**538 Evaluation of a reproducible model for necrotic enteritis in broilers and analysis of NetB toxin profiles of different field isolates of *Clostridium perfringens*.** S Shivaramaiah*[1], J. R. Barta[2], S. L. Layton[1], M. J. Morgan[1], R. E. Wolfenden[1], B. M. Hargis[1], and G Téllez[1], [1]*University of Arkansas*, *Fayetteville,* [2]*University of Guelph*, *Guelph, ON, Canada*.

Necrotic enteritis (NE) caused by Type A strains of *Clostridium perfringens* (CP) is an economically important disease in commercial poultry production. *Eimeria* infection is considered an absolute prerequisite to cause NE by disrupting intestinal integrity. Several reproducible NE models have used either immunosuppression or dietary modifications as common predisposing factors in conjunction with *Eimeria* infection. Preliminary data from our studies indicated that *Salmonella* infection early in the age followed by *Eimeria* and CP challenge accentuated NE-associated morbidity and mortality. In 2 replicate experiments, day-of-hatch chicks (n = 25/trt) were randomly assigned as Negative control (G1), *Eimeria* + CP (G2) or *Salmonella* + *Eimeria* + CP (G3). Challenge organisms included wild type *Salmonella typhimurium* (ST; ~2 × $10^8$ cfu/chick) at day-of-hatch, sporulated oocysts of *E. maxima* (4 × $10^4$/chick), at either D18 or D21, and 2 field strains of CP (1 × $10^8$ cfu/chick), at either D22–23 or D25–26. Body weight (BW) was recorded before *Eimeria* challenge and at termination (D25 or D28) to determine weight gain. In addition, total mortality and lesion scores were evaluated. BW and lesion score data were analyzed using JMP7 while mortality was analyzed using the chi-squared test of independence. In both experiments, chicks in G3 suffered reduced ($P < 0.05$) weight gain as compared with either G1 or G2. In addition, total mortality and lesion scores were higher ($P < 0.05$) in G3 as compared with G2. Toxin profiling for challenge strains were evaluated to check for the presence of NetB, a toxin which is apparently obligatory for disease. Future studies are directed toward confirmation of the obligatory role of NetB in the pathogenesis of NE and the potential of NetB negative isolates to cause NE. The ability of selected probiotics to ameliorate NE is also currently under investigation.

**Key Words:** *Salmonella*, necrotic enteritis, NetB

**539 Effects of a microbial litter amendment on litter quality and broiler performance.** M. J. Hinkle*[1], S. M. Gottselig[1], J. L. McReynolds[2], J. T. Lee[1], and C. D. Coufal[1], [1]*Texas A&M University*, *College Station*, [2]*USDA-ARS*, *College Station, Texas*.

The reuse of litter in broiler production can lead to litter pathogen buildup and high levels of ammonia in broiler housing, thus resulting in poor broiler performance. This study evaluated the effects of a commercially available microbial culture litter amendment product on litter characteristics, ammonia production and broiler performance. Eight pens approximately 3 × 3 m each were used to rear broilers to 49 d of age at a density of 743 $cm^2$ (0.8 $ft^2$) per bird. Four pens were treated with the amendment according to the manufacturer's specification, and the remaining 4 pens served as untreated controls. Litter that had been used for 14 flocks was obtained from a commercial broiler farm and placed into the pens at an average depth of 11 cm. Feed consumption and mortality were recorded for each pen throughout the experiment. Ammonia production was measured by placing an enclosed chamber over the litter and sampling the headspace after 20 min with a Drager CMS unit. Ammonia measurements were taken one week before chick placement, at the time of chick placement, and once per week for the remainder of the grow-out. Litter samples were collected at the same time and location as ammonia measurement. On d 49, all caked litter was removed from each pen, weighed and sampled. Litter and cake samples were analyzed for total aerobic and anaerobic microbial counts. Paw scores were also recorded on d 49 for all birds using a 3-point scale (0, 1 or 2). Data were subjected to ANOVA using the GLM procedure with means deemed significantly different at $P < 0.05$. Percent mortality was significantly lower for treated pens (2.1%) than control (3.65%), but no statistical differences were observed for any other parameters measured. Average ending BW, feed:gain, paw score and cake weight per pen were 3.24 kg, 1.74, 0.75 and 128 kg for control pens and 3.19 kg, 1.70, 0.69 and 104 kg for treated pens, respectively. Average chamber ammonia concentrations decreased from 193 ppm at chick placement to 70 ppm at d 21, then increased to 131 ppm on d 49. Based on this experiment, the microbial amendment had a positive effect on broiler performance.

