Broiler Breeder and Hatchery Research Summary: North American Perspective

Presented by:
Michael J. Wineland
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The following research summaries were kindly provided by the indicated researchers who may be contacted for further information

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Effects of incubation humidity upon embryo and chick

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Objectives:

- Determine effect of incubational humidity
  - Embryo growth and physiology
  - Chick performance
- Examining humidity effects during period of incubation (early & late)

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Purpose

- Determine if control of humidity with single stage incubators is superior to humidity control using multistage incubation

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Hatching egg storage and antioxidants with breeder hens

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Objectives

- Previous work (Donaldson, Wineland &Christensen)
  - 2 female lines on same male that demonstrated different abilities to maintain viable embryos after storage
  - Differences in peroxidation of vitelline membrane between the lines

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Objectives:

- Determine if a reduction of peroxidation of vitelline membrane can be accomplished by feeding additional antioxidants
- Determine if feeding of the antioxidants will improve viability of stored hatching eggs

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Purpose

- Allow for improved embryo viability during incubation in eggs stored for greater than 10 days

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Metabolic heat production of "classic type" and "high yield type" broiler embryos during incubation

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Objectives:

- Compare "classic" vs "high yield"
  - Measure metabolic heat production of embryo
    - By determining oxygen consumption and carbon dioxide production
    - Different ages of embryo
    - Different egg sizes
    - At different incubation temperatures

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Purpose

- Determine if there really is a difference in heat production, is it egg size, or is it incubator design
- Use information to determine incubation parameters better.

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Breeder Research in the Auburn University Department of Poultry Science

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Recent Research Questions

1. Can breeder pullets be reared on low phosphorus diets with phytase and will they produce?
   - Heavy breeder pullets (Ross 508) were reared from hatching to production, and were maintained through production on diets containing low phosphorus (0.1 to 0.25% available P).
   - We looked at mortality, egg production, shell quality, fertility, hatch, chick quality and waste phosphorus.

Results

1. Can breeder pullets be reared on low phosphorus diets with phytase and will they produce?
   - Pullets and breeders on lower phosphorus diets with phytase performed as well or better than pullets on normal diets without phytase.
   - Waste phosphorus was reduced up to 30% by reducing phosphate in the diet and supplementation with phytase.

Recent Research Questions

1. Can breeder males be reared on an accelerated growth schedule to improve breeding fitness?
   - Ross males were reared from hatching on one of three treatments:
     - Normal (Ross) growth curve with lighting at 21 weeks.
     - Accelerated growth curve to achieve normal 21 week body weight in 16 weeks
     - Accelerated growth curve to achieve normal 21 week body weight in 16 weeks with high protein diet

Results

2. Can breeder males be reared on an accelerated growth schedule to improve breeding fitness?
   - Males grown on the accelerated schedule:
     - Same skeletal size as normal growth males
     - Better uniformity
     - Better fertility
     - Less mortality
     - High protein hurt fertility
       - Initial study only went to 30 weeks of age. 65 week study starts soon.

Hatchery/Breeder Programs at The University of Arkansas

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- Re-evaluating hatching egg storage conditions
  - Genetic selection has drastically changed the makeup of modern breeders
  - Most store eggs on the farm at about 68 F or less when cooler temperatures are unnecessary
  - Eggs stored too cool are subject to increased embryo viability during the incubation process

Hatching Egg Storage

- Research is underway to develop a phased in on-farm egg storage program that changes with flock age
- Preliminary on-farm trials have been positive in reducing embryo mortality and increasing hatch

Embryo Viability in Commercial Flocks

- Variations in embryo viability between sister flocks with no fertility problems are becoming more common
- On farm trials are underway to determine how water quality, water intake and delivery mechanisms may play a role in embryo viability

Embryo Viability in Commercial Flocks

- Using sperm penetration values, incubation stress and critical embryodiagnosis embryo viability and livability is being evaluated
- Further research will examine rearing management practices and the effects embryo viability

Male Management

- A lot of attention has been placed on controlling male body weight throughout the life of the flock
- Research is underway to evaluate phase feeding of breeder males to both control body weight and reduce the drop in late life hatchability

