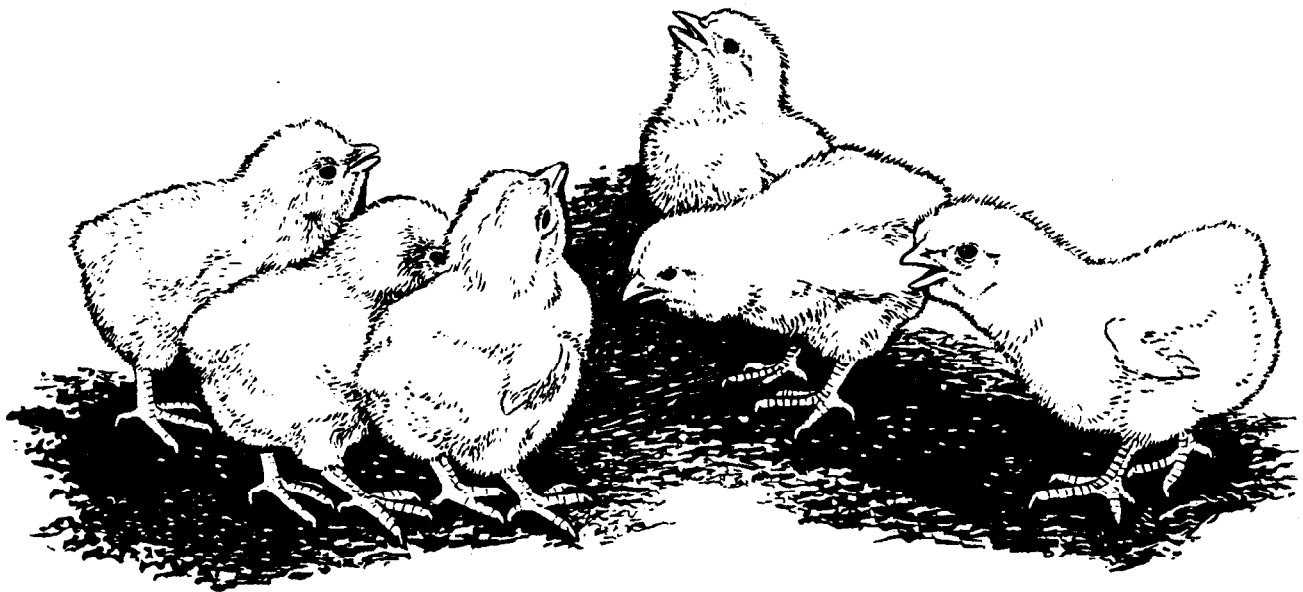


Quality Control Procedures for the Hatchery

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INTRODUCTION

Hatchery and breeder farm quality control programs are designed for fact finding, baseline data evaluation, and troubleshooting problem areas. The quality of chicks leaving the hatchery is dependent on management and environmental factors in the hatchery and on the breeder farm. For this reason, some of the quality control procedures described in this bulletin are intended for use on the breeder farm. The quality control program should be established to optimize chick performance and quality from the time the hatching egg is laid, through chick placement and until two-week chick mortalities have been determined. ■

HATCHING EGG STORAGE

The hatching egg storage room's purpose is to maintain hatching egg quality until egg pick-up. The farm egg storage room should be maintained at 64-68°F and 75-80% relative humidity. When eggs are stored for a week or longer, it is beneficial to lower the hatchery egg room temperature to 55-60°F. (See *Hatching Egg Room Safety Chart*, page 2)

Don't mount thermometers, thermostats, humidistats, or wet bulb thermometers directly on the storage room wall. The temperature of the wall is usually different than the temperature of the air in the egg room and wall mounting leads to errors. Mount thermometers, thermostats,

humidistats, and wet bulb thermometers at least two inches away from the wall and into the circulating air path within the egg room.

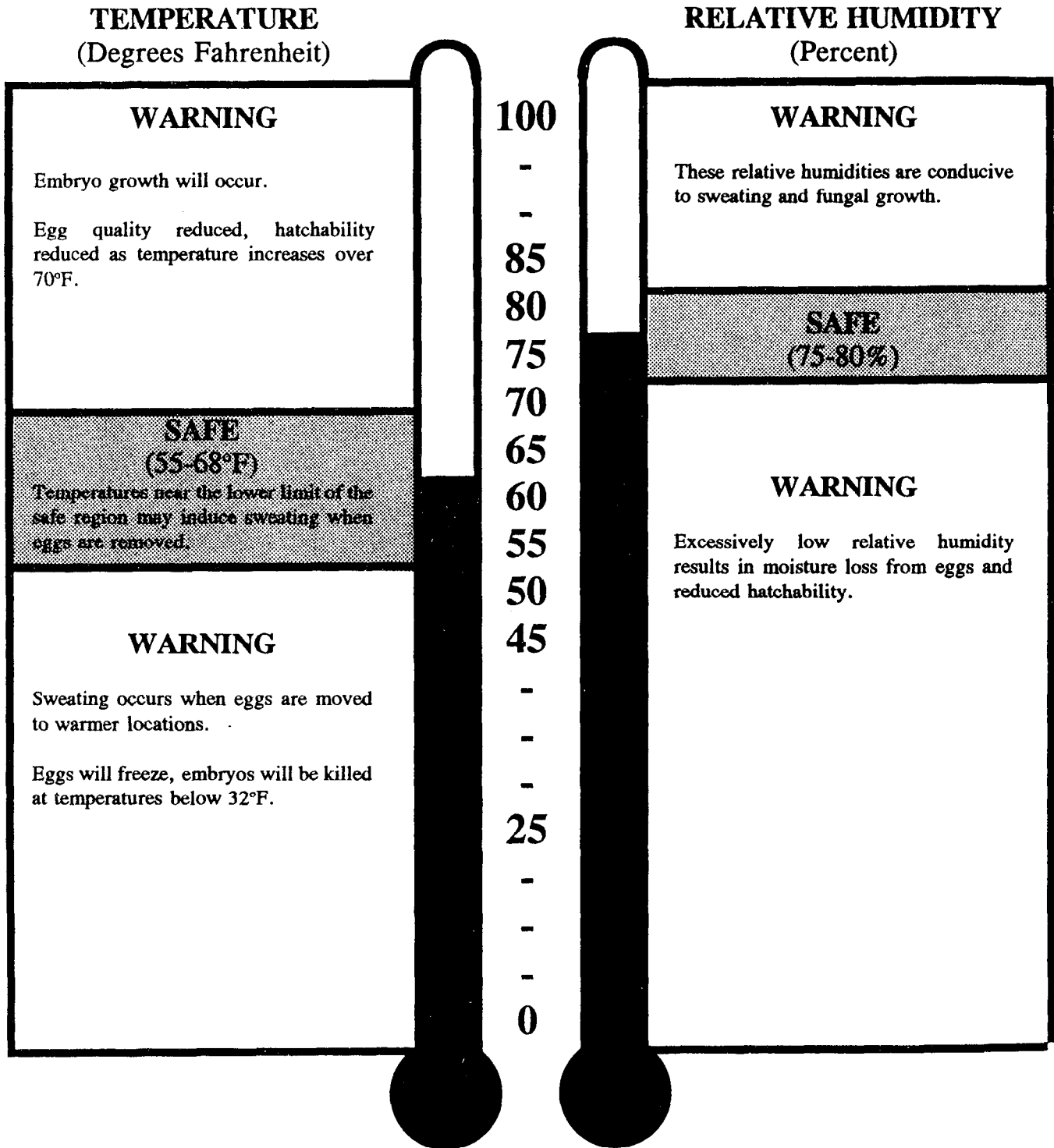
A good quality control procedure for the egg room is to measure the temperature and humidity twice daily, morning and afternoon, and record those measurements on a calendar or chart. If measurements are higher or lower than the 64-68°F range, adjustment of the cooler thermostat is necessary. Also, it is ideal to have at least one accurate mercury or digital thermometer to check thermostats and humidistats. ■

