Preventing omphalitis to reduce first week mortality

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By Gerd de Lange, senior poultry specialist, Pas Reform Academy

A major cause of increased first week chick mortality is omphalitis, or navel yolk sac infection: a hatchery borne disease also known as 'mushy chick disease' and 'navel ill'.

Various bacteria may be involved, such as coliforms, staphylococcus, streptococcus and proteus.

Mortality usually begins within 24 hours of the hatch and peaks by 5-7 days. Mortality levels of 5-10% are not uncommon, making omphalitis a significant – and largely preventable — challenge to post hatch performance.

Affected chicks appear depressed with drooping heads. Post mortem examination reveals discolouration around the navel and an inflamed yolk sac with distended blood vessels, together with an offensive odour. The chicks feel 'mushy', indicating the presence of subcutaneous oedema.

For omphalitis to occur, causative bacteria and a route of entry into the yolk sac must be present.

Chicks are not born into a sterile environment. The likelihood of omphalitis developing is much higher in a batch of eggs that includes bangers, or if the hatcher baskets are not thoroughly cleaned and disinfected prior to transfer. Infection pressures can be effectively reduced by good hygiene practice.

With optimal incubation, chicks will normally hatch with properly healed navels. In some cases, although the navel may be slightly open at hatching, it should close naturally within a couple of hours, while the chicks are drying. In this scenario, the incidence of omphalitis is minimal.

However if the navel shows any deformity, it creates a point of entry for bacteria. Nutrients in the yolk combined with the body temperature of the chick will produce rapid bacterial multiplication.

Maternally derived immunity will not offer sufficient protection against this invasive challenge while the chick's own immune system is still immature.

There can be several reasons for increased incidence of navel deformity. 'Black button' navels are caused by incubation temperatures being set too high, especially during the last days of the cycle. Temperatures that are too low during the final days of incubation will produce poorly closed navels.

Overly high humidity during incubation results in insufficient weight loss. As a result, the residual yolk sac becomes enlarged, which prevents the navel from closing properly.

Conversely, when humidity is too low, the yolk sac dehydrates and becomes hard, which can damage sensitive tissue around the navel.

When eggs are stored for prolonged periods prior to incubation, more chicks with black scab navels are observed, indicating unhealed navels at the moment of hatching.

The standard use of antibiotics to prevent omphalitis is not a sustainable solution and should be discouraged.

Advice

- Maintain thorough hygiene, from laying nest to setter, to minimise the incidence of contaminated eggs.
- Avoid eggs becoming wet (for example by sweating), as this results in bacterial penetration.
- Clean and disinfect setters and hatchers, trays and baskets and transfer equipment thoroughly after every use.
- Ensure hatcher baskets are completely dry before transfer, to minimise the risk of bacterial penetration through the pores.
- Consider fumigating the hatcher after transfer if a batch of eggs contains 'bangers',
- Aim to produce day old chicks without navel deformities by optimising incubation conditions that take breed, maternal age and duration of storage into consideration,
- Target the narrowest hatch window possible and do not pull chicks while some are still wet, as these are still likely to have slightly unclosed navels.
- Handle chicks under optimal climatic conditions from the moment of pulling until their placement on the farm, to avoid chilling or overheating, as either will be detrimental to the chicks' immune status and yolk sac resorption.
- Stimulate feed intake as soon as the chicks arrive at the farm, to accelerate yolk sac resorption.

Storage of hatching eggs 18

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By Gerd de Lange, senior poultry specialist, Pas Reform Academy

Egg storage is the time between oviposition (laying) and the start of the incubation process for hatching eggs. Optimal hatching results and chick quality can be achieved if eggs are set after an initial adaptation period of about one to two day(s).

This allows carbon dioxide to be released from the egg, which increases albumen pH from 7.6 at oviposition to pH8.8-9.3. Yolk pH remains virtually constant around pH6.5, so that the embryo, situated on the yolk, is exposed to a pH-gradient. This optimises early embryonic development.

Storing eggs beyond two days leads to loss of hatchability and reduced chick quality. An epidemiological study of Dutch hatchery data (Yassin et al. 2008) showed that, on average, each extra day of storage at the hatchery before the seventh day reduced hatchability by 0.2%, rising to 0.5% after the seventh day.

