NICK CHICK

White Egg Layers

H&N® INTERNATIONAL

The key to your profit!

NEW Management *Guide* CAGE-FREE

North American Edition

INTERNATIONAL

The key to your profit!

The geneticists and research staff at H&N have worked for many years to produce a layer with an excellent performance. This was achieved by a balanced selection procedure, taking many traits into account, such as egg production rate, livability, feed efficiency and internal and external egg quality. These traits are the major factors that determine the profitability for an egg producer.

The goal now is to enable H&N Nick Chick layers to express their full genetic potential by providing the feed, management and environment they need to obtain optimum performance. This manual outlines management practices that experience has proven to be important and will help producers with recommendations to achieve the best results. In all kind of housing systems (cage or cage-free), good poultry management is the key to success with H&N layers.

Good bird management sometimes requires a little extra effort, but this hard work will certainly be repaid. It is not complicated; it simply requires paying attention to the management on the farm and the behavior of the birds, common sense and proper decision-making throughout the lifetime of the flock. This management manual will assist you in making the correct decisions.

SUMMARY OF NICK CHICK PERFORMANCE STANDARDS

FEED

Feed intake between 0 – 20 weeks
16.1–16.5 lb (7.8 – 8.0 kg)

Daily feed intake in production
23–24 lb/100 (108 – 113 g)

Feed Conversion Rate (lb/lb | kg/kg)
until 80 weeks 2.01 | 2.08
until 90 weeks 2.04 | 2.12
until 100 weeks 2.09 | 2.17

EGG PRODUCTION

Age at 50 % Production
140 – 150 days

Peak Production
94 – 95 %

Period over 90 %
43 weeks

Eggs per Hen Housed
until 80 weeks 376
until 90 weeks 428
until 100 weeks 474

Cumulative Egg Mass per Hen Housed
until 80 weeks 50.3 lb | 22.8 kg
until 90 weeks 57.5 lb | 26.1 kg
until 100 weeks 64.2 lb | 29.1 kg

LIVABILITY

Rearing
0 – 19 weeks 96 – 98 %

Production
19 – 100 weeks 89 – 94 %

BODY WEIGHT

at 19 weeks 2.99 lb | 1.36 kg
at 30 weeks 3.52 lb | 1.60 kg
at 72 weeks 3.73 lb | 1.69 kg
at 100 weeks 3.80 lb | 1.73 kg

EGG WEIGHT

until 80 weeks
48.1 lb/case | 60.6 g

until 90 weeks
48.4 lb/case | 61.0 g

until 100 weeks
48.7 lb/case | 61.3 g

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EQUIPMENT FOR CAGE-FREE SYSTEMS

- **Several rearing / production housing systems are available for layers. There is potential to grow a quality pullet and achieve high productivity in all of them but each one has its advantages and disadvantages.**
- **No matter what kind of housing system is used, a key point for success is to follow the recommended stocking density.**
- **Training the pullets according to the production system they will be in later is crucial in cage free.**

IMPORTANT

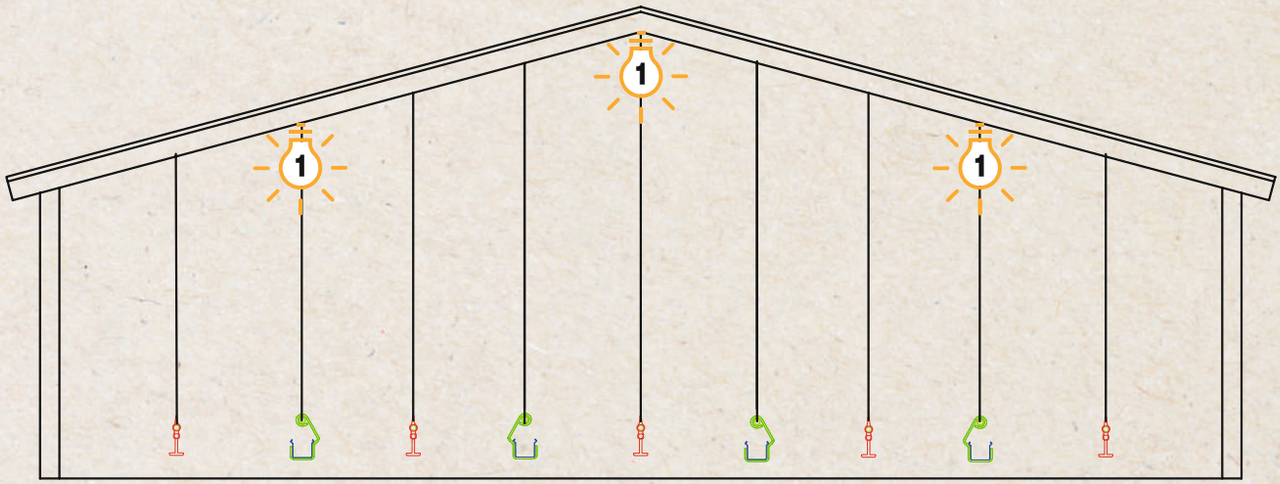
- Plan the rearing period with all those involved in the rearing and production periods.
- Train the pullets so that they can easily adapt later to the layer house environment.
- You can train the pullets too much or not enough. For example, when training them to jump, there is no benefit for training them to jump higher in rearing than they will need to jump in the laying house.
- The more closely the rearing facility resembles the future production system, the easier it will be for the pullets to settle down in their new environment after being transferred to the laying house.

TYPES OF REARING SYSTEM

Cage-free Floor systems with full Floor

- In this system the pullets stay from day 1 till the end of rearing on full floor.
- Feeders and drinkers stay on the floor level for the whole rearing period.
- Additionally, perches and height adjustable slats can be used to train the pullets to jump by 3 weeks of age.
- At night all the pullets sleep on the floor.

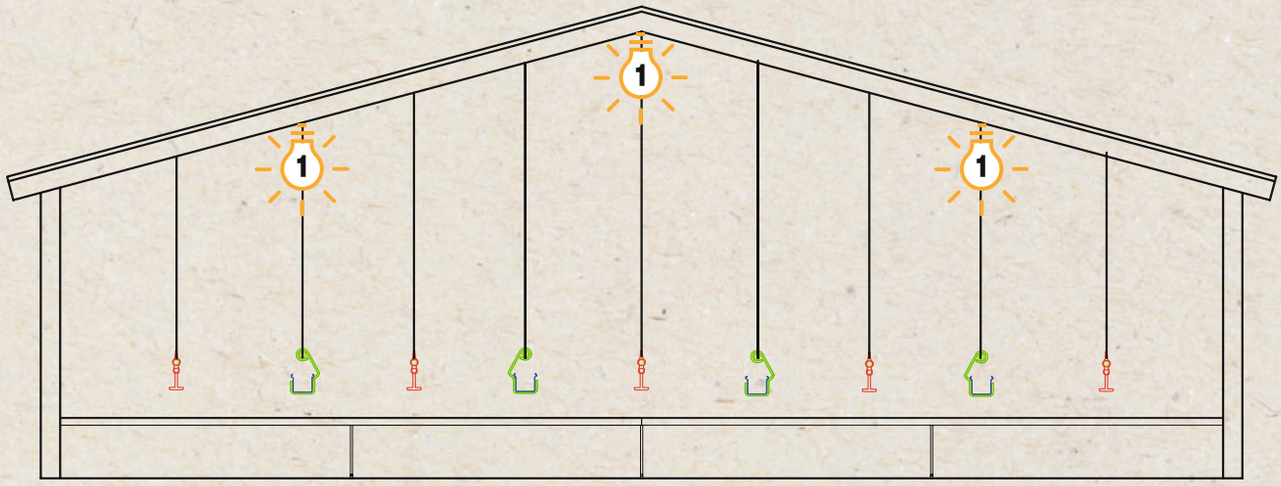
Learn more about dimming program in cage-free systems (see page 28)



EQUIPMENT FOR CAGE-FREE SYSTEMS

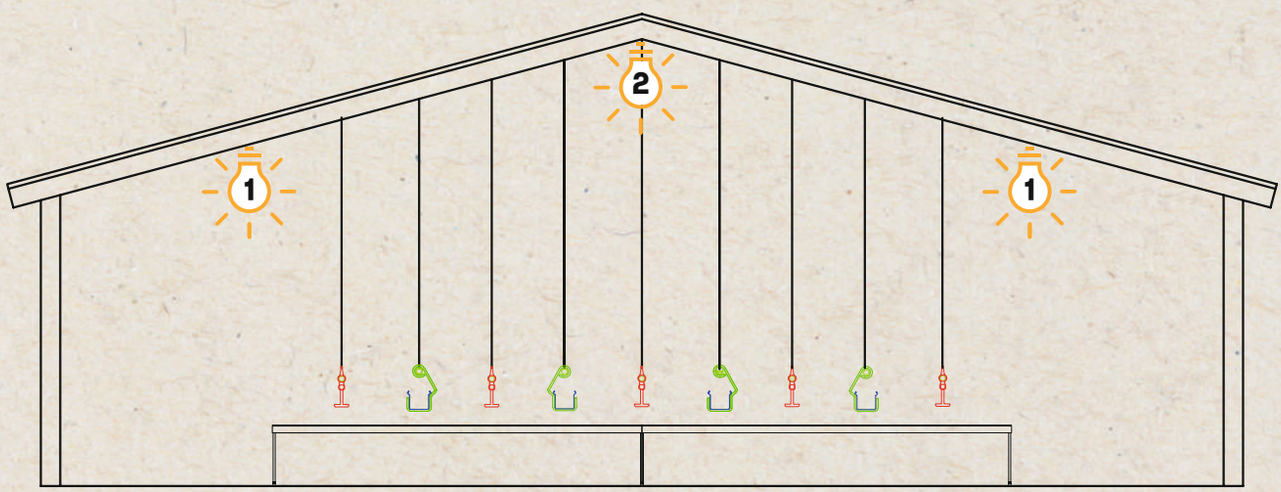
Cage-free Floor systems with full slats

- This type of rearing has no scratch area, and the pullets don´t have access to litter material.
- Additionally, perches and height adjustable slats can be used to train the pullets to jump by 3 weeks of age.



Cage-free Floor systems with ⅔ slats and ⅓ scratch area

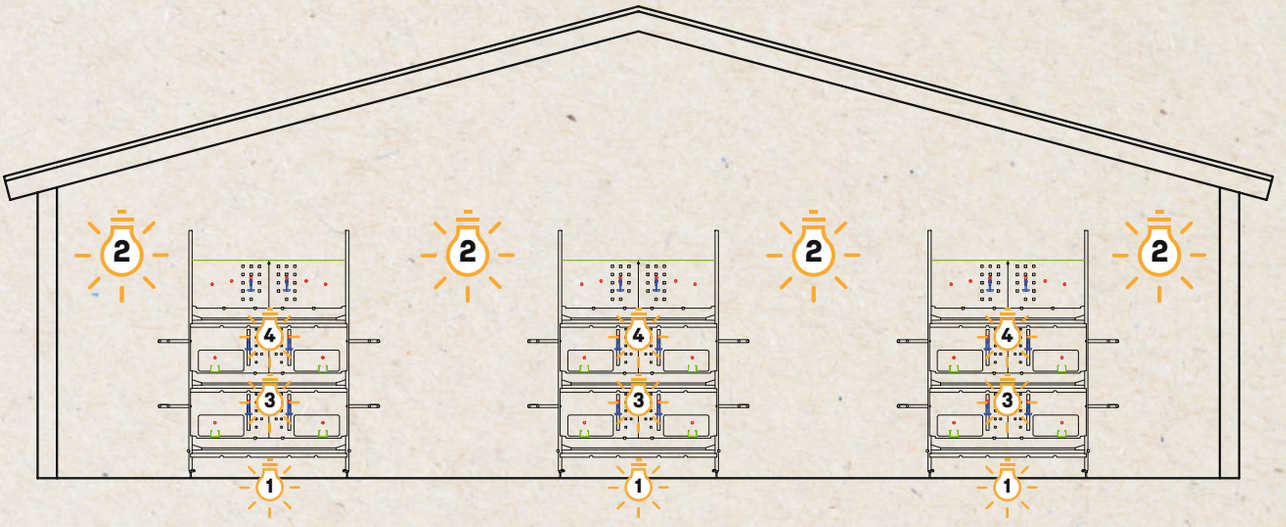
- In this type of system, the pullets stay 3–4 weeks on the slats, and then they have access to the scratch area.
- In these types of systems, all the pullets are trained to sleep on the slats and not on the scratch area during night.
- All feeders and drinkers are mostly placed on the slats.
- Remark: Perches or height adjustable slats can also be used in this type of rearing to train the pullets to jump by 3 weeks of age.



EQUIPMENT FOR CAGE-FREE SYSTEMS

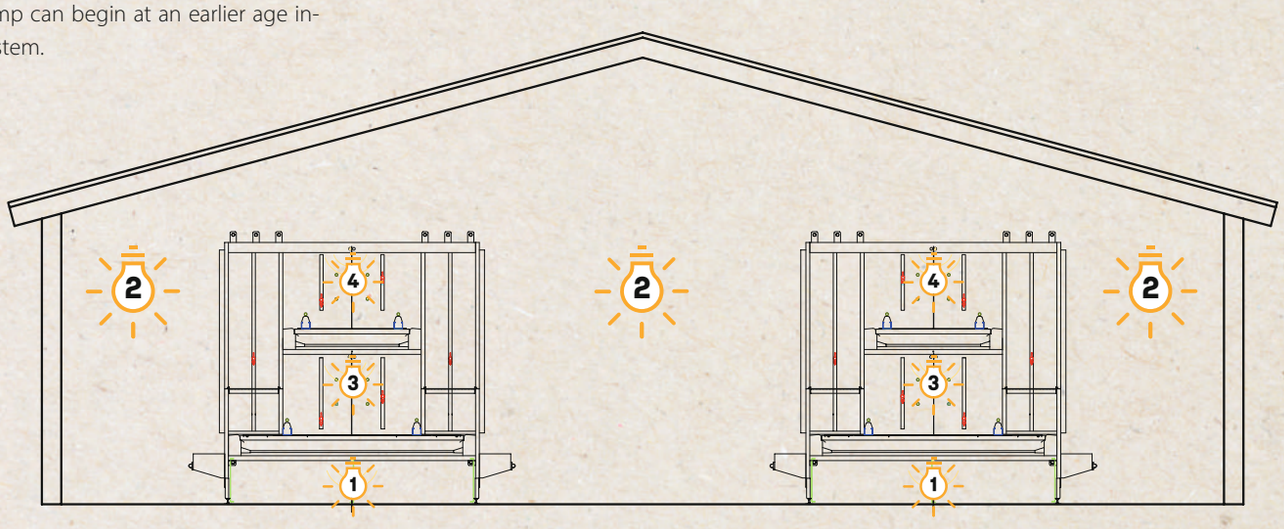
Aviary row-systems

- These types of rearing systems have more than one level of living space, they are also called multi-tier systems.
- It can be anywhere from 2 to 4 levels.
- The first two levels are usually used to house the day-old-chicks and have water and feed on each level.
- A few weeks after housing the chicks, the pullets are allowed to access the scratch area and other levels.
- In these row-systems all the pullets sleep inside the system.
- The goal of these systems is to train the pullets how to use different levels and to jump.
- The aviary row systems do not allow the chicks under the system, and light bulbs (1) are not needed.
- **Due to the availability of water and feed on the same level during the whole rearing period, there is a risk that some birds will never learn to jump during the entire rearing period.**
- These types of systems can also be equipped with an adjustable slat with additional drinking lines in the scratch area between the rows.
- The system should be equipped with a minimum of 3 inches of perch per pullet.
- The floor area between the rows should be > 6 feet.



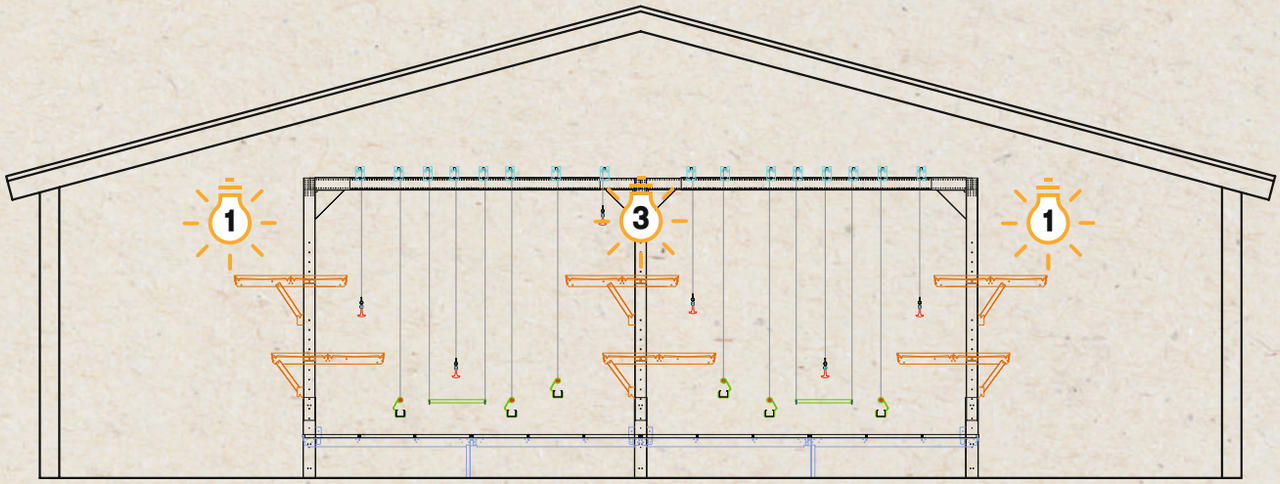
Aviary row-systems with height adjustable slats inside the system

- These types of systems have adjustable slats with nipple drinkers.
- With this slat/nipple drinker, training the birds to jump can begin at an earlier age inside the system.
- All the finished pullets will have been trained to jump during the rearing period with this system.
- The system should be equipped with a minimum of 3 inches perch per bird.



Aviary systems with height adjustable slats

- Most of these systems have ⅔ slats above the manure area or manure belts and ⅓ floor area for the pullets.
- In these types of systems, train all pullets to sleep on the slats and not on the scratch area during night.
- Most of these systems allow small adjustments, not adjustments in specific increments. The height adjustable slats are used to train the pullets to jump between different levels (feed / water)
- All the finished pullets will have been trained to jump during the rearing period with this system.
- Make sure the system is equipped with a minimum of 3 inches of perch per bird.



EQUIPMENT FOR CAGE-FREE SYSTEMS

TYPES OF CAGE-FREE PRODUCTION SYSTEMS

- Many different brands and styles of cage-free production systems are available.
- This is an overview of some of the most common systems. All these types of systems can also be used for free-range and organic production.

Cage-free floor system with full floor and nest boxes placed in the middle, or side of the house

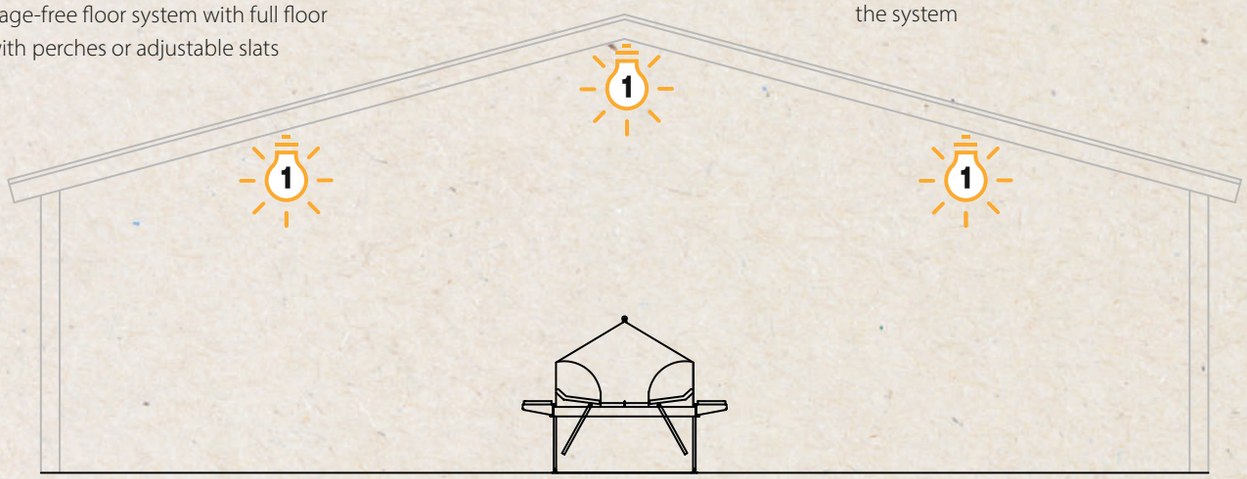
- Use additional perches in these types of systems to give the birds more room to find feed, water, nest boxes, and a place to rest.

The ideal choice for rearing in this type of production

- Cage-free floor system with full floor
- Cage-free floor system with full floor with perches or adjustable slats

Other possible rearing choices:

- Barn with ⅔ slats, and ⅓ scratch area
- Aviary systems with height adjustable slats
- Aviary row-systems
- Aviary row-systems with height adjustable slat inside the system



Cage-free system with full slats and nest boxes placed in the middle, or side of the house

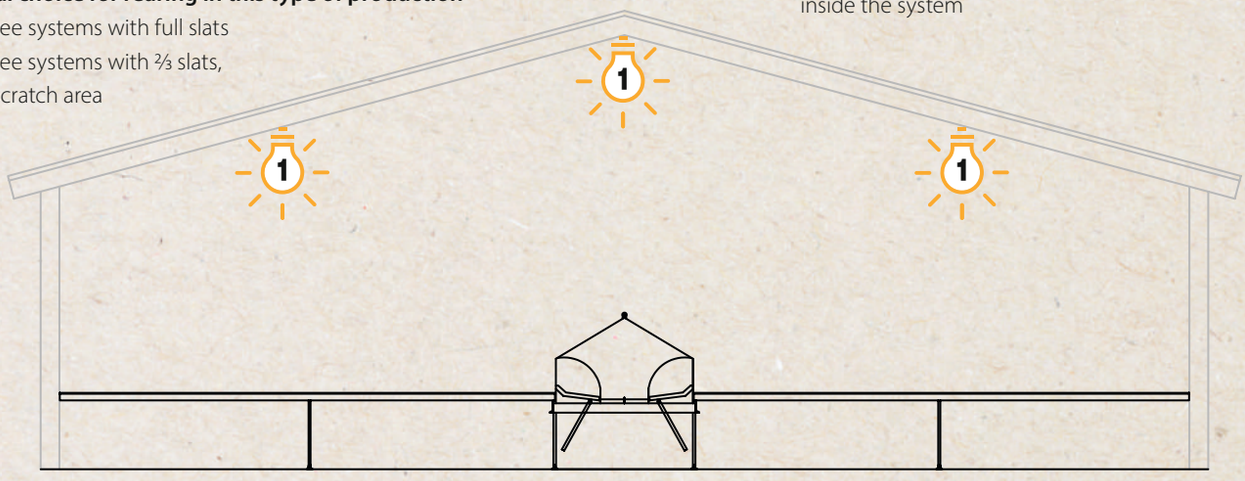
- Use additional perches in these types of systems to give birds more room to find feed, water, nest boxes, and a place to rest.

The ideal choice for rearing in this type of production

- Cage-free systems with full slats
- Cage-free systems with ⅔ slats, and ⅓ scratch area

Other possible rearing choices:

- Aviary systems with height adjustable slats
- Aviary row-systems
- Aviary row-systems with height adjustable slat inside the system



EQUIPMENT FOR CAGE-FREE SYSTEMS

Cage-free system with ⅔ slats, and ⅓ scratch area and nest boxes on the slats and / or side of the scratch area

- Use additional perches in these types of systems to give birds more room to find feed, water, nest boxes, and a place to rest on the slats.
- Feed, water, nest boxes are placed on the slats, and the birds also sleep on the perches over the slats.

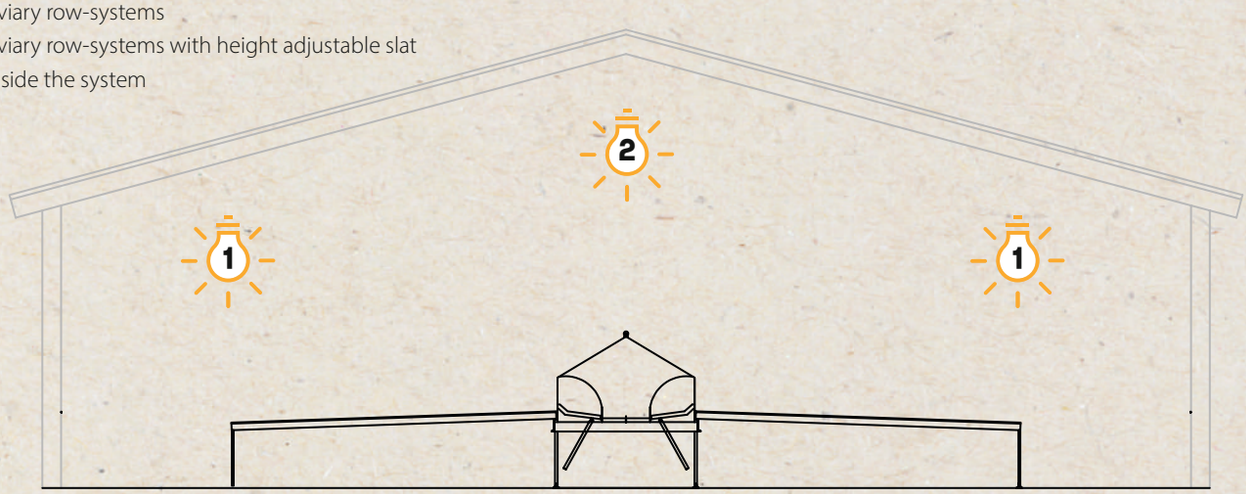
The ideal choice for rearing in this type of production

- Cage-free system with ⅔ slats and ⅓ scratch area
- Aviary systems with height adjustable slats
- Aviary row-systems
- Aviary row-systems with height adjustable slat inside the system

Other possible rearing choices:

- Cage-free floor system with full floor

  With the use of this type of rearing make some preparations before transfer to keep the pullets on the slats for 2–3 days to find feed and water.

