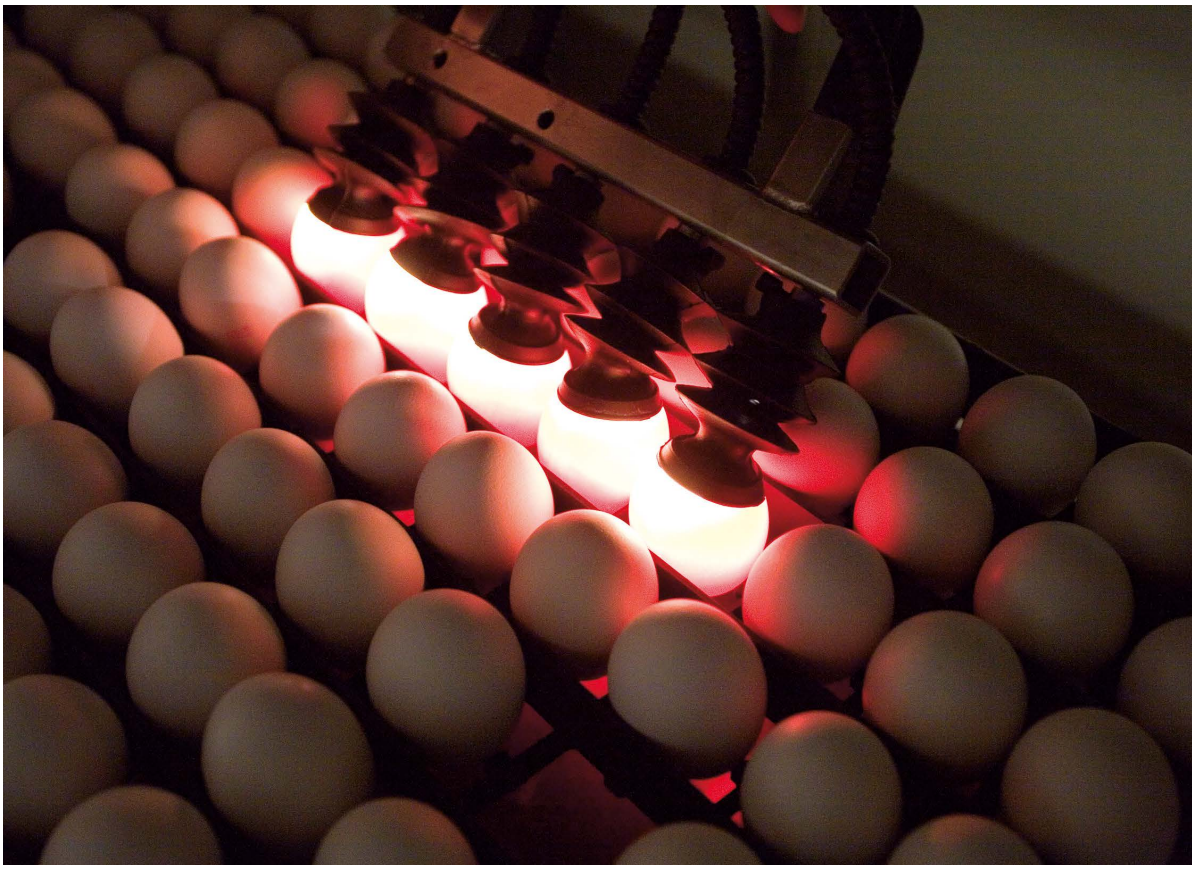
MANAGEMENT GUIDE

Hatchery



INCUBATION UNDER CONTROL

BREEDING FOR SUCCESS … TOGETHER

LOHMANN BREEDERS

CONTENT

INTRODUCTION

LOHMANN has invested many years in research and development in resources for covering all points of layers incubation. This handbook, or guide, is based on more than 70 years of experience and tests in integrate layers production and its contributors have had the benefit of working with customers throughout the whole world and experiencing necessary upgrades in the continuing evolution of the breeder, which guarantees the best performance in the best way.

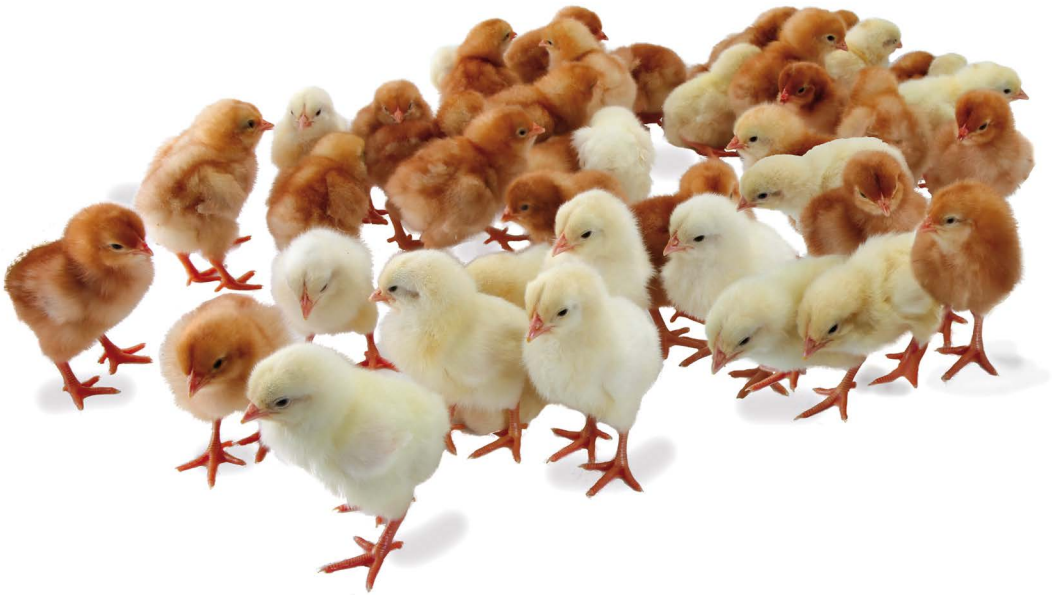
The actual layers industry is an international business with production in all corners of the world, with the relative varying climate conditions, different incubation technology, and different machines. This handbook isn't a guide for providing definitive information on all aspects of layer incubation in every scenario or condition, but in the "Hatchery Management Solution" we try to prepare the best practice to help our customers in areas such as

- Better hatchery Life
- Better management
- Better performance
- Better biosecurity
- Better layer chicks

The user must be aware of local legislation in terms of human welfare, animal welfare and chemicals and medical product registries in every different country, with can influence the management practice that they can choose to adopt. LOHMANN cannot accept any liability for consequences of using this information and is not responsible for its local wrong practical application.

The performance objective for the hatchery is to provide the highest number of perfect layers chicks with a good delivery and the best liveability, which of course is influenced by the quality of received eggs. The hatchery can preserve the quality received or can damage the quality, but cannot increase the quality of eggs received and cannot increase fertility. Both of the latter points are the result of good Parents farm Management (for more details see Farmer Management Guide).

If you have any questions after reading this handbook, we would like to encourage you to contact us; we can assist you and give you additional information on specific cases, available from LOHMANN technical department. We appreciate all advice, feedback and suggestions from our customers.



HANDLING HATCHING EGGS

Selection and management of hatching eggs

The hatching eggs are not simple eggs, they contain living embryos with all the genetic potential inside that LOHMANN has combined over many years of strong selection process. For good genetic transmission we need to guarantee the best condition of these embryos, and the first step is to have good hatching eggs: this is a crucial point.

Many factors can influence the quality of hatching eggs:

- Health condition of parents stock flock
- Age of the parents' stock
- Feed quality, water quality
- Medication treatments
- Type of housing and climate control, temperature
- Percentage and quality of male, spiking of male

The above factors determine the quality of our eggs in terms of the lay, the uniformity in size, the eggshell quality, the nutrients and maternal antibodies transmitted, the albumen and yolk percentage composition and the fertility.

- Cleanness and condition of nest
- Collecting of hatching eggs
- Disinfection of hatching eggs
- Storage and managements of eggs

The above factors determine hygiene status and the capacity of embryos to survive in storage.

At deposition, the temperature of the eggs is around 40 °C and they cool down considerately after. The surface is slightly wet: "cuticle paint isn't dry and fixed". At this moment, our eggs are cooling down to the surrounding temperature, which causes contraction. This means that air enters inside eggs through the pores (in variable amounts according to breeder, age and eggshell quality) and creates the air cell. This is a very critical point in time, and our goal here is to minimise the number of microbes which enter inside the eggs. For this reason, it is very important that eggs are laid in as clean a nest as possible. Our external disinfection processes cannot kill all microbes, especially Aspergillus spores, which may enter at this time. Only the difficult and high risk process of dipping with special pressure machines and special products can kill all "visitors" which enter the eggs through the shell and membrane; some hatcheries use this treatment for floor eggs.

Floor eggs are not considered hatching eggs, as they are already contaminated after having been in contact with the farm floor and with possible excrements, where the proportion of E. coli and other bacteria are relatively high. For this reason,

1 Good egg; and some negative examples: 2 Bad shell colours, 3 bloody, 4 plume, 5 malformed, 6 dirty

1 Good egg; and some negative examples: 2 under-sized, 3 malformed, 4 plume, 5 dirty, 6 bloody

HANDLING HATCHING EGGS

if the hatchery decides to use these eggs, it must consider the high risk of spreading the contamination and related problems to other eggs and to hatching layer chicks. Therefore, floor eggs are stored and incubated separately and preferably have a dedicated trolley and a dedicated setter (which is a better option than having a tray at the bottom of every trolley). In this way, they are easier remove to traced through every part of the process, which guarantees the best biosecurity and reduces the risk of direct transmission.

Malformed egg (note the wrong pore distribution) and a good hatching egg

Good hatching eggs must follow these criteria:

- Clean eggshell (no dirty litter, blood)
- Uniformity (no undersized or oversized eggs), weight range according to hatchery's decision (between 50 g to 70 g)
- No cracks
- Well-shaped
- No double yolk
- Set in trays or in pulp trays with the pointed end facing downwards

Warning: the production of hatchability eggs in farms situated at more than 1000 m above sea level needs particular attention and different settings.

It is important that the hatchery records the number of eggs removed from each flock and reports back to the parents' farm. **Below is an example of a records form.**

Example for a template "Egg stock and quality list"

Date of Receipt	Egg ID Code farm	Production Date	Number of Eggs	Egg Temperature	Shell Quality	Number of Dirty Eggs	Upside Down	Eggs in Stock	Note *Crack - Shaped - Double*

Disinfection of hatching eggs

Hatching eggs need to be disinfected because microorganisms multiply fast in the incubation climate of the hatchery and the temperature and humidity are perfect reproduction grounds which we need to control. Some customers decide to disinfect as soon as possible after deposition and repeat the process before setting in incubation; others disinfect during truck transport from the farm; others disinfect on the arrival of storage eggs in the hatchery, before they even enter the room. This is the personal choice of every customer, but it is important not to forget that eggs can be already contaminated during the process, either from operators' hands during the selection process, from dirty lift vacuums, from dirty trays, or from loss of liquids from damaged eggs. The real cleanness of all eggs managements is of utmost importance.

Customers have to decide on the type of product they use. For many years the cheapest and most efficient product was Formalin, fumigation with which is efficient but hazardous to human health, including that of the operator. Safety fumigation rooms with secure Formalin control and facilities for deactivation of residual gas are available. These guarantee the safety of the operator and can therefore be of great use, but it is important to check whether they are permitted in the relevant country, as well as taking into consideration that fumigation can increase mortality in embryos and overdosage can lead to malformation in chicks.

In case of use of Formalin, remember:

- Never fumigate with formaldehyde within the first 96 hours of incubation.
- The maximum correct dosage is 7 g/m^3.
- Never exceed a fumigation time of 25 minutes, max. room temperature of 21–24 °C, max. humidity 65–70 %.
- Re-ventilation of the fumigation chamber with safe clean air (to avoid recontamination of our hatching eggs) at the right temperature, as eggs do not react well in quickly changing conditions; check that the air-equipment can change the total air conditions within a few minutes.

As alternatives to Formalin, a lot of different chemical products are available. These can be based on glutaraldehyde, stabilised hydrogen, peroxide, peracetic acid, activated chlorine or quaternary ammonium. These agents can be sprayed, fogged, vaporised or used in an immersion bath, and are safer for human health. Some of these products can be used in combination with each other for increased efficiency against various bacteria, viruses and moulds, for example disinfectants that contain quaternary ammonium combined with glutaraldehyde, and disinfectants containing hydrogen peroxide combined with peracetic acid can have the same effect as disinfectants with hydroxyl radical and oxygen compounds. It has to be noted, however, that not all products can be mixed together, as certain chemical products can have chemical reactions: please make sure to control the combinability so as not to prepare a solution which is dangerous for both the operator and for the eggs. Please also be careful of overdosage, which can lead to the covering of pores or damage of cuticles. It is important that the disinfectant reaches all eggs, and that the eggs do not get wet: for this reason, eggs should ideally be placed in trays with space for the necessary ventilation, as eggs in carton pulp trays or in boxes do not undergo the right process.

In case of immersion in dedicated liquids, attention has to be paid to the cleanness and sanitised conditions of the solution, which should be at a temperature respect-

Spray nozzle

Peristaltic pump

HANDLING HATCHING EGGS

ing the eggs' natural temperature. This means that eggs should not be warmed to more than 24 °C or cooled drastically, and that eggs have to dry quickly and in a clean and controlled area after immersion. Please verify the corrosiveness of the product in use; many chemical products can damage structure, floor, trolley and trays.

The effective dosage changes the value of disinfections, and for this reason it is important to monitor consumption and percentage in use, as well as using a secure system of dispenser. A peristaltic pump is a good tool, but every different system needs a format control routine.

It is important that the hatchery controls the real efficiency of the product in use with accurate analysis, using shell tampons "swab", or by the simple use of Rodac Plates. The hatchery should then decide on the relative dosage, whether the type of product can be used and in which form, and the application desired.

Optimal egg storage condition

At the time of deposition, a fertile egg already contains a small live embryo, which is made up of approximately 30,000–55,000 cells. This is a living miracle and we have to preserve the vitality of these cells until the point of incubation. Please remember to avoid the instable temperature of eggs and to use your knowledge of handling carefully.

The developments of the embryo's life start in the body of the hen approximately 24 hours before the egg is laid, when the follicle is ovulated and fecundated. In these hours cellular replication is working very quickly – especially considering that the internal temperature of the body of the hen is 41 °C. Now our goal is to stop the fast cellular replication while at the same time maintaining the best liveability and reducing the cellular mortality as much as possible. In the past we spoke of "physiological zero", which was under 26 °C, but in reality this "zero" does not exist, as the replication and the mortality of embryo cells is still a concern. The temperature range between 26 °C and 37 °C is unbalanced and the velocity of cellular mortality is much higher than replication. If the conditions don't stay within the right parameters, we experience the "early dead" of our embryos. This is why it is especially important in countries with a hot climate to have more frequent egg collections, reducing the percentage of blastoderm mortality (early dead -72 h).

Ideally, eggs should be cooled down uniformly and gradually from the hen's body temperature to between 17 °C and 22 °C in 6–7 hours.

Please check the table showing different optimal egg storage temperatures and humidities in consideration of the storage time, set from the arrival of eggs at the correct temperature. Humidity during storage is not as important as the temperature. In short and medium storage it doesn't have an big influence, however, it should be kept between 60 % and 75 %. In long storage, the correct value can help reduce the risk of extremely high weight loss of eggs.

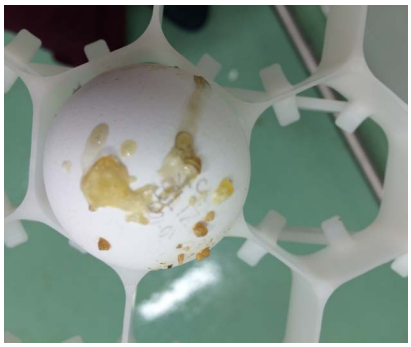
Egg storage room: climate conditions

For eggs that will be set in the first 4 days, it isn't necessary to drop the temperature; the right value helps the albumen of eggs to reach the perfect pH and also helps to bring about the right weight loss of eggs, but in the special circumstance of a Single–Stage process, this isn't easy to reach.
In a layer hatchery, it is common to store eggs for up to 10 days. For this storage length the use of S.P.I.D.E.S (Short Period Incubation During Eggs Storage) is recommended. In a well-planned schedule this isn't a complication for hatchery life, it just needs careful attention and management.

If S.P.I.D.E.S isn't possible, it is still important to have the correct temperature and to avoid the jumps (ups and downs) in temperature. For this reason, egg delivery trucks have to fix a set-point temperature at the farm storage room value and the operators in the hatchery have to send eggs into a storage room at the right temperature, in order to continue with the previous incubation schedule.

It is important to remember that eggs

should avoid condensation too and that closed pores have the effect of reducing the exchange of oxygen and carbon dioxide and of influencing relative weight loss of eggs, and can also facilitate penetration of microorganisms into the eggs, increasing their contamination.



Roth and banged

A possible solution for contaminated and explosive eggs is the use of a dipping machine, as such eggs can damage the quality of many other chicks. A dipping machine can help a lot, but this process needs delicate attention and perfect selection of a product to use as well as relative conservation. A good dipping process can increase hatchability from 0.5 % to 1 %, and some eggs are cracked, depending on their eggshell quality, but it guarantee less contaminated chicks and no explosion at all in the setter.