**Key Words:** broiler, litter, amendment

**540 Bacterial content following simulated rainfall on poultry waste.** J. H. Metcalf*[1], P. A. Moore Jr.[2], A. M. Donoghue[2], I. Reyes-Herrera[1], K. Arsi[1], P. J. Blore[1], and D. J. Donoghue[1], [1]*Poultry Science Department, University of Arkansas*, *Fayetteville,* [2]*Poultry Production and Product Safety Research Unit, USDA-ARS*, *Fayetteville, AR*.

To evaluate potential bacterial runoff from poultry litter, litter was applied to test plots and exposed to simulated rainfall. The experiment consisted of 21 small (100 sq. ft) plots which were subjected to simulated rainfall after litter was applied to the plots. Water runoff samples were tested for *Salmonella* and *Campylobacter*, 2 bacterial pathogens associated with poultry. Each trial consisted of 7 treatments; 1) controls (no litter) or the equivalent of 2) one ton/acre of normal litter, 3) 2 ton/acre of normal litter, 4) 4 ton/acre of normal litter, 5) 2 ton/acre of alum-treated litter, 6) 2 ton/acre deep stacked litter, and 7) 2 ton/acre composted litter. Rainfall was applied at the rate of 5 cm/h until the first runoff was observed from each plot (mean 37 min) and then continued for an additional 30 min. Rainfall was applied at one, 8 and 15 d after litter application and the trials were replicated 3 times. Data were analyzed by ANOVA using the GLM procedure of SAS and a probability of $P < 0.05$ was required for statistical significance. No *Campylobacter* was isolated from any of the runoff samples, and most samples tested negative for *Salmonella* as well. While most samples were negative, *Salmonella* was recovered from some plots, including the untreated control plots (no litter). Because *Salmonella* was recovered from untreated controls, the *Salmonella* detected may originate from sources other than the applied litter (e.g., wild birds, rodents, deer).

**Key Words:** Water runoff, *Salmonella*, *Campylobacter*

**541 Effect of a low sulfur diet on air emissions, nutrient excretion, and performance of laying hens.** W. Wu-Haan*[1], W. Powers[1], R. Angel[2], D. Karcher[1], and T. Applegate[3], [1]*Michigan State University*, *East Lansing,* [2]*University of Maryland*, *College Park,* [3]*Purdue University*, *West Lafayette, IN.*

The objectives of the current study were to evaluate the effect of feeding commercial diet (C), reduced S (RedS) diet, and a low S (LowS) diet on air emissions, nutrient excretion, and performance of Hy-line W36 laying hens from 47 to 50 wk of age (4 environmental rooms/diet; 56 hens/room). The C, RedS, and LowS diets were formulated to contain 0.19%, 0.11%, and no supplemental DL-Met. Methionine intake of 274.7, 361.6, or 406.7 mg/hen/d resulted in increasing egg weights