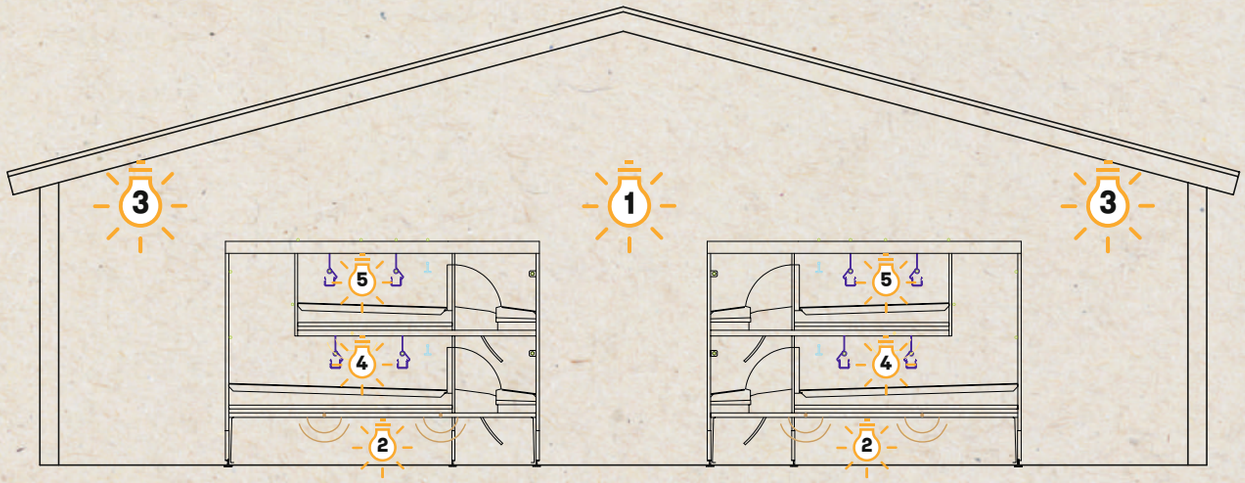


Aviary systems with feed / water / nest boxes on the same level

- With this type of production, the layers can find all they need on the same level (feed, water, nest boxes).
- It is best to train the birds to jump between different levels in the system to have a more uniform population in the production house.
- Use additional perches in this type of system to give the birds more room to find feed, water, nest boxes and a place to rest.

The ideal choice for rearing in this type of production

- Aviary systems with height adjustable slats
- Aviary row-systems
- Aviary row-systems with height adjustable slats inside the system



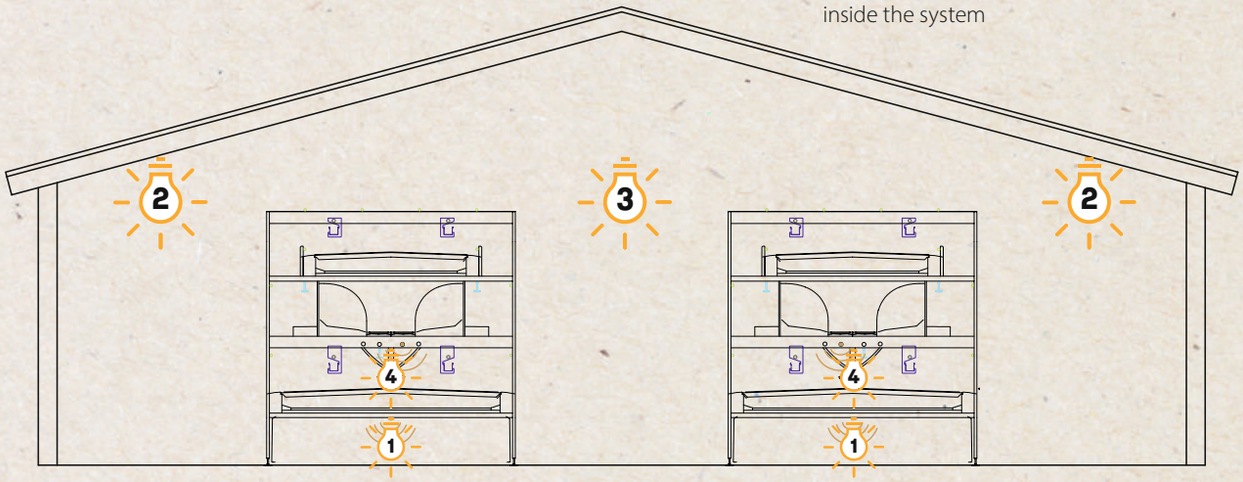
EQUIPMENT FOR CAGE-FREE SYSTEMS

Aviary systems with feed / water / nest boxes on different levels

- With this type of system, the layers must jump on different levels to find feed, water, and nest boxes.
- It is important to train all the pullets to learn how to move in this type of production system in rearing period.

The ideal choice for rearing in this type of production

- Aviary systems with height adjustable slats
- Aviary row-systems
- Aviary row-systems with height adjustable slat inside the system



WHAT TYPE OF REARING SYSTEM & TRAINING PROGRAM DO YOU NEED

Try to plan ahead to use the best type of rearing system for the layer house.
Here are a few important questions to think about when making this decision:

What kind of feeding system and drinking system do you use in production?

When pullets learn to drink and eat from the same feeding and water system, the hens will have less stress after transfer finding the feed and water in the production house.

When rearing with pan feeders, and production is fed with a chain, the birds can be startled to see the feed moving in the feed chain.

Moving pullets from bell drinkers to nipple drinkers could cause a problem because they have not learned how to use the nipple drinkers.

Do the birds need to move on slats in the production house?

When you transfer pullets from full floor to a production system with slats that they need to use for sleep, and to find feed, water or nest boxes, some problems can occur because they are not used to walking on slats.

There is more risk of the layers sleeping in the scratch area because they are used to doing this in the rearing period. It can increase the risk of mislaid eggs.

Do birds need to jump on perches to find the different levels?

Look how the layers jump to the different levels in the production system.

- **When the layers need to jump on perches to go to another level, all the pullets need to be trained to jump on a perch in rearing.**
- Chicks should have access to perches by 3 weeks of age.
- Provide minimum 3 inches perch space per pullet in rearing.

EQUIPMENT FOR CAGE-FREE SYSTEMS

Are feed, water, and nest boxes on the same level in production system?

When transferring pullets to production systems with feed, water, nest boxes on one level the pullets will find feed, water and next boxes easier.

What is the maximum jump height that the bird needs to make?

With the use of rearing systems with adjustable slats, it is important to know what is the maximum height that they need to jump in the production system.

Train the pullets according to the height in the production system, not too high and not too low. In this case, no need to train them to jump higher than needed for the production system.

Do birds need to jump in production system to go and find feed, water, nest on different levels?

This type of system requires well trained flock of pullets.
With a rearing system with adjustable slats to separate water and feed from each other you can train these pullets in the right way.

Are there any manure belts in the production system?

When rearing is without manure belts, and the pullets are transferred to a production system with manure belts, you may see nervous layers the first time the manure belt runs.

Suggestion

The best advice is to run the manure belts in the first week when light is off.

Key Points

- **IMPORTANT: Find the ideal rearing system and training with these 7 steps.**
- **Decide what kind of production system you should prepare the pullets for and what kind of training the pullets should have to find their way around this production system.**
- **The move from rearing to lay barn can be stressful. Big differences between both systems might have a negative impact on production. Rearing and layers systems that are similar are preferred.**
- **Plan together with all the people who are involved to look for the right rearing system program.**

HOUSE PREPARATION AND ARRIVAL OF CHICKS

- How to prepare the house before the day-old chicks arrive.
- How to house day-old chicks.

CLEANING AND DISINFECTION PROCEDURE

STEP 1

Preparation

It is essential to remove all equipment or waste (mortality, feed, eggs, manure, etc.) left in the house before cleaning. Any removable material / equipment should be detached.

STEP 2

Dry Cleaning

This removes all dust and dry organic material from the house using compressed air, brooms or shovels.

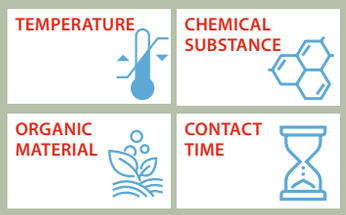
STEP 3

Wet Cleaning

This removes all remaining organic material and grease. Thoroughly clean using detergent and hot water.
Apply foam detergent and leave it to work for the specified time.

STEP 4

Disinfection



This kills all remaining pathogens that survived the previous steps. For good performance:

- Use only reliable and effective disinfectants.
- Apply the appropriate dose.
- Respect contact time and temperature.
- Follow the label instructions.
- Use appropiate PPE (personal protective equipment).

STEP 5

Fumigation

- Fumigate after liquid disinfection has been completed and the equipment has been installed again.
- Follow the label instructions.
- Use appropriate PPE (personal protective equipment).

STEP 6

Sampling

Sample after cleaning and disinfection, check if the microbiological results are acceptable. Corresponding sampling and laboratory analysis should be performed: at least eight samples per house should be taken, distributed randomly as shown in table 1. If results are unacceptable, take corrective measures.

HOUSE PREPARATION AND ARRIVAL OF CHICKS

Cleaning and disinfection procedures are key to preventing pathogens from passing from one flock to the next. They also prevent pathogens from challenging birds in their early life. The goal of this procedure is to minimize all microorganisms in the house to offer chicks the best opportunity to achieve optimum performance.

Table 1: Clean and disinfection microbiological results

Place of sampling	Salmonella spp.	Enterobacteria in 16 sq cm	
	Unacceptable	Good	Unacceptable
Wall-floor junction Drinkers Feeders Manure belt Eggs belt Fans	**Presence**	**< 5**	**> 10**

IMPORTANT

1. Do not proceed to the next step until the previous step has been completed.
2. Clean the area outside the house, storage and service areas, water lines and ventilation system.
3. Provide staff with adequate PPE.
4. Maintain the cleaning equipment regularly.
5. Pests are under control, and there is an active Pest Control Program ready before the chicks arrive.
6. Be sure that there is no disinfectant or insecticide residue left by the chick housing time.

RECOMMENDATIONS REARING

Recommended stocking density leads to success in rearing chicks. A high stocking density impacts negatively on daily growth, flock uniformity and chick development. Furthermore, a high stocking density combined with reduced feeder space will limit feed consumption, which might already be low under certain conditions (e.g. hot climate or poor feed quality,). Be sure to provide sufficient access to water.

Table 2: Stocking density in rearing farms

Age	Feeder space*		Drinker Space	
	Row-systems	Floor	Row-systems	Floor
0 – 3 weeks	0.985 inch/bird (2.5 cm/bird)	1.576 inch/bird (4 cm/bird) 60 birds/pan	0.493 trough inch/bird (1.25 trough cm/bird) 12 birds/nipple	0.552 trough inch/bird (1.4 trough cm/bird) 12 birds/nipple 100 birds/fountain
3 – 16 weeks	1.97 inch/bird (5 cm/bird)	3.152 inch/bird (8 cm/bird) 30 birds/pan	0.807 trough inch/bird (2.5 trough cm/bird) 8 birds/nipple	0.807 trough inch/bird (2.5 trough cm/bird) 8 birds/nipple 75 birds/fountain

**minimal recommendations*

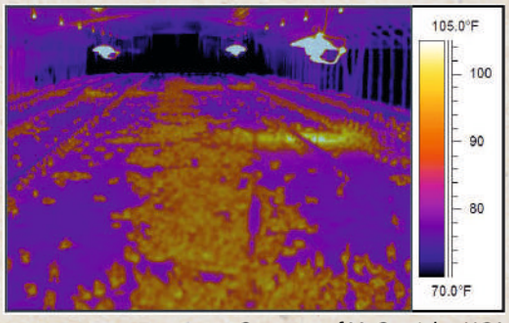
Follow equipment manufacturer recommendations and certifier's standard guidelines

PRE-HEATING THE REARING HOUSE

Pre-heat the house before the chicks arrive.
Preheat 24 hours before arrival in warm weather and 48 hours in cold weather.

Temperature recommendation Soil: 75 °F (24 °C) Litter: 86 °F (30 °C) Air: 93 °F (34 °C)

Do not only heat the air, but also litter, floor and equipment. Chicks gain and lose heat easily through conduction (see page 73–74). In case of floor rearing, bring in the litter after preheating to allow the concrete to reach the desired temperature (75 °F / 24 °C).



Courtesy of M. Czarick – UGA

REARING HOUSE PREPARATION

▶ Floor & Aviary Rearing Systems

Distribute Litter and Paper

Old litter from the previous flock should not be used. Using old litter increases the possibility of disease and may cause increased chick morbidity or mortality. Insoluble grit should be fed if the chicks are on a type of litter (e.g. shavings) that will be eaten by the chicks.

Feeding System

Supplemental feeder trays should be provided within the brooder ring for a few days until all chicks are eating from the regular feeding system. Ensure adequate feeder space is provided. Cover at least 50 % of the brooding area with paper and scatter feed over the paper.

Drinking System

Chicks must have unlimited access to clean, good quality, fresh water (75–77 °F / 20–25 °C). During the first days, cups or nipples should be checked and triggered several times per day to stimulate the chicks to drink. Supply additional drinkers which can be easily accessed until the chicks are drinking from the regular water system.

If using nipple drinkers, reduce the water pressure for a few days. This allows droplets to develop which help stimulate the chicks to drink.

Ventilation

Guarantee enough fresh air, but no drafts. With conventional pancake brooders, use chick guards (i.e. new cardboard) to prevent drafts. Start with a diameter of approx. 2 m / 6.5 feet in cool weather and approximately 4 m / 13 feet in hot weather. Enlarge the ring every couple of days and remove by six or seven days of age.

Rearing prepared for DOC

Nipple drinkers

Additional drinkers

AVIARY REARING PREPARATION

▶ Aviary Row System

Distribution

Birds are housed at a higher stocking density during the first weeks. To ensure uniform pullet growth, it is important that the birds are moved into the empty system, levels and scratch area at the appropriate time and with the correct density (see table 2 page 15).

Paper

System wires should be covered with paper during the first week of life. If vaccinating for coccidiosis leave paper for proper vaccine cycling. Avoid covering the area directly under the drinking system nipple drinkers to prevent paper from getting wet but cover the surrounding area. In cases where the wire size is too large for day old chicks, plastic matting can be used to aid the chicks in reaching the drinkers.

Feeding System

Abundant feed should be provided in the feeders and additionally on the papers inside the system before the chicks are housed to stimulate feed intake.

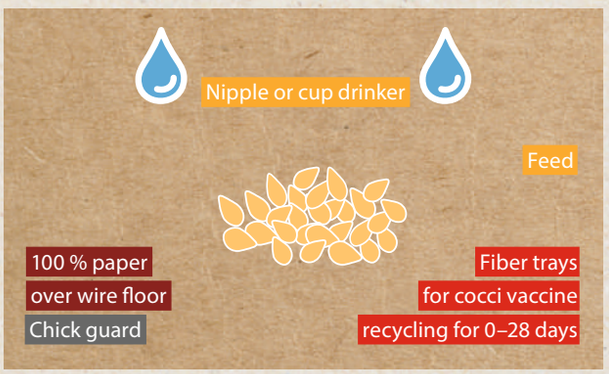
When there is a feed chain inside the system, manually fill this chain up to 100 % to reduce mortality when running the feed chain in the first day(s). For hatchery beak treated chicks cover chain so chicks do not peck it when eating for the first 7 days.

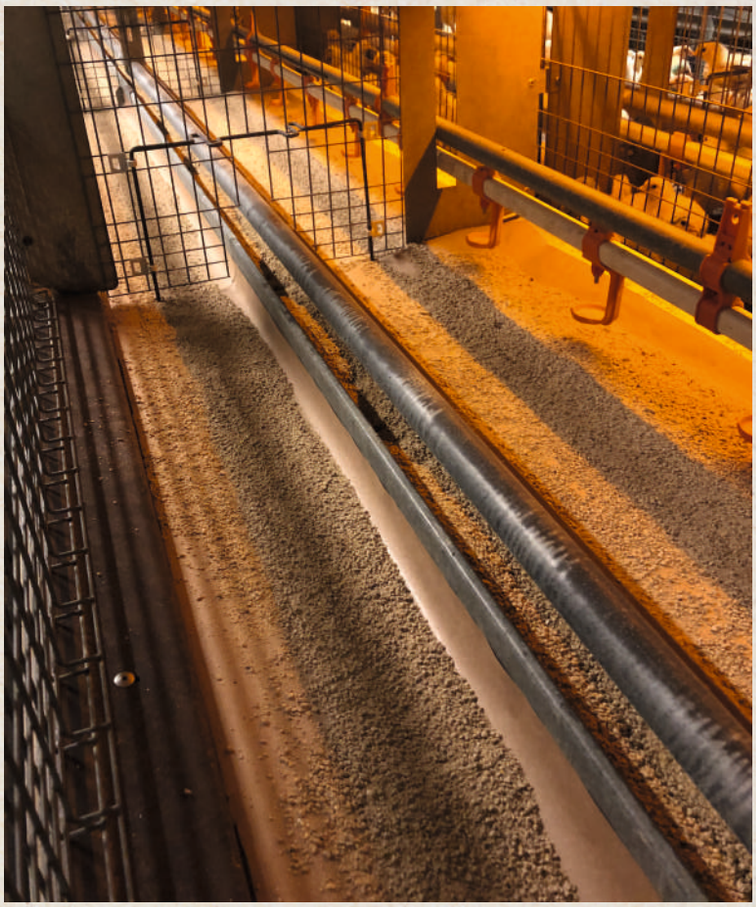
Drinking System (Row & Floor rearing)

360-activated nipples in the brooding area are preferred (especially with IRBT chicks). If unavailable, provide cup drinkers during the first week. Reduce the water pressure on the nipples to make triggering the nipples easier and attract the chicks by the drop formation.

Flush the lines and cup drinker just before housing the chicks.

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





CHECK LIST BEFORE CHICKS ARRIVE

1. Ensure a uniform temperature inside the house.
2. Check the time clock settings and light dimmer settings.
3. Check automatic water and feed systems for correct settings and uniform distribution.
4. Trigger nipples and cups to ensure they are working correctly and after they arrive to help stimulate the birds to drink.
5. Coordinate time of arrival with the hatchery and confirm the number and condition of the delivered chicks.
6. Check light intensity with a light meter.
7. Ensure adequate numbers of trained staff will be on-site for the delivery and unloading.

HOUSE PREPARATION AND ARRIVAL OF CHICKS

CHICK HOUSING

Transport

Transport can have a critical impact on day old chick quality. The correct temperature and ventilation levels should be guaranteed during transport. The transport time should be as short as possible.

Unloading the Chicks

Place the birds gently but quickly into the house and provide immediate access to water and feed. Crates should be taken onto the farm and distributed as soon as possible. Never store crates in conditions that are too hot or cold, windy or in direct sunlight. Do not place stacks of crates right next to each other, under a hanging light or directly next to the heat source.

With floor brooding, place the chicks directly over the paper and feed. With row aviary brooding place the right number of chicks in each system section.

Chick Quality

On arrival the chicks must be warm and active. Check that there is no abnormal mortality in the crates. Check the body temperature as explained on page 23 and adjust the house temperature.

Record the mortality at housing and inform the hatchery. Report chick quality back to the breed representative or hatchery.

Transport truck

Truck unload

Housing DOC

Housing DOC

Key Points

- Ensure the house has been cleaned and disinfected in time before chicks arrive.
- Preheat the house to the correct temperature: Always test at chick level.
- Observe stocking density recommendations and adapt drinking and feeding systems to the brooding period.
- House the chicks quickly so they can access water and feed.
- Take the time to inspect the chicks for body temperature and quality.

BROODING (1–21 days)

- How to promote chick livability during the first week of life.
- How to promote growth and development of key organs during the first three weeks of life.

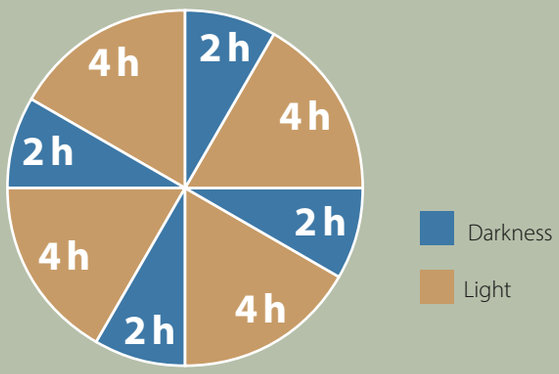
BROODING LIGHTING PROGRAM

Intermittent Lighting Program

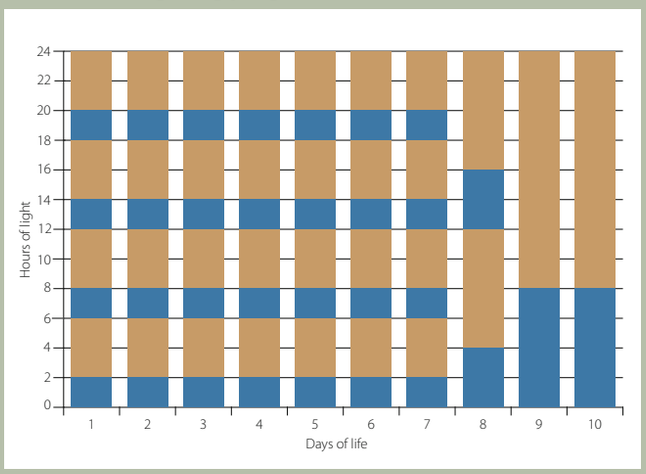
- Dark houses only (< 0.28 footcandle / 3 lux)

This program can be used for up to 7–10 days after arrival. Then switch back to the regular step-down lighting program. Using this lighting program has the following advantages:

- Chick behavior is synchronized; they rest or sleep at the same time.
- Weak chicks will be stimulated by stronger ones to move as well as to eat and drink.
- The behavior of the flock is more uniform and evaluating the flock is much easier.
- Chick mortality will decrease.



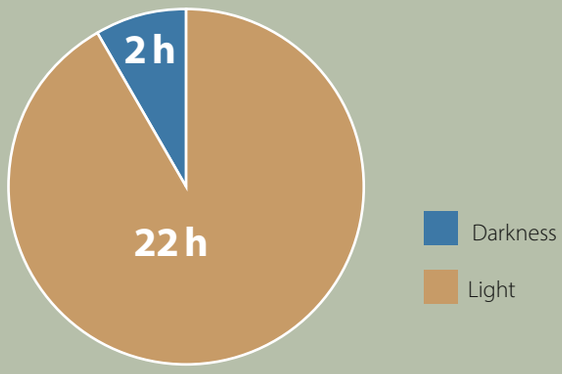
Intermittent lighting program



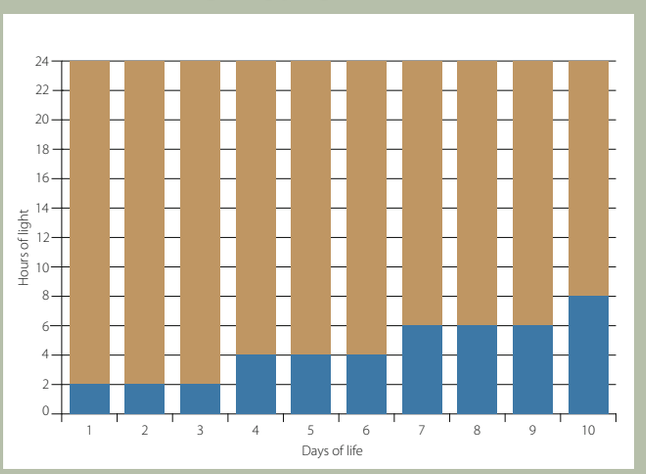
NON-Intermittent Lighting Program

- All houses

In open houses it is not easy to implement the intermittent lighting program. If this cannot be applied, 22–24 hours of light during the first 2–3 days is common practice. Providing a dark period during the day to allow the chicks to rest is highly recommended.
In a dark house the light level should be lower than 0.28 footcandle (3 lux) when the dark-out system is set. In other words, it must be completely dark.



Non-intermittent lighting program



WHAT DO CHICKS NEED DURING THE FIRST WEEK?

Temperature

The temperature should be between 93–97 °F (34–36 °C) for the first few days (see table 3).

- **Correct temperature:** Chicks will be well distributed and active.
- **Low temperature:** Chicks will group together and sound stressed.
- **High temperature:** Chicks will group in the coldest places, are inactive and pant.

Temperature recommendations:

- House temperature: 93–97 °F (34–36 °C)
- Paper and/or litter temperature: > 90 °F (32 °C)
- Concrete/ground: > 79 °F (26 °C)

Pasted vents may indicate chick are at or have been at a too high or too low temperature.

After two or three days, decrease the temperature by 1 °F (0.5 °C) every day. **Be aware that the best indicator is chick behavior and vent temperature.** Check the flock every time temperature settings are changed. The chicks will indicate if they are too hot or too cold.

If the house temperature is not uniform, take corrective measures by changing heaters and ventilation parameters.

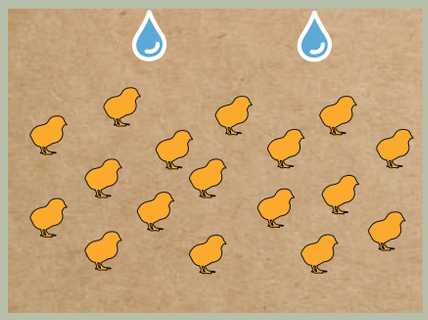
When housing the chicks, follow these recommendations:

- Place the smallest chicks in the warmest areas on the floor, or inside the aviary system.
- If the flock is arriving over several days, place the youngest chicks in the warmest areas or aviary system.
- Avoid placing chicks in very hot spots (near the heaters) or in very cold spots during the first 10 days.
- If most of the chicks are from a young breeder flock (younger than 30 weeks), increase the target temperature 33 to 36 °F (1 to 2 °C).

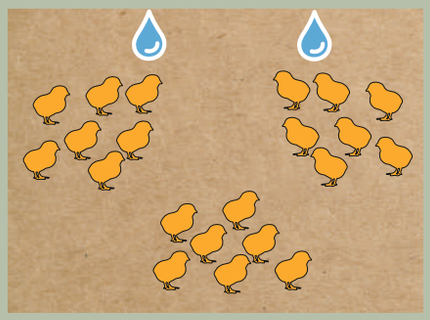
Table 3: Temperature recommendation

Type of brooding	Temperature at chicks arrival	Temperature decrease
Aviary systems	93 – 95 °F (34 – 35 °C)	Reduce 5 °F (3 °C) each week until supplementary heat is no longer needed.
Floor	95 – 97 °F (35 – 36 °C)	

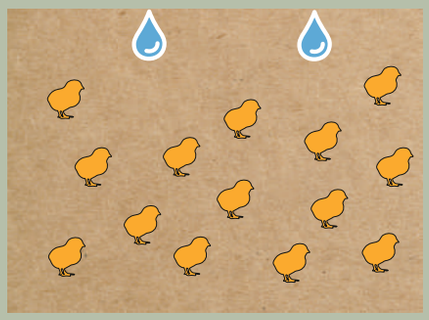
Correct temperature distribution



Low temperature distribution



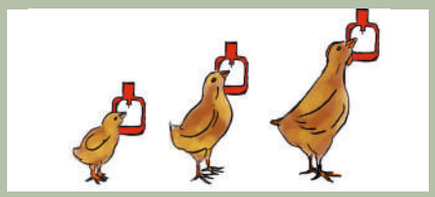
Hot temperature distribution



BROODING (1–21 days)

Water

Set the height of the drinkers so the chicks can drink easily.