Recommended climate conditions during egg storage

Storage Time days	Temperature °C	°F	Relative Humidity %	Egg Position
0–4	21–19	69–64	75–60	Trays
5–7	18–17	63–61	78–70	Trays & S.P.I.D.E.S (if done …….. temperature fixed at 18–17 °C permanently)
8–9	16–15	60–57	80	Blunt end up but ……. if S.P.I.D.E.S, trays at 18–17 °C
10 or more	14–12	56	88	Recommended to turn eggs but …….. if S.P.I.D.E.S, trays at 18–17 °C

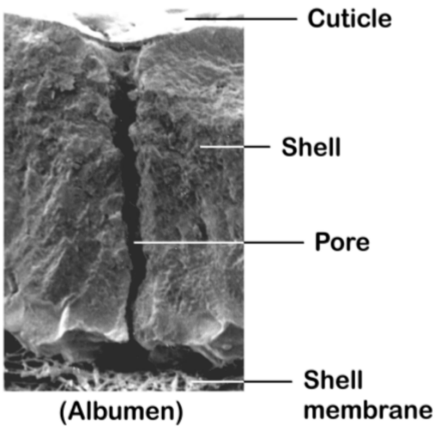
Eggs will sweat if the relative humidity % RH outside storage room is higher than:

Temperature of storage room	Temperature outside the storage room 15 °C	18 °C	21 °C	24 °C
21 °C	–	–	–	> 85 %
18 °C	–	–	> 83 %	> 71 %
16 °C	–	> 89 %	> 74 %	> 60 %
12 °C	> 74 %	> 64 %	> 53 %	> 44 %

The egg rooms can easily be kept the right set-point, to reduce risk of sweating. Even if a S.P.I.D.E.S process isn't routine, it is better to have several different storage rooms where it is possible to select the right set-point, depending on the different eggs requested.

The sufficient climate capacity, in warming, cooling and air flow, helps to reduce the risk of mistakes and condensation.
To preserve the hatchability during long storage without S.P.I.D.E.S, it is sensible to turn the eggs. If it isn't possible to have an automatic turning system, it is recommendable to turn the eggs by hand 3 times a day, approximately every 8 hours. If the eggs are not in trays, but in carton

11 mcr diameter and info about pore; 375 good eggshells



HANDLING HATCHING EGGS

pulp trays, it is of benefit to store the eggs upside-down, with the pointed end UP. However, please take care not to move or transport eggs in this position, because the right position of air cells can be lost, which could increase the percentage of malpositioned chicks.

Beyond 8 to 10 days of storage, even at optimal storage conditions, it is normal that hatchability will drop by around 0.5 % every day. This percentage increases to 1–1.5 % every day after day 11, and the chicks' quality decreases proportionately.

It is important to consider the storage day in terms of the weight loss of eggs. During the storage time, eggs lose weight, which is especially relevant in very long storage times. If we know the weight of eggs at day 3–4 from the day they were laid, we can set both Single-Stage or Multi-Stage setters to preserve the right humidity, in order to have the perfect fix point.

Dipping machine

Loss of weight module

› Incubation data › Transfer data › Hatch data

Recommended loss of weight by age

Young Flock Age 25 to 32 weeks	Min 10.5 %	Right 11 %	Max 11.5 %
Medium Flock Age 33 to 49 weeks	Min 11 %	Right 11.5 %	Max 12.5 %
Old Flock Age 50 to 63 weeks	Min 11 %	Right 12 %	Max 13 %

Remember:

› The right weight loss condition is calculated from day 3 of storage, as it is recommendable to carry out a weight test at this point.
› The clear eggs have a weight loss relative to eggshell quality; from 6 % t – 8 % max

Egg weight loss in optimal storage condition

	5 days	7 days	9 days	11 days	13 days	15 days	17 days	19 days
Brown breeds	0.07 %	0.34 %	0.68 %	1.06 %	1.19 %	1.56 %	1.64 %	1.77 %
White breeds	0.09 %	0.53 %	0.71 %	1.10 %	1.24 %	1.61 %	1.73 %	1.84 %

S.P.I.D.E.S Incubations or Pre-storage incubation

What is Short Period of Incubation During Eggs Storage?

Some time ago this was not thought well of in any incubation philosophy, but in recent years hatchery specialists have tested this process with fantastic and incredible results, with the S.P.I.D.E.S eggs at long storage being able to hatch with good percentage and good chick quality. It is very important to have knowledge like this, because with a little management we can bring a great improvement in our performance.

This process consists in helping and increasing the cellular replication during storage. This is possible by increasing the temperature. In the past we tried to reach the set-point temperature of incubation during the first test, but we quickly noted that this did not help. However, the easily reachable temperatures of 33 °C/35 °C are sufficient for cellular replication, and keep our embryos alive at hypoblast time. Concerning the following scheduling incubation step, or S.P.I.D.E.S, we reduce the time for decreasing temperature and return the eggs to the storage room more quickly.

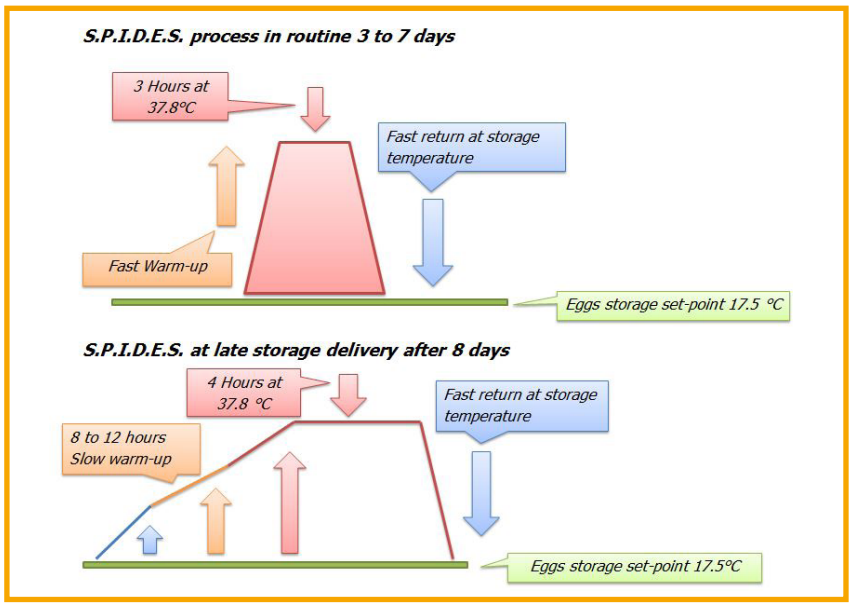
A modern hatchery which knows about the prevision of eggs storage in advance can organise a perfect schedule to arrange the cellular replication or S.P.I.D.E.S. Some hatcheries have dedicated machines or "special rooms" where this is arranged directly in the storage. In order to favour reduced movements of eggs and relative costs of the operator, eggs have to be at a minimum of storage day 3 - 5 before being warmed up. Some brands of S.P.I.D.E.S machines can have a fantastic programme and the sufficient capacity to arrange this process in 8/10 hours from; **warm-up – temperature – drop – storage set**. Please remember that our embryos have a higher possibility of surviving and hatching after this if the egg storage is 12 days. If we need to conserve the eggs for even more days, it is necessary to arrange another cellular replication between days 10 and 12 and to repeat this interval of time for the necessary schedule. We have experience and data for programmes with up to cellular replications and for over 35 days of storage in layers, and even more for turkeys.

It is important to remember to reduce the incubation time schedule;

- N° 1 S.P.I.D.E.S of less than around 4 hours
- N° 2 S.P.I.D.E.S of less than 6 hours
- N° 3 and plus S.P.I.D.E.S of less than 6–8 hours

Please remember that this length of time can change the processes of time and temperature. It is important to verify the effect of the process in the eggs with accurate testing and to balance the conditions of our hatchery.

It is important to remember that different warming and cooling capacity of machines used for S.P.I.D.E.S. can influence the value of the programme. Please verify the performance in an early candling test.



HANDLING HATCHING EGGS

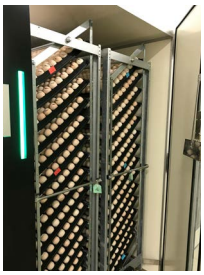
During the S.P.I.D.E.S process it isn't necessary to turn the eggs on any storage day.

NOTE: important storage advice:

- Eggs need to be cooled gradually from the body temperature of hens, (41 °C) to 22 °C – 18 °C within 6–8 hours, in as clean an atmosphere as possible.
- The right selection of a gentle cleaning process, which doesn't remove cuticles or lead to the formation of micro cracks, is important.
- Record the farm and the date of production for every tray.
- Correct fumigation or alternative disinfection for a good storage start.
- The storage start is from the deposition day, not from the day of arrival at the hatchery.
- Minimise egg storage days in order to minimise negative effects.
- There should be optimal climate conditions during the whole storage period, including the right temperature for the setting. Please also control and note issues or mistakes of the rooms (see table for days).
- Having two separate egg storage rooms with dedicated temperature and humidity control helps you to manage the processes well.
- During storage, remember not to place the eggs directly in an air flow or humidification system, or near a wall or on the floor, with a little free space from the trolley. This helps the uniformity of the condition of eggs.
- Keep weight loss of eggs under control and in respect of exigencies from day 3 of storage.
- Organise the S.P.I.D.E.S in right schedule.
- ABOUT LOHMANN: LOHMANN LSL is more negatively affected by long storage than LOHMANN BROWN. When using LOHMANN SILVER, it is important have a minimum of 3 days of storage in order to gain the best hatching potential. This is more evident in young flocks of LOHMANN BROWN and LOHMANN LSL.

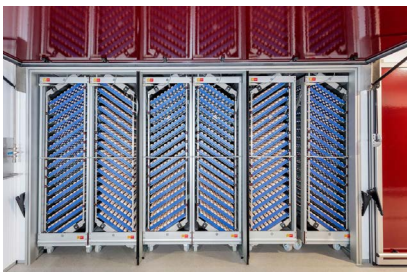
SETTER








Single-Stage VS Multi-Stage Incubation

Single-Stage = all eggs are set together in the same setter and in the same embryonic development, which can give a better biosecurity and specific environment for every different day. The conditions of setting prepared ad DOC, for genetics, breeder age, egg size and storage, all IN all OUT give the possibility of washing and an easy cleaning and disinfection process at the setter. This maintains and controls turning, sensor calibration and mechanic parts, which prevents breakdown. Setting can change depending on the capacity and adaptability of the different constructor brand to arrange Circadian incubation (change of temperature in the last days), hypercapnia incubation (high level of carbon dioxide in first week), management of setter at embryonic temperature, and impact on quality and performance in relation to the number of setting eggs,

SETTER

which don't need a constant number and which are more flexible. Moreover, some brands of Single-Stage setter can work in relatively high pressure gaps, which can help when setting a biosecurity cascade atmospheric pressure.

In contrast, a Multi-Stage incubator is filled with eggs of different embryonic ages, in order to balance all the zones. Some models have fixed trays, which are more balanced, and others have trolleys, but every machine has eggs of different embryonic ages inside it. These machines are more easily controllable and don't need any special programmes, but they have an average in all values with a fix set-point.

SINGLE-STAGE

- Environmental conditions can be adjusted according to the particular needs of the developing embryo
- Hypercapnia and Circadian incubation
- Perfect temperature from setting to transfer, relative to embryonic temperature
- Variability capacity and flexible set eggs
- Use of different ambient pressure for increased biosecurity, from egg storage to setter, transfer, hatcher, processing and delivery of chicks
- Shorter hatcher windows about 26–32 hours
- Better uniformity of chicks
- Better cleanness and biosecurity, only one flock, and setter can be washed and disinfected easily
- Lower mortality
- Better meat conversion and body growth, as well as better bone structure composition
- Easy tracing of eggs, easy flock management, and with necropsy easy solution of incubation issue

MULTI-STAGE

- Average of conditions for all the eggs setting in machine
- Problematic works with partial empty setter
- Stable value of CO_2, approx. 2,700 ppm
- Differences in chicks and related problems in uniformity
- Long hatch window: + 33 hours and often much longer
- Fix parameters and temperature from setting to transfer
- Low body growth, bone structure damaged, possible fibrosis effect in muscles
- Poor cleanliness and poor biosecurity
- Complicated tracing and it is easy to make mistakes or errors in flocks

These are the principal differences between the two philosophies of incubation. Multi-Stage can, of course, seem more simple in terms of management and control, and doesn´t need an egg programme. Multi-Stage can also be useful when energy breakdowns occur and can have good economic effects in terms of energy efficiency. However, the modern technology in heat recovering and the use of the free warming product from embryos have eliminated the disadvantage that the Single-Stage process is more expensive in term of energy. Please also remember that the setter can be washed and controlled after every incubation cycle.

Pre-Warming before setting

Pre-Warming, or pre-heating, is a process that prepares the eggs for the start of incubation after storage. At this time, the temperature of eggs slowly increases, starting from the storage temperature of 25° C (77 °F). During these hours, eggs are prepared for the increase of cellular replication following incubation, and the positive effect of recompacting the eggs and reducing the relative hatch windows is apparent. In broiler production it is naturally very important that the chicks are uniform and have the same size, but this is very important for layers too. The uniformity promotes liveability, standardises the condition and increases the chicks' quality; a good process of pre-warming reduces the risk of condensation.

Some Multi-Stage hatcheries have a special room where this process is arranged. It is important that this room has a good ventilation and a uniform temperature and air flow. Beware of arranging this process in a corridor or in a room where the temperature isn't uniform, as this will only increase the risk of a non-uniform warming and cancel the good effect of this process. However, if there is no other available solution, try to stabilise and standardise the setter corridor room at a temperature of 25 °C. Keep trolleys separated with a minimum of 25 cm on each side, as this helps the air flow and increases the time to 8–12 hours. A control of the internal egg temperature in the different levels of the trolley can help verify if conditions are good or bad.

Warning: do not arrange this in a machine with a currently functioning timer

when there isn't a real pre-warming. Don't give the necessary control in temperature and uniformity in this case either, as that can only cause damage.

Everything is easier in Single-Stage hatchery, because a good machine has perfect control in more performance programmes as the possibility of changing the time (hours), moderating the turning action and ventilation and increasing the temperature. This can be very useful in the special case of eggs which are in storage for a very long time, when the pre-warming process needs to last longer.

Many different conditions can change the pre-warming, including hours of storage, days of storage, storage temperature, flock age, egg size, and warming capacity of setter brand to reach the set-point.

- Eggs with very short storage (3–4 days) in a storage room at 20 °C don't need pre-warming. They can be damaged and their early dead mortality rate can increase.
- Eggs of 5–8 days of storage need a minimum of 6 hours.

Good S.P.I.D.E.S. schedule and when repeat treatment

Setting time and set pattern if requested

The setting time is really important for our final results, and for this reason the prevision of incubation time is the basis for good results and good chicks. It is the standard attitude to use a fixed schedule time for the Multi-Stage incubator, which can vary according to the breeder (LOHMANN LSL needs some extra hours), age of flock (youngest and oldest need a bit more time), storage of eggs (where S.P.I.D.E.S. is not used, after 9 days of storage it increases from 30 to 50 minutes every day +) and season (summer reduces it by 1 hour; winter increases it by 1 hours). Every Multi-Stage incubator brand has a perfect set pattern and a balanced setter, where all the machines have to work as much as possible and at full capacity. If this is no real possibility, a control of CO_2 at 2,700 ppm can help to determine the valve set-up and can help to bring about the correct weight loss of eggs.
Concerning total difference in real Single-Stage, where the programme in use can justify a different time, the table gives some indication of the respective embryologic temperature (100 °F–100.2 °F for LOHMANN BROWN, 100.1 °F–100.4 °F for LOHMANN LSL).

It is important to follow the conditions and setting recommended for every different incubation brand. Air flow and temperature in particular can have various different effects and for this reason it is important to use a dedicated and specific programme. It is rare that a programme built for a particular brand also has positive results for another brand.

This is the reason why we have decided not to present any programmes in the Lohmann incubation guide: programmes have to be decided upon and tested individually, hatchery by hatchery, with the objective of having the perfect embryologic temperature, perfect weight loss of eggs, and perfect embryological time. Remember that chronological time is a count of hours = time……Embryological time is the effect of air flow, temperature, CO_2 and humidity, and isn't a fixed figure but rather can be subject to all these influencing values which can either move our embryos forwards or delay the chronological time, extending or reducing our real hatch window time.

Some machines have the option of recovering energy with reduction of an rpm fan, or alternatively the option of balancing the temperature with air flow velocity. The objective of using some of these options is achieving uniformity of temperature at minimum cost, and it is possible to use them at the recommendation of the constructor.

In some special conditions, the right set pattern can help our embryos a lot. In

SETTER

the special case where we set different typologies of eggs in the same incubator, breeder age or storage time can vary. All the following information is indicative and has the objective of achieving uniform eggshell temperature and reducing the hatch windows time, for improving chicks uniformity and liveability.

Indicative time for LOHMANN LSL female line. In male lines increase the time with 3–4 hours.

Flock Age	Storage Age 1–6	7–10 Nº 1 SPIDES	11–14 Nº 1/2 SPIDES	+15 Nº 2 SPIDES
24–30	507–509	509–511	511–513	513–515
31–49	505–507	507–508	509–511	511–513
50–63	508–510	511–512	513–515	516–517
64 +	510–511	512–513	514–516	516–518

Indicative time for LOHMANN BROWN female line. In male lines increase the time with 3–4 hours.

Flock Age	Storage Age 1–6	7–10 Nº 1 SPIDES	11–14 Nº 1/2 SPIDES	+15 Nº 2 SPIDES
24–30	505–507	507–509	510–512	512–513
31–49	504–506	506–507	508–510	510–512
50–63	505–506	507–509	510–511	512–514
64 +	505–508	508–510	511–513	514–516

Optimize egg setting taking into consideration the average temperature of the machine

Optimize egg setting taking into consideration the air flow of the machine

Optimize egg setting in consideration of different breeder flock age, eggs storage etc.

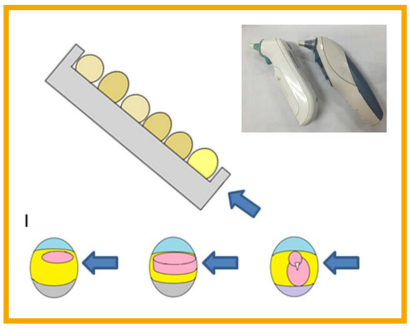
Temperature

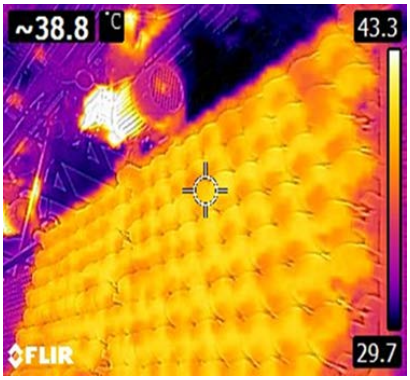
When the hatchery manager asks about perfect incubation temperature, he or she is normally referring to the fix set-point in the setter machine. And this is available for most constructor brands. This is the air temperature, which is dictated from a sensor, which is positioned in the centre of the zone controlled. All hatchery managers know that is a delicate and critical relationship between this temperature and real hatchability performance and chicks' quality.

