regression interval mapping with full-sib family and hatch as fixed effects. Chromosome-wise thresholds were determined by permutation. A 0.1% significant QTL for sexual maturity and early puncture score and a close to 1% significant QTL for early body weight were found on Chromosome Z. A 20 cM region on chromosome 4 was found to harbor 0.1% significant QTL for early and late body weight, and for early egg weight, 1% significant QTL for late puncture score, late egg weight and late albumen height, and a 5% significant QTL for early egg production. A 1% significant QTL for sexual maturity was found in another region of chromosome 4. Mapping results from selective DNA pooling was very similar to results from individual genotyping. Thus, selective DNA pooling data is extremely useful in capturing most of the information for QTL detection with a substantial reduction in genotyping costs.

Key Words: QTL mapping, Egg production and egg quality, Selective DNA pooling

208 Effect of naked neck gene and crest gene on body weight and carcass measurements in chickens raised under low ambient temperatures.

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An experiment was conducted to determine the effect of introducing naked neck (Na) and crest (Cr) genes and their interaction into chickens raised under low ambient temperatures on body weight and carcass traits. Ten heterozygous naked neck cocks (Nanacrcr) were mated with 100 heterozygous crested females (nanaCrcr) to produce F1. The produced offspring were segregated into four genotypes (normal, crest, naked neck and crested-naked neck). The chicks were raised under natural prevailing temperature (18°C Max. and 12°C Min.). Body weight was recorded on four-week intervals to 16 weeks of age. At the termination of the experiment (16 weeks), 160 males representing all genotypes (40 each) were assigned to carcass evaluation. The results revealed that, as expected under current low ambient temperature, Na gene significantly decreased body weight compared to normal type. On the other hand, introducing crest gene increased body weight in nanaCrcr genotype or enhanced growth performance in the combination type (NanaCrcr). Naked neck gene significantly increased comb and wattle length, while crest gene decreased these head appendages. However, introducing Na gene improved dressing carcass % by about 3%. Moreover, this improvement reached 4.5% in combination state (NanaCrcr). Compared to normal genotype (nanacrcr) as a control, breast meat was significantly increased by introducing of Na gene, while crest gene decreased this trait. Drumstick % significantly increased in all genotypes compared to normal one. On the other hand, abdominal fat % was reduced in all genotypes, especially in Na genotype compared to normal one. In conclusion, the results revealed that, although the Na gene decreased body weight under low prevailing temperature, carcass % and breast meat yield were improved. Also, introducing Cr gene may be useful in enhancement of naked neck genotype performance under low ambient temperature.

Key Words: Naked neck gene, Crest gene, Body weight

Nutrition

209 Comparison of traditional fasting molt versus non-fasting low density, low sodium molt diets and the requirement for cystine during molt and post-molt.

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Non-fasting molt is a management tool for laying hens that addresses current day animal welfare guidelines. Dietary requirements for optimal post molt production following non-fasting molt are not well defined. Two hundred forty 65 wk old ISA White laying hens were assigned to 60 cages (4 hens/cage) in a 2 × 4 augmented factorial (fasting or non-fasting molt with 250, 275, 300, or 325 mg Cys/hen/d). Post-molt Met level was 350 mg/hen/d. Molt diets were corn and wheat middlings based. Cystine supplementation was through feather meal. For the fasting molt, feed was withdrawn until 25% body weight loss was achieved (5 to 8 d) after which feed was increased to full intake (110 g/hen/day) by week 6 post-molt. The non-fasting molt treatment was based on a low energy, low sodium (0.05%) diet fed near 70% of ad libitum intake for 6 weeks. Photoperiod was 8 h for 6 wk of molt and then increased 30 min per wk after molt until a 16 hr photoperiod was achieved. A peak post molt second cycle corn and soybean meal diet was fed at 110 g/hen/d from week 7 to 26. Fasted hens ceased egg production (EP) 11 d sooner ($P \leq 0.05$) and were out of production 10 d longer ($P \leq 0.05$) than non-fasted hens. Non-fasted hens took 3 to 33 d to cease EP. The non-fasted hens had less body weight loss (10% of pre-molt weight) than the fasted hens ($P \leq 0.05$) which had a 25% body weight loss. There was decreased post-molt hen day production ($P \leq 0.05$) with increased supplementation of Cys. Cys had a linear effect on in egg weight ($P \leq 0.05$) and egg weight decreased with increasing levels of Cys. Total feed intake and hen mortality were not affected ($P \geq 0.05$) by treatment. From these results, non-fasting molt is an alternative for management of laying hens within animal welfare guidelines. However, increased Cys supplementation beyond 250 mg/hen/d had a negative effect on post-molt hen day production and egg weight.

