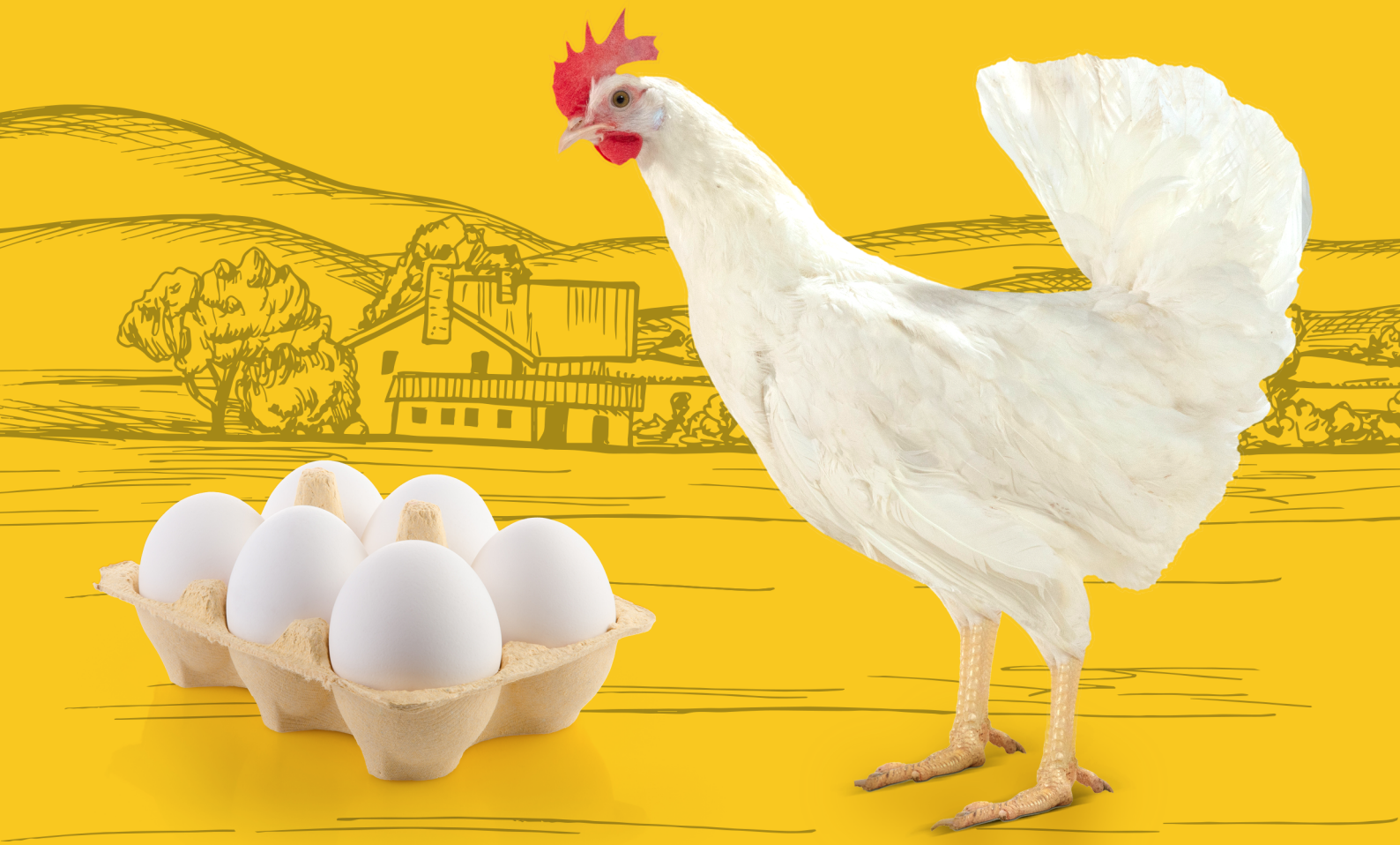
Noor Poultry

Hisex White Layer

Commercial Management Guide



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Introduction

For many years Hendrix Genetics has been breeding laying hens for the world market. As the result of a balanced breeding program Hendrix Genetics breeds demonstrate an ever-increasing genetic potential, both in technical and economic performance.

The full genetic potential of these breeds will only be achieved through good management and the know- how of experienced poultry farmers. The phenotype (e.g. the performance of your birds) is the combined result of the genotype (e.g. the breed) and the environment (your management).

This manual is a guide to general and specific rules as well as advice on egg production. The objective is to help poultry farmers to achieve optimum results. The information and suggestions contained in this management guide should be used for educational and guidance purposes only. Local environmental and disease conditions may require specific adaptations of management practices to achieve optimal results, therefore this guide cannot cover all possible circumstances. Please ensure that you are always compliant with your local/national animal welfare regulations.

We trust that this management guide will make a positive contribution to the continuous improvement in the performance of laying hens all over the globe. We hope that each reader will be able to find some useful information from this management guide. For more detailed and tailor-made advice, please contact your local representative.

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PLEASE WASH YOUR HANDS

1 Biosecurity

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1.1 Introduction

Achieving good results with your flock depends highly on the health status of your birds. A good health status is very important for two main reasons: healthy animals are more efficient producers, as disease costs energy that affects your profitability. Secondly, your goal of keeping laying hens is to produce safe and high-quality eggs. The eggs need to be safe for human consumption, free from pathogens and any other contamination. Biosecurity programs are installed to maintain a good health status. Biosecurity is the key to prevention of disease, together and in cooperation with custom made vaccination programs and disease eradication programs. Any national and local legislation, regulations and environmental restrictions must be followed. Prevention is always better and cheaper than cure.

In order to implement a biosecurity program, you need to understand what Biosecurity is about:

- Biosecurity is the prevention of introducing disease
- Biosecurity means minimizing the risk of entrance of pathogens onto a farm and into a house (flock)
- Biosecurity is the exclusion, eradication or effective management of risks.
- Biosecurity is recognizing risks and acting accordingly
- Disease can be airborne over a limited distance
- Disease can come along with the introduction of contaminated birds (direct contact)
- Disease can be introduced, attached to visitors/workers/rodents/flies/trucks/materials/feed/equipment (indirect contact)

The most important part of biosecurity programs is often changing the way of thinking about what is clean and what is dirty – and acting accordingly. An understanding of the reasons why you implement certain biosecurity measures on a farm can help significantly in persuading staff to behave according to these rules. Biosecurity measurements must be simple, easy to understand, agreed upon and monitored.

Biosecurity is the cheapest, most effective means of disease control. The difficulty is not to implement a biosecurity program but to maintain it!

1.2 Housing

Ideally, your poultry houses are located well away from other poultry houses and be managed under "all-in-all-out" principles, in order to prevent contamination between flocks of different ages. Whatever the building style, houses should be constructed in such a way that they can be easily and thoroughly cleaned and disinfected, in between flocks. In cold and temperate climates, the walls and roofs should contain insulation with a moisture barrier and rodent proof materials. Ceiling height should be adequate for proper ventilation. Equipment used in the house should be designed for easy access and removal for clean-out, maintenance and biosecurity considerations.

Observe a strict separation between the outside and the inside of the farm premises. Install fences and facilitate the clean road / dirty road principle for the delivery of feed and the removal of manure and dead birds. This will prevent indirect contact between birds of different farms/houses. Do not allow trucks and cars on the clean part of the premises. Also maintaining the strict separation between outside and inside of the houses is important. This can be implemented quite simply: by changing clothes and footwear and washing + disinfection of hands before entering a poultry house. Ideally, equipment should be dedicated exclusively to one house and if the introduction of equipment or tools from another house is necessary, they should be carefully disinfected. The risk from vehicles entering the farms must be managed also.

With electrically powered equipment, it is essential to use a reliable source of electrical power. In houses with a controlled environment, standby generators and power failure alarms are necessary.

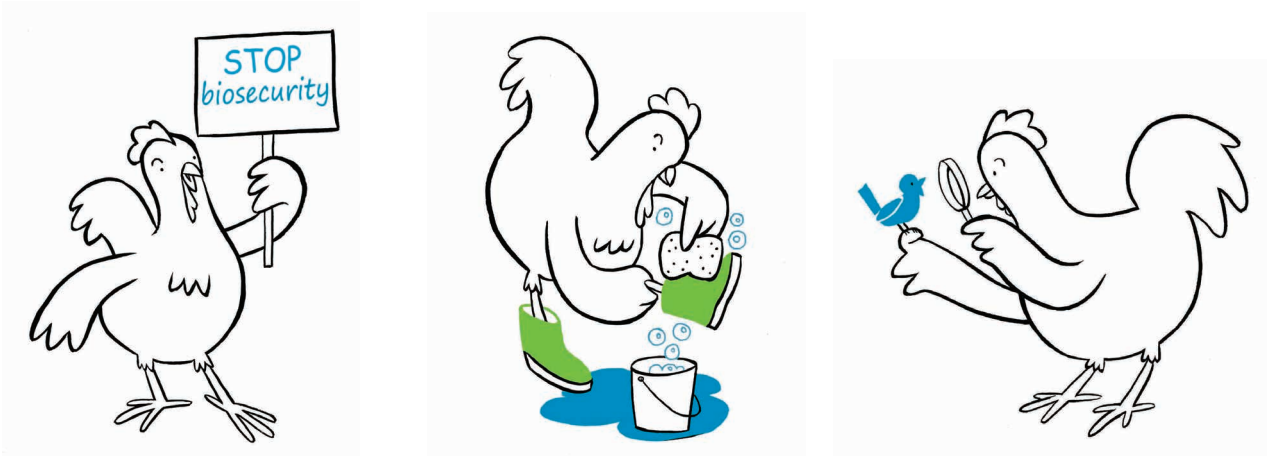
Houses should be rodent and bird-proof to prevent disease transmission from wild birds. Every air inlet should be equipped with nets to prevent this risk. Bait stations should be placed inside and outside the houses in order to control rodent activity. They should be checked regularly (once a month) in order to refill them, and the frequency of inspection

should be increased during outbreaks of rodent activity. Wild animals should not have access to feed and water to prevent vermin. Keep insects under control, as insects can also be a source of contamination. Insect activity should be monitored in order to apply appropriate treatments at the right time. Only insecticides permitted for use near animals should be used during the rearing and production periods. When you use insecticides, we strongly recommend the use inside the house just after depletion and a second treatment, just before the arrival of the replacement flock.

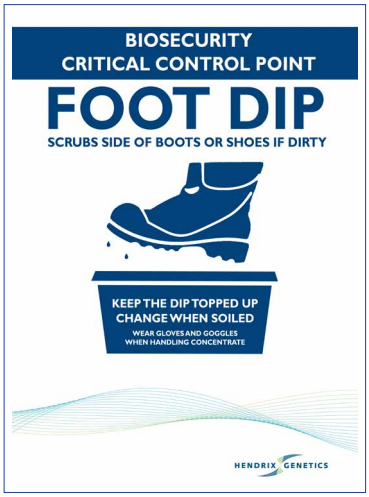
Storage rooms, where material to be used in the poultry houses is stocked, must also be bird, rodent and fly free. Feed can be a major risk factor for Salmonella. Make sure that you test that the drinking water is free from pathogens as drinking water can be contaminated with E. coli, yeast, molds and even Avian Influenza when surface water is used.

1.3 Personnel and visitors

Visits should be strictly controlled, and visitors should confirm that they have had no recent contact with other birds for at least 48 hours (preferably 72 hours). You should keep track of your visitors; you could do this via a visitor registration form (Appendix 1). Entry should be through a cloakroom with a full change of clothes and boots, and if possible, after taking a shower. Special care should be taken with boots, which should always be disinfected before entering the poultry houses. Cloakroom design should clearly show different areas with a dirty zone to remove "civilian" clothes, and a clean one, in which to put the farm clothes on.



In order to prevent cross contamination do not allow farm employees to have poultry at home. Dedicated personnel for each flock are a must to reduce the risk of contamination from house to house. If this is not possible, visits should always be done in the order from younger to older houses, and to finish with sick/affected flocks if there are any.



Please note:

- Effective hand washing is the basis of good hygiene practice and is the first line of defense against infection as hands can easily be contaminated with pathogens. We can not only infect ourselves, we can also spread infection to co-workers and patients by touching them or shared objects.
- Foot baths with disinfectant or disinfected treated pads are hard to maintain and therefore often useless.
- At any time, dogs and cats should be kept out of the farm as they are potential transmitters of diseases that can affect your flock!

1.4 Monitor your flock

Poultry keeping is all about the chickens, they are the ones producing the eggs. By monitoring the birds carefully, you can not only tell a lot about the health of your flock, but also about the quality of the housing and care. By having a close look on the flocks' production, health and behavior you should be able to understand your flock.

What to check?
Beside checking the disease-free status of your flock, as this will inform you how effective your biosecurity program is, normal production parameters should be registered and monitored in order to detect any abnormalities (reduction of lay, feed consumption or bodyweight). This is the best way to implement early corrective actions in order to solve any problem that might occur.

Overview of the main production parameters that need to be monitored

Traits	Optimal advanced practice
Feed consumption	Daily
Water consumption	Daily
Mortality	Daily
Climate	Daily
Egg production	Daily
2nd grade eggs	Daily
Egg size	Daily
Hen bodyweight	Weekly till 30 weeks, monthly after 30 weeks of age
Disease free status	Monthly

1.5 Clean up and disinfection

Bacteria and viruses can survive in environments for a long time. After flock depletion, houses must be cleaned and disinfected carefully, to prevent contamination with pathogens from the previous flock. The absence of stock permits unhindered access to all parts of the building and equipment, facilitating the terminal hygiene program of cleaning and disinfection. As soon as the stock have been depleted, work should commence. The sooner the program is completed, the greater the reduction in potential pathogens prior to restocking.

There are two basic tasks to be carried out:
1. Cleaning -the purpose is to remove organic matter and to make all surfaces visually clean.
2. Disinfection- the act of sanitizing the 'clean' surfaces.
3. Down time - the time the house is empty, very effective tool to kill pathogens

Dead birds can be a source of bacteria multiplication: make sure you remove dead birds daily. Dispose dead birds in a hygienic way, e.g. do not store them inside the laying house.

Prevent that rodents and insects have access to the dead birds as they can spread easily the pathogens. Register your mortality daily, by registering the mortalities and making it visual via a graph, you can better identify when your mortalities become too high and allows you to act in time!

There are different suppliers of chemicals, and generally different products are needed for these two tasks, detergents are used for cleaning, and disinfectants for sanitizing. There are detergents available that also have some disinfecting properties, but in the poultry house make sure that you still apply a suitably formulated disinfectant to safeguard proper disinfection of the poultry house. In the following section we explain the different phases of a proper cleaning and disinfection program, step-by-step.

Stage 1 – removal

1. Livestock
2. Deadstock: dead birds and any carcasses
3. Feedstuffs: if you plan well, this can be minimized
4. Moveable equipment
5. Manure, remove all the manure from the manure belts/manure pots
6. Whilst the house is still warm it is recommended to treat for red mite/insects
7. Bait extensively for rodents

Stage 2 – preparatory

1. Drinking system – drain and refill with detergent solution
2. Soaking – all surfaces and equipment with detergent solution
3. Hand cleaning – any non-waterproof items

Stage 3 – washing

Pressure wash all surfaces with detergent solution. This should not be restricted to internal surfaces – concrete access areas, air inlets etc., should also be washed.

Stage 4 – re-assembly

Re-instate cleaned moveable equipment into the poultry house when dry.

Stage 5 – disinfection

Spray all previously washed surfaces of building and equipment with disinfectant solution. Water lines must be cleaned first with an alkaline based detergent and after, an acid-based detergent and then flushed out thoroughly. Afterwards spray all surfaces (especially nests and slats) with appropriate chemicals for insect and mite control.

Stage 6 – fumigation

Close the building before atmospheric fogging with formalin or a suitable disinfectant.

Stage 7 – sanitary break period

The building should be kept empty for at least 2 weeks. If maintenance work is to be carried out, normal biosecurity precautions should be observed and repeat stages 5 and 6 before the new flock arrives.

Stage 8 – preparation for the arrival of new stock

1. Check the proper functioning of all equipment
2. Supply the drinking system with fresh water
3. The feeders should remain empty
4. Depending on the time of the year and the flock (day old chicks), the building should be heated

2 Drinking Water Quality

2 Drinking Water Quality

2.1 Introduction

Often neglected as a source of nutrients, but water is a very important nutrient for all production animals. Besides, water can also be used as a carrier for vaccines and antibiotics/chemotherapeutics. But on the other hand, it can also be an important source of pathogens!

Good quality drinking water is clean, clear, fresh, tasteless and free from contaminants. The birds can easily find, reach and drink it, and they can drink as much as they need. Other salient points are the source of the water and the type of drinking water system used in the houses (storage vessels, pipelines, drinkers).

Ask yourself the following questions: what is the source of the drinking water? Is piped water used or water from a borehole? Is surface water used? Is the quality of the water checked before use, or is it treated in any way? Piped water system is normally a safe source. Borehole water sometimes needs some treatments to make it suitable for drinking. The quality of borehole water should always be checked on a regular basis, at least once every year.

Once the source has been checked, look at the quality of the water at the point of delivery to the birds, at the end of the line, directly from the nipples or drinkers. The water quality also depends on the hygiene of the water system. The water system in the houses should be regularly cleaned and disinfected. It should always be disinfected in-between flocks and after water treatments. To keep the water system clean in longer production periods, check the water system regularly and if needed, also clean during production. The frequency of checking should be at least once every 3 months.
If the system is disinfected during the production cycle, care should be taken to follow the sanitizer manufacturer's instructions. Especially regarding adequate flushing and correct dosing. Make sure the water system is closed and cannot be contaminated from the outside. Pay extra attention to storage vessels, when used.

Surface water should never be used as a source for drinking water, because of the risk of contamination with bird pathogens. Waterfowl travel freely over the globe, carrying diseases with them (i.e. avian influenza) and dropping large amounts of contaminated droppings on their resting places along their way.

2.2 Water quality parameters

Water quality parameters

Parameter	Good Quality	Do not use
pH	5 - 8	< 4 and >9
Ammonium mg/l	<1.0	>2.0
Nitrite mg/l	<1.0	>1.0
Nitrate mg/l	<100	>200
Chloride mg/l	<200	>300
Sodium mg/l	<100	>200[1] >400[2]
Sulfate mg/l	<100	>250
Iron mg/l	<0.5	>1.0
Manganese mg/l	<0.5	>1.0
Hardness in German degrees	>4 <15	>20
Oxidizable organic matter mg/l	<50	>200
H2S	Non detectable	Non detectable
Coliform bacteria's cfu/ml	<10	>100
Total germ count cfu/ml	<10.000	>100.000

[1] for laying hens under 20 weeks of age
[2] for laying hens above 20 weeks of age

In general a good cleaning of the system in the empty period should be sufficient for the whole 16 weeks rearing period and the rearing birds should get the chance to build up some immunity against normal environmental bacteria's like E. coli. Semi-continuous use of water sanitizers can interfere with this.

Different products can be used for cleaning the system, both in-between flocks, when the houses are cleaned and disinfected, and during rearing or production. These products can contain (combinations of) acetic acid and hydrogen peroxide, chlorine, organic acids and inorganic acids. Be careful of the percentages used when using these products in drinking water. Also be careful with the taste and with the acidity of the water. Using acids, pH should be below 4, to achieve the disinfecting effect and above 3.5, otherwise it becomes corrosive and the birds stop drinking. High levels of chlorine have the same effect on the birds. To have an efficient disinfection with chlorine, decrease the PH. There must be no organic matter in the water, and a low iron and manganese concentration: if these conditions are not met, a proper water disinfection with chloride is not efficient. Using only organic acids as a water sanitizer for a longer period of time can be dangerous. You can see growth of yeasts and molt in the water. It is better to use acids and chlorine alternatively.

Once the water supply is clean, you need to check the following:

- Can the birds easily find and drink the water?
- For day-old chicks, is there enough light to find the water from the start?
- Is the water fresh (e.g. has the system been flushed shortly before the delivery of the day-old chickens)?
- Is the height of the drinkers correct? (adjust it over time as the chicks will grow)
- Is the system of drinkers used the same in the different phases of production (rearing versus lay)?
- Are bell drinkers used or nipple drinkers, what was used in rearing?
- What kind of nipples?
- Can the small birds easily activate the nipples?
- What is the nipple flow rate?
- Are there enough drinkers/nipples per bird installed?
- What is the water pressure?

Water is a very important nutrient, but it is also used as a carrier for drinking water vaccinations and for all kinds of in-water treatements. This means that the water quality must also be suitable for that. For (modified) live vaccines, no traces of disinfectants should be in the water during vaccinations. The solubility of some antibiotics and chemotherapeutics depends highly on the pH of the water and can be influenced by the presence of minerals. Together with these minerals, additives can form a biofilm inside the water tubes. Large amounts of bacteria can bind on this biofilm. This is the reason why the water system must always be cleaned after in-water treatments.

Birds, at all ages, must always have easy access to good quality drinking water. The quality of the drinking water should be regularly checked, as contaminated drinking water can cause serious disease problems. When birds don't drink, they won't eat and cannot grow or produce!

3 General management during the brooding period

3 General management during the brooding period

3.1 Introduction

The rearing period is of major importance for the performance of the flock later on in life. The productivity of a flock depends to a large extent on the successful attainment of bodyweight targets from an early age.

