Section 6

Embryonic Development and Hatchery Management Notes

Slide 2

A well run hatchery is critical for any integrated poultry company whether it be a primary breeder company or a commercial meat company. Hatchery operation directly impacts profitability because chick quantity is dependent on hatchery operation. Specifically in the number of eggs that hatch from fertile eggs produced but also in the quality of chicks that hatch and the chick's livability once they reach the farm.

Slide 4

But first let's discuss embryonic development. Embryonic development can be broken into two phases. Phase one occurs in the hen's body prior to the egg being laid (oviposition). Approximately 4.5% of embryonic development occurs during this phase with the 1st cell division occurring 3 hours post-fertilization, long before the egg is laid (approximately 24 hr. post fertilization).

Phase 2 of embryonic development then occurs after oviposition if the conditions are correct. The primary condition that dictates embryonic development is temperature. If the temperature of the egg is above 75 degrees F cell division will occur. When an egg temperature is below 75 the embryo will not develop and the more times an embryo transitions between this temperature zone the less likely the embryo will develop into a chick. Therefore timely collection of the eggs from a breeder house and into the egg cooler is critical.

How can you tell if an egg is fertile? When you break an egg open look for the germinal disc. This is where the hen's genetic material is on the egg. If the egg is fertile the germinal disc will have a bull's eye appearance.

Slide 5

In addition to the yolk, albumen, membranes etc. that are also present in an infertile egg there are three additional embryonic membranes that will develop in a fertile egg. The allantois breaks down the albumen for the chick to digest; it also aids in Ca absorption by the chick and stores the chick's excretory products.

The chorion fuses with the allantois and the shell; it produces carbonic acid which will release Ca from the shell for chick absorption. In this it also weakens the shell which will aid the chick in hatching. Finally, the amnion which surrounds and protects the chick.

Slide 6

When an embryo is developing there are daily changes that will occur. The embryo is developing rapidly in the egg. At day one of incubation there is evident tissue development

Slide 7

At day 7 of incubation the forming chick is evident. Day 7 marks the end of the Early Development Period the eye is pigmented, the 4-chambered heart is fully formed the beak, wings, and legs have begun to form, blood vessels in the allantoic sac are visible and the feather tract on the back is beginning.

Slide 8

The end of the 2nd week of incubation is also the end of the med-development period. Some "landmark" occurrences in this period include the toes, toenails, and wattles are present, the embryo is fully covered in down, and uric acid begins to accumulate in the allantoic sac indicated metabolic processes have begun.

Slide 9

Day 19 is the last day that the developing embryo will be considered an embryo. The hatching position is fixed at this point, there is decreased amniotic fluid present in the egg, and the allantoic fluid has been completely absorbed. Final yolk sac contraction begins on this day, and the chick will pip into the air cell initiating pulmonary respiration.

Slide 10

Chick fully formed, Yolk residue completely drawn into the body, beak will pierce air cell (pulmonary respiration occurring)

Slide 11

It can take a full day for the chick to fully hatch from the egg. Chicks typically dried and fluffed 12 hours post hatch.

Slide 13

The breeder farm plays an important role in hatching egg quality and the livability of the embryos once they reach the hatchery. Eggs will be laid on the farm that will be unsuitable for hatching eggs. It is the responsibility of the breeder farm to remove these eggs so that they are not sent onto the hatchery. Eggs that should be removed include misshapen eggs, excessively dirt eggs (help prevent cross-contamination in hatchery, excessively small eggs (excessively small chicks will result), and excessively large eggs (probably double yolked; won't produce a chick).

Slide 14

At the breeder farm eggs are packed onto carts similar to the one seen in this picture. Often times the eggs will not be handled again, this is a good thing because not only does it reduce the manual labor required at the hatchery but can prevent contamination of the eggs through handling.

At the breeder farm eggs must be stored for a time prior to pick-up and transport to the hatchery. Eggs will typically not be on the farm for more than 3-4 days therefore eggs are typically picked up 2 times a week.

It is critical that the eggs be placed on carts with the big end up, the air cell will develop at the big end of the egg and the chick needs to develop so that it will be able to pip through the air cell to get its first breath of air. If eggs are placed in the cart with the big end down hatchability can be decreased by approximately 40%!

Slide 15

The hatcheries primary responsibility can be broken down into two major segments: those regarding the fertile eggs and those regarding the chicks that hatch

Slide 16

Once the eggs reach the hatchery they could potentially be stored for several days prior to being placed in the incubator. It is critical that the temperature of the eggs remain as constant as possible and that the temperature not exceed 75 degrees F. Although temperature should not exceed 75 there can be advantages to holding eggs toward the high end of this range because sweating of the eggs can be

reduced. Sweat on the outside of the egg can potentially reduce air exchange and cause cross contamination between eggs

Relative humidity should also be monitored in the storage of hatching eggs so that moisture loss is minimalized during storage. It is recommended that RH be maintained somewhere around 60-70% during storage.

