

21 Organization of a NAFSS-ARS cooperative research project to quantify *Listeria monocytogenes* in ready-to-eat meats and poultry products. O. A. Oyarzabal^{*1}, A. Draughon², E. T. Ryser³, D. Cliver⁴, M. Hajmeer⁴, P. Pangloli², and R. Roy¹, ¹Auburn University, Auburn, Alabama, ²University of Tennessee, Knoxville, ³Michigan State University, East Lansing, ⁴University of California, Davis.

The objective of this cooperative research project is to quantify *Listeria monocytogenes* in ready-to-eat (RTE) uncured and cured poultry, pork and beef products that have been pre-sliced by the manufacturer or sliced upon demand in supermarket delis. This data will expand on a previous study sponsored by the Food Products Association (formerly National Food Processors Association; Gombas et al., 2003, J. Food Prot., 66:559) which compared the risk of listeriosis to consumers from RTE products sliced at retail stores versus the risk from products sliced and packaged by the manufacturer. This is an ongoing

study in which four states participating in the Foodborne Diseases Active Surveillance Network of the Centers for Disease Controls and Prevention Emerging Infections Program have been selected as collection sites: California Bay Area, Georgia, Minnesota and Tennessee. Samples are collected weekly from randomly selected counties and processed within 36 hours of collection. Samples positive for *L. monocytogenes* are quantitatively assessed using a standard 3-tube MPN. Data from this study will be used to estimate actual consumer exposure to *L. monocytogenes* from the sampled RTE products, and to conduct additional *L. monocytogenes* risk assessments. The importance of cooperation between industry, academia and the Food Safety and Inspection Services of the US Department of Agriculture in performing this kind of research will also be discussed.

Key Words: *Listeria monocytogenes*, Ready-to-eat, Poultry

Environment and Management: Broiler Breeders

22 Phosphorus nutrition in broiler breeder pullets and hens. M. S. Lilburn^{*1}, A. Mitchell², and E. E. M. Pierson³, ¹Ohio State University, Wooster, ²Growth Biology Lab, USDA, Beltsville, Maryland, ³Danisco Animal Nutrition, St. Louis, Missouri.

Two experiments were conducted with growing broiler breeder pullets (Experiment 1) and growing pullets and adult breeder hens (Experiment 2). In Experiment 1, pullets were fed growing diets with either 0.8 or 1.0% calcium and either 0.2, 0.3, or 0.4 % available phosphorus (all diets contained between 0.5-0.6% analyzed total phosphorus).

At 8 weeks of age, 8 pullets from each combination of Ca and AvP were placed in individual cages within Petersime growing batteries. Each pullet was fed 86 gm on alternate days (EOD) and total excreta was collected for 48 h. This was repeated twice. There were no significant effects of dietary Ca on P excretion. There was a linear increase in mean total excreta P with each increase in AvP (231 mg P, 0.2 AvP; 305 mg P, 0.3 AvP; 377 mg P, 0.4 AvP). In Experiment 2, pullets were fed diets containing 0.15, 0.25, or 0.35% AvP with and without supplemental phytase (PHYZYME). At 6 wk, pullets from each treatment combination were placed in individual cages and fed 74 g EOD. Total excreta was collected for 48 h and this was repeated twice. Similar to what was observed for Experiment 1, there was a linear increase in excreta P with each increase in dietary concentration. Phytase supplementation decreased P in the excreta by 18% in the 0.15% AvP treatment and 6.5% in the 0.25% AvP treatment. There were no differences in excreta P due to phytase supplementation in the 0.35% AvP treatment. Pullets were fed the same levels of AvP with and without phytase during the breeder phase and during each of the first four 28 d production periods, hen-day egg production in hens fed 0.15% AvP with and without phytase was similar to that of the other diets.

Key Words: Broiler breeders, Phosphorus, Excretion

23 Male-male competition for matings in broiler breeders. I. Estevez^{*}, B. Bilcik, and M. R. Luque, University of Maryland, College Park.