The objectives during the brooding period are:

- Rapid growth to reach body weight target at 5 weeks of age
- Good uniformity from the beginning
- Excellent livability

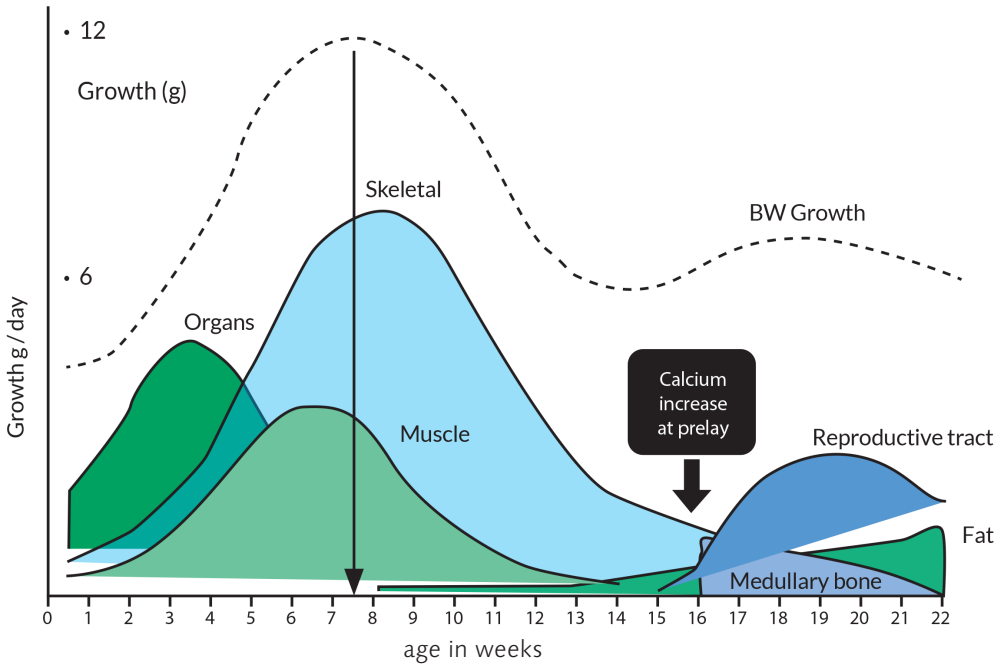
From day old to transfer, the bird will grow slowly, and organ development occurs at various ages. A lack of growth during a stage could have a detrimental impact on pullet quality. Any delay in growth at 4-5 weeks will be reflected in a reduction in bodyweight at 16 weeks and then in performance, particularly in mean egg weight in temperate climates. Two birds with the same bodyweight haven't necessarily developed the same body composition. Good growth curves lead to good pullet development.

Growth is split in the following stages:

- The first 3 weeks are devoted to the development of the organs and the immune system.
- From week 3 to week 6, skeleton and muscles are growing. Bodyweight at 5/6 weeks is the most important determinant of pullet quality. Any delay in growth at this stage is harmful to the birds, as it will have a detrimental impact on pullet quality and body composition, which will in return impact negatively the birds' performance.
- From week 6 to week 15 growth is starting to slow down,
- The final stage is characterized by ovary development and rapid growth of these organs. Sexual hormonal regulation takes place around 18 weeks and leads to sexual maturity around this age.

At all stages flock uniformity needs to be reviewed. The objective is to have a very high uniformity in order to facilitate flock management and stimulation. Low uniformity leads to poor laying performance! The number of feeders and drinkers, feed distribution, the presentation of the feed and the farmers' management are strong contributors to ensure uniformity. Heterogeneity at early age has a negative impact on uniformity during transfer.

Bodyweight development



3.2 Equipment and Environment

The standards set out in this section have been proven to give excellent performance in the production stages.
At all times: check your regional/national legal requirements.

		Floor		Cage	
		0 - 2 Weeks	2 - 5 Weeks	0 - 3 Weeks	3 - 5 Weeks
Ventilation	Minimum ventilation rate	0.7 m³/hour/kg	0.7 m³/hour/kg	0.7 m³/hour/kg	0.7 m³/hour/kg
	Required ventilation capacity	4 m³/hour/kg	4 m³/hour/kg	4 m³/hour/kg	4 m³/hour/kg
Stocking densities	Birds/m²	30	20		
	cm²/bird			125	220
Water supply	Chicks/Chick drinker	75		80 (1)	
	Birds/drinker	75	75		
	Birds/nipple	10	10	10 (2)	10 (2)
Feed supply	Birds/starting pan	50		(3)	
	cm trough feeders	4	4	2	4
	Birds/round feeder	35	35		

[1] place one additional drinker per cage for the first week
[2] make sure that all birds have access to at least 2 nipples
[3] spread sheets of paper over the cage bottom to last for 7 days, remove the top sheet every day to calculate feeder space availability
4 when chain feeders are used, both sides of the through should be taken into account if both sides are accessible

Pan diameter per number of birds

Pan diameter	Number of birds/feeder (max)
30	38
40	50
50	63

Brooding at high density (double brooding) requires special attention to the following points:
- Adjust the equipment to the bird number
- Do not release birds too late (4 - 5 weeks)

otherwise poor brooding conditions will:
- Negatively affect growth and uniformity
- Increase the potential for disease challenges
- Negatively impact litter quality when chicks are reared in floor systems

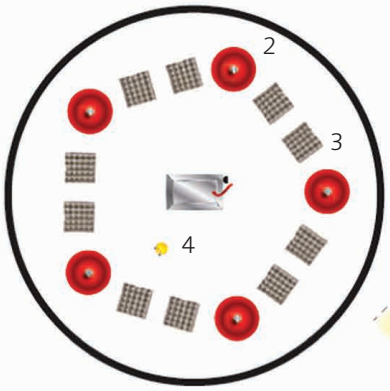
3.3 Preparing for Chick arrival

The success of brooding depends a lot on a good start for the chicks. Most of the chicks have travelled for quite some time and they are looking for a safe place that provides them with water, feed, a comfortable environment and a good place to rest. We have listed here the key points:

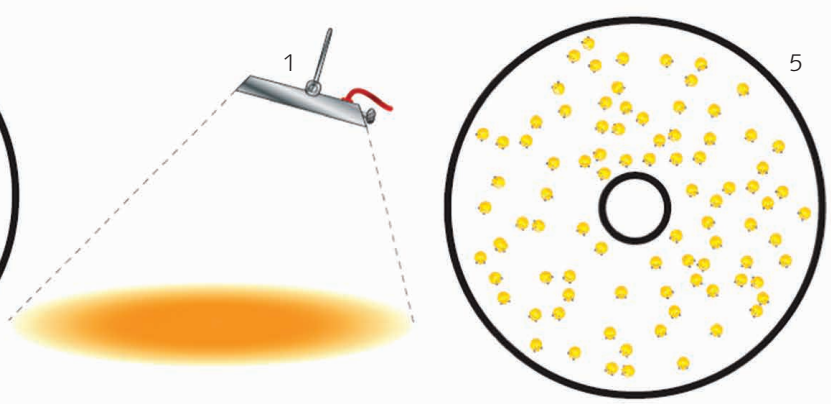
- The houses have been cleaned, disinfected and are empty for at least 14 days. The houses and its content should be dry before the new chicks come in.
- Start the heating system 24 to 36 hours before the chicks arrive (depending on climatic conditions). The brooder area and litter area should be warm enough with a constant temperature in the range of 33 – 35°C when the chicks arrive.
- Flush water lines prior to arrival of the chicks, and make sure that no disinfectant is left in the water lines when the chicks arrive.
- Make sure that the nipples and round drinkers are at the correct height: nipples should be at eye level of the chicks and round drinkers on the floor.

- Whatever drinking system is in use check whether the water supply is sufficient. When nipples are used, adjust the water pressure so that the chicks can see the water drop on the nipple and the water flows easily, at the lightest touch.
- If the chicks have been infrared beak treated in the hatchery, it is very important to use sideways activated nipples (360°) or nipple drinkers with cups and to use supplementary starting mini drinkers.
- Put paper under the nipples to attract the chicks and put extra feed on the paper or in cardboard trays.
- Check that all the birds, even the smaller ones, have access to feed and water.
- After a long transport duration, it is useful to wait for 3 to 4 hours before distributing feed, to make sure chicks first drink enough water to restore their body fluid.
- During the first 2 days use tepid water at 25°C to 30°C.
- In hot conditions, be careful not to let water temperature increase too much, as this may reduce the feed intake of the chicks. Regularly flush the water lines to maintain the temperature.
- The removal of the supplementary starter drinkers should be done gradually, making sure that the chicks have acquired the habit of using the other drinkers.
- Monitor the water consumption.
- To maintain litter quality, it is necessary to avoid water spillage, by carefully regulating the drinkers or the nipples.
- The drinkers should be always kept clean. For the first 2 weeks, they should be cleaned at least on a daily basis.

Recommended layout for 500 chicks



Radiant heater position and ground temperature



[1] Radiant heater of 1450 Kcal capacity
[2] 5 drinkers (7 for hot climates)
[3] 10 feed trays
[4] 75-Watt bulb at 1.5 meter above floor level
[5] Surround: 4m diameter – 0.6m high

Key points:

- Provide one additional drinker per cage for the first week.
- Make sure that all the birds have access to at least 2 nipples.
- Spread sheets of paper over the cage bottom to last for 7 days, remove one sheet every day.
- Place feed under the nipples and close to the automatic feeder to attract the chicks.
- Start placing the chicks in the warmest and brightest area.
- Make sure environmental conditions (temperature, ventilation, light) are uniform throughout the house. In cage systems, chicks cannot move around freely in search for their area of comfort. Uneven starting conditions lead to lack of flock uniformity

Keep in mind that during the first few days, the chicks must rely on the temperature that we maintain before their own thermoregulation starts to work properly. In order to ensure that the equipment and the litter are warm for chick arrival, we advise starting to raise the house temperature at least 36 hours before chick arrival so that the air temperature reaches 33 to 35°C when the chicks arrive. The concrete floor must be at 28°C and the litter at 30°C.

The best way to check if the house temperature is correct during the first days after arrival is to measure the cloacal temperature of the chicks (40°C). We recommend taking the temperature of at least 20 chicks throughout the house to get a good indication of the situation. Day old chicks cannot regulate their own body temperature, so they depend on ambient conditions. Be aware that chick body temperature reacts quickly after ambient conditions have been changed.

Find the correct set point for house air temperature by managing the body temperature of the chicks. Start checking the body temperature of the chicks every hour after placement. Keep checking body temperatures until the correct temperatures have been achieved and the situation is stabilized.

At day 5 the chicks will normally be able to keep up their own body temperature (within limits) and a rise in body temperature will automatically follow to about 41°C. From there on, set point for house air temperature can be gradually reduced to reach around 20°C at 5 weeks of age (e.g. by 0.5°C per day). Temperature standards are given on the next page. But again, the observation of the flock is the best indicator of the real needs of the chicks.

Measuring litter temperature

Measuring chick body temperature


A clean barn for a good start


Add extra heaters to warm the house

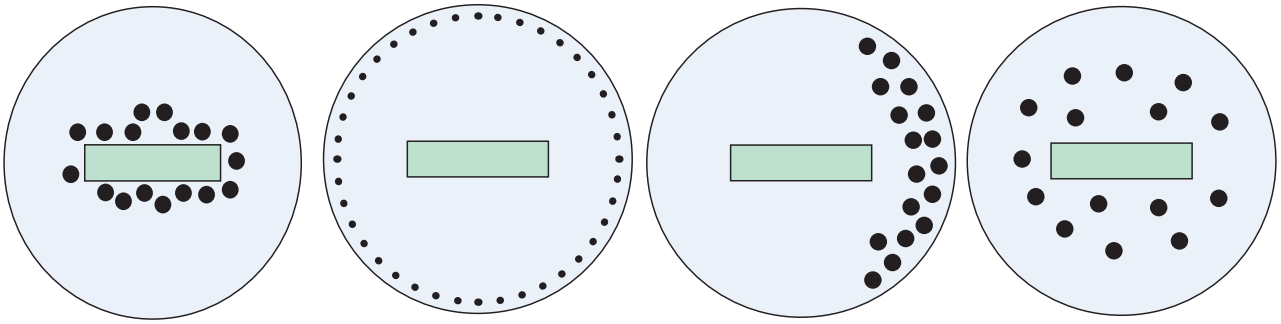
Standards for temperature and humidity

Age (days)	Brooding temperature		Room Temperature	Relative Humidity
	At the edgge of the brooders	At 2-m from the brooders		Optimum-Maximum in %
0 – 3	35°C	29 – 28°C	35 – 33°C	55 – 60 %
4 – 7	34°C	28 – 27°C	32 – 31°C	55 – 60 %
8 – 14	32°C	27 – 26°C	30 – 28°C	55 – 60 %
15 – 21	29°C	26 – 25°C	28 – 26°C	55 – 60 %
22 – 24		25 – 23°C	25 – 23°C	55 – 65 %
25 – 28		23 – 21°C	23 – 21°C	55 – 65 %
29 – 35		21 – 19°C	21 – 19°C	60 – 70 %
After 35		19 – 17°C	19 – 17°C	60 – 70 %

This table should be used as a guide, but temperatures can be adjusted according to the behavior and distribution of the chicks:

- If the chicks crowd together under the brooder, the temperature is too low.
- If the chicks are close to the surround, inactive, lethargic and spreading away from the heat source, the temperature is too high.

Distribution behavior according to temperature



Too cold | Too warm | Draught | Ideal

Key points:

- Chicks should be unloaded immediately after arriving. Avoid dehydration due to exposure to high temperatures especially when they stay too long in the chick transportation boxes.
- Observation of the flock is the best indicator of real needs!
- For the first week confine chicks to floor brooder areas and prevent air drafts.
- Temperature and relative humidity should be uniform throughout the building.
- Changes in temperature should be carried out gradually.
- Some ventilation is necessary during the first weeks to provide enough oxygen and to eliminate carbon dioxide, water vapor, ammonia as well as carbon monoxide from combustion. Maximum levels not to be exceeded are:
  - CO2: maximum 2500 ppm
  - CO: < 10 ppm
  - NH3: maximum 20 ppm

3.4 Lighting program

During the first few days, it is important to keep the chicks under a maximum light regime (22 to 23 hours) with a high intensity (30-40 lux) in order to encourage the intake of water and feed and the activity of the chicks. After the first few days the light intensity could be gradually reduced. Light intensity will also depend on bird behavior.

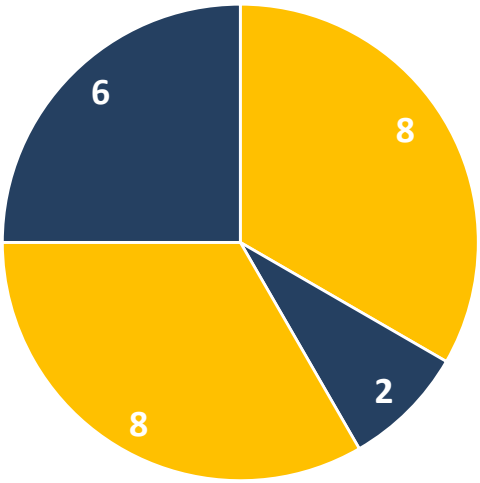
Lighting program in brooding according to age and rearing house system

	Rearing in dark or semi-dark house		Rearing in hot climate (open houses)	
	Light duration	Light intensity	Light duration	Light intensity
1 – 3 days	23 hours	20 – 40 lux	24 - 23 hours	40 lux
4 – 7 days	22 hours	15 – 30 lux	22 hours	40 lux
8 – 14 days	20 hours	10 – 20 lux	20 hours	40 lux
15 – 21 days	18 hours	5 – 10 lux	19 hours	40 lux
22 – 28 days	16 hours	5 – 10 lux	18 hours	40 lux
29 – 35 days	14 hours	5 – 10 lux	17 hours	40 lux

After arrival of the chicks an intermittent program could be applied for the first 2 weeks. This program consists of 4 hours of light/2 hours of dark repeated 4 times to equal 24 hours for the first week, followed by a transitional program on the second week (8 hours light/2 hours dark/8 hours light/6 hours dark) and then switch to the regular step-down program, which is 18 hours of light on the third week. This program allows rest periods to chicks and synchronizes their activity, which has a positive effect on feed and water consumption, makes easier monitoring the flock behavior and contributes to reduction of early mortality. This program can only be implemented if it is compatible with local regulations

Intermittent Lighting Program

Transitional Lighting Program



4 General management during the growing period

4 General management during the growing period

4.1 Building the potential

After a good start during the growing period, the objective is to ensure the full development of the birds so that they reach their highest potential for producing eggs later in life.

The objectives during the growing period are:
- to achieve the recommended weight at 5% production
- to establish a good feeding behavior pattern
- to develop the digestive tract (crop and gizzard)
- to obtain a good uniformity of at least 80%

These objectives can be achieved by:
- a correct stocking density and housing conditions
- a lighting program adapted to the rearing conditions
- a good standard of beak treatment (when local legislation allows the application of beak treatment and when it is applied)
- a good management of the feeding program and feeding techniques

4.2 Housing and equipment

Equipment requirements for the rearing period (5-17weeks)

		Floor		Cage	
		5 – 10 weeks	10 – 17 weeks	5 – 10 weeks	10 – 17 weeks
Ventilation	Minimum ventilation rate	0.7 m³/hour/kg	0.7 m³/hour/kg	0.7 m³/hour/kg	0.7 m³/hour/kg
	Required ventilation capacity	4 m³/hour/kg	4 m³/hour/kg	4 m³/hour/kg	4 m³/hour/kg
Stocking densities	Birds/m²	15	10		
	cm²/ bird			220	350
Water supply	Chicks/Chick drinker				
	Birds/drinker	100	100		
	Birds/nipple	10	10	10[1]	10[1]
Feed supply					
	cm through feeders	5	7	4	6
	Birds/round feeder	25	23		

[1] make sure that all the birds have access to at least 2 nipples

4.3 Feeding Program

The diet for the rearing period must be adapted to the actual evolution of the frame and bodyweight development. The following diets are identified for the different growth phases:

- Starter diet is recommended from one-day old to 4 weeks old. This can be extended up to 5 or 6 weeks to secure frame development in case the body weight is below the standard. Frame development occurs for the large part during the first 8 weeks of the rearing period. There is a clear correlation between body weight target at week 5 or 6 and early cull in production, therefore achieving correct body weight at early age is even more important during extended laying cycles.
- Grower diet is recommended from 4 weeks old to 10 weeks old and can be extended up to 11 or 12 weeks old, in order to secure growth. As the rearing period objective is also to develop the digestive tract, this grower diet is high in energy content and should not be given after 12 weeks old. The risk being to reduce the development of the digestive tract and feed intake at the start of lay as a result of using feed with too high energy content.
- The distribution of a developer diet up to 16 weeks will help the development of the crop capacity thanks to a lower energy level than grower feed, and slightly lower than the pre-lay or layer feed.
- In order to secure the development of the medullary bone which acts as a reservoir of calcium used for shell formation, we advise the use of a pre-lay feed for the two weeks before 2% production.

The detailed specifications for each of these diets are explained in chapter 9. A good quality starter feed should be distributed when chicks have drunk enough water to restore their body fluid (± 4 hours after delivery) where it is possible to do so. During the period from one day old to five weeks old, the chick is not able to adapt its feed consumption to its energy level. To encourage good growth, we recommend using a diet presented in crumb form. When available, micro-pellets specially produced for young chicks until 7 to 10 days of age are also a good alternative. They provide a homogeneous and suitable feed form for young chicks that will be helpful for a good start. The starter feed should contain an adequate concentration of protein (20.5%) and energy (2950 Kcal/kg) - from 0 to 28 days in temperate climates and from 0 to 35 days in hot climates- until the bodyweight target is reached.

Small additional feeders or non-smooth paper can be used to increase the feeding space for the first few days. We recommend distributing smaller quantities of feed several times per day during the first 4 weeks. When present, start to use the automatic feeding system from early age so the chicks get accustomed to it. Let the chicks empty the feeders once or twice a week to avoid the accumulation of fine particles in the feeders.

Key points:

- After the chick delivery, wait ± 4 hours with supplying feed to allow time for restorage of the chicks' body fluid.
- Check for filled crops:
  A simple tool that can be used to monitor the feed intake after arrival. Take a sample of 40 -50 chicks from 3 or 4 different places in the house and check for filled crops. You can measure this by gently feeling the crop, if you feel a round full sac the crop can be considered as full. Note than your findings on paper, and calculate the % of chicks with full crops. The target is at least 80% of crops filled after 10 hours and 95% after 24 hours.
- Check the quality of the crumbs. They should not be too hard and be of suitable size (1.5 to 2mm).
- Young chicks should be fed "ad libitum" but avoid the build-up of fine particles in the feeders in the first weeks, making sure they are emptied at least once each week. We recommend distributing smaller quantities of feed several times per day during the first 4 weeks.
- Start using the automatic feeding system from the very beginning, so that chicks get accustomed to it.
- An even distribution of feeders over the brooding area will make it easier for the chicks to locate the feed.
- Monitor growth by taking the body weight of a sample of birds:
  * From 0 – 4 weeks, weigh a group of a minimum of 100 birds each week.
  * From 4 weeks of age, start weekly individual weighing (at least 100 chicks) to determine flock uniformity.
  * If the flock is divided into separate pens, it is important to take a sample of 50 birds from each pen and then to calculate the overall mean.
  * When rearing in cages, weigh all the birds from 5 or 6 cages, chosen at random, in different parts of the poultry house, to make up a sample. Mark these cages as controls, so you can follow up these cages during the rearing period in their development.

