Hatchery Performance Control

No.1 Introduction

Chick quality is the first criterion for assessing a hatchery's quality of work, and is determined by distinguishing between marketable chicks and sorted chicks. When necessary, a quality score will be determined using specific assessment charts.

Though rarely routinely done, unhatched eggs may also be checked. Embryo diagnosis is a technique which consists in opening unhatched eggs to determine the moment embryonic development stopped and, if possible, identify the cause.

Whatever the results from these checks, it should be remembered that they include factors that are more or less controlled by the hatchery, namely the breeders' statuses and the on-farm sorting strictness. This is why it is important to regularly check eggs coming from each of the breeder flocks so as to prepare incubation correctly, ensure performance traceability, but also identify external dysfunction causes as early as possible (see table below on the factors affecting egg quality).

Weekly records are communicated to breeder farm managers along with their comparison to the hatchery's mean and their evolution. The objectivity of the results makes it possible to initiate a constructive debate between the hatchery and production managers.

Factors affecting egg quality (from Poultry Diseases, 4th Ed).

Egg abnormality		Possible causes
Small size		Young age Inappropriate lighting patterns Inadequate nutrient or water intake Moulting High temperature
Shell	Thin, fragile porous shell-less	Hens coming into lay or old age Minerals/vitamins deficiencies, or excess salinity High temperature Disease (ND, IB, EDS76, ART) Sulphonamides
	Misshapen corrugated rough	Old hens or hens coming into lay Excessive calcium Disease (ND, IB) Sulphonamides
	Ridged waist	Uterine damage Activity or stress in early calcification (afternoon) Density excess
	Loss of colour	Disease (ND, IB, EDS76, ART) Sulphonamides, nicarbazin (note: high in-feed tetracycline levels associated with yellow colour) High temperature
	Cracks	Bad shell quality (see above) High density Inappropriate cage design or collection method
Albumen & Vitellus	Loose air cell	Rough handling Disease (ND, IB)
	Blood spots	Cold or sudden variations of temperature Continuous light Old hens Low vitamin K or vitamin A levels Mycotoxins, Infectious bronchitis
	Abnormal colour	Inappropriate pigment levels or pigment mixing, Raw materials (seeds) Flock disease, parasites, mycotoxins
	Taint	Unsuitable detergents
	Flat yolk	Nicarbazin Poor shell Warm or excessive storage
	Watery white	Disease (ND, IB) Warm or excessive storage Old birds

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No.2 Chick morphology and vitality

Chicks are ready to be taken out of the hatcher when most of them have dried off. They are then removed from egg shell debris and down, sorted out and counted, and possibly sexed and vaccinated. While performing these operations, weight loss should be minimised for chicks by maintaining correct temperature and relative humidity (70-75% humidity for 21-24°C).

The primary sorting criterion is weight: the chick weighs 40g on average (between 38g and 42g is ideal). Too small chicks should be culled. It should be reminded that the chick's weight makes up 68% of the egg's weight.

Besides, chicks ready for commercialisation must respond positively to the following six criteria:

- **Vigour:** the chick is lively, sharp, curious. It responds to solicitations and explores its environment. It does not peep all the time (sign of pain).
- **Down:** it must be clean and dry, long, silky and homogeneous.
- **Eyes:** they are bright and opened, with no sticky eyelids.
- **Balance:** the chick stands steady on its legs, legs are light pink in colour, with no trauma nor malformation, redness, swelling or joint deviation.
- **Abdomen:** it is soft at palpation and not swollen nor indurated, which gives evidence of a good-quality yolk.
- **Umbilicus:** it must be healed (small, dry and closed) and have no residues of adhering membrane (no thread and clean).

If needed, methods exist for scoring chicks according to these parameters, which have the advantage of allowing:

- the quantification of results, each abnormality being scored according to their severity.
- the weighting of criteria according to their importance for the chick's survival.
- the reliable comparison of scores in time, and with various examiners.

Different assessment charts have thus been proposed; one of them is presented below. Depending on the needs, this chart can be simplified by discarding non relevant criteria and emphasising those which pose a problem.

