, [4]Empresa Brasileira de Pesquisa Agropecuária, Embrapa, Sinop, Mato Grosso, Brazil.*

Economic efficiency and productivity of 6 farms on cattle production systems were evaluated in Mato Grosso State, Amazon biome, during January 2013 and December 2014, part of the Livestock Low Carbon Integrated Project-ICV. Production and economic data were collected using control software (*Prodap Profissional GP*) and analyzed by electronic spreadsheets (Microsoft Excel). The systems was developed exclusively on a grazing system with a base herd comprised of Zebu (Nelore) and crossbred *Bos taurus* × *Bos indicus* cattle in 4 farms. The total of pasture was 6,560 ha (ha) and 14,260 cattle. The average of pasture was 547 ha/farm and 1,188 cattle/farm. Introduction of technologies related to good practices agricultural of fertilization of pasture, feeding supplementation, breeding program, animal health practices, associated with technical-administrative management were evaluated. The zootechnical and economic indexes were compared by Duncan and Tukey test with significance level of $P < 0.05$. There was no statistical difference ($P > 0.05$) between zootechnical indexes, stocking rates was 2.17 animals/ha, 755 kg live weight/ha, 256.73 kg body weight produced/ha and 0.87% of mortality rate. There was no statistical difference ($P > 0.05$) between economic indexes, total operating costs was US$0.68/kg, net margin of US$165.09/ha. The net present values (NPV) and internal rate of return (IRR) were higher in 2014 than 2013 ($P < 0.05$), due to increased financial resources for the technologies in 2013. NPV was US$74.92 and US$208.68/ha in 2013 and 2014, respectively ($P < 0.05$), IRR was 1.43 and 3.49% per month in 2013 and 2014, respectively ($P < 0.05$). The economic results indicated that the activity of beef cattle in Amazon biome can be sustainable use good agricultural practices.

Key Words: costs, profitability, sustainability

W264 Lactation and immune responses of lactating dairy cows vary with different environmental stressors. Ricardo O. Rodrigues*[1], Ann L. Kenny[1], Matthew R. Waldron[1,2], and Thomas B. McFadden[1], *[1]Division of Animal Sciences, University of Missouri, Columbia, MO, [2]Nutrition Professionals Inc., Chilton, WI.*

Meta-analysis was used to evaluate the response of dairy cows to different stressors. Holstein cows (n = 24; 2.8 ± 0.7 parity; 153 ± 25 DIM) were housed in free-stalls for 14d (P1), then moved to environmentally controlled tie-stall rooms at thermoneutral temperature for 7d (P2; constant 20°C), then exposed to 14d of programmed 12h cyclical heat stress (HS; mean THI range 72.5 ± 0.1 to 81.3 ± 0.5; P3), and finally, moved back to free-stalls for 7d (P4). Response of animals to housing (P1 vs. P2), HS (P2 vs. P3), and recovery from HS (P3 vs. P4; effect confounded with housing) were evaluated. For analyses, each variable within each period was averaged over the 3 median days. Data were analyzed using Proc MIXED of SAS; the original treatments were random effects and period was a repeated effect. For each comparison, data from the previous period were used to covariate-adjust for carryover effects. Moving cows from free- to tie-stalls did not affect BW, but reduced ($P < 0.01$) milk yield and DMI by 5 and 10%, respectively. Feed efficiency (FE) and ECM FE improved 6% ($P < 0.03$) but milk components declined ($P < 0.05$) from free- to tie-stalls, except for fat and SCS, which increased ($P < 0.05$). Plasma NEFA decreased ($P < 0.01$) and BHBA increased ($P < 0.03$) in tie-stalls. Immune measurements were minimally affected. Respiration rate (RR) increased ($P < 0.06$) 10% in cows housed in tie-stalls, but rectal temperature (RT) was only 0.2°C higher ($P < 0.01$). Heat stress negatively affected ($P < 0.01$) BW, milk yield and DMI (10, 28 and 28% decline, respectively) but did not affect FE, ECM FE or 3.5% FCM FE. Immune response was negatively affected ($P < 0.05$) during HS. Rectal temperature and RR increased ($P < 0.01$) 1.5°C and 65%, respectively, in P3 compared with P2. During recovery from HS (P4), milk yield and DMI were higher ($P < 0.03$), FE and ECM FE were lower ($P < 0.01$), and BW did not change from P3. Although recovery from HS markedly reduced RT and RR (1.7°C and 42%, respectively; $P < 0.01$), milk composition and most immune responses did not change from P3 to P4. We conclude that different stressors elicit different responses in performance variables and immune function.

Key Words: adaptation, heat stress, housing

W265 A descriptive analysis of how dairy cows convert feed into food in the United States. Juan M. Tricarico*, *Innovation Center for U.S. Dairy, Rosemont, IL.*

The net contributions dairy cows make to the food system in the United States are not necessarily well understood by consumers. Estimates of nutrient conversion efficiency are sometimes used to describe these contributions but are often poorly documented or based on dubious assumptions. The main objectives of this study were to 1) define coefficients to calculate human-edible fractions of major dairy feed ingredients used in the United States, and 2) estimate the share of the dairy ration that is human-edible on a national level using these coefficients. The analysis was performed on a national average dairy ration computed from 350 farm surveys used in the carbon footprint life cycle assessment for fluid milk (available at http://www.lcacommons.gov/). The national average ration includes weighed rations for calves, open heifers, bred heifers, first calf heifers, springers, lactating cows, and dry cows, and accounts for forage grazed during the year. The national average ration includes 33 ingredients and contains 53% forage and 47% concentrate (DM basis). Food, fuel, and fiber industry by-products (14 ingredients) account for 19% of dairy feed DM. Eight major crops account for 80% of dairy feed DM (corn 42%, alfalfa 22%, wheat 3.1%, soybean 3.0%, canola 1.8%, sorghum 1.7%, barley 1.4%, and cottonseed 1.4%). Two coefficients were calculated to estimate human-edible fractions of each ingredient. The first coefficient was calculated as 1 minus NDF content. The non-NDF fraction was considered human-edible if it does not contain toxic compounds, and ingredients containing more than 30% NDF were excluded. The second coefficient was calculated by multiplying the first coefficient by the proportion of total ingredient production currently demanded by the US food industry. This coefficient incorporates current consumer demand, preferences and eating habits. The amount of human-edible dairy feed is either 20 or 0.9% of ration DM when using coefficients 1 or 2, respectively. Dairy cows make a net positive contribution to food supply in the United States by converting significant amounts of otherwise unusable plant matter in feed into food.

