5 Infrared thermography temperature in the turkey (*Meleagris gallopavo*), correlated to feed intake but not to feed efficiency? O. W. Wilems*, S. P. Miller, and B. J. Wood1,2,1University of Guelph, Guelph, ON, Canada, 2Hybrid Turkeys, Kitchener, ON, Canada.

Due to the amount of time and effort required in measurement, often only a limited number of animals are assessed for individual feed efficiency traits, and this can lower the amount of genetic progress made. Measuring the surface temperatures of the unfeathered areas of turkeys has been proposed as a method to monitor the proportion of feed energy ingested and metabolized. Theoretically, a low temperature would mean a bird is utilizing feed more efficiently by partitioning a larger amount of energy in body weight gain then into heat production. The aim of this trial was to assess correlations between feed efficiency traits, such as body weight (BW), body weight gain (WG), feed intake (FI), residual feed intake (RFI) and residual body weight gain (RG) with infrared thermography (IR) traits, such as head area temperature (tHEAD), eye area temperature (tEYE) and distal metatarsus temperature (tDM). The trial assessed 175 toms for FI and BW over a 6-wk period, from 16 to 22 wk of age, with measurements taken each week. At the end of each week IR images were taken using an IR camera (ThermaCamTM SC2000). Turkeys had ad libitum access to feed and water. All traits were adjusted for the fixed effects of line and hatch according to the model: $Y_{ij} = \mu + line_i + hatch_j + e_{ij}$, using the GLM procedure of SAS. Traits were then compared using the CORR procedure in SAS. Correlations were low for both tHEAD and tEYE with all feed efficiency traits, however tDM showed low to moderate correlations between FI (0.04 to 0.34), BW (0.07 to 0.20), and WG (0.11 to 0.23). In the last 3 wk of the trial, tDM showed moderate correlations with RG (0.16 to 0.23) and these Pearson correlation coefficients are shown in Table 1.

Table 1. Pearson correlation coefficients between infrared thermography images of the distal metatarsus in the turkey (tDM1 to tDM5) and residual body weight gain (RG1 to RG5) over a 6-wk trial of 175 tom turkeys

<table>
<thead>
<tr>
<th>Trait</th>
<th>tDM1</th>
<th>tDM2</th>
<th>tDM3</th>
<th>tDM4</th>
<th>tDM5</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG1</td>
<td>-0.04</td>
<td>-0.13</td>
<td>-0.11</td>
<td>0.06</td>
<td>0.08</td>
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<tr>
<td>RG2</td>
<td>-0.05</td>
<td>0.08</td>
<td>0.01</td>
<td>0.05</td>
<td>-0.04</td>
</tr>
<tr>
<td>RG3</td>
<td>0.04</td>
<td>0.14</td>
<td>0.16</td>
<td>0.18</td>
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<tr>
<td>RG4</td>
<td>0.12</td>
<td>0.22</td>
<td>0.08</td>
<td>0.20</td>
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<tr>
<td>RG5</td>
<td>0.13</td>
<td>0.15</td>
<td>0.13</td>
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</table>

Key Words: turkey, feed efficiency, infrared thermography, residual body weight gain


Commercial unheated soybeans (SB) fed to turkeys results in reduced performance due to increased levels of trypsin inhibitors (TI) and anti-nutritive oligosaccharides (OLG). Non-GM SB have been selected for reduced TI and OLG. Additionally, a bedding material shortage has increased the need for alternatives such as miscanthus grass (MG). The objectives of the study were to evaluate 2 novel SB for their efficacy as a feedstuff for turkeys as well as the use of MG versus pine shavings (PS). Male LW poults (672) were raised in a curtain-sided floor-pen house with 14 birds per pen (64 ft²) from hatch to 19 wk. One of 4 dietary treatments (TRT) were randomly assigned to 48 pens: soybean meal (SBM), low TI unheated SB (LT), low TI and low OLG unheated SB (LO), and standard, untreated, and unheated SB (ST). The unheated whole SB (w/ hulls) and grains were roller milled to 700 microns. Birds were reared to 4 wk on a common crumbled diet. From 4 to 19 wk, birds were fed typical turkey rations with up to 40% milled unheated SB replacing SBM. TRT diets were iso-caloric, iso-nitrogenous, and fed as a coarse mash. The PS or MG bedding were randomly assigned to pens within dietary TRT. Feed intake (FI) and BW were measured at 6, 9, 12, 15, and 19 wk. Bedding type did not affect BW or FI. MG resulted in lower FCR at 6, 9, and 15 wk versus birds on PS (2.61 versus 2.67 ± 0.27 at 15 wk). Birds fed SBM had greater BW (19.1 ± 0.19 kg) as compared with other TRT. Birds fed LO and LT exhibited greater BW (16.7 and 16.3 ± 0.19, respectively) compared with ST (13.6 ± 0.19). The FI of birds fed LO, LT, and SBM were similar (50.0, 49.3, and 50.9 ± 0.72 kg, respectively), while ST depressed FI (43.15 ± 0.72 kg). Birds fed SBM had the best FCR (2.65 ± 0.03) followed by those fed LO, LT, and then ST (3.02, 3.01, and 3.19 ± 0.03, respectively). We conclude MG may be a viable bedding and that feeding low TI and OLG diets improve turkey performance as indicated by BW, FI and FCR when compared with commercial unheated SB.