In natural mating systems where male broiler breeder compete for access to females, male mating behavior will determine the number of successful copulations attained by each male and ultimately their fertility. We investigated the effect of male-male competition on mating behavior and compared it to a non-competitive situation. Twelve groups of three males and 12 females were housed in mixed sex pens (Phase 1). The frequency of matings, cloacal contacts and forced matings, and the identity of the male were extracted from videotapes collected by cameras installed above each pen. The reproductive success of each male during Phase 1 was determined through DNA fingerprinting. Males with the highest (H) and the lowest (L) mating frequency were later placed into groups of one male and four females (Phase 2), their behavior recorded and their fertility calculated. Our results indicate that both mating status (MS) and the MS by Phase interaction had an effect on the frequency of matings and

cloacal contacts ($P < 0.001$). H males with higher frequency of matings and cloacal contacts in the competitive situation (Phase 1) reduced their frequency during Phase 2 (Tukey, $P < 0.01$). In contrast, L males had a higher mating frequency and cloacal contacts in Phase 2 as compared with Phase 1 (Tukey, $P < 0.05$). These changes resulted in no behavioral differences across H and L males in Phase 2 (Tukey, $P > 0.05$). Despite of the differences in mating behavior during Phase 1 these did not result in differences in reproductive success of H and L males ($P > 0.05$). This may in part be explained by the tendency ($p = 0.06$) of a higher mating success (cloacal contacts / matings) for L males (71.09% and 58.03% for L and H males, respectively). The frequency of forced matings was low for both H and L males, even in the competitive situation, and was not affected by any of the factors ($P > 0.05$). In conclusion, male competition had a significant effect on the mating behavior and frequency of cloacal contacts of broiler breeders, but not on their frequency of forced matings. However these differences did not result in differential reproductive success.

Key Words: Broiler breeders, Mating behavior, Reproductive success

24 Effects of ad libitum feeding on sexual maturation, ovarian morphology, and carcass traits in 8 strains of broiler breeder hens. M. E. Rustad^{*1}, F. E. Robinson¹, R. A. Renema¹, M. J. Zuidhof², and B. Fancher³, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada, ³Aviagen, Huntsville, Alabama.

The negative correlation between reproductive traits and growth traits causes problems for broiler breeder producers. They are forced to use feed restriction to control the BW of current stocks to obtain acceptable fertility and egg production. However, this method is not consistently used effectively, and birds may get more nutrients than is recommended for that strain. The objective of this study was to determine the effect of over-feeding 8 genetic strains of broiler breeder hens on age at sexual maturity, ovarian morphology, and carcass traits.

Two replicate pens per strain were reared from 0 to 17 wks. The birds were weighed twice weekly and kept to a specific target BW via weekly feed allocations. At 17 wks, 64 birds per strain were selected based on BW and randomly allocated to one of two groups. One group was fed either ad libitum (FF) or were feed restricted (R) from 18 wk to sexual maturity (SM). The second group was fed ad libitum or feed restricted from 22 wk to SM. Birds were photostimulated at 22wks. At SM, BW, shank length, breast, liver, fatpad, ovary, oviduct, stroma, follicle weights were measured.

Strain 1 (selected for large BW) had the largest BW (4186 g), ovary (83.8 g), and number of large yellow follicles (LYF) (10.3) at SM. This strain is adept at depositing protein to increase growth and utilize lipids for follicular development. Strain 3 (pure line) had the highest percentage fatpad (3.1%), and the lowest number of LYF (8.2). This strain reacts differently than strain 1 to excess feed, as the extra nutrients are not converted to lipids for growth of more LYF, but are rather stored as carcass fat. The 18 FF treatment had the largest BW

(4218 g), percentage fatpad (3.2%), and number of LYF (10.8) at SM. The hens fed ad libitum from 18 and 22 wk had the same liver (~96 g), and ovary (~80g) weights at sexual maturity. The R treatments had the highest percent total breast (~20%) at SM. There was no effect of strain or treatment on F1 weight.