Key Words: Molt, Cystine, Sodium

210 Evaluation of low-energy molt diets for induced molting of laying hens.

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An experiment was conducted using 576 Hy-Line W-36 hens (68 wk of age) to evaluate several low-energy non-feed withdrawal molting methods. Four treatments provided *ad libitum* access for 28 d to diets containing 94% wheat midds (WM), 47% corn-47% soy hulls (C-SH), 47% wheat midds-47% soy hulls (WM-SH), and 47% wheat midds-47% rice hulls (WM-RH). Two treatments provided *ad libitum* access for 14 d to diets containing 95% soy hulls (SH) and 98% alfalfa meal (AM). After 14 d, hens on the latter two treatments were fed a 16% CP corn-soybean diet for 14 d. The final treatment consisted of feed withdrawal for 10 d followed by feeding a 16% corn-soybean meal diet for 18 d. At 28 d, all hens were fed a corn-soybean meal layer diet (16% CP) and production performance was measured for 20 weeks. Hens on the feed withdrawal, SH, and AM treatments ceased production on Day 6, and hens fed the C-SH, WM-SH, and WM-RH combination diets ceased production on Day 7. Hens fed the WM diet ceased production on Day 13. Body weight loss for hens fed the WM diet was 14% on Day 28. Hens fed the C-SH, WM-SH, and WM-RH diets had body weight losses of 27, 26, and 24%, respectively, on Day 28. Hens fed the SH and AM diets had respective body weight losses of 22 and 19% on Day 13. Egg production of all hens remained below 50% until Week 7. Although the rate of return to egg production varied among treatments, no consistent differences were observed among treatments for egg production, mortality, egg weight, egg specific gravity, feed efficiency, and feed consumption during the 20-wk post-molt period. When compared to the 10-d feed withdrawal, this research indicates that diets containing WM, RH, or AM and diets containing combinations of C-SH, WM-SH, and WM-RH are effective non-feed withdrawal methods for molting laying hens.

Key Words: Induced molting, Laying hens, Wheat midds

211 Effect of several levels of *Peniophora lycii* phytase on nutrient utilization in laying hens.

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Under a Randomized Complete Block Design, 120 Hy Line W36 52-week-old laying hens were assigned to 60 cages. The blocking criterion was cage location in the hen house. The experimental treatments were; 0, 150, 300, 450, 600 and 750 Peniophora lycii phytase units (FYT) per kg of feed, added to a sorghum-SBM diet with 15% CP, 2.82 Mcal/kg MEn, 3.8% Ca, and 0.3 Av. P. Each diet had 10 replicates, being the experimental unit the cage with two hens. The birds were adapted to diet composition by 10 days, followed by 4 days of total excreta collection. Feed intake was adjusted to 90 g/hen/day to assure that all hens ate completely their feed. Following, the actual means and variation obtained per treatment obtained for two of the variables. Metabolizable energy (AMEn), 0 FYT, 2,754; 150 FYT, 2,793; 300 FYT, 2,819; 450 FYT, 2,833; 600 FYT, 2,846; and 750 FYT, 2,856; SEM = 21.89. Phosphorus Ret., 0 FYT, 48.71; 150 FYT, 51.83; 300 FYT, 54.89; 450 FYT, 57.85; 600 FYT, 57.9; and 750 FYT, 61.2; SEM = 2.404. The relation between the level of Peniophora lycii phytase as FYT/kg (x), on nutrient utilization was linear ($P < 0.05$) as follows; Dry Matter Ret. (%) = 0.0058 x + 72.611 R2 = 0.81; N Ret.

(%) = 0.0223x + 30.002 R^2 = 0.95; P Ret. (%) = 0.0177x + 48.853 R^2 = 0.93; AMEn kcal/kg = 0.143x + 2763.8 R^2 = 0.88. Under the experimental conditions of this assay, the addition of Peniophora lycii phytase to the diet improved (P<0.05) nutrient utilization.