We have just mentioned that the incubation time and chicks' developments have a relationship to the temperature of our embryos, and accelerations or retardations of the chick's development cause extra costs in performance and quality.

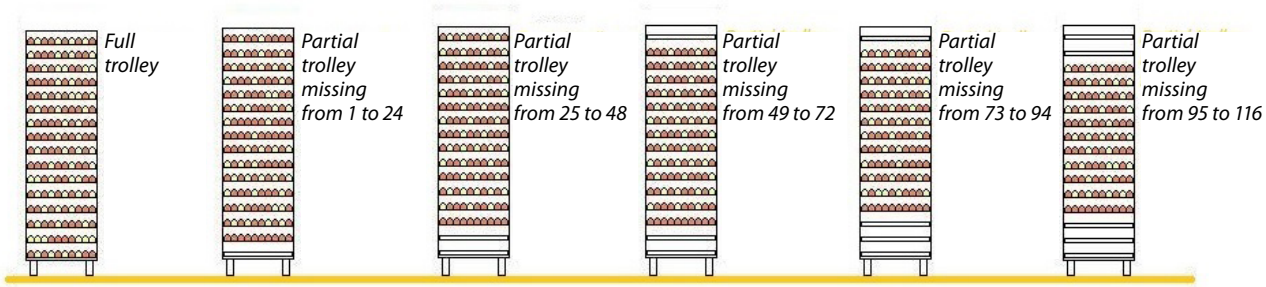
Optimising the eggshell temperature is the key to the optimum condition of embryos, and a simple control of this is the eggshell record data. The perfect temperature is, for the most part of incubation, around 100 °F–100.2 °F for LOHMANN BROWN and 100.1 °F–100.3 F° for LOHMANN LSL, in last part of incubation these temperatures gradually increase, and we know from experience and from many tests that it is very complicated to have a perfect view of the incubation process in the first two weeks, as, on same tray, on any day, the recognised temperature of eggs can vary. This is why it is important to control a sufficient number of embryos in different trays and in different positions, to remove data from infertile eggs, and to make averages.

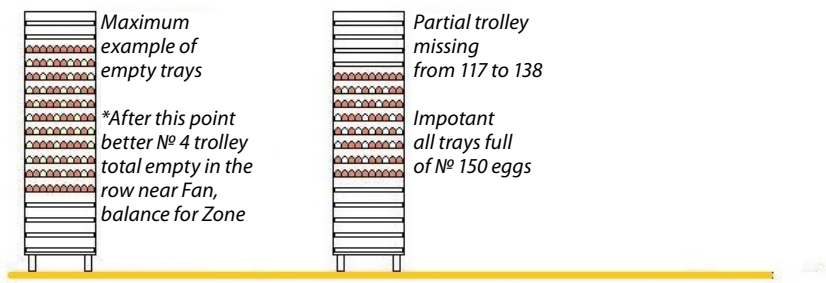
If the number of infertile eggs increases a lot because of the health or age of the flock, it is important to take action to regulate the temperature, even when the setters are not full of eggs. For this reason, it is important to consider the brand and trays and to use the right setter trays fill-up.





Setter trolley fill-up





IMPORTANT
If we don't need the complete setter capacity follow a schematic for fill-up a better AIR-FLOW in the setter

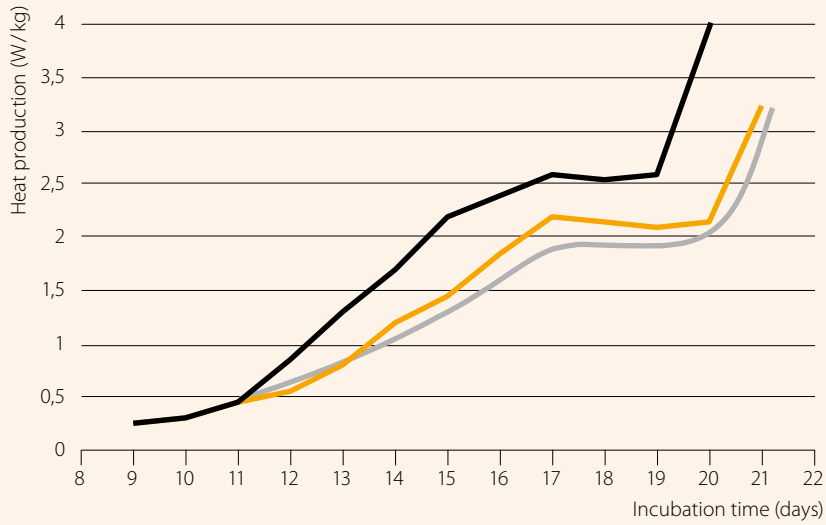
LOHMANN, Davide Assirelli

SETTER

It is important not to standardise these data in different brands of incubators, but rather to test and control brand by brand (air flow, warming and cooling system and relative action is different and can cause different reactions in our embryos).

Every breed has a different metabolic heat production, and for this reason our only reference to the air temperature set-point is the necropsy and the quality of the chicks, where we undertake repeated accurate controls.

Heat production of the embryo per kg egg mass



Adapted from Janke, Tzschenktke and Boerjan (2004)

Humidity

In the incubation process, water vapour moves through the pores of eggs to the setter atmosphere. This is very important because it has a great effect on our weight loss target for the eggs, which is determined by external data concerning number of pores (normally determined by age of flock, size or breeder), eggshell quality (size, health and breed), and the humidity value set in humidity set-point. In Multi-Stage incubation, this value normally ranges between 52 % and 55 %, and is balanced by a humidifier system. In Single-Stage incubation there are different solutions possible: some brands use the same methods as Multi-Stage incubation with a little adjustment in humidity value from 60 % at the start of incubation to 45% at the end of the process, which is followed by a constant weight loss of eggs and which involves, in some cases, a strong action of the humidity system on the last day of incubation.

This is needed for the essential formation of an air cell and the simultaneous evaporation of water, to optimise water and minerals in embryonic compartments; the movement of water from albumen to the sub-embryonic cavity guarantees the right balanced proportion of nutrients.

Different philosophies exist in extreme Single-Stage brands, where there is no humidity system in the setter, and where the setter starts with a humidity value of around 80 %, and conserves the eggs' humidity in first week with the proximity of the damper. This humidity value constantly decreases till 30 %–35 % in the final stages of the process. The objective is not to use external water, which can have negative effects in temperature stability in a microclimate and in biosecurity, but all of these points are possible with a good control of an active damper.

Remember, in both situations it is extremely important to reach the right weight loss of eggs for the respective age, in order to have a correct fix point, for a good hatcher performance.

Ventilation

Ventilation is very important for our embryos: we would like to share this argument in two parts

1. The correct ventilation in terms of air flow.
2. The correct provision of oxygen and the right conditions for the weight loss of eggs.

N°1

In Multi-Stage setters it is very important to always have the maximum air flow power for all trays setting, in order to guarantee the same treatment of all different eggs of various ages. In Single-Stage machines the air flow is very important at the start of the setter process, to guarantee uniformity of temperature and short warm-up. These are positive points and they reduce the rate of very early embryonic mortality. However, when they reach the set-point in the first 4/5 hours up until day 12/14 of the process, our eggs don't need extreme air flow; the production of warmth of our embryos is very limited, and if the machine has the possibility of saving energy, we take this opportunity. The requirement for changes in the last week of incubation are a guarantee for good air flow, good embryonic temperature, performance, and a reduction in hatch windows time.

N°2

Damper/Valve action has to guarantee the correct provision of oxygen, every time. It is important to control our machine in this phase, and as every different setter has its own plan and system of works, it is crucial to remember some basic important points in first 7/9 days. Carbon dioxide (CO_2) can help the embryos at the start and help to improve the blood vessels and the size, but after 11 days CO_2 is a poisonous gas which can increase mortality in chicks.

The drive of valves with a CO_2 sensor is a very useful tool in the situation of a partially empty setter, or with a low fertility flock.

Recommended	CO_2 value		Time
	ppm	%	
Multi-Stage incubation	2,700	0.27	All incubation process time
Single-Stage	7,000–10,000	0.7–1	Start to 9 days max
Single-Stage	2,700–4,000	0.27–0.40	9–19 days

It is important to remember that both situations can influence the attainment of the right weight loss of eggs for the age, in order to have a correct fix point for a good hatcher performance.

Turning

It is very important to replicate the natural action of a hen, in order to guarantee the correct eggshell temperature, to make sure that air flow has only one line of direction, and to change the position of eggs. The objective is to:

- Resolve adhesion of embryo to the shell membrane
- Correct development of air cell position
- Improve development of vascular area, which helps yolk condition and relative use by chicks
- Allow normal transfer of albumen proteins in amniotic fluid
- Improve the blood vessels under the shell to maximise oxygen absorption
- Avoid the lower growth of embryos shown in unturned eggs
- Help the embryos to reach the normal correct hatching position
- Reduce malposition and reduce the number of unhatched eggs

The turning has to take place every hour.

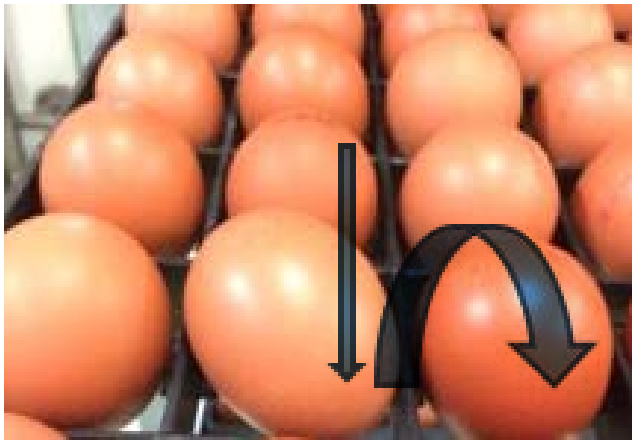
Some brands may have the possibility to change the frequency or to leave the eggs for some minutes in the horizontal position. This is a good resource and can be advantageous.

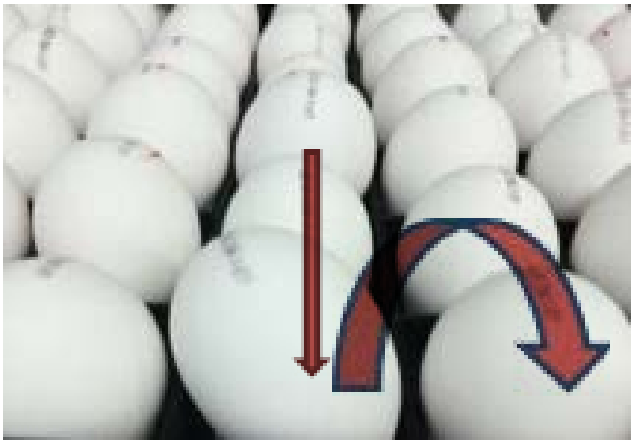
It is important for the eggs to have an angle of 43°– 45° and for them to be turned in the correct asymmetric movement. Turning has to be slow and gentle and without any "catapulting" actions. It is very important that hatchery takes care and organises routine control of actions and angles, because a malfunction can completely destroy the hatching performance. Turning isn't necessary after day 15 of incubation. For this reason, if the cooling capacity of our machine isn't sufficient, the

SETTER

flat position that helps the air flow velocity can only help the embryos when they are at the right uniform temperature.

1st week of incubation	8–15 days	16–17 days	18–19 days
45 min/1 min flat	60 min/1 min flat	60 min/10 min flat	Stop or 60 min/60 min



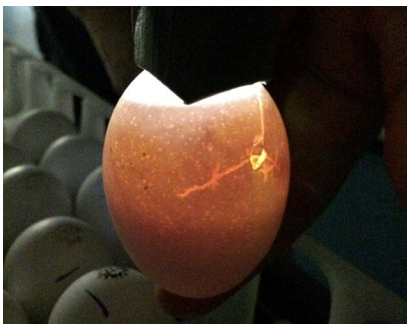


Warning: in this position these eggs cannot have a good symmetric angle of 45 degree.

CANDLING AND TRANSFER

Candling

Candling is an easy and sure methodology to determine the percentage of hatchability:



› **Early candling** gives in advance information about the condition of the farm, percentage fertility, correct storage conditions, health at the farm and condition of embryos at the start of the incubation process. Previous candling can be carried out after 6 days of incubation by an individual candling lamp, and the following breakout of eggs, shown in reliable percentage values, indicates the early deaths from blastoderm -72 h and early mortality "blood ring" at 3–6 days. These values help to determine the approximate hatch, and help us to decide the incubation number well in advance.

This method is humane and doesn't destroy or damage the live embryos. It is important to have a representative number of eggs in the test (dirty or floor eggs don't give a reliable average results).

LOHMANN BREEDERS

› **Medium candling** is carried out in some hatcheries at around day 10 of incubation, in special cases in the oldest flocks with poor fertility. It is done in order to refill the trays with fertile eggs and to improve the uniformity of temperature during the setter process, to have more space following the incubation, and also to reduce and speed up the transfer job. It is possible to use a "candling table" in a dark room, although automatic candling machines that can carry out this process also exist.

› **Transfer candling** is the most common method for every hatchery, as it isn't necessarily an extra job. During the transfer operation from tray setter to hatcher basket, the eggs can be processed with a "candling table" or automatic machine, which can remove all the clear eggs and dead embryos. Extra attention must be paid when the percentage of removed eggs is over 15 %, as it is important to refill the hatcher basket. At the moment, only prototype machines for refilling exist, and in general this refilling process is done manually. However, it is always necessary to heed the fragile condition of the eggs, so as to avoid damaging the embryos.

The candling is important, because any clear eggs transferred to the hatcher don't produce metabolic heat and therefore create an unstable climate. In situations with different flocks with different fertility rates located in the same hatcher, causes problems during hatching, from increases in hatch window time to the percentage of embryos which are piped but don't hatch. All tests which have taken place confirm that chicks' quality is improved through the candling of eggs, and that the number of chicks damaged during the chicks take-off is reduced.

In conclusion, these are the reasons for candling:

1. Early detection of farm problems, male condition and general health and storage conditions; right S.P.I.D.E.S. use; correct incubator conditions and management
2. Creation of a good collection of reference data, to use with necropsy for identifying and resolving problems quickly, and to have a general view of the farm and the hatchery
3. Good estimation of the percentage of hatched chicks
4. Optimisation of space in setter (previous and middle candling)
5. Separation of waste into a different category of risk and reduction of costs (eggs to shell calcium); the possibility of selling unfertile eggs for use as animal food; reduction in terms of kilograms of waste in the hatchery per day
6. Improvement of quality of chicks; improvement of performance; optimisation of hatcher space and use

CANDLING AND TRANSFER

Transfer

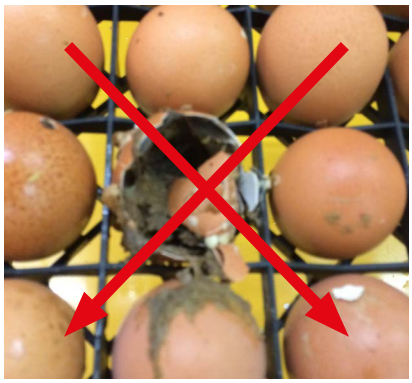
When the hatchery manager asks about perfect transfer time, many different options and windows are opened up, which we would like now to clarify.

The transfer process was standardised in the past at 444 hours, and is now set for all Multi-Stage incubators. In order to balance the temperature and the air flow of the setter, all hatcheries work with this clear chronological order, including the transfer from setter tray to hatcher basket after 18.5 days.

And in hatcheries that work with Single-Stage? There is a possibility of change at our exigencies, we don't have to balance the setters of all our incubation machines, which can be empty from day 16 to 19, but is important to remember that at some point, the target at 18.5 is the perfect parameter for the eggs' weight loss data, the hatcher basket isn't built for having the same air flow of the setter trays, and the majority of brands of hatcher have more cooling capacity, extreme air flow and ventilation. For this reason, in early transfer, we have to control and prepare a good programme which maintains in hatchers the setter condition from day 16 to day 18.5. The problem isn't to stop turning but the anticipated transfer can cause some problems at hatch windows time and can reduce hatchability by around 0.5–1 %. At the same time a delayed transfer is possible, if our hatch windows target is perfectly standard, but an excessive delay at day CANDLING AND TRANSFER 19.5 can disturb the embryos just starting with internal cut, at this time eggs are more fragile and can be damaged by the automatic vacuum transfer machine.

Incubation time is calculated from the moment that our eggs reach the set-point, not from the effective switch-on of the incubator or from pre-heating start. For this reason we have to know the effective time that our machine needs for keeping eggs at the right temperature, and from this basis our chronological time starts.

A really important point is the climate of the room and condition of transfer, warm (25 °C – 28 °C) and in high hygiene and biosecurity, the basket has to be washed and disinfected, totally dried and wormed, and process should be gentle and as short as possible. If an automatic machine is in use to keep this movement soft and stop it causing damage, and the hatcher machine is switched on and at the right temperature just at set-point, the hatcher programme, if present, should run in the perfect stage. If manually operated, the operator has to fix considering the chronological requirements.



Operators need to pay attention to biosecurity by cleaning and sanitising hands at every possible contamination; the Roth eggs (contaminated eggs that are not removed by automatic candling because it is dark) have to be removed. This is very important because these eggs can explode in baskets with chicks which have just hatched, and contaminate all chicks that have an open navel and are therefore more vulnerable. This can cause real increases in first week mortality and infection of the yolk sac.

If some flock operators arrange a refill, it is important that the same percentage of live embryos for all baskets is calculated in advance, as well as the hatcher condition number. The operator should organise the level and the distribution of the hatcher dolly. To organise a perfect balanced hatcher, follow the set pattern if necessary; below are two different examples:

Fill up hatcher Dolly to guarantee the best embryo/chick condition

Fill up hatcher Dolly to guarantee the right air-flow

HATCHER












The Hatching cycle

After the routine transfer from setter trays to the hatcher baskets and relative hatcher machine, the embryos have to continue their natural development and prepare for the hard cycle of the hatch. The general climate conditions are very important because our embryos have to finalise the transformation of internal organs and prepare the piping and the relative exit from the eggs.

