Biosecurity programs have long been known to be effective at preventing disease outbreaks in the poultry production system. However, these programs are only effective if they are properly adopted and adequately followed. Evaluation of the biosecurity practices on individual farms is needed to determine if such practices are followed and to what extent. Broiler growers for an integrator in Alabama were selected for review of their biosecurity program. This was accomplished by sending out a survey to 120 individual farms to evaluate their biosecurity practices. An example of some of the questions asked of the growers included those regarding their insect and/or rodent control programs, farm visitor practices, house or farm entry logs, age of housing and equipment, house management practices, house set-up procedure, the use of foot baths, shoe covers and hand washing. Thirty-two responses to the survey were received (27%). Analysis of the surveys indicated that over 90% of farms had a rodent control program, 100% used foot baths, and 78% had an insect control program, and 78% limited visitors to the farms. However, less than 10% of farms had a farm entry/exit log, house entry log, or had visitors change clothing before facility entrance. Soap and water or hand sanitizer was reported by 16% of the respondents to be available at each house. The results of this survey indicate that while many farms have good biosecurity practices, improvement and standardization of such practices is needed to provide adequate protection to their poultry farm as well as their neighbor’s farm.

Key Words: biosecurity, management, survey, broiler


The precision of an experiment can be measured by the coefficient of variation (CV). Low CV values indicate that the variation sources were controlled, whereas high CV values indicate low experimental control. To establish the CV ranges for laying hen performance 111 scientific papers, published in Brazilian poultry and animal science journals, that presented CV values were evaluated. The ranges were defined according to the model proposed by Costa et al. (2002), which considers low: CV ≤ (Md – PS), medium: (Md – PS) (Md + 2PS), where Md = median of the CV values, Q1 and Q3 are the first and third quartiles, and PS = IQR/1.35 is the pseudo-sigma being IQR, interquartile range (IQR = Q3 − Q1). The descriptive statistics for feed conversion, feed consumption, egg production, egg weight and egg mass CV are presented in the top part of Table 1. The CV classification ranges of the productive parameters are presented in the bottom part of Table 1. Each parameter has its own expected range of CV. Experiments that present CV values higher than 6.79, 5.65, 6.36, 3.22, and 6.87 for feed conversion, feed consumption, egg production, egg weight, and egg mass, respectively, might have uncontrolled sources of variation.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>N</th>
<th>Mean</th>
<th>Med</th>
<th>Min</th>
<th>Max</th>
<th>SD</th>
<th>PS</th>
<th>Norm</th>
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</thead>
<tbody>
<tr>
<td>Feed convers</td>
<td>27</td>
<td>5.44</td>
<td>4.35</td>
<td>0.02</td>
<td>22.10</td>
<td>4.46</td>
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<td>3.69</td>
<td>0.23</td>
<td>11.12</td>
<td>2.11</td>
<td>1.96</td>
<td>0.0948</td>
</tr>
<tr>
<td>Egg prod</td>
<td>36</td>
<td>4.47</td>
<td>4.05</td>
<td>0.90</td>
<td>14.77</td>
<td>2.74</td>
<td>2.31</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Egg wt</td>
<td>33</td>
<td>2.88</td>
<td>2.55</td>
<td>1.06</td>
<td>12.17</td>
<td>1.90</td>
<td>0.67</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>Egg mass</td>
<td>31</td>
<td>5.15</td>
<td>4.76</td>
<td>0.65</td>
<td>16.14</td>
<td>3.03</td>
<td>2.11</td>
<td>&lt;0.005</td>
</tr>
</tbody>
</table>

Key Words: coefficient of variation, laying hen, precision
increasing egg storage. Storage in room temperature resulted in higher negative effect on egg quality compared with cold storage.