of 61.1, 63.9, and 65.1 g ($P < 0.01$) for the LowS, RedS and C diets. Analyzed S contents (2,602; 2,540; and 2,460 ppm) corresponded to S intakes of 244.6, 236.6, and 217.0 mg/bird/d in hens fed C, RedS and LowS diets ($P < 0.01$). Egg production (89%) and BW change (18.4 g) were unaffected by diet ($P > 0.05$) over the study period. A decrease in daily H2S emission was observed ($P < 0.01$) as S content in the diet decreased. Daily H2S emissions from hens fed C, RedS, and LowS diets were 0.83, 0.62, and 0.44 mg/bird ($P < 0.01$). Overall, hens fed LowS diet decreased daily H2S emissions by 46.4% (mg/kg BW basis), 45.6% (mg/kg FI basis), 46.7% (mg/g egg mass basis), 22.9% (mg/kg excreta DM basis) and 44.1% (mg/g S intake basis), respectively ($P < 0.01$) compared with hens fed the C diet. Emission factors that resulted from feeding the RedS diet were intermediate to those for the C and the LowS diets. No significant diet effects on daily emissions of SO2 (0.35 mg/kg BW), NH3 (480 mg/kg BW), NO2 (3.0 mg/kg BW), CH4 (32.4 mg/kg BW), non-CH4 (4.6 mg/kg BW), CO2 (48.8 g/kg BW), and O2 utilization (−122 g/kg BW) were observed during the trial period. In addition, total DM excretion (20.8 g/bird/d) was unaffected by diet. However, S excretion decreased ($P < 0.01$) from hens fed LowS diet (98.6 mg/bird/d) and RedS diet (105.3 mg/bird/d) compared with those fed the C diet (137.6 mg/bird/d). The results of this study demonstrate that feeding less DL-Met has great potential to reduce H2S emissions and S excretion from laying hens and reducing DL-Met up to 40% had no negative impact on hen performance; however, completely eliminating DL-Met supplementation resulted in less cumulative egg mass.

**Key Words:** air emission, egg, sulfur

**542 Comparison of nutrient balance and performance of laying hens, housed in either enriched or conventional cage systems, over an entire production.** M. Neijat*[1], J. D. House[1], W. Guenter[1], and E. Kebreab[2], [1]*University of Manitoba*, *Winnipeg, Canada*, [2]*University of California*, *Davis*.

The move to alternative cage designs for laying hens has the potential to lead to differences in hen behaviors, with a resultant effect on manure characteristics and estimates of nutrient flow. To this end, an experiment was conducted to assess nitrogen (N), calcium (Ca) and phosphorus (P) balances, manure weight and composition, and indices of performance of laying hens housed under 2 distinct caging systems. A total of 4,836 commercial Shaver White hens were caged in either enriched (EC) or conventional (CC) (average floor space per hen of 642.6 and 468.4 $cm^2$ respectively) under a semi-controlled environment. Enriched cages provided hens with a curtained nesting area, scratch pad and perches. All birds were fed the same standard layer diet for 11 periods in 4 week intervals. Data, expressed on a hen basis, were analyzed as repeated measures using the MIXED model procedure of SAS. Egg production, feed conversion ratio, body weight, egg weight and egg mass were not significantly different between the 2 systems. Lower feed intake ($P < 0.01$) (92.5 vs. 95.0 g/d DM basis) and manure output ($P < 0.01$) (79.8 vs. 91.3 g/d as is basis and 27.0 vs. 28.1 g/d DM basis) were observed in birds housed in EC compared with CC. Manure DM% were 31.0 and 34.1 for CC and EC respectively. Overall mean Ca and P excretions in manure were significantly ($P < 0.01$) lower in EC birds (2.11 ± 0.04 and 0.619 ± 0.005 g/d respectively) than their counterparts in CC (2.29 and 0.643 g/d respectively). There were no significant differences in the amount of manure N excreted by birds in both cage systems (1.94 and 1.96 ± 0.02 g/d for EC and CC respectively). Taking into account the increasing intensity of poultry production, welfare and environmental concerns, enriched caging systems may help in reducing Ca and P excretions, and the total weight of manure.

**Key Words:** caging, manure, nutrient excretion

**543 Effects of the removable chicken house on the growth performance of broilers and indoor environment parameters.** A. G. Chen*, Z. Wang, X. M. Wang, Q. H. Hong, and C. M. Yang, *Zhejiang University*, *Hangzhou, China*.