In these last days, our embryos turn their body position along the long axis of the eggs, and by positioning the beak under the right wing, they are now in a perfect position. The yolk starts to retract in the abdominal cavity, and the navel starts to close. At the same time, blood circulation undergoes the necessary modifications. Now our chicks are ready…….. Turn the beak and start with the internal piping of membrane,continue with a circular cut of eggs relative to our external climate and conditions, keeping our internal condition liveability and perfect chick development (embryological time), we have start our hatch windows.

Simple in this description but this is … the miracle of life.

The phase during hatching is different, and we can help our chicks with different set stages. This is necessary in both philosophies of works, namely Single-Stage and Multi-Stage, because we can help a lot with the right action.

Some brands of hatcher have some interesting tools to better follow the chicks' condition, others believe more in different forms of control. Of course, carbon dioxide is a sure value that can help reveal a lot about the real condition of our hatcher machine, in relation to the situation that we have done in a full complete cycle.

Uniforming and stabilising the embryos' time with the right condition and synchronising chronological and embryological time creates a very nice advantage.

As mentioned in the previous chapter, in this guide we don't want to suggest any dedicated programme, as the variability and the differences between one hatcher brand and others need a dedicated investigation and test, but an important target to consider is the right hatch windows time. Of course, depending on the age of the flock and the storage period , for a good chicks' condition and for best liveability hatch window start with the first 5 % of chicks from the total chicks pull-out(it takes minimum26 to 30 hours for Single-Stage and 28 to 32 for Multi-Stage).

Warning: the definition of hatch windows isn't completely correct: in reality between 5 % and 98 % of chicks hatch, but it is impossible to have total control of every hatch basket in order to verify these parameters without having a negative influence on the climate of the hatcher, (the real hatch windows time in hours is shorter, but certainly more easy to be calculated in the form described).

Some new trends are just evolving: the hatch directly in a farm cage, or in special machines where the chicks hatch directly on the setter trays and can eat and drink as they need to. These arguments need a totally different discussion, which is more specific for each construction brand, which we don't want to touch in this general guide.





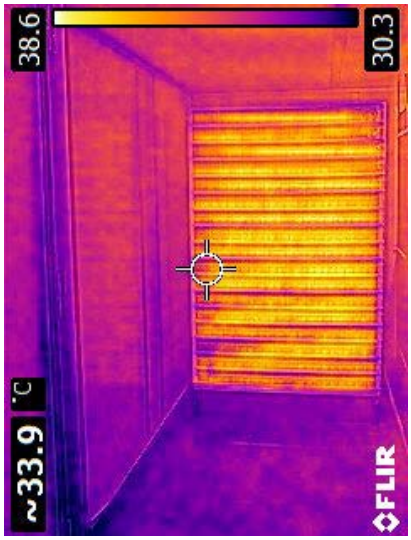

HATCHER

The Hatcher operation

This is a very important part of the process, because in this part it isn't possible to correct a wrong incubation action, but it is very easy to destroy the entire good job.

In hatchers the conditions can change in a short time and very frequently, and these factors are more complicated to control using an automatic system. For this reason, some brands are developing tools to better follow the hatcher condition or using virtual intelligence systems to change the step and relative set-point at necessity, which are free in terms of time and connected to the real condition and advancements of the hatch. The objective is to help and facilitate the piping out of our chicks, with a stimulation effect, and it is done for chicks which have just hatched, ensuring the right condition of drying and for cicatrising of the navel, which helps bring about the best quality of chicks.

- It is important that our temperature has to drop in relation to the number of chicks hatched, and a drop to real temperature could help to conserve and improve our chicks' quality after the end of the real "hatch window time".
- Humidity improved from the natural increase at the hatch can help to maintain a constant high value, but at the end, the real "hatch windows" have to change and decrease to help all chicks to dry in perfect way, which is important because the stability value of humidity UP and DOWN can destroy chicks' quality.
- CO_2 (carbon dioxide) at a value of 7,000 ppm can help in the stimulation step. Knowledge about the real density of CO_2 helps us to understand when our machine needs the change of steps and starts to provide more ventilation. Sometimes the fertility of the flock can make a big difference.
- Ventilation and an extra fan for fresh air have to work with respect to real hatcher condition: increasing the ventilation in the early phase can stop the hatch; delay in the use can change the climate condition of the chicks hatched.



To determine optimum timing, the flock age is the inherent factor; embryos youngest of 30 weeks and oldest of 60 weeks need an additional 5/6 hours of time, as is also the case for the long storage eggs that have not undergone the S.P.I.D.E.S process. The value is standardised in all our hatchery processes in these points, namely uniformity and reduction of variability, optimum time, a nice fluff condition and a good general condition.

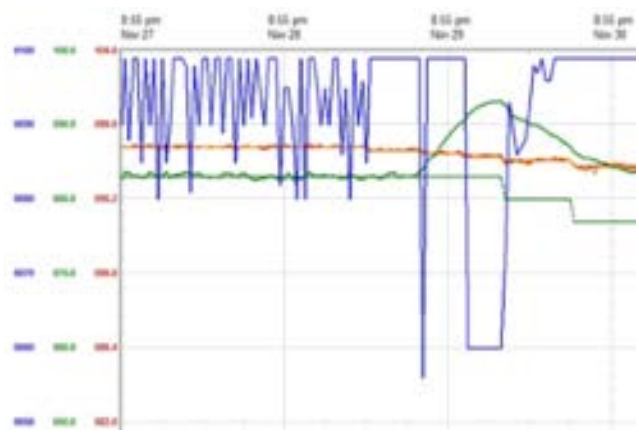
Use of a disinfection product during the hatch is very important and gives an advantage in bacteria and mycosis control. In the past it was common to use an evaporation plate with Formalin, positioned in the hatcher machine at day 19 and with a quantity sufficient to cover all processes of the hatch. This is very dangerous for the operator and for the chicks in high dosages, and, if extended, this evaporation over 12 hours can lead to permanent damage of the chicks in the hatcher (can damage trachea and encourage reactions to vaccines). However the efficiency, the cost, the easy utilisation and the positive characteristic of giving the chicks a very beautiful yellow colour have pushed managements to continue using it, although in some countries local governments don't permit its use anymore. In other countries it is permitted but only with some restrictions and safety systems for the operator. Many different typologies of products can carry out good disinfection during the hatcher process, especially if sprayed in regular frequency of time or in evaporation. Here, peroxide is one of the best and if it is used by evaporation, it is a perfect substitution.

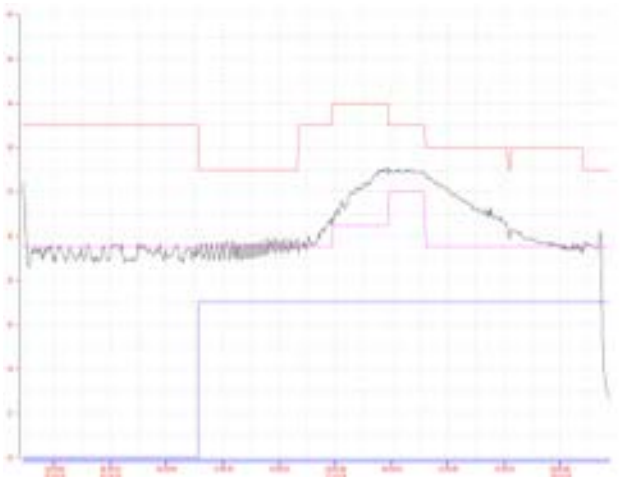
Remember, in the hatch process our chicks have a continued hatch, and with increase in number there is a relative increase of

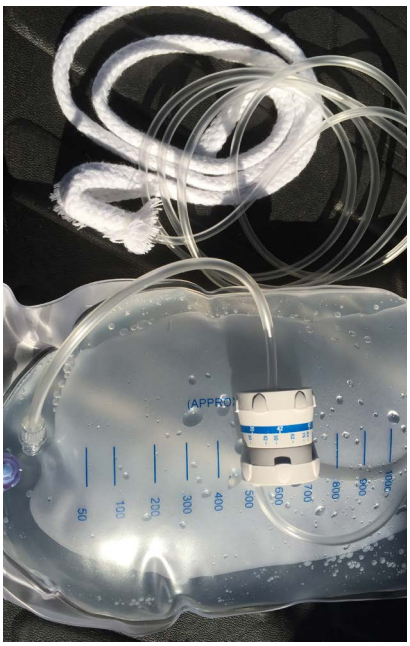
contamination. For better control, a timed dosage of disinfectant is very useful.
Disinfection which starts and finishes in one shot isn't a perfect job because of the decrease in terms of active ppm: the solution loses capacity over time. In a test, the value of disinfection is very high on day 19, at over 50 ppm, but near 0 on day 20.5. For this reason it is better to spread a higher dosage of the disinfectant that we have chosen.

IMPORTANT: all disinfectants have to strictly follow the "technical sheet info" in terms of the right dosage and the system of utilisation. Make sure to verify the disinfectant impact on with chicks' fluff thru analysis and to check whether they are compatible and not aggressive with the material construction of our hatcher machine; some disinfectants are good for bacteria control but extremely corrosive and dangerous.

Interesting hatcher graph with a good and a perfect hatch window







HATCHER

Monitoring chicks and quality control

In this guide, we have spoken about "chicks' quality". This is the appearance of the chicks in the basket, and in general this is determined by the hatchery operator according to: Visual and tactile appreciation of day old chicks.

- Activity attention and fast reaction of chicks
- Uniformity
- Good navel condition, closed, with perfect cicatrising
- Nice yolk sac absorption with a soft belly, but not too slim
- Legs in perfect condition, not dehydrated or damaged, no red hooks
- Beak clean and not damaged or inflamed, caruncles perfect
- Fluff condition vaporised dry and not dirty, with a nice smell

LOHMANN BREEDERS

In summary, the first point of control should be reached for if our chicks don't respect one of these conditions.

1. In a normal case, a right pull-out time at the right ventilation condition is the key for active and reactive chicks.
2. Uniformity varies with the quality of hatching eggs and their size and weight at deposition. Other factors that can damage or promote our chicks' uniformity include genetic background, age, health of eggs, shell composition and relative different weight loss of eggs.
3. Incubation and hatcher should be stable in temperature and humidity for the chronological development and the solution for no perfect chick's navel.
4. Perfect weight loss of eggs, correct pull-out time, development in the right embryologic temperature, correct hatcher ventilation and qualitative hatching of eggs in good health and with the right percentage of yolk/albumen/shell, are points to pay attention in order to have a soft and nice belly.
5. Right pull-out time, correct temperature at the end of the incubation time, correct temperature in the hatcher machine, favourable condition for short hatch windows, and darkness in the hatcher,in order to maintain good chicks' legs.
6. Long permanence in machine, long hatch windows, and hard cutting and exit from eggshell.
7. Ventilation and oxygen at hatching of chicks, correct temperature for the chicks which have just hatched, poor eggs tournament, eggs health and sanitiser condition at the production farm.

It is important to remember that in hatchery life, some adjustments are necessary in consideration of flock age, season, and some other variable conditions (pull-out chicks in incubation time or prepare a different programme) the correct monitoring of chicks can help you to take some different decisions and find a solution for the best setting.
Different systems exist for monitoring format and for standardising the chicks' quality, which depend on the subjective opinion of every hatcher manager. It is important not to forget the following:
"Ogni scarrafone e bello a mamma sua" = "every bitch is beautiful to the mother" … But this isn't what we want.
When we ask visitors of the hatchery for their opinion about the quality of some of the chicks, we commonly receive these answers:
Nice … Not bad … not good … These are not form of answering. for a good hatchery process and some monitoring we can answer the question with reliable data.

A good hatchery has a "Quality Control Operator" who has to follow all the chicks' pull-out and monitor the quality of the hatch (percentage and chicks conditions), record data and inform the hatchery manager about mistakes or issues. It is important that the good collaboration and the total agreement between these two members of staff exists.

Pasgar Score chicks evaluation:

This high-quality formula, which is carried out at the chicks' pull-out in the hatcher basket can value our chicks with a numerical average. It is my preferred formula as it is easy and not subjective (operator cannot be influenced by personal opinion).
Take 50 chicks from the hatchery basket, not specifically selected, and one by one test them for each of these 5 points;

1. Reflex, the reaction of the chicks to a reversed body: if the chicks stand up in regular position in a maximum time of 3 seconds, the score is =0; if chicks need more time or don't try to take the correct position the value is =1
2. Navel: a perfect navel has a score of =0: an open navel, a black button, a strictly navel, a brogue or an inflamed and red navel has a value of =1
3. Legs: good and strong legs of normal skin colour, score =0; dehydrated red and very slim legs, red hook, blood vessel in strong evidence, value =1
4. Beak: a clean and normal horn colour, nice and clear caruncle, score=0; a dirty or red beak, dirty and red caruncle, value =1
5. Belly: a soft and smooth belly scores =0; a tight and hard full belly, or chicks which immediately expel meconium when their belly is touched, value=1

Every chick starts with a value of 10 points; all positive scores don't affect the value and every negative score decreases the value. What is important in this test is the total average. If it is over 9, it shows a good chicks' quality; if it is from 8 to 8.95 it shows a medium quality, and scores of 7.95 and below indicate a low chicks' quality.
The practical value of this test is the score in numerical value, and it leads to percentage discoveries of critical points and improvement areas where we have to direct our attention.

In all LOHMANN hatcheries, quality control operators carry out the Pasgar Score Evaluation test.

Chicks' yield

When monitoring chicks' weight in relation to weight of eggs at the set incubation time, it is very important to follow the same trays from the recording of weight of eggs at the setter to the hatch pull-out. Count good chicks and record an average weight and divide by eggs average for the eggs weight percentage. This helps to inform us if the weight loss of eggs at incubation/transfer time was right and if the correct parameters were from 67.5 – 66 %. If the delivery time is from 2 to 6 hours, or, in the case of very short delivery, 1 hour, a low percentage isn't a problem but if the delivery at the farm is very long, a value of 69 %–70 % helps the liveability. Regarding standardised time for prime flocks, every 2 hours more in the hatcher is relative to 1% of weight loss.

Chicks' uniformity

The chicks must have the same weight under the condition of good parameters. The uniformity of hatching eggs is also very important for this data. The uniformity has to stay over 85 %.

Chicks' length

Another monitoring test is the recording of length in cm. This shows a perfect hatcher profile, and a perfect hatcher pull-out in case of real short delivery. This test is a little more complicated and needs attention and objectivity when recording. It is normally used in broiler hatcheries.

Empty eggshell evaluation

This monitoring test unfortunately needs good practice and experience, because it isn't easy to recognise the borderline between one condition and another condition, but we can start with this helpful information:

- Shell Membranes are still moist and stay connected to the eggshell; inside the eggs there is a substance which looks similar to latex; the blood vessels in the membrane are visible but fine; and the eggshell is extremely clean. All these points confirm the anticipated pulling-out. Chicks are "fresh", and for the best quality and performance we have to improve the chronological time.
- Shell are crushed in the hand; membrane can appear separate from eggshell in many places; and eggshell looks dirty and covered in meconium. All these points confirm retarded chicks pulling-out. Chicks are "crispy", total percentage is high, but for the best chicks' quality and relative liveability we have to reduce our chronological time.

HATCHER

- A large blood vessel which can be observed inside the eggshell and a big discharge of urea are clear indicators of overheating.
- The height of cutting in the eggshell is a forfeit indication of weight loss of eggs. A high cut near the obtuse pole of eggs is a clear example of insufficient weight loss, water and relative amniotic liquid quantity is too much for the perfect chick's metabolism, and some chicks don't manage to complete the cut and the hatch.
- The lower cut is the opposite problem. Weight loss of eggs is high, the low quantities of amniotic liquid obligate some chicks to take up a malposition and in some embryos the feet can move over the head and stop the head from cutting.
- In the ideal hatching conditions, the cutting of the eggshell is flat/plane and follows a continue line. The change of the cutting line upwards and downwards shows improper conditions and bad state of chicks.

Monitoring using necropsy

This is a real and true test of our process, because embryos can't lie. Every hatchery controls the process of carrying out professional and correct necropsies. This shows us the effective value of our hatching eggs, of our setting programme and of our maintenance and functioning of our machines, but this needs a chapter of its own.

NECROPSY AND BREAKOUTS ANALYSIS

Making breakouts Analysis

The necropsy is a sure way of monitoring in order to have all our flocks under maximum control, in necropsy of eggs we can see the real performance and know if our performance is at the right condition and in line with the genetic potential of our eggs. The best hatchery can transform the eggs into qualitative chicks if it does a perfect job, but it cannot improve the genetic value. It can destroy or it can damage the chicks' quality. But we repeat, it cannot change the base or genetic value. But what is this value? … Is really important to know.

Carrying out a correct necropsy is very important for our process, in order to make sure that our hatchery respects the genetic value. Of course, for this we need a sufficient number of eggs in the test, and we need to arrange good and affable breakouts.

Hatcheries have to prepare a dedicated table practice, which is easy to clean, comfortable for the operator that can manage the breakouts with maximum biosecurity.

In our process, the "Quality Control Team" arranges "early candling" and relative breakouts. We want these tests to be done just in order to have some information in advance (right hatchability previous percentage) and to guarantee control on the fertility value and have a clear vision of early dead in previous hours (easier to identify in the first part of incubation).

In this guide we are using LOHMANN analysis format, because it is part of my experience and in this format we conserve more than 30 years of data:

Necroscopy Analysis in order to resolve possible mistakes during incubation process

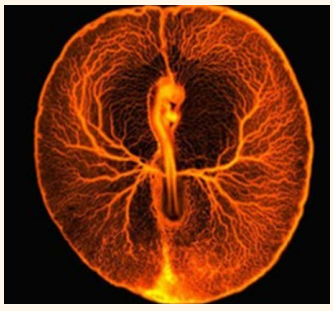
LOHMANN BREEDERS

INFERTILITY IN CLEAR EGGS WITH NO EMBRYONIC DEVELOPMENT

- **Males undernourished:** follow a recommended feeding programme to provide adequate nutrition; replace underweight males.
- **Too few males:** increase the number of males in the flock; artificially improve the frequency of insemination.
- **Seasonal decline of fertility:** use young cockerels which are more resistant to environmental stress.
- **Competition among breeding males:** do not use many males; rear all males together; place temporary partitions in large pens.
- **Diseased flock:** conduct an approved disease control programme.
- **Frozen combs and wattles:** provide comfortable housing; properly select and maintain drinking fountains.
- **Old males:** replace with younger males.
- **Selected mating in pens:** artificially inseminate infertile hens; replace males in the pen/house.
- **Male sterility:** replace males in the pen/house.
- **Crowded breeders:** provide the recommended floor space; follow recommendations of LOHMANN.
- **Improper artificial insemination techniques or use of old / over-diluted semen:** follow recommendations of LOHMANN.