HATCHING EGG SANITATION

The goal of any breeder operation is to provide clean eggs to the hatchery. Sanitation is important in every step of collection, handling, and storage. Some operations choose to spray, foam, or wash their hatching eggs to further reduce the microbial contamination on the shell surfaces. When foaming or spraying eggs, make sure that (1) the dilution of disinfectant is according to manufacturer's recommendations, and (2) the entire shell surface is covered with foam or spray.

Washing hatching eggs by immersion is dangerous. The solution in the dip tank rapidly becomes contaminated, and it is difficult to keep the proper temperature of the solution (110°F). Another hazard results from leaving the hatching eggs in the warm dip tank too long. When this happens, yolk temperatures will be elevated for a sustained period leading to embryo mortality.

HATCHING EGG ROOM SAFETY CHART



TEMPERATURE
(Degrees Fahrenheit)

RELATIVE HUMIDITY
(Percent)

WARNING

Embryo growth will occur.

Egg quality reduced, hatchability reduced as temperature increases over 70°F.

WARNING

These relative humidities are conducive to sweating and fungal growth.

SAFE
(55-68°F)

Temperatures near the lower limit of the safe region may induce sweating when eggs are removed.

SAFE
(75-80%)

WARNING

Excessively low relative humidity results in moisture loss from eggs and reduced hatchability.

WARNING

Sweating occurs when eggs are moved to warmer locations.

Eggs will freeze, embryos will be killed at temperatures below 32°F.

In recent years, there has been interest in mechanically washing hatching eggs. Mechanical washers, when set properly, keep the solutions at the correct temperatures (110°F wash cycle and 120°F sanitation cycle). Most mechanical washers filter out debris from the solutions and continually proportion in more disinfectant. The ideal mechanical washers do not recycle their sanitation solutions. With good management, mechanical egg washers will remove more than 99.5% of the coliform and total bacterial counts on the shell surface, and reduce labor by eliminating the need for buffing, sanding or wiping hatching eggs. Mechanical egg washers that use brushes may remove the egg's protective cuticle. Some degree of success in cuticle protection has been attained with the brush-type mechanical washers by adding small amounts of formalin to the wash solution. ■

HATCHING EGG SELECTION

There are at least 15 different types of defective eggs that should be culled during hatching egg selection on the breeder farm. Causes of cull eggs are numerous and must be understood in order to reduce the percentage of cull eggs as much as possible.

Mechanical Factors

Inevitably, some hatching eggs will become dirty, stained, cracked, or punctured in the breeder house. It is essential to follow good nest management practices, such as providing adequate nesting space, maintaining a good sanitation program, replenishing nest litter (at least once every

two weeks) and handling eggs gently. Avoid water leaks and wet spots on the floor litter. All recommended practices should be followed to prevent hens from laying eggs on the floor or slats.

Biological Factors

The physiologic condition of the hen can be a cause of defective eggs. Stress and fever producing diseases may cause thin or wrinkled egg shells and erratic ovulation. Early maturing pullets lay more defective eggs than when sexual maturity is delayed. An added advantage of delaying sexual maturity is an increase in egg size at the onset of lay. Nutritional causes of defective eggs are not as common as most people think. Feed the hens a diet adequate in protein, calcium, phosphorous and vitamin D. When shells appear thin, supplemental calcium may be added in the form of oyster shell or other large particles. The source of calcium is important because of solubility factors. If a source of calcium is low in solubility, thin shells will result even when dietary calcium in the ration is sufficient.

The incidence of defective eggs is also influenced by heredity, as well as environmental factors. Certain types of defective eggs, such as those produced by erratic ovulation, have a strong genetic basis. Nevertheless, in most cases good management will minimize the incidence of defective eggs more than any other factor.

When an egg is delayed in the shell gland, two types of defective eggs will be formed: one egg will be extra-calcified and the other egg will be slab-sided. The slab-sided egg has a circular, smooth area surrounded by wrinkled shell. The smooth circular area is the imprint of the first egg

which has been delayed in oviposition. The delayed egg will most likely be extra-calcified. Unfortunately, extra-calcified eggs are difficult to distinguish from normal eggs, and they do not hatch well because the excess calcium seals the pores in the shell, reducing the necessary gaseous exchange capacity between the developing embryo and its outside environment. Cull all slab-sided and extra-calcified eggs from hatchery deliveries. To reduce the incidence of this problem, make sure the hens do not become overweight or unduly stressed.

Erratic Ovulation

Erratic ovulation is the major biological factor causing defective eggs. Erratic ovulation occurs when more than one ovum or yolk is released from the ovary into the reproductive tract in less than 25 hours.

Occasionally, the hen is stimulated to lay her egg before the 20 hours required for shell deposition in the shell gland. When this happens, membranous or soft shell eggs are laid. Double and triple yolked eggs occur when two or three follicles rupture simultaneously, sending as many yolks into the oviduct.

Other Types of Defective Eggs

Body checked eggs occur when the egg shell is broken while in the shell gland. More shell is laid down on top of the cracked shell, so that the egg is repaired to some degree by the time it is laid. The majority of body checked eggs occur when hens are disturbed during the early to middle stages of shell formation when the shell is still quite thin. This usually happens in the late afternoon or early evening. Avoid management practices that disturb hens

during this period. Strains of birds that are excitable tend to have a higher incidence of body checks than more docile strains. More body checks occur when the hen has to jump too high or fly to reach the nest or slats.

