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INSIDE



# Effect of Incubating Poor Quality Broiler Breeder Hatching Eggs on Overall Hatchability and Hatch of Fertile

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**Introduction**

Previous research has shown that quality hatching eggs improve the likelihood of optimum hatchability as well as result in good chick quality (Yoho et al., 2008, Moyle et al., 2008). Pathogens can penetrate, contaminating the egg shell, its membranes and the embryo (Berrang et al., 1999). Improperly handled eggs can also explode contaminating the surrounding eggs in the setter. While proper sanitation of eggs can be beneficial to overall hatchability, failure to follow recommended sanitation procedures often has negative consequence on hatchability and chick quality (Funk et al., 1949, Scott and Swetnan., 1993).

Within the poultry industry it is understood that only clean and good quality broiler breeder hatching eggs should be sent to the hatchery for incubation. Breeder managers routinely discuss this topic with contract producers with varied success. However, increased production costs dictate that every possible hatching egg be sent to the hatchery and it would seem advantageous to have some practical method for dirt removal. Producers commonly use paper towels, rags or sanding blocks to remove dirt from eggs. If the dirt is gone then the problem should be solved, right? But, do these cleaning methods affect hatchability or chick quality? With these questions in mind, this study was undertaken to evaluate the effect poor hatching egg selection, improper egg handling techniques and "cleaning" procedures on hatchability, hatch of fertile and egg contamination rates.

**Materials and Methods**

Eight hundred forty (840) hatching eggs were obtained from the University of Arkansas broiler breeder research farm and randomly assigned to one of seven treatment groups with 120 eggs per treatment group. The control group was correctly set clean hatching eggs, while the remaining groups included: un-touched dirty eggs, dirty eggs wiped with a wet cloth, dirty eggs sanded with an abrasive pad, checked eggs (broken shells but no broken membranes), cull eggs (misshapen eggs or double yokes) and eggs set upside down. Eggs were incubated under common commercial incubation conditions, hatched chicks were tallied and a residue break-out analysis was performed on all unhatched eggs. Eggs were classified as contaminated if they were obviously malodorous or had noticeable bacterial contamination. The experiment was replicated three times. Data were analyzed using JMP® statistical software comparing the means from the observations (SAS Institute, 2006). Differences were deemed to

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*. . . helping ensure the efficient production of top quality poultry products in Arkansas and beyond.*

be significant at P< 0.05.

**Results and Discussion**

The data in Figures 1 and 2, show a significant drop compared to control in hatch and hatch of fertile in all treatment groups except checked eggs. However, the hatchability of dirty eggs that were wiped or sanded did not improve as compared to un-touched dirty eggs. Setting eggs upside down negatively affected hatchability as was expected (12%), but the most significant decrease was seen in cull eggs (~45% loss).

As illustrated in Figure 3, there were a significantly higher number of contaminated eggs in the dirty, sanded or wiped categories as compared to the control (8%). Once again, attempting to clean the eggs did little to improve their viability. An overall increase in exploding eggs from contamination was also observed as compared to commercial hatchery results. Exploding eggs further complicates hatchability and chick quality issues by involving the surrounding egg pack.

This experiment was an attempt to mimic the on-farm efforts to salvage dirty hatching eggs in a situation where proper sanitizing equipment may not be available. Instead, a wet rag or abrasive pad would perhaps be used.

Results indicate that there is no hatch benefit from wiping or cleaning dirty eggs. Therefore more emphasis should be placed on litter management and nest box maintenance to reduce the incidence of dirty eggs.

**Conclusions**

1. Wiping or sanding dirty eggs does not improve hatchability.
2. Setting cull eggs or setting eggs upside down will negatively affect over all hatch.
3. Setting checked eggs will negatively affect over all hatch, but not to the extent first believed.

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**Figure 1. Loss of hatchability in poorly selected and handled hatching eggs.**