Key Words: *Peniophora lycii* phytase, AMEn utilization, Laying hens

212 Effects of dietary selenium source on egg production, fertility, hatchability, and shell quality of broiler breeders.

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Selenomethionine yeast may impact poultry reproduction at the level of sperm formation, sperm storage, and in the hatching egg through increased protection from oxidative damage. This trial examines specific effects of dietary selenium source on fertility and embryo viability in broiler breeders. Ross 508 pullets were reared in a light tight facility following the breeder BW profile (Aviagen, Inc). From photostimulation (22 wk of age), pullets were fed a selenium-free laying ration (NEG), a standard (STD) ration containing sodium selenate (0.3 mg/kg), or a selenomethionine yeast ration (0.3 mg/kg of Sel Plex) (SPLEX) (Alltech Biotechnology, Inc). Thirty hens/tmt were inseminated weekly (from 30 wk) using pooled semen from males fed a standard, sodium selenate diet (M-STD), or a selenomethionine yeast diet (M-SPLEX). Individual egg production to 58 wk, egg weight, egg specific gravity, and BW were recorded. At 35 and 57 wk of age, eggs from 2 to 5 days after insemination were subjected to the periviteline sperm penetration assay to measure the number of sperm penetrations near the germinal disk. Eggs were incubated weekly and the hatch residue broken out to determine fertility and hatchability. Total egg production was similar early in lay, but spread in late lay, when hen-housed production was 68% in SPLEX birds compared to 60 and 61% in NEG and STD birds, respectively. Settable egg production from 40 wk in SPLEX birds (87.4) was higher than in NEG birds (80.6), while STD birds were intermediate (83.7). Unsettable egg production from 40 wk was 0.9% of SPLEX eggs compared to 3.3% of NEG eggs. Prior to 34 wk, hatchability averaged 88% in SPLEX eggs compared to 80% in STD birds and 77% in NEG birds, and was similar after peak production. Periviteline sperm holes of SPLEX and STD eggs were similar to each-other. Both treatments had more sperm holes than NEG eggs by a factor of 2 to 3. Reproductive traits were improved with the inclusion of dietary selenium, while the SPLEX treatment also improved some egg production traits.

Key Words: Broiler breeders, Selenomethionine yeast, Hatchability, Egg production

213 The effect of xylanase with or without protease and amylase on broiler performance.

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Recently published studies suggested that broilers may benefit from inclusion of amylase and protease in addition to xylanase in wheat-based diets free of animal protein sources. Protein-based antinutritional factors and storage proteins are present at higher levels in animal product free diets, thus other enzymatic activities besides xylanase may be required to improve broiler performance. To evaluate this hypothesis, 4032 one-day-old Ross 308 male broilers were assigned to 12 treatments with 8 replicates of 42 birds each. Diets were supplemented with 5 levels of xylanase (Avizyme®, Trichoderma longibrachiatum); at 0 (Negative control = NC) , 670 U/kg, 1350 U/kg, 2025 U/kg and 2700 U/kg (Treatment 1 & 5). Additionally, treatments 2 & 5 were supplemented with high levels of both amylase and protease (Avizyme® Bacillus amyloliquifaciens and Bacillus subtilis) resulting in treatments 6 & 9. Finally, the highest xylanase treatment was supplemented with three different levels of amylase and protease (treatments 10 & 12). At 21 and 42 days of age, xylanase only addition increased (P<0.05) weight gain and FCR compared to NC. Because of the low wheat viscosity present, the maximum response was reached at relatively low levels of xylanase inclusion. Adding high levels of protease and amylase to different xylanase levels (treatments 6 & 9), did not improve either 1-21 or 22-42-day weight gain. However, treatments 6 & 9 showed a significant (P<0.05) improvement in FCR at both ages compared to xylanase only treatment (1 & 5). Comparing different amylase and protease inclusions in combination with the highest xylanase level (treatments 1 and 9 & 12) suggested that relatively high levels of amylase and protease were needed to improve broiler performance beyond xylanase only response. The results are consistent with earlier reported data indicating benefits of protease and amylase addition in wheat-based animal protein free diets containing xylanase.

