304 Development of methane conversion factors for US cattle using mechanistic models. E. Kebreab*[1], K. A. Johnson[2], S. L. Archibeque[3], D. Pape[4], and T. Wirth[5], [1]*University of Manitoba*, *Winnipeg, Manitoba, Canada*, [2]*Washington State University*, *Pullman*, [3]*Colorado State University*, *Ft. Collins*, [4]*ICF International*, *Washington, DC*, [5]*Environmental Protection Agency*, *Washington, DC*.

Methane is one of the greenhouse gases emitted from livestock and up to 23 times more potent than carbon dioxide in its ability to trap heat in the atmosphere. In most countries, national estimates of enteric methane emissions are based on models developed by the Intergovernmental Panel for Climate Change (IPCC). For countries for which livestock emissions are important, the IPCC recommends a more complex approach which incorporates country-specific information and use of sophisticated models that consider diet composition in detail. Therefore, the objectives of this study were to (1) evaluate models for their prediction ability using measurements made on individual cattle and (2) develop methane conversion factors (Ym) for US cattle. The mechanistic models chosen were MOLLY, a whole-animal model developed at the University of California, Davis and COWPOLL, a largely rumen model for lactating dairy cows developed in Europe. Diet details from experiments conducted in the US were used as inputs to the models. Mean square prediction error (MSPE) was used to evaluate the models statistically. In dairy cattle, COWPOLL had the lowest root MSPE (12.5% of mean) but in feedlot, MOLLY had the lowest root MSPE (11.2% of mean). Both models had little mean bias or deviation from line of unity and over 90% of errors were random. The models were then used to estimate Ym from cattle fed different diets in various states across the US. The average Ym in dairy cows was 5.63% of gross energy (range 3.78 to 7.43%) compared to 6.5% ± 1% recommended by IPCC. In feedlot cattle, the average Ym was 3.88% (range 3.36 to 4.56%) compared to 3% ± 1% recommended by IPCC. The models were able to pick up differences in diet composition such as fat supplementation or amount and source of starch inclusion. Due to significant effect of diet on Ym, it is recommended that national inventories with large animal populations use diet specific Ym values estimated by mechanistic models to calculate methane emissions from cattle.

Key Words: Methane, Ruminant, Modeling

305 Characteristics and use of separated manure solids following anaerobic digestion for dairy freestall bedding in three Iowa dairy herds. L. L. Timms*, *Iowa State University*, *Ames*.

Study objectives were to evaluate the characteristics of separated manure solids and impact on herd performance in 3 dairy herds. All herds had mattresses in freestalls and used separted manure solid following anaerobic digestion from herd 1. Samples were collected on a biweekly basis for 1 year and included 1) raw manure 2) manure effluent post anaerobic digestion but prior to separation; 3) fresh separated manure solids ; 4) piled separated solids ; and 5) separated solids bedding samples from freestalls. Samples were analyzed for dry matter content and environmental mastitis pathogens. Bulk tank milk samples were taken for bacterial analysis and both creamery and DHI data was available. Dry matter content of fresh separated solids was 28-41% (avg. 34%) with piled solids running ~2-5% higher DM. DM% of solids in stalls averaged 65-75% during summer-fall, and 50-60% during winter. Total gram negatives and alpha streps., and coliforms post digestion and in stalls were 100,000 and 100, and 1-10 million/g and 1 million, 100,000, and 1000 for herds 1-3, respectfully. Herd 1 averages 250-350,000 and has declined slightly since solids use. Herd 2 averages 200-300,000 and has maintained that average. Herd 3 averages 100-200,000 SCC, and had maintained that average. All herds had no Strep. ag. and some evidence of Staph. aureus (contagious). Herds 1and 2 had very high levels of environmental streps., coagulase negative staphs., and some high Coli counts (> 200) indicating issues with milking preparation and teat cleanliness prior to unit attachment. This combined with some Staph. aureus may be the reason for higher SCC in these dairies . Herd 3 showed very good bulk tank results for environmental and skin bacteria indicating excellent premilking sanitation and a major reason for lower SCC. This data shows that composted manure solids can provide a comfortable, effective, economical bedding source if a consistent product is generated and managed properly, and stall, alley, and milking management areas are optimized.