Contrary to common belief this study also demonstrated that eggs from younger flocks are more sensitive to storage beyond seven days than those from older flocks, with evidence of higher first week mortality in the broiler farms, as a result of prolonged storage.

Day-old-chicks from stored eggs show a higher incidence of 'black navels'. Tona et al. (2004) found that Cobb broiler chicks hatched from eggs stored for seven days weighed over 200g less at slaughter age, than chicks from fresh eggs. Differences in body weights emerged at 14 days post hatch and increased until slaughter age at 42 days.

In recent research by Pas Reform Academy, eggs from three different broiler breeder flocks of different maternal ages (30, 38 and 50 weeks) were stored at 18-20°C and 12-14°C for seven and 11 days, both at 75% relative humidity.

Storage at the lower temperature resulted in a higher average hatchability of 0.6% (experiment 1: 7 days), 1.1% (experiment 2: 7 days) and 3.2% (experiment 3: 11 days).

These results support the view that 'the longer the storage period, the lower the storage temperature', but more research is needed before it can be concluded that suggested temperature ranges should change.

Advice

- Allow eggs to cool gradually, from the hen's body temperature to between 18-25°C in 6-8 hours; do not place them in storage (especially not if already placed on setter trays) too quickly after lay.
- Minimise the duration of storage to counter negative effects.
- Be aware that storage starts on the day of egg production, not necessarily the same as the date of receipt at the hatchery
- Label each batch of eggs with its actual date of production.
- Maintain optimal climatic conditions during storage (see table below), taking the planned duration of storage into consideration.
- Consider having two separate storage rooms, each with specific climate conditions, if storage time is not constant.
- Store eggs small end up, starting on the first day of storage, if hatchery planning dictates that eggs must be stored more than 10 days. Alternatively, if eggs are stored on setter trays (blunt ends up), turn them 90° once daily.
- Choose the upper limit of recommended temperature ranges if there is a risk of 'sweating' when eggs are removed from storage. Gradual warming in a 'pre-processing room' at an intermediate temperature may be necessary.
- Position eggs in storage to avoid direct air flow from egg room coolers and/or humidifiers – and sufficiently removed from the heating system.
- Do not place eggs directly against the wall or on the floor in the storage room.
- Allow extra incubation time for stored eggs: on average one hour extra for each additional day after an initial storage period of three days. ■

Table 1. Maintain optimal climatic conditions during storage.

Storage duration	Temperature (°C)	Relative humidity (%)
0-3 days	18-21	75
4-7 days	15-17	75
8- 10 days	10-12	80- 88
More than 10 days	10-12	80-88

The relevance of hatchery climate control

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By Derk Pijnenburg, HVAC Engineer, Pas Reform Hatchery Technologies

While optimising climate inside the incubator best supports the needs of growing embryos, accurate climate control elsewhere in the hatchery also makes an important contribution to overall efficiency.

Growing embryos use oxygen and produce carbon dioxide and water vapour during incubation, thus the air within the incubator needs to be refreshed regularly.

However, to maintain truly efficient climate control there are other important factors to consider, including temperature and relative humidity in the various rooms of the hatchery, the avoidance of airborne cross-contamination and energy saving.

Homogeneous incubation temperature is best achieved when the machines operate in an area where temperature and humidity are constantly maintained.

Maximum room temperature is reduced when the incubator depends partially on air cooling – and in this case, a greater volume of air will be required than when using a water-cooled system, to cater for both the oxygen needs of the embryos and the cooling requirement of the incubators.

Similarly, it is useful to humidify inlet air. This avoids the creation of 'cold spots', which arise with the constant operation of a humidifier in the incubator: particularly relevant for hatcheries in dry and/or cold regions.

Conversely, hatcheries in hot, humid countries can benefit from dehumidifying inlet air, so avoiding overly high humidity in the setter – which results in insufficient weight loss by the hatching eggs during incubation.

Air transport by natural ventilation substantially limits the hatchery's control of temperature and humidity.

An air handling unit (AHU) enables inlet air to be conditioned and regulated, based on the needs of the embryos.

This is achieved by controlling the output of the AHU according to the pressure required in various rooms. With pressure differences set such that air flows from 'clean' to 'dirty' areas, cross-contamination is prevented.