Check your birds regularly to see if their crops are filled and to spot any abnormalities

4.4 Feeding Technique

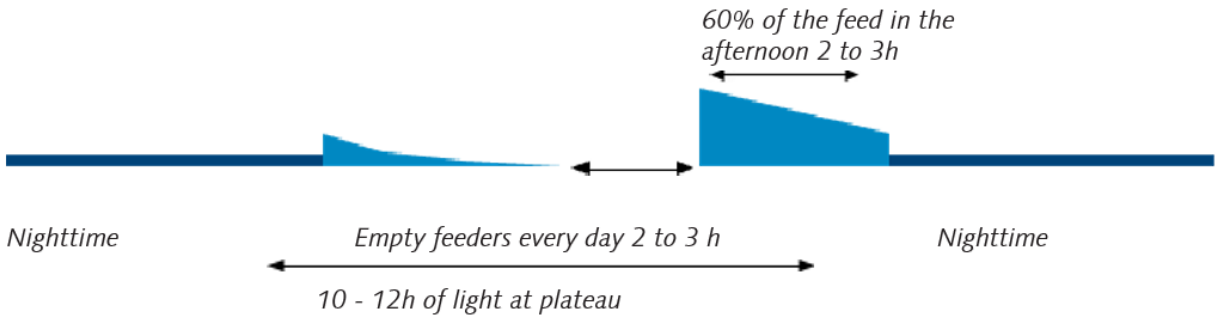
The feeding techniques used between 5 and 16 weeks are designed to:

- avoid the build-up of fine particles
- encourage crop development through rapid feed intake

Birds are grain eaters by nature, with a strong preference for coarse particles. Fine particles are more difficult for birds to eat; therefore, they spend more energy for the same quantity consumed. The accumulation of fine particles in the feeding system leads to under-consumption. In order to ensure the birds from getting all the necessary elements of the diet, it is essential that the feeders are emptied one per week till 5 weeks of age and every day from week 5 of age onwards. This rule applies equally to pullets and layers.

Feed management in rearing has an impact on feed consumption later in production. The idea is to develop the digestive tract during the rearing phase to prepare the birds to eat enough during the laying phase, especially immediately after transfer, when feed intake should increase sharply in just a few weeks. The crop is the bird's feed storage organ. It allows the bird to eat enough feed in the evening to satisfy its energy needs throughout the night. Rapid feed consumption during rearing leads to crop development. Therefore, feed consumption during the rearing period needs to be fast enough and eating speed will depend mainly on feeding times and feed texture. Since birds naturally eat earlier in the morning and in the evening, it is important to take advantage of this natural behavior and get empty feeders in the middle of the day.

Feed distribution management in rearing



To encourage rapid consumption, we recommend that the complete daily ration should be given about 2 to 3 hours before "lights off". At "lights on", because the digestive system is empty, the birds will eat finer particles. If the feeding system does not allow the entire daily ration to be given in one distribution, distribute 60% of the daily ration in the early afternoon and the 40% in the morning at "lights on". This feeding routine can be started between 4 and 8 weeks according to the feeding equipment in use. The length of time, during which the feeders are empty, should be gradually increased, so that by around 10-12 weeks of age the feeders are empty for a minimum of 2 to 3 hours per day. It is however possible, to give two distributions in the afternoon, provided that the feeding periods are kept short. Pullet feed presented in coarse particles helps gizzard development.

We recommend using a feeding system which distributes feed rapidly throughout the house and enables the birds to finish all the feed distributed each day. This encourages the birds' intake capacity and avoids fine particle accumulation. Feed troughs with rapid chains are the best option, with the easiest feed intake control. If pan or tube feeders are used, they should be adapted specifically for this technique.

4.6 Water program

Do not forget to wash the drinking system after disinfection and use tepid water for the first 2 days (20 – 25°C). Start to use the automatic drinking system when the chicks are placed. The use of supplementary drinkers during the first days will improve the health of the chicks (remove them gradually after day 4).

Always clean the drinkers daily during the first 2 weeks, as bacterial growth is stimulated under the warm conditions at brooding. After 2 weeks you can clean them with a minimum of once a week. When nipple drinkers are used, use the strips of embossed paper under the drinkers' lines. Adjust the lines height to that of the chicks, so that all of them have a chance to start. Enough drinking space, that is easily accessible is an extremely important tool to prevent non-starting chicks and uneven flock. Make sure that the water is of sufficient quality (check the table at page 11). In hot climate environments, flush the line just before the chicks arrive to provide them with fresh water. Drinking nipples should assure a water flow of 30 to 90 ml of water per minute. The required water flow rate depends on the presence of cups (60-90 ml/minute) or without cups (30-50 ml/minute).

Note: the water flow rate in nipple systems depends on the type of drinking nipple system and therefore the supplier should provide the system specific values.

4.7 Monitoring development

Weekly measurement of growth is a must to check the actual development of the flock. Early detection of abnormal weight gain is of extreme importance to determine what corrective actions must be taken. Late attempts to correct low bodyweight are not efficient at improving body composition and frame size. In addition to this, monitoring of body weight is essential to calculate the appropriate quantity of feed to be issued, as requirements vary according to the energy level of the diet as well as the house temperature and the health status of the flock.

Besides the average body weight of the flock it is also important to calculate its uniformity. The objective is to have a high uniformity to ensure an even response across the flock to management techniques, treatments and especially to light stimulation. If all the birds have a uniform development, they will react more or less as one and they will be easier to manage.

Method of weighing control:

- Weighing time should be fixed, preferably in the afternoon.
- We advise carrying out individual weighing and using histogram type weighing sheets (see the chart on the next page) which shows at a glance the weight distribution within the population.
- A sample of a minimum of 100 birds should be taken to obtain a good estimate of mean bodyweight and uniformity. However, if the flock is divided into separate pens, it is necessary to take a sample of 50 birds from each pen and then to calculate the overall mean.
- When rearing in cages, weigh all the birds from 5 or 6 cages, chosen at random, in different parts of the poultry house, to make up a sample.

The most important factor in judging the quality of a flock is its uniformity. A batch is uniform when at least 80% of the weights lie within a range of ± 10% of the mean. Using modern weighing devices, it is also possible to obtain the coefficient of variation (CV), which is the ratio of standard deviation to the mean of the population expressed in %. A CV below 8% is considered to be good.

If uniformity/CV % is outside the target range, it is necessary to identify the causes and to check:

- Feeder space and position
- Speed of the feed chain
- Quality of beak treatment
- Vaccination status
- Disease and parasitism
- Housing density

Depending on the conclusions, management should be adapted to improve uniformity.

4.8 Body weight recoding chart

Grams	No. Birds	10	15	20	25	Rearer
600						
20						Rearing
40						Actual
60						Mean WL
80						792
700	x x x x x					Target
20	x x x x x x x x					Weight
40	x x x x x x x x x x x x x x x					790
60	x x x x x x x x x x x x x x x x x x x x					Grams
80	x x x x x x x x x x x x x x x					Over/(under)
800	x x x x x x x x x x x x x x x x x					2
20	x x x x x x x x x x x x x x x x x					% evenness
40	x x x x x x x x x					. + or - 10 %
60	x x x x x					86,21
80	x x x x					. + or - 10 %
900	x x x					
20	x x x x					
40						St. Dev
60						53,65
80						cv %
1000						6,8

Time of Weighing a.m. / p.m. Weighed by:

Comments _____

_____

5 Lighting Programs

5 Lighting Programs

5.1 Introduction

Pullets are sensitive to changes in the lighting regime, and these will influence the age of sexual maturity. In addition, feed consumption is greatly influenced by the duration of daylength. During rearing, the main objectives of lighting programs are encouraging growth and controlling the birds' sexual maturity. Lighting programs should be adapted to rearing facilities (dark or open house systems), conditions of production, climate and the egg weight profile required by the market.

Two basic rules should be followed in every lighting program:
- Do not increase day length in rearing before the moment of light stimulation
- Do not decrease day length during production

Time of light stimulation should always be based on bodyweight, not on age. Premature light stimulation and/or too low bodyweight can lead to poor performance later in production (peak and persistency), as well as higher mortality and poor eggshell quality.

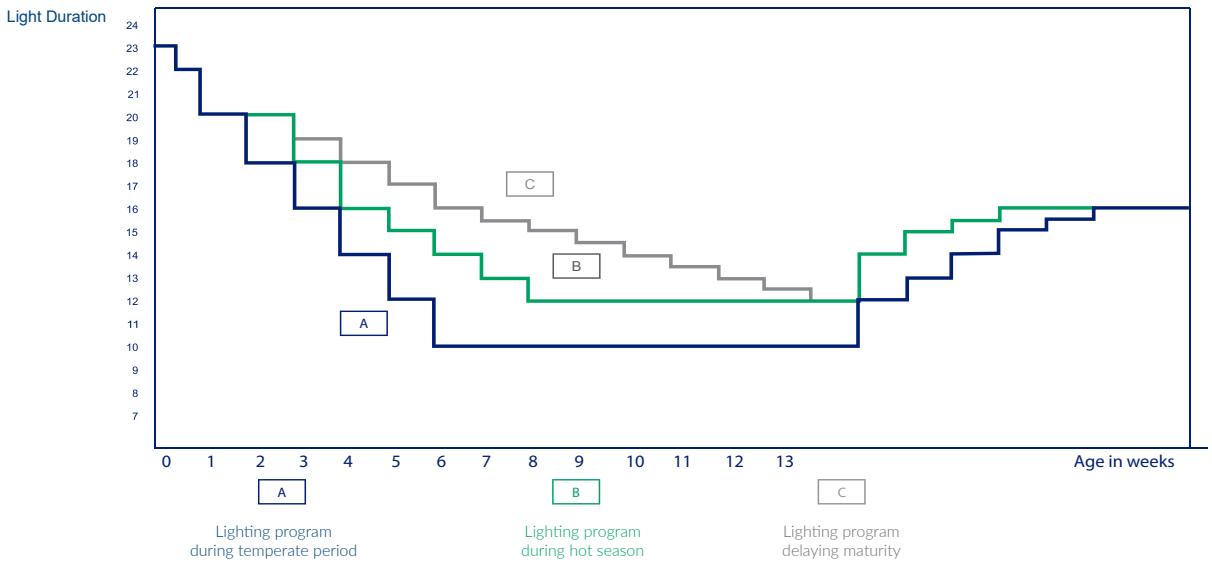
For the first weeks (rearing), a step-down lighting program is recommended in order to maximize growth, followed by a period of constant light duration. Speed of daylength reduction and hours of light at the plateau should be adapted to breed, growth performance, climate, expected sexual maturity and required egg weight.

When pullets are reared in open system houses, control of sexual maturity is difficult to achieve. It is recommended to darken the poultry house and to use a lighting program that takes the natural day length at the moment of transfer into account. Golden rule: the total light duration at the plateau must never be shorter than the longest natural day length in the period between 6 weeks of age and the moment the birds are transferred to the laying house.

Lighting programs have different objectives:

In rearing:
- To promote early development and encourage feed intake and growth
- To control the birds' sexual maturity

During production:
- To encourage growth at start of lay
- To counteract the harmful effects of decreases in natural day length



5.2 Lighting program in dark houses

The following program should be used as a guide and should be adapted to the specific circumstances of the farm and according to the performance results previously obtained.

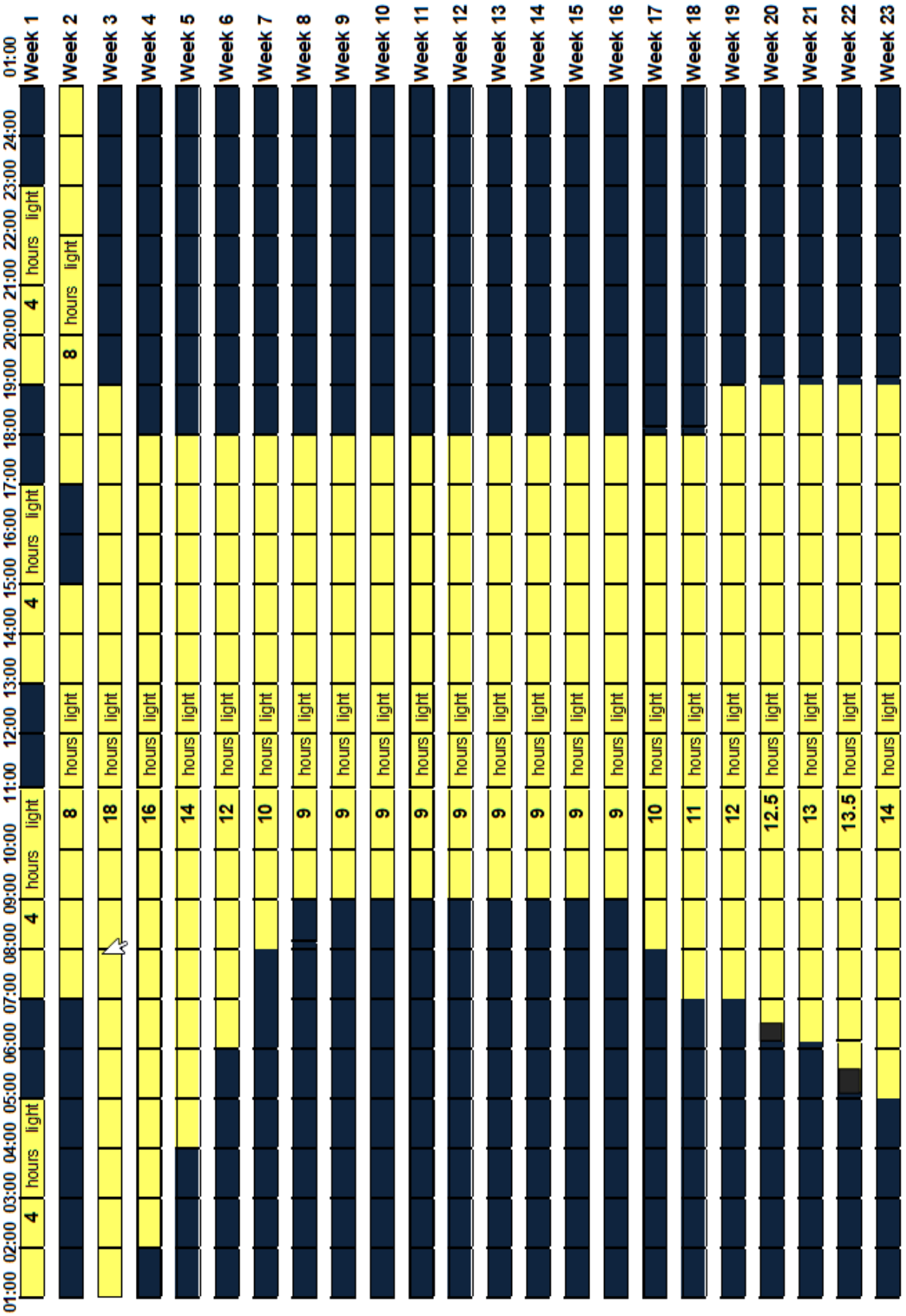
Age (weeks)	Hours of light per day		Light Intensity (lux)
	Brown Hens	White Hens	
1 – 3 days[a]	23 h	23	20 – 40
4 – 7 days	21	21	20 – 30
2	20	20	20
3	18	18	10
4	16	16	5 – 10
5	14	14	5 – 10
6	12	12	5 – 10
7	10	10	5 – 10
8	9	9	5 – 10
9	9	9	5 – 10
10	9	9	5 – 10
11	9	9	5 – 10
12	9	9	5 – 10
13	9	9	5 – 10
14	9	9	5 – 10
15	9	9	5 – 10
16	9	9	5 – 10
17	11	10	5 – 10
18	12	11	5 – 10
19	13	12	5 – 10
20	14	12.5	5 – 10
21	15	13	5 – 10
22	15.5	13.5	5 – 10
23	16	14[b]	5 – 10

[a] After arrival of the chicks an intermittent program could be applied for the first 2 weeks. This program consists of 4 hours of light/2 hours of dark repeated 4 times to equal 24 hours for the first week, followed by a transitional program on the second week (8 hours light/2 hours dark/8 hours light/6 hours dark) and then switch to the regular step-down program (see example in next page).
[b] White-egg layers can perform in production with a lighting program of 14h, but if necessary, for encouraging feed consumption, it can go up to 15 hours.

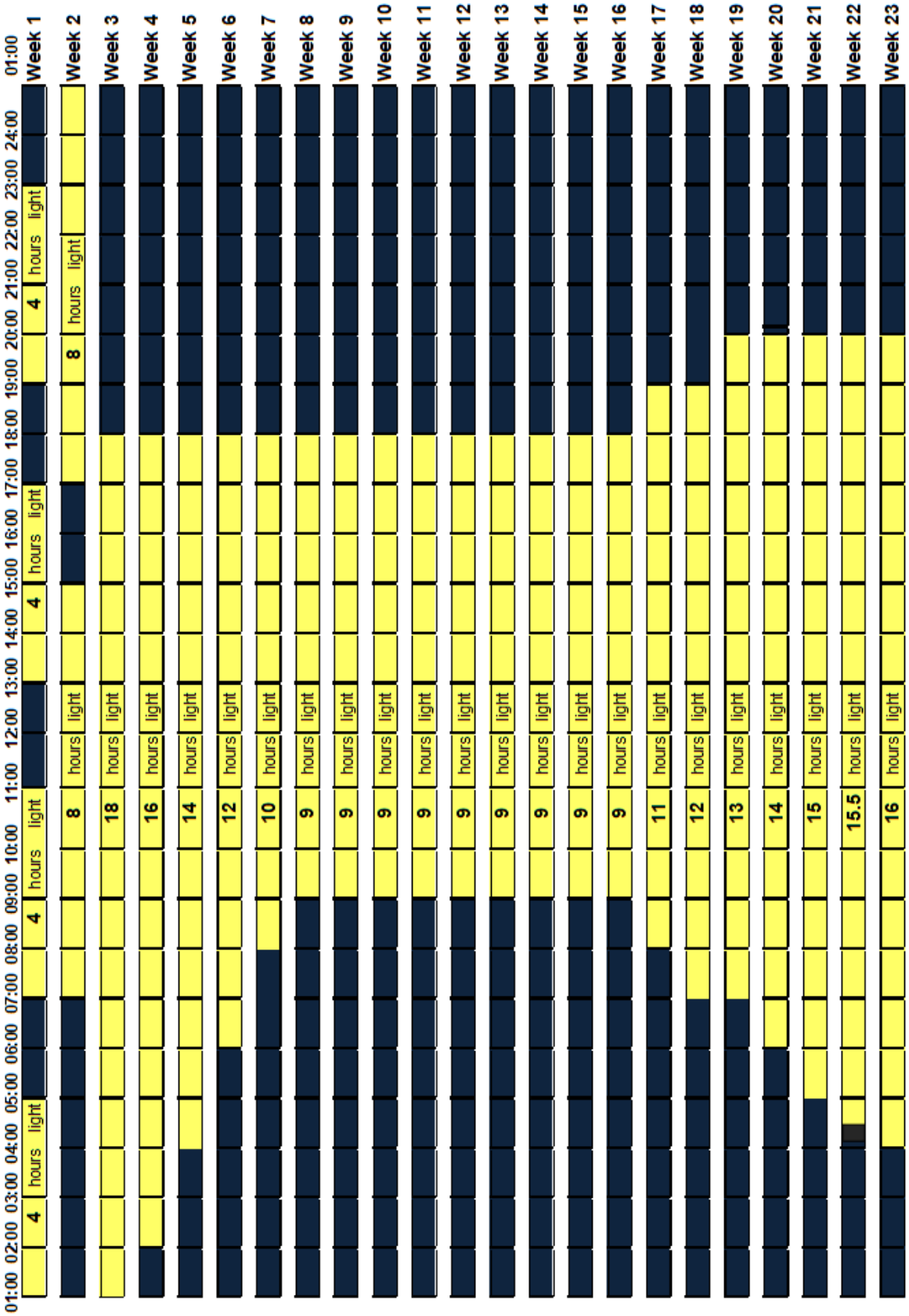
Slow step-down

If you notice that bodyweights are staying behind target, you can choose for a slower step-down lighting program. This will allow the birds more time to eat which will result in better growth.
Slower step down can also be applied when you aim for higher egg sizes straight from the beginning of production. Be aware that it will delay the onset of lay!

Example: Light schedule used for White laying hens



Example: Light schedule used for Brown laying hens



5.3 Lighting program in semi-dark or open-sided houses

Complete control of sexual maturity is difficult to achieve in this type of building because the seasonal fluctuations of day length interfere with sexual development. Sexual maturity previously observed in flocks coming from this type of rearing house, in the same season, should be considered.