Key Words: dairy, human-edible, food security

W266 Study of ethyl-2-nitropropionate, ethyl nitroacetate, nitroethane, and 2-nitroethanol as alternatives to reduce ruminal methane production. Pedro A. Ochoa*[1], Agustín Corral[1], Michael Hume[2], Oscar Ruiz[1], Claudio Arzola[1], and Robin C. Anderson[2], *[1]Facultad de Zootecnia y Ecología. Universidad Autónoma de Chihuahua, Chihuahua, Chihuahua, México, [2]U.S. Department of Agriculture, College Station, TX.*

Methane (CH4) is a greenhouse gas, as well as an energy loss in ruminant animals. Much research has been done aimed to reduce CH4 emission from cattle industry. Nitrocompounds such as nitroethane (NE), 2-nitroethanol (2NEOH), and 3-nitropropionic acid (3NPA), have been shown to possess the ability to inhibit methane production on in vitro conditions. However, the potential of ethyl-2-nitropropionate (E2NPA) and ethyl nitroacetate (ENA) to reduce methane production have never been evaluated. We evaluated the ability of ENA, E2NPA, 2NEOH, and NE to reduce total gas, CH4 production and microbial diversity changes in a consecutive batch culture. Mixed populations of ruminal bacteria were incubated in tubes 18 × 150 mm containing a basal medium with 0.2 g of ground alfalfa and a H_2/CO_2 (1:1) gas phase. Tubes were supplemented with water (control) or the corresponding nitrocompound to reach a 12 m*M* concentration and incubated at 39°C. Total gas production was determined after 24 h. Microbial diversity was determined by DGGE. Gas composition was determined by gas chromatography. Data were analyzed using PROC GLM of SAS by a complete randomized design considering each nitrocompound as sole effect. According to our results, the use of nitrocompounds as supplement had no significant effect on total gas production, except for nitroethane ($P \leq 0.000$; Table 1). In the other way, methane production was decreased ($P \leq 0.0001$) by all nitrocompounds compared with the controls. In addition, each nitrocompound does not showed difference on its capacity of reducing methane emissions ($P \leq 0.05$). The DGGE indicates that all nitrocompounds change the microbial diversity. Results of the study also reveal that the capacity of ENA and E2NPA to decrease methane production is very similar to the 2NPOH and NE. There is some evidence that these nitrocompounds could be supplemented to reduce methanogenesis.

Table 1 (Abstr. W266).

Treatment (nitrocompound)	Total gas volume production (mL)	Reduction (%)	Methane (μ*M*/mL)	Reduction (%)
Control	19.00	—	43.77	—
Ethyl nitroacetate	18.10	4.73	1.41	96.80
2-Nitropropionate	18.79	1.10	1.06	97.70
2- Nitroethanol	18.36	3.36	1.17	97.33
Nitroethane	15.40	18.94	1.83	95.86

Key Words: nitrocompounds, methane, ruminant

W267 Use of udder skin temperature as a heat stress indicator in lactating dairy cattle. Kristen M. Perano* and Kifle G. Gebremedhin, *Cornell University, Ithaca, NY.*

The objective of this research was to test whether the udder skin temperature of a cow is useful as a heat stress indicator. Heat stress leads to an increase in respiration rate, skin temperature, and rectal temperature, followed by a decrease in milk production and feed consumption. Rectal temperature is a reliable indicator of heat stress, but measuring rectal temperature may require restraint of the animal. Skin temperature is considered a less reliable indicator of heat stress, but skin temperature measurements are fast and non-invasive. For this research, 8 primiparous, mid-lactation Holstein cows producing 34.4 ± 3.7 kg/d of milk were housed in 2 identical climate-controlled rooms with tie stalls and exposed to moderate heat stress (THI 79.5 ± 1.2) for 8 h per day. Cows were given 1 week to adjust to the facility, then data was collected for 5 weeks on milk production, feed consumption, rectal temperature, respiration rate, udder skin temperature, and body surface temperature in 3 unshaved locations (neck, back and side). Cows were milked twice daily and fed ad libitum. Rectal temperature was measured twice each day before heat stress conditions and after 8 h of heat stress. Respiration rate, udder skin temperature, and body surface temperatures were measured before heat stress and every 2 h during heat stress. Four experimental cows were randomly assigned to be cooled with conductive cooling by circulating chilled water through modified DCC waterbeds, and these cows experienced less heat stress than control cows. For the final week of the experiment, experimental and control cows were switched. Correlations among daily milk production and feed consumption, rectal temperature at the end of heat stress, and the daily average under heat stress of respiration rate, udder skin temperature, and body surface temperature were analyzed in JMP. Correlation with milk production was strongest for rectal temperature (0.67), followed by feed consumption (0.58), udder skin temperature (0.53), respiration rate (0.38), and body surface temperature (0.23). Thus, udder skin temperature may be useful as a fast, non-invasive measurement of heat stress.

Key Words: heat stress, skin temperature, milk production

W268 Maternal heat stress affects calf passive immunity: Effects on intestinal cell apoptosis. Bahroz M. S. Ahmed*[1], Ana Paula A. Monteiro[1], Umair Younas[1], Turky O. Asar[1], J-D. Liu[2], Joyce Hayen[1], Sha Tao[2], and Geoffrey E. Dahl[1], *[1]University of Florida, Gainesville, FL, [2]University of Georgia, Tifton, GA.*

Heat stress (HT) in utero not only induces fetal growth retardation but also influences postnatal performance of the offspring, such as immune function and metabolic adaptation. The objective was to examine the cellular mechanism of altered passive immunity in neonatal bull calves after in utero heat stress during late gestation. Specifically, by examination of the rate of apoptosis of intestinal cells early in life, as that has been shown to influence gut closure. Cows were dried off 60 d before expected calving and randomly assigned to one of 2 treatments: HT or cooling (CL). During the dry period, all cows were housed in a freestall barn, the pen for CL cows was equipped with active cooling including water soakers and fans whereas the pen for HT cows had no soakers. Heat stress was moderate compared with other studies, as HT cows had only 0.1°C increase in rectal temperature and 8 breath/min increase in respiration rate compared with CL cows. After birth all bull calves were immediately separated from their dams and weighed. Bull calves (n = 30) were killed at birth without colostrum feeding (5/trt) and 1 and 2 d of age (DOA, following colostrum feeding, 5/trt). Colostrum (3.8 L) was fed within 2 h after birth to bulls slaughtered on 1 and 2 DOA. After slaughter, the intestine was removed, weighed, and dissected into duodenal, jejunal and ileal segments, and tissue samples from each section were fixed in 4% neutral formalin and then transferred to 70% ethanol for immunohistochemistry. Apoptosis was measured in the jejunum using TUNEL labeling, counting 6 different sections per slide per calf. Small intestine weights did not differ (HT: 1376 ± 45; CL: 1309 ± 45 g; $P = 0.30$). In both groups, apoptosis reactive cell counts decreased with time after birth (HT: 0DOA: 58.8; 1DOA: 21.6; 2DOA: 41.4; CL: 0DOA: 88.6; 1DOA: 58.0; 2DOA: 53.8; SEM = 16.7; $P = 0.05$). However, apoptotic counts in CL bulls were higher than HT bulls (66.8 ± 9.6 vs. 40.6 ± 9.6, respectively; $P = 0.10$). The results indicate that

jejunal cell apoptosis progresses with time after birth, but in utero HT reduces the apoptotic rate.

Key Words: heat stress, bull, apoptosis

W269 Methane emissions from Holstein cows in tropical environment. Camila S. Cunha*[1], Marcos I. Marcondes[1], Cristina M. Veloso[1], Maria I. B. Brandão[1], Elves C. Godinho Jr[1], Marcelo M. D. Castro[1], Aline S. Trece[1], Luisa F. L. Salazar[2], Erick Iglesias[1], Otávio H. G. B. D. Siqueira[1], Diego Zanetti[1], and Tadeu E. Silva[1], *[1]Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, [2]Universidad de Antioquia, Medellin, Colômbia.*