Key Words: Wheat, Animal by-product free, Xylanase, Amylase, Protease

214 Use of distillers grains with solubles in growing-finishing diets for turkey hens.

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An experiment utilizing 1200 Hybrid Converter hens was conducted to evaluate how much distiller's grains with solubles (DDGS) could be used in growing and finishing diets of female turkeys. Hens used in a previous study to 7 wk of age were adjusted to a common corn-soybean meal based diet for one wk. At 8 wk of age, hens were fed a corn-soybean meal based diet with 0, 10, 20 or 30% DDGS to 15 wk of age. The diets were formulated on a digestible amino acid basis and 2870 kcal/kg was used as the ME value for DDGS. The hens were weighed at 8, 11, and 15 wk of age and cumulative feed conversion (feed:gain) was calculated at 11 and 15 wk of age. Litter samples were collected from each pen the day following the removal of birds from the house. Incidence of pendulous crops was noted at each weighing. The average starting body weight at 8 wk was 3.12 kg and there were 42 or 43 birds per pen (3.08 X 4.62 m) with 7 pens per treatment. There was no significant effect (linear, P=0.258) on 11 wk BW. However, there was a linear decrease (P=0.012) in 15 wk BW as DDGS was increased in the diet. Feed conversion was not significantly affected at 11 wk of age (linear, P=0.143) or 15 wk of age (linear, P=0.243). There was a quadratic response (P=0.047) to increasing DDGS dietary inclusion on litter moisture (50.6, 49.5, 48.1 or 52.3% for 0, 10, 20, or 30% DDGS, respectively). The incidence of pendulous crops was increased linearly (P=0.018) as % DDGS was increased (0.3, 0.3, 1.7 or 3.1% for 0, 10, 20, or 30% DDGS, respectively). Inclusion of 20-30% DDGS in a simple corn-soybean meal type diet for growing-finishing turkey hens was detrimental to growth and caused more pendulous crops. The appropriate ME value of DDGS for turkeys needs to be further evaluated. The inclusion level of DDGS may need to be decreased in finisher diets to leave more space for soybean meal when relatively lower crude protein/amino acid concentrations are fed.

Key Words: Distillers grains with solubles, Metabolizable energy, Pendulous crop

215 Retention of bicarbonate infused into broiler breeder hens.

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The bicarbonate retention factor (BRF) describes the proportion of infused ^{14}C that is not recovered in the breath during Indicator Amino Acid Oxidation (IAAO) studies to determine amino acid requirements of poultry. The effects of feeding, time of day, and stage of egg formation on BRF of $NaH^{14}CO_3$ during a 30-hr period by Ross 508 breeder hens were determined. The birds (n=7), 60 wk of age and of similar body weights, were fed to maintain breeder recommended body weights. Each bird underwent surgery to implant a jugular catheter. Six birds were placed into individual metabolic chambers for the infusion studies. The birds received an average priming dose of 3.960.10 or 2.410.11 kBq /kg BW and a constant infusion rate of 0.7700.019 or 0.6010.021 kBq /kg BW/h of $NaH^{14}CO_3$ for the first and second infusion studies, respectively. The isotope was infused over a 30-hr period with a 3-d recovery period between studies. One bird was replaced for the second study due to loss of catheter. Total breath $^{14}CO_2$ was collected and sampled at 30-min intervals; $^{14}CO_2$-expiration rate as % of infused dose was plotted based on time of day (photoperiod vs scotoperiod) and physiological state (fed vs fasted and egg-forming vs non-egg-forming) of the bird. The isotopic plateau was confirmed by linear regression. Eggs laid during, and within 24 hrs of the end of each infusion period were collected immediately after laying. Each egg was weighed intact; shell (+ membrane), albumen and yolk were weighed. Each egg sample was analyzed for ^{14}C retained as a % of infused dose. Overall, the average breath $^{14}CO_2$ recovery was 90.46 4.17%. The presence or absence of an egg in the oviduct did not affect (P>0.05) $^{14}CO_2$ BRF; neither did stage of egg formation. During the photophase and fasted period, $^{14}CO_2$ recovery from the birds was less (P<0.05) than during the scotophase and fed period respectively. The BRF for breeder hens during the photoperiod, in a fed state was

determined to be 14.21%. This BRF will be used to correct future IAAO studies involving AA requirements and availability in hens.