Chick quality: an example of an assessment chart

Parameters	Characteristics	Scores
Activity	Good *(when on its back, the chick rapidly gets back on its legs)*	6
	Poor *(the chick struggles to stand again or remains lying down)*	0
Down	Clean and dry	10
	Wet	8
	Dirty and wet	0
Abdomen	Normal size, soft to the touch	12
	Large size, hard to the touch	0
Eyes	Open and shiny	16
	Open and dry	8
	Closed	0
Legs	Balance and normal joints	16
	One abnormal leg	8
	Both legs abnormal	0
Umbilicus	Entirely closed and dry, normal colour of the skin	12
	Partly closed, abnormal colour of the skin	6
	Not closed, abnormal colour of the skin	0
Residual membrane (umbilical region)	No membrane	12
	Membrane in small quantity	8
	Membrane in large quantity	4
	Membrane in very large quantity	0
Residual egg yolk	No egg yolk	16
	Small egg yolk	12
	Large egg yolk	8
	Very large egg yolk	0

*(Tona & coll., 2003 – Poultry Science, **82:**736-741)*

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No.3 Body weight uniformity

The objective at farm level, is to obtain the best possible homogeneity at slaughter age. At least 80% of birds should have a live body weight close to ± 10% of the batch mean.

In order to reach that objective and to make early growth easier, it is essential that batches of chicks be as homogeneous as possible – practically, 100% of chicks should be in a weight range of ± 10% around the batch mean.

At the hatchery, homogeneity upon hatchery exit should, therefore, be optimised by:

- Adequate grouping of eggs by origin: the age of breeders influences chick weight, primarily through egg weight (which increases with age), and secondly through embryonic development duration (shorter by a few hours for young batches, < 32 weeks).
- Adequate grouping of eggs by storage time.

One day of storage extends the incubation duration by approximately one hour.

The time lapse between two collections on the farm should not be counted out as it can have a significant impact under warm conditions.

- Finally, homogeneous incubation temperature so that embryos start to develop at the same time.

On the other hand, efforts should be made to reduce as much as possible the waiting time and to optimise delivery conditions to the farm.

As shown in Table 1, several relationships have been identified between egg weight, hatchability, chick weight, chick growth and other parameters.

Table 1. Effect of egg size on hatchability, chick size and post-hatching growth.

Eggs of intermediate size hatch better than very small and very large eggs.
The first, small eggs from young pullets have decreased hatchability, hatchling weight, chick growth, and chick livability.
Incubation time tends to be positively correlated with egg size.
Embryo weight is not correlated with egg weight during the first half of the incubation period.
The correlation between the egg weight and embryo weight reaches a maximum at the time of hatching.
Chick weight is normally 62-76% of initial egg weight.
Hatchling weight is determined primarily by egg weight and secondarily by weight loss during incubation, shell and residue weight, strain, incubation time, breeder age, chick sex and time after hatching.
The correlation of egg weight to chick weight decreases with age of the chick.
With current broiler strains marketed at 6-8 weeks of age, 1g change in egg weight results in 2-13g in market weight.
The effect of egg weight on broiler weight is greater in young breeders.

(H.R. Wilson, Avian Incubation, 1991, 282)

No.4 Embryo diagnostics

Embryo diagnosis is the diagnosis of the causes of embryonic mortality. It can be basic or detailed depending on the problems encountered and the objectives to be reached.

Diagnosis approach

Examination of embryos in unhatched eggs is the first step. It allows a general view of embryonic mortality as all the embryos which have died since the beginning of incubation – except those culled at candling at 18 days – are being examined at that time.

It is valuable to have the data from candling to transfer at one's disposal, in order to know whether embryonic mortality occurred before or after (or even at the time of) transfer.

If mortality occurred prior to transfer, a few eggs will then have to be examined in the early period of incubation in order to differentiate early embryonic mortality from true infertility.

Opening of unhatched eggs

At chick hatching, unhatched eggs will be examined to determine the reason for failing to hatch. All unhatched eggs will be opened on one or two trays per batch minimum and, at best, on 4-5 trolleys uniformly distributed in the hatcher. This represents approximately one hours work for 100 eggs. It is useful to perform this examination once a week, routinely, so as to detect/interpret abnormalities more rapidly and obtain comparative data.

After identifying the origin of each tray, all the remaining eggs will be broken and classified according to embryonic development stage.

During egg examination, the main parameters to be examined are:

- Egg size and egg shell quality.
- Air cell.
- Age of developing embryo.
- Embryo position (standard: beak under right wing, legs brought up toward the head) and embryo anatomy.

As described further later in this series, the embryo is particularly fragile during the first week of incubation, the period when organs differentiate; problems consist of early embryonic mortality or malformations. To a lesser extent, mortality can also occur in the late incubation period (18-19 days) due to respiratory failure, poor resorption of the yolk vesicle – or at hatching (called pipped unhatched chicks).

Early embryonic mortality vs true infertility: examination of eggs at the beginning of incubation

Distinguishing early embryonic mortality from true infertility is very difficult to perform on unhatched eggs.