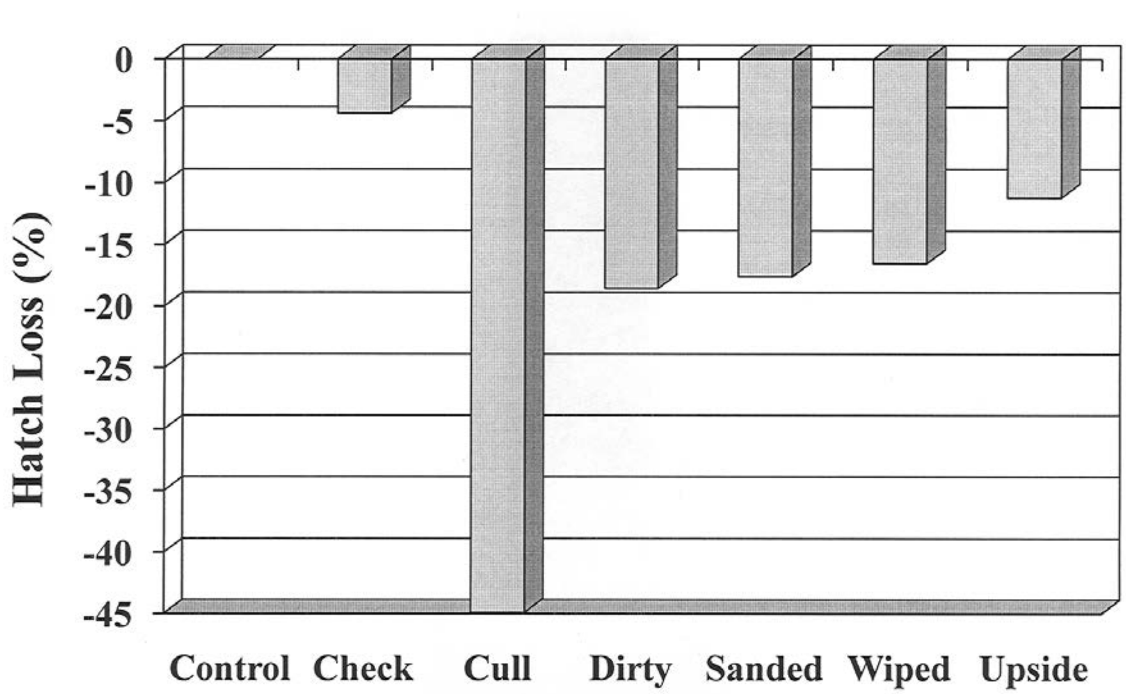


**Figure 2. Loss of hatch of fertile in poorly selected and handled hatching eggs.**

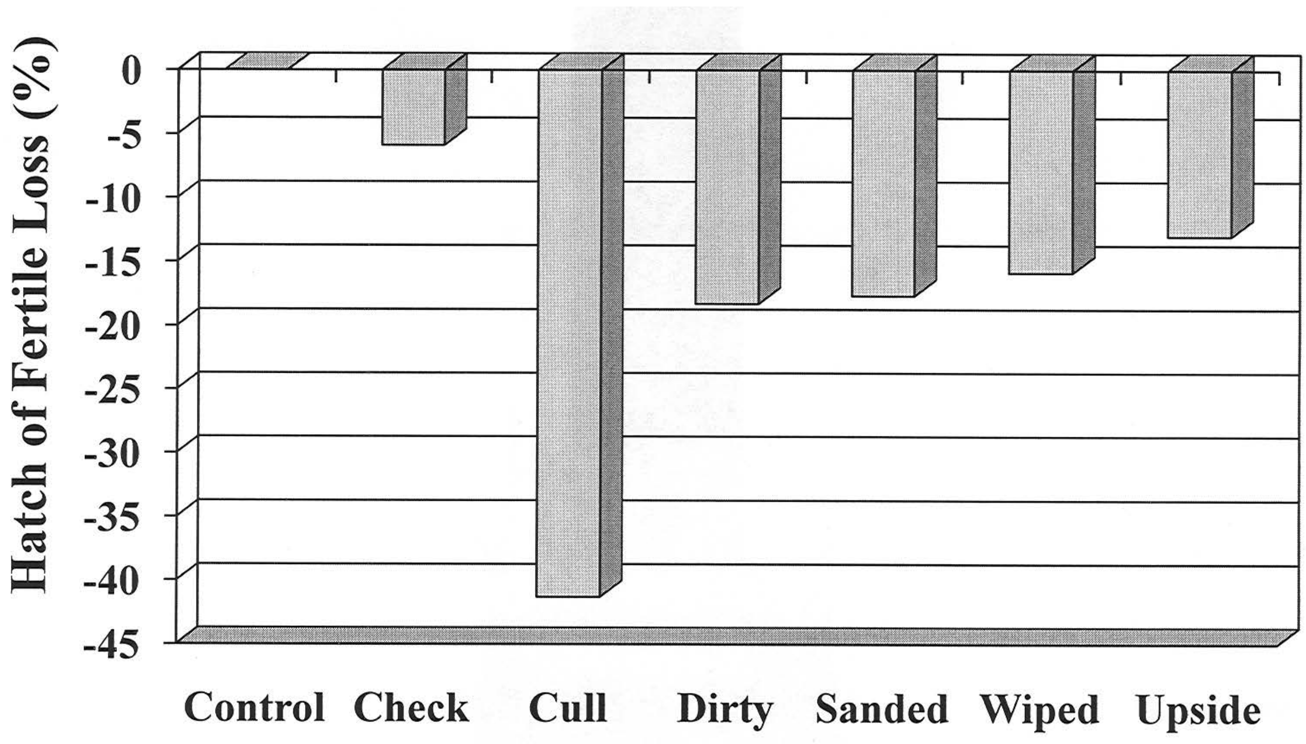
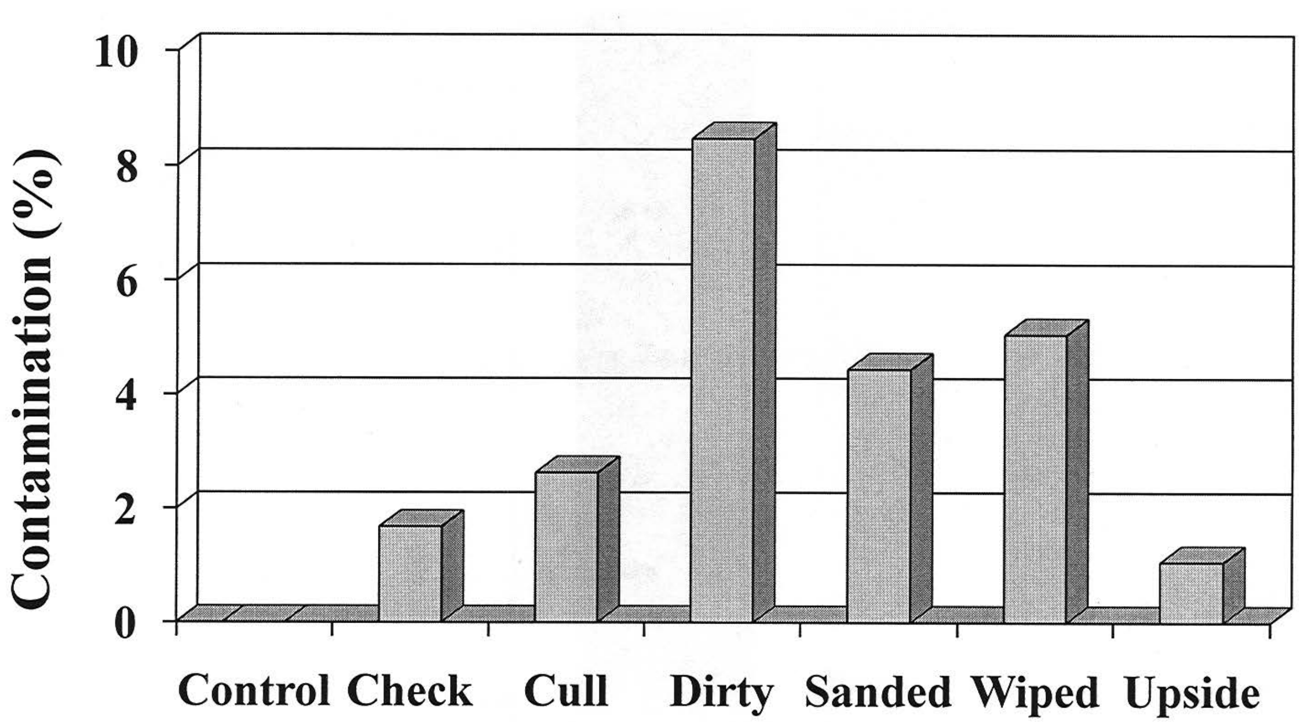



