INFO SHEET

Monitoring Hatchery Performance

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In order to ensure good hatchability and poult quality, it is necessary to meet several biological targets during incubation. This paper will describe how to monitor, measure and incorporate these targets into a routine, hatchery performance program.

From Nest to Hatchery

After the eggs are laid it is necessary to ensure that the collection, disinfection and storage on the farm are appropriate.

During storage, in order to stop embryo development of a turkey egg, it has been found that the room temperature should be 13–20°C (55.4–68 °F). An important consideration is that as storage time lengthens, early embryo mortality increases (4 days = 6.45% vs. 14 days= 8.23%). If longer storage of eggs is required (14 days vs. 4 days), it is recommended that you pre-incubate the eggs (37.5°C or 99.5°F) at the hatchery for 12 hours prior to storage. This permits the embryo to reach the development of relatively inactive hypoblast stage (Stage XI); thereby increasing its survival during storage.

Important considerations for pre-incubation include:

- The beneficial results of the preincubation on hatchability are only significant when the eggs are going to be stored for long periods (14 days vs. 4 days).
- Pre-incubation prior to long periods of storage not only provides extra incubation time for the embryos to hatch, it improves hatchability due to a reduction in embryo mortality. The pre-incubation can also contribute to a better hatch window.

Turkey eggs require a longer incubation time (when compared to broilers) because they are laid at an earlier stage of embryonic development than chicken eggs. The majority of embryos from turkey eggs (at time of lay) are undergoing, or just completing the formation of the pellucida area (Stages VI & VII). In contrast, chicken embryos have completed the formation of the pellucida area by the time of oviposition (Stage X).

Incubation Temperature

For many years, the optimal temperature was assumed to be 37–38°C (98.6–100.4°F), and was assessed on the environmental air. Does the temperature reported in one spot of the machine reflect the temperature that the embryo is facing? The answer is no. The temperature of the embryo during its development does not always match the air temperature of the incubators; especially in the last two thirds of the incubation period.

Embryonic temperature during incubation is considered to be the most important physical factor for successful commercial poultry incubation. It is a crucial biological target that needs to be monitored frequently.
The breakouts (Photos 1 and 2) demonstrate that embryos can become overheated during incubation, especially in multi-stage incubators.

Photo 1

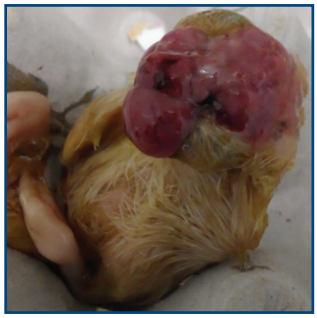
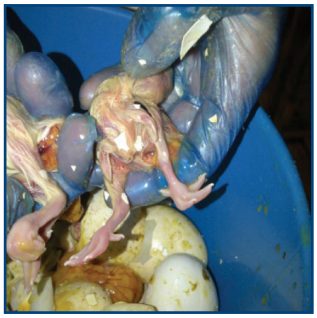


Photo 2



Signs of overheating, either in the setter or hatcher, include the following:

- Exposed brain
- Leg alterations
- Asymmetry between limbs, crooked toes, splayed legs
- Decreased yolk-free body mass (YFBM)
- Decreased heart size
- Red bruised hocks
- Enlarged yolk masses
- Unhealed navels or scabs
- Increased late embryo mortality
- Malpositions
- Head over the top of the wing or head in the small end
- White feathers

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Embryo Temperature

Embryo temperature can be measured by direct assessments (internal thermometer and egg shell temperature) and by indirect assessments (incubation time and moisture loss).

Direct measurement of embryo temperature is difficult in a commercial operation, as it requires inserting a thermocouple inside the egg. Similar results can be obtained by using an infrared thermometer, which has been allowed to equilibrate for 15 minutes inside the incubator. The use of an infrared thermometer is simple, fast and can be accomplished when the machines are in operation.

How to measure egg shell temperature

A simple way to measure egg shell temperature is to select 10 eggs, in different positions on the rack, and hold the infrared thermometer under the end of the air cell and record the reading (Photo 3).
NOTE: It is important to remember that the dead embryos will show a normal lower reading.

The target egg shell temperature will be 37.4–37.8°C (99.4–100°F) at the end of the incubation period. Special attention should be taken between days 6–13 of incubation, because both internal and external trials show that embryos at this stage of development are more susceptible to high temperatures.

Photo 3

For optimal poult quality, the temperature profile used during incubation must take into consideration the age of the breeder flock and days of storage. This is more easily accomplished in single-stage incubators than in multi-stage incubators. High temperatures have a stronger and more harmful effect on the embryo than lower temperatures. Keep in mind that large eggs will produce more heat and will have more difficulty reducing this heat.