Key Words: turkey, soybean, trypsin inhibitor, alternative litter, miscanthus grass

7 Cleaning and disinfection of broiler transport coops with peracetic acid and alkaline based cleaners. E. Fowlkes*1, D. Caldwell1, J. Byrd2, J. Lee1, C. Hinojosa-Garza1, M. Ross1, S. Iset1, R. Latham1, J. Garcia1, L. Froebel1, D. Caldwell2, and M. Farnell1, 1Texas A&M University, AgriLife Research and Extension, College Station, 2USDA-ARS, College Station, TX.

Broiler transport coops are rarely washed and may result in carcass contamination. Previous trials, conducted in our laboratory, have demonstrated that foam cleaners and disinfectants can significantly reduce bacteria when applied to a surface for the recommended 10 min contact time. We hypothesized that a commercially available disinfectant or cleaner applied through a compressed air foam system (CAFS) followed by high pressure water rinse may further reduce the microbial load if allowed an extended contact time of 30 min. Treatments consisted of (1) high pressure water rinse control, (2) product application with a 3-min low pressure water rinse and (3) product application followed by a 3-min high pressure water rinse. A foaming alkaline based cleaner (Trial 1) and a peracetic acid (PAA) with a foaming agent (Trial 2) were applied to freshly soiled coops. These products were applied via CAFS, allowed to soak for 30 min and washed with a low pressure water rinse to remove residual chemical or with a high pressure water rinse to remove organic matter. A 5 × 5 cm area of the coop floor was swabbed pre and post treatment using a flame sterilized stainless steel template and gauze pre-moistened with buffered peptone water. All samples collected were stomached, serially diluted, spread plated onto tryptic soy agar or Campy-Cefex agar, incubated and enumerated. In trial 1, the foaming alkaline based cleaner treatments resulted in no significant differences in the microbial load of the coop floors. However, significant reductions in aerobic bacteria (2.37 logs) and *Campylobacter* (3.23 logs) were observed with the PAA treatments in trial 2. These data indicate that the use of a compressed air foam system combined with PAA and a foaming agent may reduce aerobic bacteria and *Campylobacter* on the floors of broiler transport coops.
8 The effect of hydrogen peroxide and ultraviolet light egg sanitation treatment on embryo viability, hatchability and chick quality. N. L. Fuchs*, S. A. Winkler, G. S. Archer, and C. D. Coufal, Texas A&M University, College Station.

