HATCHING EGG PRODUCTION TECHNIQUES AND THE ONE-DAY-OLD CHICK

Course objectives

- How is reproduction carried out in poultry?
- What methods are use to control it?

Physiology of fertilization and egg-laying

Since fertilization occurs at the beginning of egg formation , embryonic development continues during transit through the oviduct until oviposition 24 hours later.
Sperm storage in "sperm nests" formed by glandular folds occurs at the base of the fimbriae but primarily at the uterovaginal junction. Their survival time varies among species and determines the frequency of insemination for species using artificial insemination.
Sperm are stored in the infundibulum which captures the ovum ("the yolk of the egg ") when it is laid and where fertilization takes place.
Sperm production is continuous from sexual maturity onward. The determination of sexual maturity is comparable to that of the female, in relation to variations in day length. However, while long days stimulate early sexual development, short days promote the maintenance of testicular weight and thus the persistence of sperm production.
Sexual maturity is reached around 20 to 24 weeks for light breeds and 24 to 28 weeks for heavy breeds. A rooster's sperm production is 2 to 10 billion sperm per day, while a hen's requirement is around 100 million every 7 days. It is worth noting that the rooster does not have a true semen storage system (3 to 4 days in the vas deferens, no epididymis) and that there is spontaneous evacuation with the urine when the rooster is not mated .
Sperm production is reduced in hot weather. Feed rationing is necessary to ensure better longevity and fertility in roosters.

Introduction

Selection objectives

For laying hens

- Increase in the number of eggs/hen/year
- Decrease in IC ,
- Increased eggshell strength,
- Increased quality of the albumen,
- Sufficient egg weight at the start of laying,
- Increase in the mass of eggs produced.

For broiler chickens

- Minimize the cost price of the final product,
- Improve the quality of carcasses,
- Reduction of the state of fatness,
- Increased pectoral muscles,
- Reduction of the IC

Multiplication farms are farms where the eradication and control of diseases transmitted vertically are crucial for food safety.

The possibility of contamination in hatcheries by diseases transmitted horizontally increases the importance of sanitary control measures.

1. Breeding of breeding stock

The career of breeding males and laying hens generally unfolds in three phases:
From 0 to 8 weeks: **the "start-up" phase** = the chick's adaptation to its new environment (thermoregulation, feeding, watering, social behavior) and the start of its growth.
8 to 20-22 weeks: **the "rearing" phase** until the stage of sexual maturity in males and the start of egg-laying in females.
✓ From the start of laying to the end of the laying period (or molt): **the laying phase** lasts around 50 to 52 weeks.

The rearing period for breeders extends from the one-day-old chick stage until sexual maturity in males and the start of egg-laying in females. The main criteria for judging the quality of a batch of breeders ready to start are: viability, growth rate, and weight uniformity within the batch.

Startup

Day-old chicks are normally delivered in separate sexes at a ratio of 15 males to 100 females. The layout of the premises, the preparations before and at the time of the introduction of the day-old chicks, the watering and feeding equipment, the monitoring and regulation of the climate) are comparable to those for laying hens and broiler chickens .

The temperature at the level of the chicks (under brooder) should be 35°C, then decrease by 2°C per week until 21°C, the optimum temperature in the rearing building.

Several types of buildings may be suitable, however it will need to be cemented in order to allow for good hygiene.
The proper distribution of feeders and waterers should not hinder the movement of animals.

To obtain good quality pullets, their growth must be controlled to ensure they develop good muscle mass without excess fat. This requires monitoring feed intake through weighing starting at 5 weeks of age.
As with the table egg layer, it is essential to apply restrictive feeding and lighting programs, which can delay laying and thus limit the number of small eggs.
The maximum density of 10 subjects per m2 ^{is} recommended at the start.

LIVESTOCK
Separating the sexes is recommended: males grow faster, and overconsumption of feed by the females would lead to earlier maturity in the males. The goal of this rearing method is to obtain males of average weight by limiting weekly weight gain.

It is therefore preferable to reserve different feeding and lighting programs for roosters than for hens.

The males

They are raised in batches of 80 to 100 subjects at densities of 3/m2 . The vaccination and parasite monitoring program must be consistent with that of the pullets.

At 5-6 weeks, an initial selection will be made; those with physical deformities will be eliminated. It is important to obtain well-conformed and sexually well- developed males (a ratio of 13 roosters to 100 hens at this stage).