The objective was to quantify enteric methane (CH_4) emissions from Holstein cows of 2 levels of milk production in tropical environment and compare data observed in this study to data obtained from the equations proposed by the Intergovernmental Panel in Climate Change (IPCC). The study was carried out at the Universidade Federal de Viçosa, Brazil. High milk production cows (29 ± 0.89 L/d, n = 6) and low milk production cows (10 ± 0.34 L/d, n = 5) were used in the assays. Each assay had the first 5 d for cows' adaptation plus the number of days required to have 5 d of gases samples of each animal. Cows were held in free stall barns. High production cows diet were constituted, in dry matter (DM) basis, by 48.5% of corn silage, 1.5% of Coast-cross (*Cynodon* sp.) hay and 50% of concentrate based on corn and soybean meal. The diet of low production cows were in DM basis, 80% of corn silage and 20% of concentrate based on corn, soybean meal and wheat meal. Food and refusals were sampled to dry matter ingestion (DMi) analyses. Average feed intake observed to each group of cows were, respectively, 20.14 e 13.13 kg of DM/day. The sulfur hexafluoride (SF_6) tracer methodology was used to obtain the observed methane emissions. IPCC Tier 2 equations were used to obtain the calculated methane emissions. A *t*-test were used for test the differences between the observed and the calculated data. Methane emissions observed from high production cows were 115.67 g CH_4/day, 5.74 g CH_4/kg of DMi and 3.94 g CH_4/L of milk and from low production cows were 174.68 g CH_4/day, 13.30 g CH_4/kg of DMi and 17.22 g CH_4/L of milk. When using the IPCC equations, methane emissions for the 2 groups of cows in g of CH_4/day were 403.08 and 261.15, respectively. There are significant differences ($P < 0.01$) between the observed and the calculated methane emissions data for the 2 groups of cows. It was concluded that the equations for estimating methane emissions from IPCC are not representative for high and low production cows in tropical environment.

Key Words: greenhouse gas, lactation, sulfur hexafluoride

W270 Effects of condensed tannin extract supplementation on beef cattle performance and nitrogen balance: I. Growing phase. Landon G. Canterbury*, Lee-Anne J. Walter, Brandon M. Koch, David G. Lust, and Eric A. Bailey, *West Texas A&M University, Canyon, TX.*

Condensed tannins (CT), a polyphenolic of various forages, reportedly binds with dietary protein in the rumen and may affect site of nitrogen excretion in beef cattle. To evaluate the effect of CT on N excretion, a commercially available condensed tannin extract was top-dressed on a cereal grain-based diet at 3 levels (0, 1, or 2% of diet, DM basis). Nutrient digestibility and nitrogen balance were measured in British-cross steers (n = 18; BW = 374 ± 34 kg) offered ad libitum access to the basal diet (15.6% CP). Due to a limited number of metabolism crates, steers were randomly assigned to 3 groups first and then assigned to treatments within group. Steers were offered treatments for 10 d (7 d in individual stalls and 3 d in metabolism crates), followed by 4 d for total fecal and urine collections in metabolism crates. No group by treatment interactions was detected ($P \geq 0.18$) among the response variables. Provision of CT did not affect ($P \geq 0.56$) OM intake or apparent total-tract OM digestion. Similarly, NDF intake and apparent total-tract NDF digestion were not different ($P \geq 0.52$) among treatments. Nitrogen intake was not affected ($P = 0.58$) by inclusion of CT in the diet, but fecal N output increased ($P = 0.02$) at 2% CT inclusion compared with control. However, there was no difference ($P = 0.36$) in urine N output among treatments. Nitrogen retention was lesser ($P = 0.03$) with 2% CT than 0 or 1% CT. Proportion of total N excreted in urine decreased ($P = 0.03$) with CT supplementation at 1 or 2% in the diet. Similarly the proportion of total N excreted in feces increased ($P = 0.03$) with 1 or 2% CT inclusion. Under the conditions of this experiment, site of N excretion was shifted away from urine and toward feces when CT was included in a complete diet fed to beef cattle. Further work is needed to investigate possible effects of CT on N emissions from concentrated animal feeding operations.

Key Words: condensed tannin, digestibility, nitrogen balance

W271 Tannin extract supplementation on gas production in feces of receiving bull-calves. Eva X. Murillo[1], Ernesto A. Velázquez[1], Melissa B. Corona[1], Idalia Enríquez[1], Billy J. Cervantes[2], Javier A. Romo[1], and Rubén Barajas*[1], *[1]FMVZ-Universidad Autónoma de Sinaloa, Culiacán, Sinaloa, México, [2]Ganadera Los Migueles, S.A. de C.V., Culiacán, Sinaloa, México.*

The addition of condensed tannins to feces of beef cattle decreases the amount of in vitro gas production; but it is not clear if the same effect occurs when tannin extracts are fed to cattle. In this research, 30 Brahman bull-calves (230 ± 12.7 kg) were used to evaluate the influence of tannin extract supplementation on gas production in feces of receiving bull-calves. Fecal samples were taken from each bull-calf during 3 consecutive days, 40 g aliquots were placed in 600 mL plastic flasks, and 40 g of distillated water were added, flask were closed, and connected with a plastic pipe toward a 250 mL graduate glass flask inverted in a water bath. Flasks were incubated at 37°C during 24 h, and displaced water was recorded as the in vitro gas production. Other feces aliquots of 20 g were used to DM determination. Before receiving the treatments, the values of in vitro gas production (BGP) were computed as mL gas/g of feces DM basis. Bull-calves were placed in 6 dirt-floor pens, using a completely randomized design experiment, 3 treatments were randomly assigned: 1) corn silage based-diet (15.2% CP; 1.36 Mcal NEm/kg DM) without extra additives (Control): 2) Control plus 0.6% of condensed tannin extract (CT); and 3) Control plus 0.6% of hydrolysable tannin extract (HT). After 28 d on treatment diets, fecal samples were taken during 3 continuous days again, and after treatment fecal gas production (AGP) was measured as previously described. Each bull-calf was considered as the experimental unit. Results were analyzed by ANOVA for a completely randomized design. The BGP values were similar between treatments ($P = 0.53$) with a mean of 4.7 ± 0.45 mL/g of feces DM. The AGP values were not affected by treatments ($P = 0.54$) with a mean of 5.9 ± 0.49 mL/g of feces DM. Results indicate that when both, hydrolysable or condensed tannin are supplemented in the diet; they have no influence on the amount of gas produced in the feces of receiving bull-calves.

Key Words: feces, gas production, tannin

W272 Composting of dairy manure and grape vine prunings as a tool to reduce both industries' environmental impact. Mario E. de Haro-Marti*[1], Mireille Chahine[2], Ariel Agenbroad[3], and Tony McCammon[2], *[1]University of Idaho, Gooding, ID, [2]University of Idaho, Twin Falls, ID, [3]University of Idaho, Caldwell, ID.*

Composting of dairy manures is an acceptable and greatly used technique, but in most cases dairy manures don't have the proper carbon to nitrogen ratio (C:N) for composting without the loss of nitrogen as ammonia during the composting process. At the same time, the grape industry uses burning as the most widespread technique to dispose of carbon rich annual prunings. The objectives of this project were to demonstrate the effects of increasing the C:N content of dairy manures using grape vine prunings and to showcase 3 different composting techniques. Manure from an open lot dairy was mixed with ground grape vine prunings from an organic vineyard. The C:N ratios of the initial composting mix were adjusted to >40:1 to meet organic standards. Because grape prunings had a low C:N (79:1), sawdust from a horse stable was added to reach the desired C:N level. Three composting systems were showcased, mechanically turned windrows, passively aerated, and forced aerated. Three replications were built for each system. Control windrows consisted of 3 replications of mechanically turned windrows using only dairy manure and some straw to simulate regular dairy operations (C:N 23:1). A significant nitrogen loss reduction (4.33 kg/t, equivalent to an 85% reduction on total nitrogen loss) was observed in compost windrows with carbon-enhanced mixes (0.72 kg/t, $P < 0.05$) as compared with just dairy manure mix (5.03 kg/t, $P < 0.05$). Compounds' concentrations (nutrients) that usually limit compost application rates (e.g., P, K, salts) were also reduced in the final product when grape prunings were added to the initial mix. The reduction in these components can allow an increase in field application rates of compost before reaching maximum concentrations of limiting nutrients. The project demonstrated the feasibility of using composting as a Best Management Practice to reduce or eliminate the annual burning of grape prunings, reducing carbon emissions from the grape industry. It also demonstrated the reduction in ammonia emissions that can be achieved by the dairy industry when mixing wastes rich in C:N.

