Maximising viable chick production in the hatchery

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The ultimate goal of any modern day hatchery is to maximise its output of viable day-old chicks, as this is the critical factor which determines its economic viability. More precisely, all activities in the hatchery are aimed at maximising hatchability, maximising chick quality and maximising chick uniformity.

Of course these targets should be reached at minimal cost. As the hatchery is a central hub in today's integrated poultry production industry, it is obvious that the success of the hatchery will depend to a large extent on the quality of all preceding steps of the production chain.

However, in this article we will focus on the factors that are under the hatchery's control.

Hatchery design

The eventual production results of a new hatchery project can be jeopardised if the design phase is not well thought out. Important topics are the choice of the hatchery location, taking into account proximity of other poultry businesses, elevation above sea level and prevailing wind direction.

The hatchery layout should make sure that there is one way traffic in the factory, going from clean rooms to dirty rooms. All rooms and equipment should be designed so that a good hygiene programme can be implemented. It also pays to think ahead and plan for a future extension.

The hatchery production cycle can be split up into five steps. Firstly, the hatching egg management should ensure that the quality of the eggs is as good as it can possibly be.

It is obvious that the eggs should be handled with care to avoid hairline cracks and subsequent bacterial contamination.

Apart from this, the temperature and humidity conditions should be controlled well, from oviposition up to transfer of the eggs into the hatchers.

The best results are obtained when the eggs are exposed to only two temperature direction changes: the eggs should be cooled down as quickly as possible after oviposition to below the physiological zero (24-25°C) to arrest embryological development.

Temperature shocks, egg sweating and excessive moisture loss should be avoided at all times. Egg storage temperatures should be adapted according to the expected storage time, and egg weight loss during cold storage should be monitored. For long storage times, it can also pay to apply an egg turning schedule.

No matter how well the egg storage is managed, the hatchery manager should be aware that prolonged egg storage always has a negative impact on hatchability and even on chick quality.

After storage, eggs should be allowed to warm slowly and gradually to room temperature for 6-12 hours in a pre-warming room, and they should be fumigated prior to entering the setter. Table 1 shows the target temperature and humidity values throughout the production cycle.

Secondly, during the first 18 days of incubation in the setter, the embryo goes through complex processes of cell differentiation (day 0-7) and embryological growth (day 8-17).

The challenge of the modern single stage incubator is to create the right environmental conditions to meet the changing requirements of the embryo throughout the incubation cycle. The most critical parameter of artificial incubation is the embryo temperature, as this determines the metabolic rate and therefore the rate of embryonic development.

Table 1. Target temperature and humidity values in the day-old chick production cycle.

	Humidity (% RH)	Temp. (°C)
On the farm		
Hen's body		40-41
Hen house		24-29
Egg storage room		21-24
Egg transport truck		20-23
In the hatchery		
Egg handling room	60-65	19-21
Cold store		
0-3 days	75	18-21
4-7 days	75	15-18
8-10 days	80-85	10-12
more than 10 days	82-85	10-12
(small end up OR turning is necessary)		
Prewarming room	< 45	24
Fumigation room	70	24
Setter room	50-60	24-27
Setter	50-60	37, 9-36, 6
Transfer room	50-60	25
Hatcher room	50-60	24-27
Hatcher	65-75	37, 1-36, 6
Chick handling room	55-65	24
Chick despatch room	55-65	24
Chick transport truck		
In box temperature		32
Vehicle air temperature plastic boxes		24
Vehicle air temperature cardboard boxes		20

Endothermic process

This is an endothermic process during the first nine days of incubation, which means that the incubator has to supply heat to the embryos during this period. During the second half of the incubation period, the embryos are in their exothermic phase and will need cooling to remove the excess heat.

To determine the embryo temperature without breaking the egg and consequently killing the embryo, we use the eggshell temperature as a measure for the embryo temperature. Some modern incubators are equipped with measurement devices that allow the eggshell temperature to be registered without opening the incubator doors.