Moisture Loss at Transfer

During the formation of the embryo, metabolic water is produced. The moisture loss is determined by relative humidity, temperature and shell conductance. A minimum amount of this water needs to be lost to generate a sufficient air cell for the embryo to breathe after internal pipping. Very high moisture loss will produce dehydration of the embryo and cause sticking to the shell membrane (Photo 4).

Photo 4

Several studies have shown that the highest hatchability can be achieved when the eggs are subject to the correct temperature and when the eggs lose 10–12% of the fresh egg weight by day 25 of incubation.

How to measure moisture loss at transfer

1. Select six trays of eggs to be used for this process, as well as for poult yield and egg breakout exercises.
2. Weigh each tray, and record the information.
   Note: Scale should be able to measure in increments of 5g at minimum.
3. Mark each tray.
4. Weigh an empty setter tray and record the information.
5. Calculate the initial egg weight.
   Complete tray weight minus the empty tray weight divided by the number of eggs on the tray.
6. At day 25, weigh the marked trays again and calculate the new egg weights and record the information.
7. Use the information from Step 5 (initial egg weight), subtract the new weight calculated in Step 6 and then divide back into the original egg weight. This will give you your moisture loss percentage.

If the results are different from than the expected, the humidity and ventilation profile should be revised.

Hatch Window

The hatch window is the time that it takes the poult to hatch. It is also called the "spread of hatch". The hatch window is a powerful tool used in the hatchery, used to assess the distribution of heat in the incubators and used to adjust the pulling time.

The duration of the hatch window is influenced by two factors:

- Stage of development of the embryos at the beginning of incubation
- Temperature and ventilation in the setters or incubators

When the temperature during the incubation period is uniform, the poults will hatch together in a short period of time. If the eggs are hatching too early, the poults are susceptible to dehydration; leading to an increase in first week mortality on the farms and poor overall performance. If they are hatching too late, it generates low hatchability, poor quality poults, an increase in pipped eggs and an increase in live embryos in unhatched eggs.

If the temperature, humidity and ventilation are appropriate in the incubators, you should expect to see the following for a 68–69 poult yield target:

- 36 hours before hatch: 1% of poults hatched
- 24 hours before hatch: 15% of poults hatched
- 12 hours before hatch: 95% of poults hatched

How to measure the hatch window

1. At transfer (Day 24 or 25), select a hatcher for monitoring and record how many eggs have been transferred to that particular machine.
2. Identify the projected pull time for that hatcher.
3. Calculate 36 hours prior to the identified pull time. NOTE: This timeframe should now be regarded as your ideal hatch window.
4. At the 36th hour before pull, open the hatcher and physically count how many birds are out of their shells in each tray. NOTE: The goal should be less than 1% hatched 36 hours prior to the identified pull time.

Evaluating Your Hatch

REASONS POULTS HATCH EARLY	REASONS POULTS HATCH LATE
Incorrect pre-incubation	Eggs stored for long periods without pre-incubation and/or stored at too low of a temperature
High incubator and/or hatcher temperatures	Low incubator and/or hatcher temperatures
Eggs set too early	Eggs set too late (lack of hours to compensate for flock age and days of storage)
Hot areas in the incubators and/or hatchers	Incorrect setting patterns in multi-stage incubators
Incorrect ventilation (seasonal temperature changes)	Incorrect ventilation (seasonal temperature changes)
	Low fertility (especially in multi-stage units)

Poult Yield

Monitoring the weight of poults at the time of hatch, and their relationship with the initial egg weights (poult yield) is also very useful for measuring incubation temperature and humidity.

How to measure poult yield

1 Use the same labelled trays that were weighed before setting and then monitored at transfer.

2 At pull time, weigh the birds and calculate the ratio of poult weight to initial egg weight.

It is recommend that birds which, at time of hatch, are going to have a long journey before placement (more than 6 hours), should lose 30–31% of their initial egg weight. For a short journey (less than 6 hours), the loss from initial egg weight should be 32–33%. If at the time of transfer the moisture lost was correct, but at the time of hatch the poult yield is lower than 66% of the weight of the eggs, this indicates one of the following issues:

- The incubation period was too long;
- The hatcher temperature was too high;
- The humidity was too low.

A yield of 72–73% indicates the poults are not ready and may have problems on the farm such as, laziness and unwilling to eat or drink at placement. These issues are a result of:

- Too short of a period of incubation;
- Low incubation temperature;
- High humidity levels.

It is very important to have correct timing, check hatch window frequently and adjust temperature and humidity of the hatchers accordingly. Every 1% loss in bird yield is equivalent to about 3 extra hours in the hatcher.

Breakouts

Egg breakouts should be routine in the hatchery, in both good and bad hatches, because they generate information to develop a guideline to monitor the incubation process. This allows the hatchery to react much quicker and implement corrective actions when hatch values are outside of the accepted range for the different embryonic mortality categories.