Key Words: Broiler breeder, Feed restriction, Ovarian morphology

25 Natural presence of *Campylobacter* spp. in the internal organs of early, mid and late-life broiler breeder hens. L. J. Richardson^{*1}, N. A. Cox¹, R. J. Buhr¹, J. S. Bailey¹, J. L. Wilson², D. E. Cosby¹, and D. V. Bourassa², ¹Russell Research Center, USDA-ARS-PMSRU, Athens, Georgia, ²University of Georgia, Athens.

Campylobacter spp. is known to cause acute bacterial gastroenteritis in humans. Poultry products have been implicated as a significant source of these infections. During the early (22 weeks of age), middle (38 and 40 weeks of age), and late (70, 72 and 74 weeks of age) stages in life, broiler breeder hens were euthanized, de-feathered and aseptically opened to determine if *Campylobacter* spp. exist naturally in the internal organs of different commercial sources of hens. To reduce the possibility of cross-contamination between samples, the thymus, spleen, and liver/gallbladder were aseptically removed, prior to the ceca. Individual samples were placed in sterile bags, packed on ice and transported to the laboratory for evaluation. *Campylobacter* spp. was detected in 3/3 thymus, 1/3 spleen, and 3/3 ceca from 22 week old broiler breeder hens. In broiler breeder hens 38 weeks old, *Campylobacter* spp. was found in 1/5 spleen and 3/5 ceca. In 40 week old broiler breeder hens, *Campylobacter* spp. was found in 1/5 thymus and 3/5 ceca. *Campylobacter* spp. was found in 4/10 thymus, 4/10 spleens, 3/10 liver/gallbladders and 6/10 ceca from 70 week old broiler breeder hens. In 72 week old broiler breeder hens, *Campylobacter* spp. was found in 1/10 thymus, 2/10 spleen, 1/10 liver/gallbladder, and 8/10 ceca. *Campylobacter* spp. was also found in 2/10 thymus and 7/10 ceca in 74 week old broiler breeder hens. From this study, it is apparent that *Campylobacter* spp. can be found within the internal organs of broiler breeder hens at various stages of their lay cycle. Determining how and when *Campylobacter* infects these internal organs could provide important information in determining intervention strategies for reducing *Campylobacter* spp. in broiler and broiler breeder flocks and possibly preventing vertical transmission.

Key Words: *Campylobacter*, Broiler breeder hen, Internal organs

26 Influence of initial BW and dietary nutrient density on BW, egg production and nutrient utilization of fast and slow feathering broiler breeder hens. A. Mendoza-Reiley^{*1}, W. Dozier², and J. Wilson¹, ¹The University of Georgia, Athens, ²South Control Poultry Research Center, USDA-ARS, Starkville, Mississippi.

A study was conducted to evaluate differences in egg production and nutrient utilization between fast (FF) and slow feathering (SF) broiler breeder strains provided diets varying in nutrient density. At 19 wk of age SF pullets were selected from a commercial flock in three body weight (BW) ranges: high (H), average (A) and low (L). FF birds were selected that were A in BW. Three different diet nutrient densities based on CP and apparent metabolizable energy (AME) were assigned across the BW groups in the SF strain. Birds received a high nutrient density (HD; 17% CP, 3000 kcal of ME/kg), moderate nutrient density (MD; 15.5% CP, 2920 kcal of ME/kg) or a low nutrient density (LD; 14% CP, 2845 kcal of ME/kg) diet. All the FF birds were fed the MD diet. Data on BW, egg production were summarized on weekly basis during the course of the trial. At 34 wk of age, manure samples were collected, and moisture (%), energy (kcal/g) and protein (%) levels were analyzed.

Dietary nutrient density had little immediate influence on hen BW; however, by 26 to 32 wk of age birds receiving the HD and MD diets had higher BW than those consuming the LD diet. Dietary nutrient density increased nitrogen intake, nitrogen retention and AME, but did not influence nitrogen on a relative basis. Initial BW group (birds selected at 19 wk of age) significantly influenced subsequent BW weight throughout the study. As expected, initial BW group significantly impacted initiation of lay but had little long-term effect on egg production. FF and SF strain had no influence on BW or egg production. Initial BW of the hen affected nitrogen and energy retention and excretion. The H BW

hens retained more and excreted less nitrogen and energy than A and L initial BW weight hens. However, this improved nutrient utilization did not result in higher overall egg production, but did result in greater BW gains.