The Effect of Sperm Mobility on the Duration of Flock Fertility

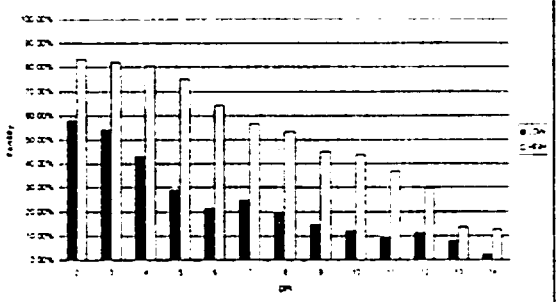
Emily Bowling, David Froman and Jeanna Wilson

The University of Georgia.

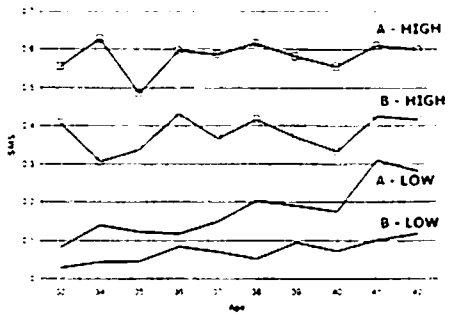
Sperm Mobility

- David Froman identified a method that tested the forward movement of a sperm cell
- Characterized roosters as producing high or low mobility sperm
- When high mobility sperm were used to artificial inseminate hens, the hens were more fertile

65 Week Fertility- Low and high mobility

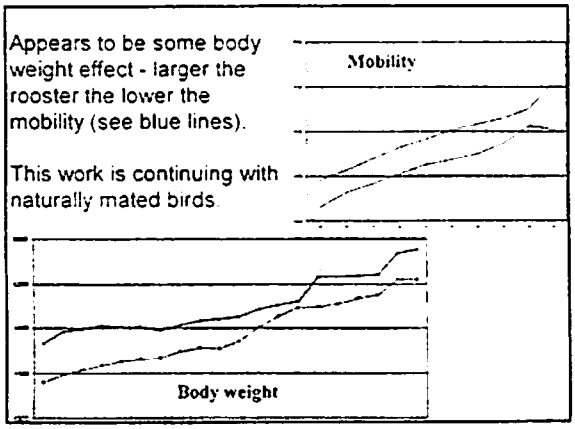


In broiler breeder some strain differences



Appears to be some body weight effect - larger the rooster the lower the mobility (see blue lines).

This work is continuing with naturally mated birds.

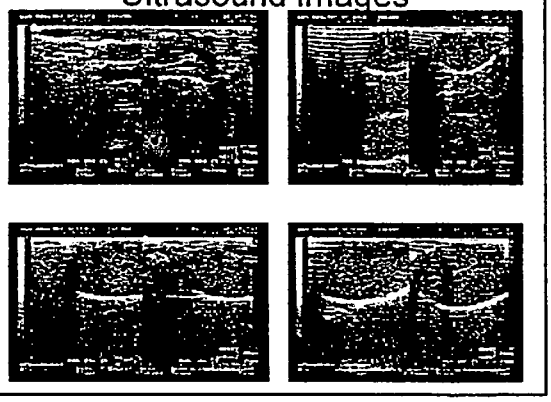


Broiler breeder roosters' ability to naturally mate after utilizing ultrasound as a non-destructive means to measure testicular size

L. J. Richardson[1], J. L .Wilson[1], E. R. Bowling[1], A. B. Caudle[2], and K. C. Powell[3]

[1]Departments of Poultry Science and [2]Veterinary Medicine, The University of Georgia, Athens, GA and [3]Roche Animal Nutrition and Health

Ultrasound images



Mating activity

Mating observations	Mean SAI Pre-ultrasound treatment	Mean SAI Post-ultrasound treatment
1 day post ultrasound	4.64[a]	5.5[a]
2 day post ultrasound	4.64[a]	5.5[a]
3 day post ultrasound	4.64[a]	5.44[a]
7 day post ultrasound	4.64[a]	4.44[a]

P>0.05

Mean % Fertility

	Control % Fertile	Treatment % Fertile
Pre-ultrasound	98.20[a]	98.05[a]
3d Post-ultrasound	97.95[a]	97.98[a]
7d Post-ultrasound	97.06[a]	97.12[a]
14d Post-ultrasound	97.96[a]	98.33[a]
Overall	97.79[a]	97.87[a]