After 21 days of incubation, only the presence of embryonic annexes and the severe deterioration of the internal structures of embryonated eggs allow the latter to be distinguished from unfertilised eggs, which have remained in a better state.

Candling at the time of transfer makes it possible to orient the diagnosis toward early or late mortality. Similarly, thorough (manual) candling around 8-10 days of incubation, makes it possible to evaluate early embryonic mortality: this is the percentage of embryos that died in the initial stage of incubation, just after the mortality peak of the first days.

However, among the other eggs, which are clear eggs, candling does not enable true infertile eggs – still at the ovum stage – to be distinguished from fertile eggs whose embryos have not resumed development when set for incubation.

This is why, when eggs are set for incubation, it is more correct to speak of non-clear eggs rather than fertile eggs, although this term is often used.

In order to make the distinction, the only method – obviously costly and therefore exceptional – consists of breaking 400-500 eggs at 4-5 days of incubation and examining the presence and appearance of the embryonic disc.

Day 4.

Day 7.

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No.5 Presentation of results

When adding up the different numbers recorded, four ratios should be retained: 'fertility', early embryonic mortality, number of chicks hatched from fertile eggs and total hatchability.

- Fertility = Number of fertile* eggs at setting/number of incubated eggs.
- Early embryonic mortality = Number of dead embryos at 10 days of incubation/number of incubated eggs.
- Hatchability of fertile eggs = number of hatched chicks (including the dying ones culled on the sorting belt)/number of 'fertile'* eggs.
- Total hatchability = Number of hatched chicks/number of incubated eggs.

** As mentioned above, the fertile eggs are in fact eggs that are non-clear when candled at 10 days.*

Table 1 gives indicative values of performance levels. Fertility and then total hatchability are not reported in these standard values as they vary greatly with age and strains.

Table 1. Indicative performance records.

Assessment	Early embryonic mortality (%)	Hatchability from fertile eggs (%)
Excellent	< 2	> 93
Very good	< 3	> 90
Good	< 5	> 87
Average	< 8	> 83
Poor	> 8	< 83

Table 2. Example of performance control until hatching.

Incubation Tray No	Eggs/ Tray	Clear eggs	Mortality (days) 1-10	10-18	18-21	Pipped unhatched	Culled chicks
No 1	150	2	4	3	1	2	1
No 6	150	4	5	4	1	1	0
No 11	150	2	3	5	1	1	2
No 16	150	3	4	3	2	2	1
Total	**600**	**11**	**16**	**15**	**5**	**6**	**4**
%	**100**	**1.8**	**2.7**	**2.5**	**0.8**	**1.0**	**0.7**

Number of 'fertile' eggs	600 - 11	=	589
Total mortality	11 + 16 + 15 + 5 + 6 + 4	=	57
Number of chicks	**600 - 57**	**=**	**543**

'Fertility'	589 ÷ 600 x 100	=	98.2%
Early mortality	16 ÷ 600 x 100	=	2.7%
Hatchability/fertiles eggs	543 ÷ 589 x 100	=	92.2%
Total hatchability	543 ÷ 600 x 100	=	90.5%

No.6 Non-hatching causes

The table below presents all the possible causes of a drop in hatchability. Infections by vertical transmission or carried by the eggs will be described in more details in a future issue.

In order to organise the potential problems according to their importance, three major sources of embryonic mortality must be cited:

● **Egg hygiene.** The hatchability of a batch is often directly correlated with the number of floor eggs, whose hatchability level is regularly lower by 10-15% compared to clean eggs.

● **Egg handling.** It is often forgotten that the egg contains an extremely fragile organism. Conveyor system and transfer automation can improve hatchability by up to 2%.

● **Storage and incubation parameters.** Temperature, relative humidity and ventilation; hyper- or hypothermia in particular result in embryonic malformations:

• Hyperthermia, with ocular, cardiac or renal lesions (following circulatory problems).

• Hypothermia, with disharmonious development of the different internal organs.

Factors affecting egg quality (Poultry Diseases, 4th Ed).