Key Words: Breeders, Slow and fast feathering, Nutrient utilization

27 The sperm quality index of fresh chicken semen predicts semen quality after storage. P. Dumpala^{*}, H. Parker, and C. McDaniel, Mississippi State University, Mississippi State.

Research has shown that the Sperm Quality Index (SQI) is correlated with sperm concentration, motility, and viability as well as fertility of fresh broiler breeder semen. However, it is not known if the SQI of chicken semen is altered by in-vitro storage. Therefore, the objective of this study was to determine if the SQI from semen prior to storage is predictive of semen quality after 16 h of storage. In this study, individual ejaculates were collected from 25 Ross males. Prior to semen dilution, sperm concentration, viability, and SQI were determined for every male's neat semen sample. Each ejaculate was then diluted 1:1 with Beltsville Poultry Semen Extender (BPSE) and maintained at 4 C on a rotary shaker for 16 h. After semen dilution, sperm concentration, viability, and the SQI were obtained for the following storage periods: 0, 2, 4, 6, 8, 10, 12 and 16 h. Regression over storage time was used to analyze the SQI and sperm viability data. Pearson's correlation coefficients were used to examine the relationship of the SQI from fresh semen with semen quality characteristics from each storage period. The SQI increased from 0 to 4 h of storage and then decreased in a quartic fashion as storage time increased ($r^2=0.83$). There was a linear decrease in sperm viability as storage time increased ($r^2=0.87$). Correlation coefficients for the SQI from fresh semen with live sperm concentration over each storage period ranged from $r=0.47$ to 0.61 ($P<0.02$). There was a negative relationship for the SQI from fresh semen with percentage of dead sperm over each storage period yielding correlation coefficients ranging from $r=-0.88$ to -0.55 ($P<0.003$). There was a strong positive relationship for the SQI from fresh semen with the SQI over storage ($r=0.84$ to 0.94 , $P<0.0001$). In conclusion, the SQI from chicken semen prior to storage is predictive of semen quality after storage.

Key Words: Sperm quality index, Semen storage, Broiler breeder

28 Effect of feed allocation program during the rearing and early production on body weight and fertility of broiler breeder males. H. Romero-Sanchez^{*2} and J. Brake¹, ¹North Carolina State University, Raleigh, ²Universidad de Antioquia, Medellin, Colombia.

Two experiments were conducted with the aim to evaluate feed allocation programs during rearing and early production on male BW and flock fertility. In Experiment 1, 300 Ross 344 male broiler breeders were reared in 12 pens randomly assigned to either a Concave or Sigmoid feed allocation program until 26 wk of age. In Experiment 2, 300 Ross 344 males were raised identically until 16 wk and then randomly assigned to three planes (Low, Medium, and High) of feed allocation that provided a gradual increase from 85 to 110 g/day between 16 and 26 wk of age with the Low and High programs matching the final portion of the two feeding programs used in Experiment 1. In both experiments, males were photostimulated at 21 wk of age when they were moved into a curtain-sided production facility and mated with Ross 308 females that had been reared separately on a standard program in the blackout facility. Both sexes received starter and grower feeds to 2 and 24 wk of age, respectively, followed by a breeder feed. All males were weighed individually at 4, 8, 12, 16, 20, 24, 26, 28, 32, 40, 48, and 56 wk of age. Percentage fertility and hatchability were evaluated by setting 180 eggs per pen biweekly. In Experiment 1, the Sigmoid program provided the slower feed increment but the Sigmoid males exhibited a heavier BW at 40 and 48 wk that was related to a significantly better fertility. Similarly, in Experiment 2, the males on the Low feed program exhibited a heavier BW at 40 wk and higher fertility values after 46 wk of age ($P<0.05$). The data suggest that the weekly feed increments used during late rearing, photostimulation, and the early phase of production play an important role in subsequent BW and fertility under typical feed restriction programs. The males that received more rapid feed increments during the same period appeared to require more feed later in production in order to sustain their BW and fertility.