**Figure 3. Contamination in poorly selected and handled hatching eggs.**



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# Litter Preparation Between Flocks: Management is the Key[1]

**Ideal Litter Conditions**

Proper litter conditioning is an essential tool of good management for keeping flocks healthy and profitable. Conditioning litter between flocks addresses where the birds live, which is the most crucial aspect of the poultry house environment. Ideal litter is loose and free flowing (friable), not too dry or too wet (20-30 % moisture is ideal), low in ammonia (less than 20 parts per million), uniform particle size (no large clumps) and contains a minimum load of insects. Moisture is the key factor which influences litter quality. Allowing litter cake to remain in a facility can trap moisture in the litter, which will promote bacterial growth, pathogen development and ammonia release once the house is closed and re-warmed for the next flock (Watkins, 2001). In fact, recent information suggests that poor litter conditions cost the grower an average of $960 per 20,000 bird house (Ritz et al., 2005).

**Litter Preparation History**

Prior to World War II, the poultry industry primarily involved small, privately owned flocks. Neither nutrition nor disease control principles were well understood so frequent litter cleanout was seen as necessary and labor was plentiful. However, the start of the war meant that labor and materials became scarce, while the war effort increased demand for poultry products. This situation forced producers to use built-up litter rather than clean out one or more times per flock. Interestingly, during this time period poultry researchers discovered that birds grown on built up litter and fed nutritionally deficient feeds were healthier and grew faster than birds fed the same feeds on new litter (Kennard, 1950). Thus, nutrition and management experts began advising, "The use of built-up litter makes it unnecessary to clean the house more than once a year" (Morrison, 1948). Yet flock sizes were smaller and growth rates for broilers were considerably slower than today's standards so many issues with litter either did not exist or could be dealt with by hand. However, since current broiler strains grow rapidly, flock sizes continue to increase and labor costs have escalated, mechanical methods are required to deal with litter issues.

In the early days producers pulled disks, harrows, weighted wire cattle panels, or old tires tied together behind tractors to break up caked litter. Garden tillers were also used to reduce litter cake in preparation for the next flock. Yet these methods tended to leave larger chunks of hard, caked, high moisture litter with rough edges. It was difficult for baby chicks to maneuver over these chunks and older birds developed foot problems. In addition, the excess moisture increased ammonia concentrations in houses and, in turn, increased the need for ventilation, resulting in increased fuel usage.

Today, many producers own or have access to tractor operated decaking machines to collect caked litter for spreading on fields or pastures. These units can do an excellent job and continue to serve the industry well. However, these units must be operated correctly to achieve the desired results and biosecurity is always a concern when several producers share any type of equipment. In addition, increasing environmental concerns and nutrient management plans of many farms now restrict or prohibit land application of litter; especially in sensitive watersheds. An alternative litter preparation method that could satisfactorily prepare used litter without cake removal would have potential benefits to the industry in many areas across the country.

[1] Mention of trade names does not constitute endorsement by the University of Arkansas Division of Agriculture and does not imply their approval to the exclusion of other products or vendors that may be suitable.

**Evaluation of an Alternative Litter Treatment Method**

**Equipment Description**

While standard decaking machines remove caked litter for spreading on pastures or fields, the Priefert Litter Saver (Priefert Ranch Equipment; Mt. Pleasant, TX) [PLS] uses a series of curved hammers or teeth to break apart caked litter. When properly done the PLS thoroughly mixes and aerates all the litter on the floor, allowing the once caked litter to remain the house and resulting in smooth, friable litter with little crust or hard pan at the pad surface.

**Equipment Operation Principles**

It is important to match PLS unit size (4', 5', or 7') to tractor PTO horse power rating to achieve proper performance. As litter depth increases over time, the horse power demand required to properly operate the PLS also increases. In addition, one pass of the PLS through the house is not enough to break up all the chunks of caked litter. We observed that 3 to 4 passes were necessary to obtain litter of the consistency and particle size desired. Initially, the litter treated with the PLS will be fluffier than litter in a decaked house, but after a few days of baby chicks walking on the litter, this difference is no longer detectable.

**Test Procedures**

Flocks 92, 93 and 94 were placed on February 26th , May 15th and July 27th, 2007 respectively and were used to compare the effects that processing litter using the PLS or a decaking machine had on flock performance. Inspection prior to the processing of litter revealed that approximately the same amount of caked litter was present in each house. Prior to flocks 92 and 93 litter in houses 1 and 3 were decaked, while cake in houses 2 and 4 were conditioned with the PLS. Prior to a third flock (flock 94), only the litter in house 3 was processed using the decaking machine and litter in the remaining houses was processed with the PLS. The PLS was used to process all the litter in each treated house three or four times over a 3-day period. Four loads of caked litter (about 7 tons per house) were removed from houses 1 and 3, prior to the placement of flocks 92 and 93, for a total of approximately 14 tons of caked litter per flock. Five loads (about 8.75 tons) were removed from house 3 prior to flock 94.

**Test Results**

Flock performance data obtained from the comparison of decaking with the PLS are shown in Table 1. While the data presented slightly favor the PLS system over decaking, the few observations mean that such conclusions can only be tentative. However, in our situation we observed a savings in litter preparation time and fuel expense with the PLS. Yet the majority of this savings was due to hauling and spreading loads of caked litter on appropriate fields. If the ABRF had a litter stacking shed, time and fuel costs would likely have been similar. In addition, if the ABRF were selling litter as an income supplement, more litter might be present in PLS treated houses. However, whether or not the PLS is a wise economic decision will depend upon the facilities and situation on the farm involved.