Key Words: Separated Manure Solids, Anaerobic Digestion, Animal Performance

306 Aerobic composting or anaerobic stockpiling of beef feedlot manure. M. K. Luebbe*, G. E. Erickson, T. J. Klopfenstein, and J. R. Benton, *University of Nebraska*, *Lincoln*.

Two manure management and storage methods, manure stockpiled anaerobically or composted aerobically for 111 d, were evaluated for nutrient recovery. In July, manure from 11 open pens was scraped, sampled, and weighed before constructing three anaerobic stockpiles and four aerobic windrows. Windrows were turned on d 14, 35, 61, and 90 while stockpiles were not disturbed. Manure core samples and temperature were collected on d 0, 36, 62, and 111. Nutrient recoveries were calculated using total ash as an internal marker. Ammonium N was measured on samples as-is and after drying for 24 h in a 100°C oven. Dry matter and OM recovery was not different ($P>0.70$) on d 111. Total N concentration was greater ($P<0.01$) on d 111 for stockpiled manure than compost (6.0 and 5.0 g/kg DM, respectively). Total N recovery was greater ($P<0.01$) for stockpiled manure than compost on d 111 (75.8 and 65.6%, respectively). Organic N (% of total N) was greater ($P<0.01$) for compost than stockpiled manure on d 36, 62, and 111. Ammonium N (% of total N) for fresh samples was greater ($P<0.01$) for stockpiled manure than compost on d 36, 62, and 111. Nitrate N was greater ($P<0.01$) for compost than stockpiled manure on d 62 and 111. Total N recoveries calculated using oven dried samples tended to be greater ($P=0.10$) for stockpiled manure than compost on d 111 (70.5 and 65.0%, respectively). Recovery of P_2O_5 was not different ($P=0.81$) for composted and stockpiled manure at d 111 (97.0 and 95.8%, respectively). Concentration of P_2O_5 was similar ($P=0.40$) for stockpiled manure and compost on d 111 (9.0 and 8.7 g/kg DM, respectively). The N:P ratio was greater ($P=0.01$) for stockpiled manure than compost on d 111 (1.54 and 1.32, respectively). When manure samples were dried down completely to simulate hot, dry conditions during field application, the amount of ammonia N lost from stockpiled manure was not great enough to offset the total N recovery advantage of this method. When evaluated on a nutrient basis, stockpiled manure has greater value as a fertilizer compared with composted manure.

Key Words: Nitrogen, Cattle, Compost

307 Effect of dietary protein level and degradability and energy density on ammonia losses from manure in dairy cows. M. Agle[1], A. N. Hristov*[1], S. Zaman[1], C. Schneider[1], P. Ndegwa[2], and V. K. Vaddella[2], [1]*University of Idaho*, *Moscow*, [2]*Washington State University*, *Pullman*.

Two trials with lactating dairy cows were conducted to investigate the effect of dietary CP level and degradability (Trial 1) and dietary energy density (Trial 2) on ammonia losses from manure. Experiments were replicated Latin square design with 2-wk adaptation periods. Three diets were tested in Trial 1 and 2 diets in Trial 2. Concentrations of CP, RDP, and RUP (NRC, 2001) in Trial 1 diets were (%, DM basis): 17.6, 12.2, and 5.4 (HighCP); 15.2, 9.8, and 5.4 (LowCP); and 14.4, 8.3, and 6.1 (ExtraLowCP). RDP supply exceeded requirements in HighCP, was adequate in LowCP, and was deficient in ExtraLowCP. In all diets, metabolizable protein intake met the requirements of the cows. Dietary NE_L concentration was similar between diets (1.54 to 1.57 Mcal/kg DM). Diets in Trial 2 had similar CP (and RDP/RUP) concentration (17.8-17.9% DM), but differed in NE_L density: 1.65 (LowEnergy; 50% forage) vs. 1.83 (HighEnergy; 30% forage) Mcal/kg DM. In both trials, diets were offered at ad libitum intake. Average DMI and milk yield in Trial 1 were 24.2 and 30.8 kg/d (respectively) and were not affected ($P = 0.153$ and 0.453) by diet. In Trial 2, average DMI and milk yield were 26.0 and 33.4 kg/d and did not differ between diets ($P = 0.502$ and 0.191). At the end of each experimental period, fresh urine and feces were collected from the cows and stored frozen at -80°C. After thawing, reconstituted manure (1 part by weight urine and 1.7 parts feces) was analyzed for ammonia emitting potential *in vitro*. In Trial 1, two weeks cumulative ammonia losses were reduced ($P = 0.001$) with LowCP and ExtraLowCP compared with HighCP (1.7, 1.4, and 2.3 g N, respectively). Diet had no effect ($P = 0.207$) on ammonia losses in Trial 2 (2.0 and 2.3 g N; LowEnergy and HighEnergy, respectively). This study demonstrated that manipulation of dietary CP/RDP, but not energy, can significantly reduce ammonia losses from dairy manure.