Houses where the light intensity entering the building from outside exceeds 0.5 lux should be considered as semi-dark, and the lighting program should be designed for natural light exposure and follow the schedule for open-sided houses. In order to get effective photo stimulation and to avoid birds reaching maturity too early, the lighting schedule used should consider the natural day length when the flock is at 16 weeks of age. To avoid any unwanted increase in light duration before light stimulation, the minimum hours of light during the rearing period, should never be less than the longest natural day in the period between 6 and 16 weeks old.

It is very important to keep the following points in mind:
- Effective stimulation is always difficult when the natural day-length is near its longest.
- Lighting programs in semi-dark or open housed should always be adapted to location and season
- Increase in light duration at light stimulation should be evenly spread in the morning and in the evening according to maximum natural daylength and arranged to suit working hours

Lighting program for cage production according to day length at 16 weeks

Age and / or weight	Duration of light at 16 weeks (hours)				
	10	11	12	13	≥14
1 – 3 days	23	23	23	23	23
4 – 7 days	22	22	22	22	22
8 – 14 days	20	20	20	20	20
15 – 21 days	18	18	18	18	18
22 – 28 days	16	16	16	16	16
29 – 35 days	14	14	14	14	15
36 – 42 days	12	13	13	13.30	14
43 – 49 days	11	12	12.30	13	14
Decreasing daylengths: from 49 days to light stimulation	10	Natural light	Natural light	Natural light	Natural
Increasing daylengths: from 49 days to light stimulation	10	11	12	13	14

Transferring birds from a semi-dark rearing house to a windowed house can bring about advanced sexual maturity. Under these conditions, there is an increased risk of having underweight birds at the point of light stimulation. To reduce this risk, we recommend working with a higher light intensity in rearing (i.e. 40 lux) or gradually increasing in the final weeks of rearing the light intensity to get adapted to the conditions to be experienced in the production house.

Transferring the birds from an open or semi-dark house to a dark laying house slows down the sexual development of the chicken and causes a delay in the onset of lay. Under these conditions, it is necessary to keep a light duration and intensity equivalent to the day-length at the time of transfer, and to gradually adjust the light intensity after the transfer.

5.4 Light Intensity

Light intensity is an important factor during the first days of the rearing period, encouraging the chicks to explore their environment and quickly locate water and the feed. Next, light intensity can gradually be reduced to a level that in practice will depend on the:

- Light required to inspect the birds
- Degree of darkness of the building (light leaking in)
- Intensity to be used during the laying period

There is a strong relationship between light intensity, physical activity, pecking behavior and feather loss. High light intensity tends to increase the nervousness of the birds and it can result in increased mortality by vent pecking. This risk is higher when birds are kept at a high stocking density. Using dim light during the production period will help to obtain better livability.

The light intensity required in production is relatively low, from 5 to 10 lux, and it is not necessary to increase it for effective light stimulation. However, a slightly higher intensity at the start of production can help to stimulate feed intake, if needed. Achieving a good uniformity of light spread is also very important.

6 Transfer

6 Transfer

6.1 Transfer to the laying house

Transfer is a stressful event for the birds. In effect they experience two stresses: 1) the handling and transport involved in movement from rearing to laying facilities, plus 2) the change from rearing to laying environment. Therefore, transfer requires careful planning and management. Transfer should ideally be done 4 weeks before egg production starts, certainly no later than 2 weeks before egg production starts. The purpose is that the birds receive the time to recover from the stress accompanied with the transfer and that the rapid ovarian development is not being depressed. Unfortunately, the latter falls exactly within the period of transfer. Late transfer bears the risk of damage to the birds, in particular to the ovaries. In the ideal situation, birds are transferred at 16 weeks of age, this will enable them to be fully adapted to the new layer house before the onset of lay. When birds are transferred too close to the onset of lay, the subsequent risk of egg peritonitis is increased. The movement of birds with mature ovaries may cause rupture of yolk follicles, which are then deposited in body cavity. When transferred, the flock should be fed a pre-lay or a layer's ration. Please note: pullet (or developer) rations must not be used, as the nutrient density of these feeds is too low!

6.2 Preparation at the rearing farm

There is an important preliminary period before transfer, in which time the stock is prepared for the conditions they will encounter in the laying house. The following points should be considered:

- The birds must always conform to the bodyweight of the breed. This should not simply be according to the age of the birds but also according to age of sexual maturity. Note that because of the stress caused by the transfer, birds' weight can be reduced by 10% to 15% due to moisture loss.
- For easier adaptation to the laying house, ideally rearing house temperature and light intensity should be gradually adjusted in the last couple of weeks before transfer to match laying house conditions
- Two weeks prior to transfer the birds should not be handled, except for routine uniformity and bodyweight checks. The birds must have had every opportunity to grow, even during this critical period.
- Feed withdrawal before departure should not exceed 6 hours and should be adapted to transport duration and climatic conditions.
- Vaccinations should be given at least one week before transfer, to obtain a good vaccine reaction. A late or long transfer often leads to delayed start of lay and higher mortality.

6.3 Preparation at the laying farm

The laying house should be well prepared prior to the arrival of the new flock. The following points should be considered:

- An appropriate terminal hygiene program must be implemented to avoid disease transmission.
- Maintenance and repairs must be completed before arrival of stock.
- Flush the water system and provide fresh water the day before arrival of new stock. This is critical, as the key to the successful start of the incoming flock is provision of water. The better the water quality, the less the depression in feed intake following transfer.
- The house should be dried prior to the arrival of the new flock. Not only are wet houses very humid, (a condition which is depressing for the birds), they are also cold – which is particularly noticeable during winter.
- The house should be preheated in cold season.

6.4 Transfer

An ideal time for transfer is during the early morning. Disturbance to routines of drinking and eating is minimized if the birds are unloaded and housed by the time their day typically starts on the rearing farm. Transport vehicle and equipment must be clean and disinfected. The flock should be transferred within the same day as this causes less stress and avoids the issue of low temperatures in partially filled rearing and laying houses. Every effort should be made before and after transfer to maintain water and feed intake according to the normal routine of the stock. Precautions should be taken to minimize undue exposure to wind and rain/sun during transfer procedure as these factors are very stressful.

Transfer is accompanied by changes in environment, temperature, humidity, and equipment. It is therefore a major source of stress and it should be carried out as rapidly as possible. Because of the stress to which pullets are subjected during and immediately after transfer, it is extremely important that transfer is completed before the appearance of the first eggs. We recommend scheduling the transfer at 16 weeks of age and ensuring that all hens are housed in the production facilities by 119 days of age.

6.5 Lighting

The duration of lighting during lay should consider the program used during rearing. Exchanging detailed information on lighting program used in rearing, is important for a better adaptation of birds by adjusting time schedules to make them match.

Water consumption

Birds can become dehydrated during transfer. The water loss is between 0.3% and 0.5% per hour according to atmospheric conditions (4 g/hour at 20°C, more than 8 g above 30°C).

The drinking water devices must have been triggered and purged before pullets arrive to ensure they are working properly. The newly arrived pullets should drink before feeding. The absence of feed at transfer helps them find the drinkers more easily. Wait for 3 to 4 hours before feed distribution and check that all the pullets drink properly. A daily check on water consumption is of paramount importance. If nipple drinkers are used in the laying house but the pullets have not been reared with nipples, increase the pressure and allow some loss of water during the first few days.

7 The productive life

7 The productive life

7.1 Arrival at the laying site

Unloading of the birds is a delicate procedure, it should be done as quickly and gently as possible. The laying house should provide the following to the birds:

- A dry house (+ its equipment) at a temperature of no less than 15°C, where 18°C is the optimum, especially in cold weather.
- In order to encourage water intake, drinking water must be clean and fresh when the pullets arrive.
- To improve the birds' appetite, it is better to use meal feeding instead of feeding ad-libitum.

Light duration should be decided according to what has been used during rearing. Some strategies can help for a better adaptation:

- Applying 22 h of light the first day
- Increasing the light intensity for 4 to 7 days to help the birds in the darkest cages to find nipples.
- Then gradual reduction of light intensity while ensuring that normal water intake continues. Too high light intensity for longer than 7 days can increase the nervousness of the flock and risks of pecking.

During the first days, the farm workers should spend time with the birds, observing their behavior and monitoring the water and feed consumption. This will also allow time for the birds to get used to their caretakers. Inspection of the flock should not be limited to daytime only! Listening to the birds after turning off the lights can be very useful: coughing or sneezing, also known as "snicking", as a result of a respiratory infection can readily be detected when the flock is resting.

7.2 Basic concept of growth

From transfer, birds continue their growth towards achieving their physical maturity around 30 weeks of age, the bodyweight gain must be around 300 g. After 30/35 weeks most bodyweight gain is fat, and its excess has a negative impact on the birds' laying performance and feed conversion. A lack of bodyweight gain after transfer makes hens vulnerable and less robust against environmental variation like disease and heat. Flock uniformity must be followed up to avoid extremes of bodyweight as this will negatively impact laying performance.

From a nutritional point of view, the prelay period is characterized by an increase of the calcium concentration of the feed. The first objective of the higher calcium levels is to reinforce the mineralization of medullary bone and layer calcium storage, before the beginning of lay.

The second objective is to prevent demineralization of early sexually mature birds. With a classical developer feed, calcium concentration is not enough compensating the calcium exported for the formation of the eggshell. This leads to the decrease in the medullary bone calcium reserve. Layers without adequate calcium content on prelay will have poor eggshell quality during the last period of lay.

Higher calcium levels in the prelay diet will prevent bone demineralization of birds that come into lay early. It will also reinforce the mineralization of medullary bone before transfer and will ensure a longer lasting eggshell quality.

The prelay diet constitutes a step, in terms of feed, between rearing and laying feed. It is strongly recommended to use a prelay diet to get the birds accustomed to the layer feed. If the prelay diet is not used, the risk for a too low feed consumption after transfer to the laying house is higher as the abrupt increase in calcium carbonate content from developer feed to layer feed can lead to a decrease in feed intake due to lower appetence.

During the prelay phase, the birds continue to grow. It is during this period that the lightest birds have the opportunity to improve and adjust their bodyweight. The birds that are early sexually mature could begin to lay. Both require a high nutritional feed to assist correct growth and production. Protein and amino-acids levels must be high at this time to meet the nutritional requirements. Without using an adapted feed, the uniformity of the flock could be jeopardized.

7.3 Housing and equipment

Equipment requirements for the production period

		Cages	Enriched cages (EU-union)
ventilation	Minimum ventilation rate	0.7 m³/hour/kg	0.7 m³/hour/kg
	Required ventilation capacity	4 m³/hour/kg	0.7 m³/hour/kg
Stocking density	cm²/bird	450*	750
	Birds/ nipple	10**	10**
	cm of through feeder	10	12
Perche space/bird	cm of perch		15

*The local legislation should be followed for the stocking density
** Make sure that all the birds have at least an access to 2 nipples.

Enriched cages

Following increasing worldwide concern for animal welfare, furnished or enriched cages have been designed to combine some of the advantages of conventional cages with additional features to allow hens to express more of their natural behaviour, such as perching, dustbathing and nesting.

Enriched cages provide extra space per bird compared to conventional battery cages and are equipped with furnishings like perches, nests, scratch pads and claw-shortening devices.

Production performances and egg quality are comparable to conventional battery cages, but depending on cage design and group size, there is a risk of more downgraded eggs (soiled and cracked eggs). Some important points to consider to minimize them:

- Adequate shape, position and height of perch rails
- Group size and number of nests: since hens in uniform flocks have similar laying cycles, competition over nest boxes can lead to eggs laid out of the nest. Midnight light can help to spread out the lay where it is allowed.
- Avoiding feed distribution during laying hours
- Using a timer or a system based on egg weight for pulling forward the belt and avoid eggs piling up in front of the nests.

7.4 Feeding/Drinking

Laying hens must have fresh, clean, potable water, readily available all time.

It is very important that birds find the same type of drinkers in the laying house as they were already accustomed to in the rearing house!

It is important to monitor the daily water and feed intake. Any strong deviations from the previous day's consumption might indicate a start of some disease or technical problem. When this is part of your regular flock inspection it will help you to avoid big surprises in the development of your flock.

7.5 Heating

The laying house temperatures should be kept between 18-22°C, though the birds will withstand the lower temperatures during winter and higher temperatures during summer. At lower temperatures a hen increases feed intake as the maintenance requirements increase. On the other hand, at higher temperatures birds tend to decrease feed consumption due to a lower maintenance requirement and to dissipate the heat excess produced in the metabolism.

Throughout the winter season, temperatures in the rearing houses before and during transfer must be adjusted to those in the production houses. Moreover, to avoid temperature stress in wintertime, it is advisable to preheat the production houses up to 18°C before transferring point of lay pullets and to respect minimum ventilation (cf. Ventilation part) requirements to avoid damage caused by C02/NH3 levels. If necessary, use heaters.

7.6 Lighting system

The objective of the lighting program during the production period is:

- To encourage feed intake and growth at start of lay
- To counteract the harmful effects of decreases in natural day length
- To control the livability through the light intensity management

Achieving the best uniformity of light spread possible is essential. Light bulbs lay out (distances and height) should allow even light intensity at all different tiers. Bulbs should be kept clean and replaced when burned out to avoid dark spots. Lighting systems using bulbs or fluorescents of too low frequency will result in flickering light which will stress birds. Warm color type (yellow-orange spectrum, maximum 3000°K) must be used. In the event of negative bird behavior, the use of lampshades and red-light covers can help. In all cases, it is advisable to install dimmers that allow the light intensity to be adjusted. Where lighting is provided by fluorescent tubes, they will need to be evenly distributed and of a warm color (maximum 3000°K) and of high frequency.

LED lights are increasingly used in poultry houses due to their high light efficiency, low running costs, long-life span and wide wavelength range. Some key points to be considered when using LED lights are:

- LED lights used for the laying period should have the appropriate color spectrum, (maximum 3000°K)
- They are easily dimmed. Please make sure that the dimmers do not cause flickering!
- Select the right beam angle, which determines the size of the area to be covered by the light. As LED light is directional it tends to create shadows. Combine beam angles, placement and spacing to avoid uneven light distribution and dark areas.

Whatever the type of laying house (natural or artificial light), the golden rule is to never decrease daylength (interval between lights on and lights off) after the start of lay. The lighting program in production should be the continuation of the lighting program used during the rearing period. It is essential to make sure that the light duration at transfer is as long as the light duration the birds have already experienced in the rearing house just before transfer. It is recommended to make a light schedule before the new flock is placed. Determine on advance how long the maximum daylength will be in production (14h - 16h) and start adding light in the morning and the evening till reaching the desired time of constant light.

If the building is dark and the pullets have been reared in dark houses, a minimum light intensity from 5 to 10 lux is required for the production house.

It is advisable to use slightly higher light intensity at the start of production to stimulate the birds' feed intake. Once the feed intake meets the desired level and the peak of production is achieved, the light intensity can be decreased.
There is a strong correlation between bird activity and feather loss during production. Too high light intensity can encourage pecking and result in increased mortality.

As the bodyweight plays a major role in the determination of the egg weight profile during the entire laying period, it is important to use light stimulation according to the observed bodyweight of the flock. Below you will find the minimum bodyweight references (Bwtr) for both white and brown laying hens. Depending on the goal later on in life (delay sexual maturity) or on the climate (hot season) we also show some advised light schedules.
Bwt Ref: the minimum bodyweight reference is:

- 1,150g to 1,200g for white egg layers
- 1,300g to 1,350g for brown egg layers

Uniformity is an important parameter to consider. If bodyweight uniformity (±10%) is below 80% for brown and 85% for white, delay the light stimulation. The bodyweight reference can fluctuate over countries and egg size requirements.

7.7 Dark laying houses

When pullets are transferred from a dark laying house to a dark production house, control of sexual maturity is easier to achieve by using a suitable lighting program. The following lighting program can be used as a guide and can be adapted to the breed and the conditions at the farm.

Age and / or Bodyweight	Standard program brown egg layers (hours)	Standard program white egg layers (hours)	Delaying maturity / hot season program (hours)
End of rearing to light stimulation	9	9	12
At bodyweight reference (Bwt ref*)	11	10	14
Bwt ref + 1 week	12	11	15
Bwt ref + 2 weeks	13	12	15.30
Bwt ref + 3 weeks	14	12.50	16
Bwt ref + 4 weeks	15	13	16
Bwt ref + 5 weeks	15.50	13.50	16
Bwt ref + 6 weeks	16	14	16

*Bwt ref : bodyweight reference must be fixed according to country and egg size requirement

Control of day-length and light intensity during the laying period helps to achieve good production performance and to control abnormal behavior, therefore light-controlled houses are also recommended for the production period.

7.8 Production in open house systems

When birds are exposed to the effect of natural light, e.g. houses with natural light entering through windows or other openings, or houses where birds have access to outdoor enclosures or a winter garden, the lighting program used should always take into account the natural day length at transfer, which will vary depending on the season and the latitude. In these houses, time of lights on and time of lights off should coincide with the time of sunrise and sunset of the longest day in that latitude.

To reduce the delay in sexual maturity induced by decreasing day length, we recommend:
Starting light stimulation when the bodyweight is on target by increasing the day length period:
- 2 hours in the evening for brown egg layers
- 1 hour in the evening for white egg layers

After the aforementioned, add 1 hour per week in order to get 13-15 hours of light at 50% production.

To avoid a premature sexual maturity, which could lead to poorer overall performances (in egg number, egg size, shell quality and livability), we recommend the following:
- To start with the light stimulation when the bodyweight is on target by increasing the day length period by 1 hour (for both brown and white egg layers).
- To add 1 hour of light per week

Please note: this advice needs to be adapted according to the breed, the birds' feed intake and the bodyweight observed.

Naturally lit houses should be built with an east-west orientation to avoid direct exposure to sunlight at dawn and at dusk.
In open-sided houses, to reduce light intensity and minimize the risk of pecking behavior, shading can be achieved by:
- Painting the windows
- Avoiding reflective ceilings
- Using netting wind-barriers to prevent penetration of sunlight at sunrise and sunset
- Using sliding shutters which allow control of the brightness inside the building during some seasons

It is not recommended to move birds from a naturally lit rearing house to a dark laying house as this will slow down the sexual development of the birds and could cause a delay in the onset of lay.

Age and / or Bodyweight	Duration of light at 16 weeks (hours)				
	10	11	12	13	≥14
Decreasing daylengths					
After 49 days	10	natural light	natural light	natural light	natural light
At bodyweight reference Bwt ref	12	13	14	15	16
At Bwt ref(*) + 1 week	13	14	14.30	15.30	16.30
At Bwt ref + 2 weeks	13.30	14.30	15	16	16.30
Increasing daylengths					
After 49 days	10	11	12	13	14
At bodyweight reference (Bwt ref)	11	12	13	14	15
At Bwt ref + 1week	12	13	14	14.30	15.30
At Bwt ref + 2 weeks	13	14	14.30	15	16
Afterward	+½ hour per week in order to reach 15 to 16.30 hours of light at 50% production				

*Bwt ref: bodyweight reference must be fixed according to country and egg size or grading requirement

Midnight lighting
Where local regulations permit it, midnight lighting (1hr 30min to 2hr in the middle of the dark period with the feeders running) is often used to encourage feed intake and growth at the beginning of production. If necessary, it can be introduced after transfer and then be gradually withdrawn, when birds reach their adult body weight.

Midnight lighting is also useful during the hot season, to reduce the negative impact of high temperatures, by allowing the birds to eat during the cooler hours of the night. It can be used during the rearing phase to promote growth, but caution should be taken when introduced between 10 to 16 weeks of age, as it could interfere with sexual maturity.
However, this is a very efficient management tool especially at the onset of lay.

In addition to this, midnight lighting helps to maintain a better eggshell quality by allowing the birds to ingest calcium at the end of shell formation. This has a beneficial impact on shell quality and hence on hatchability.

The regular lighting program (time of "lights-on" and "lights-off") should not be changed when the mid night light is added. Midnight lighting may be used throughout the flock's life if necessary, but it can be also removed if not needed (body weight target achieved, hot period is over etc.). When midnight light is withdrawn, the reduction should be gradual, in short steps, at a maximum rate of 30 minutes per week, to avoid a negative impact on daily feed intake.

7.9 Ventilation

An important priority is the provision of fresh air. If the air inside the poultry house is stuffy, humid, smelly or laden with dust, then the rate of air change is too low. The minimum air exchange rate is 0.7m³ / hour / kg live bird. A free-range house maybe ventilated automatically, naturally, or by a combination of both systems. Besides supplying fresh air to the poultry house, the following points must be taken into consideration:

- Removal of excess moisture helps to maintain a good litter quality and healthy birds.
- Removal of dust from the environment helps to prevent disease. There is a strong association between dust particles and disease, as disease organisms tend to bind to dust particles.
- Maintain a sufficient oxygen supply
- Removal of gasses such as ammonia. In addition to the specific problem of 'ammonia blindness', these gasses have a generally stressful and depressive effect on the birds.

7.10 Air Circulation

When rate of air change is low, it is important that air is circulated within the house for the following reasons:

- Fresh air should be distributed to all parts of the house
- If the warm air from higher levels in the building is mixed with lower levels air, the birds will enjoy a more balanced temperature.
- Mixing air allows greater removal of moisture from the litter: keeping the litter dry.
- During hot weather, air moving over the birds improves their comfort helping to mitigate the effect of temperature being above the optimum.
- Avoid direct drafts on the birds

There are different ways to make air circulate within the house, one of the least expensive is to purchase stir fans.