**Observations and Precautions**

It appears that the practice of reusing litter will remain the industry standard for the foreseeable future. Therefore, it will be necessary that each production unit have some strategy for processing litter prior to each flock. Since every farm and every farm manager is different, it is difficult to make overall recommendations. However, regardless of which litter processing system the unit uses, day-old chicks must not be placed on damp litter. Chicks placed on damp litter will be stressed and have reduced feed consumption, resulting in poor flock performance (Tabler, 2003).

Units are faced with a "pay me now or pay me later" choice with respect to litter processing. Skimping or short cutting litter processing will save house preparation time, but will provide a less than optimum environment for bird growth and the "pay me later" scenario may be seen in the form of a less than pleasing settlement check. The "pay me now" approach to litter processing will require extra time and effort prior to flock placement, but will likely pay dividends in the settlement check.

The approach to litter processing is entirely different when the PLS is compared to decaking. Decaking captures caked material from about the top six inches of litter and removes it from the house. The PLS pulverizes, mixes and aerates about the top 12 inches of litter into a soft, smooth, even surface. However, the PLS requires that litter be processed multiple times to achieve acceptable results. In our case, the PLS required that all the litter be processed three or four times to achieve satisfactory results. Both litter processing systems (decaking and the PLS) are only farm management tools. Both the PLS and decaking machines can produce poultry house conditions that are good… or…bad, the operator decides which environment the day-old chicks will face at placement.

**Summary**

Short down times between flocks and increased concern for the environment have created a need for alternatives to removing and land applying caked litter after every flock of birds. One such alternative was evaluated and no negative effects on flock performance were observed. However, management is the key to successful litter preparation between flocks; regardless of the method used. Skipping steps, cutting corners, and less than satisfactory conditions could prove costly to the next flock. Investing the extra time and effort to do things right will likely pay dividends.

LITTER — continued on pg. 6

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**Table 1. Bird Performance following litter preparation by decaking or PLS.**

| Litter Prep. Method | House Number | Livability (%) | Age (Days) | Avg. Wt. (Lbs.) | Net Sold (Lbs.) | Feed Conv. | Pay/lb. (cents) | Pay/house ($) | Gas Use (gals.) |
|---|---|---|---|---|---|---|---|---|---|
| **FLOCK 92 (February 26, 2007 - April 20, 2007** | | | | | | | | | |
| Decaked | 1 | 96.90 | 53 | 6.90 | 118474 | 2.06 | 5.28 | 6248 | 1263 |
| PLS[1] | 2 | 96.92 | 53 | 7.02 | 120430 | 1.99 | 5.63 | 6778 | 1134 |
| Decaked | 3 | 95.93 | 53 | 6.77 | 115006 | 1.98 | 5.57 | 6400 | 1114 |
| PLS | 4 | 96.78 | 53 | 5.74 | 115534 | 2.03 | 5.35 | 6178 | 1100 |
| **FLOCK 93 (May 15, 2007 - July 10, 2007)** | | | | | | | | | |
| Decaked | 1 | 96.56 | 56 | 7.60 | 127242 | 2.12 | 5.25 | 6676 | 376 |
| PLS | 2 | 96.23 | 56 | 7.52 | 125469 | 2.05 | 5.57 | 6934 | 375 |
| Decaked | 3 | 96.27 | 56 | 7.30 | 121880 | 2.02 | 5.63 | 6858 | 389 |
| PLS | 4 | 96.58 | 56 | 7.63 | 125413 | 2.05 | 5.54 | 6953 | 363 |
| **FLOCK 94 (July 27, 2007 - September 24, 2007)** | | | | | | | | | |
| PLS | 1 | 96.15 | 59 | 8.26 | 128770 | 2.11 | 5.27 | 6784 | 50 |
| PLS | 2 | 96.67 | 59 | 8.14 | 127497 | 2.07 | 5.43 | 6920 | 59 |
| Decaked | 3 | 96.20 | 59 | 8.23 | 128829 | 2.09 | 5.36 | 6910 | 72 |
| PLS | 4 | 96.47 | 59 | 8.17 | 129426 | 2.14 | 5.08 | 6571 | 68 |
| **Average Data** | | | | | | | | | |
| PLS | --- | 96.61 | 56.00 | 7.37 | 123961.50 | 2.06 | 5.43 | 6731.14 | 449.71 |
| Decaked | --- | 96.54 | 55.40 | 7.15 | 122391.80 | 2.06 | 5.37 | 6574.00 | 640.00 |

[1]PLS = Priefert Litter Saver (Preifert Ranch Equipment; Mt. Pleasant, TX)

BEFORE AND AFTER - The pictures above were taking in a University of Arkansas Division of Agriculture house. The one on the left was taken before using the Priefert Litter Saver, and the photo on the right was taken after four passes with the machine.

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# Measuring Hatching Egg Shell Quality

**Introduction**

Clearly hatchability is important to both small flock and commercial poultry breeder flock owners. Maintaining hatching egg shell quality is important because of its connection with hatchability. The major factors that influence egg shell quality are genetics, diet, climate, housing and age of the hens. While the average poultry operation has limited control over most of these factors, the crucial significance of hatchability makes it is important to recognize and control egg shell quality where possible.

Obviously, eggs with thin shells are more likely to break, producing ‘leakers.’ While leakers are not usually set in the incubator, thin shelled eggs crack easily in the hen house, during collection and transportation, resulting in poor hatches due to contamination. In addition to the increased likelihood of shell breakage, thin shelled eggs that do not suffer breakage allow for higher water vapor loss during the entire incubation process resulting in dehydration and higher embryonic mortality. Those chicks that do hatch from thin shelled eggs have decreased livability during the first few days of life and poor overall performance because they get off to a slow start.

Egg shell color has also been questioned in regards to its affects on hatchability. While the scientific literature contains conflicting data regarding the relationship between egg color and

EGG SHELL — continued on page 8

hatchability, poultry producers have long held the belief that in typical brown egg laying breeds, light colored eggs will not hatch as well as those that are darker in color. Indeed, it is interesting to note that in certain songbird species (flycatchers) experimental evidence suggests that healthier more well-fed females lay more intensely colored eggs (Moreno et al., 2006). Thus, there is some evidence to substantiate the assumption that darker eggs hatch better than lighter colored eggs. Eggshell color may also be associated with egg shell quality. Therefore, producers have been trained to eliminate light colored eggs from consideration as hatching eggs due to their poorer hatching expectations.