**Key Words:** egg storage, naked neck, temperature, egg component, blastoderm

4 The impact of day length on turkey health and welfare. C. Vermette*, K. Schwean-Lardner, S. Gomis, T. G. Crowe, and H. L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

The impact of graded levels of day length on turkey health and welfare was determined in hens and toms raised to 12 wk of age. Birds were allocated to 1 of 4 lighting treatments (trt) providing 14 (1L), 17 (1L7), 20 (2L), and 23 (2L7) h of day length. Two experiments were completed with each providing 2 rooms per lighting trt and each room having 3 hen and 3 tom pens. Data collection included bird mobility, the incidence of foot pad dermatitis (FPD), and breast blisters and breast buttons, ocular size and intraocular pressure. Data were analyzed using SAS 9.3 based on a randomized complete block split-plot design with experiments blocked, lighting treatment as a main plot factor, and sex as a subplot factor. Regression analysis established relationships between response criteria and day length. Differences were considered significant when $P \leq 0.05$. Mobility, FPD, and the incidence of breast blisters and buttons were assessed on 5 birds per pen at 11 wk of age. A gait scoring (GS) technique was used for judging mobility, where 0 represents no abnormality and 5 total loss of mobility. Birds in higher GS categories (2, 3, and 4) and average GS increased linearly with day length. Both hens and toms showed the same increase, but the effect was larger in toms. Footpad dermatitis was assessed using a 5-point subjective scoring technique (0 = no external lesions; 4 = >50% of footpad covered in necrotic tissue). Day length did not affect FPD, but more lesions and more severe scores were found for hens. The presence of breast blisters and buttons increased linearly with day length with the effect on blisters predominately seen in toms. Eye weight increased and corneal diameter decreased linearly with increasing day length (12 wk). Dorso-ventral and media-lateral diameter and anterior to posterior size exhibited a quadratic relationship, with the highest values seen for the 23L trt. Intraocular pressure (9 and 12 wk) was not affected by day length or sex. To conclude, darkness is beneficial for turkey health and welfare.

**Key Words:** photoperiod, gait score, breast blisters, footpad, eye

5 Meat quality characteristics in turkeys of two strains differing in open field behavior. M. A. Erasmus*, H. C. Lee, I. Kang, and J. C. Swanson, Michigan State University, East Lansing, MI.

Meat quality control remains important in the turkey industry due to the occurrence of pale, soft, exudative (PSE) meat, but associations between turkey temperament and meat quality have not been examined. The objectives of this research were to (1) examine differences in meat quality characteristics (pH, R-value, and L*, a* and b* color values) between commercial (COMM) and randombred (RB) turkey strains, and (2) examine the relationship between meat quality and behavioral/physiological responses in an open field (OF) test, which is frequently used to assess fear in poultry. Male COMM and RB turkeys were each housed in groups of 16 in 4 pens. Turkeys were individually tested in an OF (2.74 $\times$ 2.74 m, divided into 81 squares) at 11 wk, and birds were classified as high responders (HR) or low responders (LR) based on OF behavior. Plasma corticosterone levels were assessed in a subsample of birds (n = 20/strain) before and after OF testing. Turkeys were processed and meat quality characteristics were evaluated in 10 to 11 birds per pen (n = 44/strain) at 15 to 17 wk for COMM and 20 to 21 wk for RB turkeys. Results were analyzed using a mixed model (SAS 9.2). Log-transformed lsmean (±SE) pre-test (COMM: 1.01 ± 0.14; RB: 1.42 ± 0.14 ng/mL; P = 0.049) but not post-test (COMM: 2.22 ± 0.13; RB: 2.48 ± 0.13 ng/mL; P = 0.17) corticosterone levels differed between strains. Corticosterone levels did not differ between HR and LR birds of either strain. The R-value tended to be lower for COMM (1.18 ± 0.02) compared with RB turkeys (1.24 ± 0.02, P = 0.061), but pH, L*, and a* values did not differ between the strains. However, log-transformed b* values were higher for COMM (2.12 ± 0.06) than RB (1.96 ± 0.06, P = 0.011) turkeys. No differences in any meat quality characteristics were found between HR and LR birds. Results indicate that COMM and RB turkeys respond physiologically similar to OF testing and differ in some meat quality color characteristics, but within strains, individual differences in OF responses are not associated with differences in meat quality.