The best birds are dethumbed, meaning their two inner toes are amputated to limit back trauma to the hens during mating . They must also be clipped so they can be identified within the flock.

The growth of males must be controlled; the amount of feed should be limited to maintain slow growth leading to sexual maturity without excessive fat but with good fertility. The recommended weight is approximately 3100 grams at 22 weeks, which corresponds to roughly 50% of the potential weight of a male fed ad libitum. It is necessary to weigh the birds weekly to determine their average weight. However, it is important to cull inactive or unsuitable roosters.

The females

The rearing takes place on the ground at recommended densities of 8 to 6 pullets/m2 at the end of rearing.
Controlling the age at maturity of pullets is achieved through short-day lighting programs to delay this maturation, ensure production, and obtain an optimum egg size for good hatchability.

Among the programs that can be considered, the use of a controlled-environment poultry house is ideal, in order to easily control the sexual maturity of the flock.

Weekly growth monitoring is implemented from the 6th week onwards to follow the adjustment of the growth curve to the selector's recommendations: 1 to 5% of pullets per batch are weighed individually to follow the distribution of individual weights and average weight.
A vaccination program is implemented, along with parasite monitoring.
Beak trimming or beak clipping is carried out on pullets around 8 to 10 days old to avoid the consequences of social interactions (aggression, cannibalism or feather pecking).
Transfer to the laying henhouse

This transfer will take place between 20 and 25 weeks (depending on the strain). It will allow the animals to leave a space that has already been occupied for more than 20 weeks and move to a new, disinfected space, thus reducing the infectious and parasitic pressure on them.

This stage provides an opportunity for sorting to eliminate sick animals, underweight birds (both pullets and roosters), as well as birds with poor conformation and leg alignment (roosters). Approximately 2 to 6% of pullets and up to 10% of roosters will be culled. This culling constitutes a further step in the selection process: it helps reduce the heterogeneity of the breeding stock put into production and therefore that of the chicks to be hatched.
It will be necessary to keep 9 roosters for every 100 hens. The best roosters can be kept to "replenish" the flocks in case of a decrease in activity or mortality.

The management of breeding herds

The accommodation

Two types of farming are possible:

- For floor rearing: the layout of the rearing area must be primarily designed to allow good mating of hens by roosters, laying of hatching eggs and their collection under good conditions (nest or laying box) and a location of feeders allowing selective feeding of roosters and hens.
Depending on the formula, 40 to 60% of the surface area is slatted flooring (limiting litter-related problems). Stocking densities are 4 hens/m² in the original setup.
(flesh) Heavy, 6 hens/m² in light breeds (laying). An ambient temperature of 15°C is sufficient.

- Cage-rearing breeding females produces cleaner eggs and the animals are calmer. However, it generally requires the use of artificial insemination.

The diet of these breeders differs from that of laying hens for consumption eggs by an increased richness in vitamin A, vitamin E, necessary for hatching, B group vitamins and manganese.

Roosters should have access to raised feeders to receive special feed formulas. Their feeders should be well distributed, with one feeder for every 15 to 18 birds. They should be placed as far away from the nests as possible to avoid hindering the hens' access. Proper distribution of watering and feeding equipment encourages the hens to move around, which promotes fertilization.

Care must be taken not to overfeed during production if the hen is at a healthy weight. It is advisable to reduce feed intake if health problems decrease the hen's production potential. The distribution of grain can only encourage the mobility of the conveyor belt.

Weighing must be carried out regularly and in case of anomaly, a check must be carried out on the quality and quantity of food distributed as well as the evolution of weight.

Nests

At the start of laying, a few nests can be placed on the ground for two or three days to acclimate the pullets. The remaining nests should be located approximately 40 cm above the ground and should be sufficient in number to prevent ground laying, which results in broken, soiled eggs and predisposes the hens to feather pecking and prolapse. From the 22th to the 28th week. to prevent ground laying, the feeding lines should not be in operation for 8 to 12 hours.

You need to provide 1 nest or laying box for every 4 to 5 hens. The quality, number, distribution, and comfort of the nesting boxes all play a significant role in the quality of the hatching eggs and overall productivity. These nests must be protected from both cold and extreme heat. They must also be easily accessible for egg collection.

From the 26th week onwards, 90 to 92% of the eggs must be fertilized, reaching 94 to 97% by the 28th - 29th week.