Measuring shell quality: Determining shell quality involves estimating shell thickness. Although there are many methods for estimating shell thickness, egg specific gravity is the easiest and most widely utilized. There are two methods to obtain egg specific gravity measurements: the Archimedes method and the salt solution method.

The Archimedes method involves weighing eggs individually and then weighing the egg in water. Then the formula [dry egg weight/ (dry egg weight-wet egg weight)] is used to obtain the specific gravity. However, because eggs must be individually weighed, this method is seldom used. The salt bath method utilizes tubs of water each of which contains a greater concentration of salt than the previous tub (typical concentrations are 1.070, 1.075, 1.080, 1.085 and 1.090). The specific gravity of the solution in which the egg floats, is the specific gravity of the egg. Eggs are placed initially in the tub with the lowest salt solution concentration. The specific gravity estimate is recorded for those eggs that float. Those eggs that do not float are removed and placed into the next higher solution and so forth until all the eggs float. This method is popular because it allows for rapid measurement of large numbers of eggs, with minimal affect on the eggs or their hatchability. The best time to measure specific gravity is in the hatchery after the eggs have had a chance a constant temperature and to reach the same temperature as the salt solutions.

Measuring shell color: The shells of broiler breeder eggs can vary from white to almost chocolate in color. The cause of this variation in egg color is not known, but eggshell color measurements have been made using techniques ranging from visual estimation to sophisticated electronic measurements. However, digital colorimeters are generally best because they tend to remove the subjectivity from these measurements.

**Experimental Procedures**

Egg Selection and Handling: A total of 1,944 eggs were collected from five different broiler breeder flocks that were between 33 and 45 weeks of age. Eggs were labeled so that each egg individually could be followed through the testing, incubation and hatching process. For this study, cracked eggs, toe checked eggs and any misshapen, too small or large eggs, or dirty eggs were eliminated. Only eggs that would be acceptable hatching eggs by the commercial integrator were used. Eggs were hatched at the commercial hatchery using industry standards and after hatch, a hatch residue breakout was performed to determine fertility and time of embryonic mortality.

Specific gravity: Salt solutions were maintained in the egg storage room at a local commercial hatchery and measured after they had time to adjust to the temperature of the room. The salt solutions were check regularly for accuracy with a hydrometer and concentrations ranged from a low of 1.065 to a high of 1.090 in increments of 0.005.

Shell color: Eggshell color was determined for each egg using a colorimeter that gave a numeric measurement of shell color. This procedure removed human error from shell color determinations. Pure white eggs would have returned a reading of 100, while darker eggs had lower numbers. The eggs that were measured had a color range from upper 60's (dark) to the lower 90's (light colored).

**Experimental Results**

Specific Gravity and Hatch: Hatchability results are shown in Figure 1. These results indicate that eggs with a specific gravity of 1.070 hatch as well as those with higher specific gravities and that hatch is not negatively affected until specific gravity is 1.065 or lower. These results are different than those published by McDaniel et al., 1981 and Bennett, 1992, who report that eggs with specific gravities less than 1.080 had poor hatch and increased embryo mortality. This difference in results may be the result of genetic progress made during the last 15 years, or in experimental methodology.

Shell Color and Hatch: Figure 2 shows the relationship of how shell color relates to hatchability. These results show that the hatch of extremely light colored eggs is lower than the darker eggs. Since shell pigments are applied to the shell just prior to the egg being layed light egg color may be a sign of prematurely layed eggs caused by some type of environmental stress.

**Summary**

1. A measurement of specific gravity can be effectively used to rapidly evaluate the shell quality in broiler breeders.

2. Eggs with specific gravity values higher than 1.070 will hatch well while those lower will result in poor hatches and indicate poor shell quality.

3. Lighter colored eggs (color scores above 87) hatched at a lower rate than did darker eggs. However, the light colored eggs would be considered those which are 'extremely light' and not just a lighter shade.

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**Figure 1. Hatchability of commercial eggs by egg shell color code.**