Key Words: composting, manure, grapes

W273 Effect of floating islands on parlor wastewater multi-stage treatment system effectiveness. Vinicius R. Moreira*[1], Brian D. LeBlanc[2], Eric Achberger[3], and Laura Zeringue[1], *[1]LSU AgCenter Southeast Research Station, Franklinton, LA, [2]LSU AgCenter School of Plant, Environmental and Soil Sciences, Baton Rouge, LA, [3]LSU AgCenter, Baton Rouge, LA.*

Most manure stored in grazing dairy farms is wastewater collected from the milking parlor and adjacencies. Anaerobic lagoons are designed to treat this liquid waste by reducing solids and oxygen demand, but may release methane, ammonia, odors, and pathogens in the process. Treatment intensification may be a more efficient and economical long-term solution for small grazing dairies. LSU AgCenter Dairy Waste and Nutrient Management Team have been evaluating technologies and practices to improve wastewater treatment using the Southeast Research Station Dairy Wastewater Treatment Evaluation System (DWTES). The system is a replicated set of anaerobic lagoon, aerobic lagoon and constructed wetlands. The objective of this study was to evaluate the effect of artificial floating islands on DWTES effluent quality. Biohaven Floating Islands (Martin Ecosystems, Baton Rouge, LA) were deployed in an anaerobic lagoon (186-m^2 floating islands) and an aerobic lagoon (93 m^2 floating islands). Wastewater was sampled from every stage, approximately every 3 mo for 17 mo. Samples were analyzed for temperature, pH, chlorophyll-A, chemical oxygen demand (COD), total solids, total dissolved solids, total suspended solids (TSS), ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen (TKN), total phosphorus, anions, dissolved oxygen concentrations, total coliforms and *E. coli*. Total solids (931 mg/L), COD (711 mg/L), TKN (72 mg/L) and sulfate (14 mg/L) concentrations in raw wastewater decreased by 50% or more in the system's effluent. *Escherichia coli* counts were reduced from 6.5 log MPN/100 mL in raw wastewater to 3 ± 0.41 log MPN/100 mL in wetland effluents. Floating islands improved treatment effluent for TSS (66 vs. 49 ± 18 mg/L), COD (212 vs. 168 ± 16 mg/L), and TKN (27 vs. 21 ± 2 mg/L). Ammonia-N as a proportion of TKN and nitrate-N (3.79 vs. 4.73 ± 1.1 mg/L) increased in the replicate containing floating islands. Floating islands appeared to effectively improve dairy parlor wastewater treatment in a multi-stage treatment system.

Key Words: dairy wastewater, floating island, lagoon

W274 Cross-species intake responses to temperature stress. Robin R. White*[1,2] and Mark D. Hanigan[1], *[1]Department of Dairy Science, Virginia Tech, Blacksburg, VA, [2]National Animal Nutrition Program, University of Kentucky, Lexington, KY.*

The objectives of this study were to compare and model feed intake responses to temperature across species and to assess opportunities to use cross-species (CS) data to parameterize models when species-specific (SS) data were limited. Literature searches were conducted to identify studies reporting intake during climate-stress treatments compared with 1 or more thermoneutral treatments. The resulting data set comprised 614 treatment means for 108 studies on livestock responses to heat or cold stress. An ANOVA was conducted on the CS data set to identify the effects of species, temperature and species by temperature interactions on intake as a fraction of thermoneutral intake (FFI). Four models were derived from the CS data set and SS root mean squared prediction error (RMSPE) and concordance correlation coefficients (CCC) of these models were compared with models of the same form derived from SS data sets. Models used explanatory variables for (1) duration of exposure; (2) mean temperature; (3) low and high temperatures; and (4) difference between low and high temperatures and duration of exposure. An additional model accounting for temperature and stage of production was derived from the SS data. ANOVA demonstrated that the species by temperature interaction did not have a significant effect on FFI ($P = 0.162$). Across species, intake decreased with temperature. Notably, all species demonstrated a constant decrease in intake across the thermoneutral zone indicating the previous assumption of constant intake during thermoneutrality may be incorrect. The CS-derived models had marginally lower RMSPE and higher CCC when compared with those derived from the SS data sets. The model fit with production data had the lowest RMSPE and highest CCC within the study. When compared over areas with notable knowledge gaps, using CS models often had reduced RMSPE and improved CCC when compared with SS models. Although fitting models based on SS data allows for incorporating unique covariates, like level of production, fitting responses based on CS data can help to improve model estimates when knowledge gaps exist.

Key Words: modeling, multi-species, heat stress

W275 Comparative feedlot response of Angus-cross and Brahman bull-calves to pen-shade under hot weather conditions. Ruben Barajas*[1], Billy J. Cervantes[2], Alejandro Camacho[1], Leopoldo R. Flores[1], Juan J. Lomeli[1], and Javier A. Romo[1], *[1]FMVZ-Universidad Autónoma de Sinaloa, Culiacán, Sinaloa, México, [2]Ganadera Los Migueles, S.A. de C.V., Culiacán, Sinaloa, México.*

Pen-shade improves performance of beef cattle under hot weather. Brahman cattle pose better capability than Angus-cross cattle to confront hot environmental conditions. There are few comparative studies evaluating pen-shade benefices across breed's types. This research was performed to determine the comparative feedlot response of Angus-cross (AC) and Brahman (BR) bull-calves to pen shade under hot weather conditions. In a completely randomized design experiment with a 2 × 2 factorial arrangement, 30 AC and 30 BR bulls-calves (233 ± 24.9 kg) were grouped by breed type and placed in 2 types of pens: (1) Without shade (NO SHADE); or (2) Shaded (SHADE). Shade was provided by a ceiling of 6 × 4 m of metal sheeting positioned 3.7 m over soil level. Bull-calves were fed with a corn silage-based diet (15% CP 1.35 Mcal NEm/kg DM), served at 1700 h to minimize digestion heat load impact. Length experiment was 98 d, and pen was the experimental unit. Results were analyzed by covariance, and initial body weight was used as the associated co-variable. Across experiment, climatic conditions were air temperature 36.4 ± 4.04°C (range 27.6 to 49.5°C), relative humidity 47.9 ± 11.87% (range 24.7 to 82.5%), and THI 85.7 ± 3.16 (range 79.1 to 96.4). Interactions breed × pen shade ($P < 0.05$) were observed on final body weight, average daily gain, and feed efficiency. Angus-cross SHADE bull-calves were heavier ($P < 0.01$) as compared with AC NO SHADE (369.9 vs. 350.3 kg), while SHADE had no influence ($P > 0.10$) on final weight of BR. The Angus cross in SHADE gain 16% more wt ($P < 0.01$) than Angus cross allotted in NO SHADE (1.40 vs. 1.20 kg/d), but ADG was similar ($P > 0.10$) for BR both in SHADE and NO SHADE. AC SHADE bull-calves had a 12% better feed/gain ratio ($P = 0.03$) than AC NO SHADE (0.18 *vs*. 0.16 kg gain/kg DMI). Results suggest that feedlot response to pen shade vary with breed type, and become important as the proportion of Brahman breed decreases in genetic composition of beef cattle under hot climate conditions.