Wrinkled shells are usually the result of a damaged shell gland. A small percentage of wrinkled shells appear in the flock after a bronchitis infection. Although bronchitis is a respiratory infection, it sometimes localizes in uterine tissue. Irreversible damage occurs to the shell gland, and the affected hens will continue to lay wrinkled shells through the duration of their productive life.

Pimpled eggs or calcium deposits are another form of extra-calcification, and are the result of "calcium seeding" during shell formation. Severe examples should be culled. Cull all body checked, wrinkled, pimpled, and over- or under-sized eggs. They are likely to become cracked during handling, and are susceptible to dehydration and contamination. Eggs that are over- or under-sized may not qualify as defective eggs, but should not be sent to the hatchery. Odd cases of defective eggs are sometimes found, such as an egg without a yolk or a normal egg within another shell or membrane. Generally, these will be either over- or under-sized, and will be culled.

Two hatching egg selection posters have been published that present color photographs of examples of cull eggs that should be eliminated from hatching egg shipments (Mauldin, 1988 and 1989). Copies of these posters may be obtained by contacting the Poultry Science Department, Extension Section, at The University of Georgia. ■

EVALUATION OF SHELL QUALITY

It has been well documented that poor shell quality adversely affects hatchability. Age of flock, stress, disease and marginal nutritional deficiencies have strong negative influences on shell quality. Shell quality is typically high in eggs from young flocks, and rapidly declines in later ages of production. Stressors include poor management, crowding, temperature and ventilation outside of the comfort range, vaccine reactions, improper beak trimming, etc. Any fever producing disease will lower shell quality. Restoration of shell quality in a breeder flock may depend on improved management or treatment of disease rather than fortification of rations.

Shell quality may be assessed in several different ways. Poorer shell quality is apparent when increased percentages of eggs are found with cracks, rough shells, misshapen shells, ridges, sandpaper ends, and body checks. More quantitatively, shell quality is assessed by measuring shell thickness, porosity, Instron breaking strength, elasticity, and specific gravity.

Specific gravity is the least difficult of these procedures to implement in a breeder quality control program. The best compromise between accuracy and time efficiency to obtain reliable estimates of shell quality is to make three solutions of salt water with specific gravities of 1.075, 1.080, and 1.085. These solutions may be accurately prepared with the use of an hydrometer. Use Table 1 to determine approximate salt and water quantities necessary to produce these solutions. The temperature of the saline solutions must be

maintained at 65°F to insure the accuracy of this test. This procedure is most accurate when freshly laid eggs are used. On average, eggs will lose about 0.001 SG per day of storage, but this is highly variable.

TABLE 1. Amount of salt per 4 gallons of water needed to produce specific gravity solutions.

Specific Gravity Solution	Pounds of Salt per 4 Gallons of Water
1.075	2.6
1.080	4.0
1.085	4.1
Stock	7-10

Use the hydrometer to determine how much additional salt (from stock solution) or water should be added to each solution to insure accuracy.

Dip the eggs into the 3 saline solutions beginning with the lowest specific gravity; count and remove the number that float in each. For example, if you have 100 eggs and 20 float in the 1.075 solution, 40 in 1.080 and 40 in 1.085, the average specific gravity would be calculated as follows:

$$\frac{(20 \times 1.075) + (40 \times 1.080) + (40 \times 1.085)}{100}$$

$$\text{Specific Gravity} = \frac{108.1}{100} = 1.081$$

Flock averages below 1.080 generally indicate poor shell quality. In this case, consult a nutritionist and/or add oyster shell. ■

INSPECT INCOMING HATCHING EGGS TO IMPROVE QUALITY

The quality of hatching egg collection and selection is sometimes a problem for the broiler industry, and contributes to poor hatchability performance. When this problem goes unchecked, it almost always leads to more serious chick quality problems. Hatching egg collection and selection problems are easy to recognize and quantify. The quality control program detailed here may help you make substantial improvements in hatchability and chick quality.

Once per week, examine a sample of five trays of hatching eggs from each breeder flock to quantify egg collection and selection problems. Write down the numbers of problem eggs within each category. Develop standards in each category, and grade each flock accordingly.

An example of a hatching egg quality checklist is shown in Table 2. This procedure will identify those producers doing an acceptable job of egg collection and those who need more training (like the manager of flock B in the example). The information gained from this quality check should be shared with breeder service personnel so that they can work with the producers to improve the quality of hatching egg collection and selection. ■

TABLE 2. Hatching egg collection and selection.

Problem Category	Flock				
	A	B	C	D	E
upside down	10	31	8	12	10
dirty	6	11	6	5	4
stained	2	7	4	6	1
adhering sawdust	2	4	4	6	3
cracked	1	5	1	2	2
thin shells	4	6	3	5	4
culls	3	8	4	8	4
over-sanded	0	0	0	0	0
buggy condition (clean or dirty)	CLEAN	DIRTY	CLEAN	CLEAN	CLEAN

THE 7 TO 12 DAY CANDLING AND BREAKOUT PROCEDURE

The 7-12 day candling and breakout is the most accurate method of estimating breeder flock fertility. It is also useful in estimating the percentages of eggs that were set upside down, cracked, and embryos that have died early. Many hatchery managers incorporate the 7-12 day breakout into their quality control program to monitor the week-to-week status of their breeder flocks throughout the life of the flocks. Eggs can be candled and broken out as early as 7 days, but are more difficult to distinguish from viable embryos than eggs candled at 10 days of incubation.

The 21 day breakout gives considerably more information about the failure of eggs to hatch in comparison to the 7-12 day breakout, but is not as timely in gathering information about fertility and early deads.

Fertility estimates from 7-12 day breakouts are more accurate than 21 day breakouts since the contents of the eggs have not degenerated as much. For example, the presence of the germinal disc on an egg denotes an infertile and should be highly visible after 10 days of incubation. After 21 days of incubation, the germinal disc may be very faint or nearly indistinguishable.

Embryos that have died after incubation for 24 hours or less are much easier to recognize in the 7-12 day breakout compared to the 21 day breakout.

Two types of candlers can be used -- spot candlers and mass or table candlers. Mass candlers are more time efficient, and the spot candler offers considerably more accuracy. With practice, a quality control person can increase speed and determine more information with spot candling (i.e., upside downs and cracks).