Previous studies have shown that a spray application of hydrogen peroxide (H2O2) followed by exposure to UV light (UV) is an effective method (H2O2/UV method) of eggshell sanitization. The purpose of this study was to determine whether the H2O2/UV method would affect embryo viability, hatch of fertile eggs or quality of hatched chicks. In Experiment 1, eggs were collected for 5 d from a White Leghorn flock. Only visibly clean eggs were selected for use, and each day half were treated with the H2O2/UV method using a prototype machine and half were not treated (control). After collection and treatment on d 1 through 4, eggs were placed into an egg cooler for storage until the fifth day of egg collection when all eggs were set in incubators. A total of 1,350 eggs were collected. Control eggs were divided among 3 incubators and the treated eggs were divided among 3 separate incubators. All eggs were briefly removed from the incubators on d 10 and candled. Eggs with no visible development were removed and broken out for classification. A brief second experiment was conducted to assess the impact of H2O2/UV egg sanitization during long-term storage before incubation. In Experiment 2, 720 broiler breeder eggs were collected from a commercial farm. On the day of collection, half of the eggs were treated with the H2O2/UV method and half were not treated (control). Eggs were then stored in an egg cooler for 18 d. Eggs were then divided among the 6 incubators (3 incubators per treatment) as in Experiment 1. On d 18 at the time of transfer to the hatchers, eggs were candled to remove nondiagonal eggs and broken out for classification. No statistical differences were observed for embryo mortality, hatch of fertile or chick quality parameters. However, the hatch of fertile for control and treated eggs in Experiment 1 was 89.6 and 92.8%, respectively. In Experiment 2, the hatch of fertile for control and treated eggs was 60.0 and 67.4%, respectively. The data from both experiments indicate that the H2O2/UV method does not negatively impact hatchability or chick quality.

Key Words: hydrogen peroxide, UV light, egg, incubation, hatchability


An evaluation of poultry farm water supplies was conducted to determine if a difference in microbial build up existed for waterlines from commercial broiler houses which sanitize or do not sanitize the water systems. Swab samples from waterlines were taken from each of these 4 types of barns from 4 different farms: (1) clean lines Between Flocks (BF) and Sanitize Water when Birds are Present (SWBP); (2) clean lines BF but do not SWBP; (3) do not clean lines BF but SWBP; and (4) do not clean lines BF and do not SWBP. All swab samples placed in 25 mL of sterile BPD were plated for aerobic plate count (apc) and for yeast and mold counts using 3M Petrifilm. From 4 commercial type 1 barns in a farm, 8 pre-flush and 8 post-flush swab samples (2 lines randomly selected out of 8 lines/barn) were pulled using standard swabbing techniques between flocks. A second set of 8 samples was taken (2 from each of the same 4 barns but different lines) with birds present at 43 d of age. This sampling procedure was repeated for 3 consecutive flocks for the same barns. Microbial results were analyzed using least squares means of GLM procedure of SAS. The between flocks ape for post flush (average log10 - 1.20) were significantly lower ($P < 0.05$) than pre flush counts (average log10 - 4.09) for all 3 flocks for all barns. Day 43 apc counts (average log10 - 4.14) were significantly higher ($P < 0.05$) as compared with initial post-flush counts for all 3 flocks for all barns signifying build-up of biofilms regardless of water treatment. General comparisons for microbial results with type 1 barns to other barn types were made for the samples taken while birds were present (d 43 samples) and found to be not significantly different ($P > 0.05$) except for type 4 which was significantly higher ($P < 0.05$). This evaluation indicates that in spite of line cleaning between flocks and water sanitation with birds present, biofilms can still develop over a 6-wk period. These results suggest that line cleaning be done between flocks to minimize microbial shedding in water systems for the next flock of chicks.

Key Words: microbe, waterline, sanitation, biofilm, chick

10 Influence of total sulfur amino acid levels in broiler starter diets on early performance following coccidiosis vaccination. R. Latham*, J. Lee, K. Perry, S. Iseit, and D. Caldwell, Texas A&M University, College Station.

The objective of the current trials was to investigate varying starter diet calculated total sulfur amino acid levels on non-vaccinated or vaccinated broiler performance through 18 d of rearing. Vaccination during Trial 1 was by a commercial spray cabinet while Trial 2 involved vaccination by oral gavage. The experimental design was a 5 × 2 factorial with 5 diets varying in TSAA level (0.75, 0.85, 0.95, 1.00, or 1.05%) fed to either non-vaccinated or coccidiosis vaccinated broilers. On day of hatch, male Cobb 500 broiler chicks were obtained from a commercial hatchery and randomly placed for rearing in electrically heated brooder batteries. Average body weights (BW) and feed conversion ratio (FCR) were determined on d 6, 13 (d 12 in Trial 2), or 18 of each trial. During Trial 1, observed BW measurements on d 6, 13, and 18 suggest no added benefit ($P < 0.05$) of feeding a TSAA level greater than 0.95% in non-vaccinated broilers. Observed BW of vaccinated broilers on d 6 and 13 indicated feeding a TSAA concentration of 1.05% was necessary ($P < 0.05$) to achieve BW similar to non-vaccinated broilers. An interaction between TSAA level and vaccination on FCR in Trial 1 was not observed. During Trial 2, an interaction between TSAA level and vaccination on BW or FCR on d 6 or 18 was not observed. BW measurements on d 12 of Trial 2 revealed a trend of increased BW ($P < 0.05$) associated with increasing TSAA level in both vaccinated and non-vaccinated broilers. Also on d 12 of Trial 2, FCR improvements ($P < 0.05$) were observed at all TSAA levels above 0.75%, regardless of vaccination status. Future studies should focus on evaluating these parameters when starter diets are fed for industry-similar durations shorter than 18 d. These data suggest broiler performance during coccidiosis vaccination may be linked to TSAA level in the starter phase of grow-out.