By reducing supply air volume to the lowest necessary levels and eliminating unnecessary heating (including humidifying) or cooling (including de-humidifying), energy savings will be realised.

Fans operating at variable speeds are more energy efficient for controlling pressure in the hatchery than recirculation – and selecting setter/hatcher room temperature in relation to external, local climate can also have a positive impact on energy consumption.

Advice

- Consult a specialist when designing the hatchery's climate control system, as many factors need to be considered and there may be several options available.
- Ensure sufficient air supply to the various rooms in the hatchery.
- Precondition air in terms of temperature and relative humidity to meet the climate requirements in the room.
- Avoid high (>25°C) room temperatures in a cold climate.
- Use variable air supply with frequency drive instead of recirculation.
- Always maintain the highest air pressure in the setter room compared to other areas, to avoid cross-contamination.
- Avoid using air ducts to extract used air. These are difficult to clean and encourage an accumulation of pathogens (for example aspergillus).
- Maintain the AHU, regularly replacing dust filters and checking the V-belts.
- Monitor climatic conditions (temperature, relative humidity, carbon dioxide) in relation to the specified requirements for all hatchery rooms every 14 days.

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Weighing the benefits of automation in the hatchery 20

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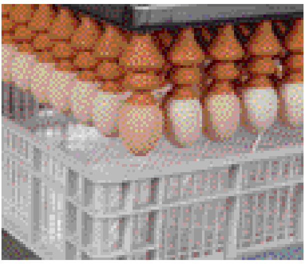
By Jan-Peter Eil, project manager, Pas Reform Hatchery Technologies

A common rationale for investing in hatchery automation has traditionally been to reduce labour costs or to overcome the challenge of recruiting for monotonous, relatively strenuous work and long working days.

Yet the use of hatchery automation systems is growing rapidly in modern hatcheries – and not only in countries with relatively high labour costs.

Hatcheries in low labour cost regions are also capitalising on the improved accuracy, workflow, overall quality and financial benefits that automation delivers.

There are many good reasons to introduce automated processes in the hatchery, and a range of (semi) automatic equipment solutions are available. These solutions reflect the variety of opportunities that exist in hatcheries of varying sizes, process plans and outputs, to improve productivity and performance.



In the egg traying room, for example, eggs are transferred from small pulp or plastic trays to setter trays. Careful handling of the eggs, to avoid hairline cracks and ensure that the eggs are placed sharp-end down, is essential for good hatchery results. Well designed and adjusted automation achieves greater accuracy and consistency than manual egg handling. And when we consider that in an ordinary hatchery transferring 230,000 eggs/week, a 1% increase in hatchability represents an additional 100,000 day-old chicks/year, it makes sense to weigh the cost of a manual v. automated process!

Care in handling during egg transfer is also critical. Here this is more challenging, because the egg shells are more fragile, due to calcium absorption by the embryo for bone development. Automated candling and egg removal save considerable labour, depending on the system chosen – and deliver better results, especially where the percentage of clears is higher than 10-15%. Automation also allows for more effective waste separation: especially beneficial if, for example, clear eggs are being brought to value, such as as egg powder for use in pet food.

Inside the chick handling room, the equipment used depends largely on the size, type and local work force situation of the hatchery. The priority is to ensure that chicks leave the hatchery as fast as possible, in premium condition. If labour saving is the main priority, stackers/destackers, connecting conveyor lines, automated basket storage and automated chick separation may be a logical choice. In weighing up the options, consider also the cost of time needed, for cleaning, disinfecting and accurately grading chicks. Further automation in chick handling may include chick counters and boxing systems, sexing tables, vaccination tables and spraying systems.

Hygiene is another area of hatchery management well served by automation. A large range of automatic washing equipment is available for cleaning setter trays, hatcher and chick boxes and various trolleys.

Systems are also available for dealing with hatchery waste, such as macerators and vacuum waste lines.

Hatchery automation systems are becoming an essential factor in the operation of the modern hatchery and cost rapidly becomes an investment, when the main benefits include a higher number of uniform, high quality chicks, accurate process planning and timely delivery.