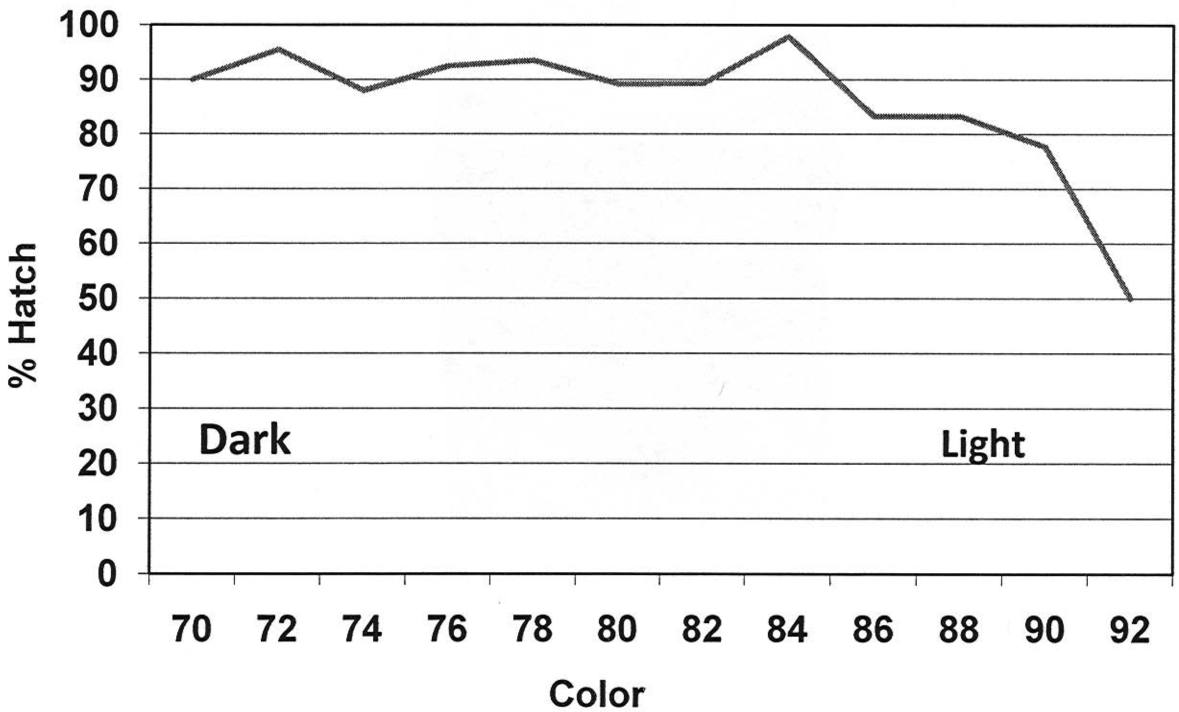
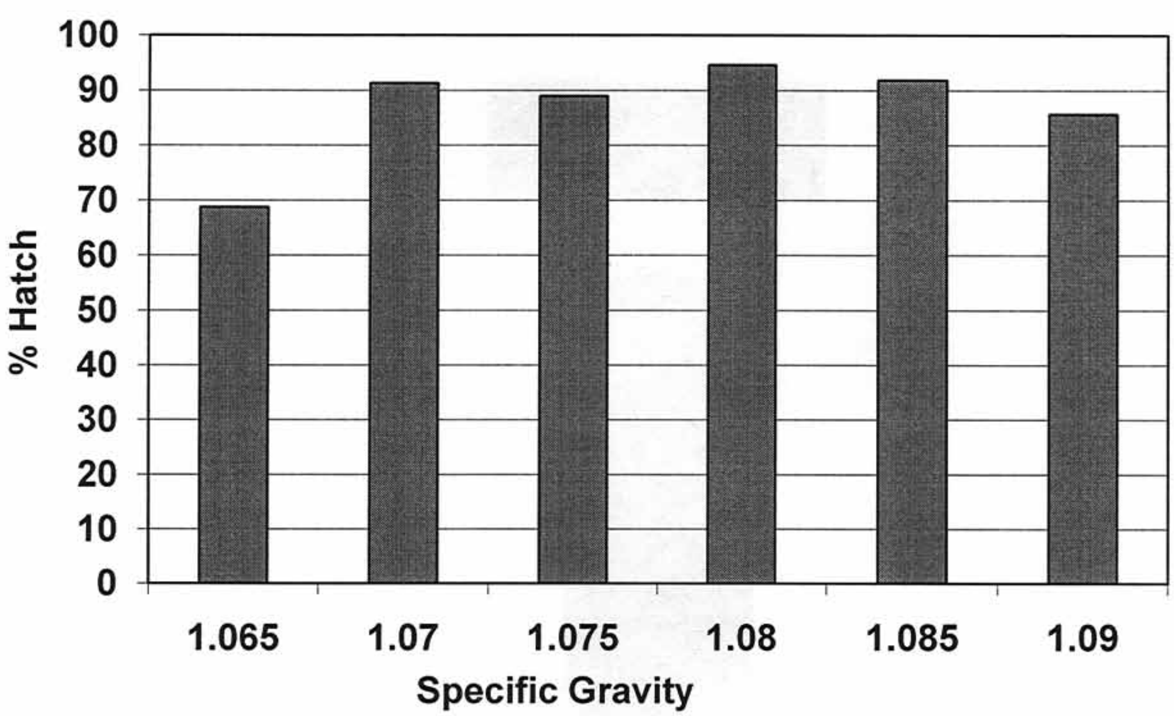



**Figure 2. Hatchability of commercial eggs by specific gravity using the salt solution method.**



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# Cooling Broiler Chickens by Direct Sprinkling[1]

## Introduction

Modern broilers grow at an extremely rapid rate and convert feed to meat with exceptional efficiency. However, this rapid growth rate and conversion efficiency have been associated with an increased susceptibility to heat stress. While a variety of genetic, nutritional, feeding and environmental strategies have been examined, much of the burden for dealing with the effects of heat falls to the producer and, in turn, the housing environment (Linn et al., 2006). Evaporative pads, fogger pads and fogger nozzles are commonly used to control heat and its effects in broiler houses (Weaver, 2002). Except in extreme conditions poultry production personnel have tended to avoid systems that deposit moisture directly on the birds. Yet, cattle and hogs are often cooled in hot weather by sprinkling with water and many poultry producers have occasionally cooled chickens by sprinkling with water hoses during extremely hot periods to avoid catastrophic mortality. In practice, the effectiveness of conventional, low-pressure misting systems in broiler houses partially depends on the deposition of much of the released water onto the chickens and their immediate surroundings. Pad systems require large volumes of water to cool birds and many producers are concerned about the availability and cost of water to operate cool cell systems. An alternative sprinkling system for cooling broiler chickens was investigated at the Applied Broiler Research Farm (ABRF).

## History

Sprinkling with controlled amounts of water on a regular basis directly on the birds was tested in 1989 in a laboratory study with promising results (Berry et al., 1990). In that study, sprinkling water was applied at the rate determined by:

$$HL = 5.0 \frac{(TA - 80)}{(TS - 80)} \qquad (1)$$

where

HL = rate of water application, in latent heat units of Btu/hr/lb bird,
TA = room air temperature, F,

and

TS = chicken wetted-surface temperature, assumed to 92ºF during study.

The control algorithm was based on data from Reece and Lott (1982), who found that the sensible heat production of broiler chickens at 80° F was nearly constant at 5.0 Btu/hr/lb bird after four weeks of age. The equation assumes that the heat transfer from the chicken body core remains at a constant 5.0 Btu/hr/lb bird as long as the wetted surface is cooled to 92°F by the addition of water with increasing air temperature. The use of 92°F for TS was based on radiometer measurements of chicken surface temperatures, recognizing that these surfaces were not necessarily the same as the wetted surfaces.

## Field Tests Procedures

Field tests were conducted from 1995 through 2005 in commercial 40 by 400-ft curtain sided broiler houses at the ABRF. A variety of more conventional misting systems were normally used with cross-ventilation in Houses 1 and 3 during this period.