Key Words: TSAA, coccidiosis vaccination, broiler performance

11 DNA barcoding, phylogenetic and morphometric analysis of Eimeria spp. infecting turkeys. M. E. Ogendede*1, S. El-Sherry1,3, M. A. Hafeez1, H. D. Chapman2, and J. R. Barta1, 3University of Guelph, Guelph, ON, Canada, 2University of Arkansas, Fayetteville, 3Assiut University, Assiut, Egypt.

Coccidiosis in turkeys is caused by enteric coccidia species belonging to genus Eimeria (including E. meleagrimitis, E. dispersa, E. gallopavonis and E. adenoideides). Current identification methods, based mainly on morphometric and biological characteristics, are insufficient to reliably differentiate among species. Although nuclear 18S rDNA sequences have

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been used widely for phylogenetic reconstructions and species characterization, this gene has limitations as a molecular marker for species differentiation in the case of closely related coccidia. To address this, new nuclear 18S rDNA and mitochondrial COI sequences were obtained from single oocyst-derived lines from Eimeria spp. isolates (E. adenoeides KCH, E. adenoeides USA; E. adenoeides Weybridge, E. meleagridis Arkansas, E. dispersa and E. meleagrimitis USMN08–01. Phylogenetic analysis of multiple 18S rDNA sequences obtained from single oocyst-derived lines of E. meleagrimitis show that divergent, paralogous 18S rDNA copies exist within the nuclear genome of this parasite: Type A with 4 new sequences; and Type B with 9 new sequences. Both Type A and Type B sequences were obtained from each of the single oocyst derived lines of E. meleagrimitis. In contrast, COI sequences of E. meleagrimitis and E. adenoeides were identical among lines from the same species and COI sequences from individual Eimeria species were easily distinguished from other Eimeria species infecting the same host with lower intraspecific genetic distances compared with 18S rDNA sequences. The COI locus is apparently free of divergent copies that were demonstrated for the nuclear rDNA loci. These observations confirm the utility of the mitochondrial COI locus as a species-level genetic marker for Eimeria spp. infecting turkeys. Histological and morphometric details obtained via experimental infections in vivo support these phylogenetic conclusions. We encourage COI-based DNA barcoding of coccidia as part of the species description or re-descriptions of any new, or newly isolated, species of Eimeria or related parasites.

**Key Words:** 18S rDNA, mt COI gene, coccidiosis, molecular taxonomy, parasitology

12 Live Eimeria vaccine success from the hatchery to the barn and the role of environmental management. K. R. Price*, 1, J. Bullon1, M. T. Guerin1, L. Newman2, B. M. Hargis3, S. Leeson1, and J. R. Barto1, 1University of Guelph, Guelph, ON, Canada, 2Merck Animal Health, Summit, NJ, 3University of Arkansas, Fayetteville.