Key Words: Bicarbonate retention factor, Broiler breeder layer, Indicator amino acid oxidation

216 The egg is refractory to soy sterol enrichment through alteration of the hen's diet. R. G. Elkin* and E. S. Lorenz, *The Pennsylvania State University, University Park, PA*.

Coronary heart disease (CHD) is the leading cause of death in the United States. Elevated levels of plasma total cholesterol (TC), and particularly plasma low density lipoprotein-cholesterol (LDLC), are primary contributing factors to CHD. Dietary plant sterols (phytosterols) have been shown to significantly reduce plasma TC and LDLC in humans, primarily through inhibition of cholesterol absorption in the gut, and are potentially effective agents for CHD risk reduction. Phytosterol-containing products are currently being marketed in the form of margarine spreads, dairy products, salad dressings, snack bars, and tablets. Conspicuously absent are phytosterol-enriched eggs, which represent a potential value-added product. In a 28-d experiment, eight 32-wk-old White Leghorn hens each were fed either a basal corn-soy-based layer diet, or the basal diet supplemented with a total of 1 g of soy sterols (61 parts sitosterol, 27 parts campesterol, and 12 parts stigmasterol; weight basis)/100 g of diet. Hen performance was determined on an individual basis, while one egg/hen/wk was collected, processed, and analyzed for yolk TC, crude protein (CP), crude fat (CF), and phytosterol content. On d 28, blood samples were obtained from each hen for subsequent plasma TC analysis. There was no effect ($P>0.05$) of supplemental dietary soy sterols on 28-d weight gain, feed consumption, plasma TC, hen-day egg production, egg weights, egg component weights and percentages, and yolk TC, CP, and CF contents. Sitosterol and stigmasterol were virtually absent from all eggs tested. In contrast, eggs from both control and phytosterol-fed hens generally contained campesterol, although the average amounts were extremely small (0.3 vs. 1.0 mg/yolk, respectively). It was concluded that phytosterols are either poorly absorbed from the laying hen intestine or, if they are absorbed, that they are efficiently secreted back into the intestinal lumen, possibly via an as yet uncharacterized ATP-binding cassette transporter protein(s). Alternately, it may be necessary to feed laying hens greater amounts and/or different combinations of soy sterols in order to enrich egg yolks and possibly reduce egg yolk TC contents via sterol substitution following absorption and transport to the ovary.

Key Words: Phytosterols, Eggs, Laying hens

217 Differential effects of conjugated linoleic, n-6 or n-3 polyunsaturated fatty acids on hepatic lipid characteristics and histopathology of laying hens. Gita Cherian* and Mary P. Goeger, *Department of Animal Sciences, Oregon State University, Corvallis, Oregon, 97331-6702*.

The effect of dietary conjugated linoleic (CLA) and polyunsaturated fatty acids (PUFA)on hepatic lipid characteristics and histopathology of laying hens were investigated. One hundred and twenty thirty-week old Single Comb White Leghorn laying hens were distributed randomly to four treatments (3 replications of 10 birds per replication) and were fed diets containing(CLA), sunflower oil (SFO, n-6 PUFA), flax oil (FLO, n-3 PUFA) or fish oil (FO, long chain n-3 PUFA). The total lipid content of each diet was 3%. Feeding CLA resulted in an increase in hepatic total lipids ($P<0.05$). Liver triacylglycerol (TAG) content varied from 32.2, 18.7, 18.9 and 29.4 mg/g for hens fed CLA, SFO, FLO and FO diets, respectively ($P<0.05$). Serum TAG was lowest in birds fed FLO ($P<0.05$). Dietary CLA resulted in an increase in the total number of fat vacuoles and lipid infiltration in hepatocytes ($P<0.05$). The number of cells with 75% or higher lipid vacuolation was observed only in CLA-fed hens. Feeding CLA resulted in an increase in the content of c9t11 CLA isomer in the liver TAG ($P<0.05$). No difference was observed in the concentration of CLA in the hepatic phosphatidylcholine (PC) and phosphatidylethanolamine (PE) fractions. The content of docosahexaenoic acid (DHA, C22:6 n-3) was higher in the TAG, PC and PE of hens fed FLO and FO than other treatments ($P<0.05$). Feeding CLA resulted in an increase in total saturated fatty acids in the TAG and PC fractions ($P<0.05$).