Advice

- Consult a specialist when planning hatchery automation systems, as many factors need to be considered and several options are available.
- Decide what has the highest priority in making the choice for which processes should be automated; labour saving or quality improvement.
- Invest first in egg handling automation for setting and transfer if the focus is on quality improvement, as this is where relevant benefits will be gained – mainly by reducing the incidence of hairline cracks and a greater accuracy in point-setting.
- If the aim is to save on labour, invest first in internal flow automation systems – from stackers/ destackers, conveyor systems and automated chick separation, to fully automated basket storage.

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Optimising hatchery design for peak performance

By Sander Koster, project engineer, Pas Reform Academy

Having chosen a green field site for the new hatchery, it is important first to consider the layout of the facility carefully, followed by producing an engineering plan of drains, piping, ducting and cabling.

Good design is crucial to cost effective hatchery operation – and should avoid long walking distances anywhere on the site, to minimise the use of internal transport.

To prevent cross-contamination, the plan should incorporate a uni-directional flow of people, eggs, air, trays, baskets and trolleys: 'clean' should never meet 'dirty'. A well designed hatchery lay-out will set out five distinct areas for the eggs, incubation, newly hatched chicks, technical operations and personnel.

In the egg area, will the eggs arrive on farm trolleys, paper/plastic trays or egg boxes – and in what quantities? How long will eggs be stored and will they require different temperatures? Will grading and selection take place at the hatchery or at the farm – and is egg handling automated or manual? Are eggs fumigated on arrival, or before setting? Should there be a room for storing discarded hatching eggs and are rooms for washing and storing trays or trolleys required?

The incubation area will be subdivided into setter room, candling and transfer room and hatcher room.

Depending on how many setters are installed, there will be one or more rooms to maintain a reasonable walking distance along the length of each row of setters. The size of the transfer room depends on the automation equipment being used and on the number of eggs being processed. Also consider how candling waste will be dealt with.

Finally in this area, the number of hatchers in each hatcher room should allow efficient 'all in-all out' operation and therefore depends on the setters' capacity and the number of hatches weekly. The chick area may need additional space for sexing and vaccination equipment. The size of the handling room also depends on the level of automation. Holding room dimensions should be based on the number of chicks stored and whether or not males and females are separated.

In harsh climatic conditions, it makes sense to plan for loading onto trucks inside the building. And a soaking room for cleaning dirty chick boxes returned from the farm is also advised. Ideally, this is located adjacent to the storage area for empty chick boxes.

Hatchery waste, empty shells, unhatched eggs and dead chicks, can be removed from the hatchery by a macerator and screw conveyor, situated near an outside wall. A vacuum waste system offers more flexibility and improved hygiene.

Ideally the technical area is divided into separate rooms for electrical installation, hot water installation and ventilation. Technical operations should also be located on an outside wall, so that engineers need not enter the hatchery unnecessarily. Every hatchery should also have a small workshop for repairs and storing spare parts.

Personnel require sufficient male and female showers and changing rooms to comfortably accommodate the number of people employed.

Similarly, egg handling and chick handling personnel should ideally have separate canteens. A laboratory and an office for the hatchery manager, perhaps with additional offices for sales, transport and administration, are also advised.

Advice

- Consult a specialist for advice and guidance in designing the hatchery layout: someone qualified and experienced, who will consider the various options available to you.
- Treat the prevention of cross-contamination as a major factor when designing the hatchery layout.
- Avoid very long rooms, to minimise the use of internal transport.
- Situate staff areas, particularly comfort areas, on outside walls for natural light whenever possible.
- Design with future expansion in mind, such that, for example, the addition of setter and hatcher rooms allows egg and chick areas to remain in their original location. ■

Hatching egg quality 22

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By Dr Marleen Boerjan, Director Research & Development, Pas Reform.

Hatchability and chick data are the most important references for optimising incubation management.

The age of the flock, number of storage days and incubation program are typically included in the analysis and optimisation of hatchery results, but very often, insufficient attention is paid to the quality of the hatching eggs.

While external quality is usually considered, there is much debate regarding internal quality control on a regular basis. Egg quality in the broadest sense has been affected by genetic selection, for production traits like growth, feed conversion, number of eggs and egg shell quality.

Breeding companies generally pay less attention to egg parameters related to hatchability and chick quality, which has led to increasing variability between batches of hatching eggs.

Ongoing research shows that genetic selection for production traits makes high demands of breeder management with respect to feed composition and feed restriction management.