Key Words: Dietary Protein, Ammonia Losses from Manure, Dairy Cow

308 Simulating effects of grass management on methane emission in lactating cows. A. Bannink*[1], M. C. J. Smits[1], J. A. N. Mills[2], E. Kebreab[3], J. L. Ellis[4], J. France[4], and J. Dijkstra[5], [1]*Animal Sciences Group, Wageningen University Research Centre*, *Lelystad, The Netherlands*, [2]*University of Reading*, *Reading, United Kingdom*, [3]*University of Manitoba*, *Winnipeg, Canada*, [4]*University of Guelph*, *Guelph, Canada*, [5]*Wageningen University*, *Wageningen, The Netherlands*.

The type and rate of degradation of carbohydrates in the rumen affect methane production. Because experimental data for grass based diets are essentially lacking, the objective was to simulate the effect of grass characteristics on methane emission from enteric fermentation. A dynamic model of rumen and hindgut fermentation processes (Mills et al., JAS 79:1584-1597) was used. Stoichiometry of yield of volatile fatty acids from differen types of carbohydrates and protein was updated based on a recent analysis of in vivo data from lactating cows. Methane yield was calculated from predicted hydrogen balance. Various types of ryegrass products were evaluated: fresh grass (G) and grass silage (GS), high (HF) and low (LF) N fertilization level, and early (EC) and late (LC) cutting. Simulations were performed with various levels of DM intake (DMI), and low (10%) or high (60%) level of concentrate on a DM basis. The results demonstrated a strong impact of DMI, proportion of concentrate and type of grass consumed on methane emission rate and milk yield (FCM). At constant DMI of 17 kg/d, methane loss per kg FCM increased with a reduced N fertilization level (LF vs. HF) and delayed cutting (LC vs. EC). Lowest emissions were predicted for HF fresh grass and HFEC silage. The higher concentrate level decreased losses with LFEC but not with HFEC. Increasing DMI level strongly reduced methane loss per kg FCM.

Table 1. Simulated methane yield from ryegrass diets

% concentrate	10	10	10	10	10	10	60	60	60
DMI kg/d	17	17	17	17	17	17	17	17	23
Grass type	GS	GS	G	GS	GS	G	GS	GS	GS
Management	HFEC	HFLC	HF	LFEC	LFLC	LC	HFEC	HFLC	HFEC
Methane									
g/d	320	318	345	347	330	366	353	349	399
g/kg DMI	18.8	18.7	20.3	20.4	19.4	21.5	20.8	20.5	17.3
g/kg FCM	13.5	15.0	13.5	15.7	16.1	15.7	13.7	14.1	10.5
% GEI	5.8	5.6	6.1	6.5	6.0	6.7	6.4	6.2	5.3

Key Words: Grass Quality, Methane, Modeling

309 Application of computer models in evaluating alternatives to reduce excess nutrients on a beef farm. M. J. Baker*[1], D. G. Fox[1], and L. O. Tedeschi[2], [1]*Cornell University*, *Ithaca, NY*, [2]*Texas A&M University*, *College Station*.