In rearing houses 360-activated nipples are required for a successful chick start. If not available, and especially with infrared beak treated chicks, it is recommended to use cups or supplemental drinkers at a ratio of 80 to 100 birds per extra drinker during the first 5–7 days.
It is especially important to have extra drinkers when brooding on floor with circle or partial house brooding.

Reduce the water pressure in the drinking system to create a hanging drop at chick eye level.
Follow manufacturer recommendations.
Trigger the nipples or cups during the first 3–4 days, several times a day, to encourage chicks to drink.
Flush the lines just before housing the chicks and if possible, daily for the first 4 days, and keep water temperature between 68–77 °F (20– 25 °C). It is best to flush before the lights are on or after lights are off so no cold water is provided to the chicks.
Do not give cold water to chicks. Be careful when flushing water lines. Allow water time to warm up in the facility so chicks are comfortable drinking.

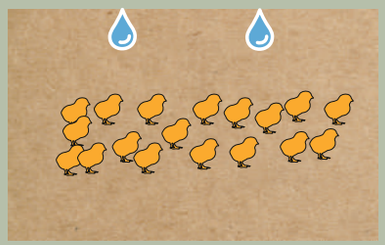
Ventilation

Supply sufficient volumes of fresh air to remove dust and undesirable gases.
Ensure sufficient air movement even on cool days (try to keep minimum ventilation of 24.71 ft^3/hour/kg | 0.7 m^3/hour/kg).

Strong movements of air disturb the chicks, they will avoid using drafty areas. This can negatively impact chick distribution and activity.

Adequate ventilation is especially important in hot weather.

Draft incorrect



An excellent brooding period is key to developing the gut, immune system, and the skeleton. This period is therefore crucial to improve flock livability during the first weeks, and to obtain good quality and productive pullets

Humidity

Humidity should be at least 60 %. Under 40 % humidity, chicks may dehydrate or damage their respiratory tract.

Adjust temperature according to relative humidity. For instance, the temperatures in this section are set for a humidity between 60–70 %. Above 80 %, the comfortable temperature reduces by 1.8 °F (1 °C) and below 40 % increase by 1.8 °F (1 °C).

In aviary row systems, and systems where the floor area is not used the first 3 weeks, water can be sprayed on the floor or concrete areas to increase humidity.

Fog installation in rearing house

WHAT DO CHICKS NEED DURING THE FIRST WEEK?

Feed

Good quality feed should be available for chicks immediately after placement.
Correct feed structure is also extremely important (see page 72).
Feed should be scattered on the paper and replenished during the first 3 – 5 days.

Place abundant feed in the feeders to attract the chicks.
Keep a high of level feed the first days or week.
To keep the chicks out of the feed chain, it is recommended to use a slow starter feed chain.

Chick saver in aviary rearing to prevent that day old chick moving in the running feed chain

Use of sponges in aviary row systems for good distribution of day-old chick in first day

Good distribution of day-old chick in the first days

Light

Light should be spread uniformly throughout the entire area where chicks are housed.
Light intensity between 3.72–5.57 footcandle (40–60 lux) during the first week inside the aviary row system, floor or slat area measured at drinker level. Light should be spread uniformly throughout the entire aviary system. It is important to avoid shadows and dark areas in the brooding levels. When the chicks are 14 days old, start with a dimming period at the end of the lighting program (see page 28, Step 6).

This can be done with automatic dimmers on the lights, switching off different areas of lights systematically.
This is to prepare the chicks for the time that they get access to the scratch area 1 or 2 weeks later, and bring them on the slats, or inside the aviary system at the end of the lighting program.
With this 15–30-minute dimming period they have enough time to find their way up to the slats, or into the aviary system. Staggered dimming is common in aviaries, for example under system lights dim to off in 1 minute, then the ceiling lights dim to off in 10 minutes and last the system lights dim to off in 20 to 30 minutes.
Ask equipment or chick supplier how to correctly use the lighting and equipment for a successful dimming period.

Always watch the pullet behavior when starting the training period. Always keep an eye on chick behavior when you start with this change in lighting program.

HOW DO YOU KNOW THAT EVERYTHING IS RUNNING SMOOTHLY?

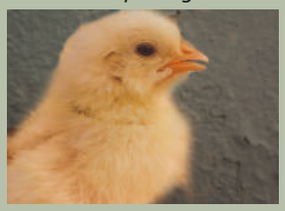
Crop Fill Measurement

Crop fill measurement is a good tool to check if the chicks are eating in the first two days of life.

1. Sample approximately 100 chicks.
   Take them randomly from around the house to ensure a reliable overview.
2. Gently feel the crop.
3. The crop should be full, soft, and rounded in started chicks.
4. Check the result according to the time after placement. If the result is below target, check the brooding conditions, and take corrective measures.

Correct crop filling

Incorrect crop filling



% of chicks with feed in the crop

6 HOURS AFTER PLACEMENT	12 HOURS AFTER PLACEMENT	24 HOURS AFTER PLACEMENT
75 %	85 %	100 %

Behavior

PAY ATTENTION TO YOUR CHICKS!!!

Chicks cannot talk but they send you many signals:

- Check their distribution
- Check their activity
- Check the water and feed intake
- Check what kind of sound they are making
- Check to see if they are content

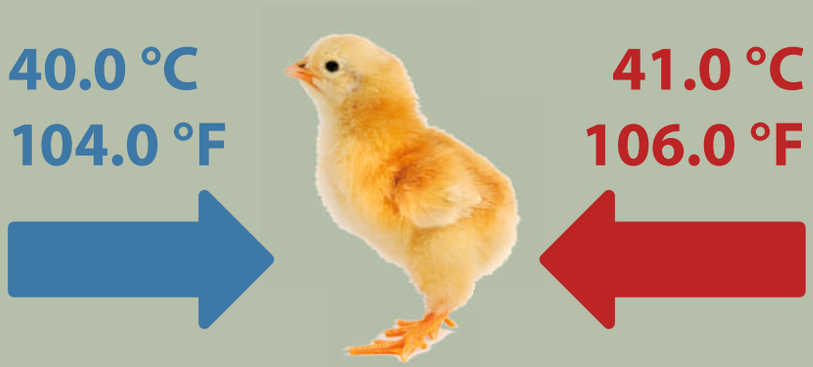
Body weight

At the end of the first week, it is best if the body weight doubles. Chicks with feed in the crop placement and uniformity should both be > 80 %. If these goals are not achieved, a review of management (drinking or feeding management, temperature, etc) and nutrition needs to be performed.

Cloacal Temperature

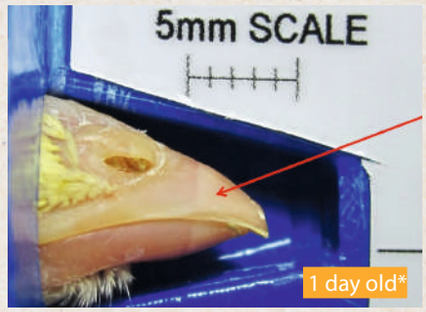
Chick temperature is between 104–106 °F (40–41 °C) after the moment of full homeothermy. During the first week of life chicks are unable to control their body temperature and it varies according to the ambient temperature. This information can be used to adjust house temperatures optimally.
Use modern ear thermometers (see picture).

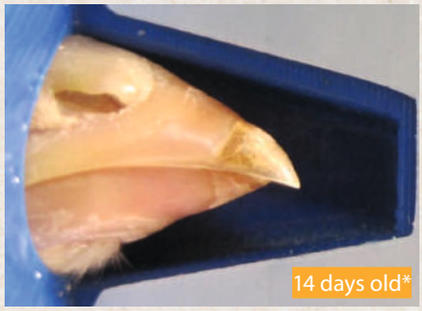
1. Make sure to collect samples of chicks from different parts of the house. Sample chicks distributed throughout the house for reliable readings. Circle or spot brooding take temperature of 4–5 chicks per circle brooder. In floor / slat / aviary brooding 60 samples (20 front, 20 middle, 20 back side of the house).
2. Check their cloacal temperature.
3. Collect the information, calculate the average, and adjust the house temperatures accordingly to achieve optimal chick temperatures for all the chicks. Adjust the environmental set point or temperature: +/– 1°F per 0.5 °F (+/– 0.5 °C per 0.3 °C) above the upper limit or below the lower limit of optimal vent temperature.

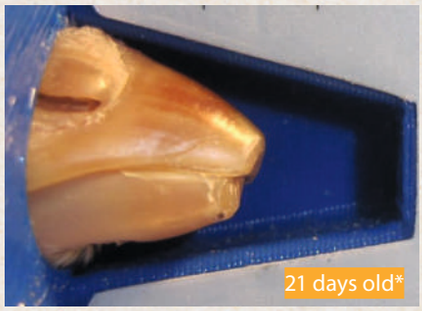


Important!

A chick's body temperature does not correlate with the current temperature but with the temperature of the last few hours.







**Pictures courtesy of Nova-Tech®*

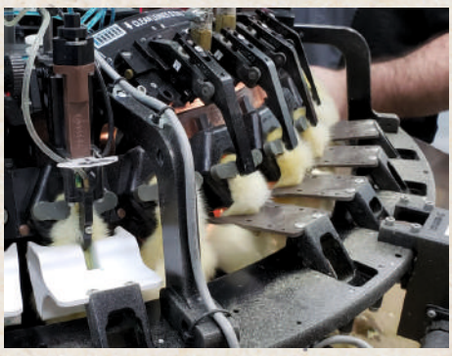
If you would like to have more information about this treatment please contact your H&N North America representative.

BEAK TREATMENT

Beak treatment is an important injury prevention measure in poultry management, especially in open houses with high light intensity. While various methods of beak treatment may be used: the objective is to treat the beak at the right time in a uniform manner that will permanently slow future beak growth. Place higher levels of feed in the feeders for a few days or weeks after beak treatment to reduce pecking on an empty feeder or chain.

Infrared Beak treatment (IRBT) of day-old chicks

The beaks of day-old chicks can be treated at the hatchery using infrared technology. This method will provide a uniform beak treatment.



PAY ATTENTION TO:

- **Drinking water:** It is vital to encourage the water intake in the first days. In rearing houses 360-activated nipples are required for a successful chick start. Additional cup drinkers are also preferable. If bi-directional nipples are the only option, providing additional cup drinkers might be necessary. Trigger nipples twice a day for the first 2 – 4 days to place a drop of water on the nipple waterer.
- **Light:** Ensure the light level in the drinker area is minimum 3.72–5.57 footcandle (40–60 lux) for 3 to 5 days.
- **Feed:** Scatter feed on paper until day 7 and place a higher level of feed in the feeders for a few days or weeks after housing hatchery beak treated chicks to reduce pecking on an empty feeder / chain.

Key Points

- **Focus on water, feed, light intensity, air temperature and humidity during the first week.**
- **Check chick behavior and adjust the brooding conditions.**
- **Implement an intermittent lighting program if possible, in the first 2 weeks and start to implement a dimming period at end of the lighting program after 14 days. This will begin to teach the birds to find their place inside the aviary system after the system is open.**
- **Give the chicks the correct space they need to grow (see recommendation on page 15).**
- **When flock is vaccinated for coccidiosis and chicks are split from one level to another level in aviary row systems, move part of the paper to this new level**
- **Beginning in week 1, take body weights every week. Always weigh the birds on the same day of the week and at the same time of day.**

GROWING (3 – 9 weeks)

- **How to set the correct lighting program in rearing according to your geographical situation, house type and production objectives, how to train the chicks effectively.**
- **How to promote pullet growth during this period.**
- **How to use the chicks feathering and natural molting pattern to monitor chick development.**
- **How to use system and perches in floor or aviary rearing to promote bird welfare, livability, body development and prevent future mislaid eggs.**
- **Provide additional space (feeder, drinker and stocking density) around 3–4 weeks. Give the chicks more space (drinkers, feeders, stocking density) a.s.a.p. The earlier the better.**

LIGHTING PROGRAM

BASIC PRINCIPLES

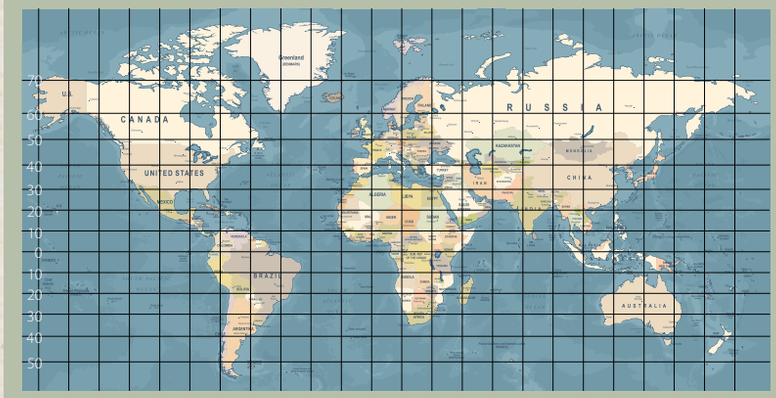
- The hours of light at the end of rearing should equal the hours of light at the production house before the start of light stimulation.
- The light intensity should be similar to what the pullets will find in the production house.

DESIGN YOUR LIGHTING PROGRAM IN SIX STEPS

STEP 1

What is the Destination of the Pullets?

- How many hours of light do you have in your region?



- Examples

Country	Hemisphere	Hatch date	Start of lay date	Light hours at start lay
Mexico	20° North	5th February	June	12 h 29 min.
Peru	10° South	5th February	June	11 h 35 min.
Senegal	20° North	5th July	November	11 h 53 min.
Indonesia	10° South	5th July	November	12 h 31 min.

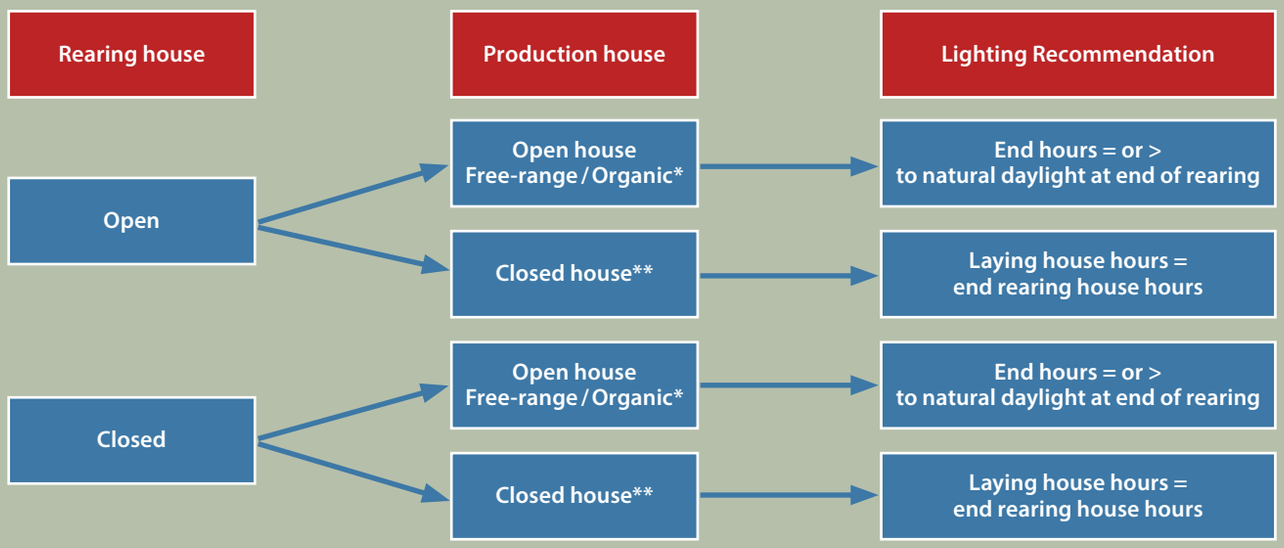
Hours between Sunrise and Sunset in the Northern and Southern Hemispheres

Northern date	0°	10°	20°	30°	40°	50°	Southern date
5-Jan	12:07	11:34	10:59	10:17	9:27	8:14	5-Jul
20-Jan	12:07	11:38	11:05	10:31	9:47	8:45	20-Jul
5-Feb	12:07	11:44	11:19	10:52	10:19	9:32	5-Aug
20-Feb	12:06	11:50	11:35	11:16	10:55	10:23	20-Aug
5-Mar	12:06	11:58	11:49	11:38	11:28	11:11	5-Sep
20-Mar	12:06	12:07	12:06	12:06	12:07	12:09	20-Sep
5-Apr	12:06	12:14	12:25	12:35	12:49	13:08	5-Oct
20-Apr	12:06	12:24	12:41	13:02	13:27	14:03	20-Oct
5-May	12:07	12:31	12:56	13:26	14:02	14:54	5-Nov
20-May	12:07	12:37	13:08	13:45	14:32	15:37	20-Nov
5-Jun	12:07	12:41	13:17	14:00	14:53	16:09	5-Dec
20-Jun	12:07	12:42	13:20	14:05	15:01	16:22	20-Dec
5-Jul	12:07	12:41	13:19	14:01	14:55	16:14	5-Jan
20-Jul	12:07	12:37	13:11	13:49	14:38	15:46	20-Jan
5-Aug	12:07	12:32	12:59	13:29	14:09	15:02	5-Feb
20-Aug	12:06	12:25	12:44	13:06	13:35	14:14	20-Feb
5-Sep	12:06	12:17	12:26	12:40	12:55	13:16	5-Mar
20-Sep	12:06	12:08	12:10	12:13	12:16	12:22	20-Mar
5-Oct	12:07	12:01	11:53	11:46	11:37	11:26	5-Apr
20-Oct	12:07	11:52	11:36	11:20	10:59	10:31	20-Apr
5-Nov	12:07	11:44	11:20	10:55	10:21	9:36	5-May
20-Nov	12:07	11:38	11:07	10:34	9:51	8:51	20-May
5-Dec	12:07	11: 35	10:59	10:19	9:29	8:18	5-Jun
20-Dec	12:07	11:33	10:55	10:13	9:20	8:05	20-Jun

STEP 2

Where will the Birds be transported to and from?

▶ This determines the number of hours at the end of the program.



** Open house: any construction where there is > 0.28 footcandle (3 lux). House with free-range/organic production, curtains, or nothing at all.*

*** Closed house: any construction where there is < 0.28 footcandle (3 lux). House made of panels or bricks.*

STEP 3

Number of Hours in the Rearing House

▶ Depending on limitations in step 1 and 2, determines the optimum end hours for your type of house: open or dark.

Short: ending at 10 – 11 hours / day

- Only in closed house
- Free-range and organic production depending on the season.
- Electricity savings
- Concentrate time for feed intake
- Feed intake challenge

Long: ending at 12 – 14 hours / day

- Open and closed houses
- Free-range and organic production depending on the season.
- More time for feed intake
- High electricity cost in light-tight houses

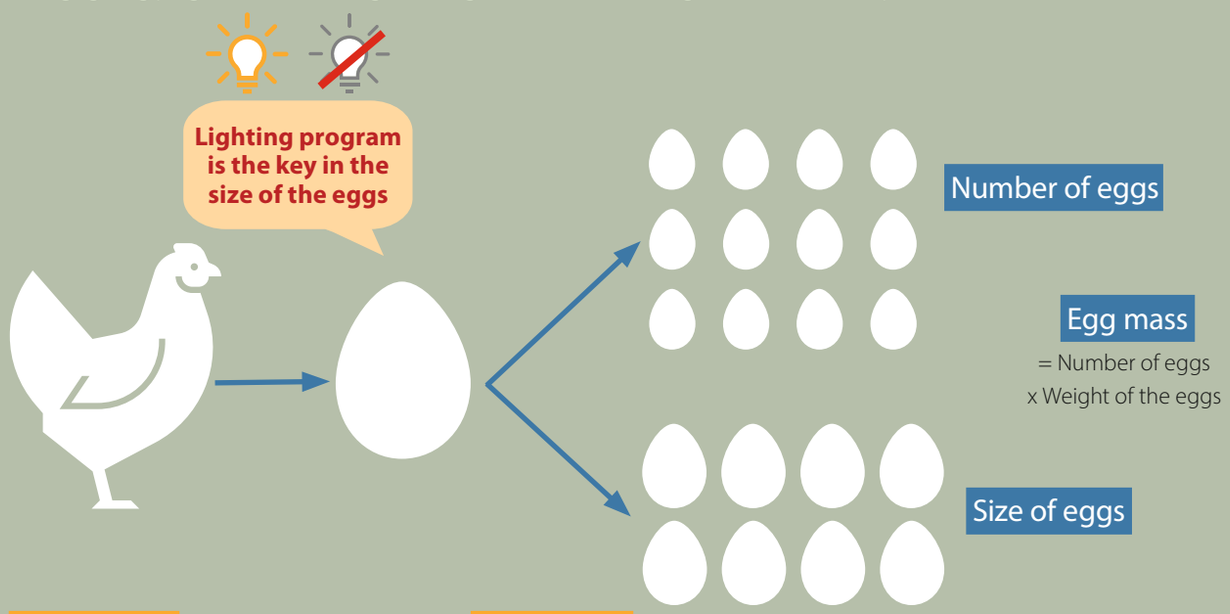
Remember: The hours of light at the end of rearing should equal the hours of light at the production house before the start of light stimulation.

STEP 4

Speed of Light Reduction

- Driven by your market requirements, egg size target and feed intakes.

The lighting program in laying hens is an essential tool to achieve a specific type of production. This is especially true for egg size as the rearing lighting program and the timing for the light stimulation, have a greater effect on this parameter.



Slow Step Down

- Bigger egg size in production
- More time for feed intake
- Recommended for Hot climates

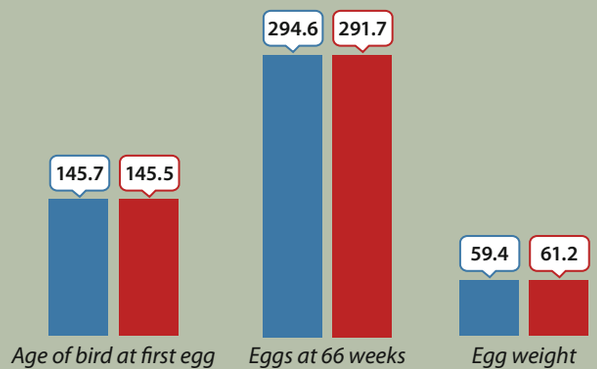
Fast Step Down

- Higher sensitivity to light, faster start in production
- If it does not appear that body weight targets will be met at week 5, it is recommended to change to a slower step down to allow body weights to improve. Once achieved you can return to the fast step down.

The flocks with slow step down (one hour per week) tend to produce larger egg size than those with faster step downs (two hours or more per week).

W	1	2	3	4	5	6	7	8	9	10	...	18
	23	22	21	8	8	8	8	8	8	8	8	10
	23	22	21	20	19	18	17	16	15	8	8	10

Source: Leeson 2005



IMPORTANT

Note that everything described in this chapter is only applicable for birds that reached their standard weight and have had a uniform development during their production phase as explained before.

For more details check out Technical Tip Egg Size:

STEP 5

Light Intensity at the Destination

▶ Light intensity should be adapted across the different rearing periods.

On floor / aviary, measure at bird level head, between light bulbs, at drinker and feeder level. Use the lower value to adjust to follow the recommendations.

During the first week a higher intensity is needed to encourage the birds to eat and move through the area.

From 14 days of age, start to use a dimming period of the light for 15–30 minutes at the end of the lighting program, to start training the pullets to find their way back inside the system or on the slats in the evening / night.

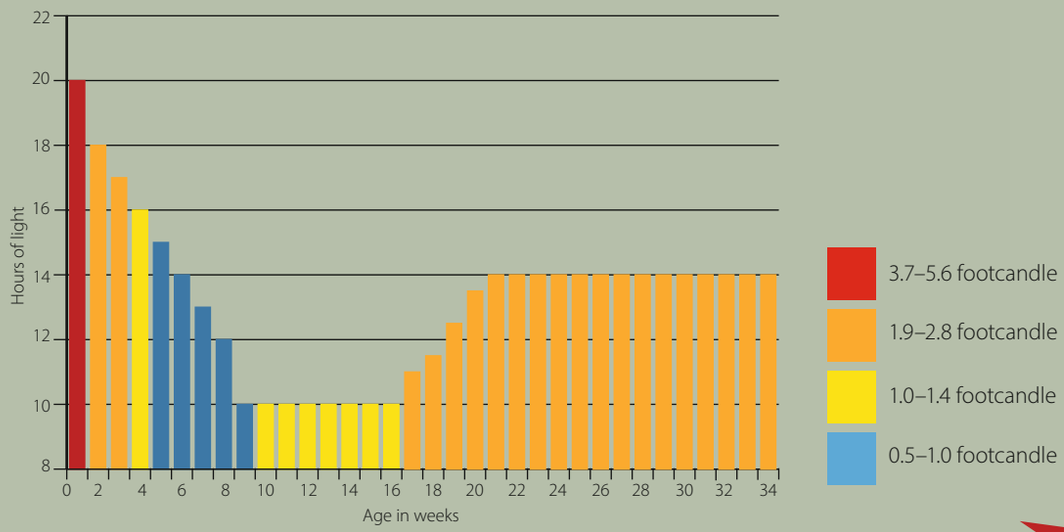
After week 5, the light intensity should be decreased to calm the birds and prevent pecking and cannibalism. This is also recommended in open rearing houses and organic rearing.

After 10–12 weeks of age, it is recommended to have a minimum of 1 footcandle (10 lux) to prevent floor and system eggs in later production period.

Light intensity in rearing never should be much lower than what will be expected in the production house.

Always avoid any sharp increases of light intensity after transfer.

Example of lighting program for dark houses



STEP 6

Dimming Period in Rearing / Production

IMPORTANT

Discuss this dimming program with technical advisors from your chick and system suppliers

▶ From 14 days of age, start to use a dimming period at the end of the lighting program.

When pullets are released from the slats or aviary systems at 3–6 weeks of age, they need to be trained to find their way back at the end of the day to stay on the slats, or inside the aviary system during the night. Earlier is better, be mindful of stocking density.

Train the pullets by switching off different light zones, step by step in a dimming period of 15–30 minutes.

Depending on the rearing system, there may be 2 to 5 lights that need to be dimmed to off at different steps. This is 15–30 minutes time total (see pictures of different rearing/production systems on page 6 to 12). Start to dim or switch off Light 1 then followed by zones 2-3-4 or 5. By starting at 14 days of age, the chicks are already training, and this program will allow for an easier transition at the time they are released to the slats or system.