Key Words: Body weight, Broiler breeder, Feed program

29 Effect of incubation turning angle on hatchability, embryonic mortality, and malpositioned embryos. O. Elibol², K. E. Brannan^{*1}, and J. Brake¹, ¹North Carolina State University, Raleigh, ²University of Ankara, Ankara, Turkey.

Commercial incubators have often been observed to exhibit turning angles that were less than the expected 45° from vertical. Hatching eggs were collected from two commercial flocks of Ross 344 x Ross 308 broiler breeders and incubated to evaluate the effect of the turning angle on embryo development. In Experiment 1, eggs from a 57-week-old flock were incubated at 35°, 40°, and 45° turning angles (each direction from vertical) from setting to 18 d of incubation. Eggs from a 55-week-old flock were used in Experiment 2 with the same turning angles. Early dead, middle dead, late dead, malpositions (head in small end of egg), and hatchability of fertile eggs were determined. There was a numerical increase in hatchability of fertile eggs with increasing turning angle in both experiments. This was due to the statistically significant decrease in malpositioned embryos as turning angle increased in each experiment. However, the turning angle did not have a clear relationship with stage of embryonic mortality. Overall, turning angle did show a remarkable reduction in the incidence of malpositions that could have implications in commercial hatcheries where the angle of the incubation turner has been often overlooked and could easily be adjusted.

Key Words: Turning angle, Incubation, Malpositions

30 Effects of early and slow feed withdrawal times on life of flock production in commercial broiler breeders. R. K. Bramwell^{*1}, C. N. Coon¹, and C. Wiernusz², ¹The University of Arkansas, Fayetteville, ²Cobb-Vantress, Inc., Siloam Springs, Arkansas.

The optimum rate at which broiler breeders are fed coming into production, as they attain peak production and as they attempt to maintain production after peak is continually evolving. A study was conducted on the University of Arkansas Broiler Breeder Research Farm that compared three feed withdrawal programs for broiler breeder hens from the onset of egg production until 58 weeks of age. At 21 weeks of age 4,080 Cobb 500 pullets were randomly divided into 48 pens housing 85 hens per pen in a solid sidewall environmentally controlled facility. Each pen also contained eight Cobb males that were fed separate from the hens to maintain industry body weight and conformation standards. Each pen was randomly assigned to one of three treatment groups consisting of 16 pens per group. All birds were provided water *ad libitum* and were subjected to the same lighting and environment control programs. Early feed withdrawal (EW), normal withdrawal (C) and slow withdrawal (SW) programs were initiated as each group attained 5 % egg production. In the EW program feed withdrawal began when the birds reached 70% egg production while feed withdrawal in the C hens began immediately after peak production while being fed a commercially prepared 460 kcal broiler breeder diet. The SW group was fed a 444 kcal diet with peak feed attained at 50 % production and feed withdrawal occurring in smaller increments after the group attained normal peak feed levels. While there was no difference in the onset of egg production between the three groups, at 58 weeks of age eggs produced per hen per group were 143.0, 144.4, and 146.9 for the EW, C and SW treatment groups, respectively. There were no consistently significant differences in BW or mortality between the three groups. Broiler breeders fed according to the slower feed withdrawal program on the lower energy feed produced more hatching eggs per hen as compared to the either the normal or early feed withdrawal treatment groups.

Key Words: Broiler breeder production, Feed withdrawal

31 Effects of skip-a-day feeding versus everyday feeding in broiler breeder hens after housing. R. K. Bramwell^{*1}, C. N. Coon¹, and C. Wiernusz², ¹University of Arkansas, Fayetteville, ²Cobb-Vantress, Inc., Siloam Springs, Arkansas.