Houses 2 and 4 were arranged as tunnel ventilated houses and contained identical fan

[1]Mention of trade names does not constitute endorsement by the University of Arkansas Division of Agriculture and does not imply their approval to the exclusion of other products or vendors that may be suitable.

configuration patterns. Chickens in House 4 were cooled by the modified tunnel ventilation system with 200 ft of 4-in pads 4-ft in height. The pad cooling system seemed to work adequately, but air velocity in about half the house was not desirably high for tunnel ventilation. Additional heat stress may have resulted from some blockage of natural ventilation by the wall sections with cooling pads during evening hours. Water was applied in House 2 directly to the birds in a coarse mist sprinkled from 63 plastic spinner nozzles (Meter-Man UCS23) placed at 19-ft intervals along three longitudinal 3/4-in PVC pipes in House 2. The nozzles on the center pipe were staggered from those on the outside pipes, which were placed 10 ft from the side walls. Nozzles were placed about 2 in. above the pipes on risers that contained check valves. The pipes were suspended from the roof framing by a winched system so that nozzle height could be adjusted. Water was supplied to the nozzles through a pressure regulator set to 20 psi, so that each nozzle emitted about 0.25 gallons/min over a circle of about 22-ft diameter. The amount of water was metered by controlling the on-time of the nozzles in every 10-min cycle. Separate solenoid valves alternated water pressure to the three pipes to prevent overloading of the house water supply system. During this period, the maximum air velocity was maintained through the entire 400-ft length. Litter removal from all houses was via a farm tractor and pull behind single axle decaking machine (Lewis Brothers Mfg. Co., Model #2; Baxley, GA) capable of hauling 3,500 to 4,000 lbs per load.

**Field Test Results**

Table 1 shows the average daily mortality (dead chickens per day per house) from age 35 days until the day before harvesting. Average daily mortality was lowest in House 2 (direct sprinkling system) while House 4 (pad cooled house) had the next to highest mortality rate. The relative failure of House 4 was partially blamed on the low air velocity in part of that house. During Flocks 39 and 44, higher mortality in House 1 was probably averted by hand spraying with a garden hose.

Table 2 compares Houses 2 and 4 with respect to water used for cooling birds and loads of caked litter removed at the end of the grow-out period. While the average number of caked litter loads removed was approximately equal, House 2 used just over 85% less water to cool birds as compared to House 4. While fan electricity use was similar in both houses, feed conversion, average weight, and integrator pay rate showed a general trend in favor of the direct sprinkling system in House 2 as compared to House 4 (Table 3). These data suggest that, direct sprinkling of chickens was as effective at cooling birds as tunnel ventilation.

**Observations**

Tunnel ventilation is thought by many to be the best available management tool to prevent heat related stress and mortality in broiler flocks. Such houses have been reported to reduce the effective ambient temperature in the vicinity of the birds by more than 35ºF on a typical summer day. However, water usage in tunnel houses is nearly double that of conventional houses on warm days (Lacy and Czarick, 1992). Water usage in the direct sprinkler house was about 85% lower than that used in the tunnel house, while loads of caked litter removed at the end of the flock were approximately equal (Table 2).

Random temperature observations with the direct sprinkler house suggest that this approach typically reduced the temperature of the ventilation air by less than 2°F. This is primarily because much of the water was applied directly to the birds. The lack of association between inside air temperature and the cooling benefits of the direct sprinkler system meant that the system benefits were not obvious to the casual observer unless he was actually sprinkled. In addition, inside air temperature could not be used to provide feedback for controlling water application rates. Instead, water application rates were based on outside air temperature and predicted body temperatures of birds using the previously presented algorithm. Earlier testing with the direct sprinklers has suggested that the system effectively removes heat directly from the birds (Xin et al., 2001). However, the increasing growth rates of broilers, solid sidewall housing and improvements in production methods suggest that an updated algorithm will be necessary under current production conditions. This work is currently underway.

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**Summary**

Cool cell pad systems use large volumes of water to cool the air temperature inside poultry houses during hot weather. Producers are increasingly concerned about the availability of their water supply and the cost of water, especially on large farms that may have 5 to 10 houses or more. An experimental method of cooling broilers in hot weather utilizing a low cost sprinkling system that consumes only a fraction of the water of a pad system was field tested at the ABRF with promising results. Such a system developed commercially could possibly offer an effective, viable, inexpensive alternative to current strategies used for summer cooling of broiler chickens.

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**Table 1. Average Daily Mortality of Chickens during Summer Flocks.[1]**

| Flock No. | Length (Days) | Dates | Average Daily Mortality[2] | | | |
|---|---|---|---|---|---|---|
| | | | House 1 | House 2 | House 3 | House 4 |
| 27 | 41 | June 29 - Aug. 9, 1995 | 8.00 | 8.00 | 9.17 | 20.67 |
| 33 | 42 | May 9 - June 20, 1996 | 12.43 | 8.86 | 9.43 | 10.71 |
| 34 | 43 | July 4 - Aug. 16, 1996 | 9.00 | 5.50 | 6.00 | 7.50 |
| 39 | 53 | June 26 - Aug. 18, 1997 | 16.19 | 12.00 | 11.44 | 22.56 |
| 43 | 50 | April 16 - May 26, 1998 | 30.25 | 26.92 | 23.25 | 23.67 |
| 44 | 55 | June 12 - Aug. 6, 1998 | 65.28 | 21.33 | 16.72 | 27.89 |
| 49 | 57 | May 31 - July 27, 1999 | 18.05 | 9.20 | 22.45 | 46.30 |
| 50 | 55 | Aug. 5 - Sept. 29, 1999 | 10.11 | 14.94 | 16.28 | 16.56 |
| 54 | 56 | May 16 - July 11, 2000 | 34.74 | 27.05 | 21.42 | 75.95 |
| 55 | 53 | July 21 - Sept. 12, 2000 | 20.00 | 12.82 | 15.82 | 29.35 |
| 60 | 42.5 | May 18 - June 30, 2001 | 40.89 | 18.38 | 19.86 | 11.00 |
| 61 | 43 | July 5 - Aug. 17, 2001 | 16.13 | 18.37 | 16.63 | 18.38 |
| 67 | 45 | June 4, - July 19, 2002 | 41.60 | 11.40 | 37.20 | 20.10 |
| 73 | 42 | June 19 - July 31, 2003 | 36.29 | 16.71 | 26.71 | 38.85 |
| 79 | 44 | June 3 - July 17, 2004 | 35.67 | 24.56 | 42.44 | 31.67 |
| 80 | 41.36 | Aug. 22 - Oct. 11, 2004 | 20.33 | 24.33 | 33.00 | 28.17 |
| 85 | 39 | June 13 - July 22, 2005 | 69.25 | 55.25 | 65.75 | 43.25 |
| -- | -- | **Average** | **28.48** | **18.57** | **23.15** | **27.80** |

[1]Mortality is calculated for age 35 days until the day before the harvest.
[2]Houses 1 and 3 were conventionally ventilated with mist systems, while House 4 was a pad-cooled, tunnel-ventilated house and the cooling system in House 2 sprinkled water directly on the birds.