Key Words: bull-calves, feedlot performance, pen shade

W276 A multi-objective diet optimization to reduce land, water, and greenhouse gas emissions from US dairy production.
Robin R. White* and Mark D. Hanigan, *Department of Dairy Science, Virginia Tech, Blacksburg, VA.*

The objectives of this study were to construct an optimization model to identify opportunities to reduce land use, water use and greenhouse gas (GHG) emissions within dairy production systems and to assess how improved energy and protein use efficiency could affect opportunities to reduce environmental impact (EI) of dairy production systems. Nonlinear programming was used to adjust monthly diets fed to 10 cattle groups to minimize EI associated with an average United States (US) dairy production system. System boundaries extended from the inputs to the cropping system to the dairy farm gate. The effects of improved biological efficiencies were modeled as a 15% decrease in the allometric energy constant used to calculate maintenance energy requirements or as a 15% decrease in maintenance metabolizable protein requirements. Least-cost optimization was used as a baseline. A total of 28 scenarios were simulated which varied in objective, biological efficiency and allowable cost increase. Objectives included minimizing land, water, greenhouse gases, or all EI metrics. Allowable cost increases ranged from 1% to 20%. Baseline land use (1.22 m^2/kg milk), water use (14.6 m^3/kg) and GHG emissions (1.45 kg CO_2/kg) agreed well with established values for US dairy production. At cost increases between 1% and 20% above baseline, EI metrics could be simultaneously reduced by 5.9 to 16.6%. Improving energy or protein efficiency greatly improved opportunity to reduce EI. When both energy and protein efficiency were improved by 15%, EI reductions ranged from 14.6 to 21.1%. Opportunity to reduce EI varied greatly with allowable cost increase and diminishing environmental returns to cost were apparent. The cost of reducing environmental impact by 15% was decreased by 87.7% when energy and protein efficiency improved compared with the national average production efficiency scenario. Improving energy and protein use efficiency of dairy cattle represents a promising way to reduce EI without sacrificing profitability.

Key Words: feed efficiency, dairy, environmental impact

W277 Effect of temperature humidity index patterns on fertility, postpartum disease and culling risk in New York dairy farms.
Benjamin D. Scott* and Julio O. Giordano, *Department of Animal Science, Cornell University, Ithaca, NY.*

Objectives were to use within-barn measurements of temperature-humidity index (THI) to evaluate its effect on (1) Pregnancies per AI (P/AI) relative to THI at or near AI; (2) postpartum disease incidence rates (DZ30); and (3) exit from the herd (E30) relative to THI near parturition. Temperature and humidity measurements were collected hourly on 5 farms using HOBOware data loggers. Hourly measurements were averaged daily. The effect of THI on P/AI was evaluated using a THI threshold of 72 on the day of AI (THI1) or by 3-d (THI3) and 7-d (THI7) rolling averages (day of AI and prior). The DZ30 and E30 were analyzed by THI on the day of parturition (THIC), THI 7 d before and after parturition (THI14), 7 d before parturition (PreTHI), and the day of parturition plus 6 d after (PostTHI). The DZ30 and E30 were analyzed by a 68 THI threshold and represent a 30-d risk period. DZ30 represented a minimum of 1 reported event of: displaced abomasum, milk fever, metritis, retained placenta, ketosis, or mastitis. Pregnancies per AI were lower ($P < 0.01$) for AI occurring at ≥72 THI threshold using all 3 THI approximations. Mean P/AI were 38.7% (n = 9,334) vs 32.5% (n = 1,140) for THI1 <72 or ≥72, 34.8% (n = 9,291) vs 30.3% (n = 1,074) for THI3 <72 or ≥72, and 38.8% (n = 9,392) vs 28.9% (n = 748) for THI7 <72 or ≥72. The DZ30 for THI ≥68 vs THI <68 tended to be different for THIC ($P = 0.08$), was similar for PostTHI ($P = 0.15$) but it was greater for THI14 ($P = 0.01$) and PreTHI ($P = 0.02$). Mean (95% CI) DZ30 was 26.3% (24.3–28.4%) vs 30.3% (27.9–32.9%) for THI14 <68 (n = 2,381) or ≥68 (n = 1,922) and was 26.3% (24.3–28.5%) vs 30.2% (27.8–32.7%) for PreTHI <68 (n = 2,388) or ≥68 (n = 1,905). Relative risk (RR) of DZ30 (95% CI) was greater than 1 for THI14 ≥68:THI14 <68 (1.15, 1.03–1.29) and PreTHI ≥68:PreTHI <68 (1.15, 1.02–1.29). Thus, attributable risk (AR) of THI14 ≥68 to DZ30 is 13.2% and of PreTHI ≥68 is 12.9%. Rates of E30 were similar ($P > 0.10$) for all THI measurements using a 68-unit threshold. We conclude that THI before insemination reduces P/AI, that THI around parturition affects 30-d postpartum disease risk with prepartum THI having the greatest effect. Also, THI around parturition does not strongly affect postpartum 30-d exit probabilities.

Key Words: heat stress, disease risk, transition

W278 Methane and carbon dioxide emissions from manure of dairy cows fed regular or brown midrib corn silage-based diets.
Fadi Hassanat* and Chaouki Benchaar, *Agriculture and Agri-Food Canada, Dairy and Swine Research and Development Centre, Sherbrooke, QC, Canada.*

The objective of this study was to examine the effects of feeding dairy cows with regular corn (RCS) or brown midrib (BMCS) corn silage on CH_4 and CO_2 emissions from manure storage. For this purpose, 8 lactating cows fed diets containing 59% of RCS or BMCS were used in a block design. Total manure (feces and urine) collection from each

cow was performed on 2 consecutive days. Manure was mixed (1:1) with an inoculum from a bioreactor and stored (20°C) under anaerobic conditions in glass bottles (6 replicates/cow) for 17 weeks. Quantity of gas produced was measured daily and sampled to determine gas composition, while manure was sampled weekly to measure volatile fatty acid (VFA) and NH_3 concentrations. The MIXED procedure of SAS was used to determine the effects of corn silage cultivar on measured parameters and significance was declared at $P \leq 0.05$. Cows fed BMCS-based diets excreted more ($P < 0.01$) manure (86 vs 64 kg/d, respectively) and organic matter (8.6 vs 6.5 kg/d, respectively) than cows fed RCS-based diets. Excretion of N averaged 370 g/d and was not affected ($P = 0.16$) by the dietary treatment. Compared with manure from cows fed RCS-based diets, manure from cows fed BMCS-based diets emitted more ($P \leq 0.01$) CH_4 (173 vs 146 L/kg organic matter [OM]) and CO_2 (148 vs 118 L/ kg OM) during storage period. Total VFA concentration tended to higher ($P = 0.08$) in manure from cows fed BMCS compared with cows fed RCS, indicating more extensive degradation of OM during storage of manure when cows were fed BMCS vs. RCS. Losses of OM from manure of cows fed BMCS based-diets was higher ($P < 0.01$) than losses from cows fed RCS-based diets (38 vs. 31%). In conclusion, feeding BMCS-based diets to dairy cows can increase daily volatile solid excretion and CH_4 and CO_2 emissions (per kg volatile solids) compared with feeding RCS-based diets.