VERY EARLY DEAD BLASTODERM PHASE – 72 HOURS

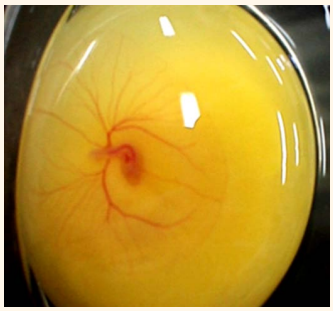
- **Males undernourished:** follow a recommended feeding programme to provide adequate nutrition; replace underweight males.
- **Too few males:** increase the number of males in the flock; artificially improve the frequency of insemination.
- **Seasonal decline of fertility:** use young cockerels which are more resistant to environmental stress.
- **Competition among breeding males:** do not use many males; rear all male together; place temporary partitions in large pens.
- **Diseased flock:** conduct an approved disease control programme.
- **Frozen combs and wattles:** provide comfortable housing; properly select and maintain drinking fountains.
- **Old males:** replace with younger males.
- **Selected mating in pens:** artificially inseminate infertile hens; replace males in the pen/house.
- **Crowded breeders:** provide recommended floor space; follow recommendations of LOHMANN.
- **Improper artificial insemination techniques or use of old/over-diluted semen:** follow recommendations of LOHMANN.
- **Eggs damaged by environment:** gather eggs frequently with accurate control of conditions.
- **Eggs stored for too long or incorrectly:** store eggs at the wrong temperature, or too cold or too warm, or at an instable temperature and humidity; bad and incorrect or inappropriate S.P.I.D.E.S. process; long interval from one S.P.I.D.E.S. process to another.
- **Shaker eggs and trouble in handling and transport:** pay attention to gentle handling.
- **Improper disinfections:** follow disinfections recommendations and dosage and time recommendations.
- **Eggs of the day:** incubate eggs without waiting for minimum time from the production day; improve blastoderm mortality; instable pH is wrong for incubation; a minimum of 48 hours is necessary to stabilise pH and conditions.

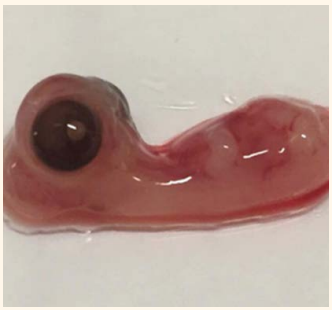


NECROPSY AND BREAKOUTS ANALYSIS

EARLY DEAD BLOOD RING, 3 – 6 DAYS

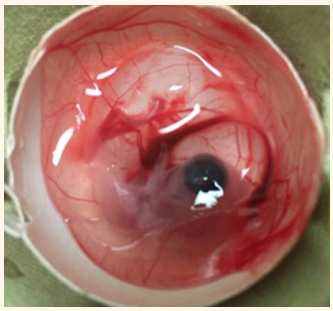
- **Improper storage:** follow recommended egg storage and gathering recommendations.
- **Improper incubation temperatures:** check calibration and accuracy of incubator set-point; follow recommended temperature settings.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels.
- **Improper disinfections:** follow disinfections recommendations and dosage and time recommendations.
- **Bacteria contamination:** handle eggs gently and check eggshell quality of transport eggs; check cleanness of nests and conditions of the farm floor; make sure the operator has clean hands; check the share of new males; look out for floor and dirty eggs; be careful of improper or accidental showers of eggs; look out for the sweating of old eggs in storage; be careful of changes of new males; pay attention to aspergillus or mycosis contamination; control and improve disinfection processes.

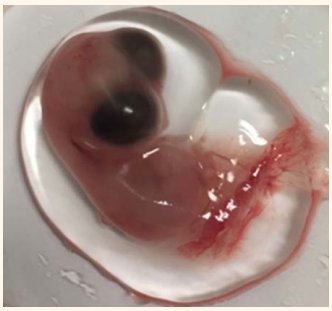




MEDIUM DEAD MORTALITY, 7 – 12 DAYS

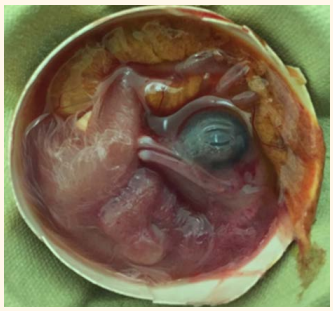
- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Improper eggs turning:** control turning functions for eggs. This is especially important in the first 12 days of the process.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value; if location is high above sea level then add oxygen.
- **Inherited low hatchability, poultry disease:** check genetic potential; test for diseases in flocks, make use of medical care; check health; investigate factors under veterinarian action.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels.
- **Micro cracks and bacteria contamination:** handle eggs gently and check eggshell quality of transport eggs, check cleanness of nests and conditions of the farm floor, make sure the operator has clean hands; check the share of new males; look out for floor and dirty eggs; be careful of improper or accidental showers of eggs, look out for the sweating of eggs in storage; be careful of changes of new males, pay attention to aspergillus or mycosis contamination; control and improve disinfection processes.

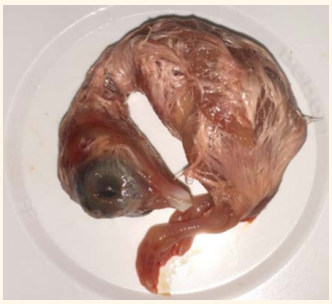




SETTER LATER MORTALITY, 13 – 16 DAYS

- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Improper eggs turning:** control turning functions for eggs. This is especially important in the first 15 days of the process.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value; if location is high above sea level then add oxygen.
- **Inherited low hatchability, poultry disease:** check genetic potential; test for diseases in flocks; make use of medical care; check health; investigate factors under veterinarian action.
- **Micro cracks and bacteria contamination:** handle eggs gently and check eggshell quality of transport eggs; check cleanness of nests and conditions of the farm floor; make sure the operator has clean hands; check the share of new males; look out for floor and dirty eggs; be careful of improper or accidental showers of eggs; look out for the sweating of eggs in storage; be careful of changes of new males; pay attention to aspergillus or mycosis contamination; control and improve disinfection processes.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels.





Contamination:

- **Micro cracks and bacteria contamination:** handle eggs gently and control eggshell quality of transport eggs; check cleanness of nests and conditions of the farm floor; make sure the operator has clean hands; be careful of improper or accidental showers of eggs; look out for the sweating of eggs in storage; be careful of changes of new males, look out for floor and dirty eggs; pay attention to aspergillus or mycosis contamination; control and improve disinfection processes.

Malformed brain exposed:

- **Brain exposed:** high temperature in the first 9 days of incubation.

NECROPSY AND BREAKOUTS ANALYSIS

General malformations:

- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Extreme low humidity in process:** control average weight loss of eggs; control humidifier action.
- **Improper eggs turning:** control turning functions for eggs. This is extremely important in the first 15 days of the process.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value, if location is high above sea level then add oxygen.
- **Farm health, poultry disease:** check genetic heredity consanguinity; test for diseases in flocks; make use of medical care; check health; investigate factors under veterinarian action.
- **Improper transport and management, shaker:** pay attention to gentle transport and handling.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels.

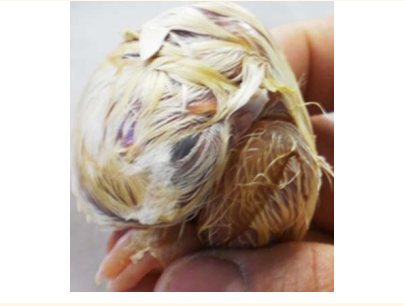
Please note:
Some specific malformations have a direct relation to certain conditions. Please check data for values and interpretations.

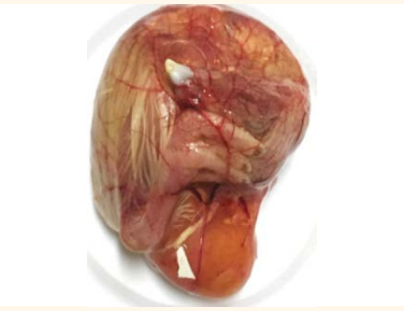
Malformed beak:

- **Cruxes beak:** incubation temperature too high in the first 11 days.
- **Parrot beak:** extremely high concentration of disinfectant or too long an exposure; intoxication from chemical agents.

Malposition of air cell:

- **General malposition; head in middle of legs; head on left side:** wrong turning; wrong angle; too high or too low incubation temperature; incorrect humidity; shaking during eggs handling; shocks in turning .
- **Lateral air cells:** problems with turning at the wrong angle; transport of eggs blunt-up; wrong positioning in trays; bad trays (too much space for little eggs).
- **Horizontal position of embryos, with big air cells:** excessive weight loss of eggs; micro cracks; turning failure.
- **Feet on head:** low level of amniotic liquid; control weight loss of eggs, eggs percentage composition (Yolk/albumen%, feed breeder vitamin support).



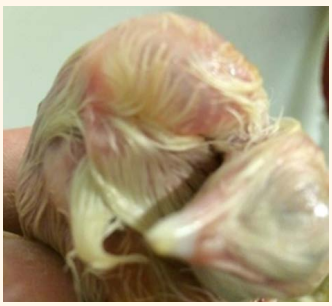


Malposition: wings under head:

- **Head over wings:** control turning; control symmetric action to right/ left at the same angle; bad trays (too much space for little eggs).

Upside-down eggs:

- **Upside-down chick's position:** wrong positioning of eggs at collection; transport of eggs blunt-up.

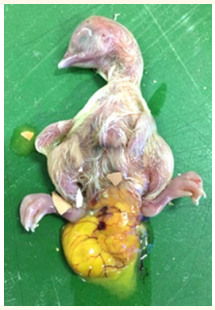


These are eggs and embryos which were lost just before the transfer process due to wrong flock conditions, wrong farm conditions, wrong handling of eggs, wrong setting and wrong incubation.
The following records can be attributed to genetics, farms, and setter and hatcher issues.

NECROPSY AND BREAKOUTS ANALYSIS

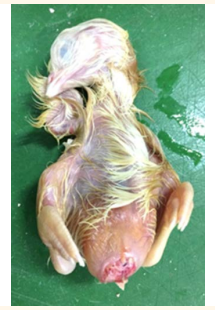
DEAD AT TRANSFER TIME, 17 – 18.5 DAYS

- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Improper eggs turning:** control turning functions of eggs and relative correct angles.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value, if location is high above sea level then add oxygen.
- **Inherited low hatchability, poultry disease:** check genetic potential; test for disease in flocks; make use of medical care; test health, investigate factors under veterinarian action.
- **Improper humidity value:** too low or too high humidity.
- **Transfer anomaly:** control transfer at the right time and in a warm room, warm basket or warm hatcher machine which is switched on; avoid thermic shock and inopportune shower of eggs.
- **Disinfection in hatcher after transfer:** some hatcheries have use of fumigation in processes or choose special disinfection immediately after transfer. Always control product and relative dosage.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels.



DEAD AT HATCHER TIME, 19 – 21 DAYS

- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Improper eggs turning:** control turning function of eggs and relative correct angle.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value, if location is high above sea level then add oxygen.
- **Improper hatcher conditions:** verify the hatcher setting programme and respect the steps.
- **Inherited low hatchability, poultry disease:** check genetic potential; test for disease in flocks; make use of medical care; check health; investigate factors under veterinarian action.
- **Improper humidity value:** too low or too high humidity.
- **Transfer anomaly:** control transfer at the right time and in a warm room, a warm basket or a warm hatcher machine which is switched on; avoid thermic shock and inopportune shower of eggs.
- **Disinfections during hatcher time:** some hatcheries use special methods of disinfection during the hatcher process time. Always control product and relative dosage.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels. If this is a problem in this period, it is easy to note that some chicks have a big oedema in the back of the head.
- **Wrong hatcher step:** check effective embryological time and synchronise with hatcher time and programme.

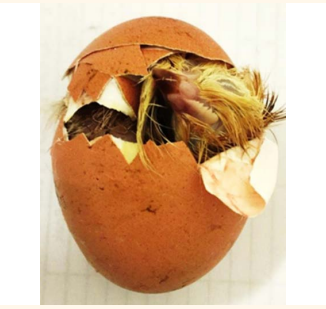


Pip live chicks:

- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Improper eggs turning:** control turning function of eggs and relative correct angle.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value, if location is high above sea level then add oxygen.
- **Improper hatcher conditions:** verify the hatcher setting programme and respect the steps.
- **Inherited low hatchability, poultry disease:** check genetic potential; test for disease in flocks; make use of medical care; check health; investigate factors under veterinarian action.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels. If this is a problem in this period, it is easy to note that some chicks have a big oedema in the back of the head.
- **Wrong hatcher step:** check effective embryological time and synchronise with hatcher time and programme.
- **Wrong time:** a wrong time or a too short time increases the problem.

Pip dead chicks:

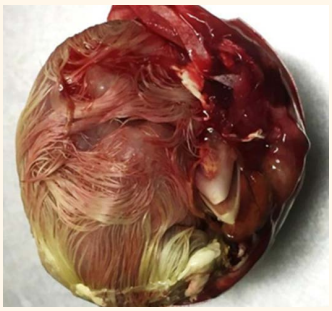
- **Improper incubation temperature:** follow recommended incubation, not too warm and not too cold.
- **Improper eggs turning:** control turning function of eggs and relative correct angle.
- **Improper ventilation:** increase ventilation and control carbon dioxide (CO_2) value, if location is high above sea level then add oxygen.
- **Improper hatcher conditions:** verify the hatcher setting programme and respect the steps.
- **Inherited low hatchability, poultry disease:** check genetic potential; test for disease in flocks; make use of medical care; check health; investigate factors under veterinarian action.
- **Improper breeder nutrition:** feed breeders a diet with balanced nutrient levels. If this is a problem in this period, it is easy to note that some chicks have a big oedema in the back of the head.
- **Wrong hatcher step:** check effective embryological time and synchronise with hatcher time and programme.
- **Wrong time:** a wrong time or a too long time increases the problem.
- **Contamination by aspergillus:** be aware that contamination can cause many issues at our embryos in piping out time; the percentage of E-coli increases to a very high value and can kill our chicks in this delicate phase. A correct disinfection with the right product at the right dosage can help.



NECROPSY AND BREAKOUTS ANALYSIS

No pip embryos:

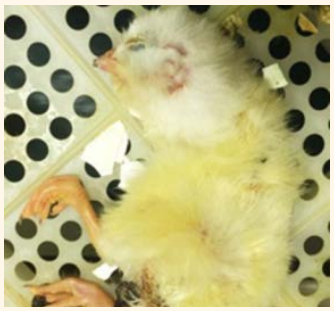
› **Chicks are live but no cut eggs:** check point of descript over, setting programme, calibration of machine; pay particular attention to the right time for the typology of eggs.



Chicks dead in basket:

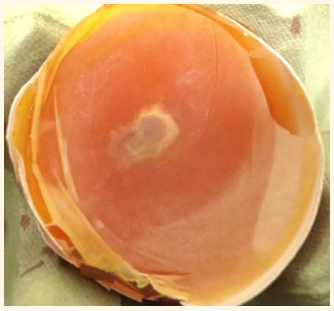
› **Perfect chicks, fully formed but dead:** be aware that the chicks may be dead due to external issues: the operator may have moved the basket aggressively, the chicks may have suffered because of a damaged basket or because of an extremely long hatch window time or an extremely long process in the hatcher at critical conditions.

› **Chicks are fully formed and have a soft body and a bad smell:** check for contamination; check E-coli value; check for aspergillus; introduce the right disinfection format in the hatcher process; pay attention that dirty eggs, if used, can cause these problems.



Broken eggs in setter:

› **Eggs which have been damaged in farm collection, in storage, handling or in setter time:** check eggshell and share information with farm management; improve the actions of the operator; request more gentle action.

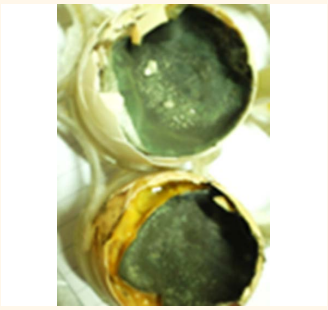


Broken eggs in hatcher:

› **Embryos with eggshell injury or shock during transfer; signs of a dry or sticky membrane on embryo's body:** control transfer action: if automatic, set to slow and if manual, ask for consideration and attention - otherwise these damaged eggs will not hatch.

Aspergillus:

› **If aspergillus is present in the air chamber, the membrane is a strong yellow colour:** provide a fast reaction with an increase of biosecurity and specific treatments on arrival from the hatchery, but it is important to avoid the possibility of replication in the hatchery or in the machine.



These are eggs and embryos which were lost just before the transfer process due to wrong flock conditions, wrong farm conditions, wrong handling of eggs, wrong setting and wrong incubation.
The following records can be attributed to genetics, farms, and setter and hatcher issues.