A total of 880 one-day-old Ling-nan broilers were selected to study the effects of the removable chicken house on the growth performance and indoor environment parameters. All broilers were raised in the removable house during 0–21d period and then were randomly divided equally into 2 groups, each with 4 replications, and respectively raised in the removable chicken house (the trial) and in the general fixed one (the control) from 22d to 70d. Both groups of chickens received the same diets include a starter for 0–21d, a grower for 22–49d and a finisher for 50–70d period, respectively. The growth performance of broilers was determined every period and the indoor environment parameters, average temperature (AT), average relative humidity (ARH) were measured daily and average ammonia concentration ($NH_3$) was detected at 0800, 1400 and 2000 h every other day. During the entire test period, the average daily gain (ADG) in the trial group was 28.05 ± 7.04g and was 0.75% ($P > 0.05$) higher than that in the control, and the feed to gain ratio (F/G) 3.10 ± 0.82 was 0.96% ($P > 0.05$) lower than that of the control, respectively. The survive rate of the trial group was 94.38%, a little higher than the control′s (93.75%). The incidence of diseases in the removable group was 5.00 ± 0.68% and in the fixed group was 8.25 ± 1.71%. When the average outdoor temperature was 6.12°C, AT, ARH and $NH_3$ in the removable chicken house were 11.22°C, 64.67% and 2.98ppm, respectively, while in the general fixed one, the data were 9.96°C, 67.60% and 2.70ppm, respectively. The results showed that there were similar indoor environment parameters and growth performance of broilers in 2 types of chicken houses, but the removable chicken house resulted in lowered incidence of diseases.

**Key Words:** removable chicken house, fixed chicken house, environment parameters

**544 Effect of DDGS and mineral sources on air emissions from laying hens.** W. Li*[1], W. Powers[1], D. Karcher[1], R. Angel[2], and T. J. Applegate[3], [1]*Michigan State University*, *East Lansing*, [2]*University of Maryland*, *College Park*, [3]*Purdue University*, *West Lafayette, IN*.

The objectives of the current study were to evaluate the dietary effects of distillers dried grains with solubles (DDGS) and the sources of mineral supplement on air emissions from Hy-line W-36 hens from 50 to 53 wk of age (3 environmental rooms/diet; 56 hens/room). Diets were arranged in a 2 × 2 factorial design. Factors were dietary concentration of DDGS (0 or 20% of diet dry matter) and source of minerals (common inorganic sources; In or organic mineral sources from Pancosma, Geneva, Switzerland; Org). Analyzed diets contained 18.31% CP, 0.68% P and 4.20 Ca. Analyzed S content was 0.25%, 0.26%, 0.30% and 0.31% for the 0In, 0Org, 20In and 20Org diets. Concentration and airflow of ammonia ($NH_3$), hydrogen sulfide ($H_2S$), nitrous oxide ($N_2O$), methane ($CH_4$) and non-methane total hydrocarbons (NMTHC) were measured in exhaust air from each room. Egg weight (65.12g) and egg production (88%) were not affected by diet ($P > 0.05$). Feed intake in hens fed the 0Org (106.88 g/d/hen) was greater than for hens fed any of the other treatments (104.29, 104.93 and 103.92 g/d/hen in 0In, 20In and 20Org). Feeding DDGS decreased mass of NH3 emitted daily (592 vs. 512 mg/hen/d for 0% and 20% DDGS) and the following emission factors: mg/kg BW (by 16%), mg/g N consumed (by 17%), mg/g egg (by 14%). No mineral source effects were observed for $NH_3$ emission variables. Feeding DDGS increased daily $CH_4$ emissions by 13 to 15% (39.3 vs. 45.4 mg/hen/d; and 0.70 vs. 0.82 mg/g egg/d; $P < 0.05$). Daily $H_2S$ emitted (0.78 mg/hen/d), $N_2O$ emitted (58.6 mg/hen/d), non-methane total

hydrocarbon (24.4 mg/hen/d) ($P > 0.05$) were not changed as a result of diet fed. Mass of excreta (27.3 vs. 31.5 kg DM) and mass of N excreted (1.25 vs. 1.52 kg N) from 56 hens over a 3-wk period were increased as a result of feeding DDGS. Diet inclusion of DDGS or organic trace minerals did not change short-term performance of laying hens. Feeding 20% DDGS reduced $NH_3$ emissions, increased $CH_4$ emissions and had no effect on emissions of other gases. Substitution of inorganic trace mineral sources with organic sources did not alter air emissions.