Key Words: manure, CH_4 emission, brown midrib corn silage

W279 Determination of climatologically suitable places in Turkey for feedlot cattle production by using comprehensive climate index model. Hayati Koknaroglu*[1], John A. Harrington Jr[2], and Terry L. Mader[3], *[1]Suleyman Demirel University, Isparta, Turkey, [2]Kansas State University, Manhattan, KS, [3]University Nebraska, Lincoln, NE.*

The objective of this study was to determine climatologically suitable places to raise feedlot cattle in Turkey. Daily average temperature, relative humidity and wind speed values for 15 locations (Antalya, Balikesir, Corum, Diyarbakir, Edirne, Elazig, Erzincan, Erzurum, Eskisehir, Isparta, Izmir, Kayseri, Konya, Sivas and Van), spanning last 30 years, were obtained. Daily solar radiation values could not be obtained from the weather stations and were calculated based on a formula that takes hemisphere, latitude and day of the year into account. The comprehensive climate index (CCI) model that enables one to quantify beef cattle performance based on environmental conditions (temperature, relative humidity, wind speed, solar radiation) at any time in the year was used to predict dry matter intake (DMI), average daily gain and feed efficiency of feedlot cattle. Because mostly dairy breed calves are placed into the feedlot in Turkey, Holstein option in CCI was chosen to calculate maintenance energy requirement of cattle. Based on the previous feedlot feeding studies conducted in Turkey, it was assumed that calves would be placed on feed at 250 kg and be marketed at 520 kg, diet would have 2600 kcal/kg metabolic energy and would have dry matter intake of 2.31% of the body weight. Results comparing the 15 locations indicate that cattle raised in Antalya, known to be hottest place and Erzurum, known to be coldest place, had the lowest and highest DMI, respectively ($P < 0.05$). Environmental conditions in summer lowered cattle DMI in hotter locations and winter conditions increased DMI in colder locations ($P < 0.05$). Feedlot cattle raised in hotter and colder portion of Turkey had lower average daily gain than other places having a milder climate ($P < 0.05$). In general, cattle raised in hotter climate had better feed efficiency than those raised in cold climate ($P < 0.05$).

Key Words: comprehensive climate index, feedlot, performance

W280 Methane prediction equations for beef cattle fed high forage diet. Paul Escobar-Bahamondes*[1,2], Masahito Oba[1], and Karen A. Beauchemin[2], *[1]University of Alberta, Edmonton, AB, Canada, [2]Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

The study aim was to improve the prediction of CH_4 emissions from beef cattle by developing equations specific for high forage diets (≥40% DM basis). Treatment means from 38 beef studies published between 2000 and 2014 with dietary forage ≥40% DM were compiled into a database. Criteria for inclusion in the database were intake, diet composition and enteric CH_4 production. Principal component analysis detected relevant variables associated with CH_4. Because of the limited size of the original database (n = 123), a Monte Carlo technique was used to resample 1,000 times the data from each study to create a new virtual data set. Outliers were excluded by Mahalanobis distance in both the original database and virtual data set. Using the original database, forward stepwise multiple regression was used to obtain prediction equations. The random effect of study was included in the analysis using the Mixed procedure and 'leave-one-out' cross validation was used to internally validate the equations. Using the virtual data set (n = 100,305), equations were developed using forward stepwise multiple regression and K-fold cross validation (n = 10). Model performance was evaluated as observed-predicted values using concordance correlation (r_c) and root mean square prediction error (RMSPE, g/d). Statistical analysis was performed using JMP v11. Using the original database, the best-fit equation was: CH_4 (g/d) = 71.5(±11.45) + 0.12(±0.03) × BW (kg) + 0.10(±0.01) × DMI^3 (kg/d) − 244.8(±56.44) × fat^3 (kg/d) with $P < 0.0001$, r_c: 0.72 and RMSPE: 39.1; where BW = body weight; DMI = dry matter intake. Using the Monte Carlo data set, the best-fit equation was: CH_4 (g/d) = 25.9(±0.54) + 0.13(±0.001) × BW (kg) + 145.4 (±1.31) × fat (kg/d) + 10.3(±0.16) × $(NDF - ADF)^2$ (kg/d) + 0.1(±0.00) × DMI^3 (kg/d) − 27.4 (±0.20) × (starch/NDF) with $P < 0.0001$, r_c: 0.81 and RMSPE: 36.4 where NDF = neutral detergent fiber and ADF = acid detergent fiber. Monte Carlo data set equation improved prediction accuracy compared with the original database equation, but extensive feed analysis is required to use the equation. Both equations specifically developed for beef cattle fed forage diets may increase the accuracy of predicting CH_4 production.

Key Words: methane, beef cattle, equation

W281 Mathematical models to predict phosphorus output in manure and milk from lactating dairy cows. G. Alvarez[1,2], J. A. D. R.N. Appuhamy*[2], and E. Kebreab[2], *[1]Universidad Autonoma de San Luis Potosi, San Luis Potosi, Mexico, [2]Department of Animal Science, University of California, Davis, CA.*

Accurate manure and milk phosphorus (P) output estimates are important for monitoring P released to the environment and assist in quantifying P balance in lactating dairy cows. The objectives of the study were (1) to develop empirical models, and (2) evaluate extant models for estimating P output from lactating dairy cows. A meta-regression analysis was conducted using 191 fecal (Pf), 83 urine (Pu), and 110 milk (Pm) P output measurements from 39 studies. Dry matter intake (kg/cow/d), diet composition, milk yield and composition and DIM were used as predictor variables. The Pu was highly variable with a mean of 0.34 ± 0.027 g/cow/d. Two models; with and without DMI data were developed for each Pf and Pm (g/cow/d, Table 1). The DMI-based extant model by Weiss and Wyatt (2004) was the most successful in predicting manure P output [root mean square prediction error (RMSPE) as a percentage of average observed value = 19.6%]. Models developed in this study with and without DMI predicted Pf with RMSPE of 18.6 and 24.0%, respectively. The Pm predictions with and without DMI were related to

RMSPE <17.0% of the average measured Pm. Our models also predicted total P output [Pf + Pm + Pu] from lactating dairy cows with good accuracy (RMSPE = 11.8 – 17.3%). The models can be used to improve our understanding of P utilization and excretion in dairy production systems.

Table 1 (Abstr. W281). Models developed in this study

Equation[1]	RMSPE (%)
With DMI data	
Pf = −10.7(4.06) + 0.69(0.03) × Pintake + 0.56(0.24) × CP + 0.68(0.17) × GE –0.50(0.10)×Milk	18.6
Pm = 19.1(7.28) + 1.25(0.17) × DMI + 0.20(0.06) × Milk – 6.20(2.21) × MProt –0.02(0.01) × DIM	13.9
Without DMI data	
Pf = −10.2(7.43) + 151.0(10.6) × P + 0.96(0.22) × GE – 0.52(0.22) × ADF	24.0
Pm = 36.6(8.46) + 0.45(0.06) × Milk – 0.03(0.01) × DIM – 5.20(2.7) × MProt	16.9

[1]PIntake = P intake (g/cow/d), GE = dietary gross energy (MJ/kg DM), Milk = milk yield (kg/cow/d), MProt = milk protein (%), CP, P and ADF (% of dietary DM).