After releasing the pullets, during the first days, lights must be dimmed manually to see how much time it takes for the birds to return inside the system or slat area.

It is strongly advised during the rearing period to regularly check every 2 weeks to see if all birds are entering the slats or system at the end of the lighting program.

▶ Continue this dimming program in the production house after transferring the pullets

TRAINING PULLETS IN CAGE-FREE REARING

Release the Pullets to the scratch Area

▶ With the use of aviary row systems, ⅔ slats, and aviary systems within height adjustable slats.

- Depending on the height of the system, start to release the chicks beginning at 3 to 6 weeks of age.

Release the pullets as early as possible.

- Stocking density needs to be considered.
- The sooner the chicks have access to the floor, behavior problems are reduced in the second part of the rearing period and production.
- Use minimal amount of litter in the scratch area.
- Use additional ramps or stairs to help the chicks find their way inside the system at the end of the lighting program.
- Open the system 1 hour after the start of the lighting program, and let the chicks find their way out.

Release the pullets out of the system in stages.

- Try letting out the bottom tier of a few rows of the aviary or one side at a time. This will help limit the number of pullets that will need to be placed back in the system at the end of the day. When this works well after a few days, release the other rows, and other sides.
- Allocate enough people at the time that lighting program ends.
- With the use of a dimming program, many pullets will find their way up into the system by themselves. If they don't find their way, they will need to be placed up in the system every evening for the first week or how long it takes to get the flock trained.
- Initially, you can use some laser pointers to stimulate the pullets to jump on the slats, or inside the aviary system.
- Place the pullets on the slat area or inside aviary system at the end of the lighting program.
- An option is to provide alfalfa on the scratch area a week after release of the pullets. This gives the farm manager a tool to check if everything is on target, for example if the alfalfa is consumed rapidly this is an indication you need to check the house temperature, feed ration, feed management. The bale will last longer if these areas are correct.
- **When the pullets consume the alfalfa, the feed intake and feed formulas need to be reviewed.**

IMPORTANT

We would like to see 100 % of the pullets up, or inside the system at the end of the lighting program!

During the entire Rearing Period

- Make sure that all the pullets are moving up to the slats, or inside the aviary system during the entire rearing period. Verify in the evening after the lights are out.
- Reactions to vaccinations or temperature stress can disrupt the training of the pullets. Pullets can regress and they may revert to sleeping on the floor. Training needs to be monitored on a regular basis.
- Please check that pullets are going up after the lighting program once a week.

PULLET DEVELOPMENT

Pullets show extreme body growth during this period. This is especially true if we consider the percentage of growth compared with the previous body weight.

Even more importantly, at this stage the birds will develop most of their organs, skeletal system and muscles which are essential for their health and performance. Therefore, correct growth during this period is key to having healthy and productive adult birds.

If growth is delayed in this period, further compensatory growth will be impossible for bone frame. The birds can reach the standard weight, but the body development will differ, and hens can become over conditioned. Check that you are achieving the correct body weight from week 1 and take corrective measures before it is too late.

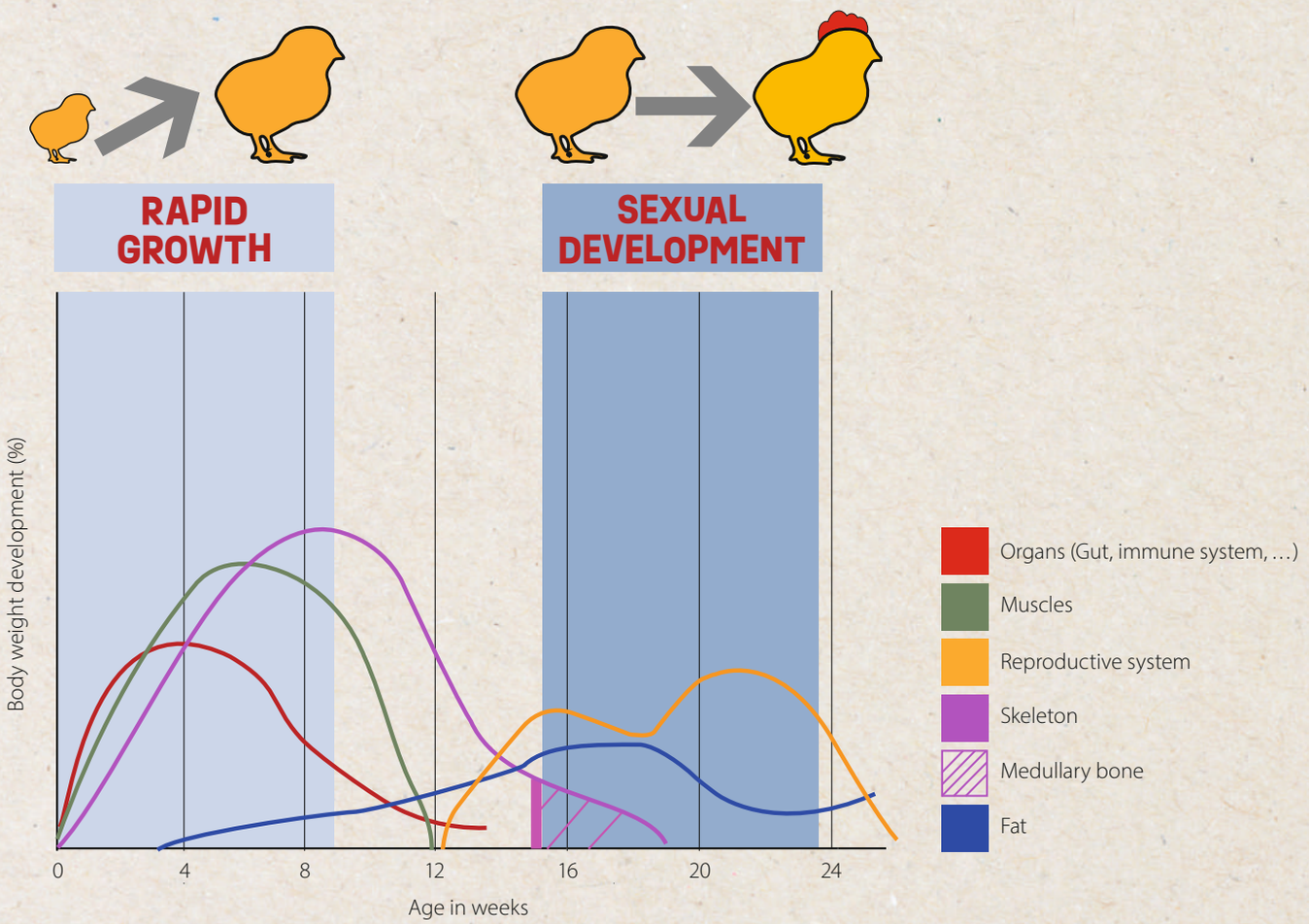
Uniformity should be above 85 %.

Change diets if body weight is on target at the corresponding age: 0 to 5, 6 to 10 and 11 to 17 weeks (see the nutrition chapter) with a uniformity above 80%. If the body weight goals were not met, delay the change one or two weeks. Also, it is a possibility to delay the change in case of stress events, like vaccinations. It is very important to achieve the standard body weight during the first 12 weeks of age.

If body weight is too far ahead of the standard, you can change diets faster to ensure they stay on target. If the body weight stays above target during this period, the hens may grow too large, which can reduce feed efficiency.

IMPORTANT

It is very important to achieve the standard body weight at week 5 – 6.

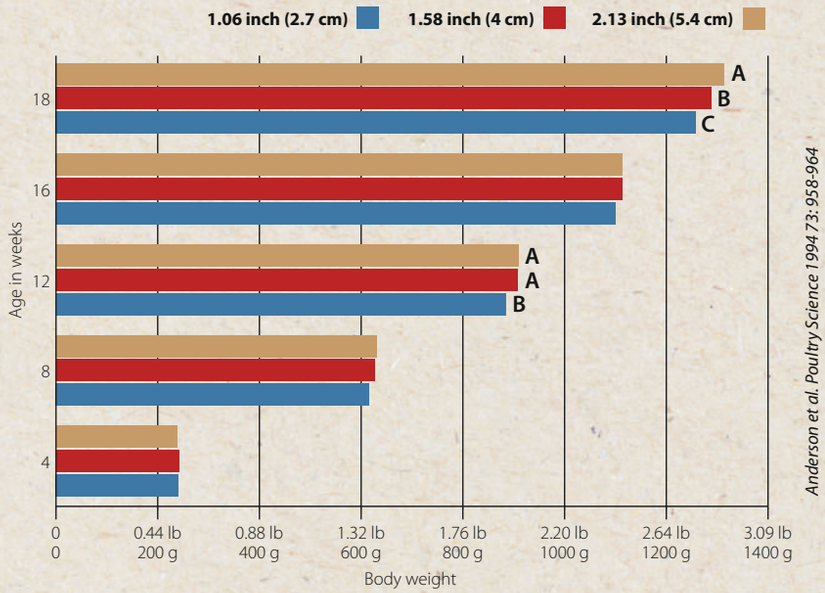


FEED INTAKE

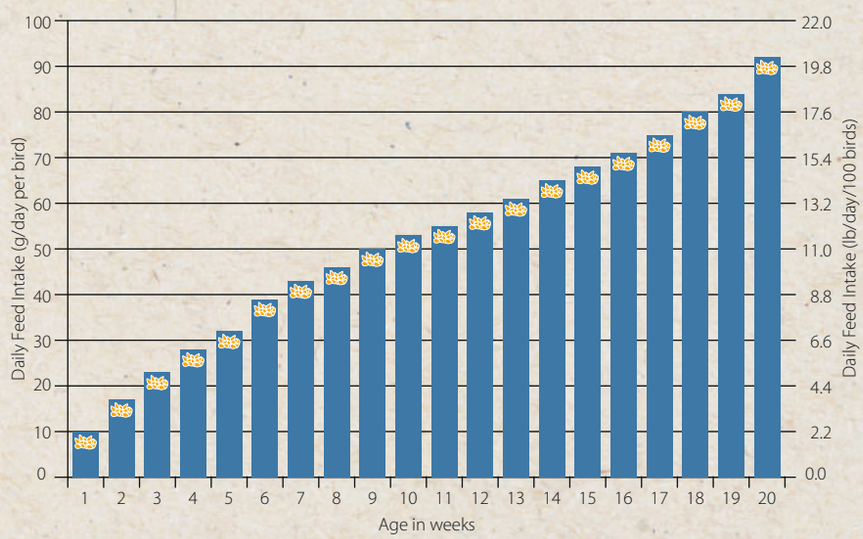
Considering the importance of growth in this period, it is a priority to promote good feed consumption to maintain correct development:

- Temperature at week 3 should be 71.6–73.4 °F (22–23 °C). This can be slowly reduced over the next few weeks to around 66.2 °F (19 °C) at 9 weeks of age.
- Maintain stocking density on target. In aviary systems birds should be distributed along all the levels as soon as possible.
- Maintain adequate feeder space.
- Beginning at week 5–6, train the chicks to empty the feeders once a day, BUT never restrict the feed intake.
- If the birds are ahead on body weight, advance the diet to the next one, but don't restrict feed.
- Provide a midnight feeding if the standard weight is not reached. In floor and aviary rearing keep an eye on your bird's behavior during its implementation.
- Providing good quality feed is also key to good bird development.

Effect of the feeder space on body weight



Daily feed intake pattern



▶ Daily intake can vary depending on feed composition.

FEATHERING

Correct feathering is essential to enable a bird to regulate its temperature properly and is indicative of good development. A series of natural molting will occur during the rearing period. One complete molting (between 1 to 6 weeks) and three partials at 7 to 9 weeks, 12 to 16 weeks and 20 to 22 weeks when the stiff tail feathers are grown. It is important that molting occurs in the indicated periods, otherwise it may signal delayed physiological development of the birds: nutritional, management, disease or other problems.

It is important to periodically evaluate the feather conditions both during rearing and production periods. Loss of feathers during production could indicate a stressor, impacting the flock.

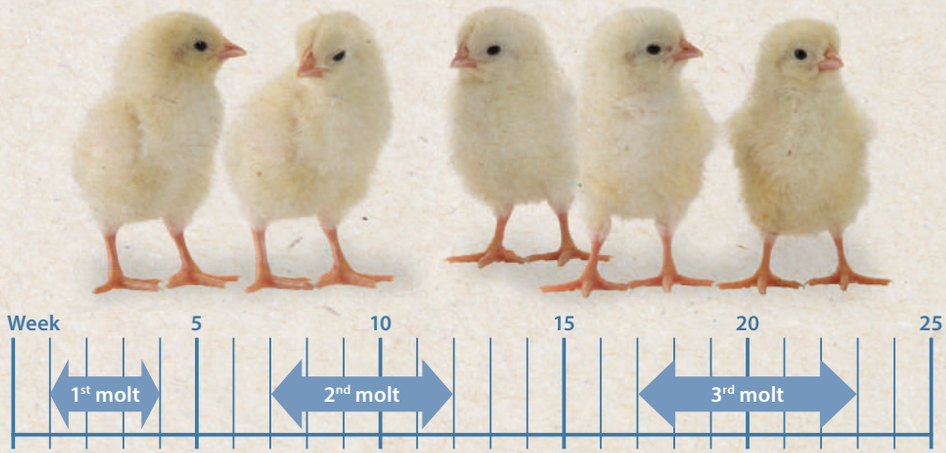
One of the tools to evaluate the status of the flock is by the primary feathers condition which can be done frequently (for example, every other week). This can help us to evaluate the status of feathering during rearing and production. Keep in mind that the number of molted feathers could give us an indication of the extent and magnitude of the stressor.

Here is a list of some stress factors that can impact the flock inducing partial "molting" and consequently impacting the primary feather development:

- Decrease of daylight
- Loss of body weight
- Disease
- Excessive cold or hot
- Irregular feeding
- Insufficient feed
- Management (overcrowding, bad distribution in the system, water deprivation or low flow)
- Insufficient feed or water space
- Ventilation issue

Some birds reduce body weight and production but never completely stop producing eggs. In a molt, excessive feathers on the floor or manure belt can be seen.

Feathering and molting across the rearing period



Insoluble grit

Start to provide insoluble grit in a round feeder or spread over the scratch area once a week. This to stimulate the development of the crop and gizzard. This also improves the litter quality and keeps the birds active.

Start to provide it from 3–4 weeks until 10 weeks of age 0.66 lb (3 g)/week/100 birds with clean grit (2–3 mm). Up to 10 weeks of age till end of rearing 0.88–1.10 lb (4–5 g)/week/100 birds (3–5 mm).

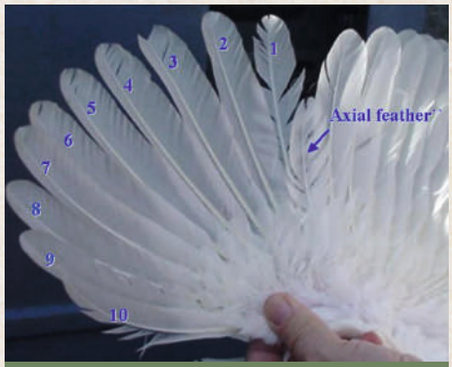
An option is to provide some alfalfa in floor or aviary rearing during stressful periods (1 bale of 10 kg / 2000 pullets).

Start to provide it 1 week after the chicks have access to the floor area and continue at least until 10–12 weeks of age.

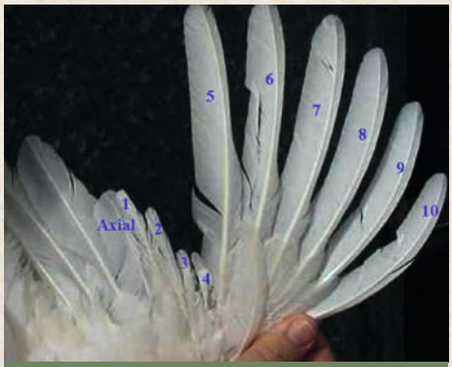
If pullets consume the alfalfa fast, check the feed density and feed distribution. After that, slowly reduce the quantity of alfalfa until there is none remaining. Use pickstones in flocks that are not beak treated.

When bird behavior or feathering is not adequate, please continue with grit, pickstones, and alfalfa additions, until the end of rearing. They may also be used in production.

Keep litter level low during rearing period and try to keep the litter material dry. This will significantly reduce problems with ammonia concentrations, as well as pullets that sleep on the floor at night.



The axial and primary feathers on a wing of a chicken not in molt



Four feather molt, induced by an important stressor

One feather molt (First one); partial molting induced by a stressor.

Pictures from University of Kentucky: Evaluating Egg-Laying Hens

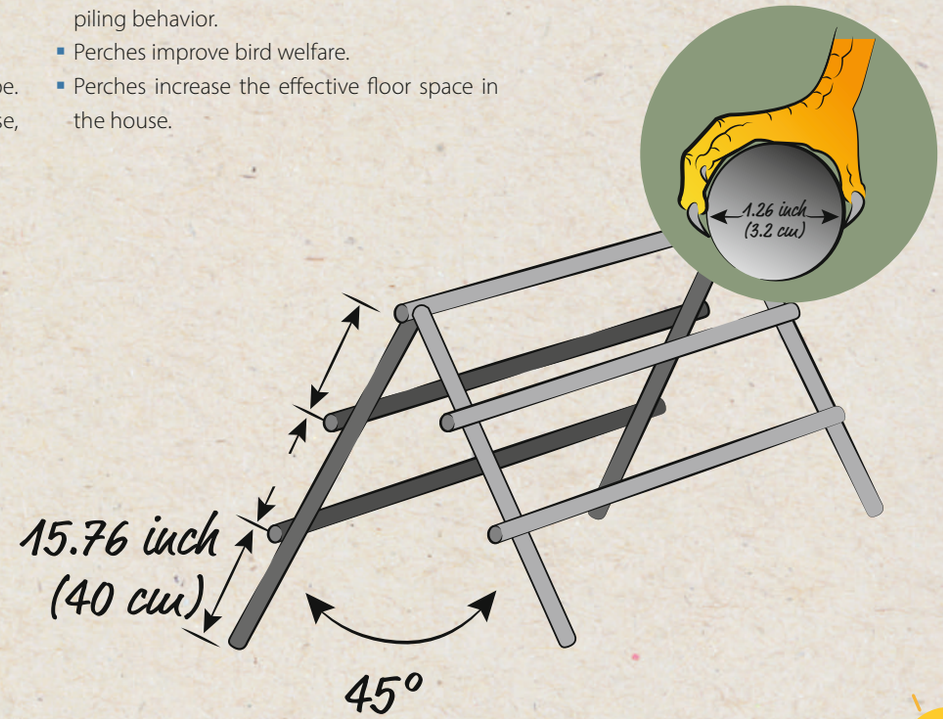
PERCHES

In most row aviary systems, and in height adjustable slats, perches are already integrated. For other rearing systems perches are strongly recommended.

Perching improves nesting behavior, animal welfare, improve livability, bone and muscle structure and reduces mislaid eggs. Perches need to be placed as early as 3 weeks of age.

Characteristics:

- Perches should have a round or oval shape. If square perches are used in the layer house, they can be used in the rearing facility.
- Perches should have minimum 1.97–2.76 inch (5–7 cm) of available space per bird. The value depends on the bird density (higher value for high stocking density).
- At least 0.39 inch (2.5 cm) width or wider.
- Is recommended to place the perches as early as 3 weeks of age.
- Perches help to promote activity and reduce piling behavior.
- Perches improve bird welfare.
- Perches increase the effective floor space in the house.
- If houses have ⅓ of floor with slats, always place the perches on the slats.
- Use the same type of perches in rearing and production.
- Preferably, place perches over the feeder line.
- Seal cracks, fissures and open ends of pipes to reduce areas where mites can hide.



Key Points

- Implement the lighting program according to your location and housing conditions.
- Never allow day length to increase during the rearing period.
- Give the chicks access to different levels, and the floor area as soon as possible.
- Provide enough feeder and drinker space as soon as possible.
- Place perches at 3 weeks of age (floor rearing).
- Start with feed management and feeding on an empty feeder once a day when the pullets are 5–6 weeks of age.
- Achieve the required body weight at weeks 5 and 6 of age.
- Follow the feathering and natural molting timeline to monitor physiological development.
- It's beneficial to provide alfalfa, pick stones and insoluble grit in rearing.

REARING PERIOD (10 – 17 weeks)

- How to ensure weight gain and development during the last weeks of the rearing period.
- How to train the feed intake capacity to be ready for the production peak.
- How to prepare hens for the production period.

BODY WEIGHT

Weight gain slows down during this period, but the chicks will continue to grow and develop. Most of the skeleton and muscular systems have already been formed and fat deposition will now begin.

A correct fat level in the body is necessary to achieve a good production peak, but over conditioned pullets will face many issues in production (prolapse and pecking late in production). The feed intake is higher than in previous weeks. The birds may be given a less dense feed.

If birds are within the weight standard or slightly above:

- Train feed intake capacity for the production peak challenge.
- Promote weight uniformity.

If birds are under the standard weight:

- Some compensatory weight can be gained by maintaining grower feed for several weeks. However, this is very limited and the production period should be delayed.
- Maintain a low stocking density. In alternative systems birds should be distributed along the complete system on every level. Give ALL the birds access to all different levels.

Take weekly body weights from birds on different levels, and in the front and the back of the house.
This is to verify that body weight is increasing, and uniformity is improving in the flock.
When there is a difference in body weight, you need to check the feed distribution.
Producers can adjust weight for the age in days if needed to match the weight on the day the weight is taken.

Table 4: Pullet Body weight

Age (weeks)	Body Weight lb	Body Weight g	Diet
1	0.14	65	STARTER
2	0.26	116	
3	0.39	175	
4	0.54	245	
5	0.72	325	
6	0.90	410	GROWER
7	1.09	496	
8	1.28	582	
9	1.47	665	
10	1.64	745	
11	1.81	822	DEVELOPER
12	1.98	896	
13	2.13	967	
14	2.28	1035	
15	2.43	1101	
16	2.58	1168	
17	2.72	1235	
18	2.87	1300	HYBRID FEED
19	2.99	1358	
20	3.10	1408	

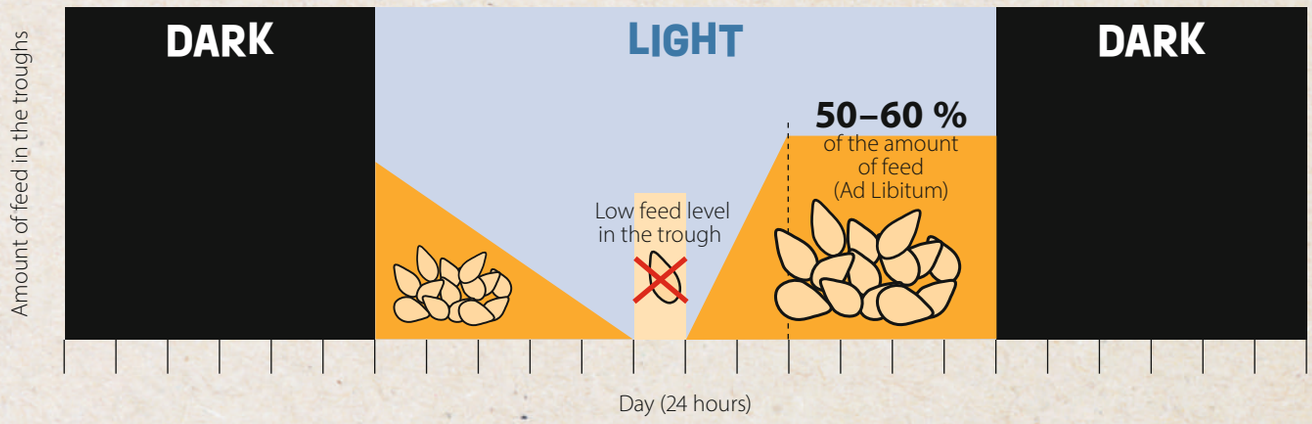
FEED INTAKE TRAINING

During the last weeks of the rearing period, the nutritional requirement is not very high. However, it will change dramatically in the first weeks of production. To help the hens to deal with this change it is beneficial to train them to increase their feed intake during the end of the rearing period.

- **Low density feed.** From 10 to 17 weeks, it can be useful to switch to a more diluted feed (2700 Kcal, 15 % CP, 4.5 % fiber) that promotes feed intake.
- **Feed distribution program** allows hens to empty the feeders once during the day (see the diagram below).

The feeding schedule should be similar to the one the layers will have in production. You can start this program as soon as 5–6 weeks of age (growing period) when pullets have access to all the living space in the systems (see pictures of low-level feeder on page 46).

Feed distribution in rearing from 5 till 17 weeks



REARING PERIOD (10 – 17 weeks)

Body weights should be at or above standard, and uniformity above 85 %. **This is only possible if the hens are kept at the correct stocking density and there is enough feeder space.**
To prepare the pullets to find the feed, water, and nest in the production system, be sure that they ALL move through the system in rearing.
Match the production system with the training provided to the pullets in rearing.
Train enough but be careful that you don't train too much, for example training pullets to jump higher than they need to in the production house.

When pullets go to a cage-free floor system with slats, and nest boxes on the slat level, or combi systems with feed / water / nest on every level, it is not needed that all the pullets move out of the system in aviary systems, or of the slats in rearing. When pullets are transfered to aviary production systems where feed/ water/ nest boxes are on different levels each, you need to be sure that ALL pullets move through all the levels in rearing.

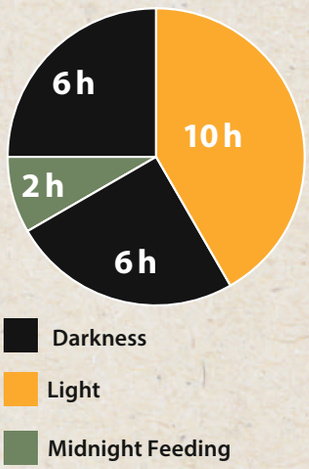
Gizzard with (left) or without (right) feed intake training

WATER TRAINING IN ROW SYSTEMS

- This water training is used to encourage ALL the pullets to go out of the levels with feed or water and jump to other levels.
- **Discuss the need and kind of water training program with technical people from your chick and equipment supplier.**

MIDNIGHT LIGHTING

Midnight Feeding



This management technique is used to increase feed intake and body weight during rearing period. It consists of lighting in the dark period to allow hens to feed and refill the crop.
The following guidelines should be followed for the correct application:

- Switch on the lighting for at least one hour and up to two hours. These hours are in addition to the normal period of light.
- Midnight period must be at least (and never less than) three hours after switching off the lighting and at least three hours before the lights switch on.
- Feeders must be filled before the lights are turned on.
- Water must be available

Midnight Feeding can be used with different objectives:

- Increase feed consumption. It can be used in rearing and/or production. It is especially useful in hot climates where birds are unable to feed properly during the day.
- This will help in improving eggshell quality during production. The availability of extra calcium in the intestine allows better calcification and reduces bone decalcification (see midnight lighting program in production on page 76).