**Key Words:** laying hen, DDGS, organic trace mineral

**545 Effect of amino acid formulation and supplementation on nutrient mass balance and air emissions from turkeys.** Z. Liu[1], W. Powers*[1], D. Karcher[1], R. Angel[2], and T. J. Applegate[3], [1]*Michigan State University*, *East Lansing*, [2]*University of Maryland*, *College Park*, [3]*Purdue University*, *West Lafayette, IN*.

Nutrient mass balance and air emissions were determined for turkeys fed 4 diets in a 2 × 2 factorial design to determine the effects of diets with 100 or 110% of NRC (1994) recommended amino acid (AA) formulation and diets containing 2 (Lys and Met) or 3 (Lys, Met, and Thr) supplemental AA. Hybrid tom turkeys were raised and monitored in 12 rooms (3 reps/diet; 20 toms/room at hatch culled to 16 toms/room at 4 wk then 12 toms/room at 8 wk of age). All feed and litter entering and leaving the rooms were quantified and analyzed for nutrient content. Air emissions were measured throughout the 20-wk study. Data were analyzed statistically by ANOVA using the MIXED model procedure of SAS. The 100% NRC diets contained less N compared with the 110% NRC (2.64% vs. 2.73% during wk 16 to 20). Diets containing 3 vs. 2 supplemental AA had less N content (2.61% vs. 2.76% during wk 16 to 20). Cumulative feed intake (55.67 kg/tom) and BW (19.85 kg/tom) were not affected by diet. Feeding 3 supplemental AA resulted in lower N content in excretion (3.21% vs. 3.50%, $P < 0.05$) as compared with feeding 2 supplemental AA and an interaction between the main effects was observed ($P < 0.05$). The 100% NRC diets resulted in lower emission rates of $NH_3$ (1.52 vs. 1.77 g/tom-d), non-methane hydrocarbon (0.10 vs. 0.12 g/tom-d) and $H_2S$ (3.78 vs. 4.69 mg/tom-d) compared with the 110% NRC diets ($P < 0.05$). Feeding 3 supplemental AA resulted in lower $NH_3$ emission rates (1.23 vs. 1.68 g/tom-d, $P < 0.05$) as compared with feeding 2 supplemental AA and a significant interaction was observed ($P < 0.05$). The 100% NRC diets reduced cumulative $NH_3$ emission by 14% compared with the 110% NRC (187 vs. 218 gN/tom, $P < 0.05$). The 3 supplemental AA diets reduced cumulative $NH_3$ emission by 23% compared with the 2 supplemental AA (176 vs. 230 gN/tom, $P < 0.05$). Total N emission averaged 217 gN/tom. Across all 4 diets, N partitioning, as a percentage of inputs, averaged 32%, 58%, 12%, and −2% for retention, excretion, air emission, and unaccounted losses respectively. The results demonstrated the potential of reducing nutrient excretion and air emissions from turkeys through diet modification of AA, and illustrated fate of N, P and S in a turkey production system.

**Key Words:** diets, retention, excretion

**546 Magnitude and variability of distillers grains greenhouse gas credits in the corn-ethanol-livestock life cycle.** V. R. Bremer*, A. J. Liska, H. S. Yang, T. J. Klopfenstein, G. E. Erickson, D. T. Walters, and K. G. Cassman, *University of Nebraska*, *Lincoln*.