NECROPSY AND BREAKOUTS ANALYSIS

Perfect LOHMANN BROWN, Necropsy

Age	Fertility	Day 0–2	Day 3–6	Day 7–12	Day 13–16	Roth	Mal-formed	Malf. Beck	Brain Exp.	Malp.	Head Wing
24	10/20	2/5	2/5	0.5/1	0.7/1.3	0.1/0.5	0.1/0.7	0.1/0.7	0.1/0.4	0.3/0.7	0.1/0.4
25	7/15	2/4	2/4	0.3/1	0.3/1.3	0.1/0.5	0.1/0.7	0.1/0.6	0.1/0.4	0.3/0.7	0.1/0.4
26	7/10	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
27	7	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
28	5	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
29	4	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
30	4	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
31	3	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
32	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
33	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
34	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
35	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
36	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
37	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
38	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
39	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
40	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
41	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
42	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
43	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
44	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
45	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
46	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
47	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
48	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
49	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
50	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
51	3	2/3	2/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
52	3/4	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
53	3/4	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
54	3/4	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
55	3/4	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
56	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
57	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
58	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
59	3/6	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
60	3/6	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.3/1	0.1/0.4
61	4/7	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.4	0.3/1	0.1/0.4
62	4/7	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.3/1	0.1/0.4
63	5/8	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.3/1	0.1/0.4
64	5/8	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.3/1	0.1/0.4
65	5/9	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.3/1	0.1/0.4

Perfect LOHMANN BROWN, Necropsy

Age	Ups. Dow.	Day 17–18	Day 19–20	Pip Live	Pip dead	No Pip	Dead bask	Brock setter	Brock Hatch	Hatchability perfect/possible
24	0/0.4	0.5/1.3	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	81.6 / 55.3
25	0/0.4	0.5/1.1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	84.6 / 62.3
26	0/0.4	0.5/1.1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	85.1 / 70.3
27	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	85.2 / 73.4
28	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	87.2 / 76
29	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	88.2 / 76
30	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	88.2 / 76.4
31	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	89.2 / 77.4
32	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	89.2 / 77.4
33	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
34	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
35	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
36	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
37	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
38	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
39	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
40	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	91.2 / 78.4
41	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
42	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
43	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
44	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
45	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
46	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
47	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
48	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
49	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
50	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	90.2 / 77.4
51	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.3	0/0.3	89.2 / 77.4
52	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 76.2
53	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 76
54	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 76
55	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 75.2
56	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 74.2
57	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 74.3
58	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 74.3
59	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.3	0/0.3	88.4 / 73.2
60	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.3/ 71.8
61	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.1/0.5	0.1/0.5	87.3/ 70
62	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.1/0.5	0.1/0.5	87.3/ 70
63	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.1/0.5	0.1/0.5	86.3/ 69
64	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.1/0.5	0.1/0.5	86.3 / 68.8
65	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.1/0.5	0.1/0.5	86.3 / 68.8

Attention: all values are relative for eggs with perfect storage 3 to 6 day in perfect health, perfect hatchability, eggs uniformity and genetic condition.
The table is the result of a huge collection of data, in order to define the perfect parameters of actions.

NECROPSY AND BREAKOUTS ANALYSIS

Perfect LOHMANN LSL, Necropsy

Age	Fertility	Day 0–2	Day 3–6	Day 7–12	Day 13–16	Roth	Mal-formed	Malf. Beck	Brain Exp.	Malp.	Head Wing
24	10/20	2/5	2/5	0.5/1	0.7/1.3	0.1/0.5	0.1/0.7	0.1/0.7	0.1/0.4	0.3/0.7	0.1/0.4
25	7/15	2/4	2/4	0.3/1	0.3/1.3	0.1/0.5	0.1/0.7	0.1/0.6	0.1/0.4	0.3/0.7	0.1/0.4
26	5/10	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
27	5/7	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
28	5/6	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
29	5	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
30	4	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
31	3	2/3	2/3	0.3/0.7	0.3/0.7	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
32	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
33	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
34	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
35	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
36	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
37	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
38	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
39	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
40	2	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
41	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
42	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
43	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
44	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
45	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
46	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.7	0.1/0.4
47	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.8	0.1/0.4
48	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.8	0.1/0.4
49	3	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.8	0.1/0.4
50	3/4	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.3/0.8	0.1/0.4
51	3/4	2/3	1/3	0.1/0.5	0.1/0.5	0.1/0.5	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
52	3/4	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
53	3/4	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
54	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
55	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
56	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
57	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
58	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
59	3/5	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1	0.1/0.4
60	3/6	2/3	2/3	0.3/0.6	0.3/0.6	0.5/1	0.1/0.7	0.1/0.5	0.1/0.4	0.5/1.1	0.1/0.4
61	4/7	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.4	0.5/1.1	0.1/0.4
62	4/7	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.5/1.1	0.1/0.4
63	4/8	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.5/1.1	0.1/0.4
64	5/8	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.5/1.1	0.1/0.4
65	5/9	2/3.5	2/3.5	0.3/0.7	0.3/0.7	0.5/1	0.1/0.9	0.1/0.7	0.1/0.5	0.5/1.1	0.1/0.4

Perfect LOHMANN LSL, Necropsy

Age	Ups. Dow.	Day 17–18	Day 19–20	Pip Live	Pip dead	No Pip	Dead bask	Brock setter	Brock Hatch	Hatchability perfect/possible
24	0/0.4	0.5/1.3	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	81.5 / 55
25	0/0.4	0.5/1.1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	85.2 / 62.3
26	0/0.4	0.5/1.1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	87.1 /71.8
27	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	87.1 / 74.8
28	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	87.1 / 75.8
29	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	87.1 / 76.8
30	0/0.4	0.5/1	0.5/1.5	0.5/2	0.5/2	0.3/1	0.1/0.5	0/0.3	0/0.3	88.1 / 77.8
31	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.4	0/0.4	88.9 / 81.2
32	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.4	0/0.4	89.9 / 81.2
33	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
34	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
35	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
36	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
37	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
38	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
39	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
40	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	91.1 / 82.2
41	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	90.1 / 81.2
42	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	90.1 /81.2
43	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	90.1 / 81.2
44	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	90.1 / 81.2
45	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	90.1 / 81.2
46	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0/0.4	0/0.4	90.1 / 81.2
47	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0.1/0.5	0.1/0.5	89.9 / 80.8
48	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0.1/0.5	0.1/0.5	89.9 / 80.8
49	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0.1/0.5	0.1/0.5	89.9 / 80.8
50	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0.1/0.5	0.1/0.5	89.9 / 79.8
51	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.5	0.1/0.5	0.1/0.5	0.1/0.5	89.7 / 79.7
52	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 79
53	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 79
54	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 78
55	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 78
56	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 78
57	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 78
58	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 78
59	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 78
60	0/0.4	0.5/0.7	0.5/0.7	0.3/0.7	0.3/0.7	0.2/0.7	0.1/0.5	0.1/0.5	0.1/0.5	88.9 / 76.9
61	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.3/0.6	0.3/0.6	87 / 73.2
62	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.3/0.6	0.3/0.6	87 / 72.9
63	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.3/0.6	0.3/0.6	87 / 71.9
64	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.3/0.6	0.3/0.6	86 / 71.9
65	0/0.4	0.5/1	0.5/1	0.5/1	0.5/1	0.3/1	0.1/0.5	0.3/0.6	0.3/0.6	86 / 70.9

Attention: all values are relative for eggs with perfect storage 3 to 6 day in perfect health, perfect hatchability, eggs uniformity and genetic condition.
The table is the result of a huge collection of data, in order to define the perfect parameters of actions.

PROCESSING OF CHICKS

At the exit from the hatcher machine, the general environmental conditions are important. We have to remember that this is a delicate phase and that our chicks are stressed about external conditions. Any movement and transport can scare them, which why a fast processing can help.

Chicks' temperature

An easy and clear indication of chicks' condition is the body temperature, which is very important because we don't want to damage the quality of our hatched chicks in take-off and handling. It would be a paradox if any action on embryos in perfect condition, which respected hatcher time, increased the risk of damaging liveability and destroying quality only because of the poor conditions in the processing stage before delivery.

At collection, pay attention to rectal temperature. It provides very helpful and very accurate data, but testing this temperature can damage the rectum of the chicks and some unfortunate chicks may die. For this reason, I prefer to take ventral temperature. Remember to take a large sample (many chicks), because the temperature can vary a lot due to size and sexual differences, but our chicks stay within a perfect range of temperatures when:

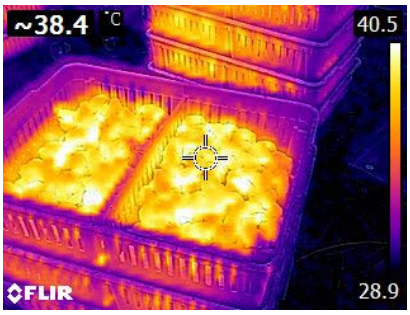
Average chicks' body temperature

Temperature in machine or immediately after hatcher take-out	40.5–39.5 °C	105–103 °F
Temperature of chicks when relaxing in delivery basket	39.5–38.5 °C	103–101 °F

During chicks' selection, sexing, and vaccination, the body temperature isn't a valuable piece of data, because the chicks' external conditions and stress factors interfere.

It is easy to check temperature visually, because:

- At low temperatures, the chicks huddle together in a corner to try to maintain body temperature and reduce their maximum activity.
- At temperatures which are too high, the chicks open their becks and pant. In this state they lose a lot of humidity and some chicks' liveability is reduced. They become noisy (cry) and spread their wings to try to reduce body temperature; the fluff looks smooth. Significantly improving air flows and humidity value can greatly help our chicks to regain the right body temperature quickly.



Chicks' take-off and sexing

LOHMANN varieties of commercial layers are all either colour sexable or feather sexable. These different processes need different amounts of time (chronological time), which have to be calculated by the hatchery manager in advance, in relation to the number of workers and the distance of delivery. This is done so that the wings develop correctly, which means that chicks can be sexed more easily, so error is reduced.

In a normal air flow, the recommended temperature that guarantees chicks good room conditions is 25 °C (77 °F) and the recommended relative humidity is around 45–65 %. These values are, of course, relative to the room and the quantity of chicks in the process.

In a biosecurity hatchery, the chicks' processing room needs a negative pressure, because this condition allows the removal of fluff in a secure way and doesn't necessitate moving from room to room in a dangerous condition. This is different for a vaccination room, which has to maintain as clean an atmosphere as possible, and for a vaccine storage room, which has to stay at a pressure above environmental pressure – here it has to be guaranteed that the only exit of air from this room happens when the operator prepares vaccine dilution and injection bags.

Chicks' take-off has to respect the welfare of the chicks and must give the chicks and the operator the best conditions in terms of temperature and oxygen while producing as little fluff and noise as possible.

Chicks' vaccination

In this hatchery guide we don't want to recommend any vaccine or system of use. Every country, every customer and every hatchery has a specific preference for a typology of vaccine and system, which can be INOVO, intra-muscles in legs, in neck with handle injection, semi-automatic injector, total automatic robot or sprayed. All these tools are used differently and have different things to look out during use. Whatever the vaccine and the method of use, it is very important to follow the manufacturer's instructions for every vaccine concerning the system of providing the vaccine, the dosage, the time of use after dilution/DE-frozen (time and temperature) and the disinfection. Everything is very important in this delicate job and our main objective is to protect our chicks from poultry disease. This isn't easy because it is important to damage neither the value of the vaccine, nor our chicks.

Don't mix different vaccines on your own initiative; if several different vaccinations are required, use only registered combinations formulated by the different manufacturers and respect the "pause" time between one vaccination and the next. Use authorised diluents conserved in perfect conditions and check that the use of some products doesn't damage "the vaccination titer".

The vaccine world is experiencing a continuing upgrade process. New products and new discoveries can change the use and the priority, so we need the latest information, where it is just as important to respect the use and the conditions. Every vaccine manufacturer gives the perfect recommendations for their entire selection of different vaccines, and it is important to respect this for all the different systems used. Do not change the vaccine preparation, but notice and verify the dosage for every system.

INOVO

This is the most modern vaccination and is in continued evolution. The embryos are vaccinated in the eggs transfer time from day 18.5 (no earlier, in order not to lose percentage) to day 19.5. In the past there was only one provider, but now several different brands of constructor build this type of eggs injector machine. In this vaccination it is really important that the general biosecurity of the vaccine dispenser pipe to the needle of the INOVO machine, is cleaned at the hatcheries and is disinfected after every dosage with a good product. This is the basis for reducing late mortality, and it is necessary to pay maximum attention to contamination of eggs and Aspergillus, which can completely destroy the hatchability. Advantages of INOVO vaccination include the velocity of the process and the reduced stress to the chicks, the early start of antibody coverage and the 100 % guarantee of injection in the right place.

INOVO

INOVO

INOVO

PROCESSING OF CHICKS

Manual injector

This is the most widely spread vaccination system in all countries and is cheap and easy to use, but it is very important that the operator has manual experience and carries out the task gently and accurately without any hard or brutal actions towards the chicks. Attention needs to be paid to avoid damaging the legs or neck bones, and the needle should be changed and disinfected frequently. Remember that chicks can be effectively vaccinated as soon as the solution enters the body: for this reason accurate control should be practised by the vaccine operator and use of colour in diluents can prove useful in the best vaccination procedures and resolve many problems without injuring our chicks.

Manuel injector

Semi-automatic vaccinator

Various different providers build these high-performance machines. When using, remember to use the dedicated specific injection settings for legs or neck. In these vaccinators, the cleanness and biosecurity are of course important, but attention also has to be paid to vaccine dosage, which has to be controlled by way out of a regular schedule. A routine change of needles is also important, and it helps to trace the effective vaccination with a coloured diluent. The machine has to stay dry and clean, as loss of the vaccine and the presence of residual blood or fluff are not tolerable.

Semi-automatic vaccinator

Total automatics vaccinator (robot)

In recent years these systems have become much more commonplace in many hatcheries. This is a very nice machine that uses relatively sophisticated technology, and to do a good job the operator only has to load the chicks into a carousel system, which can arrange different vaccinations in a fixed place. Additionally, some of these machines can carry out extra processes on the chicks. It is important to control the condition of the needles (avoid bent needles, which can cause injury and death) and the frequency of needle disinfections, as a loss of the vaccine and residual blood or fluff are not tolerable. You should also arrange the solution quickly.

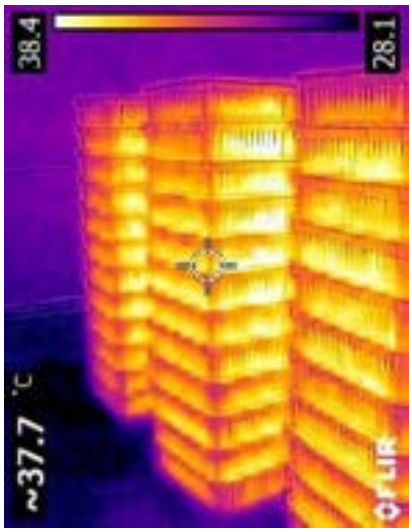
Spray vaccinations

Some vaccines can have spray usages. This is easiest system, isn't invasive, and doesn't cause problems for infection, if the preparation of solution follows the vaccine manufacturer's recommendations. Please be aware, however, that it isn't totally free of risks: it is important know that our chicks need some time to relax and return to a tranquil condition after vaccination (it is a very stressful event for our day-old chicks) in perfect climate conditions. When using spray vaccination, the dosage of water, the size of the nozzle that determines the vaccine distribution and the temperature of the solution and of the room where the vaccine is used are all very important. The chicks need some time in an illuminated room for a proper assimilation of some typologies of vaccine.

Holding and delivery of chicks

The holding or storage of chicks has to maintain the perfect conditions for the chicks: a dark or blue light condition helps them to relax, for example. Checking body temperature is the key for maintaining perfect conditions, whether or not we have a holding cabinet.

Transport of day-old chicks from the hatchery to the farm is a delicate phase, as the wrong transport conditions can totally destroy chicks' quality and liveability, and therefore ruin the good work done in the farm production stage and in all hatchery processes. The risk of exposing the chicks to the wrong conditions is real, and the goal is to



Thermos photo inside a truck

PROCESSING OF CHICKS

maintain the right environment for the whole delivery time. The day-old chicks have a natural equipment, that is "the residual yolk percentage in correct parameters", and this makes the chicks comfortable without food and water for the first 48 hours.

It is of primary importance that the temperature stays under control inside at the chicks' box. A clear indicator of good climate conditions is when the chicks are breathing calmly through closed nostrils and are spread out within all box surfaces; this allows for the conservation of humidity and the avoidance of stress, as the chicks don't have to use energy for thermoregulation of the body and they therefore have more energy to use for liveability.

Of course, the temperature set-point of transport is relative to the air flow velocity inside the truck: the higher the air velocity the higher the temperature set-point, and vice versa.

- Optimise the delivery in consideration of transport time, truck climate capacity and condition of roads.
- Remember that a strong air flow can help in critical temperature conditions.
- Use a data logger to record conditions and place it in the right place in the chicks' box; count and control the loose chicks.
- Load and unload quickly; in a normal truck there is no good ventilation in this phase and boxes aren't well distributed.
- Adjust the number of chicks/box in relation to the climate conditions (season-size) and the previously scheduled hours of transport time.
- Use proper feed and hydrated feed for chicks in the case of extra-long delivery.
- The truck driver should be trained and should have professional motivation for taking care of live chicks and for optimising time and transport.

QUALITY ASSURANCE

Implementing a basic quality assurance system in hatcheries

Quality assurance is a complex system which includes different interrelated programmes. It has the aims of keeping quality at high levels by preventing any hazards and defects, and of satisfying customers. Together with other quality functions like quality policy, quality design, quality control and quality improvement, quality assurance closes the circle of a complex quality system that can help companies to comply with changing requirements both from customers and from regulatory governments.

Quality assurance systems include documents that describe operations and activities that directly relate quality and safety, and should be followed by people inside organisations. In companies that operate with quality management systems, the quality assurance activities are integrated into the quality management systems.

QUALITY ASSURANCE

Prerequisite programmes – the basis of a quality management system

In order to build a quality management system in any one organisation, some different steps need to be followed in order to create a solid structure that can successfully provide the company with the capability to meet all quality requirements.

In addition to different practices that have been developed by national governments, some practices that work as prerequisite programmes have been developed to be used at international level for the purposes of facilitating fairness in global food trade, and for the protection of health of consumers worldwide. Some recognised programmes originally designed for the food industry are described in the "Recommended International Code of Practice, General Principles of Food Hygiene" of the Codex Alimentarius Commission, Food and Agricultural Organization/ World Health Organization (FAO/WHO) Food Standards Programme.

These Codex Alimentarius prerequisite programmes cover the following sections: Primary Production; Establishment: Design And Facilities; Control of Operation; Establishment: Maintenance And Sanitation; Establishment: Personal Hygiene; Transportation; Product Information and Consumer Awareness; and Training.