Genetic selection has influenced egg size, the yolk:albumen ratio and shell quality. Feed restriction management influences the development of the reproductive tract and the nutrients available to the growing embryo from yolk and albumen.

In addition, with the management of breeders becoming more complicated, the risk of stress, aggressive males and overcrowding has increased – with inherent consequences for egg (embryo) quality.

In conclusion, if specific protocols for optimising incubation management are used, it is necessary to evaluate hatching egg quality on a routine basis.

A brief summary of internal and external parameters is presented below.

Egg shape

A good quality hatching egg has a blunt side containing a small air cell and a clearly recognisable sharp end. Too many abnormal or misshapen eggs signifies immaturity of the shell gland, young parent stock, disease, stress and overcrowding in the flock.

Egg shell

High quality hatching egg shells are smooth, without ridges or small lumps of calcified material (pimples). The colour of eggs within a batch is uniform. Young flocks produce eggs with thicker shells and when the flock ages, the shell becomes thinner and the incidence of abnormal shells increases.

Insufficient calcium or vitamin D3 content in feed will produce thin egg shells. Saline drinking water and high levels of chlorine will also cause shell-quality problems.

Abnormal white, thin-shelled eggs may indicate a variety of diseases (IB, NCO, EDS).

Albumen

Good quality hatching eggs contain a higher proportion of thick, viscous albumen with less thin albumen. The volume of thick albumen reduces with increased flock age and after storage.

Good quality albumen is translucent with a greenish or yellow cast indicating the presence of riboflavin. Meat or blood spots point to stress or overcrowding in the flock.

Yolk

The size of the yolk increases with flock age and thus the ratio of yolk to albumen increases. In good quality hatching eggs, the yolk has a uniform colour without any blood or meat spot. Mottled yolk points to stress in the flock.

Embryo

The embryo floats on top of the yolk. In the un-incubated egg, the embryo is visible as a doughnut-like opaque ring with a translucent centre. A good quality embryo is 3-5mm in diameter.

Advice

- Do not take egg quality for granted when optimising hatchery economics.
- Use specific egg quality forms to record the quality of each batch of eggs received at the hatchery.
- Record the number of good quality eggs and the number of eggs not fulfilling required standards for every batch of eggs received.
- Take a minimum sample of 10 eggs to record the quality of the embryo, albumen and yolk.
- Communicate openly with your egg supplier regarding egg quality, with the mutual aim of improving and/or maintaining quality.

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Empty shells – a valuable source of information 23

By Gerd de Lange, Senior Poultry Specialist, Pas Reform Hatchery Academy.

On hatch day, unhatched eggs, dead and culled chicks and empty shells are inevitably produced as hatchery waste.

It is generally accepted that unhatched eggs and dead or culled chicks can be used to evaluate the incubation process, to help determine where improvements can be made.

Empty egg shells are usually overlooked. But these also form a valuable source of information for the hatchery.

Empty shells can provide additional information about the pulling time of the chicks and their hatching conditions. When empty shells are crushed in the hand, the dryness of the shell membranes can be judged.

Pulling time and hatching conditions are good if the membranes crumble in your fist without falling apart into small pieces.

When the membranes completely stay together and do not crumble they are still too moist, indicating that the chicks were pulled too early. In this scenario, we also expect to see some partially wet chicks – or even externally pipped chicks still alive.

The membranes falling apart into small pieces indicates that pulling time was too late or that relative humidity may have been too low during hatching, possibly due to excessive ventilation.

If pulling time was too late, a lot of meconium (the greenish droppings produced by the chicks) will also be observed on the empty shells.

The height of pipping is an indication of weight loss during incubation. If weight loss was insufficient, the air cell remains small and the chicks are forced to pip high. Some chicks will not be able to pip at all and will drown inside the egg. The correct height for pipping is roughly at half, or just above half, the height of the egg (see photo).

Exposed to ideal hatching conditions, the chicks will pip the rest of the shell neatly in a circular manner. Rough or incomplete pipping is an indication of sub-optimal hatching conditions.

At days 11-12 of incubation, the chorio-allantoic membrane reaches the sharp end of the egg. If the albumen sac is too large due to insufficient weight loss, this membrane cannot reach the sharp end and will not be closed.