Live Eimeria vaccination is gaining acceptance in poultry production as this method stimulates immunity from the first dose of vaccine oocysts and is enhanced through fecal-oral transmission (“cycling”). Commonly, day old chicks are inoculated with a spray that, like any indirect application method, may lead to non-uniform oocyst ingestion. Insufficient cycling following vaccination may only allow for limited immunity to develop and chickens risk coccidiosis when challenged. Environmental management becomes critical for vaccine success. Uniformity of initial vaccine uptake and the level of protection from challenge infections with modifications to the cage environment were tested. Variation in spray vaccine uptake was assessed by counting oocysts shed at 6 d post inoculation. Oocyst shedding ranged from 0 to > 100,000 oocysts per gram of feces. An additional experiment indicated that low relative humidity (<25%) during the initial vaccination period had a negative impact on vaccine success. In a secondary trial, birds were separated into 4 groups and reared on 3 different cage floor modifications to examine protection against challenge infection. Treatment groups were: oral-gavage “vaccinated” (E. acervulina, E. brunetti and E. tenella); fecal-oral transmission, “contact-vaccinated”; and controls. Cage floor modifications were: 0% cage floor coverage (CFC); 40% CFC with thick paper; and 40% CFC with fiber trays. In general, vaccinated and contact-vaccinated birds reared on 40% CFC with paper or trays during the treatment phase had significantly higher body weight gains than challenged controls during challenge infection with E. acervulina at 3 weeks of age. However, no significant difference was noted for birds reared on 0% CFC. Birds challenged with homologous E. brunetti or E. tenella did not follow this trend, which may have been due to a decrease in relative humidity during the initial oocyst sporulation stage in the barn. Complete live Eimeria vaccine success requires environmental management to moderate fecal-oral transmission of vaccine parasites.

**Key Words:** coccidiosis, disease control, immunization, poultry environment, parasitology

13 Impact of skip-a-day and every-day feeding programs on the colonization of Salmonella Typhimurium in broiler breeder pullets. K. M. Wilson*1,2, B. L. McLendon1, D. V. Bourassa1, E. R. Montiel1, J. L. Wilson2, N. A. Cox1, and R. J. Buhr1, 1USDA-ARS, Athens, GA, 2University of Georgia, Athens, 3Merial Select Inc., Gainesville, GA

Feed restriction during pullet rearing is required to maintain flock uniformity, limit body weight gain, and optimize broiler breeder reproductive fitness. The impact of restrictive feeding programs on Salmonella colonization after environmental challenge was investigated in broiler breeder pullets in an experimental rearing facility at the University of Georgia. Pullets (135 chicks/pen) were placed on litter into the 3 feeding program rooms, each room containing duplicate pens. The feeding programs were as follows: 1) Skip-a-day in trough feeders (SAD); 2) Every-day in trough feeders (EDT); 3) Every-day on the litter (EDL). On d 1, an additional group of hatchmate chicks were gavaged with 4 × 10⁸ cells of a nalidixic acid-resistant Salmonella Typhimurium. The ceca from these seeder chicks (n = 10/wk) were sampled at 4 and 5 wk to determine Salmonella colonization. All were positive, and at 5 wk, 5 Salmonella-seeder pullets were commingled into each pen. At 7 and 11 wk, stepped-on drag swab sampling of the litter was conducted and confirmed persistence of Salmonella. At 8 and 12 wk, ceca were sampled from 10 pullet penmates/pen and 2 composite spleen samples (5 spleens per composite) were collected/pen before feeding. At 12 wk, cloacal swabs were also taken from all pullets sampled and an additional day of collection occurred for SAD (off feed day). Salmonella prevalence for ceca from SAD pullets was significantly (P < 0.05) higher at both 8 wk (70% combined direct and enriched culture) and at 12 wk (40% positive) for both on and off feed sample days. EDT fed pullets had 40% Salmonella-positive ceca at 8 wk and only 5% at 12 wk. EDL fed pullets had 30% Salmonella-positive ceca at 8 wk and 5% at 12 wk. Spleens were positive in all treatments at 8 wk, only SAD at 12 wk, and the cloacal swabs only 2/80 (2.5%) were Salmonella-positive and neither appeared associated with ceca results. These results suggest that feeding broiler breeder pullets SAD may contribute to a persistently higher Salmonella ceca colonization after environmental challenge.