**Key Words:** turkey, meat quality, fearfulness, open field test

6 Effect of feeding program during rearing on body weight, egg production, and hatchability of broiler breeder females. Y. M. Lin* and J. Brake, Prestige Department of Poultry Science, North Carolina State University, Raleigh, NC.

Four female breeder feed allocation programs were compared during the starter (17.5% CP, 2.9 kcal/g, 0–6 wk) and grower (14.5% CP, 2.85 kcal/g, 7–21 wk) phases. The 4 female breeder feeding programs were termed high-high (HH), high-low (HL), low-high (LH), and low-low (LL) with feed/pullet/d at 6, 15, and 21 wk being (HH) 52–70–94, (HL) 52–64–94, (LH) 47.5–70–94, and (LL) 47.5–64–94, respectively. The cumulative feed to photostimulation was (HH) 9,128 g, (HL) 8,808 g, (LL) 8,943 g, and (LL) 8,616 g. The females were fed similarly thereafter. Hatchability and fertility was determined weekly from 28 to 63 wk of age. Egg production was recorded daily from 24 to 64 wk of age. There were no effects of the different feeding programs on feed conversion, hen-housed or hen-day egg production, and female mortality. With regards to hatchability and fertility, there were no differences from 25 to 35 wk of age. However, from 36 to 45 wk of age, the LH feeding program had greater hatchability (94.1%) than HL (92.1%) and LL (92.3%) feeding programs with HH (93.1%) intermediate (P = 0.048). From 46 to 55 wk the HH feeding program exhibited greater early deaths (4.4%) than LH (3.6%) and LL (3.4%) feeding programs with HL (3.8%) intermediate (P = 0.017). From 56 to 64 wk, the LH and LL feeding programs exhibited greater fertility (P = 0.051) and hatchability (P = 0.103) than the HH feeding program, with HL being intermediate. Overall, the LH feeding program exhibited the best fertility (94.9%) and hatchability (89.3%), whereas the HH feeding program produced the poorest results (fertility 90.5%; hatchability 84.7%).

**Key Words:** broiler breeder, feeding program, hatchability, fertility


*Miscanthus* is a genus of perennial grass that can be used as a bedding material in broiler houses. This study was designed to measure the effect of Miscanthus on broiler performance and paw scores, and evaluate its suitability as a poultry bedding material. Parameters measured during this first flock of the study include live performance, litter moisture, gait score, and paw pad scores. Day-old males from the Cobb 500 female line were allocated to 48 pens (25 chicks/pen; 24 pens/Trt) at 0.88 ft²/pen,

Poul. Sci. 93(E-Suppl. 1)
bird, and grown to 42 d. Two different bedding materials comprised the 2 treatments. Control consisted of new pine shavings, whereas treatment 2 consisted of new, dried Miscanthus cut into 1-inch pieces. Live weights, feed conversion, and livability were evaluated at 14, 30, and 42 d. Paw scores and litter moisture were measured at 12, 28, and 41 d. Gait score was measured at 41 d. No significance existed in live performance ($P \leq 0.05$) for d 14 or 30. Initial litter moisture was 8.6% for pine and 14.75% for Miscanthus, and was not significantly different at d 12 ($P \leq 0.05$). Paw scores were significantly different between the 2 treatments ($P \leq 0.05$) at d 12 and 28. Paw scores on d 12 and 28 from Miscanthus pens were significantly higher than pens using pine shavings ($P \leq 0.05$). Day 12 mean paw score for pine was 0.0034, whereas mean paw score for Miscanthus was 0.1739. Day 28 mean paw score for pine was 0.5345, compared with a mean paw score of 0.7577 for Miscanthus. Although paw scores remain significantly different ($P \leq 0.05$) from d 12 to 28, the pine shaving paw scores increased at a faster rate than the Miscanthus paw scores, and both treatments had low incidence of paw pad lesions. These results suggest Miscanthus may present slightly more challenges to paw pad integrity than pine shavings. However, the results also indicate that Miscanthus shows promise as a suitable bedding material in the poultry industry.