Slide 17

In the incubator the majority of embryo development will occur (approximately 95%). Chicken eggs will remain in the incubator for 19 days and turkey eggs will remain in the incubator 25 days.

There are three critical factors to consider when incubating eggs and we will talk about these several times during this lesson. These factors are: temperature, humidity and egg rotation.

Slide 18

Temperature in the incubator should be maintained as constant as possible, there is a range of appropriate temperature for every machine and often times the most optimum temperature is machine dependent.

It should be noted however, that embryos have low tolerance for temperatures over 104 degrees F PARTICULARLY TOWARDS END OF INCUBATION. The embryos can withstand these temperatures for a short time typically however prolonged high temperature will reduce hatchability and will also increase the number of abnormal chicks that will hatch.

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Slide 20

Temperature in the incubator is measured by what is referred to as the dry bulb temperature. This is just a thermometer in the incubator. Relative humidity is measured by what is referred to as the wet

bulb temperature which is defined as the temperature if the bulb were immersed in water. This is accomplished in the incubator by a wet "sock" covering the bulb of the thermometer. Below is an example of a psychometric chart, from the dry bulb temperature and the wet bulb temperature the relative humidity can be determined. For example, if your dry bulb temperature is 80 degrees and your wet bulb temperature is 60 degrees the relative humidity is approximately 55%. (Remember Physiology section – amount of water air can hold and how it changes with temperature)

Slide 21

Commercial incubators display both the dry bulb and the wet bulb temperature. So that with a dry bulb temperature between 97 and 100 degrees F and a wet bulb temperature between 79 and 85 degrees F the incubator will have a relative humidity of around 50-60%.

Slide 22

Finally egg rotation is key to successful hatchery management. Egg rotation commonly occurs one time per hour and should occur 6-8 times per day. From the photos taken at the University of Arkansas Pilot Hatchery, egg rotation is set to automatically occur without management intervention. Egg rotation is important because if the embryo settles to one side of the egg for a prolonged time as the albumen thins it will adhere to the egg shell.

Slide 23

At day 19 for chicken eggs and day 25 for turkey eggs will be removed from the carts in the incubator and placed in hatching trays. This is accomplished automatically with the use of suction cups, also at this time an in-ovo vaccination will commonly occur. Embrex is the company that has the technology for this vaccination method, basically, a small hole is poked in the large end of the egg and the vaccine is administered directly into the egg.

Slide 24

In the hatcher temperature and humidity also remain important, remember chicks are particularly sensitive to high temperature toward the end of incubation. This is because feather covering is in place and amount of buffering fluid in the egg is lowest at end of incubation.

Slide 25

Air quality is another factor in hatchery management that must be controlled. Air exchange occurs across the shell as the embryo grows. Fresh air (O_2) is absorbed through the pores in the egg shell through the shell membranes. Embryo producing CO_2 through normal metabolism therefore having a constant fresh air supply as well as proper exhaustion of CO_2 is critical because CO_2 can become toxic to the embryo in high concentrations.

Slide 26

Of course not all of the eggs placed in the incubator/hatcher will hatch. For broilers hatching will occur on d 21, for turkeys d 28. There are several factors that would cause an egg not to hatch from infertility, to malnutrition in the hen, to improper egg handling, or temperature or humidity abuse.

But regardless of cause the un-hatched eggs and empty shells must be separated from the live chicks. In most hatcheries, this is completed automatically with a series of belts with rollers.

Chick counting and processing is a large portion of the responsibility of the hatchery. Typically it is completed with a combination of automatic and manual labor although broiler hatcheries are typically much more automated than turkey hatcheries.

Slide 27

There are several chick processing procedures that will be completed at the hatchery.

Vaccinating is completed using a spray vaccine; in the top picture you see a typical vaccine “cabinet.” The vaccinations typically administered via this method include new castle and bronchitis.

Slide 28

After processing, the chicks will be counted into batches of 100 chicks and placed in hatchery trays. They are held in a heated storage area until they can be loaded and delivered to the grow-out farm. Climate controlled trucks, or chick buses, are used to transport the chicks to the grow-out farm.

Slide 29

Tracking productivity of both breeder flock and hatchery performance is critical to maintaining profitability. For evaluating breeder flock performance true fertility is a calculation commonly used. True fertility is defined as the number of eggs set that is fertile at point of ovipostion. Therefore, it can be used to not only evaluate breeder flock performance but also artificial inseminating crew efficiency (commonly used in the turkey industry). True fertility can be evaluated as early as 10-12 days of

incubation. The eggs are candled and the presence of a developing embryo would indicate a fertile egg. Eggs that don't have an embryo clearly developing can be broken open to determine whether the egg is early dead (fertile but not developing) or infertile.

Slide 30

Hatchability is perhaps the measure of most importance for evaluating hatchery performance because it is a direct measure of hatchery performance as most of the fertile eggs that are brought to the hatchery should hatch. There are many factors that can affect hatchability including egg handling, and equipment performance. Therefore, low hatchability can indicate many problems including incubator or hatcher conditions.