Skip-a-day (SD) feeding programs are the standard in rearing broiler breeder pullets and cockerels. However, continuing with SD feeding once the birds are housed in the hen house is not considered a standard industry practice. A study was conducted on the University of Arkansas Broiler Breeder Research Farm

that compared every day versus a 5-2 SD feeding program for pullets from 21 weeks of age until the onset of egg production. Four thousand and eighty Cobb 500 pullets were randomly divided into 48 pens housing 85 hens per pen in a solid sidewall environmentally controlled facility. Each pen contained eight Cobb males which were fed separate from the hens to maintain industry body weight and conformation standards. At housing 24 pens were fed on a 5-2 feeding schedule with the remaining pens fed daily. Feed allotments for all birds were determined based upon the initial pullet weight obtained at housing and total feed consumed was the same for each group. Those pens assigned to the SD feed program remained on this program from housing until the group reached 5 % production and then they were fed on an every-day feed program similar to the control group. Each group was then fed into production with feed allotments changing in accordance with changes in egg production. All birds were provided water *ad libitum* and were subjected to the same lighting and environment control programs. The breeders were then managed for the commercial production of hatching eggs to 60 weeks of age. Hens on a SD feed reached 5 % production five days later and attained peak production eight days later than those fed daily. However, peak production attained was similar and at 60 weeks of age those fed SD had laid an average of 145.5 eggs per hen while the daily fed birds had laid 144.1 eggs per hen. There were no significant differences in bird weight or hen mortality between the SD and control fed groups. In summary, while birds subjected to a SD feed program came into production slower and reached their apex in egg production later, they produced more overall eggs per hen by the conclusion of the study at 60 weeks of age.

Key Words: Broiler breeders, Skip-a-day feeding

32 Effect of temperature during incubation on broiler chick development and growth. N. Leksrisompong^{*}, P. W. Plumstead, H. Romero-Sanchez, and J. Brake, North Carolina State University, Raleigh.

Two experiments were conducted to study the effects of incubation temperature on embryological development and early broiler performance. Ross 344 x Ross 308 broiler hatching eggs were set in two identical incubators. During the first 14 d of incubation temperature air temperature was maintained between 37.5 and 37.7 °C following which one incubator was assigned to the HIGH (39.4-40.6 °C) and one incubator to the NORMAL (37.5-38.3 °C) incubation temperature treatments. Relative humidity was maintained at 53%. Egg temperatures were monitored with a Braun Thermoscan thermometer. At 19 d eggs were transferred to hatcher baskets and returned to the same machines. Machines and treatments were reversed between the two experiments. In Experiment 1, all chicks were sexed and randomly allocated to two brooding temperature regimes of 26.7-28.9 °C (COOL) and 37.2-36.7 °C (HOT). In Experiment 2, a sample of chicks was necropsied at hatching to study organ development. The remaining chicks were sexed and allocated to pens in a single brooding temperature condition. BW, feed consumption, and livability were determined at 7, 14, and 21 d in Experiment 1 and at 7, 12, 21, 28, and 35 d of age in Experiment 2. Feed consumption for the 0-7, 7-14, and 14-21 d periods were significantly decreased by increased incubation temperature but increased by higher brooding temperature during the first 7 d period but decreased during the subsequent 7-14 and 14-21 d periods in Experiment 1. Feed consumption for the 0-21, 0-28, 14-21, 21-28, and 28-35 d periods of Experiment 2 were decreased by increased incubation temperature. In Experiment 1, HIGH incubation decreased BW at 0, 7, 14, and 21 d. In Experiment 2, HIGH incubation decreased relative weight of the heart at 0 d and decreased BW at 0, 14, 21, 28, and 35 d. Elevated incubation temperature appeared to negatively affect embryo development and broiler performance up to 35 d of age.

Key Words: Incubation, Brooding, Temperature

33 Effects of storage time and position with or without turning followed by two turning frequencies during incubation on hatchability of broiler hatching eggs. J. Brake^{*1} and O. Elibol², ¹North Carolina State University, Raleigh, ²University of Ankara, Ankara, Turkey.