**Key Words:** Miscanthus, bedding, paw score, broiler


The objective of this study was to model nutrient intake patterns and growth performance of different types of chickens when given a self-selection feeding program. Birds used were 3 meat-type birds (Cornish Cross males, Cornish Cross females, Red Ranger males) and males of 3 heritage breeds (Rhode Island Red, Barred Plymouth Rock, and Black Australorp). For each type of bird, 3 replicate groups of 25 chicks, 1 d of age, were randomly assigned to floor pens at 929 cm$^2$ per bird. All chicks received a complete diet for the first 14 d, and then were given a cafeteria-style self-selection feeding program consisting of 4 feed choices provided on ad libitum basis. Feed choices included a protein concentrate (39% CP) without added methionine and 3 grains (cracked corn, naked oats, and pearl millet) that were similar in energy content, but differed in protein content. Feeds were randomly allocated to 4 identical feeders within each pen. Two to 3 times per week, consumption for each feeder was recorded and the feeder locations were rotated. Body weight was recorded weekly. Linear and nonlinear models were constructed to describe the growth and nutrient intake patterns for each type of bird from 3 wk of age to processing at a BW of 2,300 g. All of the linear models for growth vs. time provided a good fit to the data ($R^2 = 0.98-0.99$). Models for the meat-type birds had significantly steeper slopes than those for the heritage breeds ($P \leq 0.01$). At any given age, the meat-type birds were heavier than the heritage breeds ($P \leq 0.01$). Intake of feed, kcal of ME, CP, and methionine all showed linear relationships to BW for meat-type birds ($R^2 = 0.78-0.95$) and a quadratic ($P \leq 0.01$) relationship to BW for the heritage breeds ($R^2 = 0.96$). At any given BW, the meat-type birds consumed more energy, CP, and Met than the heritage breeds ($P \leq 0.01$). At any given feed intake, the meat-type birds consumed less energy, more CP, and more methionine than the heritage breeds ($P \leq 0.01$). Based on self-selection, the growth and nutrient intake patterns varied among the different types of chickens and should be considered when rearing these heritage breeds.

**Key Words:** self-selection, heritage breed, modeling


Rearing broilers on flat or sloping wire flooring is an effective method for consistently triggering lameness attributable to bacterial chondronecrosis with osteomyelitis (BCO). Portable obstacles known as “speed bumps” (SB) also consistently trigger modest incidences of BCO when they are installed between feed and water lines in litter flooring facilities. Two experiments (E1, E2) were conducted to determine the most effective broiler age for introducing SB into litter flooring pens, and to evaluate alternative configurations of the traditional SB with the expectation that amplified mechanical challenges to the legs of broilers should increase the incidence of BCO. Broiler chicks obtained from commercial hatcheries (lines B and D in E1, lines A and B in E2) were reared in floor pens with ad libitum feed and water and a 23L:1D photoperiod. In E1, the 5 floor treatments included wood shavings litter only (L), flat wire only (W), or litter plus SB installed at 14, 28, or 42 d of age (SB14, SB28, SB42). Line B was more susceptible to lameness than Line D (25.9% vs. 15.3% for all treatments combined; $P = 0.001$). Both lines developed low incidences of lameness on L (11 to 13%), intermediate incidences on SB regardless of day of installation (12 to 23%), and high incidences on W (21 to 39%). In E2, broilers were reared with 7 floor treatments: L, W, SB with a 50% slope (SB50%), SB50% with a limbo bar installed over the apex (SBL50%), a SB with a 66% slope and limbo bar (SBL66%), SB50% with a nipple water line suspended over the apex (SBW50%), and a pagoda-top SB (PT). All SB were inserted on d 28. Line B was more susceptible to lameness than Line A (20.2% vs. 16.1% for all treatments combined; $P \leq 0.05$), and for both lines combined, the lameness percentages averaged 7.7% ($L$), 29.2% ($W$), 17.3% (SB50%), 16.2% (SBL50%), 21.5% (SBL66%), 20.8% (SBW50%), and 11.5% (PT). These studies demonstrate that portable SB can be effectively used to experimentally trigger BCO in broilers.