Poor air quality affects not only the birds' environment but also affects the birds' respiratory system, which can have a negative impact on the birds' health: reducing productivity and increasing mortality.

Air Quality Levels

Traits	Recommended level
Ammonia (NH^3)	20 ppm max
Carbon dioxide (CO^2)	2500 ppm max

Frequent problems associated with improper ventilation

Poor	Excessive	Uneven
E. coli	E. coli	E. coli
Respiratory diseases	Respiratory diseases	Respiratory diseases
Feed intake	Feed intake	Feed intake
Poor internal and external egg quality	Nervousness	Nervousness
Poor production		Poor production

8 Beak Treatment

8 Beak treatment

8.1 Introduction

This treatment is normally carried out to prevent feather pecking and cannibalism. Poor beak treatment often leads to unevenness and, in some birds, causes difficulties with feeding and drinking. Well treated birds hardly suffer and future suffering due to pecking behavior can be prevented. In addition to technical recommendations any codes and local regulations concerned with animal welfare should always be followed.

Different methods for beak treatment are used, for example cauterization by hot blade or infra-red treatment. The infra-red treatment is the preferred method as this will have the lowest negative impact on the wellbeing of the chicks and their development. Cauterization by hot blade is a delicate operation, which should only be performed by specially trained personnel. Beak treatment by hot blade is a stressful operation: it is not recommended to beak treat birds if the flock is not in good health or if it is suffering from vaccine reactions. In the rearing house, adding vitamin K to the drinking water 48 hours prior to beak treatment is helpful to prevent hemorrhages.

The decision about the age at which beak treatment takes place depends mostly on the housing system and local regulations:

- Always check the latest local regulation on approved beak treatment practices
- In dark houses, when the intensity of the light is low, beaks should be treated at one day old or at 7-10 days.
- For production in open-sided houses, where there is exposure to high natural light intensity, one single beak treatment at one day old or a light tipping at 10 days may not prevent pecking completely. If done too severely at that age, it will lead to a reduction in growth rate and uniformity. Under these conditions, beak treatment could be carried out twice - a light tipping at 10 days and then a second operation between 8 and 10 weeks of age, where local regulations allow it.

8.2 Beak treatment at one day old

The preferred method used for beak treatment at one-day old is the infrared beak treatment system (IRBT) in the hatchery. It is a convenient system with low costs and, depending on housing conditions, it may not be necessary to carry out a second beak treatment.

As the beak of a chick treated at one-day old is still sensitive, it is very important to use sideways activated nipples (360°) or nipple drinkers with cups and supplementary starting mini drinkers for the first few days, to ensure an easy access to drinking water in the rearing farm. Lowering the pressure in the nipples will also make it easier for the chicks to drink. The infrared treated part of the beak will fall off within 10 and 24 days of age.

Infrared beak treated day-old chick

Infrared beak treated chick at 3 weeks of age

8.3 Beak treatment at approximately 10 days

Early precision beak treatment at 7 – 10 days, when carried out properly, will have a minor effect on bodyweight development. In open-sided houses, where a second beak treatment at later age is scheduled and when local animal welfare regulations allow it, the early beak treatment should be performed less severely.

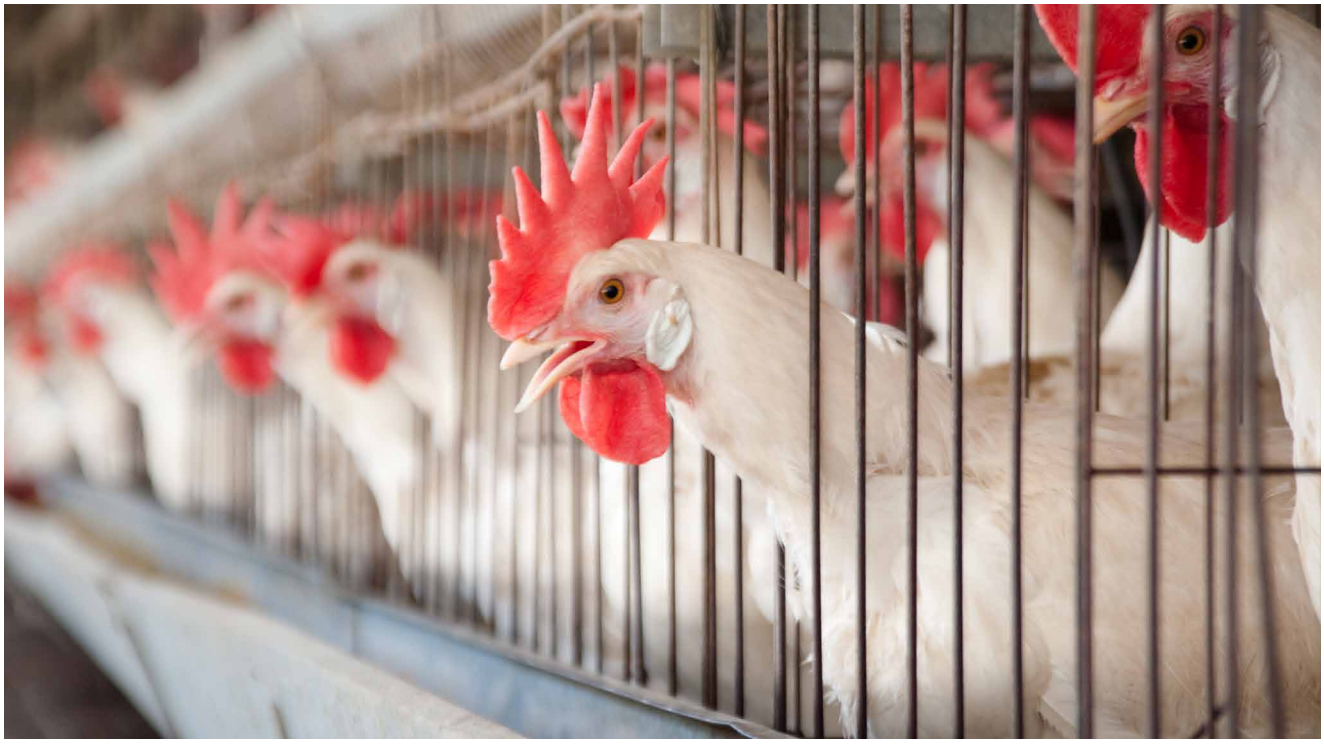
Method:
- Carefully choose the correct diameter hole on the beak treatment machine.
- Hold the chick in one hand, with the thumb behind the head, holding the head firmly in position resting the beak on the forefinger.
- Tilt the chick's beak upwards at an angle of 15° above horizontal and cauterize the reinforced side edges of the beak, to avoid unequal re-growth of the 2 mandibles.
- Cauterization contact time should be between 2 and 2.5 seconds.
- Check the temperature of the blade (600 - 650°C) for each operator and machine, every hour.

Attention points

Before beak treatment:
- Do not beak treat birds if the flock is not in good health or if it is suffering from vaccine reactions.
- Add vitamin K to the drinking water 48 hours prior to treatment and afterwards to prevent hemorrhages.
- Check the equipment and make sure that the trimming blade is at the right temperature to cauterize but not too high to form a blister on the beak later. If the temperature is too low, bleeding can occur.

During beak treatment:
- The operator should be seated comfortably so that each beak is cut in the same manner.
- Do not rush the process. Going too quickly (number of birds/minute) could lead to a higher chance of errors and poor uniformity.
- Change blades when required.
- Make sure the birds' tongues do not get burned.

After beak treatment:
- Increase the water level in the drinkers and lower the pressure in the pipes
- Avoid the feeders from becoming empty for one week
- Use sideways activated nipples (360°) or nipple drinkers with cups
- Use supplementary mini drinkers in the rearing farm for the first few days



Beak treatment can minimize the damage in case of pecking, but this behavior is usually a combination of multiple stressing factors: knowing these factors and careful observation of the birds will help to an early detection of the problem and to install corrective actions.

Possible causes of pecking are:

- Parasitic infection: external (red mites, lice) or worm infestation
- Enteritis and diarrhea
- Inadequate ventilation: excess of humidity, dust or ammonia. Drafts.
- Overcrowding: non respect of density and equipment (feeder space, drinkers) specifications
- Shortage of water or feed
- Nutritional problems: deficiencies (sodium, amino acids), lack of insoluble fiber, sudden changes in feed ingredients or feed particle size, excessive energy level
- Light intensity: too bright light source, entry of direct sunlight into the poultry house, flickering bulbs

9 Nutrition

9 Nutrition

9.1 Feeding during the rearing period

Basic feeding principles for chicks
- Do not change the feed if birds do not reach the standard body weight.
- Promote early growth, skeleton and organ development by providing feed in crumble form for starter diet for at least 4 weeks, and if necessary to reach standard bodyweight up to 5 or 6 weeks of age.
- Use a uniform and good coarse mash feed for grower, developer and pre-lay feed.
- Promote the development of the digestive tract and the birds' feed intake capacity by feeding management (fiber and coarse calcium).

During the first few weeks of life, it is advised to provide young pullets the feed in a crumb form, so they can increase their feed intake and have a more homogenous feed intake. When available (2mm) micro-pellets specially producted for young chicks until 7 - 10 days of age are also good alternative. During the period 10 - 17 weeks, under-consumption is often the result of a poor particle size. It is important to develop the digestive system by using diets at the end of rearing with an energy concentration lower than or equal to that of the first layer phase diet.

Protein requirement

The amino acid requirements are to a large extent dependent on the feed conversion ratio and, therefore on age. Any delay in growth during the first few weeks will be reflected in a reduced bodyweight at 17 weeks and in later performance. It is, therefore, important to use a starter diet for the first 4 or 5 weeks, which has a high energy and protein content. Any amino acid deficiency will result in a reduction in growth rate and an increase in the FCR. In hot climates, the amino acids and minerals concentrations should be slightly higher than in temperate climates.

Energy requirement

Depending on the energy consentration, housing system, the temperature and the birds' feathering, feed consumption can be increased by 3 to 20%. If the energy requirement is increasing, amino acid requirement should be decreased or the energy concentration should be increased accordingly.

Feed presentation

Feed consumption is determined to a large extent by the form of feed presentation and the stage to which the digestive tract has developed. Presenting starter feed in crumb form makes it easier for the chicken to eat it, makes the feed intake more homogenous as all particles should be equal, reduces the time taken in eating, and encourages growth. This benefit of feeding crumbs will only be obtained when the birds have access to good quality crumbs in the feeders. A poor-quality crumb can lead to a build-up of fine particles in the feeders and, therefore have the opposite effect. We recommend using a mash diet from 5 weeks, to avoid the risk of under- consumption at the beginning of the sexual maturity, if the change is made later.

Development of the digestive system

A larger crop and more developed gizzard will increase the feed intake capacity of the bird. Gastrointestinal development can be stimulated in the second part of the rearing period by providing coarse particles in the feed. This can be done by including coarse insoluble fibers or larger particles of slowly soluble limestone. If a high fiber diet is difficult to achieve lignocellulose can be used, which provides the correct form of fiber in powder form. Limestone granules can be provided from 10 weeks of age onwards. From this age 50% of the calcium can be supplied as coarse, slow soluble, calcium carbonate with a particle size of 2 to 4mm.

Pre-lay feed

Medullary bone is developed in long bone before the first ovulation. The total calcium contained in this medullary is around 1.5 to 2 grams. A pre-layer feed with a higher calcium level compared to a developer feed is needed to establish this bone reserve. Furthermore, it is a transition diet to increase the calcium level between the developer and layer diet more gradually. It must be used from approximately 10-14 days before the first egg till 2% production. Its characteristics are similar to the layer 1, but with a level of calcium of 2–2.2%.

A prelay diet will facilitate feed consumption after transfer. Layer diets contain high amounts of coarse calcium carbonate particles and therefore differs strongly compared to the rearing diets. The prelay diet minimizes the negative transition effect and increased layer feed palatability.

Feed specifications during the rearing period

These requirements are based on the "European Amino Acids Table" (WPSA, 1992) of raw materials composition and expressed as apparent feacal digestible amino acids by using the digestibility coefficients mentioned in the "Tables de composition et de valeur nutritive des matières premières destinées aux animaux d'élevage" (INRA editions 2002).

Amino acid and nutrient requirements for rearing at all ages

Between 18 & 24°C	Diet Units	Starter 0-4 weeks	Grower 4 - 10 weeks	Pullet 10 - 16 weeks	Pre-lay 112 days to
		1 - 28 days	28 - 70 days	70 - 112 days	2% lay
Metabolizable energy	Kcal/kg	2950-2975	2850-2875	2725-2750	2750
	MJ/kg	12.3-12.4	11.9-12.0	11.4-11.5	11.5
Crude protein	%	20.5	19	16	16.8
Methionine	%	0.52	0.45	0.35	0.40
Methionine + Cystine	%	0.86	0.76	0.62	0.67
Lysine	%	1.16	0.98	0.76	0.80
Threonine	%	0.78	0.66	0.52	0.56
Tryptophan	%	0.21	0.19	0.178	0.18
Digestible amino acids					
Dig. Methionine	%	0.48	0.41	0.32	0.38
Dig. Meth. + Cystine	%	0.78	0.66	0.55	0.60
Dig. Lysine	%	1.00	0.85	0.66	0.71
Dig. Threonine.	%	0.67	0.57	0.45	0.48
Dig. Tryptophan	%	0.19	0.17	0.15	0.16
Major minerals					
Calcium	%	1.05 - 1.10	0.90 - 1.10	0.90 - 1.10	2.00 - 2.10 [1]
Available Phosphorus	%	0.48	0.42	0.39	0.42
Chlorine minimum	%	0.15	0.15	0.15	0.15
Sodium minimum	%	0.7	0.6	0.6	0.6

[1] it is recommended to provide 50% of the calcium in granular form with a diameter between 2 and 4mm.

Above 24°C	Diet Units	Starter 0-5 weeks	Grower 5 - 10 weeks	Pullet 10 - 16 weeks	Pre-lay 112 days to
		1 - 35 days	35 - 70 days	70 - 112 days	2% lay
Metabolizable energy	Kcal/kg	2950-2975	2850-2875	2750	2750
	MJ/kg	12.3-12.4	11.9-12.0	11.5	11.5
Crude protein	%	20.5	20.0	16.8	17.5
Methionine	%	0.52	0.47	0.37	0.42
Methionine + Cystine	%	0.86	0.80	0.65	0.70
Lysine	%	1.16	1.03	0.80	0.84
Threonine	%	0.78	0.69	0.55	0.59
Tryptophan	%	0.22	0.21	0.18	0.19
Digestible amino acids					
Dig. Methionine	%	0.48	0.43	0.32	0.40
Dig. Meth. + Cystine	%	0.78	0.69	0.56	0.63
Dig. Lysine	%	1.00	0.89	0.67	0.74
Dig. Threonine.	%	0.67	0.61	0.47	0.50
Dig. Tryptophan	%	0.20	0.18	0.15	0.16
Major minerals					
Calcium	%	1.05 - 1.10	0.95 - 1.10	0.95 - 1.10	2.10 - 2.20 [1]
Available Phosphorus	%	0.48	0.44	0.40	0.44
Chlorine minimum	%	0.16	0.16	0.16	0.16
Sodium minimum	%	0.17	0.17	0.17	0.17

[1] it is recommended to provide 50% of the calcium in granular form with a diameter between 2 and 4mm.

9.2 Feeding program during the production period

Feeding management

Feeding management during production should follow several simple rules:

- Preferably the birds should eat a greater part of their daily ration (60%) during the second half of the day. The fast accumulation of calcium in the eggshell starts at this time and the birds can effectively utilize the calcium from the feed to form a good eggshell. The amount of feed distributed must be sufficient to cover the increased consumption during the next morning
- Birds are very sensitive to feed presentation and the introduction of new raw materials. For this reason, we recommend a limited number of feed changes and a stepwise introduction of unknown or new harvested raw materials.
- Amino acid requirements depend of the productivity of the flocks and the uniformity of productivity. Our amino acid recommendations are based on an average productivity of 59.5g egg mass per day. At 50 weeks, the daily egg mass produced is around 58g. Many birds are able to produce more than 60g of egg mass over a period of 50 – 65 weeks. Therefore, we recommend changing to a next feed phase if daily egg mass is decreasing.

The amount of feed distributed must be sufficient to cover the increased consumption during the next morning: the birds will be hungry after the night period and will easily finish the less attractive fine particles. As the feed is not distributed in the early morning, the hens have time to lay the eggs without being disturbed by a new feeding round. The feeding system may stay empty for one or two hours. This will create enough appetite in the birds to start the intensive feed consumption in the afternoon when you want the birds to eat the most.

Layer 1

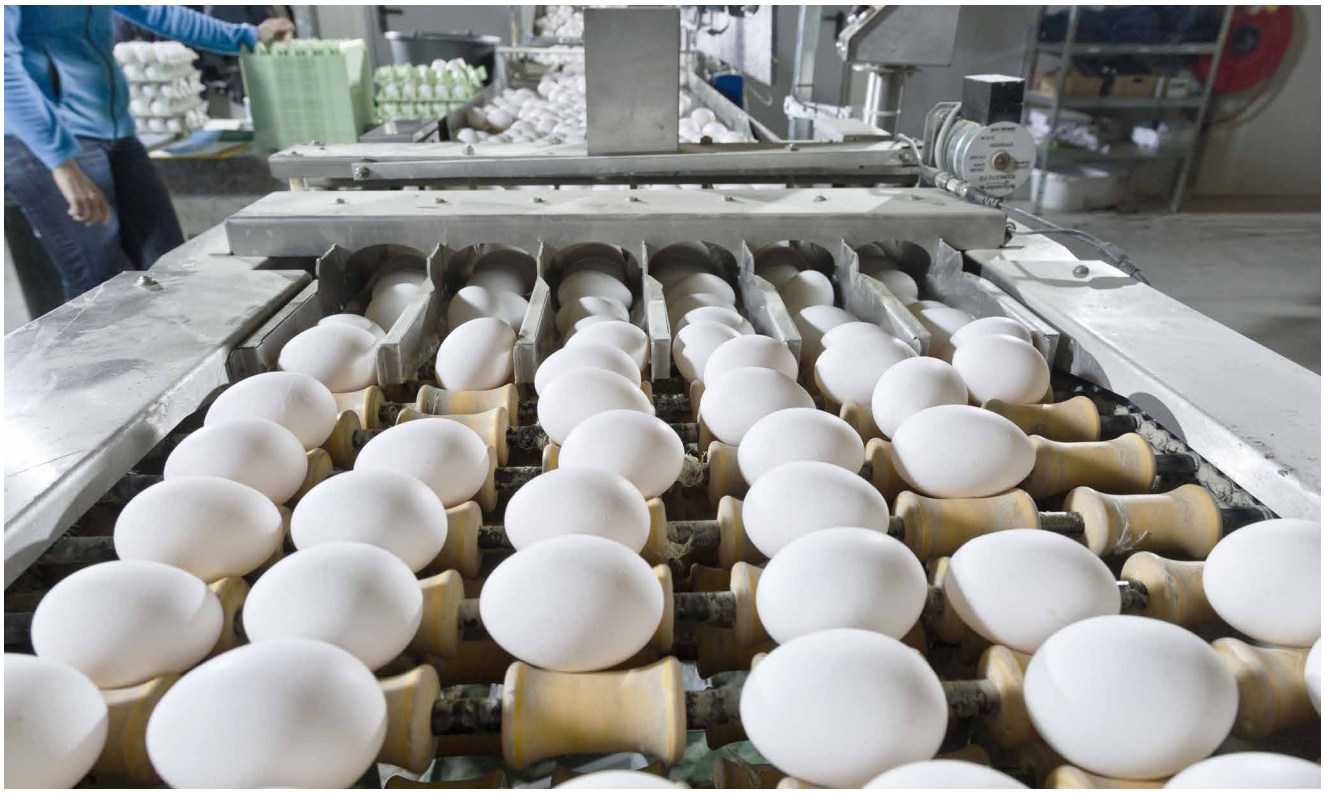
At the start of lay feed consumption is lower because feed intake capacity is still limited due to an underdeveloped crop and gizzard, while growth is not completely finished by 28 weeks of age. This feed must be used until the moment that the feed consumption is normal with the correct average egg size, or around 28 weeks.