The following recommendation guide for hatcheries has been designed while taking into consideration some requirements from Codex Alimentarius Recommended International Code of Practice, General Principles of Food Hygiene. For a better understanding, it is recommended to read the complete Codex Alimentarius guide: Recommended International Code of Practice, General Principles of Food Hygiene. In this hatchery guide, the Codex will be referred to only on some topics regarding biosecurity, control of operation and cleaning and disinfection.

Control of operation

The main purpose of this section is to reduce the risk of unsafe products by taking preventive measures to assure the safety and suitability at an appropriate stage in the operation and by controlling hazards.

Product business operators should control hazards through the use of systems such as HACCP (Hazard Analysis and Critical Control Points). These systems should be applied throughout the chain, in order to control hygiene throughout the product life cycle through proper product and process design.

Example of a control procedure: eggs control at reception – process description

In order to be sure that all trolleys with eggs from farms are received in good condition at the hatchery, the eggs are further collected and processed after their arrival, before being set into trays.

Due to the fact that at the hatchery, only good quality eggs with no or reduced or hazards will be used, some methods and ways of control must be carried out besides the measures that have been taken at the farm level related to eggs hygiene; in this, eggs' reception inside the hatchery is accomplished. Certain principles and techniques must be used in order to make an evaluation of the process of egg collection at farms, and also concerning transport in order to identify negative aspects influencing use of eggs further. This step eliminates eggs that are less likely to hatch and would negatively influence quality of chicks, or that are contaminated with yolk, dried blood or faeces, which pose a biological threat.

Eggs are currently transported from farms by trucks. Upon arrival it is necessary to check if the eggs are being shipped securely so that they do not arrive broken. In order to properly receive eggs, please maintain the following procedure:

1. After the truck is positioned at the hatchery bay, open the door in order to receive the eggs from the trucks. Once the truck is docked, safely position the truck loading ramp in order to unload the trolleys.
2. Remove the trolleys with eggs from the truck and place them into the egg reception room.

QUALITY ASSURANCE

3. Visually inspect the trolleys in order to check that the eggs have arrived in good condition, are well positioned on trays, are not dirty and do not present great damage (content leaking through trays).
4. After inspection, place the trolleys in the transfer room in order to further process the eggs.

Other measures that can be used in order to identify and eliminate some hazards:

1. Eggs surface sampling – to be tested microbiologically and for yeasts and moulds.
2. Monitoring temperature and humidity in trucks.
3. Use of a machine for grading in transfer, in order to select the eggs and eliminate eggs with hairline crack.

Product analysis

There shall be procedures in order to monitor that all specified product requirements are met, including legal requirements and specifications. Microbiological, physical and chemical analysis required for this purpose shall be performed internally and/or subcontracted.

A test plan shall be drawn up for internal and external analysis, based on hazard analysis and assessment of associated risks, which covers raw materials, finished products as well as processing equipment and packaging materials. The test results shall be documented and periodically evaluated in order to analyse the trend. Corrective measures shall be introduced for any unsatisfactory results.

Control activities in order to monitor the process in one hatchery

Process	Control action	Quality control	Analysis measurement	Monitoring	Quality indicator
Eggs reception and storage	Inspection and eggs monitoring	Visual inspection of trolleys	Check if eggs have arrived in good condition, are well positioned on trays, are not dirty or damaged, and are leaking through trays	Every trolley	Compare with targets
		Eggs surface sampling	Bacteria (colonies, Salmonella and Aspergillus), other mould and yeasts	Every flock – before fumigation	Reduce colonies. No Salmonella. No Aspergillus
		Eggs weight	Scale measurement	Every flock	Egg weight (g)
Eggs grading, selection and transfer	Data collection from eggs candling and transfer process	Number of eggs not processed	% of eggs	Every flock	Small eggs – big eggs; hairline cracks
Eggs fumigation	Fumigation control	Eggs surface sampling	Bacteria (colonies, Salmonella and Aspergillus), moulds and yeasts	Every flock – before fumigation	Reduced colonies. No Salmonella, no Aspergillus
Clean eggs storage	Monitoring environment	Cool storage	Temperature and humidity	Every day	Compare with targets
Eggs short periods of incubation during storage S.P.I.D.E.S.	S.P.I.D.E.S. Incubators	Process control	Time and temperature	Every S.P.I.D.E.S.	Compare with targets
Eggs incubation setters	Incubation monitoring	Eggs weight	Scale measurement	Every flock	Egg weight (g)
		Setters activity control	Check next parameters: - Temperature - Humidity - CO_2 - Ventilation - Turning	Every setter	Visual check of graphics and comparison with targets
		Infertile and early dead control at 7 days	If necessary	By flock	Compare with targets
Eggs candling and transfer		Data collection from eggs candling and transfer process	Clear eggs and early dead	Every transferred trolley	Compare with targets
		Eggs weight at transfer	Scale measurement	Every flock	Egg weight loss (%)

Control activities in order to monitor the process in one hatchery

Process	Control action	Quality control	Analysis measurement	Monitoring	Quality indicator
Eggs incubation hatchers		Setters activity control	Check next parameters: - Temperature - Humidity - CO_2 - Ventilation	Every hatcher	Visual check of graphics and compare with targets
Chicks take off	Day-old chicks' quality and laboratory sampling	Day-old chicks' quality	Pasgar Score	Every flock	Compare with targets
			Uniformity Chick weight Chick yield	Every flock	Compare with targets
			Breakout analysis	Every flock	Compare with targets
		Chicks to be sampled for laboratory for bio-burden analysis	Bio-burden analysis	Every flock	Bacterial contaminati-on, yeast and moulds
		Fluff to be sampled for laboratory	Salmonella	Every flock	No Salmonella
		Meconium to be sampled for laboratory	E-coli	Every flock	E-coli
Chicks Sexing		Sexing errors	Male or female selection	All day-old chicks	Monitor by hour
Chicks vaccination		Control of vaccine preparation	Bacterial contamination	Every flock	Bacterial contamination
		Vaccination	Control of vaccine activity	Vaccinated day-old chicks	Monitor and compare with targets
		Control of vaccine residues	Laboratory control	Sampling plan	Bacterial contamination
Chicks or eggs packaging	Packaging control	Sampling of boxes	Laboratory control	Sampling plan	Bacterial, yeasts and mould contamination
Chicks storage	Storage monitoring	Storage rooms activity control	Check next parameters: - Temperature - Humidity - Ventilation - Chicks body temperature	Every room	Compare with targets
Eggs candling and transfer		Data collection from eggs candling and transfer process	Clear eggs and early dead	Every transferred trolley	Compare with targets
		Eggs weight at transfer	Scale measurement	Every flock	Egg weight loss (%)
Cleaning and disinfection in the hatchery	Floors, walls and windows cleaning Cleaning of setters Cleaning of hatchers Cleaning of equipment	Clean and disinfection records	Visual check	Records	Corrective action
	Cleaning and disin-fection of trays and baskets	Clean and disinfection samples	Sampling for laboratory	Sampling plan	Bacterial, yeasts and mould contamination
		Clean and disinfection samples	Sampling for laboratory	Sampling plan	Bacterial, yeasts and mould contamination
Personal hygiene	Personal health	Health status of employees	Health certificates	Plan	Heath status
		Visitors monitoring	Records or health certificates	Every visit	Health status
	Laundry cleaning in the hatchery	Clean and disinfection samples	Sampling for laboratory	Sampling plan	Bacterial, yeasts and mould contamination

QUALITY ASSURANCE

Control activities in order to monitor the process in one hatchery

Process	Control action	Quality control	Analysis measurement	Monitoring	Quality indicator
Maintenance	Preventive maintenance	Follow manufacturer instruction for all equipment	Keep records about maintenance procedures	Organise case by case, a daily, weekly, monthly, yearly schedule	Visual check of graphics and compare with targets
	Calibration	Follow manufacturer's recommendation for all equipment	Keep records about calibration	Organise a yearly schedule	Keep records
	Repair	Follow manufacturer's instruction for all repaired equipment	Keep records about all repaired equipment	Organise case by case, a daily, weekly, monthly, yearly schedule	Keep records and analyse the trend
Training	Training	Employees need to be trained internally or externally	Keep records about participation	Organise periodical training sessions	Organise open sessions and verification activities
	Refresher training	Organise periodical training sessions for employees, taking into consideration the specificity of their work	Keep records about participation	Organise periodical training sessions (twice a year for example)	Organise open sessions and verification activities

TROUBLE SHOOTING

Life is full of trouble, and our hatchery is granted no exception. We need to have the right processes and the right conditions of biosecurity. The necessary analysis and tests for having total control of equipment can help to limit the issue and to give us "Peace of Mind", but some problems can still occur. This is natural, and a correct and fast reaction helps a lot to minimise the problem.

Data and comparison with the hatchery target average helps towards a preventive discovery of an issue, and optimal adjustments of conditions, the correct necropsy and a good analysis of breakouts is the key for the solution.

REACT quickly and don't loose time; hatchery operators have to continue following the best principles. This is the correct attitude, instead of a decrease in performance having to push our hatchery to revolution. We have to switch ON the red light and improve our attention.

Practice based on technical service

1) Parents farm problem; health of group and fertility issues.
2) Storage issue, wrong condition of S.P.I.D.E.S.
3) Human error and wrong track and trace of our eggs; mixed flock; change of data and relative equipment (machine).
4) Decrease of hatcher performance; loss of some embryos from problems relative to setter conditions.
5) Accidental break in trolley or in transfer process.
6) High loss in hatchery machine (setter/hatcher) from missing of alarm; software failure; human mistake; breakdowns.
7) Poor biosecurity in vaccine preparation and application.
8) Aspergillus contamination and presence of E-coli, leading to a decrease in liveability.
9) Transport issues; wrong delivery
10) Farm issues; wrong home condition.

These are the principal 10 points ON practical life, which were investigated in a case of troubleshooting.

SEXING GUIDE

Female

Females are brown with a light stripe in the middle of the back , or uniformly brown; have a broad light stripe with brown edging on a lighter background colour; or have a brown coloured head with a lighter colouring of the body.

Male

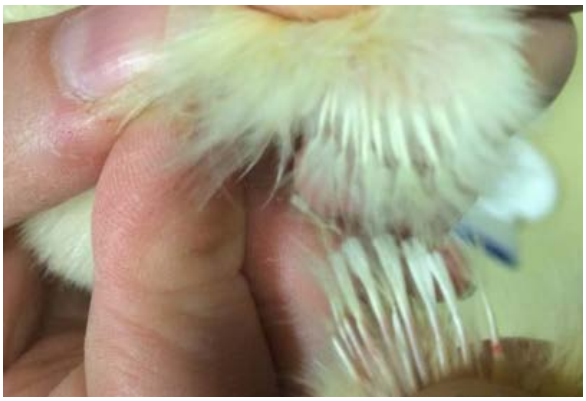
Males are white or have slight striping in a light brown colour; or have distinct light strips with a brown border; or have a dark stripe in middle of the back.

SEXING GUIDE

LOHMANN LSL White

LOHMANN BROWN

Males are slow-feathering in cockerel chicks primaries (row of feathers in picture 2) and are shorter than or of the same length as coverts (row of feathers in picture 1)



Males are slow-feathering in cockerel chicks primaries (row of feathers in picture 2) and are shorter than or of the same length as coverts (row of feathers in picture 1)

HYGIENE

Biosecurity in hatcheries

"Biosecurity" refers to a series of practices designed to prevent hazards (biological, chemical and physical) from coming into contact with birds inside the hatchery.

Components of biosecurity:

- Isolation
- Traffic control
- Sanitation

Isolation

Potential sources of contamination need to be considered when deciding where to locate product establishments, as well as the effectiveness of any reasonable measures that might be taken to protect products. Establishments should not be located in any place where, after considering such protective measures, it is clear that there will be a threat to product safety or suitability. In particular, establishments should normally be located away from:

- environmentally polluted areas and industrial activities which pose a serious threat of contaminating product;
- areas subject to flooding, unless sufficient safeguards are provided;
- areas prone to infestations of pests;
- areas where wastes, either solid or liquid, cannot be removed effectively.

Pests pose a major threat to the safety and suitability of products. Pest infestations can occur where there are breeding sites and a supply of raw products. Good hygiene practices should be employed to avoid creating an environment conducive to pests. Good sanitation, inspection of incoming materials and good monitoring can minimise the likelihood of infestation and thereby limit the need for pesticides.
The hatchery building shall be designed to include adequate space for all work areas. Physical separation is recommended for different areas, in order to restrain biological cross-contamination by humans.

Traffic control

People known or suspected to be suffering from, or to be a carrier of, a disease or illness likely to be transmitted to a product (day old chick), should not be allowed to enter any product handling area if there is a likelihood of their contaminating the products. Any person so affected should immediately report the illness or symptoms of illness to the management. Medical examination of a product handler should be carried out if any disease clinically or epidemiologically indicated.
Visitors to manufacturing, processing or handling areas should wear protective clothing and adhere to the other personal hygiene provisions in this section. The number of visitors should be minimised.
All incoming materials shall be delivered and stored in such a manner as to prevent spoilage, deterioration, damage and contamination.
All chemicals, vaccines and drugs shall be properly sourced for their intended purpose and labelled properly at all times.

Sanitation – cleaning procedures and methods

Cleaning can be carried out by the separate or the combined use of physical methods, such as scrubbing, turbulent flow, vacuum cleaning or other methods that avoid the use of water, and chemical methods using detergents, alkalis or acids.

Cleaning procedures will involve, where appropriate:

- removing gross debris from surfaces;
- applying a detergent solution, to loosen soil and bacterial film and hold them in solution or suspension;
- rinsing with water in order to remove loosened soil and residues of detergent;
- dry cleaning or other appropriate methods for removing and collecting residues and debris;
- where necessary, disinfection with subsequent rinsing, unless the manufacturer's instructions indicate on scientific basis that rinsing is not required.

Cleaning equipment

HYGIENE

Cleaning programmes

Cleaning and disinfection programmes should ensure that all parts of the establishment are appropriately clean, and should also include the cleaning of cleaning equipment.

Cleaning and disinfection programmes should be continually and effectively monitored for their suitability and effectiveness and, where necessary, documented.

Where written cleaning programmes are used, they should specify:

- areas, items of equipment and utensils to be cleaned;
- responsibility for particular tasks;
- method and frequency of cleaning;
- monitoring arrangements.

Cleaning activities shall be carried out in periods of non-production. If this is not possible, these operations shall be controlled so as not to affect the product.

Where a company hires a third-party service provider for cleaning and disinfection activities, all requirements specified within this section shall be clearly defined in the respective contract.

Where appropriate, programmes should be drawn up in consultation with relevant specialist expert advisors.

The efficiency of cleaning and sanitisation should be checked and recorded at routine intervals by the quality control responsible.

Mechanisms of monitoring and verification of the effectiveness of cleaning include:

- visual inspection;
- contact microbiological swabs or plates;

- ATP bioluminescence techniques;
- microbiological testing of partly processed and finished products;
- microbiological and chemical checks of rinse water.

The monitoring of cleaning should be formally documented, records should be maintained, any trends should be analysed and, where required, corrective action should be implemented to improve cleaning and sanitisation practices.

Example of a control procedure: cleaning and disinfection – process description

The objectives of a cleaning procedure are:

- to ensure that all hatchery areas are properly cleaned, sanitised and maintained at the highest level of cleanliness;
- to minimise as far as practicable the numbers of microorganisms;
- to reduce cross-contamination between clean and dirty areas of the building and between batches of eggs in incubation and chicks in hatchers;
- to minimise the build-up of bacterial flora in the environment of the building.

Responsibilities

This procedure applies to hatchery employees involved in the cleaning and the sanitising of different areas. It is the responsibility of the hatchery area supervisor to ensure that these procedures are followed.

Process description

The procedure definition section of a procedure will contain a step-by-step description of the task or function to be carried out.

Removal of debris from a surface takes three steps:

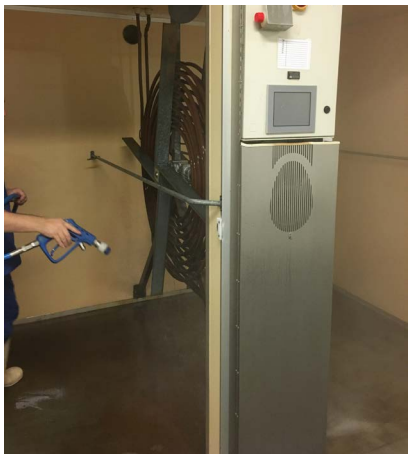
1) ´eparating the debris from the surface;
2) Dispersing the debris in the cleaning solution;
3) Preventing dispersed debris from reattaching to the surface.

For equipment

All equipment and other surfaces that could come into contact with products should be cleaned and sanitised case by case at the end of the shift in which they were used, following these steps:

1. Where possible open / disassemble the equipment.

2. Physically remove product debris by hand or with tools such as water pressure machineries.
3. Visually check equipment for missing parts or parts / surfaces that are worn to the extent that debris will accumulate and cause product contamination.
4. Apply an approved cleaner to parts and clean according to manufacturer's directions. Note that it is recommended to clean floors first and then clean equipment from top to bottom.



5. Rinse equipment parts with warm potable water to remove remaining debris. Note: a potability certificate for water from the municipal water authority or a satisfactory well test report (done at least every 6 months) should be available to prove that the water supply is potable.
6. Sanitise equipment with an approved sanitiser that is mixed and used according to the manufacturer's directions.
7. Check and reassemble the equipment.

For areas:

1. Physically remove product debris by hand or with tools such as water pressure machineries.
2. Apply an approved cleaner.
3. Rinse equipment parts with warm potable water to remove remaining debris.
4. Sanitise equipment with an approved sanitiser that is mixed and used according to the manufacturer's directions.

This procedure can be applied taking into consideration additional documents like:

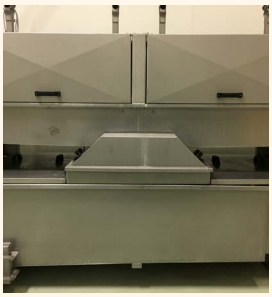
1. Map of the designated areas for cleaning.
2. The cleaning programme for every areas.
3. Work instructions for different cleaning areas.