Key Words: mathematical model, phosphorus excretion, dairy cow

W282 Enteric methane mitigation and evaluation ruminal parameters of cattle fed cottonseed and vitamin E. Ricardo Galbiatti Sandoval Nogueira*, Flavio Perna Jr., Eduardo Cuellar Orlandi Cassiano, Lizbeth Collazo Paucar, Mariane Cheschin Ernandes, Diana Carolina Zapata Vasquez, Adrielle Matias Ferrinho, Romulo Germano de Resende, Felipe Bispo Mendonça, Renata Gardenalli, Angélica Simone Cravo Pereira, and Paulo Henrique Mazza Rodrigues, *University of São Paulo, Pirassununga, São Paulo, Brazil.*

Objective this study was verify the enteric methane emissions and evaluate ruminal parameters caused by the inclusion of 30% of cottonseed (diet with 8,32% ether extract) and 0,4% vitamin E (500 IU) in the diet of cattle. Six cannulated cows were distributed in a replicate 3x3 Latin square. Treatments were (1) control: basal diet; 2) CS: basal diet plus 30% cottonseed and 3) VitE: basal diet plus 30% cottonseed plus 0,4% vitamin E. Ruminal fermentation ex situ (micro-rumen) technique, in which, a sample (10 mL solid and 20 mL liquid) of rumen content was collected via cannula and put inside a sealed glass flask and incubated for 30 min at 39°C, starting samples removed the vials analyzed for the enteric methane emissions, total short chain fatty acids production (SCFA) and energy loss on methane compared with other products of rumen fermentation (REL). Results were compared through orthogonal contrast, where contrast 1: CS and VitE vs control; contrast 2: CS vs VitE. Data analyzed for SAS 9.3 and was considered 5% significance level. Results are shown in Table 1. Cottonseed inclusion reduced methane emissions. Production of propionate was similar between treatments, in average 82.76 g kg d⁻1. Cottonseed inclusion reduced the acetate, butyrate, SCFA and acetate propionate ratio (C2:C3). REL was similar between treatments, in average 29.45%. Include 30% of cottonseed in cattle diet reduces rumen fermentation, resulting in lower enteric methane emissions and total short chain fatty acids production. Vitamin E does not affect ruminal fermentation products.

Contd.

Table 1 (Abstr. W282). Effect of including cottonseed and vitamin E on the production of SCFA, methane, and REL

Variable	Control	CS	VitE	SEM	C1	C2
Acetic, g kg d^{-1}	210.1	143.9	133.9	11.8	0.0028	0.7091
Propionic, g kg d^{-1}	80.94	85.35	82.02	5.51	0.8017	0.7910
Butyric, g kg d^{-1}	90.72	51.36	44.30	4.22	0.0001	0.3883
SCFA total, g kg d^{-1}	381.8	280.6	260.2	19.6	0.0045	0.6411
C2:C3	3.607	2.193	2.413	0.17	0.0097	0.6139
Methane, g kg d^{-1}	43.79	26.40	24.13	1.42	0.0001	0.3584
REL	31.31	29.67	27.35	1.36	0.4623	0.5980

C1 = CS and VitE vs. control; C2 = CS vs. VitE.

Key Words: lipids, energy loss on methane, short-chain fatty acids

W283 The effect of temperature, pH, total solids and type of shape of goat manure for biogas production. Bruno Biagioli*[1], Kleber T. Resende[1], Izabelle A. M. A. Teixeira[1], Normand St-Pierre[2], Carla J. Härter[1], and Márcia H. M. R. Fernandes[1], *[1]Univ. Estadual Paulista, Department of Animal Sciences, Jaboticabal, SP, Brazil, [2]The Ohio State University, Department of Animal Sciences, Columbus, OH.*

The aim of this study was to obtain the best combination of factors that could be easily manipulated by men to optimize the production of biogas. To evaluate the anaerobic digestion of goat manure, we used 24 digesters distributed in factorial design 3 × 3 × 3 × 2, and considered the following factors: temperature (20.1°C, 21.5°C, 30.2°C, 33.7°C and 34.7°C), pH (6.8, 6.84, 7.01, 7.15, 7.22), total solids (2.6%, 3.5%, 4.5%, 6.8%, 6.9%), and type of shape (whole goat manure and broken goat manure) in a central composite design. Data were analyzed as a mixed model with fixed effect of temperature, pH, TS, shape of manure, and their interactions and the random effect of day and digester, using the PROC MIXED procedure of SAS (version 9.0). The shape of manure did not affect biogas production. The isolated effect of temperature and pH in the biogas production was not significant whereas only the highest level of total solids resulted in greater biogas production by day (0.11 m^3 ± 0.02; P = 0.0008). We also observed interaction among temperature, pH, and total solids (5.36 m^3 ± 0.12 P = 0.0020) on the biogas production. Additionally, the percentage of methane in the biogas was not affected by the amount of total solids, pH, and temperature in the biodigester. The best volume of biogas production was obtained when the following values were applied: 34.7 (temperature), 6.8 (pH) and 7.0 (total solids). Our results reveal that even under low pH and low temperature, biogas production increases as a function of increasing total solids of goat manure, however none of the factors affected the proportion of methane in the biogas. The fact that we detected the best biogas yield using 6.8% total solids is extremely important, because a greater supply of substrate requires fewer amounts of water and time, it is less labor-intensive, while methane production is greater than that found using 5% total solids. Even though water returns in the biofertilizer form, if less water is required through biodigestion it would represent a significant water saving.

Key Words: biodigester, methane, caprine

W284 Idle cattle, water buffalo, and swine consume 44% of global feed resources. J. R. Knapp*[1] and R. A. Cady[2], *[1]Fox Hollow Consulting LLC, Columbus, OH, [2]Elanco Animal Health, Greenfield, IN.*

The objectives of this study were to estimate the number of idle cattle, water buffalo, and swine globally and evaluate their impact on feed and water resource utilization as part of the larger Food Forward Sustainability Project. The term "idle" is defined as an animal that is not growing, pregnant, lactating, held for breeding, or used for draft. Two data sources were used: 1) USDA Foreign Ag Service data that includes cattle and swine inventories for 19 countries, and 2) FAO data that includes inventories of cattle, water buffalo, and swine for 16 sub-continental regions. A gamma distribution was used to estimate survival and the number of non-breeding animals alive after 4, 5, and 1 years for cattle, water buffalo, and swine, respectively. Non-breeding stocks were adjusted for imports and exports. Turnover age was calculated as stock numbers divided by slaughter numbers and represents the average lifespan of an animal in the non-breeding population in steady state conditions. Feed consumption estimates were cross-validated using maintenance energy requirements and found to be in reasonable agreement. Turnover ages ranged from 2.6 to 14.7 years for cattle, 3.0 to 8.5 years for water buffalo, and 4.8 to 21.1 mo for swine across regions. It was estimated that 46.6 ± 0.6% of 1.45 billion cattle, 61.1 ± 0.5% of 190 million buffalo, and 9.8 ± 0.3% of 946 million swine in the world in 2010 were mature, non-breeding animals. With cattle and water buffalo, a portion of these animals may be maintained for draft purposes and would not be completely idle. At this time, no data are available to reliably estimate the draft use of cattle and water buffalo. Also, in some societies, mature animals may be maintained as a form of personal wealth, defense against times of food scarcity, or both. Idle and draft cattle, water buffalo, and swine consumed an estimated 1068, 132, and 62 million metric tons of feed (DM basis) or 44% of total feed required, and 2840, 364, and 154 billion liters of water, respectively, in 2010. Reducing the number of idle cattle, water buffalo, and swine is one of several viable options to increase system-wide production efficiency and decrease the total amount of resources required to produce animal-based foods.