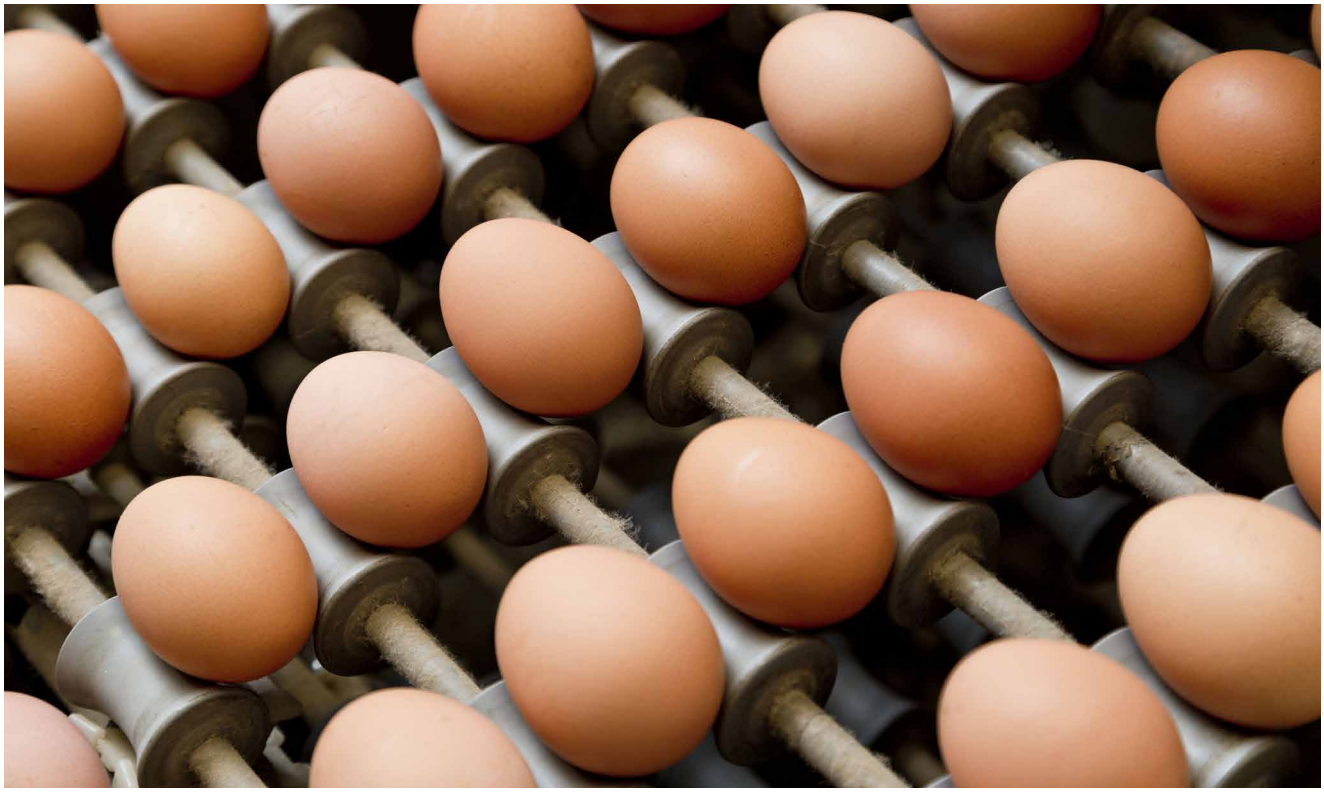
Layer 2

This feed should be used from 28 weeks, normal feed consumption or correct egg weight until the end of lay. As long as production and feed intake is high, it is recommended not to lower the amount of amino acids in order to secure laying persistency.

Shell quality

Shell weight increases while the absorption rate decreases with age throughout lay. For that reason, we advise increasing the calcium concentration in the diet from 50 weeks of age.





Effect granulometry

Feed consumption is highly dependent upon granulometry. Chickens have a marked preference for coarse particles as they are natural grain eaters. During lay we recommend the following particle sizes:

- Particles below 0.5 mm: 10 % maximum
- Particles above 3.2 mm: 10 % maximum
- At least 80% of the particles should be between 0.5 and 3.2 mm

Genetic progress and nutritional consequences

Genetic progress has a considerable influence on dietary amino acid concentrations. Over the last 50 years, measured at a consistent age, production has increased by more than 40%, while feed consumption has been reduced by about 10%. Therefore, the daily amino acid requirements need to be adjusted according to the daily egg mass and to the feed consumption.

Conclusion

The feed density (g/liter) seems to be the limiting factor in ingestion regulation. The use of insoluble fiber increases gizzard size, it improves nutrient digestibility and limits feather pecking by reducing the need to ingest feathers. The feed presentation influences feed consumption and consequently nutrient consumption.

It follows that 3 factors must be controlled and a balance between these 3 criteria must be sought in order to realize the full genetic potential at the lowest cost. The factors are:

1. the physical form of the feed
2. the insoluble fiber contents
3. the nutrient density

9.3 Feed formulation

Nutrient Recommendations

The amino acid concentration of the diets depends on:
1. The potential of egg mass produced, which determines the daily requirements.
2. The daily feed consumption which determines the amino acid concentration.

From a practical point of view, we estimate that it is necessary to increase the concentration of amino acids by about 6% during the 18-28 weeks period depending on the feed consumption observed after 28 weeks. Total or digestible amino acids levels are established for a production of 59.5g egg mass per day.

Amino acid and nutrient requirements for layers at all ages

Recommended energy: 2750 - 2900kcal / kg	From 2% lay to 28 weeks old (1)				
Average feed intake in g/day	**95**	**100**	**105**	**110**	**115**
Crude protein %	19.2-19.7	18.7-19.2	18.2-18.7	17.7-18.2	17.2-17.6
Total amino acids %					
Lysine	1,01	0,96	0,91	0,87	0,83
Methionine	0,50	0,48	0,46	0,44	0,42
Methionine + Cystine	0,85	0,81	0,77	0,74	0,71
Tryptophan	0,23	0,22	0,21	0,20	0,19
Threonine	0,73	0,69	0,66	0,63	0,6
Isoleucine	0,88	0,84	0,80	0,77	0,73
Valine	0,95	0,90	0,86	0,82	0,79
Digestible amino acids %					
Lysine	0,90	0,85	0,81	0,78	0,74
Methionine	0,48	0,46	0,44	0,42	0,4
Methionine + Cystine	0,81	0,77	0,73	0,66	0,64
Tryptophan	0,20	0,19	0,18	0,17	0,16
Threonine	0,63	0,60	0,57	0,54	0,52
Isoleucine	0,81	0,77	0,73	0,7	0,67
Valine	0,86	0,82	0,78	0,75	0,71

Recommended energy: 2700-2850 kcal / kg Average feed intake in g/day	From 28 weeks to the end of lay				
Crude protein %	(17.9-18.4)	(17.4-17.9)	(16.9-17.4)	(16.4-16.9)	(15.9-16.4)
Total amino acids %					
Lysine	0,91	0,86	0,82	0,79	0,75
Methionine	0,46	0,44	0,42	0,40	0,38
Methionine + Cystine	0,77	0,73	0,70	0,63	0,64
Tryptophan	0,21	0,20	0,19	0,18	0,17
Threonine	0,65	0,62	0,60	0,57	0,55
Isoleucine	0,80	0,76	0,72	0,69	0,66
Valine	0,85	0,81	0,78	0,74	0,71
Digestible amino acids %					
Lysine	0,81	0,77	0,73	0,70	0,67
Methionine	0,42	0,41	0,40	0,38	0,36
Methionine + Cystine	0,70	0,66	0,63	0,60	0,55
Tryptophan	0,18	0,17	0,16	0,16	0,15
Threonine	0,56	0,53	0,51	0,49	0,47
Isoleucine	0,72	0,69	0,66	0,63	0,61
Valine	0,78	0,74	0,70	0,67	0,65

The above requirements are based on the "European Amino Acids Table" (WPSA, 1992) of raw materials composition and expressed as apparent feacel digestible amino acids by using the digestibility coefficients mentioned in the "Tables de composition et de valeur nutritive des matières premières destinées aux animaux d'élevage" (INRA editions 2002).

Calcium nutrition and particle size

Nowadays, the time taken to produce the egg is close to 24 hours which enables us to achieve very high rates of production with eggs being laid early in the morning. Calcification of the eggshell takes about 12 hours, being completed on average 2h – 2h 30 minutes before oviposition. Eggshell quality depends to a large extent on the quantity of calcium absorbed in the digestive tract during the night, which is influenced the time, form and solubility in which calcium carbonate is supplied.

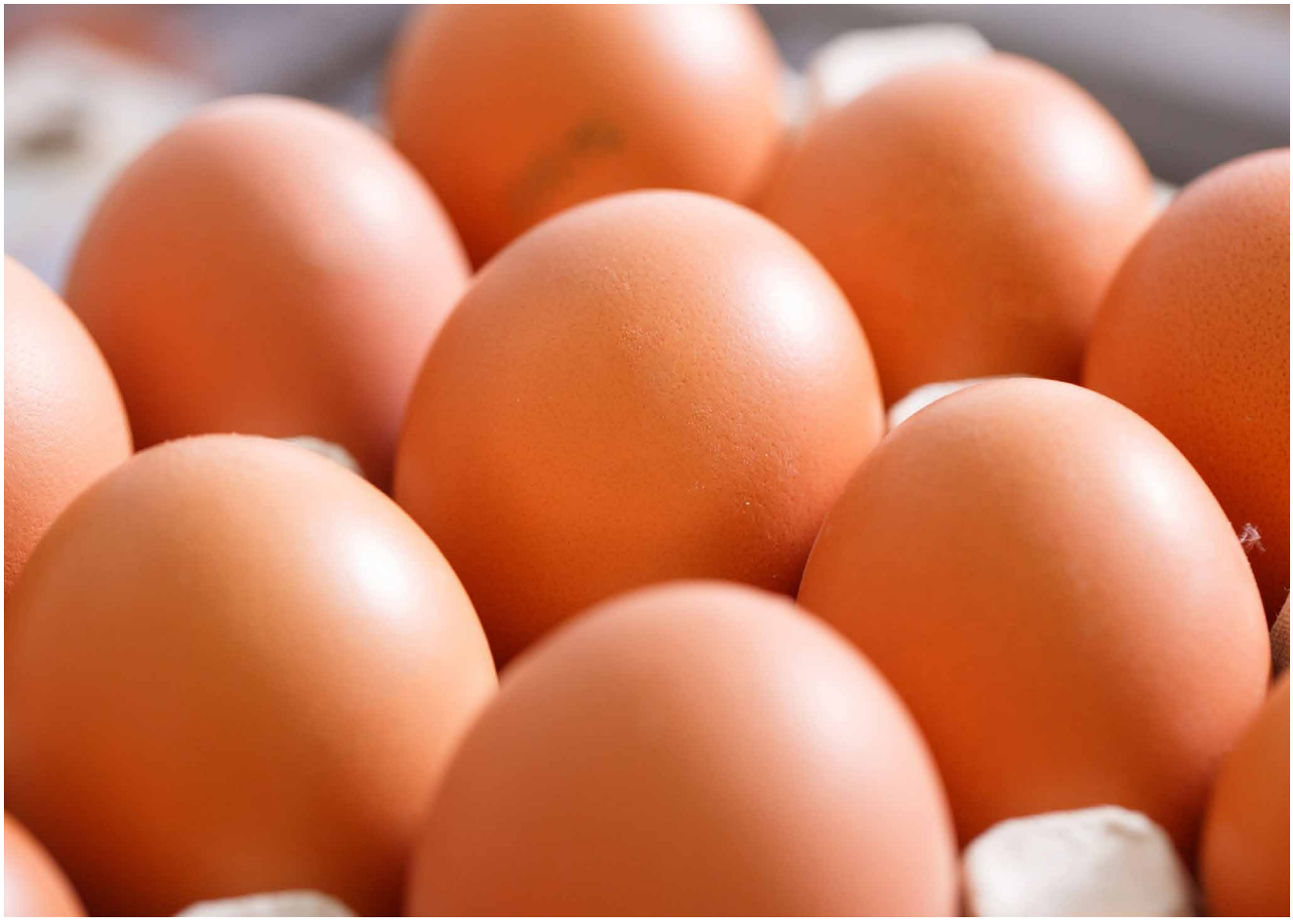
There is a difference between brown and white birds in the moment when calcium deposition for eggshell formation takes place. A high percentage of brown birds stop calcification at "lights on" or just after, while white layers finished their shell after "lights on". Therefore, we recommend using 70% coarse limestone for brown-egg layers and 50% coarse limestone for white-egg layers.

Calcium absorption

Regular gizzard contractions deliver calcium through the intestine. The availability of calcium via the feed at the end of the night period is improved by using a coarse calcium source with a low solubility. When the quantity of absorbable calcium is insufficient, bone reserves are used. Birds which are forced to use their bone reserves produce eggs of poorer shell quality. Furthermore, this can be a risk in bone quality for birds housed in cages. Calcium deposition is slow during the first 5 hours after it enters into the shell gland. After that and for approximately 10 hours, the rate of shell deposition is rapid and linear. Calcium absorption varies from approximately 30% to over 80% between periods without calcification and the period of shell formation. For this reason, all increases in the quantity of calcium available at the end of the night lead to an improvement in shell quality.

Recommendations absorption

White layers finish their shells after "lights on", consequently 50% of the calcium must be in particles of 2 to 4mm and 50% in a powder form. Around 40% of brown layers have finished their eggshell at "lights on", consequently 70% of the calcium must be in particles of 2 to 4 mm and 30% in a powder form.



Mineral and oil level recommendations

Nutrient requirement in percentage depends on feed intake after 28 weeks of age.

Average feed intake observed		From 2% lay to 28 weeks				
After 28 weeks in g/day		**100**	**105**	**110**	**115**	**120**
Available phosphorus (1)	%	0,43	0,41	0,39	0,37	0,35
Available phosphorus (2)	%	0,47	0,45	0,43	0,41	0,39
Total calcium	%	4.0 - 4.2	3.9 - 4.1	3.8 – 4.0	3.6 - 3.8	3.4 – 3.6
Sodium minimum	%	0,18	0,18	0,17	0,16	0,16
Chlorine mini-maxi	%	0.17 - 0.26	0.17 - 0.26	0.16 - 0.25	0.16 - 0.24	0.15 - 0.23
		From 28 weeks to 50 weeks				
Available phosphorus (1)	%	0,38	0,36	0,34	0,33	0,32
Available phosphorus (2)	%	0,42	0,4	0,38	0,37	0,35
Total calcium	%	4.0 - 4.2	3.9 - 4.1	3.7 - 3.9	3.6 - 3.8	3.4 - 3.6
Sodium minimum	%	0,17	0,17	0,16	0,16	0,15
Chlorine mini-maxi	%	0.16 - 0.25	0.16 - 0.25	0.16 - 0.24	0.15 - 0.23	0.14 - 0.22
		From 50 weeks to the end of lay				
Available phosphorus (1)	%	0,33	0,32	0,3	0,29	0,28
Available phosphorus (2)	%	0,38	0,36	0,34	0,33	0,32
Total calcium	%	4.2 - 4.4.	4.1 – 4.3	3.9 – 4.1	3.8 – 4.0	3.6 – 3.8
Sodium minimum	%	0,17	0,17	0,16	0,16	0,15
Chlorine mini-maxi	%	0.16 - 2.5	0.16 - 0.25	0.16 - 0.24	0.15 - 0.23	0.14 - 0.22

[1] When coarse limestone is supplied as particles of 2 to 4mm, it is possible to use these values.
[2] We advise using these values when the calcium is supplied in powder form.
Adding vegetable oils which are rich in unsaturated fatty acids increases egg weight. The suggested inclusion rate for medium to large sized eggs is 2

Importance of the feed particle size
Mixing difficulties, inappropriate particle size and separation problems have been resolved by milling the raw materials relatively fine. However, diets, which are too finely ground, often seriously reduce feed intake. Low consumption has been avoided by using diets presented as crumbs or pellets. In effect, the ease of eating and the reduction in feeding time, due to pelleting, leads to an increase in the number of feeds taken by the birds and in their growth. Please note that birds are grain eaters and their feed consumption depend on feed presentation.

Pelleted or crumbled diets

In theory, presenting a diet in crumb or pellet form will result in higher feed consumption. That presupposes that the feeding systems in operation and the raw materials used are providing the laying hen with a good quality pellet or crumb.

Apart from the increased costs of manufacturing, very often, the difficulties in obtaining a good quality crumb are responsible for under-consumption and some technical problems because of:

- the breaking down of the crumb in the feed distribution system
- the build-up of fine feed particles in the feeders
- more shell quality problems related to the difficulties in using a granular limestone
- more feather pecking due to a shorter feeding time and a lack of structure

To develop a good digestive system, it is necessary to have coarsely milled feed. With the intention of keeping good shell quality we suggest:

- use granular limestone if the diameter of the diet is adapted
- add some of the limestone after grinding
- distribute 3 to 4g per bird of granular limestone (2 to 4mm) in the poultry house each afternoon.

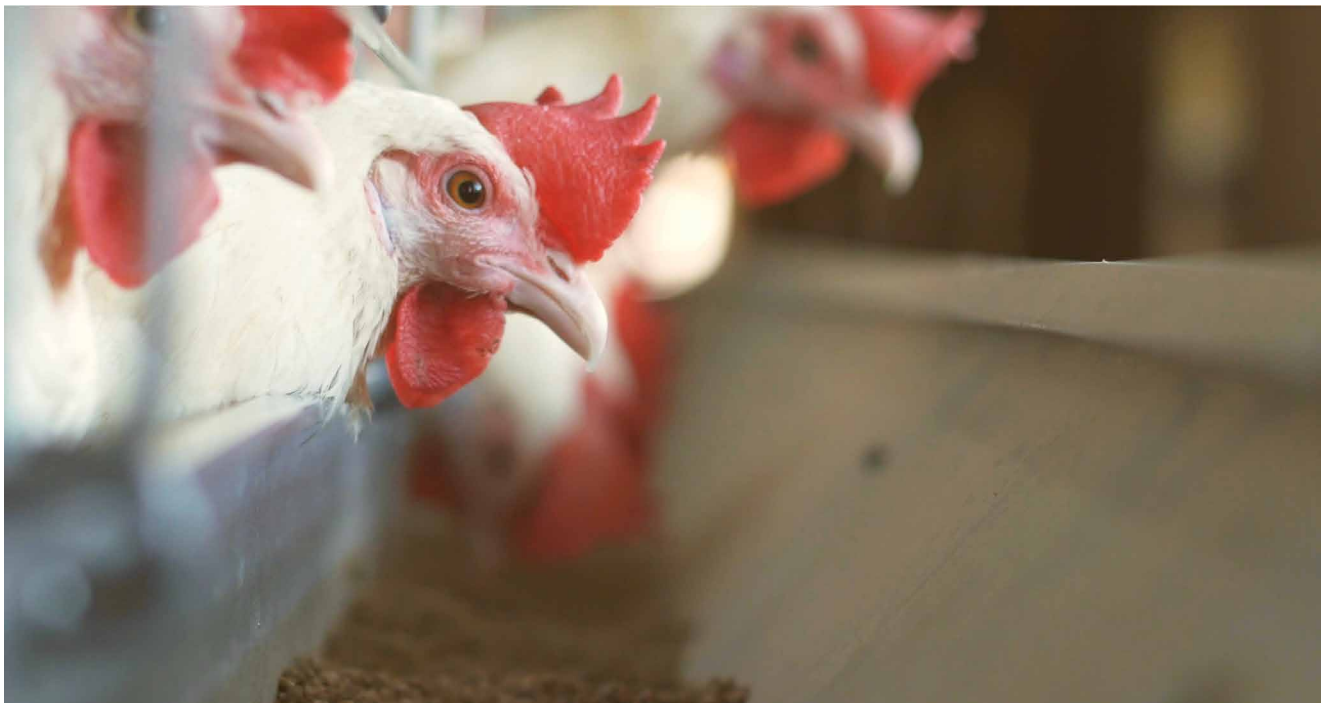
Mash diet good texture

During rearing, except for the first 5 weeks, when the diet should be crumbs, a good particle size will allow good growth and the development of a robust digestive system. During the laying period, a good textured diet will allow the birds to increase their feed consumption, their production and their growth. In hot climates, a good textured feed can reduce the under-consumption experienced in summer. This type of diet is in fact easier and cheaper to produce, because there is only a need for grinding and mixing.

Particle size distribution

Maximum Particle sizes less than 0.5mm:	10%
Maximum Particle sizes above 3.2mm:	10%

These recommendations also apply to the rearing diets after the age of 5 weeks. The attractiveness of the diet improves markedly if the fine particles are sticking together. That can be achieved by the addition of 1.5 to 2.5% vegetable oil.



Feed distribution

When birds are not eating enough the classic response is to increase the number of feed distributions. However, this practice encourages selective eating and does not solve the feed intake problem. To avoid selection, the feeder needs to be empty once a day from week 5 onwards and once a week before 5 weeks of age. It is recommended to have empty feeders by the beginning of the afternoon. Too early feed distribution during the laying period increases dirty eggs. For eggshell quality reasons and in line with the natural behavioral pattern, a minimum of 60% of the feed needs to be distributed in the afternoon. The feed program needs to be adapted depending on the observation on the flock, and the type of feed distribution equipment.

The impact of light and temperature
Just after transfer, the light intensity needs to be high. This encourages hens to discover their new environment (location of the drinkers and feeders). Light intensity will also stimulate the feed consumption. Dimming the lights can serve as a tool to reduce feed consumption. When local legislation allows it, a maximum of two hours of light (night flash) could be given to the hens 3 hours after the lights are turned off. During the night flash, one distribution of feed is provided. This technique can be very useful during hot seasons to encourage the birds to eat enough feed and to prevent them consuming less nutrients than they require at that moment. Reducing the temperature by 1 or 2 °C can also be used as a tool to stimulate the birds' feed consumption.