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**Table 2. A Comparison of Summer Cooling Water Usage and Caked Litter Removal from House 2 (Direct Sprinkler System) and House 4 (Pad Cooled).**

| Year | Flock # | Cooling H20 (gal) | | Cake removed (loads)[1] | |
|---|---|---|---|---|---|
| | | House 2 | House 4 | House 2 | House 4 |
| 1995 | 27 | 18289 | 42950 | 7 | 8 |
| 1996 | 33 | 1599 | 6193 | 0 | 0 |
| | 34 | 2905 | 12834 | 0 | 0 |
| 1997 | 39 | 4828 | 62945 | 2 | 1 |
| 1998 | 43 | 1200 | 33425 | 2 | 3 |
| | 44 | 13224 | 133349 | 0 | 2 |
| 1999 | 49 | 9653 | 114337 | 2 | 1 |
| | 50 | 128 | 2320 | 5 | 3 |
| 2000 | 54 | 5271 | 35510 | 8 | 6 |
| | 55 | 13578 | 33604 | 4 | 5 |
| 2001 | 60 | 142 | 4567 | 2 | 3 |
| | 61 | 4996 | 40010 | 2 | 2 |
| 2002 | 67 | 2677 | 12800 | 5 | 4 |
| 2003 | 73 | 1731 | 18337 | 4 | 4 |
| 2004 | 79 | 1064 | 12222 | 2 | 3 |
| | 80 | 0 | 5895 | 4 | 3 |
| 2005 | 85 | 2456 | 6706 | 0 | 3 |
| **Ave.** | -- | **4926** | **34000** | **2.88** | **3** |

[1]Total annual cleanout performed on Flock 33 and total cleanout of experimental bedding on Flock 34 in 1996.

**Table 3. Production Figures, Flock Water Consumption and Fan Electricity Use for Summer Flocks.**

| Flock No. | Feed Conversion House No. 2 | Feed Conversion House No. 4 | Avg. Wt. (lbs) House No. 2 | Avg. Wt. (lbs) House No. 4 | Pay/lb. (cents) House No. 2 | Pay/lb. (cents) House No. 4 | Water Consumption/flk (gals) House No. 2 | Water Consumption/flk (gals) House No. 4 | Fan Electricity/flk (kwh) House No. 2 | Fan Electricity/flk (kwh) House No. 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 1.81 | 1.90 | 3.80 | 3.70 | 4.92 | 4.21 | 32,955 | 35,378 | 3,671 | 3,252 |
| 33 | 1.84 | 1.91 | 3.80 | 3.81 | 4.93 | 4.42 | 34,589 | 37,453 | 1,288 | 1.736 |
| 34 | 1.91 | 1.95 | 3.83 | 3.80 | 4.45 | 4.15 | 35,321 | 37,488 | 1,939 | 1,838 |
| 39 | 2.05 | 2.06 | 4.99 | 5.04 | 4.12 | 4.05 | 41,931 | 45,735 | 3,961 | 4,585 |
| 43 | 2.03 | 2.09 | 4.89 | 5.10 | 4.07 | 3.99 | 36,655 | 40,046 | 1,939 | 1,694 |
| 44 | 2.08 | 2.02 | 5.15 | 5.46 | 4.62 | 4.60 | 40,737 | 41,069 | 4,824 | 4,370 |
| 49 | 2.22 | 2.32 | 6.29 | 6.02 | 5.23 | 4.37 | 55,193 | 51,705 | 5,049 | 4,842 |
| 50 | 2.13 | 2.11 | 6.26 | 6.08 | 3.57 | 3.60 | 55,924 | 52,711 | 4,038 | 3,128 |
| 54 | 2.08 | 2.18 | 6.24 | 5.77 | 4.71 | 3.81 | 54,349 | 53,569 | 4,350 | 4,217 |
| 55 | 2.07 | 2.04 | 5.75 | 5.59 | 3.88 | 3.88 | 55,207 | 53,348 | 6,412 | 5,777 |
| 60 | 1.80 | 1.92 | 4.37 | 3.94 | 4.42 | 3.36 | 42,699 | 40,926 | 3,247 | 3,218 |
| 61 | 1.86 | 1.86 | 4.31 | 4.43 | 4.19 | 4.33 | 46,833 | 49,252 | 5,458 | 5,987 |
| 67 | 1.93 | 2.04 | 4.64 | 4.39 | 4.94 | 4.15 | 48,190 | 51,994 | 5,592 | 5,347 |
| 73 | 1.86 | 1.79 | 4.17 | 4.60 | 3.88 | 4.56 | 34,688 | 36,458 | 3,204 | 3,624 |
| 79 | 1.95 | 1.94 | 4.63 | 4.44 | 4.04 | 3.65 | 38,621 | 35,717 | 2,765 | 3,457 |
| 80 | 1.72 | 1.66 | 4.79 | 4.93 | 4.93 | 5.32 | 42,913 | 42,574 | 3,151 | 3,379 |
| 85 | 1.80 | 1.78 | 4.09 | 3.92 | 4.26 | 4.12 | 36,028 | 35,767 | 3,311 | 3,729 |
| **Avg.** | **1.95** | **1.97** | **4.82** | **4.77** | **4.42** | **4.15** | **43,108** | **43,599** | **3,776** | **3,775** |

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