Driving and monitoring

Mortality and laying performance data for the flock are continuously recorded on breeding records, allowing for regular comparison of results with the strain's objectives. The number of eggs collected enables the calculation of the ratios of eggs laid per week per hen present.

Feedback from the hatchery provides information on flock fertility and the percentage of eggs hatched per incubable egg after approximately four weeks (storage + incubation). In case of abnormalities, it is necessary to check the weight of the roosters, their proper distribution and behavior within the group, and to observe the behavior of the hens, their mobility, etc.

A breeding hen has no problem going broody. However, a turkey, especially at the beginning of the laying period, is quite frequently prone to this behavior. It is then necessary to isolate and stress her in a hatching pen to bring her back to normal.

The hatching egg

The results obtained at the hatchery level reflect the quality of the work at the rearing level.

Receiving the eggs

egg reception and disinfection airlock.

Storing and preparing hatching eggs

Egg-laying is fairly concentrated at the beginning of the day, so the egg-laying boxes are quite full. When there is no automatic collection system, several visits are necessary throughout the day to prevent soiling and breakage.

The eggs must be collected at regular times in order to check the daily progress of egg laying, which should be 3% per day.

The eggs are collected in plastic trays with individual compartments (washable and disinfectable). Cardboard trays should be avoided as they absorb moisture from the egg. It is essential to cool the egg quickly, as embryonic development continues above 27°C.

Among the eggs that will not be incubated are: those that are too small, too large (2 yolks), those that are deformed and those with micro cracks: this therefore requires sorting based on calibration (55 to 65g are retained) and on visual examination.

For soiled eggs, cleaning according to a precise protocol can be considered (before the egg cools and the surface elements shrink inwards): the quality of this cleaning is essential to prevent contamination of other eggs in the hatchery. Egg disinfection is carried out by fumigation with formaldehyde at 20°C and a relative humidity of 80%. Antibiotic treatments are also administered (e.g., tylosin).

Storage is an important phase because it allows a sufficient number of eggs to be gathered over several days for simultaneous incubation. This storage must be carried out under strict hygiene conditions and at relatively precise temperatures and humidity levels (10 to 15 °C and 70 to 85% humidity).

The seeds should be stored with the large end facing upwards and tilted at a 45° angle. The loss of germination capacity is 1% in 5 days.

Artificial incubation

This activity takes place in hatcheries, which are industrial facilities representing a significant investment. Indeed, several tasks are carried out in hatcheries, including storage, egg preparation before incubating , egg incubation and hatching, sorting (if necessary), sexing, certain vaccinations, chick packaging, and shipping.

The hatchery is a place highly exposed to health alerts since a large number of individuals of different health origins are gathered there in conditions of heat, humidity and handling that are particularly conducive to the multiplication of germs and their transmission.

Temperature

The hen's body temperature is 41°C, as is the egg's temperature upon hatching. It is recommended to keep the eggs at a temperature of 21 to 27°C for several hours after laying, before lowering them to storage temperature.

Technically, we distinguish the thermal preparation of the eggs before putting them in the incubator, the incubation itself, in the incubator which lasts 18 days and the hatching in the hatcher, for 3 days, i.e. a total duration of 21 days in the hen.

	Chicken	Turkey
Total duration (days)	**21**	**28**
Incubator duration	**18**	**24**
Temperature (°C) Incubation.	**37.8**	**37.8**
Hatching .	**37.5**	**37.2**
Relative humidity (%) Incubation .	**55**	**50**
Hatched .	**65 - 85**	**75 - 85**

Table 1: Thermal preparation of eggs

The thermal preparation of eggs involves heating them from their intentionally cool storage temperature to the desired incubator temperature (close to 38°C). This thermal preparation helps to limit temperature fluctuations when the incubator is loaded.

The incubator is loaded onto trolleys where the egg trays are stacked. The eggs must be placed point down.
The trays where the eggs are placed are tilted alternately; otherwise, the embryo remains stuck to the shell membrane, which would limit the development of the vascular area. This rocking motion occurs regularly every two hours. During its embryonic development, the egg produces heat, carbon dioxide, and water, and consumes oxygen.

Humidity

In a dry atmosphere, egg evaporates rapidly due to the loss of water contained within the egg. The albumen deteriorates, and the air cell expands, potentially leading to early embryonic death. Therefore, adequate humidity in the storage chamber is essential. High humidity in the hatcher facilitates hatching. Humidity levels are shown in Table 3. Once hatching is complete, the air must be dehumidified (to 40 % relative humidity) to dry the chicks' down.