IMPORTANT

Please observe the behavior of the birds closely when you provide a midnight feeding in floor and aviary systems.

Key Points

- **Ensure body weight gain and correct development by monitoring feed consumption.**
- **Train hens to develop a good feed intake capacity by working with diluted feed and adapted feeding times where they empty the feeders once a day.**
- **Remove or separate small pullets from the flock.**
- **Maintain a target stocking density. In alternative systems birds should be distributed along the complete system on every level. Give ALL the birds complete access to the feed.**
- **Train hens to move between the different levels in the rearing system for good behavior in production system.**

TRANSFER (16 – 17 weeks)

- How to prepare a flock for transfer to the laying house.
- How to transfer a flock to the laying house.
- How to house a flock in the laying house.

PREPARING THE PULLETS TO MOVE TO THE LAYING HOUSE

- It is recommended to transfer the birds between 16 and 17 weeks and once the vaccination program has been completed (after the last killed vaccine is administered). The birds should have time to become familiar with the new environment before they start to lay.
- If the feed and water systems used in the rearing and the laying house are similar it will help the birds to make a smooth transition. The same lighting program as in the rearing house should be applied. As page 26 shows, good communication and coordination between the rearing and the laying house personnel is necessary to synchronize flock management.
- **It is a good management practice for the laying house manager to visit the pullets several times during the rearing period.**
- Complete the vaccination program before transfer. If possible do not administer vaccines during the transport or catching processes.
- Make sure pullets have access to feed and water before the transport.
- In hot climates, or long-distance transport, plan with your technical adviser how to handle feed and water for the day before.

PRODUCTION HOUSE 	▪ All maintenance completed ▪ House clean and disinfected ▪ Feed in the silos ▪ Correct temperature ▪ Sampling of Cleaning and Disinfecting (C&D) process performed and satisfactory laboratory results received. ▪ Pre-heating in cold periods
FLOCK 	▪ Pullets on body weight and uniformity ▪ Vaccine program administered ▪ Approved Sanitary certificate ▪ Flock information sent to production house (lighting program, feeding times, type of feed, body weight, etc.)
TRANSPORT 	▪ Transport truck ready ▪ Catching crew ready ▪ Housing crew ready ▪ Weather condition checked ▪ **NO VACCINATION DURING CATCHING AND TRANSPORT!**

- There are aviary rearing row systems that allow containing the pullets inside the system the evening before the transfer to make the catching easier.
- Use the same lighting program from rearing in the laying house, with the same dimming times at the end of the day.
- Complete the vaccination program early enough so that the flock is not still reacting to the last vaccine.

STOCKING DENSITY IN THE LAYING HOUSE

The birds should have enough space, especially in hot climates.

When pullets are enclosed in the aviary system, only keep them enclosed the minimum amount of time needed for the move. For stocking density requirements refer to the UEP Certified Standards. It is important that there is enough feed/water/nest box per bird in the house. (a minimal recommendation is given in table 5).

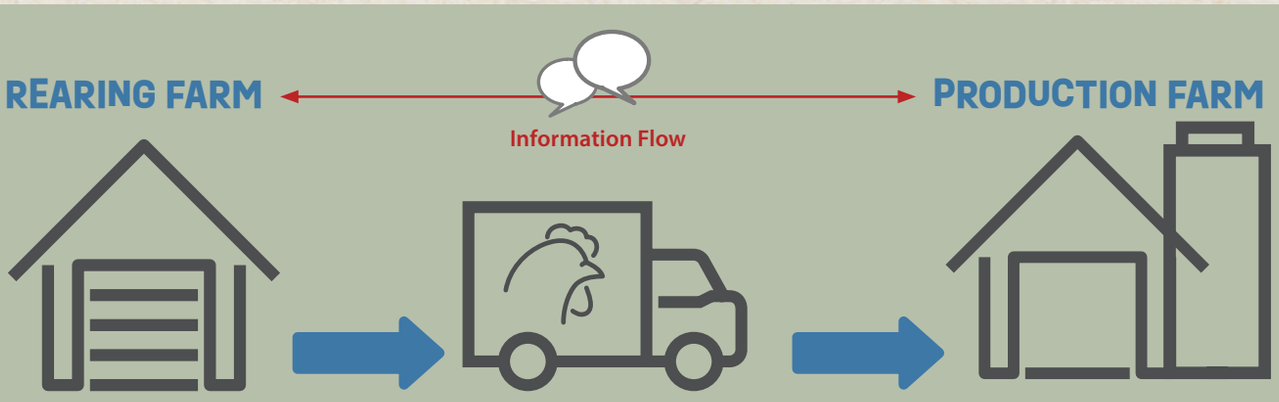
Overstocking has a direct impact on mortality, body weight, uniformity, feathering status and finally eggs per hen housed.

Table 5: Stocking density at production house

Equipment	Requirements*
Stocking Density	Refer to certification standards
Drinkers	
Round drinkers	1 drinker (Ø 18.12 inch / 46 cm) for 125 hens
Linear drinkers	3.28 feet (1 running meter) for 80–100 hens
Nipple drinkers	1 nipple for 8–10 hens (access to 2 nipples/hen)
Feeders	
Round feeder	1 feeder (Ø 15.76 inch / 40 cm) for 25 hens
Chain feeder	3.94–5.91 inch (10–15 cm) / hen
Nest	
Familiy type nest boxes	12 hens/sq ft (120 hens/m^2)
Familiy nest in family cages	7.75 in^2 (50 cm^2) / hen (6.51 to 10.08 in^2 / 42 to 65 cm^2)
Single nest (26 x 30 cm)	4 to 6 hens per nest

** These recommendations should be adjusted to meet local regulations.*

TRANSPORT TO THE LAYING HOUSE



Catching

- Low light intensity
- Trained staff
- Careful bird handling
- Gently but quickly

Transport

- Skilled Driver
- Clean and disinfected transport
- Optimum stocking density
- Meeting current local regulations

Reception

- Clean and disinfected
- Equipment tested and working
- Water and feed available
- Use the same lighting program as rearing farm (hours and dimming period)
- Pre-heating in cold areas

Preparation

Transport should be planned well in advance and all staff involved should be informed. Transport equipment should be in good condition and thoroughly cleaned and disinfected. The staff in charge of handling and moving the birds should follow the biosecurity programs, wear clean clothing and footwear that has not been exposed to poultry. Choose the best time of the day for transportation (especially in hot climates). Make sure pullets have access to feed and water before the transfer.

Keep water readily available.

Keep an eye on the behavior of the flock during this period.

Loading

Load quickly but with care and maintain an adequate stocking density in the transport carts.

Discuss catching pullets safely and efficiently with your technical advisor and equipment supplier. Continue to ventilate the house during the procedure. The staff should be well trained and should handle the birds according to animal welfare programs, catching and holding the birds by both shanks. Ensure enough ventilation for the birds between loading and unloading.

Transport

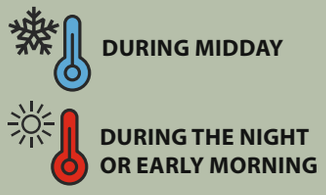
Transport time should be as short as possible, avoiding unnecessary stops. Also avoid moving the birds during the part of the day with extreme temperatures, or when climate conditions could have a negative effect on the birds. Unload the carts as soon as possible after arrival at the production house.

In all Cases

- Follow animal husbandry guidelines when catching birds.
- Do not overstock transport carts
- Do not leave hens in carts in sunlight or unventilated areas.
- Do not load carts in closed and unventilated trailers.

Hens could lose some weight during the transport depending on the duration and the temperature. This loss will be quickly recovered if the lay housing conditions are correct

When to move the Birds?



TRANSFER (16 – 17 weeks)

HOUSING IN THE PRODUCTION HOUSE

Housing the Pullets

- Be sure that the housing plan is ready and shared between departments before the move starts.
- Distribute the correct numbers of pullets in every section of the production house.
- Place the pullets on the levels with feed and water in the barn with aviary systems, and/or slats.

When the equipment has the option to lock the pullets inside the system, or on the slats with doors or nets, do this only for a maximum of 3–4 days. This is to help them find feed and water.

When pullets are locked up for an extended period of time, the increased density will decrease the uniformity of the flock and affect egg numbers at peak production.

Also, training the birds to move in the right way through the system is going to be more difficult when they are confined for many days.

Feed

Follow the same feeding schedule as used at the end of rearing. Let the pullets empty the feeders once a day in the lay house. Feeders should be filled when the pullets arrive, so it is easy for them to locate the feed. Encourage the birds to eat by running the feeding lines more frequently, often called stirring the feed lines.

When pullets come from a pan feeder system in rearing, be aware that they could be scared when the feed chain starts to run and can jump out of the aviary system or slats.

If pullets are reluctant to eat, corrective measures should be taken at once.

It is important to NOT run the feeders during the daily peak of production, which is usually mid-morning, to prevent hens moving out of the nests.

Temperature

The temperature in the laying house should be between 64.4 and 75.2 °F (18 and 24 °C) (Pre-heating).

This is even more important in cage-free production, because of the lower stocking density pounds /ft^3 (kg/m^3).

Place the pullets on the levels with feed and water in aviary systems, and not on the scratch area.

Feed

Place the pullets on the levels with feed and water. An "all-in, all-out" system is recommended to break disease cycles and improve the health status. The production house should have been thoroughly cleaned and disinfected in advance. The transfer should be done as smoothly and quickly as possible to allow the birds to adjust well for the start of laying. Cool water and feed must be available when the pullets arrive at the house.

Racks must be cleaned and disinfected before arriving at the farm and beginning the move. Take all precautions needed to prevent any infections from one farm to another.

When possible, for biosecurity use the carts once a day, and/ clean in between use. This way you prevent infection from production to rearing farm.

Water

It is recommended to use open water cups or 360 nipple drinkers. The drinkers should be set at the correct height and pressure to encourage the birds to drink. Lower pressure for the first few days will help.

During the first days check frequently that the birds are drinking. Adapting to a new drinker system could be difficult (especially if pullets have been reared with a different kind of drinker). If water consumption does not increase in the days after housing, or it fails to reach normal levels, corrective measures should be taken at once.

Nipple drinkers should have perches on them to prevent damage to them when birds are going to sleep on top of them at night.

Nest Boxes

Keep nest boxes closed while housing the pullets, when possible.

Hens need to use nest boxes to produce eggs, and not to hide in the first days.

It is recommended to open the nest boxes 1–2 weeks before the onset of lay.

Note that in aviary systems with one level of nest boxes, the birds need more time to find them.

Open the nest boxes 3–4 hours before start of lights on, this allows time to address any alarms with next boxes failure and gives the young hens plenty of time to find the nest. Close about 1 hour before lights off, later in lay these times may be adjusted.

TRANSFER (16 – 17 weeks)

Light

Use the same lighting program as used in rearing, which means the same hours of daylength.
If transporting and housing the pullets takes more time during the day, give some additional hours of light the first day to give them time to get used to the new environment.
The best way to initiate the dimming period at the end of the day(s) is manual, by a caretaker not relying on the computer, for the first few days after the move. This allows the caretaker to observe the bird behavior.
Because of the new environment, the birds need extra time to find their way inside the aviary system, or on the slats.
Discuss the dimming program with technical advisers from the pullet and equipment supplier.
Watch the behavior of the pullets during this dimming period and switch off the light step by step.
Light intensity can be a little bit higher during the first week (1.86 footcandle / 20 lux) to encourage hens to explore the house and find water and feed. Avoid "light-shock" (big step in light intensity between rearing and production) preventing stress and overstimulation.
Strive for even light distribution and work to prevent shadows where birds can produce mislaid eggs.

Weight

Weight lost during transport should be recovered in the first days in the production house. The birds should continue gaining body weight and maintain a good flock weight uniformity to achieve a good start of production

Behavior

Observe the behavior of the pullets during housing, and also during the dimming period at the end of the day. **Watch this the first days after housing.**

Litter

Appropriate litter level

Make sure that the litter material is placed before the pullets arrive.

Different materials may be used:
- Wood shavings
- Cellulose pellets
- Coarse wood shavings

Regardless of the litter material used, it should be hygienic.

A litter level should be kept to a minimum. Litter material should preferably be distributed after the house is pre-heated, and when the layers have been housed.
This prevents the formation of condensed water between the floor and litter.
Keep the level of litter low and dry during the whole production period.

Key Points

- **Transfer the birds at least two weeks before the onset of lay to get used to the new environment.**
- **Only transfer flocks that are healthy and in good condition.**
- **Plan transport in advance and organize it well to ensure optimal comfort of the birds.**
- **Avoid transferring flocks during high temperatures. Transport by night if necessary.**
- **Monitor the body weight before and after transfer to guarantee that the flock is developing correctly.**
- **Closely monitor water and feed consumption during the week after arrival at the laying house.**
- **In floor houses and aviaries, verify that the number of pullets per department is adequate.**
- **No vaccinations during transfer when possible.**

ONSET OF PRODUCTION (18 – 25 weeks)

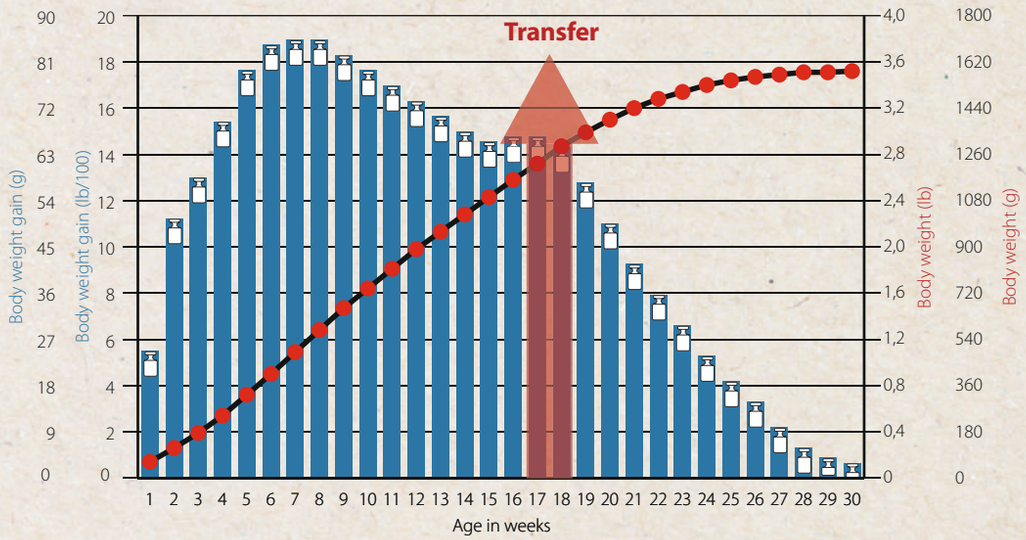
- **How to manage the flock during the first weeks in the laying house.**
- **How to correctly apply light stimulation in line with flock status and production objectives.**
- **How to manage the flock to achieve a high production peak.**

PERIOD AFTER TRANSFER

During the first days after housing, it is important to stimulate sufficient feed intake. The birds should increase their feed intake as fast as possible and continue gaining weight (see graph below).

Some useful recommendations:

- Provide attractive feed with a good structure that avoids fine particles.
- Provide good quality, fresh water.
- Feed on an empty feeder.
- Light intensity should not be less in the laying house than in the rearing house, it can be slightly higher.
- Avoid excessive stimulation when transferring birds to open houses.
- Run the feeding lines frequently during the second part of the day (not during production time in the morning). This is to prevent hens from coming out of the nest. If birds are accustomed to a different feed system in rearing like feed pans and they move into a laying barn with feed chains, keep an eye on their behavior. Another suggestion is to feed when the lights are out when possible as the feed chain can startle the birds.
- Ensure there is enough light at the feeders and drinkers.
- Open the nest boxes 1–2 weeks before onset of production (first eggs) 3-4 hours before start of lighting program and close them 1 hour before start of the dimming period at the end of the lighting program.
- The hens should be inside the system or on the slats at the end of the lighting program every day.
- Continue to give 0.66 lb (3g) / week / 100 birds / month insoluble grit (4–6 mm) to stimulate the gizzard muscle and digestion of the layers.



ACTIVITY MATERIAL

- An option is to provide pick stones in the scratch area (1 stone / 1000 layers) to keep the layers busy and control excess beak growth.
- It can be provided alfalfa (1 bale / 1000 layers) in the scratch area to keep the layers busy, and to control the complete nutrition intake of the layers. When layers consume alfalfa very quickly, check the nutrition and feeding management to be sure that ALL the layers are receiving the complete nutrient intake.

Make sure that all the material you provide for the layers is clean and heat-treated to prevent diseases.

LIGHTING PROGRAM AND LIGHT INTENSITY

There are two main factors that stimulate the onset of lay in the flock:

- **Body weight**
- **Photoperiod**

In the absence of other stimuli, hens will begin to lay when they reach an appropriate body weight. However, the duration of the photoperiod can stimulate or delay the onset of lay as follows:

- Stable or increasing photoperiods with a duration exceeding 14 hours will stimulate the onset of lay.
- Stable photoperiods with a duration of less than 14 hours will delay the onset of lay.

Decreasing photoperiods should never be used in production period.

Choose the right Stimulation Age

- **How to choose the right stimulation age**

Normally a flock should be kept with a stable photoperiod until light stimulation starts. If hens are in the weight range, a standard recommendation for standard production is 119 days (17 weeks) of age. Refer to the Egg Size Tech Tip for more information on how Bird Management, Lighting and Nutrition can impact egg size.

However, this may vary according to two factors:

- Flock body weight status: If the birds' body weight is far below the standard it is preferable to delay light stimulation for at least one week. Equally, if the uniformity is not good and the weight of part of the flock is far behind the standard, later light stimulation is preferable.
- Accumulated egg weight objective: egg size strongly correlates with the size of the bird. A simple way to achieve heavier birds in the production onset is to delay light stimulation. Age and body weight at 50 % lay are two parameters that can greatly help to forecast the egg weight.

Take the natural Day LengTH into account

- **How to manage natural day length**

The lighting program in open houses should take the natural day length at the stimulation age into account. Determine the lighting program during rearing as explained in the chapter on growing (page 26).

Stimulation should differ depending on the day length.

- The lighting program in open houses, free-range and organic should take the natural day length at the stimulation age into account.
- Increasing day length period: the flock risks being stimulated by natural light before they reach the correct body weight. To avoid this, the artificial day length should always be longer than the natural day length until the flock is ready to be stimulated. This should be considered in the rearing lighting program.
- Decreasing day length period: flocks exposed to decreasing day length can show delayed onset of lay. To avoid this, create an artificial day length longer than the natural day length from week 10 in the rearing.

To achieve this goal, use the app: H&N lighting program

Use correct Light Stimulation

- **How to apply light stimulation in a flock**

Once the light stimulation age is defined, light stimulation starts with an initial photoperiod increase. Take the following into account:

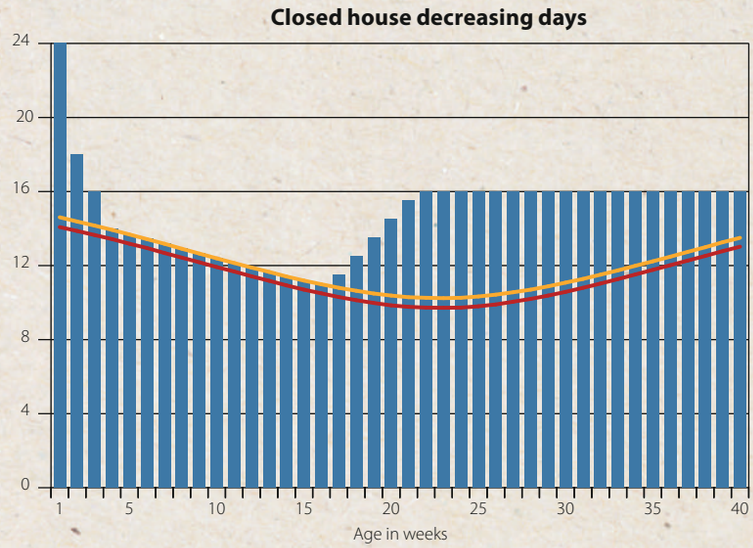
- Light distribution should avoid dark and shady areas, to prevent mislaid eggs.
- Start to increase day length at least one hour after sunset, or after switching off the light at the end of the day. Keep the last hours to increase at the beginning of the day.
- Ensure that first eggs are not produced before starting the light stimulation and cause floor or system eggs.
- Increase the day length at least one hour. Initial light can be added at the end of the lighting period, after 50% production light can be added to the start of the lighting period.
- Light intensity in the laying house should be slightly higher than in the rearing house.
- Keep light sources and bulbs clean.

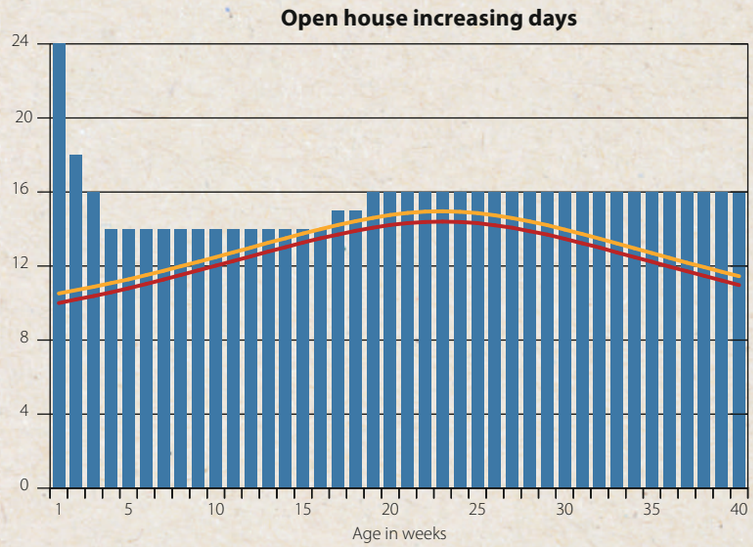
Subsequently, the photoperiod must be increased weekly. Light increases should be at least half an hour, although a higher increase is possible if the laying percentage increases rapidly. The more hours the hens have, the more time they will use to consume feed. It is therefore important to achieve at least 14 hours of light to allow the flock to reach a proper feed intake.

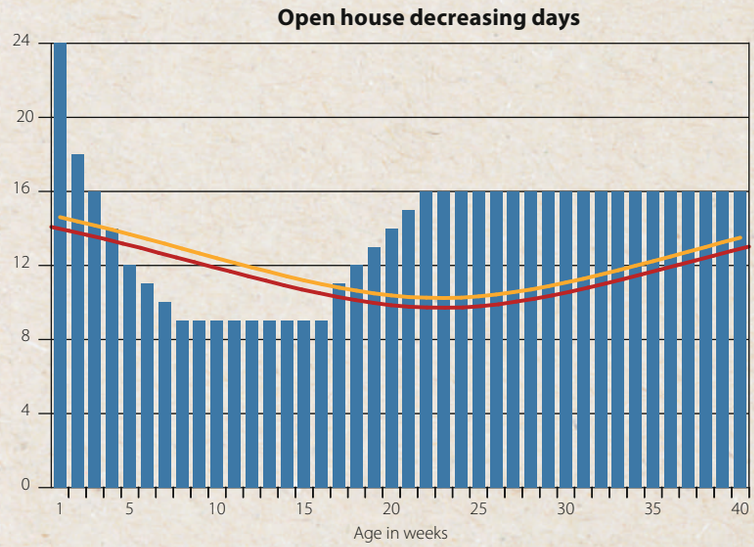
SEXUAL MATURATION AND ONSET OF LAY

At the start of their productive life, hens develop their secondary sexual characteristics. This is a good indication that the bird's hormone development is correct. In addition to the start of the reproductive capacity (and therefore production of eggs) other changes occur in the bird's metabolism.

One of the most important metabolic processes is the ability to capture calcium to create medullary bone. It is very important that the birds develop this type of bone to ensure good quality eggshells during the late lay period. A good practice is to **use a transition feed** as is explained in the nutrition chapter.







ONSET OF PRODUCTION (18 – 25 weeks)

MANAGEMENT TO ACHIEVE A GOOD PRODUCTION PEAK

Water

Cool water of good quality should always be available with the required water flow. Continuously monitor the water quality. Water consumption is normally 1.5–2 times higher than feed consumption. It is recommended to monitor the water consumption for early detection of possible problems. Regular cleaning and flushing of the water lines as well as the supply tank is essential. Water consumption will clearly increase at 10–14 days prior to the onset of lay. During this period, the ovary and reproductive organs and medullary bone will develop, and water will be stored in the follicles of the ovary.

- Take in your hands some hens on different levels a few times a week and check their body condition.
- Often you feel that some hens are weak, or crops are only filled with either feed or water.
- Keep in mind that a well-trained pullet should find their way around the aviary system.
- With hens who go outside the house (free-range / organic) prevent elevated water intake from rainwater in the outside area, standing water is not a clean water source.

Space

The birds should have enough space, especially in hot climates. Important aspects are **not only ft²/cm² living space / bird,** but also how many in/cm of feeder, and how many drinkers are available per bird (see stocking density requirements on page 36).

Feed

The birds need good quality feed, with the structure and nutrient density necessary to match their feed intake as well as provide their egg production, growing and maintenance requirements.

Nutrient requirements in this phase increase rapidly so the feed intake of the birds should increase simultaneously. If not, then the birds' nutrient requirement will not be covered, and they will be forced to mobilize their reserves. This may lead to soft bones and potentially harm the bird for the rest of the laying cycle. Switching to a layer diet with more than 2.5 % calcium stimulates the birds to lay eggs. This feed phase I aims to cover the requirements to obtain the maximum egg mass (see nutrition chapter for further details of feed recommendations).

Allow the birds to empty the troughs before the next feeding in the middle of the day to clean up the fine particles as trained in the rearing period. Prevent select feed intake (see Technical Tip "Feeding management").

Mash Feed

Crumble Feed

Pellet Feed

Ventilation & Temperature

Proper ventilation should be used to guarantee fresh air quality in the house and ensure a low concentration of gases and dust. At the same time, the temperature in the house should be optimally maintained between 64.4–75.2 °F (18–24 °C) with a relative humidity of 50–60 %. Birds do not tolerate temperatures above 86.0 °F (30 °C) well, especially if high temperatures are combined with high humidity. During heat stress, ensure that sufficient air circulates around the birds. The use of additional fans as well as evaporative cooling pads should be considered to reduce the house temperature.