Use the form on page 8 to record the data on each flock, and to calculate percentages of problem eggs. The 7-12 day candling and breakout procedure offers advantages in speed and accuracy in troubleshooting breeder flock fertility problems. It can be a useful addition to a hatchery-breeder flock quality assurance program. Copies of the *7-12 Day Candling and Breakout Analysis Form* may be obtained by contacting the Poultry Science Department, Extension Section, at The University of Georgia. ■

**7-12 DAY CANDLING
AND
BREAKOUT ANALYSIS FORM**

Date: 11-30-92		Company: GEORGIA BIRD		Hatchery Location: ATHENS		
Flock #: 122-A		Test: NO TEST		Breeder Flock Hatch Date: 2-24-92		
Male		Female		Age (wks): 40		
Breed: X		Y				
tray #	# eggs/tray	infertile	early dead	farm cracks	upside down	cull eggs
1	162		##	1		1
5	162	###	##			
10	162					1
15	162			1		1
TOTALS:	648	15	16	4	4	5
PERCENTS:		2.31	2.47	0.62	0.62	0.77

Fertility = 100 - % infertile = 97.69 %

OTHER OBSERVATIONS: 4 OUT OF THE 5 CULL EGGS HAD DARK TOP.

**ANALYZING HATCH DAY
BREAKOUT ANALYSES,
EMBRYONIC MORTALITY AND
REPRODUCTIVE EFFICIENCY**

You may be throwing away valuable information in your hatchery waste that could help you solve hatchery and breeder flock problems, or improve hatchability and profitability. Unhatched eggs hold information that breeder and hatchery managers need. Without breaking eggs to gain this information, reasons for moderate to low hatchability are only guesses (Mauldin and Buhr, 1991).

Breakout analysis involves sampling unhatched eggs from breeder flocks, and classifying them into the various causes of reproductive failure. The procedures for this valuable management tool follow.

The hatch day breakout analysis should be performed at least once every two weeks on samples of eggs from all breeder flocks regardless of hatchability performance. Even good hatching flocks should be monitored to get a true picture of hatchery and reproductive efficiency. Breakout analysis on all breeder flocks is critical in pinpointing problems in setters and hatchers; comparing breeder companies; evaluating flock or farm management; and compiling flock histories for production, fertility, hatchability and reproductive failure. Breakouts are also beneficial for trouble-shooting problems in production, egg handling and storage. For example, high numbers of early deads may indicate prolonged storage or storage at elevated temperatures, or inadequate egg collection procedures. In most hatcheries, the

breakout should be performed on two consecutive hatch days to ensure that all breeder flocks are sampled.

Breakout Procedure

1. Immediately after the chicks are pulled, collect a minimum of four trays of eggs per breeder flock from different parts of a single setter.
2. Remove all unhatched eggs, including pips, from the hatching tray. Place them in filler flats with the large end up and record the flock number.
3. Record the number of cull and dead chicks left in the tray.
4. Break out the eggs and classify them into the appropriate categories of reproductive failure listed in Table 3.

TABLE 3. Data collection.

General	Reproductive Failures
Flock number	Infertiles
Flock Age	Embryo mortality
Male breed	Pipped, unhatched
Female breed	Cull eggs
Sample size, sample index	Farm and transfer cracks
Setter number	Contaminated eggs
Management type (test)	Cull eggs

The best procedure is to break and peel the large end of the eggs since embryonic development will be located at the large end. The alternative method of cracking the eggs over a pan is not as accurate because quite often the embryo or germinal disc rotates beneath the yolk and is difficult to locate. Cracking eggs also increases the likelihood of rupturing the yolk membrane (these membranes are weak after 21 days of incubation). When the yolk membrane ruptures, it is difficult to know if that egg contained an early dead embryo or was infertile.

Embryo Mortality Determination

There are some cases when the embryo or the blastodisc will not appear on the top of the yolk. When this occurs, rotate the egg and pour off some albumen so that the germinal disc (fertile or infertile) will appear at the top. If the embryonic development is still not found, the yolk may then be poured into an empty pan and examined.

The classifications of embryonic death may be as detailed as the hatchery manager wishes. It must be kept in mind when starting a breakout program that the quality control person need not be an embryologist. In most cases, sufficient information is obtained by classifying the dead embryos by the week that death occurred (i.e., first, second, or third) and malformations. This is easily done after a few practice runs.

The clarity of the development is not as good in eggs broken after 21 days of incubation as when eggs are broken while the embryos are still alive. However, with practice one can conduct an accurate

breakout analysis by judging the embryos according to size and looking for some of the obvious changes in the developmental sequence (Table 4). A good training technique for someone not previously involved in breakout analyses would be to examine live embryos at different stages of development and compare them to the dead embryos obtained from unhatched 21-day incubated eggs, or compare to posters (Buhr and Mauldin, 1990; Mauldin and Buhr, 1991).

Identifying Fertility in 21-Day Incubated Eggs

Fertility of a 21-day incubated egg can be identified by looking for signs of development, and by examining yolk color and albumen consistency. Two statements follow regarding the identification of very early deads, positive development, and infertile eggs at 21 days, although there may be instances when these statements are not fail safe.

Generally speaking, an infertile yolk will be a brighter yellow than a fertile yolk.

The albumen of infertile eggs is thicker than the albumen of fertile eggs. An infertile yolk is held in the center of the egg while a fertile yolk will sink near the point end.

To accurately classify the egg, the presence or absence of early embryonic development must be established. Most eggs can be classified as soon as the top of the shell is peeled back. Others require closer inspection. Be careful not to let blood spots, meat spots, or yolk mottling trick you into classifying an infertile egg as fertile.

TABLE 4. Signs of embryonic development.

Day	Signs
1	Appearance of primitive streak and first somite
2	Appearance of amniotic folds; heart beats; blood circulation
3	Amnion completely encircles embryo; embryo rotates to left side
4	Eye pigmented; leg buds larger than wing
5	Appearance of elbows and knees
6	Appearance of beak; voluntary movement; demarcation of digits and toes
7	Comb growth begins; appearance of egg tooth
8	Feather tracts prominent; upper and lower beak equal in length
9	Bird-like appearance; mouth opening appears
10	Digits completely separated; toe nails
11	Comb serrated clearly; tail feathers apparent; eye lid oval
12	Eyelids almost closed and elliptical
13	Appearance of overlapping scales; embryo covered with down; eye lid slit opening
14	Embryo aligned with long axis
15	Small intestines taken into abdomen
16	Feathers cover body
17	Head between legs
18	Head under right wing
19	Amniotic fluid disappears (embryo swallows it); yolk sac half withdrawn
20	Yolk sac completely drawn into body; beak pips into air cell
21	Shell pipping; normal hatching

(Mauldin and Buhr, 1990)

Another pitfall is that most embryos that die during the second week of incubation look dark and are often mistaken for contaminated eggs. They appear dark due to the oxidation of the blood in the tremendous vascular system of the extraembryonic membranes. Most contaminated eggs will be malodorous.