Hatching eggs from two old (64 (Experiment 1) and 58 wk (Experiment 2)) broiler breeder flocks were stored for 3 or 14 d at 18 °C and 75% RH while being held either large end up (LEU) or small end up (SEU) and being turned either 0 or 4 times daily. These eggs were then turned either 24 or 96 times per day

during subsequent incubation in two experiments. Treatment groups had four replicate incubation trays of 150 eggs each. As expected, hatchability of fertile eggs declined with length of egg storage in both experiments ($P < 0.01$). This was due to increases in both percentage early and late dead embryos in both experiments. Hatchability of fertile eggs was increased by SEU storage and turning during storage in Experiment 1, and by turning 96 times daily during incubation in Experiment 2. There was a consistent turning during storage \times storage position interaction for hatchability of fertile eggs that demonstrated that turning during storage benefited only eggs stored LEU. Other interactions suggested that turning during storage and storage in the SEU position worked best with long-stored eggs. Furthermore, the data suggested that storage in the SEU position or turning during storage were equally effective in ameliorating the adverse effects of storage for 14 days.

Key Words: Turning, Egg storage, Egg position

34 Egg weight, fertility, and hatchability of broiler breeders as influenced by time of oviposition and breeder flock age. A. H. Zakaria², P. W. Plumstead^{*1}, H. Romero-Sanchez¹, N. Lekrisompong¹, J. Osborne³, and J. Brake¹, ¹North Carolina State University, Raleigh, ²Damascus University, Damascus, Syria, ³North Carolina State University, Raleigh.

Time of oviposition has been reported to affect the fertility of eggs produced by caged and artificially-inseminated broiler breeders but this was not found with naturally-mated broiler breeders housed in conventional, partial slat houses. To clarify the situation, two experiments were conducted to investigate egg weight, fertility, and fertile hatchability in relation to time of oviposition of young (34 wk) and old (59 wk) broiler breeder flocks. In Experiment 1, eggs were collected from young and old flocks for two days at hourly intervals from 0700 hr to 1900 hr. Most eggs for the young flock were laid in a three-hour window from 0800 to 1000 hr while the old flock had a broader, less defined peak of egg production from 0900 to 1400 hr. Egg weight of early laid eggs was significantly greater than that of late laid eggs at both flock ages. In Experiment 2, eggs were further categorized as early laid first-in-sequence (C1) eggs (0700-0800 hr), mid-sequence (Cs) eggs (0900-1200 hr), and late laid terminal-in-sequence (Ct) eggs (1300-1700). These eggs were incubated to determine fertility and fertile hatchability relative to oviposition time and flock age. Fertility declined with flock age but was not affected by time of oviposition nor were there differences in fertile hatchability relative to time of oviposition (sequence position) or flock age. These results showed that while the distribution of ovi-

position time changed with flock age, the important production variables of fertility and fertile hatchability were not affected by the egg sequence position in either young or old naturally-mated broiler breeders.

Key Words: Broiler breeders, Egg sequence, Oviposition time

35 Effect of full feeding broiler breeder pullets until 1 or 3 wk of age on frame size, fatness and fleshing at 4, 8, 12, and 16 wk of age. R. Renema^{*1}, A. Pishnamazi¹, F. Robinson¹, and M. Zuidhof², ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.

This study examined the effects of smoothing the transition to feed restriction by feed restricting from 1 wk of age. This may improve pullet welfare by reducing the degree of change in feed allocation. A total of 720 Ross 308 pullets were placed at day of hatch (8 pens). Chicks were provided ad libitum access to feed for 1 (1WK) or 3 wk (3WK) of age, after which a 5:2 feed restriction program was initiated. BW was recorded twice/wk to allow the growth profiles to be gradually converged (target of 8-10 wk of age). Individual BW was recorded at 2 wk intervals for calculation of BW uniformity. At 4, 8, 12, and 16 wk, external carcass and fleshing scores were recorded for all birds, and 14 birds/pens were dissected for assessment of muscle mass, fatness, and reproductive development.