In aviary and floor production, ventilation and temperature are even more important during the housing time. Start with a low target house temperature before transferring the pullets.

The stocking density is less than conventional systems, and good temperature and ventilation to stimulate pullets to find water and feed on the different levels in the system is needed (important in aviaries).

Mortality from smothering and floor or system eggs can be enhanced by poor ventilation.

Good air quality:
The back of the house can be seen.

NEST MANAGEMENT

Key points of using nest boxes in cage-free systems:

- The correct position of the nest boxes is with drinking lines in front of them.
- Use clean, automatic closing nest boxes with a comfortable floor / mat.
- Nest boxes should have the correct intensity of light (enough to find the nest, and inside dark enough to keep birds quiet).
- Allow enough nest space.
- Layers should not be allowed access to the nests too early. Open the nest boxes 1–2 weeks before the onset of lay. Open them 3-4 hours before start of day-lighting program and close 1 hour before the end of the lighting program (NEVER leave them open overnight).
- In an aviary system with one tier or level of nest boxes the birds need more time to find the nests than a traditional floor house with slats or combi system where nest boxes are on every level.
- A system with in-line nest boxes can be equipped with incorporated barriers. The best way to use them is every 2 meters (6 feet) at 6 meters (20 feet) from every compartment wall. This spacing is important to prevent high density in these front and back nests.
- In case of hens laying eggs early or before the photoperiod you can also use very low light intensity lights inside the nests. This light can start 1–2 hours before the start of the lighting program to give the birds that produce early the ability to find their way to the nest boxes. These 1–2 hours are not included in the daylength.
- Always plan enough nest space in cage-free systems to catch all the eggs during the laying process. This is especially important at the onset of production of very uniform flocks.
- After the production peak at > 30 weeks, we can start gradually closing the nest boxes a bit earlier every 1–2 weeks. In the afternoon, the birds don't need access to the nest boxes after the production period (10 hours after lights on). This is especially important if you start to see a lot of dirty nests (bedding or mat) and eggs due to nest material.
- Close the nest in very small steps and keep an eye on the total number of eggs, and number of mislaid eggs. When the volume of mislaid eggs stay at the same level, the nest can be closed a little earlier in the day to prevent broody hens sitting in the nesting area.
- For correct nest management, always keep in mind the difference in the laying behavior between white and brown strains:
  a) Browns tend to start producing earlier in the day than whites, so the egg collection must start earlier. Furthermore they have a wider time window where they lay eggs
  b) In white flocks, the laying time window is much more concentrated, plus the hens stay longer inside the nest than browns, therefore nest space is more critical for the white layers than brown layers (refer to graph page 49).

Type of nest	Requirements*
Family type nest boxes	9 hens/sq ft (100 hens/m^2)
Single nest (10.24 x 11.82 inch / 26 x 30 cm)	4 to 6 hens per nest

** These recommendations should be adjusted to meet manufacturers recommendations.*

Practical advise

- **Start the day with an even distribution of feed.**
- **Do not run feeders mid-morning while hens are laying.**
- **Restart feed distribution when the feed troughs are empty. This usually takes about 5–7 hours but may vary between flocks. This should be determined by visiting the house and observing the levels in the feeders on each level of the system.**
- **It is not necessary to keep the feeders empty once the birds have eaten their entire ration. In aviaries, if one of the feeder lines is empty, distribution can be restarted. If the difference in feed level is too big between lines, their adjustment and the distribution of the birds should be reviewed.**
- **Restart the feed distribution by running two consecutive feedings (stack feeding). The aim is to ensure that all birds have feed available.**
- **After this, continue to distribute feed throughout the afternoon and until lights out. The number of feedings may vary but, in any case, ensure that the birds have an acceptable amount at the end of the day.**

ONSET OF LAY

Monitoring production data is essential for timely taking actions in response to any issue that occurs in the weeks between the first eggs and the production peak. Production data should be monitored daily or at least weekly.

Check that the first eggs are produced after the lights are on to be sure that day length covers the production period.

Percent Lay

This should increase daily. During the first week, the increase may be small, but a bigger increase should be seen every day afterwards. In the middle part of onset of lay, the increase should be stronger: at least 2 % per day and ideally close to 3 %. Finally, in the last weeks, the increase should be close to 1 % until the production peak is reached. The rate of increase cannot be monitored correctly if the eggs are collected at different times.

Body Weight

Body weight increases could be a little erratic as not all the hens develop their reproductive system at the same time. However, body weight should never decrease, and a clear growth trend should be observed.

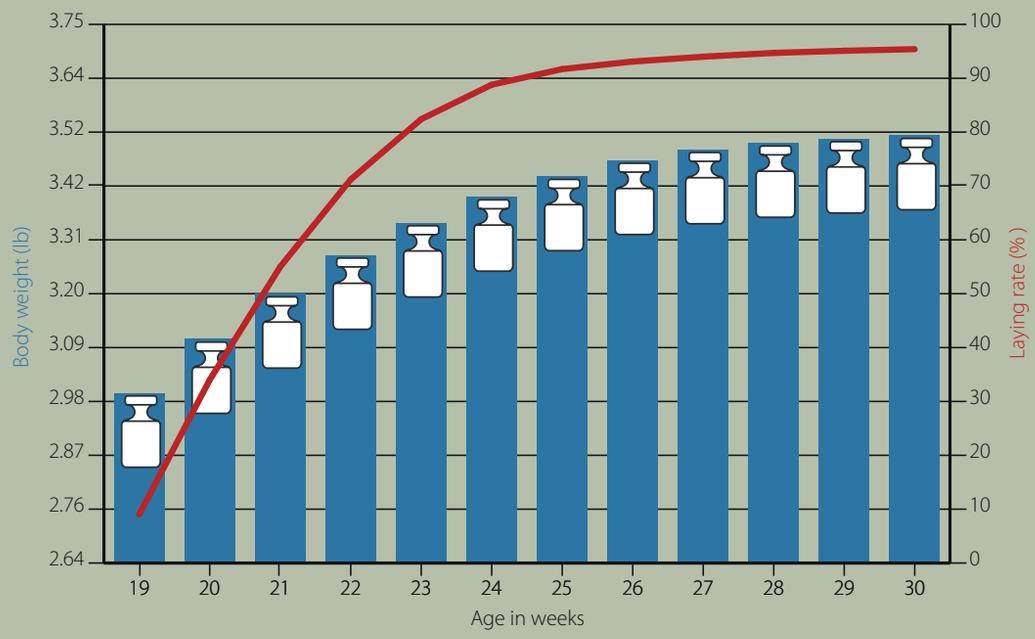
Check the body weight of layers in all areas of the house, in the front and the back, and at all levels to be sure that feed distribution is running consistently throughout the house.

Feed & Water

As mentioned, consumption should increase every day.

Water is the easiest parameter to monitor daily and is a critical management measure.

Body weight and % lay until week 30



STRESS MONITORING IN LAYERS

A simple and effective way to monitor the stress level of the birds is the use of alfalfa. The hens do not use it for feed but for entertainment and to see if the birds are on balance concerning nutrition intake.

If the consumption of alfalfa is observed to increase dramatically, this should be taken as a clear message that the flock is being exposed to some form of stress or nutritional deficiency. This gives precious time to check which factor is affecting the birds and to apply corrective measures before behavior issues occur.

Alfalfa net

Alfalfa rack

FEEDING LAYERS DURING PRODUCTION

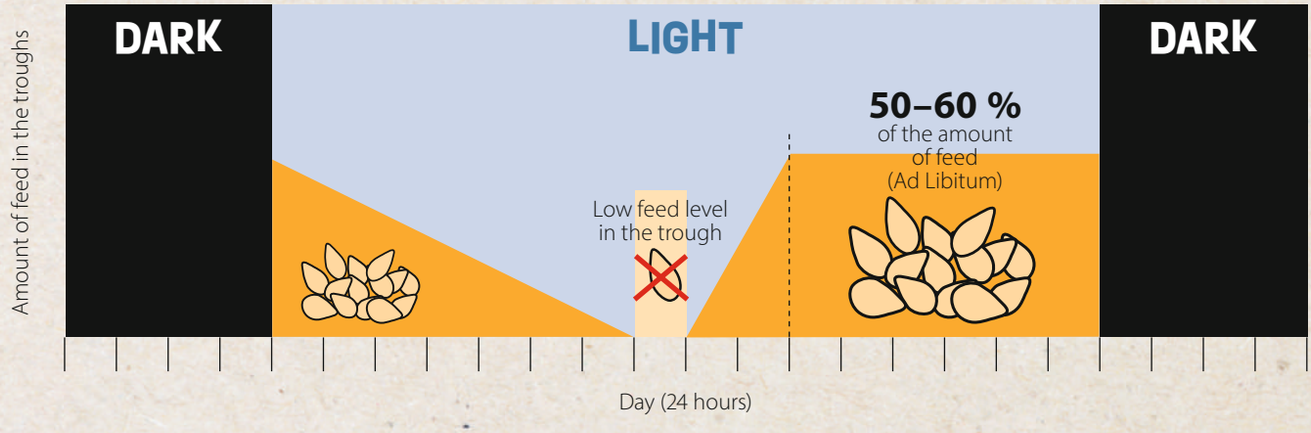
Hens have a strong feed selection behavior based on particle size. Coarse feed particles will be much more attractive than fine feed particles to the hens and they will actively seek them out. In cage-free systems, each hen has access to many feeding points where she can consume only the coarse fraction of the feed. If this behavior is allowed, the birds will eventually reject the fine fraction of the feed. This will greatly complicate the feeding of the birds and can be the starting point for many potential issues.

To avoid this problem, it is an absolute must to force the birds to eat the entire feed ration daily. The simplest way is to allow them to eat the fines. To do this, feed distribution should be paused during the morning. During the afternoon the birds should be fed ad libitum. In no case should this management imply that birds are subjected to feed restriction.

Normal level

Low level

Feed distribution in production



FLOOR & SYSTEM EGGS

The correct use of nests is very important in order to keep the percentage of mislaid eggs at a good level. Birds tend to lay their eggs in the same place every day and are attracted to dark, enclosed places as well as to the presence of eggs laid by other hens. It is therefore critical to manage the flock correctly and to avoid the habit of the hen laying in places other than the nest.

A correct stocking density is a precondition for a good use of nest boxes. If the stocking densities are not respected, the nests will be overcrowded and some of the hens will be forced to look for alternative laying locations. Keep in mind that white birds have a greater need for nest space as they tend to all lay in the same time slot.

It is important that the hens regard the nest as the best place to lay. It should be dark, secluded and free of drafts. The temperature inside should be warm but not too high. Likewise, the material of the nest floor and its design is essential both to give comfort to the hen and to prevent the eggs from being soiled, broken or pecked.

Finally, any obstacle that prevent the birds from easily entering the nest should be removed.

There should be no other attractive spots in the house for the hens to lay. First of all, it is important to check that the litter be kept to a minimum to avoid nesting on the floor. Poorly lit areas should also be avoided, especially corner and wall areas. When allowed, it is a good idea to divide the house into horizontal segments by wire fences. This will prevent hen migrations from creating overcrowded areas.

The birds must be well trained during rearing to move to sleep in the slat area or in the aviary at night. In any case, during the first weeks in the production house, this should be checked and hens which are sleeping on the litter should be moved manually to the slat area. It is also very important to collect the eggs laid in the litter daily and under no circumstances to leave eggs in the house after the lights have been switched off. The areas of the house where hens lay eggs most intensively should be identified to take corrective action.

It is also advisable to take frequent walks around the house in the morning to prevent hens from nesting in corners or against walls. Likewise, feed should not be distributed during peak laying hours (mainly mornings) so as not to attract hens out of the nesting area.

Floor Eggs

Floor / System Eggs

Floor / System Eggs

Key Points

- **Monitor how well the flock has adapted to the laying house by measuring water and feed consumption daily and body weight and uniformity weekly.**
- **Control the onset of lay and egg weight by correctly applying the lighting program.**
- **Never decrease day length in the production period.**
- **Closely monitor the increase in egg production, egg weight, body weight, feed and water consumption during the weeks preceding the production peak. If the flock is not performing correctly, take corrective measures as soon as possible.**

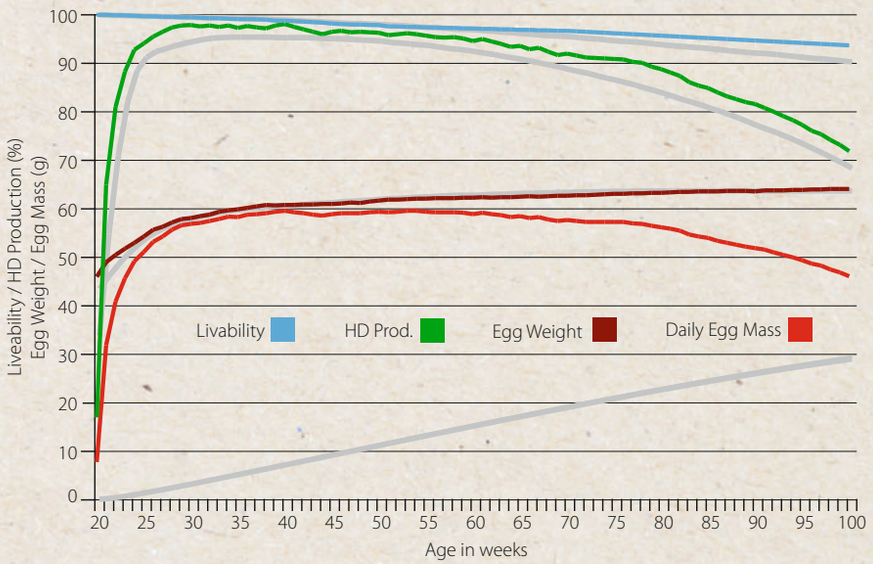
PRODUCTION PERIOD (25 – 100 weeks)

- **How to manage the flock to maintain optimal production levels during the production period.**
- **How to maintain hens in good condition regarding body weight and feather covering.**
- **How to correctly manage the produced eggs.**

PRODUCTION STAGE

After reaching a strong production peak, H&N hens should enter a production plateau. Their genetic potential allows them to maintain a high production level and excellent eggshell quality for many weeks but to achieve this, pay close attention to certain aspects:

- Feed quality
- Daily intake
- Presence of disease
- Body weight and uniformity



	Weeks > 90 %	Eggs/HH	Livability	Cum. EW (g)	Cum. EM (kg)
	55	494.6	93.7	61.2	30.3
Standard	43	474.0	90.3	61.3	29.1

PRODUCTION MONITORING

Detailed laying cycle records are necessary to evaluate performance and profitability. Daily figures for hen-day production, egg weight, feed and water consumption, mislaid eggs and mortality are necessary. This information will allow you to calculate important data including daily egg mass, cumulative egg mass and feed conversion. All results should be presented in graphs.

Use of graphs will improve analyses of flock performance trends. Growth records and accurate pen counts are also very important. This enables timely intervention in response to any irregularities and generates historical data for more in-depth analysis of production performance.

PRODUCTION RECORDING SHEET

Number of hens housed (A)

	Flock				Production week					Production cum.				Egg weight				Egg Mass / HH				Feed Intake			Feed conversion	
Date	Age	Mortality (No.)	Hens remaining	% Livability cum.	Eggs produced	% Production	% Standard	Mislaid Eggs	% Mislaid Eggs	Cum. Egg production	Eggs / HH	Standard	Cum Mislaid Eggs	In the week	Standard	Cumulative	Standard	In the week	Standard	Cumulative	Standard	In the week	lb/day/100 birds	pounds/feed/HH	In the week	Cumulative
		B	C	D	E	F		G	H	I	J		K	L		M		N		O		P	Q	R	S	T
			C (A) - B	C / A *100		E/C/7 *100			G/E *100	I+E	I/A		K+G			L / H		E*L/A		O+N				R+P	P/E /L * 1000	R/I /M * 1000

LAYING PROCESS

Laying Process

Egg formation is a complex process that occurs in the oviduct of the hen. The whole process takes around 24 hours, but forming the eggshell takes the majority of the time (18–21 hours).

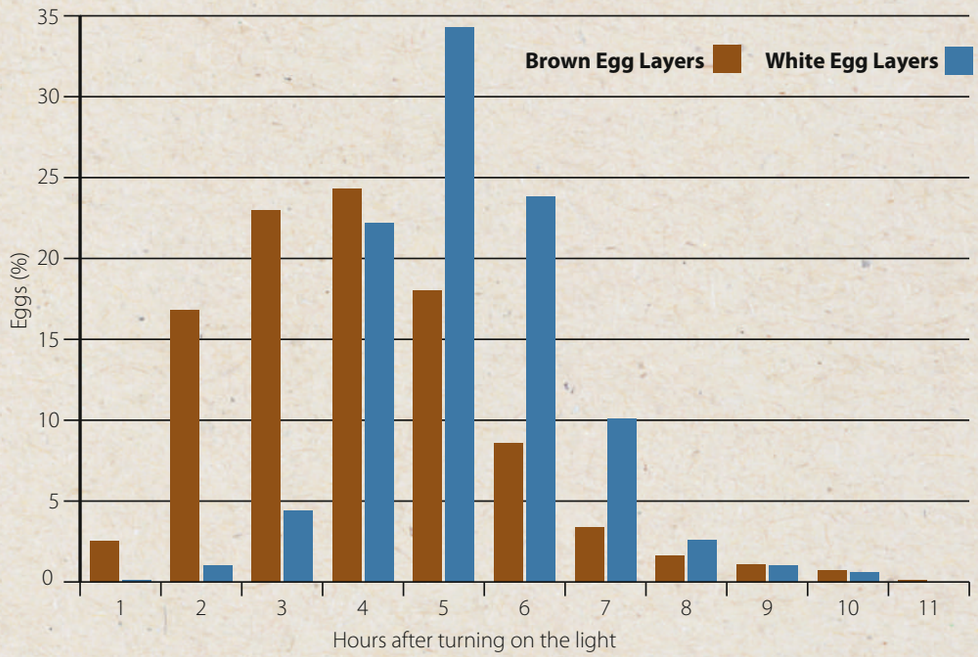
Lay is a critical moment for hens. If possible, they prefer a protected and dark area. The cloaca will be reversed during the lay process which can encourage cannibalism.

If hens retain eggs due to stress, shell defects may occur. Therefore, avoid disturbing hens during maximum laying hours to reduce this kind of defect. This means not disturbing them by removing mortality, feed distribution, inspecting nest boxes . . .

Laying Window

The laying window is defined as the time in hours since the lay of the first egg to the last one. Its range varies between breeds of hens. White breeds lay in a shorter period of the day than brown breeds. Additionally, white hens spend more time in the nest box. This is the reason for the need of more nest space for white hens.
In any case, 50 % of the lay takes place around 4–6 hours after turning lights on. It is useful to know when most of the eggs have been laid for a better collection window.

Lay distribution during the day



EGG COLLECTION

Egg collection impacts the external and internal quality of the produced eggs. It must therefore be performed correctly in order not to degrade the value of the eggs:

- Collect eggs as soon as possible. Do not keep eggs in the house but collect them and store them in a cooler above freezing and at or below 45°F
- Collect the eggs twice a day, especially in hot climate periods.
- Avoid overstocked nests or egg belts. This may increase the number of cracked and soiled eggs.
- Prevent hens from eating or pecking the eggs.

PRODUCTION PERIOD (25 – 100 weeks)

NEST MANAGEMENT

Nest boxes should be kept closed at night to prevent hens from sleeping inside them. This would cause the floor material to become soiled with feces and increase the percent of dirty eggs.

Therefore, the nest boxes should be opened at least 4–5 hours before lights on and closed one hour before lights off.

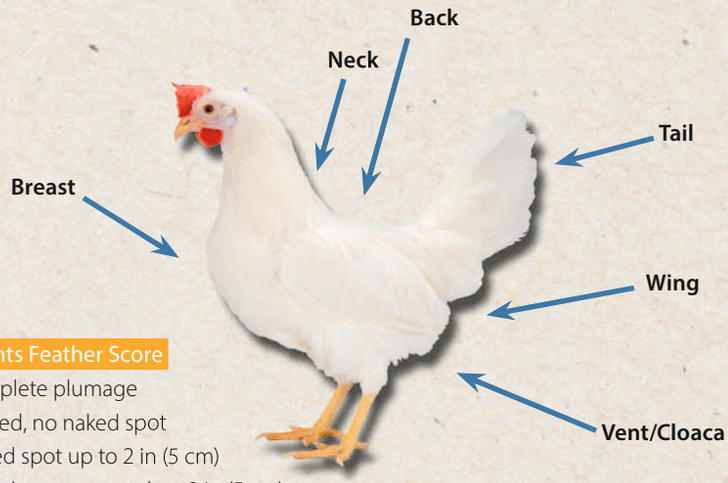
After peak production and stabilization of the percent of mislaid eggs, nest closure can be earlier in small increments every week. This should always be done while checking that the percent of mislaid eggs does not increase.

FEATHER COVERING

Feather coverage is a key indicator of the hen's body condition. If hens lose their feathers, their thermal insulation capacity will remain seriously impaired. This impacts feed intake and maintenance energy needs. It therefore means an increase in the production feed costs. Poor feathering can also be caused by stress, pecking or incorrect feeding.

Monitoring feathering can help signal potential problems caused by aggression, nutritional deficiencies, or other problems.

Feathering Condition Scoring



4-points Feather Score

1. Complete plumage
2. Ruffled, no naked spot
3. Naked spot up to 2 in (5 cm)
4. Naked spot greater than 2 in (5 cm)

FEATHER PECKING

Feather pecking can be considered in hens as part of hen social interaction if it is kept at a low level. However, if birds are subjected to stress or are unable to express their behavior, feather pecking can become exacerbated and develop into aggression.

Beak treatment has been proven to be effective in preventing feather pecking.

In any case, it is necessary to control the sources of stress affecting the birds. Not all sources of stress are equally disturbing to birds, but many sources of stress can accumulate to a major stressor.

The following points should be avoided:

Most common Causes of Stress

- Sudden increases in light intensity
- High light intensity (> 3 FC)
- Direct sunlight entering into the house
- Nutrient-deficient feed formulations
- High or low salt levels in the feed
- Birds not being required to empty feeder daily
- High density due to over housing of birds or too poor distribution of birds in the house
- Birds housed in a system for which they were not trained in rearing

Other possible Causes of Stress

- Bulbs with inappropriate light color and producing a flickering effect
- Lack of partitioning in the house
- Litter in poor condition or dusty substrate
- Environment: Lack of sufficient perches
- Heat stress during warm season
- External or internal parasite infestation
- Presence of predators

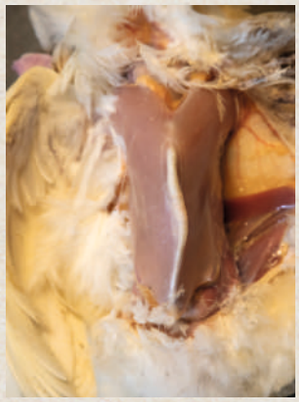
KEEL BONE FRACTURES

Hens often suffer collisions against equipment when moving around the interior of the house. This can lead to keel bone fracture if this bone is impacted while it is weak and brittle.
As result, it will cause injuries in the birds that produce chronic pain, refusal to move, immunosuppression and reduced egg production. Unfortunately, this is reported to happen at an elevated percentage for cage-free flocks.
Some risk factors for collisions have been identified, such as

- the absence of ramps between floors,
- the height and placement of perches and
- the type of aviary.

However, a number of hens are likely to collide with the system, no matter which aviary is used. Bone integrity and strength therefore seem to play a key role. Calcium physiology is always understood as a challenge in birds with a high production capacity. Therefore, a solid rearing period and specifically excellent bone ossification before first egg production seems to be key to create a strong bone system and avoid keel bone fractures.

Keel bone fracture – courtesy of ZTHZ, Universität Bern



Keel bone deformation

PILING

Piling is a behavior of birds whereby individuals are crowded together in high densities in a certain place. One of the most common consequences is mortality by smothering. It can be the leading cause of mortality in some flocks. The cause of this behavior is sometimes not easy to identify, but it is possible to distinguish at least three types of origins:

Nest Piling

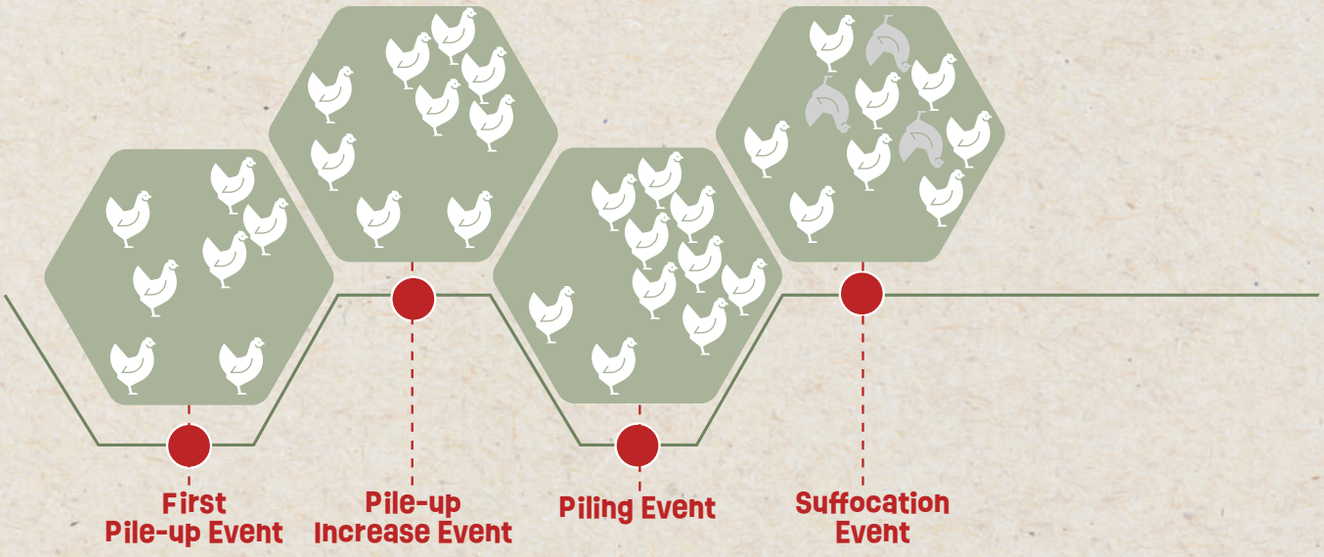
This refers to piling where the origin of the crowding is the use of the nest by more hens than the maximum capacity. In fact, hens may prefer some nests to others and crowd into them. This can also happen with the use of perches at the top of the aviary. They are easily identifiable as the smothered birds always appear in the nests or in the same location. An aid to reduce nest piling is to increase light in the beginning of the photoperiod after production has reached 40 % in two 30-minute increases to get hens to use the nest at different times. These increases should be part of the normal light stimulation program, this technique also helps to incorporate hens laying eggs early in the photoperiod.