Keep Accurate Records

It is necessary to collect general and reproductive failure data (Table 3) to provide a basis for analysis. Building a data base of information enables the evaluation of reproductive efficiency by flock and breeder, and is an excellent diagnostic tool

when problems arise in the hatchery or breeder flocks (Mauldin, 1989 and 1990; Mauldin, 1990). Also, the influences of flock management, field and incubation equipment can be measured by studying their effects on fertility, hatchability, and reproductive failure.

There are several efficiency variables that can be generated from the data collection. The examples provided in Table 5 are taken from the *Hatch Day Breakout Analysis Form* on page 13. This form may be obtained by contacting the Poultry Science Department, Extension Section, at The University of Georgia.

TABLE 5. Calculating reproductive efficiency values.

Formula:	% Fertility = $100 - (\# \text{ infertiles } \div \text{ sample size}) \times 100$
Example:	$100 - (48 \div 672) \times 100 = 92.86\%$
Formula:	% Hatchability = $(\# \text{ hatched } \div \# \text{ set}) \times 100$
Example:	$(19,661 \div 24,300) \times 100 = 80.91\%$
Formula:	% Hatch of Fertiles = $(\text{Hatchability } \div \text{ Fertility}) \times 100$
Example:	$(80.91 \div 92.86) \times 100 = 87.13\%$
Formula:	Spread = Fertility - Hatchability
Example:	$92.86 - 80.91 = 11.95$
Formula:	% Estimated Hatchability = $100 - \% \text{ Reproductive Failures}$
Example:	$100 - (7.14 + 3.27 + 0.45 + 2.23 + 1.64 + 0.89 + 0.45 + 0.30 + 0.60 + 0.60 + 0.30) = 82.13\%$
Formula:	Sample Index = $\% \text{ Estimated Hatchability} - \% \text{ Hatchability}$
Example:	$82.13 - 80.91 = 1.22$

All examples used in these calculations were taken from the *Hatch Day Breakout Analysis Form* provided on the following page.

HATCH DAY BREAKOUT ANALYSIS FORM

Date: <u>7-10-92</u> Company: <u>GEORGIA BIRD</u> Flock #: <u>WG-136</u> Test: <u>NO TEST</u>											
% Egg Production: <u>74.4</u>		Hatchery Location: <u>ATHENS</u>		Male Breed: <u>X</u>		Female Breed: <u>Y</u>		Age (wks): <u>36</u>			
Breeder Flock Hatch Date: <u>11-1-91</u> # Set: <u>24,300</u>				Actual Hatch %: <u>80.91</u>				Setter #: <u>16</u>			
# eggs/tray	infert	dead embryos			pipped unhatched	cull chicks	cracks		cont	cull eggs	small end up
		1-7	8-14	15-21			farm	trans			
168	### ###										
168	### ###	## #									
168	### ###	## #		## #							
168	### ###	## #									
TOTALS:											
672	48	22	3	15	11	6	3	2	4	4	2
PERCENTS:											
	7.14	3.27	0.45	2.23	1.64	0.89	0.45	0.30	0.60	0.60	0.30

OTHER OBSERVATIONS: _____

% FERTILITY: 92.86 % ESTIMATED HATCH: 82.13 SAMPLE INDEX: 1.23
 % HATCH OF FERTILES: 87.13 SPREAD: 11.95
 SHELL QUALITY: _____ MALFORMATIONS: _____

By examining the results of the example provided, an analysis of the problem areas of Flock #WG-136 can be understood. This 36 week old flock should have hatched considerably higher than 80.91%. First, the fertility of 92.86% should be about 4% higher for this age flock. Also, the percent hatch of fertiles was too low at 87.13%. This was caused by the elevated percentages noted for early deads (3.27%); pipped, unhatched (1.64%); cull chicks (0.89%); contaminated (0.60%); and cull eggs (0.60%). It is obvious that the problems of low hatchability of Flock #WG-136 stem from both breeder flock and hatchery. The low sample index of 1.22 reveals that the sample was reliable in providing an estimate of true performance.

The sample index listed in this table is a valuable measure of how representative your sample is of the true reproductive performance of the entire setting of eggs. A large sample index (greater than 3.0) would indicate that the sample was not a good representation of actual performance. Small sample sizes will result in greater variation in the sample index. Calculating these measures is necessary in interpreting results and taking corrective action. Figures 1 and 2 depict how building a data base on the life of the flock can be useful in evaluating reproductive efficiency. Notice how the age of a flock causes considerable variation in fertility, hatchability and embryonic mortality. Plotting these data enables flock evaluations over time, and enables a manager to determine the genetic potential of breeding stock by using the best hatching flocks as examples.

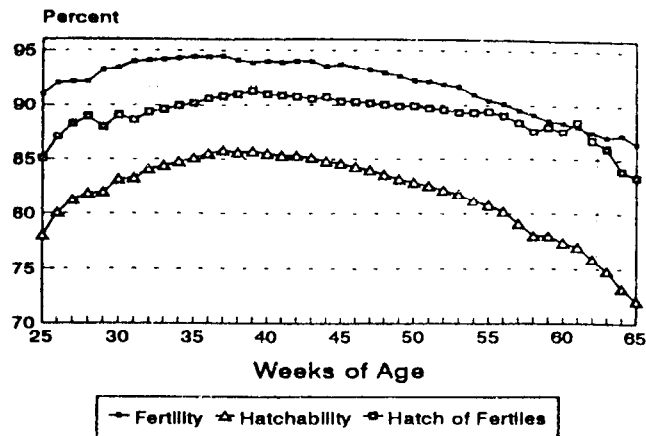


FIGURE 1. Influence of Flock Age on Reproductive Performance

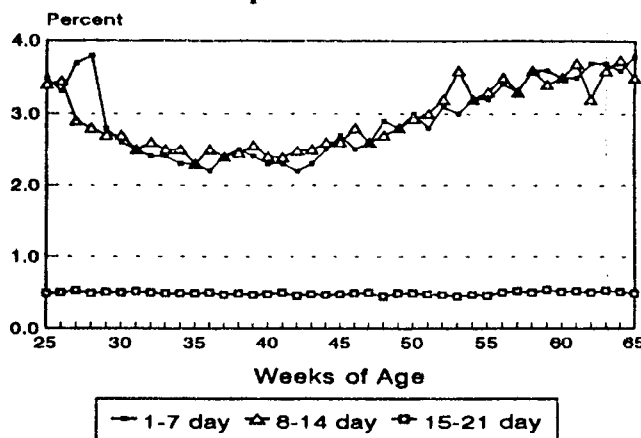


FIGURE 2. Influence of Flock Age on Embryonic Mortality.