TRUE INFERTILITY – PROBLEMS ON THE FARM		
Roosters	Sterility or unsuitable age of roosters (too young, too old) Or insemination problem Excessive weight gain or weight loss incorrect percentage of roosters	
Hens	Excessive density Broodiness	
Both sexes	Nutritional deficiency Lameness, parasitism or other pathology Thermal stress or treatment causing a drop in consumption Intoxication (Nicarbazin) Aggressive behaviours (mostly concerns roosters) Building design impeding treading	
EMBRYONIC MORTALITY – PROBLEMS ON THE FARM OR AT THE HATCHERY		
	Farm	**Storage**
Early mortality	Contaminated eggs Pre-incubation Cracked eggs (age of breeders) Infectious disease Nutritional deficiency	Cooled or overheated eggs Too long Washing with too warm water Lack of oxygen, excess of carbon dioxide
Late mortality	Contaminated eggs Infectious disease Nutritional deficiency	Too long
Pipped, unhatched	Genetic problem Infectious disease Nutritional deficiency	Too long
Malformations Incorrect positions	Genetic or infection (crossed beak) Nutrition (twisted neck, crooked toes) Misshapen eggs	
Broken eggs	Rough handling Age of breeders Nutritional or infectious problem, thermal stress	Rough handling
Contaminated eggs	Poor egg shell quality Too infrequent egg collection Poor nest hygiene	Condensation on eggs Insufficient decontamination
Culled chicks	Small eggs (early hatching) Large eggs (late hatching)	Too long: late hatching, omphalitis problems

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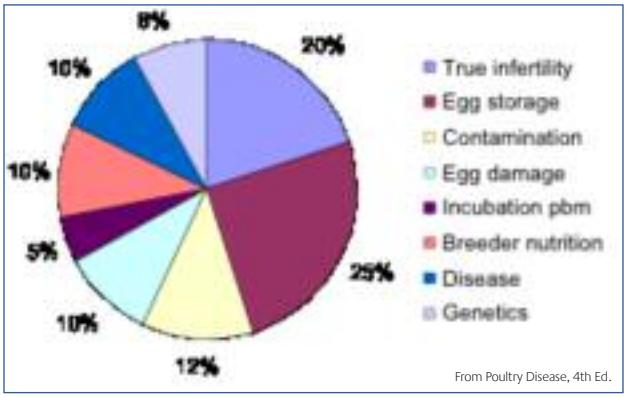
No.7 Non-hatching causes

Factors affecting egg quality From Poultry Diseases, 4th Ed.

EMBRYONIC MORTALITY: PROBLEM ON THE FARM OR AT THE HATCHERY

	Incubation	**Transfer / Hatching**
Early mortality	Excessive fumigation Too low T and too high RH Incorrect egg turning	
Late mortality	Too high T and too low RH Too low T and too high RH Incorrect egg turning	Poor ventilation T and RH too high
Pipped Unhatched	Eggs small end up Incorrect egg turning Insufficient ventilation Too low T and too high RH	Trauma during transfer Late transfer Excessive fumigation
Malformations Incorrect positions	T variations (absence of eyes) Handling during 1st week Eggs small end up Incorrect egg turning	
Broken eggs	Rough handling	Rough handling
Contaminated Eggs	Incubation of dirty eggs	
Culled chicks	High T: early hatching, omphalitis problems Low T or RH: late hatching Incorrect egg turning	Low T: late hatching High RH: weak chicks, Omphalitis problems

No.8 Conclusions



Respective weight of non-hatching causes under normal conditions, in Gallus species.

We have thoroughly reviewed all the steps which the egg must go through to yield a suitable chick, and this has allowed us to begin by stressing the importance of the quality of the hatching egg.

After reading this diverse information, there is no doubt that incubation is a complex matter, in which logic rules. Nevertheless, any abnormal result can be explained by an in-depth analysis of the various parameters, particularly by 'opening' the eggs set for incubation.

Therefore, to conclude, each technician or hatchery manager should clearly understand that he/she must implement regular performance monitoring in his/her organisation or service in order to improve results, as well as to prevent mishaps or rapidly identify their causes.

This monitoring activity may require the hiring of an employee specifically trained to this type of work; however, one should be aware that the investment return will be substantial: 1% improvement of total hatchability can represent considerable profits even in medium-sized structures

Vitamin or mineral deficiencies in breeders affecting egg quality.

Liposoluble vitamins	
Vitamin D	Shortened beak
Vitamin E	Encephalomalacia, cornea oedema, immunity disorders
Vitamin K	Haemorrhages
Hydrosoluble vitamins (B group)	
Riboflavin (B2)	Stunting, oedema, clubbed down, curled toe, nerve degeneration
Panthotenic acid (B5)	Poor feathering, oedema, haemorrhages, fatty liver, twisted legs
Biotin (H)	Chondrodystrophy, parrot beak
Folic acid	Oedema, leg and beak abnormalities, early death after pipping
Cyanocobalamin (B12)	Haemorrhages, oedema, fatty liver, malposition, myoatrophy
Minerals	
Calcium, Phosphorus, Sodium, Potassium, Magnesium	Decrease of eggshell quality
Manganese	Chondrodystrophy, parrot beak, globular head, oedema, retarded down feather, ataxia
Selenium, Zinc	Impairment of immune system development