**Key Words:** broiler, lameness, BCO, wire floor model, speed bumps

10 Simple environmental modification to cage-reared pullets greatly improves efficacy of live coccidiosis vaccines and overcomes nonuniform vaccine administration. K. R. Price*, M. A. Hafeez2, M. T. Guerin3, and J. R. Barta1, 1Department of Pathobiology, University of Guelph, Guelph, ON, Canada, 2Department of Population Medicine, University of Guelph, Guelph, ON, Canada.

Coccidiosis caused by Eimeria species is as an emerging issue of layers housed in conventional cages. Outbreaks often occur following transfer to the production barn. Live Eimeria vaccines administered to day old chicks can be used immunize the birds and prevent outbreaks. Immunity is initiated by ingestion of a small dose of vaccine oocysts and enhanced by fecal-oral transmission of vaccine progeny oocysts in the barn (“cycling”). Two factors are needed for the live vaccine to reach its full protective potential: (1) uniform administration, and (2) environmental control in the barn. Typically, chicks are vaccinated in a spray cabinet at the hatchery with a colored spray to encourage oocyst ingestion. However, studies have found that this system does not allow for complete uniform ingestion. Our preliminary study showed that when uniformly vaccinated (via oral gavage) pullets reared with 40% cage floor coverage (CFC) with hatchery paper from 0 to 5 wk of age and then challenged with mixed Eimeria species, these birds had better protection as measured by body weight, oocyst output, and lesion scores than birds reared with 0% CFC. We subsequently tested whether nonuniform vaccine administration in combination with 40% CFC could...
Poult. Sci. 93(E-Suppl. 1)

11 Comparison of male and female broiler breeder mating behaviors across four different breed strains in a commercial setting. E. K. Lhamon* and R. K. Bramwell, University of Arkansas, Fayetteville, AR.

The objective of this study was comparing differences in mating and courtship behaviors exhibited by 4 different breed strains of broiler breeder males and females in a commercial setting. The breed strains evaluated were Hubbard M-99 and Cobb MX males and Ross 708 and Cobb 500 females. Behaviors observed were male-hen aggression, male-male aggression, hen-hen aggression, male waltz, male wing flap, male neck flare, hen crouch, attempted hen mounts, hens mounted, attempted matings, and completed matings. These behavioral characteristics exemplify natural mating behavior and can be observed in naturally mated breeder flocks. For this study, cameras were set up in commercial broiler breeder houses to record activity for 4-h periods in 2 separate houses during mid-afternoon. Four observations were from a Hubbard M-99 and Ross 708 cross and 3 samples were from a Cobb MX and a Cobb 500 cross. All commercial flocks were managed by the same integrator of similar age near 50 wk old. The resulting videos were analyzed and behavioral characteristics were tabulated. Each category was further separated into instances per hour and significance was held at $P < 0.05$. A significant difference was found regarding male-hen aggression ($P < 0.0072$), hen-hen aggression ($P < 0.0275$), and overall aggressive behavior ($P < 0.0146$). However, no significant difference was determined in any of the other categories. We conclude, therefore, that aggressiveness, rather than courtship and mating behavior, is significantly different in these 2 strain pairings. From a behavioral perspective, general courtship behavior in commercial breed strains is not as prevalent as in wild populations of birds. However, they do exhibit different levels of courtship, which appears to be strain dependent. More studies will need to be conducted with more breed strains and different crosses to evaluate interactions between male and female breed strain crosses.

Key Words: mating behavior, breeder

Enhance protection against challenge. Individually identified chicks ($n = 1,232$) were randomly selected to receive an oral gavage of live vaccine or saline (“contact-vaccinated”), then commingled and reared from 0 to 5 wk of age with 0 or 40% CFC. At 5 wk, pullets were challenged with mixed Eimeria species and assessed after 5 d. Preliminary results showed that pullets reared with 40% CFC, regardless of vaccination status, had significantly lower mean oocyst output and intestinal lesion scores and higher body weight gains than pullets reared with 0% CFC. Environmental control in the barn, especially covering 40% of the cage floor with hatchery paper, will enhance live vaccine success in the face of nonuniform vaccine administration.

Key Words: Eimeria, transmission dynamics, spray vaccine, cage rearing