Summary

A breakout analysis is a useful hatchery management procedure that provides valuable information in isolating problems in the breeder and hatchery program. The brief amount of time involved in performing breakouts will pay large dividends by increasing reproductive efficiency. The hatch day breakout analysis separates and quantifies the problem areas that cause low hatchability. With this information, the hatchery and breeder managers can take the appropriate corrective action to improve fertility, hatchability and chick quality. ■

MEASURE INCUBATION MOISTURE WEIGHT LOSS

The optimum range of weight loss of hatching eggs during incubation is 12-13% of the pre-incubation egg weight. Moisture losses inside the range of 11-14% are acceptable. Egg weight loss is due to moisture evaporation through the shell pores which provides a good way to measure and evaluate setter relative humidity. If the hatchery is performing outside this range (losing less than 11% or more than 14%), or if you don't know how much weight your eggs are losing, this procedure could help your hatchability and chick quality.

The most accurate way to determine your setters' humidity performance is to weigh a sample of eggs prior to setting, and follow those eggs through incubation with subsequent weighings. This procedure requires only a few minutes of effort each day of egg weighing, but will give an accurate moisture loss determination.

Gathering Data

Weigh individual trays to get tray weight, then add the eggs and re-weigh. Mark each tray so it can be found easily for subsequent weighings. Subtract the tray weights to get actual egg weights. A scale that is accurate to at least 0.10 pounds is recommended. When each tray is weighed, examine the eggs closely for cracks or culls -- if any are found, replace them.

Calculate Loss

Table 6 is an example from a recent study on how to determine egg weight loss (Mauldin and Wilson, 1988). The example calculations represent one moisture loss measurement. If eggs are weighed twice

during incubation, one weighing should be taken between 14 days of incubation and time of transfer. If day-to-day fluctuation is a concern, take several measurements, and use the appropriate days of incubation in the formula. It is important to calculate the 20-day projected loss to see if it falls within the acceptable range of 11-14%.

Even if eggs are weighed each day from day 1-19, calculate the projected 20-day loss after each of these weighings. This provides an immediate appraisal of setter performance. In the example calculations (Table 6), the projected 20-day moisture loss was 14.63% for one of the 10 trays. This figure is higher than the upper limit (14%) of the acceptable range indicating low relative humidity in the setter.

Moisture Weight Loss Varies

Most cases of moisture loss that fall outside the acceptable range are due to too little moisture being lost during incubation. Chick quality is also adversely affected when this happens. The chicks hatched from a high humidity environment are large, mushy, and have increased susceptibility to infection. When the eggs have a projected 20-day weight loss less than 11%, it is necessary to lower the humidity settings in the setter to compensate.

Factors which may influence the degree of moisture weight loss during incubation include setter humidity control, setter room humidity, season, ambient relative humidity, age of breeder flock, egg size, shell quality and shell porosity. The humidity output of the setter has the strongest influence on this measurement. Periodic weighing of eggs during incubation is an excellent quality control procedure to enhance the output of quality chicks. ■

TABLE 6. Example of egg moisture weight loss determination.

tray weight = 6.65 lbs.
egg and tray weight = 25.80 lbs. (day 0)
egg and tray weight = 23.70 lbs. (day 15)

Formula:

$$\text{egg weight} = \text{egg and tray weight} - \text{tray weight}$$

Example:

$$\begin{aligned} \text{day 0 egg weight} &= 25.8 - 6.65 \\ &= 19.15 \text{ lbs.} \end{aligned}$$

$$\begin{aligned} \text{day 15 egg weight} &= 23.70 - 6.65 \\ &= 17.05 \text{ lbs.} \end{aligned}$$

Formula:

$$\% \text{ weight loss (day 15)} = \frac{(\text{day 0 egg weight} - \text{day 15 egg weight})}{\text{day 0 egg weight}} \times 100$$

Example:

$$\begin{aligned} \% \text{ weight loss (day 15)} &= \frac{(19.15 - 17.05)}{19.15} \times 100 \\ &= 10.97\% \end{aligned}$$

Formula:

$$\text{average daily loss} = \frac{\% \text{ weight loss (15 day)}}{15 \text{ days}}$$

Example:

$$\begin{aligned} \text{average daily loss} &= \frac{10.97}{15} \\ &= 0.73\% \end{aligned}$$

Formula:

$$\text{projected 20 day loss} = \text{average daily loss} \times 20$$

Example:

$$\begin{aligned} \text{projected 20 day loss} &= 0.73 \times 20 \\ &= 14.63\% \end{aligned}$$

MICROBIOLOGICAL MONITORING OF HATCHERY AND BREEDER FARMS

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The credit for producing a good quality chick can not be taken by either the breeder farm or hatchery alone. It is truly a joint effort. The same holds true for hatching egg sanitation. There are many ways inadequate hatchery sanitation can result in poor chick quality; but, the hatchery is at a disadvantage when it receives eggs that were contaminated on the breeder farm. This discussion will cover sanitation monitoring for the breeder farm and the hatchery.

Supplies:

1. Culture plates:
Blood Agar for bacteria.
Sabouraud's Dextrose Agar (SDA) for fungi.
2. Pipettes:
For sampling mixed Marek's vaccine, evaporative coolers, etc.
3. Culturettes:
To swab the surface of eggs - qualitative.
4. Whirl pack bags:
Fluff counts - quantitative egg culture.
5. Tongue blades:
Fluff collection.

Culture plates should be stored in the refrigerator with the agar side on the top looking down. Allow the plates to come to room temperature before using them. When exposing plates, avoid breathing on or touching the agar surface or contamination readings will be falsely elevated. Pipettes work by suction, so use a small rubber bulb.

Breeder Farm

To check the sanitation of the egg room, use the pipette to obtain 1/10th ml of water from the humidifier. Place it on the blood agar plate and rotate to distribute the liquid. Air samples should be taken by exposing media plates for 3 minutes in the egg room. Egg surfaces can be swabbed, or whole eggs collected and sent to the lab for quantitative bacterial counts. To check the quality of egg surface contamination, use a culturette-type swab. (Quantitative testing requires a whole intact egg to be submitted to the lab.) Break the ampule in the bottom of the plastic container before swabbing the surface of the egg. This contains growth media and will moisten the cotton tip making it easier to pick up any surface contamination. Swabbing an area of shell 1 cm in diameter is a common technique. Carefully replace the swab in the plastic container. Take care to avoid touching the stick portion of the swab during any part of this procedure. Bacteria from hands can contaminate the culture. Some companies will spray sanitizer on the eggs at the breeder farm. The most benefit is derived from the earliest possible application. Some companies take egg buggies directly from the farm into the setter, so every effort must be made to keep the egg buggies sanitized. The surface of the egg buggies can be cultured in the same manner as described for egg surfaces, except that a 2 inch square area is swabbed.