P>0.05

Ultrasound imaging allows:

- Testicular evaluation of roosters
- No physical damage
- No change in mating frequency or fertility rate after ultrasound imaging

Effect of Dietary Zinc Source on Performance of Broiler Breeder Hens and their Progeny

B. P. Hudson[1], W. A. Dozier, III[1], J. L. Wilson[1], J. E. Sander[2], and T. L. Ward[3]

[1]Department of Poultry Science and [2]Department of Avian Medicine, University of Georgia, Athens, GA; [3]Zinpro Corporation, Eden Prairie, MN

Objective: to determine the effects of dietary zinc source on reproductive performance and immune status of broiler breeder hens

Design: 600 pullets & 100 cockerels reared in floor pens, moved to cages 20wk

- 3 experimental diets, fed to day old pullet
  - **Zinc sulfate ($ZnSO_4$),**
  - **Availa^{6}Zn (ZnAA) or**
  - **ZnAA + $ZnSO_4$ (80 ppm Zn from each)**
- 192 hens/treatment in lay

Other measurements

-Hens artificially inseminated (50 µL dose)

-Eggs set weekly (25-35 wk), biweekly (37-45 wk) & every fourth wk (49-65 wk)

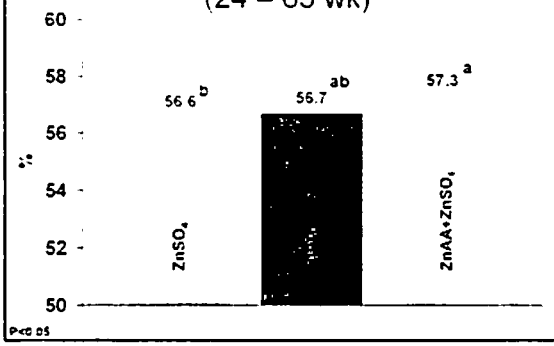
-Candle and residue analysis

-Egg shell quality – specific gravity and egg shell breaking strength

- Cellular immunity tested at 26, 44and 62 weeks

- Humoral response tested by HI titers for NDV, serum collected every 6 wk (20-62 wk), birds given a standard vaccination schedule

Hen-Day Egg Production (24 – 65 wk)

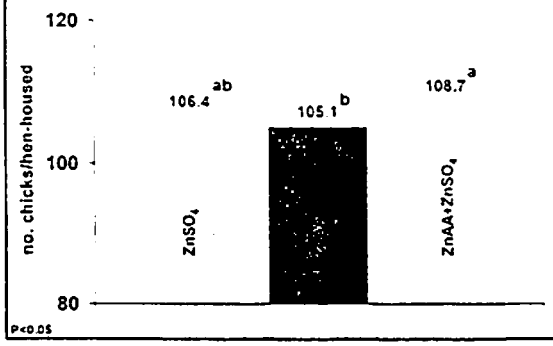


Eggshell Quality (LOF)

Source of Variation	*Specific Gravity*	*Cracked Eggs, %*	*Hatching Eggs, %*
$ZnSO_4$	1.0791 [b]	8.0 [a]	90.3 [c]
ZnAA	1.0797 [a]	7.3 [b]	91.3 [b]
$ZnSO_4$ + ZnAA	1.0802 [a]	6.6 [c]	92.1 [a]
SEM	0.0002	0.20	0.22

P<0.05

Cumulative Chick Production



Summary

- Providing a mixture of ZnAA and $ZnSO_4$ enhanced eggshell quality and hen-day egg production.
- Greater ZnAA intake enhanced humoral and cellular immune responses.

Cottonseed meal diets improve body weight uniformity in broiler breeder pullets

M.M. Lordelo, A.J. Davis, J. L. Wilson and N.M. Dale
Department of Poultry Science, The University of Georgia, Athens, GA

Diets – cottonseed meal

- Breeder pullet rearing diet contained 20% cottonseed meal vs. standard corn soybean meal diet (2860 kcal/kg and 15.5% crude protein).
- Cottonseed meal was processed by expander solvent extraction methods and contained 1.5% total and 0.15% free gossypol.
- Treatment diets fed from 2-18 weeks of age, and all birds fed a standard pullet rearing diet until 21 weeks of age (cottonseed meal removed 4-5 weeks before start of lay).