Key Words: sustainability, food supply, resource utilization

W285 Crop and grazing land requirements to meet consumer demand for animal products in 2050. J. R. Knapp*[1] and R. A. Cady[2], *[1]Fox Hollow Consulting LLC, Columbus, OH, [2]Elanco Animal Health, Greenfield, IN.*

As part of the larger Food Forward Sustainability Project, we have estimated the quantity of feed required to produce animal products and meet global consumer demands in 2050 under different production scenarios using population-based models (Table). The objectives of this study were 1) to determine how much crops and crop residues were available globally in 2010 in support of animal feed production and might be available in 2050 under reasonable estimates of increasing crop yields, 2) compare them to feed requirements, and 3) to evaluate the impact on land requirements for feed production. Data from USDA National Agricultural Statistics Service and FAO were utilized to estimate yields and utilization of major grain and oilseed crops. Proportions of crops used in feed, food, seed, and other uses were assumed to be the same in 2050 as in 2010. Crop residues were estimated from crop yields and represent the maximum potentially available feed, but do not account for use in bedding, soil amendment, etc. While production and utilization of grain, oilseed, and byproducts for feed in 2010 appears to be lower than feed requirements (Table), it is likely underestimated due to under-reporting of grain byproducts by FAO and neither data source fully accounting for secondary byproducts or animal protein byproducts. These results indicate that continued innovation supporting sustainable intensification in livestock and poultry agriculture and increasing crop yields can produce adequate amounts of food and feed in 2050 without increasing crop lands (Table). Also, increasing crop yields have the potential to provide more crop residues for feeding ruminant livestock that could increase the efficiency of feed use and reduce pressure on grazing lands (Table). Without innovation in animal and plant agriculture, 36 to 58% more land would be required in 2050 to produce food and feed.

Table 1 (Asbtr. W285). Feed requirements and annual production (million metric tonnes as is, 85-90% dry matter)

	2010	2050 Continued innovation	2050 Frozen productivity
Feed requirements			
Grain & byproducts	1,111	1,331	1,872
Oilseed & byproducts	320	396	557
Crop residues & forage	3,146	3,245	4,545
Feed production & utilization			
Grains & by-products	878	1,403	
Oilseeds & byproducts	261	367	
Crop residues	2,075	2,905	

Key Words: sustainability, food supply, animal protein

W286 Climatic factors associated with abortion occurrences in Japanese commercial pig herds. Ryosuke Iida, Satomi Tani*, and Yuzo Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

Our objectives were to determine climatic and production factors associated with abortions in female pigs in commercial herds and to compare the reproductive performances and culling patterns between aborting and nonaborting reserviced female pigs. We analyzed 309,427 service records of female pigs entered into 100 herds located in humid subtropical or continental climate zones. Climate data were obtained from 21 weather stations located close to the studied herds. Mean daily average temperatures (Tavg) for the 21-d pre-mating period for each female pig were coordinated with that female's reproductive data. Generalized linear models were conducted for whether or not a female pig aborting. Abortion risk per service (±SEM) was 0.7 ± 0.06%, and mean daily average temperature (range) was 15.0°C (−11.0 to 32.7°C). Risk factors associated with an increased abortion risk per service were higher parity, having more stillborn piglets, higher Tavg and reservicing ($P < 0.05$). Also, abortion risks in parity 1 and parity 2–5 sows linearly increased by 0.3 and 0.1%, respectively, as Tavg increased from 20 to 30°C ($P < 0.05$), but there were no such associations in parity 0 and or parity 6 or higher female pigs ($P \geq 0.37$). Aborting reserviced female pigs had 0.4 fewer pigs born alive than nonaborting reserviced female pigs ($P < 0.05$). Also, 64.6% of all aborting female pigs were culled for reproductive failure, compared with only 23.4% of nonaborting females. In conclusion, producers should closely monitor female pigs at high risk of aborting and apply more advanced cooling systems.

Key Words: abortion, heat stress, incidence rate

W287 Estimated feed and water requirements to meet global 2050 demand for animal proteins. J. R. Knapp*[1] and R. A. Cady[2], *[1]Fox Hollow Consulting LLC, Columbus, OH, [2]Elanco Animal Health, Greenfield, IN.*

FAO has published predictions for 2050 global milk and meat consumption. As part of the larger Food Forward Sustainability Project, the objective of this study was to estimate the quantities of feed and water

required to produce the FAO forecasted quantities of animal products under 2 scenarios and independent of advances in crop production. In the first scenario, innovation continues, and in the second, development and application of technologies are limited, freezing productivity at 2010 levels. Models capturing animal population dynamics were formulated with biological constraints and used to predict the resources needed for egg, dairy, and meat production from chickens, swine, cattle, and water buffalo. Global consumption of chicken meat, pork, and beef is expected to increase 134, 51, 43%, respectively, based on increases in population and per capita consumption. For swine and beef, options exist with current technology and management that if applied more broadly could increase production efficiency and maintain or reduce resource utilization by these species' production systems relative to 2010 levels. The impact of increased dairy consumption would increase feed and water utilization by 10% with continued innovation. In swine, beef, and dairy, it is biologically possible to increase total production while decreasing animal numbers. In contrast, production of chicken meat cannot be increased to meet the very large projected demand without significant increases in both animal numbers and carcass size. Likewise, increasing egg production to meet future demands will require modest increases in eggs per hen and number of hens. Innovation and broader adoption of existing technology have strong potential to mitigate the impacts of increased animal production on feed and water utilization while meeting future demands for animal products, thus minimizing the expansion of animal numbers as has happened historically.

Table 1 (Abstr. W287).

	2010	2050 Cont. Innovation	2050 Frozen Productivity
Human population (billion)	6.9	9.4	9.4
Animal product consumption ($kg \times yr^{-1} \times person^{-1}$)	148.4	170.7	170.7
Total animal product consumption (billion MT)	1.02	1.60	1.60
Feed (as is, billion MT)	4.6	5.0	7.0
Water (trillion L)	15.8	17.3	24.9

Key Words: sustainability, food supply, animal protein

W288 Climatic factors associated with reproductive performance in English Berkshire pigs raised in a subtropical climate region of Japan. Shiho Usui, Satomi Tani*, and Yuzo Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

Our objective was to clarify the reproductive characteristics of English Berkshire female pigs in a humid subtropical zone. We examined interactions between 2 breeds (English Berkshire and crossbred females) and climatic factors for reproductive performance. We analyzed 63,227 first-service records of 11,992 females in 12 herds. Climate data were obtained from 4 weather stations located close to the studied herds. Mean daily maximum temperatures (Tmax) and daily average relative humidity (ARH) for different periods around servicing and farrowing of each female were coordinated with that female's reproductive performance data. Multilevel mixed-effects models were applied to the data. There were 2-way interactions between the breed and either Tmax or ARH for weaning-to-first-mating interval (WMI), total born and farrowing rate ($P < 0.05$). The WMI in Berkshire sows increased by 0.10 (SE: 0.008) days as Tmax increased by each degree Celsius ($P < 0.05$), whereas in crossbred sows it only increased by 0.01 (0.005) days ($P < 0.05$). The WMI in crossbred sows also increased by 0.03 (0.007) days as ARH increased by one percent ($P < 0.05$). However, there was no such association in Berkshire sows ($P = 0.37$). In Berkshire females total born decreased by 0.02 (0.003) pigs for each degree Celsius increase in Tmax ($P < 0.05$), whereas that in crossbred females decreased by 0.03 (0.002) pigs ($P < 0.05$). With regard to farrowing rates, the odds ratios in Berkshire and crossbred females were 0.973 (95% confidence intervals: 0.967–0.979) and 0.986 (0.981–0.991) for Tmax, respectively. Therefore, we recommend producers applying advanced cooling systems for Berkshire females as well as crossbred females.

Key Words: Berkshire, climatic factor, reproductive performance