Feeding distillers grains (DGS) to livestock is an important part of the greenhouse gas (GHG) mitigation benefit due to ethanol production. Three scenarios were used to evaluate the magnitude and variability of DGS GHG emissions credit and GHG balance of ethanol relative to gasoline in the corn-ethanol-livestock life cycle with the Biofuel Energy Systems Simulator (BESS; www.bess.unl.edu). The BESS model accounts for GHG emissions associated with corn production for ethanol and livestock feed, ethanol plant operation based on type of DGS produced, corn, urea, and soybean meal displaced when DGS is added to livestock diets, differences in feedlot cattle enteric fermentation, and feedlot fuel use change due to DGS feeding. Scenario 1evaluated feeding Nebraska wet, modified, or dry DGS to feedlot steers, Scenario 2 evaluated feeding Midwest dry DGS to beef, dairy, or swine, and Scenario 3 evaluated Iowa, Nebraska, and Texas corn-ethanol-livestock production systems by types of DGS fed to different livestock classes. The DGS GHG emissions credit from the analyzed scenarios varied by more than 2-fold, from 11.5 to 28.3 g CO2e per MJ of ethanol produced, depending on the fraction of DGS used without drying, the proportion of DGS used to feed feedlot cattle vs. dairy or swine, and the location of corn production. Quadratic improvements in DMI ($P = 0.01$), ADG ($P < 0.01$), and G:F ($P = 0.09$) of feedlot cattle fed increasing levels of wet DGS are an important part of maximizing DGS GHG credits. Regional variability in GHG intensity of crop production and future livestock feeding trends will determine the magnitude of DGS GHG offset against GHG emissions elsewhere in the corn-ethanol-livestock life cycle. The DGS GHG credit represents a 19 to 38% offset of total corn-ethanol-livestock life cycle positive emissions and a 41 to 60% reduction in GHG emissions of ethanol motor fuel relative to gasoline. The DGS GHG credit was optimized when wet DGS was fed to beef cattle.

**Key Words:** distillers grains, environment, greenhouse gases

**547 Methane production, fermentation patterns and protozoa numbers In Vitro as related to sources of rumen fluid from different cattle feeding systems and animal waste substrate digestion.** C. L. Ross*, M. A. Froetschel, S. Buaphan, S. Chinnasamy, and K. C. Das, *The University of Georgia*, *Athens*.

Rumen fluid, collected by stomach tube, from beef cattle grazing pasture, lactating dairy cattle fed a total mixed ration, and beef cattle fed a feedlot ration were used to determine the influence of different rumen microbial inoculations on In Vitro methane production and fermentation of animal wastes, in a 3x3 factorial designed experiment. Broiler litter, dairy and swine manure were used as substrates. A modified Tilley and Terry procedure was used and fermentation gas was collected in sampling bags with septum valves. Dry matter and gross energy digestion and volatile fatty acids and ammonia production and protozoa counts were measured using standard techniques after 24 h incubations. All parameters were corrected with measurements from rumen fluid blank incubations without substrate. The source of rumen fluid did not affect the volume of methane produced ($P > 0.3$), but the volume of methane produced in vitro tended to increase by 75% with broiler litter as a substrate ($P < 0.08$). Ammonia production increased with rumen fluid from dairy and feedlot compared with grazing cattle, several fold especially with broiler litter as substrate (rumen fluid by substrate interaction $P < 0.02$). Total VFA produced were 40 to 90% higher with broiler litter and swine manure as compared with dairy manure ($P < 0.01$) and IVDMD was almost 2 fold greater with broiler litter as compared with the other wastes as substrate ($P < 0.01$). The moles of methane produced per digestible energy fermented was 2-fold greater with rumen fluid from feedlot cattle ($P < 0.08$) but there was no difference in efficiency of methane produced as related to type of animal waste used as substrate. The methane produced per energy fermented was positively correlated to protozoa counts ($r = 0.58$, $P < 0.03$) and negatively correlated to VFA production ($r = 0.70$, $P < 0.01$). Mixed cultures of rumen fluid especially from feedlot cattle, have potential to enhance animal waste remediation and methane generation for bio-fuel production.

**Key Words:** animal waste, bio-fuel production, methane