Hatchery

The traffic pattern within the hatchery is an important part of maintaining hatchery sanitation. There should be no cross-over of people doing dirty and then clean jobs. Traffic should move from clean to dirty areas only -- not in reverse.

Samples to be taken:

1. Egg room air
2. Air intake into setters
3. Inside setters
4. Chick handling area
5. Vaccine room air
6. Vaccination machines
Mareks', Spray Vac, etc.

To check the cleanliness of air in the egg room, open the plate and expose the agar surface. The surface of eggs can be swabbed as well. This technique will be the same in the hatchery as on the breeder farm. Make sure each culture plate and swab is labeled so the lab will be able to keep track of the samples.

The quality of air going into the setters is important. In some hatcheries the intake is located near an exhaust or recirculating fan. Open the plate and hold the agar surface towards the air being pulled into the air duct. Hold the open plates in the air, or set them on the floor for a sampling inside setters. Be consistent between machines and from one time to the next.

If a specific problem has occurred and you want to find if bacteria or fungus is present in the hatchery, fluff samples can be collected. These are time consuming and tedious to perform, but are a good way to find out what organisms are present.

Collect some fluff from the vacated hatcher, and place in a whirl pack bag for submission to the lab.

The chick handling room is an area with a lot of activity where air bacterial and fungal counts will usually be higher here. Expose the agar plates to air in this area. To test the cleanliness of the Marek's vaccine as it reaches the chicks, squirt a dose of vaccine directly from the machines onto the agar plate. Check the spray vaccination by placing opened plates in empty, clean chick boxes and send them through the spray cabinet.

The vaccine preparation room is one area that should be kept very clean. Expose the agar plates to air in this area. Also, check the vaccine after mixing before it goes into the machines to make sure it is not being contaminated during mixing. Check the vaccine prepared to go into the spray cabinet as well.

The length of time that plates are exposed to air will depend on your sanitation goal. The longer plates are exposed, the more contamination will be detected. Start with a 3 minute exposure time. After your problem areas have been determined and corrected, try exposing plates for 5 or 10 minutes for a further challenge.

The evaporative coolers on top of the building are a neglected area. The water in these coolers should be sampled for contamination by pipetting 1/10th ml and rotating the liquid on the agar plate. Check the filters to make sure they are clean and in place.

Reports

Reports received from the lab typically give only the number of colonies present in each area tested. The lab will identify bacterial or fungal types when requested. This is not necessary for routine hatchery sanitation monitoring, but is available if a particular problem is present. An area is considered to be satisfactorily clean if the count comes back as 0-10 colonies. It is slightly contaminated if 11-20 colonies are present, while 21-30 colonies suggest moderate contamination. Too numerous to count or TNTC is never acceptable.

The best hatchery monitoring program occurs when the hatchery establishes its own sanitation monitoring system. This will allow the hatchery to maintain a schedule, and assure that the sampling is done the same way each time. It is a waste of time and money to do a less than thorough job. Check a minimum of four times a year to account for seasonal differences. Sanitation monitoring on a monthly basis, however, will prevent problems from getting out of control. Also, it is advisable to test before and after any new sanitation protocols are put into effect to insure that the new procedure is effective. Any time chick quality is poor, hatchery sanitation should be checked. ■

HATCHERY VENTILATION

Ventilation is critical to hatchery operation, and is often the least understood aspect of hatchery management. The purpose of the hatchery ventilation system is to supply the hatchery with plenty of clean, fresh air (oxygen), and to remove stale air (carbon dioxide and contaminated air). Further conditioning and filtering of the incoming, fresh air is necessary in most hatchery rooms, and the type of conditioning (heating, cooling, humidifying, dehumidifying) is variable depending on which hatchery room is being ventilated and the time of year. This discussion will focus on baseline requirements of the different hatchery rooms for winter and summer ventilation, and how to accurately measure air flow and air quality.

Positive and Negative Pressure Rooms

Generally, all clean rooms (vaccine room, setter and hatcher room, egg storage room, etc.) need to have positive air pressure, while all dirty rooms need to have negative pressure. There are some rooms, however, which do not fit easily into a category of positive or negative air pressure requirements, such as tray washing rooms.

During the operation of washing trays, the tray and buggy washing room should have negative pressure ventilation. The hot and excessively moist air should be ventilated out of the hatchery rapidly; however, many hatcheries store clean trays and buggies in this room. Serving as a storage room for clean equipment, it would be best if it were a positive pressure room.

Fresh Air is #1

The number one consideration for hatchery ventilation is a generous supply of fresh air. When fresh air is considered as a powerful disinfectant which replaces stale, contaminated air, then it is easy to visualize its disinfectant qualities.

One of the best instruments used in determining whether ventilation is good or poor is your nose. Does the air smell fresh and clean, or is it stale and stuffy with a hint of rotten or exploding eggs? The olfactory sense will give a good first impression of air quality the moment the hatchery entrance door is opened.

When designing a hatchery ventilation system, it is worth the extra money involved to exceed the requirements for ventilation. Sometimes, the extra air movement and ventilation during critical times can mean the difference between good and poor hatches, and good and poor quality chicks. Most hatchery managers think they need more ventilation capacity; no hatchery managers think they have too much.

Hatchery Room Ventilation Requirements

In the summer, when it is hot and humid, it is best to bring in as much fresh air as possible. This is especially true for the setter and hatcher rooms. A good ventilation system will completely exchange the air in these rooms every minute.

To determine the number of exhaust fans needed for summer ventilation, calculate the cubic area of the room to be ventilated. An example is provided below.

High summer humidity presents a serious ventilation problem for maintaining good air quality, especially when the evaporative coolers are running. Evaporative coolers add moisture to the air even when humidity already exceeds ideal incubation conditions. A good way to reduce the amount of water brought into the setter and hatcher rooms is to stage the evaporative coolers to circulate water only when the temperature is high. It is useless and even detrimental to try to evaporatively cool a room at night when the outside relative humidity (RH) is near 100%.

Example: Room with 10 setters

Length = 102 ft. Width = 33 ft. Height = 12 ft.

L x W x H = cubic feet

102 x 33 x 12 = 40,392 cubic feet

36" diameter exhaust fans move 10,000 cubic feet per minute

of 36" diameter exhaust fans needed:

40,392/10,000 = 4

Setter or hatcher space may be deducted in these calculations.

Table 7 is an example of a temperature staged system where water is circulated through the evaporative cooler pads only when the temperature is high. Some hatcheries have had some success by lowering their wet bulb humidistats inside the setters to 84° or 83°F.

TABLE 7. Temperature staging evaporative coolers.