By 3 wk of age, the daily gain of the 3WK pullets was double that of the 1WK pullets. Whereas the sudden drop in allocation to 3WK birds improved feed efficiency, these birds had more fleshing at 4 wk of age. The 3WK birds weighed 30% more, had a larger shank and keel length, and carried a higher proportion of breast muscle (12.6% compared to 11.5%) than the 1WK birds. By 8 wk of age, the 3WK birds still weighed 100 g more than 1WK birds ($P = 0.006$) and carried a higher proportion of breast muscle. The BW profiles met at 10 wk of age, resulting in carcass measures being similar at 12 wk of age, although the 3WK birds still had a wider chest ($P = 0.048$). The BW uniformity of the 1WK birds was better than that of the 3WK birds from 14 wk of age (CV of 13.0% compared to 16.7%). At 16 wk of age, the 3WK birds were slightly fatter than the 1WK birds ($P = 0.046$), while the frame size of 1WK birds was increasing more quickly than in 3 wk birds ($P < 0.0001$). Changing the starting age of feed restriction altered growth and conformation traits to 8 wk of age, after which the conformation of birds became similar.

Key Words: Broiler breeder, Feed restriction, Fleshing

Immunology: Immunology A

36 Expression of reovirus sigma C protein in Arabidopsis thaliana. H. Wu^{*1}, Y. Williams¹, K. Gunn¹, R. Locy², N. Singh², and J. Giambrone², ¹Alabama State University, Montgomery, ²Auburn University, Auburn, Alabama.

The sigma C protein is the major host-protective immunogen of avian reovirus (ARV). Transgenic lines of Arabidopsis thaliana, expressing recombinant sigma C, were developed. The S1 gene, which encodes the sigma C protein, from the S1133 reovirus strain was isolated, amplified by RT-PCR, and introduced into a plant expression vector. This vector, (pE1857), has a strong promoter for plant expression. A construct, with the Bar gene cassette for bialaphos selection in plants (rpE-S1), was introduced into Agrobacterium tumefaciens by electroporation. Agrobacterium, containing the rpE-S1 construct, was used to transform A. thaliana, and transgenic plants were selected using bialaphos. The sigma C transgene was confirmed by PCR analysis and its expression confirmed by a real-time quantitative RT-PCR. Western blot analysis, using chicken anti-ARV sera, confirmed the expression of Sigma C protein in the plants. Six transgenic lines, with high expression of sigma C protein, were selected with real-time quantitative PCR. The immunogenic and immunoprotective potential of the plant-derived recombinant sigma C protein will be tested in future oral feeding and live ARV challenge experiments in chickens

37 Characterizing Rous sarcoma growth for major histocompatibility (B) complex haplotype B61. R.L. Taylor, Jr. ^{*1}, W. E. Briles², and J. E. Fulton³, ¹University of New Hampshire, Durham, ²Northern Illinois University, DeKalb, ³Hy-Line International, Dallas Center, IA.

The major histocompatibility (B) complex has a crucial role in Rous sarcoma virus (RSV) tumor outcome. The immune response to RSV tumors was tested in chickens segregating for haplotype B61 which occurs in a commercial line. A single B8B61 sire mated to B2B5 dams (50% Line 6.15-5) produced B2B61, B5B61, B2B8, and B5B8 progeny. Genotypes bearing B61 were studied further. The first mating consisted of one B2B61 male bred to five B2B61 dams. A second mating used the same procedure for B5B61 parents. Six-week-old chicks from each mating were challenged with 20 pock forming units (pfu) of subgroup A RSV. Tumors were scored for size six times over a ten week period post-inoculation. Tumor size scores were used to assign each bird a tumor profile index (TPI). The TPI criteria were 1 = complete regression by 28 days, or earlier; 2 = complete regression by 42 or 56 days; 3 = complete regression by 70 days, or a decreasing slope, or complete regression by 56 days followed by recurrence; 4 = general upward trend, or plateau or slight regression after 56 days; and 5 = terminal tumor prior to 70 days. Mean tumor sizes and rank transformed TPI values were evaluated using a repeated measures design and ANOVA, respectively. Hatch, sex, dam, and B genotype were the main effects.