Fiber

Birds have a specific requirement for fiber during egg production. It has been shown that birds that are deficient in fiber ingest feathers as a fiber source. A good supply of fiber improves feathering, decreases mortality, and improves both gut health and digestion, which will result in drier manure. Characteristics of good fiber sources for layers are insoluble fiber of a coarse structure. Cellulose, hemicellulose and especially lignin are classified as insoluble fiber. These fibers are not digested or fermented in the gastrointestinal tract, and therefore serve as filling material that stimulate gastrointestinal movements without increasing the viscosity of the intestinal content. If fiber particles are small (finely ground), the effect on gastrointestinal movements is minimal therefore coarse fiber is recommended. For cage birds, 2.5% of crude fiber is sufficient, but higher levels, up to 4.5% crude fiber (insoluble fiber, like oat hulls) can improve results in terms of production parameters and livability.

Livability is positively influenced by fibers because it increases the feeling of satiety in birds, which in turn results in quieter birds, by eliminating need for feather ingestion (pecking and cannibalism). Diluting the feed helps to maintain a good energy balance in older birds and to prevent fatty livers.

Mixing

Trace elements and vitamins should be correctly mixed before being added to the raw materials. Heat treated for extra feed safety can have a negative effect on premix stability and consequently decrease nutrient availability. Therefore, the use of an increased level of vitamins with excellent stability and an additional antioxidant is highly recommended.

Suggested premix composition for birds in rearing and production.

Added trace elements	Unit	Rearing period 0 - 10 weeks	10 - 2 % lay	Laying Period
Manganese Mn)	mg	85	85	100
Zinc (Zn)	mg	80	80	80
Iron (Fe)	mg	60	60	60
Iodine (I)	mg	1	1	1
Copper (Cu)	mg	10	10	10
Selenium (Se)	mg	0.3	0.3	0.3
Added vitamins				
Vitamin A[1]	IU	13000	10000	12000
Vitamn D3[2]	IU	3250	2500	3500
Vitamin E	mg	100	75	50
Vitamin K3	mg	3	3	3
Vitamin B1 (Thianine)	mg	2.5	2.5	2.5
Vitamin B2 (Riboflavin)	mg	10	5	6.5
Vitamin B6 (Pyridoxine)	mg	5	5	5
Vitamin B12	mg	0.03	0.02	0.03
Nicotinic Acid (Niacin)	mg	60	30	40
Pantothenic acid	mg	15	10	10
Folic Acid	mg	1	1	1
Biotin	mg	0.2	0.2	0.2
Choline	mg	1000	500	1000

[1] Vitamin A: Legal limits needs to be observed: chickens up to 14 days max. 20.000 IU/kg feed (DM 88%) and chickens older than 14 days max. 10.000 IU/kg feed (DM 88%). Reference regulations (EU) 2015/724

[2] Vitamin D3: legal limits needs to be observed: chickens max 3.200 IU/kg feed(DM 88%). Reference (EU) 2019/849

Toxicity of some minerals

Maximum admissible levels for different minerals can be estimated as follows:

Added vitamins per kg of feed	Standard feed[1]
Potassium	2000 ppm
SODIUM	5000 ppm
Iron	500 ppm
Zinc	2000 ppm
Selenium	10 ppm
Vanadium	10 ppm (due to contamination from rock phosphates)
Magnesium	5000 ppm
Chlorine	5000 ppm
Manganese	1000 ppm
Copper	300-500 ppm
Iodine	300-500 ppm

Mycotoxins

Mycotoxins are natural substances produced by molds and fungi, which are common in almost all farm environments. Mycotoxins can survive in many places and on many different types of feed sources. Laying hens are susceptible to mycotoxins for various reasons. The longer production cycle makes them ideal candidates for chronic mycotoxicosis. This can be further influenced by the increased use of feed by-products in layer diets, as by-products can contain up to three times more mycotoxins than grains.
Common signs of mycotoxicosis in poultry include:

- Reduced feed consumption
- Poor growth rates
- Reduced egg production
- Reduced feed conversion efficiency
- Increased susceptibility to diseases
- Increased mortality
- Poor eggshell quality
- Reduced fertility
- Leg problems
- Carcass condemnation

Egg size increases with the age of the flock, but management can influence egg size as well. Important points to be considered are the following:

- Bodyweight at onset of lay: average egg weight is largely determined by the pullet's weight on coming into lay. Pullets which are too heavy at the onset of lay will lay larger eggs throughout the lifetime of the flock.
- Oil content in feed: high oil levels in the diet leads to increased feed intake and a larger egg size. Consider limiting feed oil content or replacing it by saturated fats.
- Amino acids: reducing the amino acid level in the laying diet will have an impact on decreasing the egg weight but will also lead to a reduction in rate of lay. We therefore advise against any big change in amino acid levels during lay.
- Energy intake: if necessary, from 45 weeks of age, a slight reduction of about 50 Kcal in energy level could be considered to stabilize egg weight, as long as changes in feed composition do not lead to under-consumption.
- Temperature: house temperatures which are too low cause over-consumption and consequently increases egg weight and should be avoided.
- Feathering: the better the feathering, the easier to manage the egg size profiles of your birds. Birds with good feather cover are better able to control their body temperature and therefore their feed intake.

10 The care for the eggs

10 The care for the eggs

10.1 Collection of eggs

Egg belts must be always kept clean. Manure and broken eggs should be removed frequently. Egg collecting devices such as plastic trays and belts must have holes to allow organic contamination debris to fall away from the eggshell surface and to avoid contamination of other eggs. These devices should be cleaned and disinfected before use. Cardboard trays must better not be re-used (biosecurity). Prior to handling eggs, hands should be washed and then disinfected with a sanitizing solution. Hands should be sanitized frequently during egg collecting time and whenever returning from other tasks. It is advised to collect eggs at least 1 time per day. We also advise to increase this in extreme hot or cold weather.

10.2 Shell quality

Shell quality is another important external aspect when it comes to producing eggs. The shell must be smooth and free of cracks. Thin-shelled eggs tend to crack more easily, with the consequent risk of contaminating other eggs and they should not be used. At peak production, during periods of extreme temperatures, and at the end of the production period, special attention should be given to a proper balance in calcium allowances (supplementary coarse limestone or oyster shell) to ensure good shell quality.

10.3 Egg washing

Washing eggs is possible, but it is not allowed in all parts of the world. It requires a well-constructed egg-washing machine, which should be operated in the correct way to avoid adverse effects on contamination and therefor shelf-life.
Strictly follow the manufacturer's recommendations regarding water quality and temperature, choice and level of sanitizer, duration of washing, frequency of change of the washing solution, rinsing and drying conditions etc. If the requirements are not met, it can result in the contamination of eggs.

10.4 Storage of eggs

An appropriate egg storage room is required for the storage of eggs. It should be well insulated and equipped with a cooling and heating system with a humidifier to maintain a constant temperature and humidity. Room temperature between 5°C - 10°C is advised together with a humidity between 80 – 85%. Walls and roofs should be kept free of dust and floors tiled for easy cleaning and frequent fumigation. Drafts should be avoided, and mice always kept out of the egg storage room.

Storing conditions should be set in order to avoid water condensation on the shell's surface ("egg sweating"), which creates favorable conditions for microbial growth. This phenomenon occurs when stored eggs are transferred to a warmer environment and the dew point is reached. To avoid temperature fluctuations and egg sweating during transport, truck and farm egg storage room temperatures should be equal.

Eggs should always be handled with care in order to avoid mechanical shocks at loading, during transport and unloading. If an egg storage room is not available on the farm, eggs must be collected from the farms to the packing station or directly to the retailer more frequent.

Downgraded Egg Chart Brown Eggs

GOOD EGG
Normal (oval) shape with one end larger than the other and tapers towards the small end. The shell is smooth, without pimples, rough areas, wrinkles or ridges. There are no cracks, windows or flat sides.

CRACKED EGG
Shell has mild to severe cracks (hairline crack, star crack or body check), is broken or has albumen/yolk leaking.

WHITE BANDED EGG
Shell contains a white band which resultrs from two eggs coming into contact in the shell gland.

SPECKLED EGG
Small brown spots on the shell.

PIMPLED EGG
Shell has rough areas or pimples of calcified material and is not smooth. The level of roughness may range from a few pimples to a severe level, with the shell sometimes feeling like sandpaper on touch.

DIRTY EGG
Shell is not broken but has dirt or foreign material, such as faeces adhering to its surface. It has prominent, or moderate stains, which may be localized or scattered, covering about 3% to 6% respectively of the shell surface.

MISSHAPED EGG
Such an egg does not have the oval shape of a normal egg and the shell is not smooth. Such eggs include those with flat sides or body checks, and those usually too large or too small.

SLAB-SIDED EGG
The egg is flattened on one side, which is the side where it made contact with the first egg in the pouch. It is wrinkled and misshapen.

DOUBLE YOLK EGG
Such an egg has two yolks and occurs when a hen's ovaries release two yolks at once rather than one delivery. Double Yolk eggs are generally too large and elongated.

COLOUR SPECTRUM EXAMPLE EGG
There is a spectrum of acceptable and unacceptable colouring of a brown egg shell. Eggs with shells the shade of the example egg (above) or lighter should be culled. If unsure, refer to the Colour Spectrum Chart Brown Eggs.

DOWNGRADED EGG: Any egg that fails to meet the minimum standards must be removed. This chart outlines some major reasons for downgrading eggs. There are reasons other than these shown.

HENDRIX GENETICS

Downgraded Egg Chart White Eggs

GOOD EGG
Normal (oval) shape with one end larger than the other and tapers towards the small end. The shell is smooth, without pimples, rough areas, wrinkles or ridges. There are no cracks, windows or flat sides.

CRACKED EGG
Shell has mild to severe cracks (hairline crack, star crack or body check), is broken or has albumen/yolk leaking.

STAINED EGG
Shell has foreign material such as blood or faeces and stains or discolourations that are readily visible.

WRINKLED EGG
Shell has ridges or wrinkles on surface. This may range from a few tiny wrinkles to severe wrinkles that completely cover the egg.

PIMPLED EGG
Shell has rough areas or pimples of calcified material and is not smooth. The level of roughness may range from a few pimples to a severe level, with the shell sometimes feeling like sandpaper on touch.

ROUND EGG
The shape of such egg is not oval but rather appears round like a ball or sphere. The two ends are so close to the same shape it is difficult to determine which is the large end and which is the small end.

DIRTY EGG
Shell is not broken but has dirt or foreign material, such as faeces adhering to its surface. It has prominent, or moderate stains, which may be localized or scattered, covering about 3% to 6% respectively of the shell surface.

MISSHAPED EGG
Such an egg does not have the oval shape of a normal egg and the shell is not smooth. Such eggs include those with flat sides or body checks, and those usually too large or too small.

SLAB-SIDED EGG
The egg is flattened on one side, which is the side where it made contact with the first egg in the pouch. It is wrinkled and misshapen.

DOUBLE YOLK EGG
Such an egg has two yolks and occurs when a hen's ovaries release two yolks at once rather than one delivery. Double Yolk eggs are generally too large and elongated.

DOWNGRADED EGG: Any egg that fails to meet the minimum standards must be removed. This chart outlines some major reasons for downgrading eggs. There are reasons other than these shown.

HENDRIX GENETICS

11 Vaccination

11 Vaccination

11.1 Introduction

Vaccination is the process in which the animals are infected with a dead or much weakened pathogen. It is done in a controlled way to build up the defense against infections, e.g. to make the birds themselves less susceptible to poultry pathogens. Parent stock can be vaccinated to make their offspring less susceptible for disease (providing them with maternal immunity via the yolk). Poultry can be vaccinated to make them less susceptible for contamination with human pathogens, i.e. Salmonella species.

Each vaccination will produce a reaction in the birds' defense mechanism, as a result your birds will be slightly stressed or sick for a few days post vaccination. In case of improper vaccination, the birds can be in severe pain and this will severely hinder the birds' development.

Always keep in mind that a very intensive vaccination scheme puts a lot of pressure on the birds and her development. More vaccinations do not necessarily offer more guarantees. Hindering growth in the first 5 weeks of life can have serious and negative consequences later on in life, all the way up to the production period. Always make sure there is adequate time in between repetitive vaccinations, as a repeat vaccination can severely reduce the immunity that a chicken has already built up to a particular virus for a short time, and the vaccination will not take well because of the chicks existing immunity.

Vaccination programs should always be tailor made, taking into account the following questions:

- What is the local disease situation, e.g. which diseases are present in the area?
- What is the location of the farm, what's the distance to neighboring farms and what type of birds are housed on the neighboring farms?
- Which diseases are present on the farm itself (endemic diseases)?
- Does it hold parent stock or final product?
- Is it a multi-age or a single-age farm?
- Are the chickens fit and healthy?

You must make a risk assessment:

- What is the risk of infection?
- What are the costs of infection and how do they relate to the costs of vaccination?
- What's the damage done by vaccination compared to the expected benefits of vaccination?
- Is protection needed during rearing and/or during lay and/or should the offspring be protected by vaccination?
- Should you use live or killed vaccines?
- What is the most suitable/practical route of administration of the vaccine? Take into account the principle of priming and boosting. Take into account the minimum time distance between two vaccinations targeting the same organ system.

When you vaccinate it is important to monitor the vaccine take. Was the vaccine administered at the right time, in the right way? You can monitor the endemic diseases on a farm. Which pathogens are present and what is their behavior / dynamics?

You can use regularly taken serum samples for diagnostic reasons. Can observed clinical signs be linked to a rise in antibody titer for a certain pathogen? You can monitor the specific pathogen free status of a farm, consult your local veterinarian to set up a monitoring scheme.

An individual becomes "immunized" or resistant to a specific disease after inoculation with a specific vaccine, or after exposure to a disease agent in the field. Vaccination programs should be designed to "immunize" flocks against diseases with an economic impact; and against disease agents that could potentially compromise food safety. The entire disease control program relies on sound and well-designed vaccination programs and adequate biosecurity, husbandry and nutrition. At the same time, vaccinations should be administered at times or ages when their detrimental impact is minimal, and at times when the best possible benefit can be obtained from them.

Most vaccination programs are intended to immunize chickens against diseases that affect the immune system; cause tumors in chickens; affect the respiratory, urinary or reproductive tracts; affect the nervous system; induce disease in the intestinal tract; or represent a food safety concern. Fortunately, there are vaccines and vaccination methods available to protect chickens against most of these groups of conditions. Prior to using any vaccines, ensure that their use is legal and that it will not disqualify specialty flocks because of the type of preservatives contained in the vaccines.

11.2 Types of vaccines

There are many types of vaccines available for commercial poultry. It is important to become familiar with their basic characteristics related to their potential for protection, safety, ease of administration, relative cost, reactivity, compatibility with other vaccines, etc. This is a list of some of the most important types of vaccines:

- Live virus vaccines
- Recombinant virus vaccines
- Live bacterial vaccines
- Inactivated bacterial vaccines (bacterins)
- Gene modified and deletion mutant live bacterial vaccines
- Autogenous inactivated bacterial vaccines
- Autogenous inactivated viral vaccines
- Live coccidiosis vaccines
- Live Mycoplasma vaccines
- Inactivated Mycoplasma vaccines (bacterins)
- Recombinant Mycoplasma vaccines
- Competitive exclusion products

11.3 Vaccination methods

It is important to understand the characteristics of each vaccine and to use each product according to the manufacturer's recommendations. Vaccines are designed and approved for individual or mass application methods.

Individual vaccination methods include:
- Eye-drop
- Beak dipping or intranasal
- Subcutaneous injection
- Intramuscular injection
- Transcutaneous injection (wing web)
- Vent brush application

Mass vaccination methods include:
- In ovo injection
- Drinking water vaccination
- Spray vaccination

11.3.1 Eye drop

Eye-drop vaccination is commonly used to protect chickens against respiratory viruses, Mycoplasma and occasionally against infectious bursal disease. Eye-drop vaccination is most suitable for delivery of live vaccines against diseases or agents such as (but not exclusively) Newcastle disease, infectious bronchitis, infectious laryngotracheitis, and Mycoplasma gallisepticum. Eye drop vaccination is likely the most effective and safest method for respiratory viruses. Direct contact of the vaccine with the mucosa of the eye will result in stimulation of the Harderian gland and a strong local immune response.

Despite being highly effective, eye drop vaccination is labor intensive and time consuming and thus it is usually limited to application of vaccines that must be administered via the ocular route and by no other method, such as some (but not all) live MG vaccines and live attenuated vaccines against ILT.

11.3.2 Beak dipping or Intranasal

Intranasal and beak dipping application of vaccines has the same objectives as the ocular route. Intranasal application is popular in some countries, but beak dipping is rarely used. The vaccine is administered by depositing a drop (usually 30 ul or 0.03 ml) of reconstituted vaccine directly on the eye or into the nostrils. The advantage of eye drop application is that if applied properly, every bird receives a similar dose of vaccine and is thus likely to be immunized (protected) against the disease, as opposed to mass application methods, which unavoidably result in suboptimal coverage since not every bird receives an equally immunizing dose.

Because beak dipping vaccination requires individual handling of birds, biosecurity is most important, and the vaccination crews must follow strict biosecurity procedures so as not to bring infectious diseases to the flock being vaccinated. For the beak dipping method to be successful, both nostrils must be immersed in the vaccine. This method is suitable only for chicks up to 7 days of age and is used for immunization against NDV or IBDV. It is used in areas or farms where even vaccine uptake is not possible using the drinking water or spray methods, or with the objective of minimizing vaccine reactions.

11.3.3 Subcutaneous and intramuscular injection

Injection via the intramuscular and subcutaneous routes is reserved primarily for inactivated vaccines and bacterins. The vaccination equipment should be sterile, and the needles used should be of the proper caliber and length for the age of the bird and also for the type of product being injected. The needles should be replaced with sterile needles at least every 500 injections to prevent injections with bent or blunt needles, and to avoid transmission of some diseases from infected to non-infected chickens. Most inactivated (killed) vaccines are administered at approximately 12-14 weeks of age. Should it be necessary to vaccinate younger chickens with inactivated products it should be kept in mind that handling and administration of inactivated vaccines or bacterins between 6 and 11 weeks of age might delay or alter the development of the pullets. Inactivated viral vaccines are usually available in a water-in-oil (WO) or water-in-oil-in-water (WOW) emulsion, which are typically not very reactive. Thus, such products can be injected with confidence intramuscularly or subcutaneously, provided the injection is done in the proper area and without depositing any of the vaccine product in the cavity or directly into the internal organs. Inactivated products containing Mycoplasmas and/or bacteria such as Salmonella may be quite reactive, and every effort should be made to minimize the local vaccine reactions that can be derived from the injections. For subcutaneous injections, it is especially important to avoid the thymus by injecting the vaccine in the middle line (avoiding the sides of the neck), and by not injecting too close to the head or the base of the

neck. For intramuscular injections (in the breast muscle), every effort should be made to avoid injecting the product into the abdominal cavity. Vaccinations in the thigh may contribute to reduced adverse reactions but care must be exercised to minimize injuries resulting in lameness.

11.3.4 Transcutaneous injection (wing web)

Transcutaneous (wing web) application is used almost exclusively to vaccinate chickens against poxvirus (POX). For convenience, manufacturers of vaccines have added other agents such as chicken infectious anemia virus (CAV) and avian encephalomyelitis virus (AE) to POX vaccines and thus it is possible to vaccinate pullets simultaneously against AE, POX and CAV in one injection. The latter (CAV) is only necessary in layer breeders but AE and POX are routinely used in commercial layers. In addition, there are recombinant vaccines with a poxvirus as a vector carrying genes that express proteins from ILTV. Thus, such products can also be administered by wing web application.

11.3.5 Vent brush vaccination

Vent brush vaccination was developed decades ago to protect chickens against ILTV using vaccine strains that were extremely reactive and caused vaccine induced ILT. The procedure involves dipping a rough brush into the reconstituted ILTV vaccine vial and brushing harshly the mucosa of the vent. This procedure is still used with relative success in some countries for administration of live attenuated vaccines against ILTV.

11.3.6 In ovo injection

In ovo vaccination is a mass-application procedure that is reserved for vaccination of embryos in the hatchery and is typically done at 17 to 19 days of incubation. The procedure was designed for immunization against Marek's disease virus (MDV). With the advent of recombinant vaccines, in ovo vaccination can now be used to protect chickens against diseases such as Marek's disease, fowl poxvirus, infectious laryngotracheitis, infectious bursal diseases (Gumboro) and Newcastle disease. In addition, coccidiosis vaccines are now registered and approved for in ovo administration.

11.3.7 Drinking water (oral) vaccination

Water vaccination can also be accomplished using a water pump to "inject" or "force" the vaccine into the water lines, which is a popular and very effective method of mass application using the drinking water for delivery of live vaccines. Water pump vaccination requires a closed water system (nipple drinker lines) and can be used successfully for delivery of vaccines against diseases or disease agents such as IBDV or CIAV. As with other methods involving water delivery, this one requires that the birds be thirsty prior to delivering the vaccine to them. Wherever possible, the drinker lines are raised high enough so as to prevent drinking by the birds in the 2-3 hours prior to vaccination. Water vaccination requires flushing the drinker lines with fresh water to minimize the number of unwanted residues. Commercial products can be used to clean the drinker lines thoroughly prior to vaccination. Even after the use of commercial products, it is recommended to flush the lines with clean fresh water before vaccinating the flock. This is particularly important in operations that have hard water, or in operations that have used antibacterial drugs or other products that may have formed a film in the drinker lines. Prior to vaccination, it is important to water-starve the pullets to be vaccinated so that most will consume vaccine upon its administration. Check the drinkers or nipple drinkers to ensure they are clean and operational and shut down all water sanitizing systems. Allow the birds to become thirsty by interrupting access to water. The amount of time required for the birds to become thirsty will depend on their age, environmental temperature, feed formulation, etc. The goal should be for all pullets to consume the vaccine in a matter of 60 minutes. Vaccination via the drinking water should be used in birds one week old or older because water consumption in younger pullets might be too irregular.