A two part study was conducted to evaluate the use of the Cornell Net Carbohydrate and Protein System (CNCPS) and the Cornell Value Discovery System (CVDS) in predicting animal performance and in designing a cropping and feeding system that minimizes land applied nutrients while optimizing profitability on a Holstein steer feeding operation. Study 1 utilized farm records to compare several cropping and feeding strategies to baseline data. Replacing alfalfa silage with corn silage (strategy 1) or grass haycrop silage (strategy 2) was predicted to reduce excess nitrogen (N) due to increased utilization by the crop and reducing imported N due to N fixation by alfalfa. However soil erosion control and soil fertility maintenance required that alfalfa be part of the crop plan. Over 19 months (Study 2), complete data was collected on animal (n=450), environment, feed and manure nutrients for four groups of Holstein steers. The average arrival and harvest weight was 149 kg and 597 kg, respectively. Cattle were managed in three weight phases: light, middle and heavy and marketed at thirteen months. Using observed DMI, the CNCPS was able to predict animal ADG within 0.20 kg, 0.07 kg and 0.06 kg for the light, medium and heavy groups, respectively. The CVDS accurately predicted the DM required for the observed gain (predicted DM required was 101% of actual DM fed). Correlations between dietary and manure N, phosphorous (P) and potassium (K) were variable, possibly due to sampling procedure and the interaction of temperature and manure ammonia volatilization. Compared to a dairy, purchased feed was less resulting in lower imported N, P and K. Nutrient efficiency was also low due to the small amount of product that leaves the farm as meat compared to milk. Increasing nutrient efficiency will be difficult because there is little excess dietary N and the increases in product for export will be small. We conclude computer models can be used to aid farmers in designing feeding systems that optimize nutrient utilization.

Key Words: Nutrient Modeling, Holstein Steer

310 Challenges in using flux chambers to measure ammonia and VOC flux from simulated feedlot pen surfaces and retention ponds. N. A. Cole*[1], R. W. Todd[1], D. B. Parker[2], M. B. Rhoades[2], and E. Caraway[2], [1]*USDA-ARS-CPRL*, *Bushland, TX*, [2]*West Texas A&M University*, *Canyon, TX*.

Few methodologies currently available to estimate ammonia and volatile organic compound (VOC) emissions from livestock operations have been adequately validated for accuracy. Flow-through flux chambers and wind tunnels are sometimes used; however, ammonia and VOC flux from pen or pond surfaces are affected by atmospheric turbulence, atmospheric concentration, and temperature, all of which are altered by a chamber. Two lab-scale studies were conducted to determine the effects of flux chamber air exchange rate (0 to 4 turnovers/minute) on ammonia flux from a simulated retention pond or feedlot pen surface. Buffered ammonium sulfate solutions (pH = 7.6, 8.6, and 9.6) were used as a surrogate ammonia source to simulate a feedlot retention pond. Similar buffer solutions were added to a cellulose media to simulate a feedlot pen surface. With both simulated surfaces, ammonia flux increased with increasing air turnover rate. Flux rates at 4 turnovers/minute were approximately 2x flux rates at 0.5 turnovers/minute and 50% of flux rates from "unaffected" containers placed outside the flux chambers. In a third lab experiment, VOC flux was measured from fresh cattle feces and retention pond effluent using a wind tunnel with air flow rates ranging from 0.5 to 9.7 meters/second (approximately 1 to 32 turnovers/minute). In general, VOC flux doubled for each 2-fold increase in air flow rate. Previous chamber studies have noted a large spatial variability in ammonia flux from pen and lagoon surfaces with CV ranging from 23 to 192%. Based on 11 chamber studies, the number of ammonia flux estimates required to be 95% confident that the estimated mean is within 20% of the true mean (determined as $CV^2/100$) ranges from 5 to 369; with a mean of approximately 75. These findings suggest that flux chambers will not give accurate estimates of ammonia or VOC flux from pen or lagoon surfaces and that large numbers of samples may be required when using chambers for treatment comparisons.

Key Words: Ammonia, VOC, Flux Chamber

311 Odorant production and persistence of generic *E. coli* in manure slurries from cattle fed 0, 20, 40, and 60% wet distillers grains with solubles (WDGS). V. H. Varel*[1], J. E. Wells[1], E. D. Berry[1], M. J. Spiehs[1], D. N. Miller[2], C. L. Ferrell[1], S. D. Shackelford[1], and M. Koohmaraie[1], [1]*USDA-ARS, US Meat Animal Research Center*, *Clay Center, NE*, [2]*USDA-ARS, Agroecosystem Management Unit*, *Lincoln, NE*.