Ventilation

Air renewal in the incubator is essential to ensure proper embryo respiration. An oxygen level of 21% must be maintained. Embryos suffocate below 15% oxygen and above 2% carbon dioxide in the air. The average requirement is 1.8 to 2 liters per hour per egg. This air renewal is generally provided by the hatchery's ventilation systems. Simply adjust the opening of the incubator's air intake and exhaust vents to meet the specific needs.

Care for hatching eggs

As soon as an egg is laid, it has the potential to hatch into a chick. Hatching eggs require careful attention.
The egg, warm when laid, cools rapidly to room temperature and its contents contract, absorbing air and any microorganisms it contains. Therefore, maintaining good hygiene throughout the poultry house, and especially around the nests, is essential.

Candling eggs

Candling involves placing the egg over a light source. Performed on the 18th day, it allows for the detection of eggs with normal development (homogeneous dark area) from other eggs (light) and for sorting before placement in the hatcher.

Preparing a one-day-old chick

It consists of a selection: the chicks selected are healthy in appearance, dry, clean, with a healed umbilicus, who stand well on their legs, who are rigorous, whose weight corresponds to the standard of the strain and who have no defects.

Vaccinations (collective by nebulization or individual by injection) can be carried out at this stage. Then the chicks are packed into boxes (50 to 100 chicks per compartment); for transport to the farm: upon their arrival, 24 to 48 hours may have passed since hatching.

Artificial insemination

Artificial insemination saves space in the housing but requires additional cage equipment. It allows for a reduction in the number of roosters raised per hen (3 % roosters are then sufficient) and better control of their fertility (concentration control, semen mixing).

Sperm collection and processing

The semen is collected using a dorso-abdominal massage. The ejaculate volume is 0.2 to 2 ml at a concentration of 1 to 3 billion/ml for heavy strains and 4 to 6 billion/ml for light strains. A dose of 100 to 120 million spermatozoa is required per hen per week. Therefore, one ejaculate can be used to prepare 3 to 10 doses of heavy strain and 10 to 30 doses of light strain. in a light strain.

A suction system collects the semen in the collection tube. Since roosters do not store semen, the best use of their semen is through daily collection for 5 days a week. Due to significant individual variation in concentration, the semen from 10 roosters is mixed before use. The semen can then be used quickly as fresh semen without dilution.

Seed placement

The fertilization rate remains high when the interval between two artificial inseminations is increased from 5 to 7 days, so the hen is inseminated once a week. One rooster for 50 hens is then sufficient.
Insemination is performed vaginally, at a depth of 3 cm. The procedure is automated using a fixed-dose gun.

Terminologie avicole (Français → Anglais)

1. Animaux et catégories

- Poule → Hen
- Coq → Rooster / Cock
- Poussin → Chick
- Poulette → Pullet (jeune femelle)
- Jeune coq → Cockerel
- Volailles → Poultry
- Troupeau → Flock

2. Reproduction

- Reproducteurs → Breeders
- Ponte → Egg laying
- Œuf fertile → Fertile egg
- Fécondation → Fertilization
- Ovulation → Ovulation
- Taux de fertilité → Fertility rate
- Taux d'éclosion → Hatchability
- Accouplement → Mating
- Insémination artificielle → Artificial insemination

3. Anatomie reproductive

- Ovaire → Ovary
- Oviducte → Oviduct
- Testicules → Testes
- Sperme → Semen
- Jaune d'œuf → Yolk
- Blanc d'œuf → Albumen
- Coquille → Eggshell

4. Incubation et couvoir

- Incubation → Incubation
- Couveuse → Incubator

- Éclosion → Hatching
- Couvoir → Hatchery
- Température d’incubation → Incubation temperature
- Humidité → Humidity
- Retournement des œufs → Egg turning

5. Alimentation et élevage

- Aliment → Feed
- Ration → Diet / Ration
- Eau de boisson → Drinking water
- Croissance → Growth
- Engraissement → Fattening
- Élevage → Farming / Rearing

6. Santé et gestion

- Maladie → Disease
- Vaccination → Vaccination
- Biosécurité → Biosecurity
- Mortalité → Mortality
- Stress → Stress

7. Production

- Production d’œufs → Egg production
- Production de viande → Meat production
- Rendement → Yield
- Poids vif → Live weight
- Gain de poids → Weight gain