A hatch residue sample from six trays per flock (the same trays used for measuring egg moisture loss and poult yield) is used to routinely monitor a flock. The sample should be at least within 1% of the total hatch for the flock.

How to conduct a breakout

1. Count all the poults and the culls. Record and make note of abnormalities.
2. Of the remaining unhatched eggs, the embryonic mortality should be determined and recorded.
3. Divide the eggs minimally into the following categories:
   - Early dead membrane (1–3 days of development)
   - Early dead blood (4–6 days of development)
   - Mid dead (7–14 days when candling is made, or 7–16 days of development)
   - Late dead (17–28 days of development)
   - Pipped
   - Totally developed dead
   - Contaminated
   - Culls

A normal fertility score should be 95–97%. When fertility is low, the insemination process is the first factor considered.

Early dead membrane over 2% is usually linked to adverse conditions preceding the setting of the eggs (farm storage, transportation, handling, storage, disinfection, etc.) or a very high initial incubation temperature.

High early dead blood values, over 1.5%, indicate that the temperature, the turning and the ventilation during the first few days need to be reviewed. Disinfection, transportation and the storage should be also reviewed. This could also be linked to vitamin deficiencies of vitamin E, riboflavin, biotin, pantothenic acid or linoleic acid.

Mid dead has a high association with contamination or extreme incubation temperature. It also is associated with high early dead blood embryos that are carried over into the mid stage. Nutritional deficiencies in riboflavin, vitamin B12, biotin, niacin, pyridoxine, pantothenic acid, phosphorus, boron or linoleic acid are also associated with mid dead.

Contaminated and cracked shells are typically less than 0.5%. Late dead and pipped embryos are around 3%.

Poult Quality

Measuring the poult quality is complex because, until now, there has not been a perfect test that allowed the hatchery manager to predict the on-farm performance of the poults.

Poult weight (over 60 grams from a 90 grams egg) and poult yield (68–69%) are easily measured. However, the disadvantage is that the amount of residual yolk sac cannot be measured. Both poult weight and poult yield are not very useful to predict first week mortality or on-farm performance.

Yolk-Free Body Mass (YFBM) is a better indicator of bird development than body weight. Different studies have shown a positive relationship between YFBM and subsequent performance of the bird. YFBM is calculated by subtracting the residual yolk from the body weight. A higher YFBM (89–92%) indicates a better development of the poult during incubation. The increase in egg size due to an older breeder flock age must be taken into account in the evaluation. Although this is an accurate method to evaluate poult quality, animals have to be sacrificed and the method is time consuming.

Poult length is an interesting test to estimate the performance of turkeys at the farm. Unfortunately, due to the long life of the turkeys, it is very complex to determine the value of it.

Diagram 1: Tona and Pasgar Score is one of the more popular measurement tools that put a visual score, by a quality control person, into a measureable and repeatable number. The Tona and Pasgar Score evaluates different criteria, such as navel, legs, beak, yolk sac, eyes and reflexes or other activity that primarily reflect conditions during the last part of incubation. These criteria are good indications of poult livability in the first week post hatch, but not good at predicting long-term production performance. In any case, these tests are useful to the hatchery manager when reviewing incubations conditions; especially if they are done on a routine basis. Diagram 1 shows the physical characteristics that have been associated with low first-week mortality after placement.

Diagram 1: Tona and Pasgar Score

Reflex:
when poult is placed on its back, it can quickly return to its feet

Eyes:
open, alert and bright

Beak:
strong and clean (no blood or malformations)

Down:
appearance is dry and clean

Yolk:
small and soft to the touch

Navel:
closed with no scabs, strings or blood

Legs:
strong, stands easily, no swelling or redness of hocks, no malformations

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Transportation and Farm Placement

To ensure optimal performance and to minimize mortality, turkey poults should be given food and water as soon after hatching as possible. A common practice in the turkey industry is to hold poults in the hatchery overnight, prior to placing on food and water. Poults that are delayed access to feed for 48 hours post-hatch show depressed body weights.

It is very important that the birds maintain a state of homeostasis during transportation. This is achieved with good ventilation, humidity levels of 50–60%, and proper temperatures of 39.4–40°C (103–104°F) (measured rectally in the birds).
NOTE: Internal poult temperature above 40.6°C (105°F) will lead to panting.

Conclusion

Artificial incubation is a process that involves several stages. During each stage the embryo is required to cope with some biological targets. Every stage should be monitored in order to collect information, note alterations and make corrections, if and when necessary. Making these measurements a routine occurrence in the hatchery is important. Having this information throughout the process makes us better prepared, so that on hatch day there are no surprises and that poult quality can continue to improve.

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