Ethanol production from corn removes starch and concentrates the remaining nutrients including CP and minerals. When WDGS are fed to cattle in place of corn, CP and minerals exceed dietary needs. This may increase N emission, P run-off, and odor production. Crossbred steers (n = 160; 434 kg) were assigned in a completely randomized block design to 9 × 9 m pens with concrete floor (10 animals/pen; 4 pens/trt). Steers were fed a finishing diet that contained either 0, 20, 40, or 60% WDGS on a DM basis, and provided 13.4, 14.6, 18.7 or 22.8% CP, respectively. One kg of manure slurry (14 to 23% DM) was randomly collected across each pen (Aug. 20, Sept. 24, and Oct. 22). Samples were analyzed immediately for odorants, DM, pH, ammonia, L-lactate, and level of generic *E. coli*. After incubation of the samples at 22°C for 2, 4, 7, 10, 14, 21, and 28 d, samples were analyzed for the above parameters plus methane production. Ammonia, reduced sulfur, indole, phenol, isovalerate, isobutyrate and acetate increased ($P < 0.01$) with increasing amounts of WDGS in the diet. Other odorants, skatole, caproate, valerate, butyrate, and propionate were greater ($P < 0.01$) in manure slurries from cattle fed either 20 or 40% WDGS, compared to 0% WDGS. L-lactate was greater ($P < 0.01$) in slurries from cattle fed 0% WDGS (447 μmol/g DM) compared to the other treatment slurries (14-15 μmol/g DM). L-lactate lowered slurry pH (6.3, 7.1, 7.6, and 8.2, respectively, for 0, 20, 40, and 60% WDGS) which inhibited microbial fermentation, generic *E. coli* persistence, and methane production. Because of the favorable pH in the 40 and 60% WDGS slurries, most of the odorant compounds were rapidly converted to methane during a 28 d static incubation. These data indicate feeding WDGS can increase odorants in manure slurries and extend the persistence of generic *E. coli*.

Key Words: Distillers Grains, Feedlot Cattle, Manure Odor

312 Quantification of nutrient excretion and volatile fatty acid production from a swine wean-finish facility. D. M. Sholly*, D. T. Kelly, A. L. Sutton, B. T. Richert, and J. S. Radcliffe, *Purdue University*, *West Lafayette, IN*.

A total of 1,920 pigs were used in a 2 × 2 factorial, wean-finish experiment to determine the effects of diet (control, CTL vs. low nutrient excretion, LNE) and manure pit management (6 mo. deep-pit, DP vs. monthly pull plug, PP) on nutrient excretion and VFA production. Pigs were housed in a 12-room environmental building where quantitative manure collection in 24 pits (2/room) was available. Each room housed 30 barrows and 30 gilts (3 pens each), which were split-sex and phase-fed to meet or exceed the nutrient requirements of pigs (NRC, 1998) at different stages of growth. The CTL and LNE diets were corn-SBM based and had equal Lys:calorie. The LNE diets had reduced CP and P, increased synthetic amino acids, phytase, non-sulfur TM premix and added fat. Regardless of manure storage, manure generation was reduced by 0.39 L/pig/d when pigs were fed the LNE diet vs. the CTL diet (4.05 vs. 4.44 L/pig/d, $P<0.008$). Excretion of total N, P, and K was reduced ($P<0.001$) by 27.5, 42.5, and 20.4%, respectively, from LNE fed pigs. Pigs fed the LNE diet also had a 25.5, 23.8, 32.3, 18.5, 35.8, and 26.7% reduction ($P<0.05$) in acetate, iso-butyrate, butyrate, iso-valerate, valerate, and total VFA production, respectively, compared to CTL fed pigs. Ammonium N production was reduced (16.5 vs. 18.4 g/pig/d, $P<0.002$) with PP manure strategy compared to DP strategy. The PP strategy also reduced total VFA production by 20.5% (26.0 vs. 32.7 mM/pig/d, $P<0.001$) compared to DP strategy. There was no interaction ($P>0.05$) of diet and storage for nutrient or VFA production. In summary, implementing LNE diet formulation or using a monthly pull plug strategy can significantly decrease nutrient excretion and VFA production.

Key Words: Nutrient Excretion, Volatile Fatty Acids, Pigs