Key Words: Conjugated linoleic acid, Polyunsaturated fatty acid, Laying hens, Histopathology

218 The effect of various levels of conjugated linoleic acid on chicken egg yolk fatty acid content and hatchability. R. Aydin*, E. Ozsan, and M. E. Cook, [1]*Kahramanmaras Sutcuimam University, Turkey,* [2]*Kahramanmaras Sutcuimam University, Turkey,* [3]*University of Wisconsin Madison, USA*.

Previous studies in our laboratory showed that feeding conjugated linoleic acid (CLA) in a low-fat diet resulted in increased yolk CLA content, changed fatty acid composition of yolk and caused embryo mortality. We also showed that CLA was not directly toxic for the developing chick embryo. The objective of this study was to determine the lowest level of CLA in the diet influencing fatty acid content and hatchability. Six 24 wks old SCWL laying hens per treatment were assigned to diets containing 0 (0.5% canola oil-Group A), 0.06% (Group B), 0.12% (Group C), 0.25% (Group D) or 0.5% CLA (Group E) for 22 days. Three eggs were collected at the last day of feeding for fatty acid analysis. Laying hens were artificially inseminated weekly. Fertile eggs were collected daily, stored at 15C for 24hours and then incubated. Embryo mortality was affected significantly by feeding Groups D and E, compared to Group A. Cis-9, trans-11 CLA (as % of fatty acids) of yolk from Groups A, B, C, D and E was 0.12, 0.27, 0.59, 0.58 and 1.25%, respectively. Trans-10, cis-12 CLA isomer (%) in Groups A, B, C, D and E was 0, 0.06, 0.16, 0.19, and 0.49%, respectively. The ratio of SAFA/UFA in eggs from Groups A, B, C, D and E was 0.64, 0.77, 0.90, 1.11, and 1.53, respectively. This study showed that 0.25% CLA is the lowest level of dietary CLA affecting hatchability by changing fatty acid composition of egg yolk.

Key Words: Conjugated Linoleic Acid (CLA), Chicken, Egg yolk, Fatty acid content, Hatchability

Processing and Products - Egg Microbiology

219 National Egg Temperature Survey: 1. Production. P. H. Patterson*[1], K. W. Koelkebeck[2], K. E. Anderson[3], M. J. Darre[4], J. B. Carey[5], D. U. Ahn[6], R. A. Ernst[7], D. R. Kuney[8], and D. R. Jones[9], [1]*Penn State University, University Park, PA,* [2]*University of Illinois, Urbana, IL,* [3]*North Carolina State University, Raleigh, NC,* [4]*University of Connecticut, Storrs, CT,* [5]*Texas A&M University, College Station, TX,* [6]*Iowa State University, Ames, IA,* [7]*University of California, Davis, CA,* [8]*University of California, Riverside, CA,* [9]*USDA-ARS, Athens, GA*.

During the hearings on the Egg Safety Action Plan in Washington, DC, many questions were raised concerning the egg temperature (T) patterns used in the risk assessment model. Therefore, a national study was initiated to determine the T of eggs from oviposition through distribution. Researchers from Extension and USDA-ARS, in CA, CT, GA, IA, IL, NC TX, and PA gathered data on internal and surface egg T from commercial egg production facilities. An infrared thermometer was used to rapidly measure egg surface T, and interior T was determined by probing the egg. The main effects evaluated were; geographic region, season, and operation type. Egg T data was recorded at specific locations in the production facilities in order to standardize the comparisons. The experimental design was a mixed model with two random effects of season and geographic region and a fixed effect component for operation type, i.e. in-line or off-line operations. Egg winter surface T in the hen house averaged 24.0C with a range of 40.0 to 10.0C. Mean summer surface T was 28.3C, from 38.0 to 21.0C, with a seasonal difference of 4.3C. Interior egg T averaged 27.3 in winter and 30.1C in summer. There was a significant correlation (0.832) between egg surface and interior T that validated further use of the infrared thermometer. Additional data were collected with the goal of building an egg T x time risk model. The T differential (dT) between internal egg T and hen house ambient T during mechanical belt gathering (90min) was 2.2C in summer and 1.4C in winter. Ambient T on the rod conveyors averaged 24.4 and 19.0C in summer and winter with an egg residence time of 29 to 43min for in-line complexes of 6 to 9 houses.

Key Words: Shell eggs, Production, Temperature, Risk model