The information from these sensors is used to adjust the machine temperature throughout the incubation cycle in such a way that a target eggshell temperature of a constant 100°F is achieved.

Machine temperature is set at a higher level at the start of incubation to heat up the eggs quickly to the target embryo temperature. As incubation proceeds, the machine setpoint temperature is gradually lowered as the embryos generate more and more metabolic heat. Maintaining the appropriate humidity level in the incubator is another important parameter as it determines the rate of metabolic water loss of the eggs.

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The water metabolism of the embryo, to a certain extent, compensates for variations of the humidity level of the air in the incubator, but nevertheless it should be correct to achieve the optimal weight loss by day 18 of incubation (between 11 and 13%).

If humidity is too high and the eggs do not lose enough water, the air cell will be too small, resulting into problems to switch from chorio-allantoic to pulmonary respiration, and there will be an increased incidence of late embryo deaths. If humidity is too low, the chicks will suffer from dehydration. In both cases, chick quality will be heavily affected. Some incubators can be equipped with an on-line link to the embryos that continuously keeps track of the weight loss. With this information, the controller adjusts the humidity setpoint to achieve the correct weight loss in a linear or a non-linear curve.

The primary function of the ventilation system of the incubator is to supply oxygen for the breathing embryos and to remove carbon dioxide. The pulsator system pulls fresh air into the incubator, and moves the air around. An effective ventilation system will create sufficient and homogeneous air speeds throughout the incubator cabinet, also in the corners and other difficult to reach places. This is critical to allow a uniform exchange of heat and respiratory gases between the eggs and the air and to create a uniform climate in the incubator.

The ventilation system also has a secondary function: it serves as a supplemental cooling system. The carbon dioxide level is another parameter that should be monitored and controlled during the incubation process.

All industrial incubators also have an automatic egg turning mechanism. The eggs should be turned at a 90° angle at regular intervals (preferably hourly) up to at least day 15, but normally this is continued up to transfer time at day 18. Turning is not only important to prevent the embryo from touching the shell membrane and sticking to it, but it also brings the embryo into contact with fresh nutrient. During the first week of incubation, turning is especially important for the formation of the extra-embryonic membranes (amnion, chorion and allantois).

Thirdly, at day 18 there is the egg candling and transfer from the setter trays to the hatcher baskets: the eggs are laid on their sides so that the chicks can move freely during the hatching process.

First the clear eggs are removed, and then the live embryos are transferred into clean and dry hatcher baskets. Obviously the eggs should be handled with care because the shell has become quite brittle by this time of incubation. It is also important to minimise the candling and transfer time to avoid cooling the eggs too much.

Maximising uniformity

Fourthly, during the last three days in the hatcher, the chicks are being born. In order to achieve maximum uniformity of the hatch, it is important to minimise the hatch window by steering the hatching process by means of carbon dioxide control.

The essence of this technique is to 'suffocate' the chicks to encourage them to get out of the eggshell as quickly as possible.

Pulling the hatch at the correct time is another important factor which has a big influence on the chick quality: the chicks should be removed from the hatcher when most chicks (90-95%) are dry and fluffy, and only a few chicks (5-10%) still have some moisture on the back of their necks.

Pulling the chicks too soon will result in a high number of wet chicks; pulling them too late causes dehydration. In either case, chick quality is adversely affected: first week mortality increases and bird performance on the farm goes down. Fifthly and finally, the day-old chick handling procedures should be aimed at minimising stress for the birds from the moment of pulling to the delivery of the chicks at the farm. A modern hatchery cannot be managed properly without an information system that gathers and stores all the relevant information, so that it can be analysed and used to continuously improve results.

We can conclude that maximising viable chick production is a challenging target for the modern hatchery, a target which requires in-depth knowledge of embryonic development combined with top performance of all departments in the hatchery. ■