Diets – cottonseed meal

- Breeder pullets were weighed weekly from 2-32 weeks of age and body weight and coefficient of variation calculated.
- Egg production, fertility and hatchability was measured and reported on a weekly basis through 32 weeks of age.
- Feed allocations were increased by 6.3 to 12.5% during rearing to allow similar growth in the pullets receiving cottonseed meal diet.

Diets – cottonseed meal

- Generally, the cottonseed meal feed pullets were more uniform (coefficient of variation, 13.1 to 16.38% CV).
- Total gossypol levels in the livers of the pullets reached a high of 416 ug/g liver at 14 weeks of age (12 weeks after feeding) and declined to 8.6 ug/g liver at 32 weeks of age in the hens (13 weeks after removal).

Diets – cottonseed meal

- No differences in egg numbers through 32 weeks of age (peak egg production of 80% in CSM and 78% in SBM).
- No differences in fertility (range with natural mating of 87.1 to 98.8% from 25 to 32 weeks of age).
- No differences in hatchability (range of 56.8 to 89.6% from 25 to 32 weeks of age).
- No difference in egg weight.

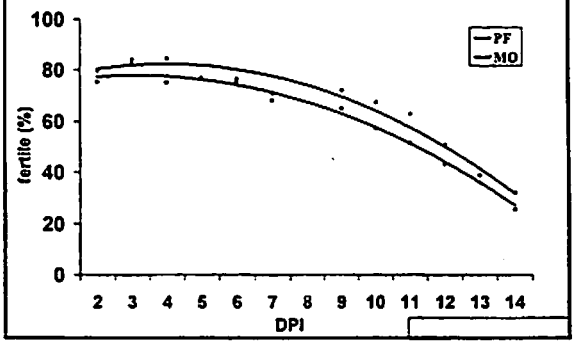
EFFECTS OF DIETARY MENHADEN OIL ON FERTILITY AND SPERM QUALITY OF BROILER BREEDER MALES

B. P. Hudson and J. L. Wilson
Department of Poultry Science, The University of Georgia, Athens, GA

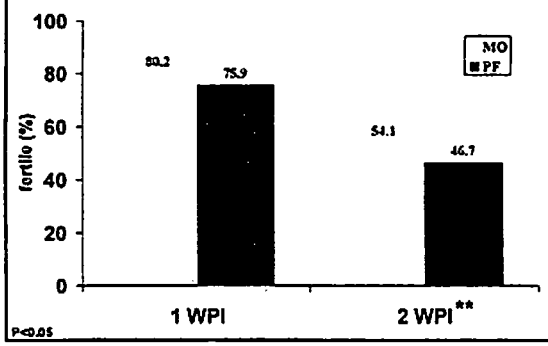
Diets – Menhaden oil replacement of poultry fat

- Broiler breeder males were fed a standard industry formulated rearing diet with one of two fat sources, 3% **poultry fat (PF)** or 3% **Menhaden oil (MO)** and continuing the fat sources at the 2% in the lay period.
- Hens were inseminated from pooled semen samples within dietary treatment at 47, 50, 53, 56, 59, 62 and 65 weeks of age.
- Low insemination dose (50 µL diluted semen, 7.5 x 10^7 sperm) so as not to mask potential sperm quality differences.

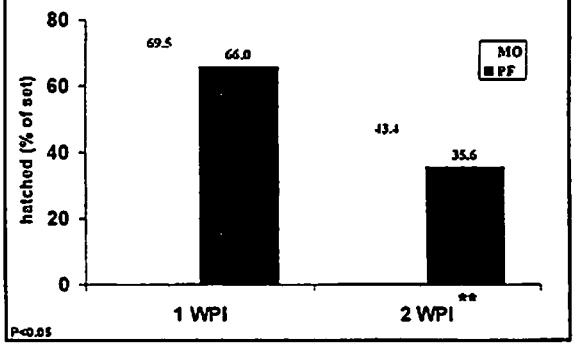
Fertility by Days Post-Insemination



Fertility by Weeks Post-Insemination



Hatchability of Total Eggs Set



Conclusions

- Dietary Menhaden oil enhanced fertility and hatchability during the second week post insemination.
- Dietary Menhaden oil for would be most effective in improving fertility in older flocks (lower mating frequency and poorer sperm storage in the hen).
- Dietary Menhaden oil for males may enhance sperm livability in the oviduct.
- Providing Menhaden oil to males may be a simple means to improving fertility.