Stage	Temp	Blower/water
1	76	low/no water
2	78	low/water
3	80	high/water

During the winter, it is economical to bring in less air since it has to be heated and humidified in the setter and hatcher rooms. Temperature should be maintained at 75°F to 78°F; RH at 55% to 60%. However, the minimum air requirements must be met to provide enough oxygen to the developing embryos. Most incubator manufacturers recommend 200 cfm fresh air intake per machine. However, it was stated earlier that it is best to have the capacity to exceed the manufacturers' recommendations.

One well-known designer of hatchery ventilation systems makes the following recommendations:

<u>Setter and Hatcher</u>	<u>CFM per machine</u>
Air cooled	475
Water cooled	300

Table 8 provides recommendations for the amount of ventilation required for the egg and chick rooms.

TABLE 8. Air intake required for egg and chick rooms.

Room	Fresh Air Required
Egg Room	5 cfm/1000 eggs
Chick Room	25 cfm/1000 chicks

The best way to measure air movement is with a hot wire anemometer. These types of anemometers are best, because they can be inserted inside the duct work by drilling a small hole. After the measurements are taken, the drilled holes can be closed with a small rubber plug or with epoxy.

To ensure accurate measurements, the location of the anemometer is critical since there is air turbulence within ducts. Turbulence is always found when air has to make a turn in the duct work, or when the duct work changes diameter. To avoid turbulence, take the measurements at least 12 to 18 inches from any turn and from any change in the duct size. Drill three holes into the duct (one center, one left, one right), insert the probe and measure each one for two minutes. Take the average of three readings to determine the cfm. Remember, anemometers measure only linear feet per minute (fpm). To get the cubic feet per minute, the linear fpm must be multiplied by the area of the duct or inlet where the measurement was taken.

Examples for Calculating CFM in Rectangular and Circular Ducts

Rectangular Inlet:

$$\begin{aligned}\text{inlet area} &= 1/2" \times 14" = 7 \text{ square inches} \\ \text{velocity} &= 4000 \text{ fpm} \\ \text{cfm} &= (7 \times 4000) \div 144* \\ &= 194 \text{ cfm}\end{aligned}$$

Circular Duct: (8" diameter)

$$\begin{aligned}r \text{ (radius)} &= d \text{ (diameter)} \div 2 \\ \text{area} &= \pi r^2 \\ 3.14 \times 4^2 &= 50.24 \text{ square inches} \\ \text{velocity} &= 650 \text{ fpm} \\ \text{cfm} &= 50.24 (650) \div 144* \\ &= 227 \text{ cfm}\end{aligned}$$

Measuring Air Quality

Air quality can be monitored by measuring the amount of carbon dioxide in the air. The setters and hatcher are the most important areas to measure, but it is a good idea to periodically measure the amounts of CO₂ in the setter room, hatcher room and chick room.

There are instruments available which were originally designed to measure air quality in mines where gases, such as carbon dioxide, carbon monoxide, mercaptans, amines, etc. can be lethal to mine workers. These same instruments can be used to measure CO₂ in the hatchery or ammonia in the poultry house. For CO₂ readings in setters and hatcher, place the tube into the exhaust duct. Table 9 provides acceptable CO₂ levels for setters, hatcher and rooms. ■

TABLE 9. Acceptable CO₂ levels.

Environment	Maximum CO ₂	
	ppm	%
Setter	3,000	0.30
Hatcher	5,000	0.50
Room	300	0.03

CHICK QUALITY DETERMINATION

The quality of chicks is a report card on the entire hatchery breeder operation and is one of the most important measures of quality. The chick processing operators are important in this process, because they separate the obvious cull and weak chicks while processing. It is a good procedure to count, record, and determine what made the chicks lesser in quality for each flock. For example, when the percentage of cull chicks is abnormally high, inspect the cull boxes. A high percentage of chicks with red hocks could indicate a humidity problem where too little moisture was lost during incubation. A high percentage of open navels, "button" navels, or mushy navels could indicate too little moisture loss, too short an incubation time, or omphalitis. Chick boxes should also be examined to record the numbers of cull chicks going into the placements.

The vaccination procedure also determines chick quality after placement. Dye in vaccine allows an evaluation of the quality of the Marek's injection. By observing the necks of vaccinated chicks, the quality control person can determine if the vaccine was correctly placed, was incorrectly injected into the muscle tissues, or was missed entirely. The effectiveness of Newcastle-Bronchitis vaccination can be tested by observing the spray vaccinated chick boxes. A uniform dampness of the down should be seen on chicks throughout the box.

First and second week chick mortalities provide an important evaluation of chick quality and should be communicated back to the hatchery manager. The more detailed and specific the information on mortality, the better. Records on mortality from 1-3 days, culls versus real mortality, and type of mortality are particularly beneficial. At a minimum, the hatchery manager should keep chick mortality records on all flock placements, such as those provided in Table 10. ■

TABLE 10. Two week chick mortality.

Grower	Started	First Week Mortality		Second Week Mortality	
		#	%	#	%
A	22,100	355	1.61	111	0.50
B	20,900	326	1.56	140	0.67
C	21,300	288	1.35	96	0.45
D	22,300	204	0.91	104	0.47
E	20,500	252	1.23	121	0.59
Total	107,100	1,425		572	
Average	21,420	285	1.33	114.4	0.53

CONCLUSION

The key to improving quality is to first determine quality. The quality control procedures described in this bulletin provide tools for quality determination and troubleshooting problem areas. Remember, the effort of collecting all the data and information with these procedures must be followed through to completion by taking corrective action. This will insure that quality is actually improved. ■

REFERENCES

- Mauldin, J. M., 1988. Reduciendo la incidencia de huevos defectuosos para la incubacion. *Avicultura Profesional*, Vol. 6:41-44.
- Mauldin, J. M., and J. L. Wilson, 1988. Watch egg weight during incubation. *Poultry Digest*, August.

- Mauldin, J. M., 1989. A six year history of reproductive performance in Georgia broiler hatcheries. *International Hatchery Practice*, 4:13-16.
- Mauldin, J. M., 1989. Hatching egg selection: Eliminate culls. *Misset World Poultry*, March.
- Buhr, R. J., and J. M. Mauldin, 1990. Daily embryonic development of the chick. Poster for *Misset World Poultry*, January.
- Mauldin, J. M., and R. J. Buhr, 1990. Recognize problems in embryonic development. *Misset World Poultry*, January.
- Mauldin, J. M., 1990. Evaluating reproductive efficiency in Georgia broiler hatcheries. *International Hatchery Practice*, 4:23-27.
- Mauldin, J. M., and R. J. Buhr, 1991. Analyzing hatch day breakout and embryonic mortality. *Misset World Poultry*, Vol. 7.
- Mauldin, J. M., and R. J. Buhr, 1991. Embryonic mortality viewed at hatch time with live embryo comparisons. Poster for *Misset World Poultry*, Vol. 7. ■

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