Insufficient weight loss is typically caused either by too low a temperature or over high humidity.

Observe whether or not the chorio-allantoic membrane is closed by looking inside the bottom part of the empty shells.

If there was overheating during the last days in the setter or in the hatcher, excessively thick and clearly visible blood vessels will be observed.

Advice

- Judge the accuracy of pulling time and hatching conditions by crumbling empty shells in your fist and by checking the amount of meconium on the egg shells.
- Check the height and manner of pipping, to judge whether weight loss during incubation was sufficient.
- Check the inside of the empty shells for signs of insufficient weight loss during the first half of incubation (blood vessels not reaching until sharp end of egg).
- Observe the inside of the empty shells for signs of overheating (excessively large and clearly visible blood vessels).
- Use information obtained from assessing the empty shells in conjunction with other observations, to avoid hasty or incorrect conclusions. ■

Optimising poultry production from egg to chicken 24

By Marleen Boerjan, Director of R&D, Pas Reform Hatchery Academy.

Hatching egg quality and incubation conditions influence broiler performance. It is therefore important to continually optimise every stage of incubation management, based on specific protocols for quality control and best performance.

In addition to data collection and data analysis, open, regular communication between breeder farm, hatchery and broiler farm is essential, both for quality control and to produce first-class results in integrated poultry meat production. The hatchery is a natural hub for communications between separate production links, because hatchery management receives production data both from the breeder farm and the broiler farm.

The basis for optimisation is found (1) in quantifiable criteria and (2) in references or standards for each of these criteria (see Table 1).

Reference data may be based on general standards provided by incubation consultants or breeder companies. Highly practical references are usually provided by the hatchery itself. Hatchery managers generally collect data on egg quality, fertility, hatchability and first-week mortality per batch of eggs – and from this data, hatchery specific standard curves can be produced.

Optimisation protocols are then directed to perform above the hatchery specific standards. A disadvantage of hatchery specific standard curves is that structural failures and mismanagement may be hidden and not found. For this reason, it is still advisable to compare hatchery specific data with more general reference data from consultants or companies periodically.

Advice

- Record key data on specific forms designed for this purpose.
- Record information on medication at breeder farm and hatchery, including vaccination.
- Define hatchery standards with reference to egg quality, hatchability, chick quality and first-week mortality.
- Compare data from each batch with hatchery's own reference data.
- Regularly compare hatchery specific data with more general reference, for example from consultants or breeder companies.
- Take appropriate action if quantifiable data falls below reference data.
- Investigate for structural failures if hatchery specific standards deviate below the standard curves provided by consultants or breeder companies.
- Always evaluate the results of any measures taken to improve or alter standards. ■

Table 1. The steps in the incubation process and quantifiable criteria.

- **Egg handling at the farm and during transport:** Temperature and relative humidity at the farm and during transport; egg temperature on arrival; flock specific data: strain and age, lay percentage, health status; percentage of first class hatching eggs; percentages of dirty eggs, floor eggs, cracked eggs and eggs with hairline cracks, upside down eggs.
- **Egg storage:** Temperature and relative humidity.
- **Preparation for incubation (egg traying, prewarming, preheating):** Flock age and length of storage; average egg weights and coefficient of variation (CV); temperature and duration of preheating in the setter (or of prewarming in the setter room).
- **Incubation in the setter:** Start of incubation and time to reach the temperature set points; incubation program (temperature, relative humidity, ventilation profiles); egg weight loss.
- **Transfer to hatchers:** Incubation time at moment of transfer; percentage of clear eggs; results of break-out of clear eggs.
- **Incubation in the hatchers:** Hatcher climate (temperature, relative humidity, ventilation profiles); time point increase of humidity and maximum level of relative humidity; time point of first chicks; time point of chick collection; hatch window.
- **Chick collection:** Total number of saleable chicks; percentage culled; average chick weights and coefficient of variation (CV); chick yields (ratio chicken body weight and initial egg weight); chick quality expressed in Pasgar-score units.
- **After chick transport and first week at the farm:** Temperature during transport measured with small data loggers; number of dead chicks upon arrival at the farm; weight of chicks upon arrival; percentage and weight of dead chicks at day seven; relative growth during the first week.
- **Medication:** At the breeder farm; vaccination of day old chicks before delivery.

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