Evaluation of Embryonic Metabolism and Heat Production of High Yielding Broiler Breeds: Single Stage Environment

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Objectives (Single Stage Incubator):

1) Determine Heat Output of Different Strains of Broiler Breeder eggs during incubation as measured by CO_2 Output.

2) Study the Effects of Late Incubational Heat Challenge on Hatchability and Post-hatch Growth Efficiency

3) Calculate Heat Output by Age of Breeder Flock as measured by CO_2 Output.

4) Examine the Interaction of Temperature and Humidity on Chick Quality.

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Summary:

- Heat production at maximum ranged between .18 and .22 watt/egg for the different strains. Romanoff (1960) values for maximum embryo/egg heat production was .11 watt/egg.
- Hatch of transferred eggs for the Control Shell Temperature (100 °F) treatment was significantly greater (90.12%) than for the High Shell Temperature (103 °F) treated eggs (83.79%)

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Summary (continued):

- Increased late-dead (16 – 21 days incubation) embryos were found for eggs incubated at a shell temperature of 103 °F for last seven days of incubation when compared to a control temperature treatment (100 °F.
- Egg Shell Temperature should be maintained between 100 and 101 °F for optimum performance of high yielding broiler breeders (hatchability and chick growth)

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REPRODUCTIVE EFFICIENCY IN BROILER BREEDERS

F. E. Robinson, R. A. Renema, University of Alberta
M. J. Zuidhof, Alberta Agriculture, Food and Rural Development

October 21, 2003

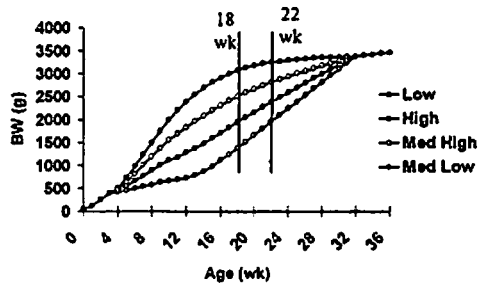
Research Project:
Genotypic, Growth and Photostimulatory Effects on Reproductive and Metabolic Efficiency in Female Broiler Breeders

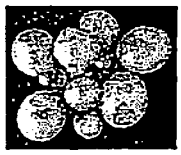
F. E. Robinson, R. A. Renema and M. J. Zuidhof

Research Objectives

- To define the relationship between growth rate and sexual maturation in three strains of pullets.
- To examine juvenile, point-of-lay, and end-of-lay carcass composition
- To study reproductive efficiency (rate of lay, egg sequence length, fertility and hatchability).
- To mathematically describe egg and chick output.
- To incorporate the data into an overall bio-economic model of the broiler supply chain.

BW Targets and Age at Lighting





Identification of early indicators of metabolic and reproductive dysfunction from over-feeding female broiler breeders

F. E. Robinson, R. A. Renema,
M. J. Zuidhof and M. E. Rustad

Research Objectives

- To determine the relative growth and yield potential of commercial and specialized lines
- To characterize genetic variation in response to acute full-feeding both prior to and during sexual maturation.
- To characterize the physiology of the reproductive response of commercial and specialized broiler breeder strains under normal and challenging nutritional states.
- To identify early indicators of metabolic and reproductive dysfunction

Growth patterns and reproductive efficiency and livability in male broiler breeders

F. E. Robinson, R. A. Renema and M. J. Zuidhof
J. L. Wilson (University of Georgia)

Research Objectives (a)

- To determine how chick quality impacts the ability of a male to grow and be a viable male.
- To see if males that experience a linear, concave or convex growth curve from 0 to 22 weeks of age vary in performance and end-of-cycle carcass traits and testis morphology?
- To find out if body weight and carcass morphology influence reproductive success and health status.
- To see how important flock uniformity is to livability.