**Key Words:** restrictive feeding, broiler breeder pullet, Salmonella Typhimurium, colonization

14 Gut bacterial ecology of developing Pekin ducks. A. L. Porter*, 1, S. Colton1, C. Campbell1, E. Gerometta1, R. Haas1, A. Lindberg1, S. Gallemore1, G. S. Fraley1, A. A. Best1, and S. M. Fraley2, 1Hope College, Holland, MI, 2South Crossing Veterinary Center, Kentwood, MI

Riemerella anatipestifer (RA) is a bacterial pathogen causing septicemia in Pekin ducks. This disease generates substantial economic losses for poultry duck producers in the food industry. Little is known about the pathogenesis or the source of this pathogen in ducks. To determine if RA is a natural part of the gut ecology within ducks, we collected the contents of the paired ceca in ducks over a 6-wk period, isolated the total bacterial DNA from the samples, and analyzed for the presence of RA, E. coli, and Salmonella using PCR. Data shows the absence of RA
in samples in the ceca of ducks from hatch to market weight. Given the lack of current knowledge regarding the gut ecology of Pekin ducks we submitted the isolated bacterial DNA for total community ecological analyses, using next generation sequencing technology to sequence bacterial 16S rRNA taxonomic markers. Initial analyses revealed as many as approximately 36,000 unique bacterial taxa present in the gut of developing Pekin ducks. Interestingly, we observed a complete shift in gut bacterial taxonomic composition around d 8 post-hatch. This time frame may correlate with observations that maternally derived passive immunity is also lost at about d 8 of age. Thus maternal antibodies may contribute to the gut ecology of Pekin ducks.

Key Words: cecum, gut health, yolk sac

15 The effects of different wavelengths of light on development and behavior of grow-out Pekin ducks. C. L. Campbell*1, S. Colton1, M. Rice1, M. Turk1, S. M. Fraley2, and G. S. Fraley1, 1Hope College, Holland, MI, 2South Crossing Veterinary Center, Kentwood, MI, 3CMT Dux Consulting, Leesburg, IN.

Research has shown that red light conditions improve growth and decrease aggressive behaviors in chickens and turkeys, although more recent study suggests that blue-green light may improve production of broilers. However, to date no research has been conducted to examine whether different wavelengths of light have an impact on production in the Pekin duck. To determine this, we raised Pekin ducks under aviary conditions that were similar to standard commercial barns. The ducks (final n ~160 ducks/pen) were housed under 3 conditions: red light, blue light, and white light. Light sources in each pen were standardized to produce peak (approximately 780nm), blue light (approximately 450nm) and white light. Ducks housed under blue light began panting, they were much less inquisitive than other ducks, they took longer to exhibit normal social behavior once evaluation was completed, and they frequently “swarmed” without apparent stimulation. Ducks under blue lights also showed significantly ($P < 0.05$) elevated corticosterone, but reduced growth hormone levels. There were no differences in any measurements between the red and white lighted pens. These data suggest that unlike the chicken, blue lights may be inappropriate for raising Pekin ducks in a commercial setting.

Key Words: corticosterone, growth hormone, behavior, stress

16 Growth performance of fast growing broilers reared under different types of pasture management: Implications for organic and alternative production systems. H. R. Arambel*1, J. R. Moyle2, A. N. Woo-Ming1, K. Arsi1, P. J. Blore1, F. D. Clark1, D. J. Donoghue1, and A. M. Donoghue2, 1University of Arkansas, Fayetteville, 2USDA-ARS, Fayetteville, AR.

Outdoor access is a critical component of organic poultry production and currently there is a demand to provide organic poultry producers with information concerning housing options, especially as the National Organic Program is considering the need for increased outdoor access. The purpose of this study was to evaluate different housing systems and their environmental influence on growth parameters, leg strength and pathogen colonization of Salmonella. This study used fast-growing broilers to simulate the current trend of switching from slower growing broilers to modern broilers, ultimately reducing feed and labor costs. The pasture used in the study contained a mixture of forages to mimic the conditions commonly used for pasture poultry farms in our area. Four treatment groups were used: 1) a fixed house without pasture access (control), 2) a fixed house with pasture access, 3) hoop houses without pasture access (environmental control), and 4) hoop houses with pasture access. To determine potential seasonal effects of pasture consumption on production parameters, this study was repeated in the spring, summer and fall. Our results found that birds moved to hoop houses had reduced growth rates compared with birds that remained in the fixed houses. In addition, the pasture access did not significantly alter growth rate or feed conversion compared with birds that did not have pasture access; leg strength (determined by bone breaking strength) was also unaffected by varying housing management. Salmonella was not detected in any of the treatment groups. This study provides information for organic producers to consider when developing a production program, specifically focusing on housing options. Funded in part by the USDA-NIFA-OREI 2011-01955.

Key Words: free range, broiler, management, organic, housing