Example of a control procedure: cleaning and disinfection of baskets and trays

Objectives of cleaning and disinfection of baskets and trays cleaning procedure:

- to ensure that egg trays and baskets are properly cleaned, sanitised and maintained at the highest level of cleanliness;
- to minimise as far as practicable the number of microorganisms;
- to reduce cross-contamination between clean and dirty areas of the building and between batches of eggs in incubation and chicks in hatchers;
- to minimise the build-up of bacterial flora in the setters and hatchers.

HYGIENE

Steps	Instructions	Baskets washing machine	Tray washing machine	Expected results
1	Start the machines Use potable water Temperature of the water: 60 °C Pressure: 20–30 (cleaning) – 15-20 (pre-cleaning) bars Time: 15 min Introduce the cleaning agent			To start the process at the time when the temperature of the water is enough for the cleaning programme
	Introduce the cleaning agent	Manual or automatic	Manual or automatic	Monitor the recommended quantity of cleaning agent
2	Automatically, the machine uses a pre-cleaning programme to remove the dirt			Automatic process
3	Cleaning: automatic equipment spreads the cleaning agent on the surface of tray and baskets.			Automatic process
4	Rinsing: automatic pressure water at: Temperature :15–20 °C Final rising: 10 °C Pressure: 5–10 bars			Visually check if the area and equipment are clean. If not repeat the steps 1–3
5	Disinfection: the equipment automatically spreads disinfectant on surfaces of trays and baskets Agent:			Visually check to monitor that all equipment surfaces are clean. If not, repeat the steps 1 to 4 and check again. Monitor the continuous usage of the disinfectant.

Responsibilities

This procedure applies to hatchery employees involved in the cleaning and sanitising of tray and baskets. It is the responsibility of the quality control specialist (or hatchery supervisor area) to ensure that these procedures are followed.

Process description

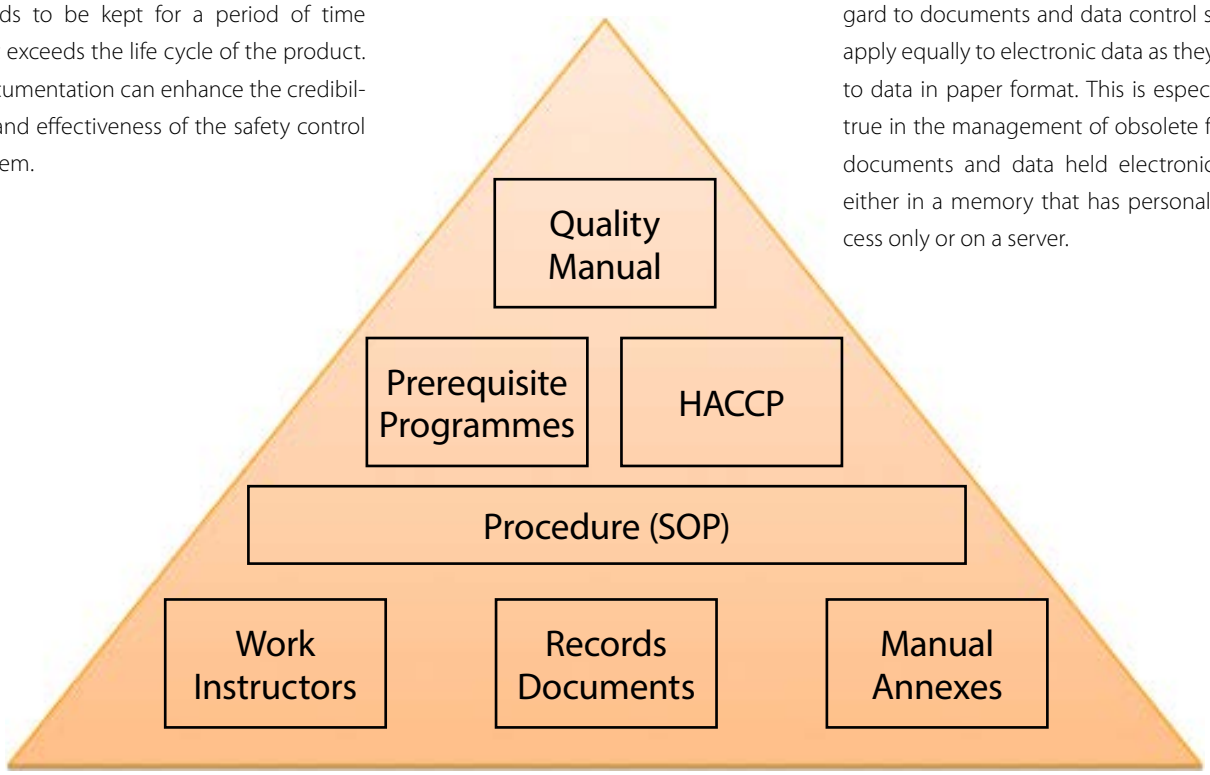
The washing equipment is cleaned and disinfected in the following steps:

1. Physically remove product debris by the use of water pressure.
2. Clean using a cleaning agent.
3. Rinse with warm potable water to remove remaining debris and cleaning agent.
4. Disinfect using an automatic system. Sanitise equipment with an approved sanitiser that is mixed and used according to the manufacturer's directions.
5. Check and reassemble the equipment.

Documentation and data storage

An appropriate system of records on processing, production and distribution needs to be kept for a period of time that exceeds the life cycle of the product. Documentation can enhance the credibility and effectiveness of the safety control system.

At the same time, an effective back-up system is essential. The requirements with regard to documents and data control shall apply equally to electronic data as they do to data in paper format. This is especially true in the management of obsolete files, documents and data held electronically either in a memory that has personal access only or on a server.



Example of a structure of documents in a Quality Management System

Hazard Analysis and Critical Control Point – the next step in building a quality management system

Prior to application of HACCP to any sector of the food chain, that sector should have in place prerequisite programmes such as good hygienic practices according to the Codex General Principles of Food Hygiene, the appropriate Codex Codes of Practice, and appropriate food safety requirements. These prerequisite programmes to HACCP, including training, should be well established, fully operational and verified in order to facilitate the successful application and implementation of the HACCP system.

HACCP is an acronym used to describe the Hazard Analysis and Critical Control Point, a systematic approach used to identify, evaluate and control safety hazards. HACCP is very logical sequence of steps that cover all stages of production in order to identify the hazards that are likely to occur at any stage and put methods of control in place that will prevent them.

Developed in the early 1960s, HACCP is a system of control based on prevention that provides a structured approach for the assurance of the safety of specific products and their associated processes.

In essence, it involves:

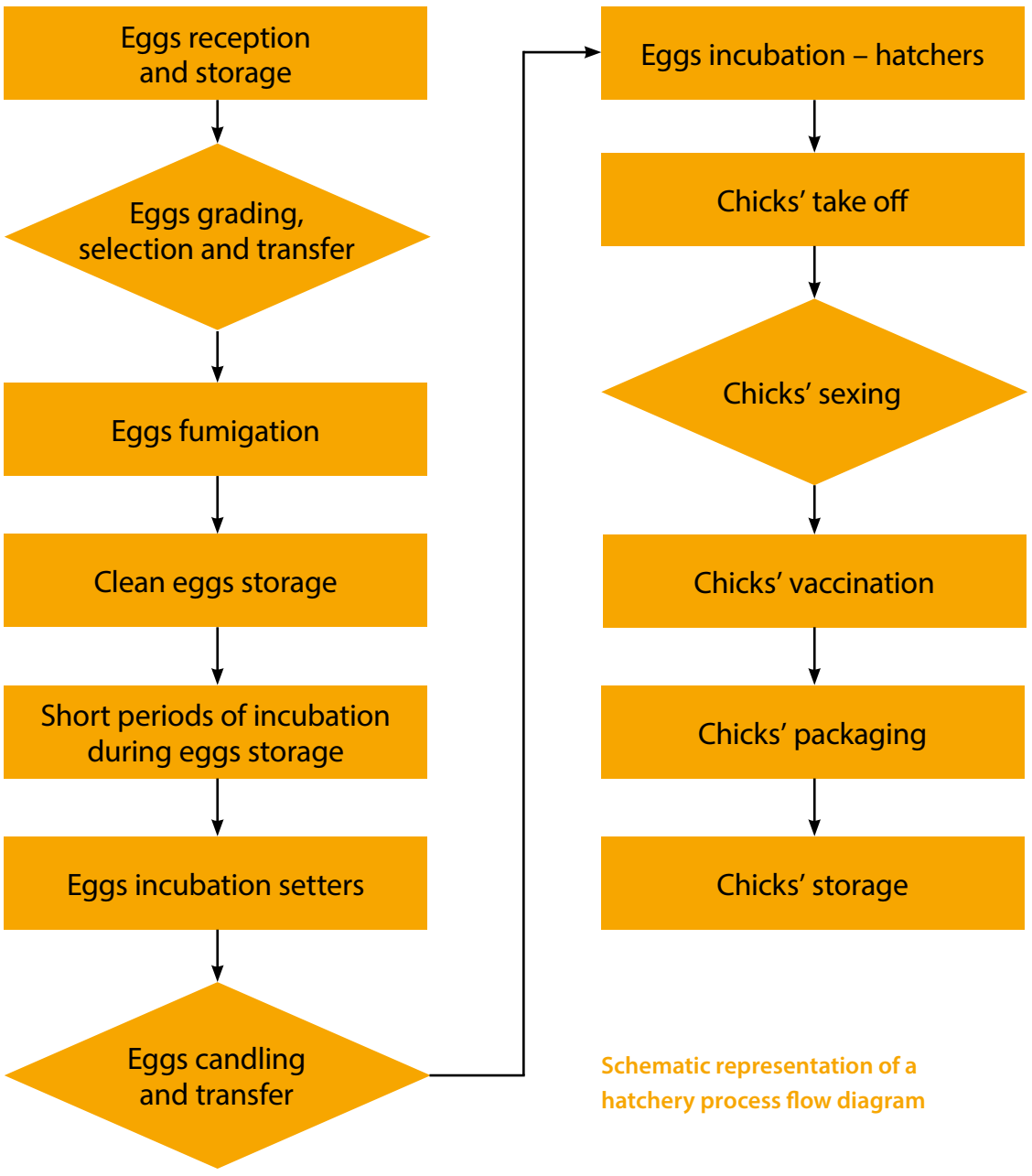
- Identification and evaluation of hazards, such as biological, chemical and physical contaminants and the conditions leading to their presence and proliferation;
- Identification of the specific requirements for control, in order to reduce or eliminate the hazards;
- Mechanisms to measure and continuously assess the efficacy of the HACCP system.

HYGIENE

Popular in the food industry, HACCP is used in animal farms and hatcheries today in order to limit the presence of hazards along the food chain. All LOHMANN hatcheries have implemented HACCP systems in order to better control the hazards and to be sure that our products have a higher degree of safety along the chain.

The application of HACCP principles consists of the following tasks, as identified in the Logic Sequence for Application of HACCP.

1) Assemble HACCP team.
2) Describe product.
3) Identify intended use.
4) Construct flow diagram.
5) On-site confirmation of flow diagram. (Note the following figure)
6) Hazard analysis - list all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards.
7) Identify Critical Control Points (CCP).
8) Establish critical limits for each CCP.
9) Establish a monitoring system for each CCP.
10) Establish corrective actions.
11) Establish verification procedures.
12) Establish Documentation and Record Keeping.



Schematic representation of a hatchery process flow diagram

PSYCHOMETRIC AND CONVERSION TABLE

Table Conversion C-Fh and Relative Humidity in %

°C		35.6	35.8	36.1	36.4	36.7	37.0	37.2	37.5	37.8	38.1
	°F	96.0	96.5	97.0	97.5	98.0	98.5	99.0	99.5	100.0	100.5
°C	°F	Temperature Dry thermometer									
26.7	80.0	50	48.2	47.8	46.8	45.8	44.8	44	42.6	40.8	40.2
27.0	80.5	51	50	49	48	46.8	46	45	44	42.4	42
27.2	81.0	52	50.8	50	49.4	48	47	46	45	44	43
27.5	81.5	54	52.2	51.8	50.4	49.8	48.2	47.8	46	45	44
27.8	82.0	55	54	53	52	50.4	49.8	48.4	47.8	46	45.8
28.0	82.5	57	54.8	54.2	53.8	52	51	50	49	47.8	46.4
28.3	83.0	58	57	56	55	52.8	52	51.8	50	49	48
28.6	83.5	60	58.2	57	56	54.6	53.8	52.4	51.8	50	49
28.9	84.0	61	60	58.4	57.8	56	55	54	52.5	51.6	50
29.2	84.5	62.2	61.2	60	58.4	56.8	56.4	55	54	52.4	51.8
29.4	85.0	64	62.4	61.8	60	58.6	58	56	55.4	54	53
29.8	85.5	64.7	64	62.8	61.8	60	59	57.8	56.6	55.8	54
30.0	86.0	66.5	65.4	64	63	61.8	60	59	58	56.4	55.8
30.3	86.5	68	66.4	65.8	64.4	63	62	60	58.8	58	57
30.6	87.0	70	68	67	66	64.4	63.8	62	60.4	59.8	58
30.8	87.05	72	69.4	68	67.8	66	64.5	63.2	62	60.4	60
31.1	88.0	73	71	69.8	68.4	67.8	66	64.4	63.8	62	61
31.3	88.5	74.2	73.4	71.8	70	68.4	67.8	66	65	63.8	62.2
31.7	89.0	76	74.2	73.6	71.8	70	69	68	66	65	64
32.0	89.5	78	76	74.5	73.2	71.8	70	69	68	66.2	65
32.2	90.0	79	78	76	75	73.2	72	70	69	68	66.2
32.5	90.5	80.9	79.8	78	76	75	73.8	72	70.2	69	68
32.8	91.0	83	81	79.8	78	76	75	74	72	70.2	69.8
33.1	91.5	84.2	82.4	81	79.8	78	76.4	75.8	74	72	71
33.3	92.0	86	84	82.4	81.8	79.9	78	76.2	75	72.8	72
33.7	92.5	88	85.8	84	73	81	80	78	76.4	75	74
33.9	93.0	90	87.2	86	84.2	82.6	80.8	80	78	76.2	74.8
34.1	93.5	92	89.8	87.8	86	84.6	83	82	80	78	77
34.4	94.0	93	91.8	90	88	86	85	83	82	80	79
Temperature wet sensor		Relative Humidity RH in %									

PSYCHOMETRIC AND CONVERSION TABLE

Celsius-Fahrenheit	Celsius-Fahrenheit	Celsius-Fahrenheit
22.0 = 71.6	35.3 = 95.54	38.2 = 100.76
22.5 = 72.5	35.4 = 95.72	38.3 = 100.94
23.0 = 73.4	35.5 = 95.90	38.4 = 101.12
23.5 = 74.3	35.6 = 96.08	38.5 = 101.30
24.0 = 75.2	35.7 = 96.26	38.6 = 101.48
24.5 = 76.1	35.8 = 96.44	38.7 = 101.66
25.0 = 77.0	35.9 = 96.62	38.8 = 101.84
25.5 = 77.9	36.0 = 96.80	38.9 = 102.02
26.0 = 78.8	36.1 = 96.98	39.0 = 102.20
26.5 = 79.7	36.2 = 97.16	39.1 = 102.38
27.0 = 80.6	36.3 = 97.34	39.2 = 102.56
27.5 = 81.5	36.4 = 97.52	39.3 = 102.74
28.0 = 82.4	36.5 = 97.70	39.4 = 102.92
28.5 = 83.3	36.6 = 97.88	39.5 = 103.10
29.0 = 84.2	36.7 = 98.06	39.6 = 103.28
29.5 = 85.1	36.8 = 98.24	39.7 = 103.46
30.0 = 86.0	36.9 = 98.42	39.8 = 103.64
30.5 = 86.9	37.0 = 98.60	39.9 = 103.82
31.0 = 87.8	37.1 = 98.78	40.0 = 104.00
31.5 = 88.7	37.2 = 98.96	40.1 = 104.18
32.0 = 89.6	37.3 = 99.14	40.2 = 104.36
32.5 = 90.5	37.4 = 99.32	40.3 = 104.54
33.0 = 91.4	37.5 = 99.50	40.4 = 104.72
33.5 = 92.3	37.6 = 99.68	40.5 = 104.90
34.0 = 93.2	37.7 = 99.86	40.6 = 105.08
34.5 = 94.1	37.8 = 100.04	40.7 = 105.26
35.0 = 95.0	37.9 = 100.22	40.8 = 105.44
35.1 = 95.18	38.0 = 100.40	40.9 = 105.62
35.2 = 95.36	38.1 = 100.58	50.0 = 105.80
0 of incubation	Hatch cons. limit	Start warm dead
Limit cold dead	Average Inc. M-S	Tot dead warm

Change from C to F = (Cx9:5+32) from F to C = (F-32x5:9)

INFORMATION

HOW LOHMANN IS CALCULATING THE ENERGY CONTENT OF FEED AND RAW MATERIALS (INTERNATIONAL WPSA-FORMULA):

ME MJ/kg = g crude protein x 0.01551
+ g crude fat x 0.03431
+ g starch x 0.01669
+ g sugar x 0.01301 (as saccharose)

ME = metabolizable energy in MJ/kg
1 kcal = 4.187 kJ

ACKNOWLEDGEMENT

We would like to thank following companies for sharing the pictures on page 13 & 24:
EMKA, EmTech, HatchTech, Jamesway, Pas Reform and Petersime.

DISCLAIMER

The information, advices and suggestions given in this management guide should be used for guidance and educational purposes only, recognizing that local environmental and disease conditions may vary and a guide cannot cover all possible circumstances. While every attempt has been made to ensure that the information presented is accurate and reliable at the time of publication, LOHMANN cannot accept responsibility for any errors, omissions or inaccuracies in such information or management suggestions.

Further, LOHMANN does not warrant or make any representations or guarantees regarding the use, validity, accuracy, or reliability of, or flock performance or productivity resulting from the use of, or otherwise respecting, such information or management suggestions. In no event LOHMANN be liable for any special, indirect or consequential damages or special damages whatsoever arising out of or in connection with the use of the information or management suggestions containing in this management guide.

LOHMANN BREEDERS GmbH
Am Seedeich 9–11 | 27472 Cuxhaven | Germany
Phone +49 (0) 4721/505-0
Email info@lohmann-breeders.com | www.lohmann-breeders.com

05/24_V01-24

LOHMANN
BREEDERS

BREEDING FOR SUCCESS … TOGETHER