Research Objectives (b)

- To discover if spiking males stimulate increased mating activity in original males.
- To determine if males that mate more frequently exhibit better testes morphology and higher testosterone levels late in lay.
- Does testes weight give the same data, as does examination of the amount of functional spermatogenic tissue determined histologically?

The Impact of Timing of Protein Intake on Reproductive Efficiency in Broiler Breeder Females

F. E. Robinson, R. A. Renema and M. J. Zuidhof

Research Objectives (a)

- To determine the impact of varying protein intake pattern during the rearing phase on carcass traits and reproductive potential.
- To characterize the physiology of the reproductive response under normal and alternative CP intake.
- To seek early indicators of metabolic and reproductive dysfunction.
- To determine if changes in dietary CP affect the way females will deposit breast muscle.

Research Objectives (b)

- To determine if changes in dietary CP affect the way females will deposit breast muscle.
- To study the responsiveness of the ovary to early and standard photostimulation ages.
- To trace changes in weight and external fleshing measurements in commercial broiler breeder flocks and relate these measurements to the health, livability and reproductive status of the birds at the end of lay.

Research on Factors Affecting Embryo Metabolism & Chick Quality

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Egg Turning Duration and Embryo & Chick Survival

- objective: identify minimum duration eggs must spend at 45 degree to horizontal for normal hatchability
- eggs held on horizontal - better air flow through incubator

10 min 40 min 10 min

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To be presented at Atlanta meeting in January 2004

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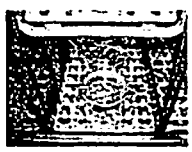
Comparing Embryo Metabolism & Heat Production of Modern Broiler Strains

- objective: determine if modern strains have a higher embryonic heat output than older unselected strains
- compare different modern strains at various parent flock ages



Measure metabolism of individual embryos by placing eggs in metabolic chambers capable of recording carbon dioxide output

To be presented at Atlanta meeting in January 2004

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Comparing Hatchability & Chick Quality of Multi versus Single Stage Incubators

- objective: determine if there are differences in hatchability & chick quality in eggs from the same flock set in different incubator types
- field trial with a local hatchery

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Establishing if the hole into the air cell created by *in ovo* injection influences hatchability

- objective: determine if the hole created when eggs are "embrexed" improves hatchability
- hole increases conductance of air into the shell - does this help the late incubation embryo survive?
- no vaccine or nutrients injected

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Comparing Air Cell and Shell Temperatures

- objective: determine if there is a correlation between air cell & egg shell temperatures
- placed thermocouples in air cell and on shell and monitored throughout incubation

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To be presented at Atlanta meeting in January 2004

Alberta Poultry Research Centre

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Improve Hatching Egg Management

- Define optimum storage temperatures
- Define effect of storage time
- Define effect of storage humidity
- Determine how to best use egg turning
- Account for flock age, albumen quality, and strain effects
- Improve sanitation programs

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Improve Hatchability

- Optimize preheating programs
- Determine optimum incubation temperature
- Determine optimum incubation humidity
- Optimize machine air flow
- Optimize room ventilation and temperature control strategies

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Improve Chick Quality

- Reduce egg temperatures during incubation
- Develop improved brooding strategies
- Develop improved ventilation strategies
- Investigate nutritional intervention strategies for the breeder and broiler
- Improve sanitation programs

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Improve Broiler Performance

- Develop feeding programs that allow parents with greatest genetic potential to reproduce
- Better define how breeder management, apart from egg weight and egg composition, affects broiler performance
- Examine factors that make reduced use of medications successful

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Improve Environmental Quality and Industry Sustainability

- Develop strategies to best reduce phosphorus excretion
- Develop strategies to best reduce nitrogen excretion
- Develop strategies to best utilize feed additives and enzymes

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Educational Outreach Program

Assists commercial managers and decision-makers to better understand the complex long-term relationships that arise from broiler genetic selection programs and flow through broiler breeders to the hatchery and on to the broilers.

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Progress Reports, Updates and Interactive Discussions Are Provided Each Spring at the NCSU Broiler Breeder Research Workshop in Raleigh

Next Workshop Is Scheduled For April 1, 2004

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