A few essential steps for water vaccination are listed as follows:

- Clean and flush the water lines.
- Turn off the water sanitation system.
- Ensure proper functioning of the drinker system.
- Water-starve the pullets enough for them to consume the vaccine in less than one hour.
- Verify that the vaccine to be administered has been stored according to the manufacturer's recommendations; that it is still viable (before expiry); and maintain a record of the type of vaccine, serial (lot) number, number of doses per vial and number of vials used, as well as the expiry date.
- Reconstitute the vaccine in an aseptic manner and verify that the number of vials used matches the number of doses to be given. The amount of vaccine to be consumed in volume should be equivalent to approximately 1/7 the total water consumed the previous day.
- Use a commercially produced vaccine stabilizer or powdered skim milk to help protect the vaccine viruses. Closely follow the recommendations of the manufacturer of the vaccine stabilizer. If skimmed milk is used, approximately 2.5 g of well dissolved skim milk per liter of water plus vaccine is enough to protect the vaccine from any residual chemicals or minerals in the drinking water. Keep the reconstituted vaccine cool and away from exposure to the sunlight.
- Deliver the vaccine into the drinkers and drinker lines. To ensure a complete fill out of the drinker lines (pipes) add a visual aid such as commercial blue dye and let the vaccine be flushed to the end of the lines until blue dye is seen at the end of the lines. At this time close the end of the water lines and allow the birds to drink. If the vaccine is delivered into open water systems, it is important to walk slowly through the house to stimulate water consumption and to help distribute the birds in the house.
- Check at least 100 birds throughout the barn to verify that they have consumed the vaccine. If enough dye was used, it should be easy to observe a blue coloring of the tongue, head feathers and occasionally the crop, which is visible through the skin. Vaccine coverage of at least 90% should be a realistic goal.

11.3.8 Vaccination through a medicator

Vaccination through a medicator is one of the methods of vaccination with live virus vaccines which is least recommended, although it is a suitable method for administration of drugs, vitamins, etc. Coccidiosis vaccination using a medicator should be avoided because the Eimeria oocysts will tend to settle and the actual dose of oocysts per bird will vary greatly, and so giving very poor results.

11.3.9 Spray Vaccination

Spray vaccination is used primarily for immunization against respiratory viruses such as Newcastle disease virus (NDV) and infectious bronchitis virus (IBV). However, it should be noted that spray vaccination should involve the less invasive forms or strains of viruses, such as the B1B1 strain of Newcastle, or H120 of infectious bronchitis. In general, the more invasive the virus, the better the protection against disease but the harsher the vaccine reactions, especially in flocks infected with MG or some strains of MS. Coccidiosis vaccines are sometimes sprayed on the feed of layer breeders in some areas. Some live Mycoplasma gallisepticum vaccines (but not all) can be sprayed directly on chickens in the field. Each type of equipment intended for spray vaccinations may be different and the operator must be thoroughly familiar with each piece of equipment and its spray patterns, pressure and particle size. For example, pressurized sprayers are excellent to deliver vaccine to the respiratory tract but because of the small particle size that they produce, the vaccine will tend to remain suspended in the air or it may be sucked towards the house fans if they are not turned off prior to vaccinating the birds. With some types of sprayers, the equipment must be located not more than 50 cm over those birds to be vaccinated. This method is therefore not practical for mass application over chickens on the ground. Rather, sprayers intended for horticultural use or pesticide application in the horticultural industry have proved very popular and effective for application of live respiratory vaccines in the field. The particle size will range between 100 and 300 ums, which is suitable for most respiratory viruses. In general, spray vaccination is used for protection against respiratory viruses and Mycoplasma in pullets; and for protection against respiratory viruses in hens in production.

A few essential considerations for spray vaccination are listed as follows:

- Prior to choosing spray vaccination to immunize chickens against respiratory viral diseases, consider all possible options. Be aware that spray vaccination against Newcastle disease and Infectious Bronchitis generally provides better protection than water vaccination, but vaccine reactions can be harsh, particularly in Mycoplasma-positive chickens. Spray vaccination against Infectious Laryngotracheitis should be avoided and must never be done in chickens in production. Only vaccinate healthy chickens.
- For adult flocks, verify the flock antibody titers prior to vaccination. If antibody titers are low, vaccine reactions may be harsh.
- Ensure that the vaccination equipment has been thoroughly cleaned, disinfected and rinsed to remove all traces of vaccine and disinfectant.
- Drive the birds (if reared on the floor) to an area of the barn where they can be vaccinated without them flying or moving freely away from the vaccination equipment.
- Calculate the total number of doses and the total volume of diluent (distilled deionized water) required to vaccine all chickens. The water used should not be chlorinated and should have a pH of 5,5 to 7,0.
- Turn off the lights, brooders and ventilation system while ensuring the birds do not overheat or suffocate. The flock should be relatively calm at the moment of spraying the vaccine on them.
- Reconstitute the vaccine aseptically and in the shade, and only immediately prior to vaccinating the flock.
- Use appropriate personal protective equipment (PPE), including protective mask and goggles.
- Adjust the spray nozzle to a proper droplet size. Coarse sprays (>80-120 microns) are recommended for priming vaccinations and also, for invasive vaccines. Fine sprays (50-60 microns) are recommended for boost vaccinations in older chickens, but only after they have been primed with similar viruses.
- MG-infected chickens tend to react too severely to spray vaccinations, particularly if the droplet size is too small.
- Use distilled water to dilute the vaccine (the amount should be adjusted to every situation). If a pressurized spray apparatus is used, it should be kept in mind that this type of equipment delivers droplets with a diameter range of 50-1000 microns, and thus only part of the vaccine will be inhaled. Thus, it is necessary to spray the vaccine at a distance not larger than 50cm from the chickens. This type of equipment typically requires a relatively large volume per chicken house (15-20 liters). For situations where a controlled-droplet application apparatus is used, the droplet size is considerably more uniform (~50-150 microns). Although the droplet size is more uniform with this type of equipment, some of the droplets are too small and may remain in suspension for quite some time after the vaccine is sprayed. This may represent a problem because a vaccine that stays in suspension a long time may decrease in virus titer before it is inhaled and much of the vaccine ends up on house and equipment surfaces but not in the chickens. In addition, if much of the vaccine remains in suspension (in the form of a mist), re-activating the ventilation system will draw the vaccine out of the house through the exhaust fans.
- Only spray-vaccinate healthy birds. Avoid spraying birds that are infected with MG.
- Adjust the nozzle to obtain the desired droplet size.
- Wear a mask and goggles for personal protection when spray vaccinating. Make sure the sprayer to be used is clean and has no residual disinfectant. The vaccine containers of the spray apparatus should be rinsed with distilled water prior to and after every use.
- Use only one dose per bird or less.
- Reconstitute the vaccine only immediately prior to use.
- Close up the house including curtains and doors and shut the ventilation system and dim the lights while the birds are being vaccinated and if possible, for 20-30 minutes postvaccination (provided the air quality and temperature allow for a

temporary shut down without compromising the flock integrity). If the flock is in a high temperature area, vaccinate birds at night or early in the morning. Make sure the ventilation system is not running at the time the vaccine is being applied or that it runs at a minimum power. Dim the lights to a minimum to settle the birds.

- Spray the birds evenly and thoroughly at least twice and ensure that all calculated doses are used evenly. The heads and upper body of the sprayed birds should appear wet after vaccination.
- Make a point of not leaving the farm without making sure the ventilation system and the lights have been re-engaged.
- Ventilation should be restored approximately 20 minutes after the initiation of the vaccination process.
- Rinse, clean, disinfect and re-rinse the vaccination equipment before leaving the farm.
- Destroy all residual vaccine and vaccine vials by incineration. Follow local regulations regarding adequate disposal of vaccines, vaccine vials and biological materials.

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Credits

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Appendix: conversion table

1 mtr.	= 3,282 feet	1 foot	= 0,305 mtr.
1 sq. mtr.	= 10,76 sq. feet	1 sq. foot	= 0,093 sq. mtr.
1 cub. mtr.	= 35,316 cub. feet	1 sq. foot	= 0,093 sq. mtr.
1 cm.	= 0,394 inches	1 inch	= 2,54 cm.
1 sq. cm.	= 0,155 sq. inch	1 sq. inch	= 6,45 sq.cm.
1 kg.	= 2,205 lbs.	1 lb.	= 0,454 kg.
1 g.	= 0,035 ozs.	1 oz.	= 28,35 g.
1 ltr.	= 0,22 gallons	1 gallon	= 4,54 ltr.

1 bird per square metre	= 10,76 square feet per bird
3 birds per square metre	= 3,59 square feet per bird
4 birds per square metre	= 2,69 square feet per bird
5 birds per square metre	= 2,15 square feet per bird
7 birds per square metre	= 1,54 square feet per bird
11 birds per square metre	= 0,98 square feet per bird
13 birds per square metre	= 0,83 square feet per bird
1 cubic meter/kilogram/hour	= 16,016 cubic feet/lb./hour
1 cubic foot/lb./hour	= 0,0624 cubic meter/kilogram/ hour

F °	= 9/5 °C+32	°C	= 5/9 (°F-32)		
45 °C	= 113 °F	22 °C	= 72 °F	10 °C	= 50 °F
40 °C	= 104 °F	20 °C	= 68 °F	8 °C	= 46 °F
35 °C	= 95 °F	18 °C	= 64 °F	6 °C	= 43 °F
30 °C	= 86 °F	16 °C	= 61 °F	4 °C	= 39 °F
27 °C	= 81 °F	14 °C	= 57 °F	2 °C	= 36 °F
24 °C	= 75 °F	12 °C	= 54 °F	0 °C	= 32 °F

1 Joule per second = 1 Watt = Volt x Ampere 1 KJ =1000J
1 MJ = 1000KJ
1 MJ = 239 Kcal
1 Kcal = 4.2 KJ
1 KWh = 3.6MJ - 860 Kcal
1 BTU = 1055J

Appendix: daylength according to the Northern Hemisphere Latitude

Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	12:07	12:07	12:06	12:06	12:06	12:07	12:07	12:06	12:06	12:06	12:06	12:07
5	11:50	11:54	12:01	12:09	12:17	12:23	12:24	12:19	12:12	12:04	11:56	11:51
10	11:33	11:42	11:56	12:13	12:28	12:40	12:41	12:33	12:18	12:01	11:46	11:35
15	11:15	11:29	11:50	12:16	12:40	12:57	13:00	12:47	12:24	11:59	11:35	11:18
20	10:57	11:16	11:45	12:20	12:52	13:15	13:19	13:01	12:30	11:57	11:23	11:00
25	10:37	11:02	11:39	12:24	13:05	13:35	13:39	13:17	12:37	11:54	11:12	10:41
30	10:15	10:46	11:33	12:29	13:20	13:57	14:02	13:34	12:45	11:52	10:59	10:21
35	9:51	10:29	11:26	12:34	13:36	14:21	14:28	13:53	12:54	11:49	10:44	9:58
40	9:23	10:10	11:18	12:40	13:54	14:49	14:57	14:15	13:03	11:46	10:28	9:32
45	8:50	9:48	11:09	12:47	14:16	15:23	15:33	14:41	13:15	11:42	10:09	9:01
50	8:10	9:20	10:58	12:55	14:42	16:04	16:17	15:13	13:28	11:38	9:47	8:24
55	7:17	8:46	10:45	13:05	15:15	16:59	17:16	15:53	13:46	11:33	9:18	7:35
60	6:03	8:00	10:29	13:18	16:00	18:18	18:42	16:49	14:08	11:26	8:41	6:27
65	3:54	6:54	10:06	13:37	17:05	20:42	21:36	18:14	14:39	11:18	7:48	4:36

Appendix: daylength according to the Southern Hemisphere Latitude

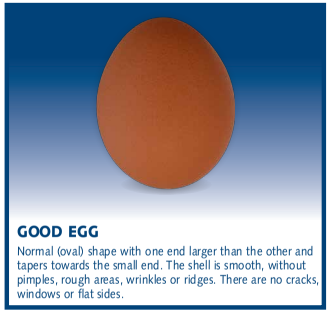
Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	12:07	12:06	12:06	12:06	12:06	12:07	12:07	12:07	12:06	12:06	12:06	12:07
5	12:24	12:19	12:12	12:04	11:56	11:51	11:50	11:54	12:01	12:09	12:17	12:23
10	12:41	12:33	12:18	12:01	11:46	11:35	11:33	11:42	11:56	12:13	12:28	12:40
15	13:00	12:47	12:24	11:59	11:35	11:18	11:15	11:29	11:50	12:16	12:40	12:57
20	13:19	13:01	12:30	11:57	11:23	11:00	10:57	11:16	11:45	12:20	12:52	13:15
25	13:39	13:17	12:37	11:54	11:12	10:41	10:37	11:02	11:39	12:24	13:05	13:35
30	14:02	13:34	12:45	11:52	10:59	10:21	10:15	10:46	11:33	12:29	13:20	13:57
35	14:28	13:53	12:54	11:49	10:44	9:58	9:51	10:29	11:26	12:34	13:36	14:21
40	14:57	14:15	13:03	11:46	10:28	9:32	9:23	10:10	11:18	12:40	13:54	14:49
45	15:33	14:41	13:15	11:42	10:09	9:01	8:50	9:48	11:09	12:47	14:16	15:23
50	16:17	15:13	13:28	11:38	9:47	8:24	8:10	9:20	10:58	12:55	14:42	16:04
55	17:16	15:53	13:46	11:33	9:18	7:35	7:17	8:46	10:45	13:05	15:15	16:59
60	18:42	16:49	14:08	11:26	8:41	6:27	6:03	8:00	10:29	13:18	16:00	18:18
65	21:36	18:14	14:39	11:18	7:48	4:36	3:54	6:54	10:06	13:37	17:05	20:42

Visitor registration						If "NO" always consult the location manager before entering!				
Date	Name visitor	License plate	Arrival time	Departure time	Appointment for visit	72h free of contact with poultry?*	48h free of contact with pigs, veal, calves. fur animals? **	Date of contact	Name company visited	Signature visitor
30/01/2018	Piet Jansen	12-ABC-34	10:20	12:05	Health inspection	Yes / No	Yes / No	12/06/19	HG	P. Jansen
						Yes / No				
						Yes / No				
						Yes / No				
						Yes / No				
						Yes / No				

*Have you had contact with poultry / birds in the previous 72 hours? If so, always consult the location manager before entering. Fill out date and address of this poultry contact.

**Have you had contact with pigs / veal calves / fur producing animals in the previous 72 hours? If yes, consult the manager before entering. Fill out date and address of this contact.

Downgraded Egg Chart Brown Eggs



GOOD EGG

Normal (oval) shape with one end larger than the other and tapers towards the small end. The shell is smooth, without pimples, rough areas, wrinkles or ridges. There are no cracks, windows or flat sides.

CRACKED EGG

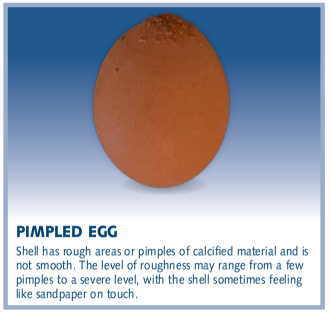
Shell has mild to severe cracks (hairline crack, star crack or body check), is broken or has albumen/yolk leaking.

WHITE BANDED EGG

Shell contains a white band which resultrs from two eggs coming into contact in the shell gland.

SPECKLED EGG

Small brown spots on the shell.



PIMPLED EGG

Shell has rough areas or pimples of calcified material and is not smooth. The level of roughness may range from a few pimples to a severe level, with the shell sometimes feeling like sandpaper on touch.

DIRTY EGG

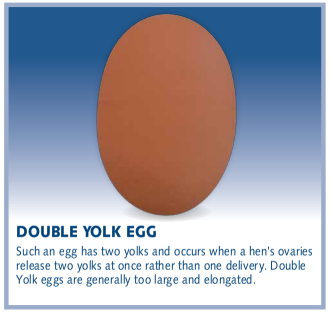
Shell is not broken but has dirt or foreign material, such as faeces adhering to its surface. It has prominent, or moderate stains, which may be localized or scattered, covering about 3% to 6% respectively of the shell surface.

MISSHAPED EGG

Such an egg does not have the oval shape of a normal egg and the shell is not smooth. Such eggs include those with flat sides or body checks, and those usually too large or too small.

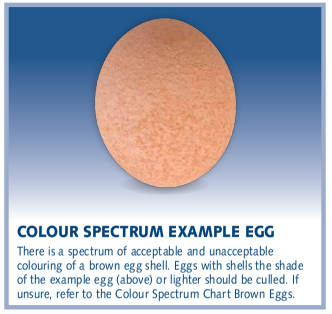
SLAB-SIDED EGG

The egg is flattened on one side, which is the side where it made contact with the first egg in the pouch. It is wrinkled and misshapen.



DOUBLE YOLK EGG

Such an egg has two yolks and occurs when a hen's ovaries release two yolks at once rather than one delivery. Double Yolk eggs are generally too large and elongated.



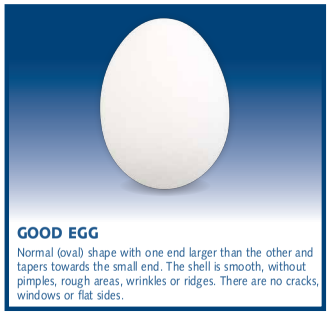
COLOUR SPECTRUM EXAMPLE EGG

There is a spectrum of acceptable and unacceptable colouring of a brown egg shell. Eggs with shells the shade of the example egg (above) or lighter should be culled. If unsure, refer to the Colour Spectrum Chart Brown Eggs.

DOWNGRADED EGG: Any egg that fails to meet the minimum standards must be removed. This chart outlines some major reasons for downgrading eggs. There are reasons other than these shown.

HENDRIX GENETICS

Downgraded Egg Chart White Eggs



GOOD EGG

Normal (oval) shape with one end larger than the other and tapers towards the small end. The shell is smooth, without pimples, rough areas, wrinkles or ridges. There are no cracks, windows or flat sides.

CRACKED EGG

Shell has mild to severe cracks (hairline crack, star crack or body check), is broken or has albumen/yolk leaking.

STAINED EGG

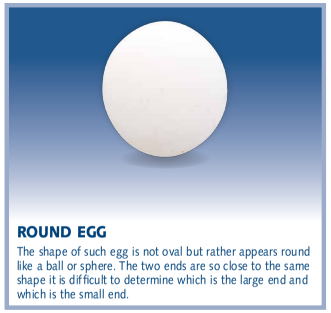
Shell has foreign material such as blood or faeces and stains or discolourations that are readily visible.

WRINKLED EGG

Shell has ridges or wrinkles on surface. This may range from a few tiny wrinkles to severe wrinkles that completely cover the egg.

PIMPLED EGG

Shell has rough areas or pimples of calcified material and is not smooth. The level of roughness may range from a few pimples to a severe level, with the shell sometimes feeling like sandpaper on touch.



ROUND EGG

The shape of such egg is not oval but rather appears round like a ball or sphere. The two ends are so close to the same shape it is difficult to determine which is the large end and which is the small end.

DIRTY EGG

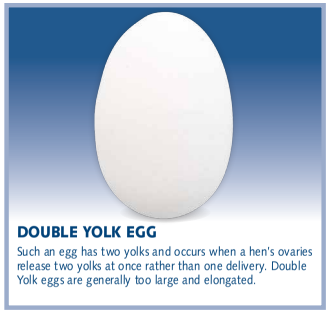
Shell is not broken but has dirt or foreign material, such as faeces adhering to its surface. It has prominent, or moderate stains, which may be localized or scattered, covering about 3% to 6% respectively of the shell surface.

MISSHAPED EGG

Such an egg does not have the oval shape of a normal egg and the shell is not smooth. Such eggs include those with flat sides or body checks, and those usually too large or too small.

SLAB-SIDED EGG

The egg is flattened on one side, which is the side where it made contact with the first egg in the pouch. It is wrinkled and misshapen.



DOUBLE YOLK EGG

Such an egg has two yolks and occurs when a hen's ovaries release two yolks at once rather than one delivery. Double Yolk eggs are generally too large and elongated.

DOWNGRADED EGG: Any egg that fails to meet the minimum standards must be removed. This chart outlines some major reasons for downgrading eggs. There are reasons other than these shown.

HENDRIX GENETICS

Appendix: Body weight recording form

Grams	No. Birds	10	15	20	25	Rearer
600						
20						Rearing
40						Actual
60						Mean WL
80						792
700						Target
20						Weight
40						790
60						Grams
80						Over/(under)
800						2
20						% evenness
40						. + or - 10 %
60						86,21
80						. + or - 10 %
900						
20						
40						St. Dev
60						53,65
80						cv %
1000						6,8

Notes:

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