Panic Piling

This refers to piling whose origin is a specific event that causes an episode of panic in the birds. Usually, the number of smothered birds is high and can be found in corners or against walls. Sometimes they are easy to identify when this event is very evident (predation episode, loud sounds, disturbing visits, ...). At other times the initial panic event is more sporadic and spread out over a larger area. This is especially true when the flock is previously under stress. In this case subtle events will be sufficient to trigger an episode.

Reiterative Piling

This refers to piling occurring in the same place repeatedly throughout the laying period and does not usually involve large numbers of birds. It is not easy to find the reason for this, but temperature in different parts of the house, condition of the litter, drafts in certain sections of the house or incoming sunlight have been blamed in some cases. As with the previous group, if the birds are under stress, piling is more likely to occur.



TROUBLE SHOOTING

Problem	Possible cause
Lay drop	Low feed intake, low water intake, stress factors, feed quality, decreasing lighting program, pathology, incorrect feed distribution
Low feed consumption	Temperature, water supply, feed quality, inadequate feeder space, incorrect feed supply, pathology, incorrect feed distribution
Low egg weight	Temperature, low feed consumption, low body weight at light stimulation, incorrect feed formulation
Mortality	Flock uniformity, light intensity, stress factors, pathology, pecking cannibalism, smothering, predation
Low body weight	Incorrect feed formulation, low feed intake, high stocking density, incorrect feed distribution
High body weight	Incorrect feed formulation, overfeeding
Cracked eggs	Ca / P ratio, Ca particle size, temperature, water quality, pathology, incorrect egg collection management, incorrect feed formulation, incorrect grading machine maintenance, mislaid eggs
Stained eggs	Water quality, pathology, incorrect egg collection management, incorrect feed formulation, incorrect grading machine maintenance, high stocking density, pest / diseases, mislaid eggs, dirty nest
Mislaid Eggs	Incorrect nest management, incorrect flock distribution, high stocking density, wrong illumination, uncomfortable nest, Incorrect trained pullets, incorrect lighting program, incorrect feeding program, i ncorrect light distribution, excessive litter depth, delayed removal of mislaid eggs
Poor feather coverage	See Feather pecking
Feather pecking	Incorrect feed distribution, incorrect feed formulation, light intensity, incorrect light bulbs, incorrect feed intake and / or distribution
Nest piling	Less nest box space, uneven distribution of layers in the barn
Panic piling	Unexpected noise, unbalanced nutrition or feed distribution, feed deliveries at night, vehicle headlight shock

Key Points

- Ensure a gain in body weight and correct development to maintain egg production.
- Correct management of feed distribution and feeding times.
- Monitor body weight and feather covering.
- Monitor production outputs to enable corrective measures as soon as possible.
- Monitor feed and water intake.
- Diligently work to control mislaid eggs during the first weeks of lay as well as throughout peak.
- Avoid stress factors leading to feather pecking or piling episodes.
- Be analytical with piling events and try to understand the reason behind them and implement the corrective measures.

PRODUCTION UP TO > 100 WEEKS

- **How to manage the flock to achieve longer production cycles.**
- **How to decrease mortality during the late production period.**

EGGSHELL QUALITY

Body weight at 5–6 weeks of age

The frame of the hen is mainly developed during the first 5–6 weeks of age. A loss of body weight in this period will reduce the longevity of the layer hen impacting on the eggshell quality during the production period.

Correct use of Pre-Lay Feed or Hybrid Feed

Incorrect use of pre-lay feed might induce damage to the medullary bone, affecting the capability of the layer hen to utilize Calcium (Ca) from the bone. Hybrid feed is preferred.

Feed Intake Development using a Developer Feed

Increase the feed intake capacity of your hens with developer feed to ensure adequate feed consumption at the beginning of laying (see more in chapter on nutrition).

Calcium Sources

60–70 % of Ca in the eggshell is sourced from the diet and 30–40 % from the bones, especially the medullary bone. The availability of Ca during eggshell formation will improve eggshell quality. Particle size and solubility of the Ca sources (see more in chapter on nutrition) are strategies to improve eggshell quality.

Balanced Ca, Phosphorus (P) and Vitamin D in Diet

Excess or deficiencies in Ca, P, and Vit D will trigger eggshell challenges (see more in chapter on nutrition).

Use of organic trace Minerals

Trace minerals are part of the inner eggshell and in eggshell formation through the enzymes. Use could be justified when, as the egg size increases, the eggshell becomes thinner.

Medullary bone in young hen

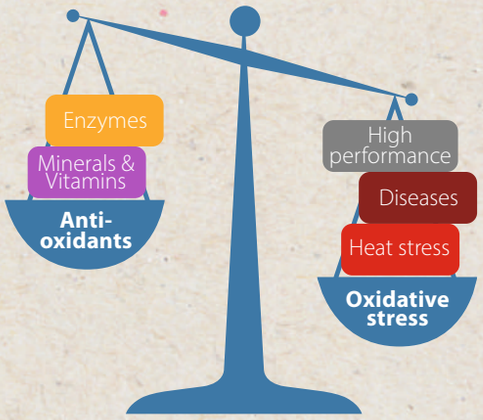
Medullary bone in old hen

REDUCE THE METABOLIC CHALLENGES

Oxidative Stress

Physiological stress on the body can be caused by the cumulative damage done by free radicals inadequately neutralized by the antioxidant system. This stress is held to be associated with aging.

- **Free radicals:** they are produced during metabolism when ATP is produced, as part of the inflammatory response, heat or cold, stress, high levels of ammonia, oxidized fat in diet.
- **Antioxidant system:** it is a complex system involving enzymes, as glutathione dependent of Cys availability or like super oxide dismutase, vitamins and minerals as co factors of the enzymes.
- **Symptoms:** unspecific mortality as the hens age and feather loss increases.



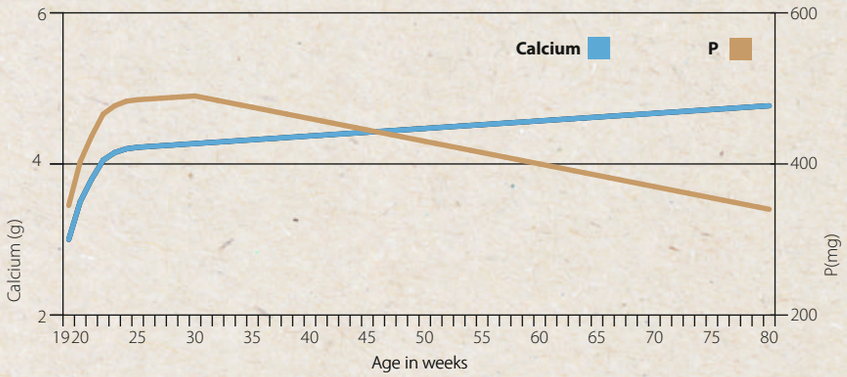
PRODUCTION UP TO > 100 WEEKS

System Fatigue

A decalcification of the bones of the hens occurs when there isn't a balance of the Ca, P and vitamin D in the diet.

- Ca levels should increase as the birds get older
- P levels should be reduced as the birds get older
- Vitamin D should be supplemented

Needs of Ca and available P in production



IMPROVE GUT HEALTH

Feed Hygiene

Reduce feed contamination as much as possible.

- HACCP (Hazard Analysis Critical Control Point) quality system to control raw materials and final product quality
- Addition of additives that can reduce contamination in the feed

Don't forget to monitor the water quality.

Stimulate Gizzard Activity

The gizzard is the first natural barrier for contaminants in the feed. Increasing its activity will reduce the pH thereby improving the pathogen barrier and improving the digestion of nutrients. This reduces the availability of nutrients used for the growth of the pathogens in the lower part of the gut.

Gut Health Additives

Gut health additives are used by some producers to reduce the growth of the pathogens in the gut. The combination should be based on the area of action, level of pathogens in the area and other challenges.

- Enzymes; essential oils; organic acids; prebiotics; probiotics

	Mash CFU log/gr	Pellet/ crumble CFU log/gr
Enterobacteria	< 3	< 1.5
Escherichia coli	< 1	< 1
Anaerobic sulfite reducers at 46 °C	< 1	< 1
Salmonella	0	0
Molds	< 3	< 1.5
Yeast	< 3	< 1.5

FACTORS INFLUENCING EGG SIZE

Energy

In cage free production the needs of the birds increase. The source of energy could become amino acids and therefore limit egg size (refer to Egg Size Tech Tip). Therefore, be sure that the energy intake is adjusted in cage free diets (see the nutrition section) Methionine is the first limiting amino acid in egg weight. However, if we want to control the egg size, we need to do it with the whole amino acid profile so the ideal protein ratio is not broken.

Linoleic Acid

There is a minimum requirement of linoleic acid, so the egg yolk size isn't a limitation in the egg size. Be careful when raw materials with low linoleic acid are used.

Added Fat

Adding fats (vegetable or animal fats) in the diet increases the egg size. It improves the feed efficiency and reduces the dustiness of the feed.

Weight of the Birds

Birds with high body weight (above the standard) at week 5 will produce bigger eggs. It is not recommended to have birds below the standard at week 5 (no more than 3 %) to control egg weight in production as performance will be compromised.

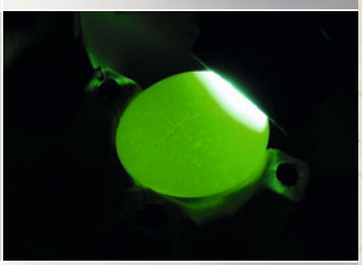
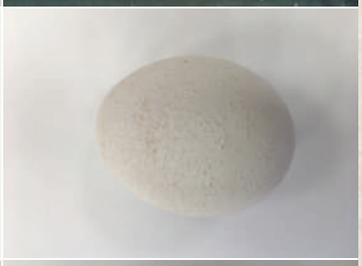
Key Points

- **When keeping hens for a longer lay-cycle, be proactive at an early age.**
- **Start to collect eggs two times a day to continue egg quality in older flocks.**
- **Poor eggshell quality is a major cause for lower saleable eggs output in the late production period. Take corrective measures in advance.**
- **Limit immunosuppression by avoiding mycotoxins, stress, or poor nutrition.**
- **Good gut health is needed to properly assimilate the nutrients, pay attention to it.**

EGG QUALITY

- How to identify eggshell quality defects and the causes.
- How to identify internal egg quality defects and the causes.

EGGSHELL QUALITY

Problem	Causes	
Cracked/broken eggs: large cracks and holes ▪ % in production: increases with the age of the hen. 1–5 % of total production	▪ Old birds (> 50–60 weeks) ▪ Mineral deficiencies or imbalance ▪ Saline water ▪ Diseases with ovary tropism ▪ High temperatures ▪ Mechanical damage during collection	
Hairline cracks: very fine cracks that require efficient candling ▪ % in production: varies with the age and the % of cracked of broken eggs	▪ Old birds (> 50–60 weeks) ▪ Mineral deficiencies or imbalance ▪ Saline water ▪ Diseases with ovary tropism ▪ High temperatures ▪ Mechanical damage during collection ▪ Infrequent egg collection	
Star cracks: fine cracks radiating outwards from a central point of impact ▪ % in production: varies with the age, 1–2 % of the total production	▪ Old birds (> 50–60 weeks) ▪ Mineral deficiencies or imbalance ▪ Saline water ▪ Diseases with ovary tropism ▪ High temperatures ▪ Mechanical damage during collection ▪ Infrequent egg collection	
Shell-less eggs and thin shelled: no shell or very thin shell, very easy to break ▪ % in production: varies 0.5–6 %. High levels possible with pullets in early maturity	▪ Immature shell gland ▪ Disrupted deposition of calcium in shell ▪ Mineral deficiencies or imbalance ▪ Saline water ▪ Diseases with ovary tropism ▪ Mechanical damage during collection ▪ Infrequent egg collection	
Sandpaper or rough shell: eggs with rough texture areas unevenly distributed over the shell ▪ % in production: the incidence should be < 1 %	▪ Diseases with ovary tropism and avian encephalomyelitis ▪ Disrupted egg oviposition or egg retention ▪ Sudden increase of light during lay ▪ Water shortage	
Misshapen eggs: shell marred by flat sides or body checks (ribs or grooves) ▪ % in production: can rise to 2 % at start of lay and later almost disappear unless there is an issue	▪ Immature shell gland ▪ Diseases with ovary tropism ▪ Stress caused by frights and disruption ▪ Crowding	

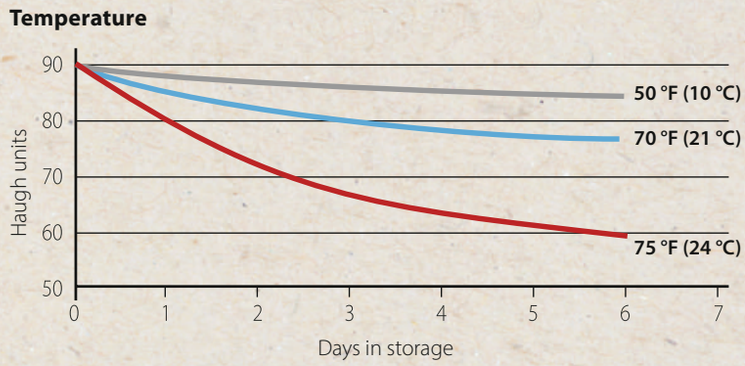
EGGSHELL QUALITY

Problem	Causes	
Flat sided eggs: part of the shell is flattened ▪ % in production: < 1 %	▪ Diseases with ovary tropism and avian encephalomyelitis ▪ Disrupted egg deposition ▪ Sudden increase of light during lay ▪ Crowding	
Pimples: small lumps of calcified material on the eggshell ▪ % in production: around 1 % is common	▪ Old birds ▪ Excess of Ca ▪ Sudden increase of light during lay ▪ Crowding	
Pinholes: small holes in the eggshell ▪ % in production: < 0.5%	▪ Old birds ▪ Mineral deficiencies or imbalance ▪ Damage caused by hen or sharp objects in cages or collection conveyor	
Mottled or glassy shell: appears mottled at candling ▪ % in production: not usually undegraded unless the condition is obvious. Incidence varies	▪ High humidity in the layer house ▪ Mineral deficiencies ▪ Crowding ▪ Diseases with ovary tropism and infection bursal disease in parent stocks	

EGG QUALITY

ALBUMEN QUALITY

Description	Causes
Physiological	Age of bird
Management	High temperature of storage. Heat stress
Diseases	Bronchitis, Newcastle
Nutrition	Low CP or Lys diets Low level of vitamin E or C during heat stress Low levels of trace minerals
Contamination	Vanadium



YOLK QUALITY

Problem	Causes	
Blood spots: blood spots on the surface of the yolk ▪ % in production: incidence varies, 0.5–1 %	▪ Deficiencies in vitamin A and K ▪ Fungal toxins ▪ Continuous lighting programs or intermittent light periods ▪ Fright and disruption ▪ Avian encephalomyelitis ▪ Seasonal or ventilation changes	
Meat spots: brown colored, pieces of tissue of the ovary or partially broken-down blood spots ▪ % in production: 0.5–1 %	▪ Deficiencies in vitamin A and K ▪ Fungal toxins ▪ Continuous lighting programs or intermittent light periods ▪ Fright and disruption ▪ Avian encephalomyelitis	
Pale yolks: the egg yolk doesn't have the expected color ▪ % in production: incidence varies based on the issue	▪ Gut health issues ▪ Mycotoxines ▪ Liver damage ▪ Oxidation of the added pigments ▪ Wrong mixing of the pigments	

Key Points

- **Internal and external egg quality is a powerful indicator to address production issues.**
- **A certain percentage of defects is considered normal.**
- **Correct egg management is the best way to improve internal and external egg quality.**

FREE-RANGE & ORGANIC PRODUCTION

Pullets

- Use the correct lighting program to train the pullets for an excellent start in production.
- **Points of attention:**
- Use of dark rearing house, or with daylight influence
- Season of the year (daylength)
- Please refer to the lighting program recommendation

Paddocks

When the certifier allows multiple paddocks (3–4), rotate the layers access to give the other paddocks time to regenerate.
In that time, the empty paddocks can be cleaned, and grass and soil can recover.

Covered Porch / Veranda / Wintergarden

- Covered porches can be used to create a barrier between the barn and the pasture range area.
  In this case there is a possibility to start training the pullets and layers to go in and outside the barn in-between, to make the transition, and to use the complete range area. This barrier is also useful as shelter for weather conditions which can affect climate and litter quality inside the barn.
- Create a clean entry into the barn or covered porch with the use of material that absorbs moisture and dirt in the first part of the pasture area, to avoid the occurrence of standing water after a rain.
  For this you can use concrete or gravel (with or without drainage) for the perimeter around the barn.

Climate Control

- When the rearing or production house is getting ready for free-range or organic, look for opportunities to update the ventilation system to keep climate and litter in good condition.
- Close the doors for outdoor access, also called pop holes, during inclement weather if permitted.
- Look for the possibilities to use climate control with equal pressure ventilation, or a day and night settings to control the time that pop holes are open and closed.

IMPORTANT

Requirements for free-range / organic rearing and production can vary by certifier. These requirements are based on:

- Age when layers need to go outside.
- Divide the range area in 3–4 different areas and use another range every 4–8 weeks so the other areas can recover.
- Amount and position of land.
- Numbers and format of pop holes.
- Placement of pop holes compared to pasture range area.
- Time of opening and closing the pop holes during the day.
- Separate range areas for maximum numbers of pullets/layers.
- Use of trees and shelters in the pasture range area.

Clean, concrete, stones, tree roots for entrance barn or covered porch

Open Pop holes

Closed Pop holes

Under pressure climate control system in free-range barn

Pasture range

Pasture range area needs to be clean and dry to avoid the occurrence of standing water as much as possible.

- Check the health condition of the previous flock, and when needed take some extra time to maintain the pasture area.
- When needed clean and reseed this area.
- Cleaning can involve spreading 500 gram/ m² quicklime on the pasture range, before reseeding.
- Use trees and shelters to protect the layers from climatic conditions (sunlight / rain) and also from predators in the sky. This stimulates the layers to use the complete pasture range.

Fencing

- To keep the pullets and layers inside, and predators outside, the pasture range you need to maintain a secure perimeter fence.
- When needed also fence off multiple compartments or paddocks inside the complete pasture range.
- The best fence is about 2 meters (6 ft) high with electric wire at the top (when allowed) to protect the hens from foxes or similar predators. It should be 50 cm (18 inches) deep underground to act as an anti-tunnelling barrier.

Predation

Predation is a problem to be considered when birds have access to an outdoor run as hens are often easy prey. Several national studies report that this can reach between 0.5 % and 29 % of all mortality in free-range systems. Predators can also carry poultry diseases.

There are mainly two types of predators:

- **Terrestrial predator:** foxes may be a common example but in different ecosystems it is possible to find other types of animals such as minks, badgers, snakes or even dogs. Many of these tend to be nocturnal predators.
- **Birds of prey:** Eagles, hawks, harriers and buzzards are among the bird species involved but these may also vary depending on geographical location and ecosystem. They are usually diurnal hunters.

Predation damage not only results in the killing of healthy, productive hens, but also has the effect of stress on production occurring from the hunting process. This is especially severe for some terrestrial predators.

It is common to have an episode of smothering, feather pecking or aggression during, just after or in the days following a predation episode.

How to reduce predation:

- Complete fencing of all outdoor runs. Hen houses must be entry-proof for foxes or other nocturnal ground predators.
- Outdoor runs must be free of abandoned objects and grass clippings to prevent predators from easily stalking hens.
- Overhead netting can be used to prevent attacks by birds of prey in some areas of the outdoor runs.
- It must be ensured that all birds enter the house before dusk.

Clean, dry pasture range with grass

Pasture range with water puddle, no grass

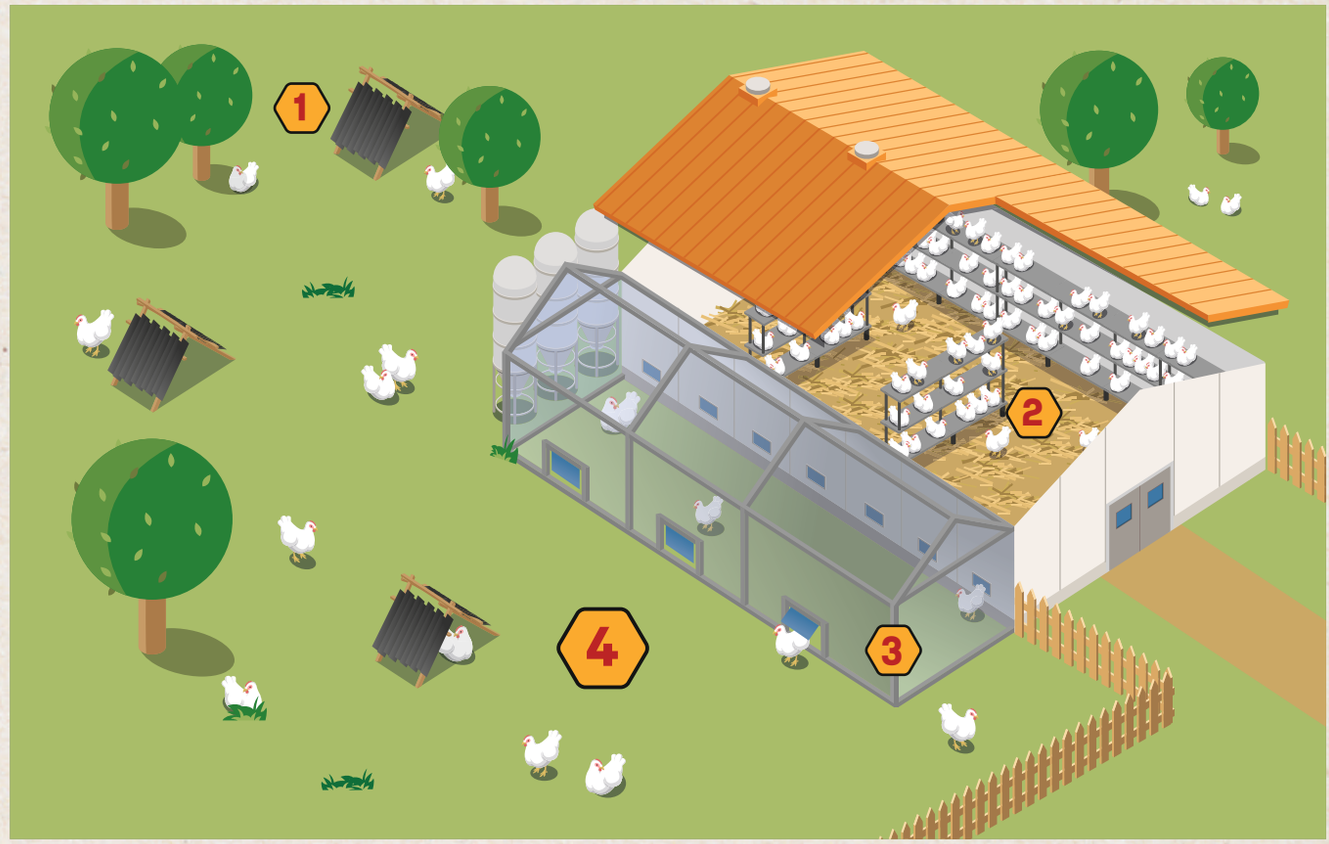
Secure fencing on pasture range

Trees in pasture range

Shelter in pasture range

RANGE MANAGEMENT

- Work with the correct lighting program in rearing and production, to make it easier to encourage ALL the pullets or layers back inside the barn for the night.
- Give the birds a good morning feeding before they go outside to the pasture range.
- It is possible to train the pullets already in rearing to go back inside when the feeders start to run.
- A few minutes before feeders start to run, present the sound of a bell. After doing this during the rearing period, you can use this bell sound also outside the barn to attract the birds to go inside for eating.
- To control climate during evening and night close the pop holes if permitted.



1 *Shelters* 2 *Feed – Water – Nest boxes* 3 *Wintergarden* 4 *Outdoor pasture*

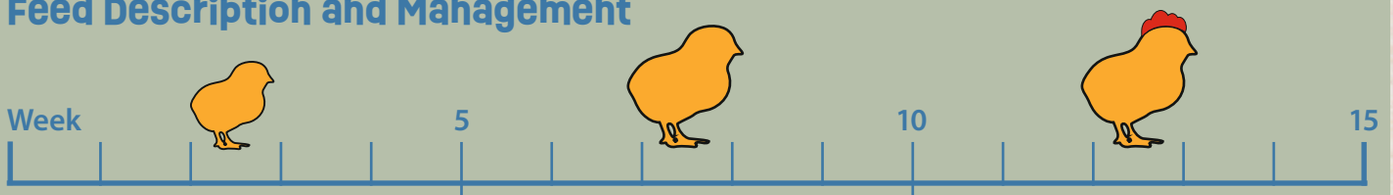
Key Points

- Start with a clean and empty pasture area with the introduction of a new flock.
- Prepare the pullets with a lighting program that corresponds to the time of the year.
- A covered porch can be used to make a barrier between the barn and pasture range.
- Adjust the climate system for optimum performance during the day and nighttime.
- Avoid the occurrence of standing water.
- Use secure fencing to keep predators outside the pasture area and barn.
- Be sure that all the layers are inside the barn at night.

Rearing Nutrition

- How to develop the skeleton and muscle of the pullet at each phase.
- How to develop the feed intake capacity for the start of lay.

Feed Description and Management



Starter Feed

- High density diet with highly digestible raw materials.
- Investment that sets up the basis of skeletal and muscular growth of the pullet.
- Feed should always be available.

Grower Feed

- Medium density diet with more variety of raw materials.
- This supports skeletal and muscular growth.

Developer Feed

- Low density diet with raw materials high in fiber.
- Feed with significant levels of fiber or a higher particle size to develop the feed intake for the start of lay.

Changing diets

- Delay a change to the diet if the target body weight is not reached.
- If the body weight isn't achieved by 5 or 11 weeks of age, there is a need to review the nutrition, density, and management in the previous weeks.
- If the birds are over the target body weight, the change to the next diet can be done a week earlier.

Formulation Tips

Starter

- Crumble feed presentation will improve growth and make it easier to reach the standard body weight.
- It could be beneficial to invest in highly digestible raw materials if they are available.
- A minimum of 0.30 % of salt will help to increase feed intake.

Grower

- Transition to mash feed if the starter was crumble feed.
- A minimum of 0.28 % of salt will help to have enough feed intake.
- A minimum of added fat will reduce the dustiness of the mash feed (1–2 % based on cost impact).

Developer

- Crude fiber level needs to be as high as possible based on the available raw materials (> 3 %, up to 5.5 %). See possible raw materials to supply the necessary fiber (table 9). These values can be applied, or even exceeded, as long as they are of good quality.
- If the available raw materials does not allow for following the recommendations below, the nutritionist should make a proportionally higher specification and the feed mill needs to make a higher particle size feed to compensate the lack of fiber.
- A minimum of added fat will reduce the dustiness of the mash feed (1–2 % based on cost impact).

Others

- Calcium particle size in pullet feed should be fine (average 1 mm).
- Enzymes: use and effect in the diet should be based on the available substrate in the diet.
- Antioxidants: protect against oxidation of the oils in the feed mill and the oxidation of fats and others in the diet.
- Organic minerals: provide additional benefits to the existing inorganics and may reduce the inclusion levels of the minerals.

Nutrient Requirements

Fiber in the diet

- The feed intake development is one of the key factors for growing a pullet ready to lay. The feed intake capacity is related to the gut size and the addition of fiber in the diet expands the size of the gut and improves the feed intake capacity.
- The fiber concept is becoming complex in poultry. There is new knowledge showing how different types have a different effect.
- Fiber can be classified as follows:
  The total dietary fiber (TDF) is a sum of water-soluble fiber (WSF), neutral detergent fiber (NDF), acid detergent fiber (ADF), crude fiber (CF) and acid detergent lignin (ADL).
- The addition of certain levels of fiber from early in rearing grow will support the feed intake capacity (see table 10).
- There are several raw materials that can supply the necessary fiber in the diets to develop the feed intake capacity (table 9)

Energy

- The energy requirement in feed is given as a range because of the several systems available for energy evaluation.

Amino Acids

- Follow the recommended Ideal Protein Ratio (table 7).

Vitamins and Minerals

- See table 8

Table 6: Nutrient Recommendations for the Rearing Period

Nutrient		Starter	Grower	Developer
		0 – 5 weeks	6 – 10 weeks	11 – 17 weeks
M Energy	lb/kg MJ/lb	21315–1383 5.50–5.78	1270–1338 5.31–5.60	1224–1270 5.12–5.31
Crude protein	%	19–20	17–18	14.5–15.5
Lysine	%	1.15	0.94	0.64
Dig. Lysine	%	0.98	0.80	0.54
Methionine	%	0.51	0.42	0.30
Dig. Methionine	%	0.43	0.36	0.25
Met. + Cysteine	%	0.86	0.75	0.54
Dig. Met + Cys	%	0.74	0.64	0.46
Threonine	%	0.76	0.65	0.44
Dig. Threonine	%	0.65	0.56	0.38
Tryptophane	%	0.22	0.20	0.15
Dig. Tryptophane	%	0.19	0.17	0.13
Isoleucine	%	0.80	0.72	0.48
Dig. Isoleucine	%	0.68	0.61	0.41
Valine	%	0.90	0.73	0.51
Dig. Valine	%	0.76	0.62	0.43
Arginine	%	1.21	0.99	0.67
Dig. Arginine	%	1.03	0.84	0.57
Calcium	%	1.05	1.00	0.90
Total Phosphorus*	%	0.75	0.70	0.58
Available Phosphorus*	%	0.48	0.45	0.37
Dig. Phosphorus*	%	0.41	0.38	0.32
Sodium minimum	%	0.18	0.17	0.16
Potassium minimum	%	0.50	0.50	0.50
Potassium maximum	%	1.10	1.10	1.10
Chloride minimum	%	0.20	0.18	0.16
Salt minimum	%	0.30	0.28	0.26
Choline total	mg/kg	1260	1240	1200

** without phytase*

Table 7: Ideal Protein Ratio in Rearing

	Starter	Grower	Developer
Lysine	100	100	100
Methionine	44	45	47
Met. + Cys.	75	80	85
Threonine	66	70	70
Tryptophane	19	21	24
Ile	69	76	76
Valine	78	78	80
Arginine	105	105	106

Amount express in % compared to Lysine.

Table 8: Vitamin and Trace Mineral Recommendation in Rearing

		Starter / Grower	Developer
Vitamin A*	IU	10000	10000
Vitamin D_3	IU	2000	2000
Vitamin E	IU	20 – 30	20 – 30
Vitamin K_3	mg	3**	3**
Vitamin B_1	mg	1	1
Vitamin B_2	mg	6	6
Vitamin B_6	mg	3	3
Vitamin B_{12}	mcg	15	15
Pantothenic acid	mg	8	8
Nicotinic acid	mg	30	30
Folic acid	mg	1.0	1.0
Biotin	mcg	50	50
Cholin	mg	300	300
Coccidiostat		as required	as required
Manganese	mg	100	80
Zinc	mg	70	60
Iron	mg	25	25
Copper	mg	10	10
Iodine	mg	0.5	0.5
Selenium	mg	0.3	0.3

**Higher levels may be possible according to local state and national regulations.*
***double in case of heat-treated feed*

Table 9: Inclusion Level (%) of Raw Materials Rich in Fiber

Raw material	Range (%)
Rice bran	5 – 15
DDGs	5 – 20
Wheat bran	10 – 20
Wheat pollard	10 – 25
Bakery by-products	5 – 10
Barley sprouts	5 – 8
Sunflower meal	5 – 15
Lupins	5 – 10
Oat hulls	2 – 4
Soybean hulls	2 – 4

Table 10: Crude Fiber Levels (%) in Rearing

	0 – 5 weeks	6 – 10 weeks	11 – 17 weeks
Minimum	3	3.5	4
Maximum	4	5	6.5

Hybrid Feed for Onset of Lay Nutrition

▶ **From light stimulation to 70 % of production.**

Feed Description and Management

- A transition feed that supports the final development of the pullet and the nutrients needed for the start of lay.
- This feed is recommended to use until the flock reaches 70 % of laying rate and have an increasing feed intake curve is achieved.
- This feed is a replacement of the prelay feed. It should be used after the developer feed, once the light stimulation is given.

Nutrient Requirements

- The ideal protein profile is the same as the layer rations.
- The vitamins and minerals are the same as the layer rations.
- Crude fiber: maintain high levels as in the developer feed supports the increasing feed intake.
- Formulate for a minimum of 3.5 % or higher crude fiber.

Formulation Tips

- The addition of fats will give the formula room for the requested calcium and fiber.
- A minimum of salt, 0.28 %, will help in the feed intake stimulation.
- 60 % of the calcium carbonate should be in coarse particle size
- Choose the nutrient profile below based on the feed intake (lb/100) at 17 weeks of age.

Table 11: Nutrient recommendations for the Onset of lay period

Nutrient					
Energy		265 – 275 kcal/hen/day 1.109 – 1.151 MJ/hen/day			
Crude protein		16.0 g/hen/day			
		mg / hen / day	15.4	16.5	17.6
Lysine	%	847	0.941	0.892	0.847
Dig. Lysine	%	720	0.800	0.758	0.720
Methionine	%	424	0.471	0.446	0.424
Dig. Methionine	%	360	0.400	0.379	0.360
Met. + Cysteine	%	762	0.847	0.802	0.762
Dig. Met + Cys	%	648	0.720	0.682	0.648
Threonine	%	593	0.659	0.624	0.593
Dig. Threonine	%	504	0.560	0.531	0.504
Tryptophane	%	186	0.207	0.196	0.186
Dig. Tryptophane	%	158	0.176	0.167	0.158
Isoleucine	%	678	0.753	0.713	0.678
Dig. Isoleucine	%	576	0.640	0.606	0.576
Valine	%	741	0.824	0.780	0.741
Dig. Valine	%	630	0.700	0.663	0.630
Arginine	%	881	0.979	0.927	0.881
Dig. Arginine	%	749	0.832	0.788	0.749
Sodium	%	180	0.200	0.189	0.180
Potassium	%	500	0.556	0.526	0.500
Chloride	%	180	0.200	0.189	0.180
Calcium	%	3600	4.000	3.790	3.600
Phosphorus	%	600	0.667	0.630	0.600
Avail. Phosphorus	%	420	0.467	0.440	0.420
Dig. Phosphorus	%	360	0.400	0.380	0.360

Laying Nutrition

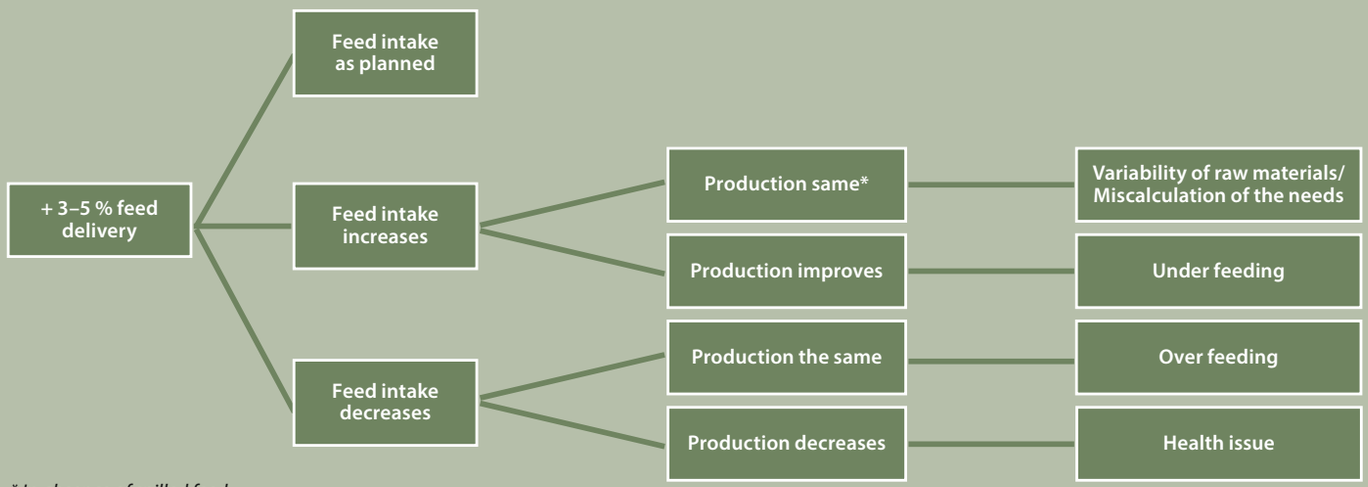
▶ **How to feed hens for achieving as many as saleable eggs as possible during the laying period.**

Feed Description and Management

Type of Feed

- The feed should fulfill the maintenance, growth, and production needs. The feed should be adjusted when:
  - **Egg mass changes:** DO NOT change amino acids if the % lay drops unless the egg mass (% lay x size egg) is dropping too.
  - **Body weight changes:** body weight affects energy needs, around +/–4 kcal every 50 grams of body weight change.
  - **Calcium and phosphorus requirement changes:** the phosphorus requirement decreases and the calcium requirement increases as the bird gets older.
  - **Feed intake changes:** housing temperature will impact the feed intake. Hot temperatures reduce feed intake and vice versa.

Chart 1: Flow diagram based on raw materials variability through the feed management on farm



** In absence of spilled feed*

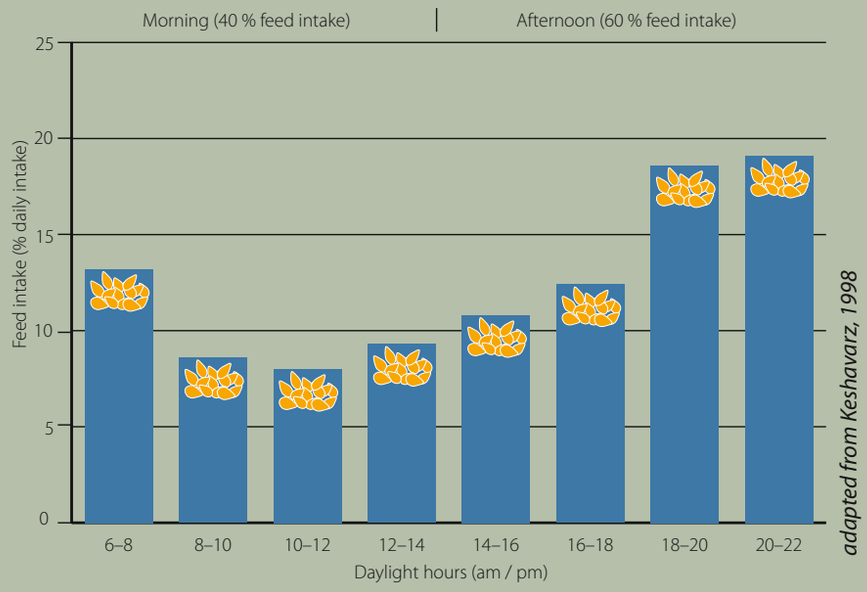
Feed Management on Farm

- Due to the variability of the raw materials the nutrient composition of the feed can be inconsistent. To avoid this challenge, we recommend following the Chart 1 decision tree.

Feed Recommendation

- Layer hens should clean up all feed left in the feeder during the noon period.
- The time at which the feeder is empty depends on the lighting program.

Chart 2: Daily feed intake pattern



Nutrient Requirements

- Recommendations below are based on egg mass production.
- After the Hybrid feed, it is recommended to use the 60–58 egg mass recommendation until the target egg weight is achieved. The other recommendations can be applied to control the egg size on target or when the egg mass production drops as the laying hen ages

Energy

- The energy recommendation of this guide does not consider the effect of the temperature in the needs of the layer hen. This needs additional adjustments by the nutritionist.
- Most of the energy intake will be used for maintenance. However, in cage free production there will be an additional need for energy, for the activity of the bird in the system. We have estimated that the needs will increase by 8 % of the maintenance needs (see chart 3).
- There are different models and literature references (INRA, FEDNA, NRC …) to approach the energy evaluation. Usually, it is described in Metabolizable Energy (MEn) and the calculations are based on formulas in accordance with the different elements of the raw materials. Due to the variability of the values given by different systems, the recommendation of energy is defined as a range.
- The energy recommendation is calculated for a specific body weight of the bird, and this may need adjustments (see foot notes of table 12).

Amino Acids

- Most of the amino acid (AA) intake will be used for egg mass production. The egg mass, % lay x egg size, drives the amino acid needs (chart 4)
- The total amino acid recommendation is based on a feed with 85 % digestibility. It will need further adjustments by the nutritionist based on the digestibility of the diets of each customer. The formulation can be done using total or digestible AA. Do not use both values at the same time.
- Working with digestible AA is highly recommended when low digestible raw materials are used in the diet (see table 20 for the Ideal Protein Ratio recommendation).

Minerals and Vitamins

- The vitamin and mineral requirement are shown in table 17.

Ca/P

- Ca and P requirement are shown in table 16.
  - Adapt the data in table 11 to suit the feed intake target.
  - Example: Average Phosphorus (Av P) requirement after peak 380 mg: if feed intake is 115 grams, the minimum amount in feed should be 0.33 %.

Chart 3: Daily requirements of energy of the bird

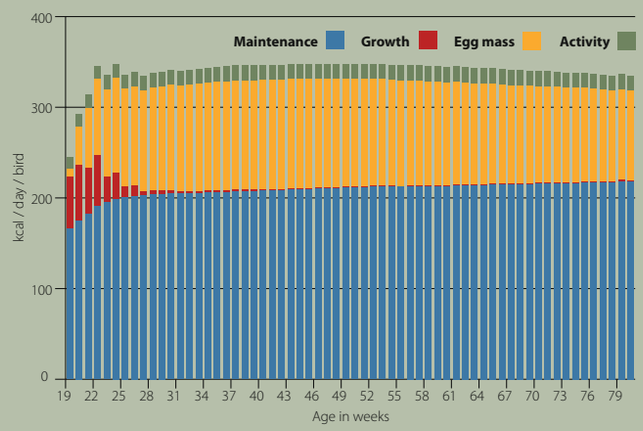
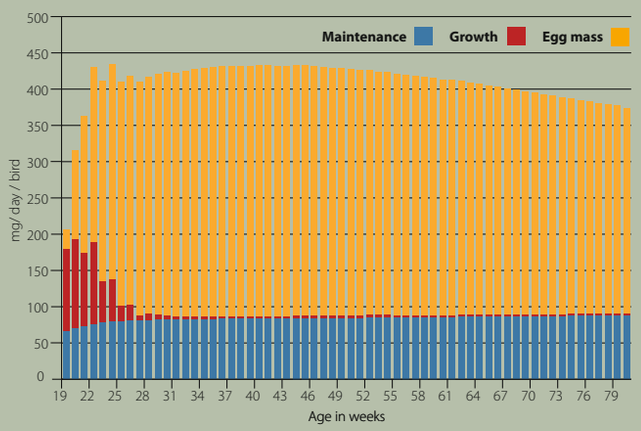


Chart 4: Daily requirements of digestible Methionine



Formulation Tips

Crude Protein

- Using the minimum amount of crude protein is recommended if there is limited information reported on the raw materials.

Fat

- Added fat will reduce the dustiness of the mash feed (1 – 2 % based on cost impact).

Ca/P Balance

- Levels of Ca and P must be adapted as the laying hen matures.
- An excess or deficiency of P can cause eggshell issues in the short or long term.
- Coarse limestone is necessary for eggshell quality. It can be replaced in part by oyster shells.
- Table 19 indicates the limestone particle ratio in layers.
- Table 18 indicates how much coarse calcium should be added directly to the feeding system.

Others

- Enzymes: use and effect in the diet should be based on the available raw materials in the diet.
- Antioxidants: protect against oxidation of the oils in the feed mill and the oxidation of fats and other ingredients in the diet.
- Organic minerals: provide additional benefits to the existing inorganics and may reduce the inclusion levels of the minerals.

Table 12: Nutrient requirement for a daily egg mass target of 12.7–13.2 lb/100 birds / 46.0–47.6 lb/case (58–60 g/hen)

Nutrient						
Energy		296 – 312 kcal/hen/day 1,241 – 1,306 MJ/hen/day				
Crude protein		3.7 lb/100 birds/day				
		mg / hen / day	23.1	24.2	25.3	26.4
Lysine	%	941	0.896	0.856	0.818	0.784
Dig. Lysine	%	800	0.762	0.727	0.696	0.667
Methionine	%	471	0.448	0.428	0.409	0.392
Dig. Methionine	%	400	0.381	0.364	0.348	0.333
Met. + Cysteine	%	866	0.825	0.787	0.753	0.722
Dig. Met + Cys	%	736	0.701	0.669	0.640	0.613
Threonine	%	659	0.627	0.599	0.573	0.549
Dig. Threonine	%	560	0.533	0.509	0.487	0.467
Tryptophane	%	226	0.215	0.205	0.196	0.188
Dig. Tryptophane	%	192	0.183	0.175	0.167	0.160
Isoleucine	%	753	0.717	0.684	0.655	0.627
Dig. Isoleucine	%	640	0.610	0.582	0.557	0.533
Valine	%	824	0.784	0.749	0.716	0.686
Dig. Valine	%	700	0.667	0.636	0.609	0.583
Arginine	%	980	0.934	0.891	0.853	0.817
Dig. Arginine	%	833	0.794	0.758	0.725	0.694
Sodium	%	190	0.181	0.173	0.165	0.158
Potassium	%	500	0.476	0.455	0.435	0.417
Chloride min.	%	190	0.181	0.173	0.165	0.158
Chloride max.	%	310	0.295	0.282	0.270	0.258
Linoleic acid	%	1550	1.476	1.409	1.348	1.292

** The energy needs are calculated for a body weight of 3.527 lb (1600 g).*
Every 110 lb (50 g) of change will have an impact of +/– 4 kcal / bird / day.

Table 13: Nutrient requirement for a daily egg mass target of 12.0–12.6 lb/100 birds / 43.7–45.9 lb/case (55–57 g/hen)

Nutrient						
Energy		291 – 306 kcal/hen/day 1,217 – 1,281 MJ/hen/day				
Crude protein		3.6 lb/100 birds/day				
		mg / hen / day	23.1	24.2	25.3	26.4
Lysine	%	918	0.874	0.834	0.798	0.765
Dig. Lysine	%	780	0.743	0.709	0.678	0.650
Methionine	%	459	0.437	0.417	0.399	0.382
Dig. Methionine	%	390	0.371	0.355	0.339	0.325
Met. + Cysteine	%	844	0.804	0.767	0.734	0.704
Dig. Met + Cys	%	718	0.683	0.652	0.624	0.598
Threonine	%	642	0.612	0.584	0.559	0.535
Dig. Threonine	%	546	0.520	0.496	0.475	0.455
Tryptophane	%	220	0.210	0.200	0.192	0.184
Dig. Tryptophane	%	187	0.178	0.170	0.163	0.156
Isoleucine	%	734	0.699	0.667	0.638	0.612
Dig. Isoleucine	%	624	0.594	0.567	0.543	0.520
Valine	%	803	0.765	0.730	0.698	0.669
Dig. Valine	%	683	0.650	0.620	0.593	0.569
Arginine	%	956	0.910	0.869	0.831	0.797
Dig. Arginine	%	813	0.774	0.739	0.707	0.677
Sodium	%	190	0.181	0.173	0.165	0.158
Potassium	%	500	0.476	0.455	0.435	0.417
Chloride min.	%	190	0.181	0.173	0.165	0.158
Chloride max.	%	310	0.295	0.282	0.270	0.258
Linoleic acid	%	1550	1.476	1.409	1.348	1.292

** The energy needs are calculated for a body weight of 3.527 lb (1600 g).*
Every 110 lb (50 g) of change will have an impact of +/– 4 kcal / bird / day.

Table 14: Nutrient requirement for a daily egg mass target of 11.4–11.9 lb/100 birds / 41.3–43.6 lb/case (52–54 g/hen)

Nutrient						
Energy		283 – 298 kcal/hen/day 1,185 – 1,248 MJ/hen/day				
Crude protein		3.6 lb/100 birds/day				
		mg / hen / day	23.1	24.2	25.3	26.4
Lysine	%	865	0.824	0.786	0.752	0.721
Dig. Lysine	%	735	0.700	0.668	0.639	0.613
Methionine	%	432	0.412	0.393	0.376	0.360
Dig. Methionine	%	368	0.350	0.334	0.320	0.306
Met. + Cysteine	%	796	0.758	0.723	0.692	0.663
Dig. Met + Cys	%	676	0.644	0.615	0.588	0.564
Threonine	%	605	0.576	0.550	0.526	0.504
Dig. Threonine	%	515	0.490	0.468	0.447	0.429
Tryptophane	%	208	0.198	0.189	0.180	0.173
Dig. Tryptophane	%	176	0.168	0.160	0.153	0.147
Isoleucine	%	692	0.659	0.629	0.602	0.576
Dig. Isoleucine	%	588	0.560	0.535	0.511	0.490
Valine	%	757	0.721	0.688	0.658	0.631
Dig. Valine	%	643	0.613	0.585	0.559	0.536
Arginine	%	901	0.858	0.819	0.783	0.751
Dig. Arginine	%	766	0.729	0.696	0.666	0.638
Sodium	%	180	0.171	0.164	0.157	0.150
Potassium	%	500	0.476	0.455	0.435	0.417
Chloride min.	%	180	0.171	0.164	0.157	0.150
Chloride max.	%	310	0.295	0.282	0.270	0.258
Linoleic acid	%	1550	1.476	1.409	1.348	1.292

** The energy needs are calculated for a body weight of 3.527 lb (1600 g).*
Every 110 lb (50 g) of change will have an impact of +/– 4 kcal / bird / day.

Table 15: Nutrient requirement for a daily egg mass target of less than 11.3 lb/100 birds / 41.3 lb/case (51 g/hen)

Nutrient						
Energy		279 – 294 kcal/hen/day 1,169 – 1,231 MJ/hen/day				
Crude protein		3.4 lb/100birds/day				
		mg / hen / day	23.1	24.2	25.3	26.4
Lysine	%	841	0.801	0.765	0.731	0.701
Dig. Lysine	%	715	0.681	0.650	0.622	0.596
Methionine	%	421	0.401	0.382	0.366	0.350
Dig. Methionine	%	358	0.340	0.325	0.311	0.298
Met. + Cysteine	%	774	0.737	0.704	0.673	0.645
Dig. Met + Cys	%	658	0.626	0.598	0.572	0.548
Threonine	%	589	0.561	0.535	0.512	0.491
Dig. Threonine	%	501	0.477	0.455	0.435	0.417
Tryptophane	%	202	0.192	0.184	0.176	0.168
Dig. Tryptophane	%	172	0.163	0.156	0.149	0.143
Isoleucine	%	673	0.641	0.612	0.585	0.561
Dig. Isoleucine	%	572	0.545	0.520	0.497	0.477
Valine	%	736	0.701	0.669	0.640	0.613
Dig. Valine	%	626	0.596	0.569	0.544	0.521
Arginine	%	876	0.835	0.797	0.762	0.730
Dig. Arginine	%	745	0.709	0.677	0.648	0.621
Sodium	%	180	0.171	0.164	0.157	0.150
Potassium	%	500	0.476	0.455	0.435	0.417
Chloride min.	%	180	0.171	0.164	0.157	0.150
Chloride max.	%	310	0.295	0.282	0.270	0.258
Linoleic acid	%	1550	1.476	1.409	1.348	1.292

** The energy needs are calculated for a body weight of 3.527 lb (1600 g).*
Every 110 lb (50 g) of change will have an impact of +/– 4 kcal / bird / day.

Table 16: Ca and P needs during Laying Period

	Before peak	Peak to 45 weeks	45 – 70 weeks	> 70 weeks
Ca w (mg/bird/day)	3800	4000	4300	4500
Phosphorus* (mg/bird/day)	600	540	480	430
Av. Phosphorus (mg/bird/day)	420	380	340	300
Dig. Phosphorus (mg/bird/day)	360	325	290	255

Different phytase additives enable hens to utilize different percentages of consumed phosphorus.

Table 17: Vitamin and Trace Mineral Recommendations in Lay

		Lay
Vitamin A*	IU	10000
Vitamin D_3	IU	2500
Vitamin E	IU	30 – 100
Vitamin K_3	mg	3**
Vitamin B_1	mg	1
Vitamin B_2	mg	4
Vitamin B_6	mg	3
Vitamin B_{12}	mcg	15
Pantothenic acid	mg	10
Nicotinic acid	mg	30
Folic acid	mg	0.5
Biotin	mcg	50
Cholin	mg	400
Coccidiostat		–
Manganese	mg	100
Zinc	mg	90
Iron	mg	25
Copper	mg	10
Iodine	mg	0.5
Selenium	mg	0.3

**Higher level might be possible according to local state and national regulations.*

*** double in case of heat treated feed*

Tabel 18: Addition of Coarse Calcium at farm in the afternoon is an option where applicable

Week	Grams
18 – 25	1.0
26 – 45	2.0
46 – 70	3.5
> 70	4.0

**Review the formulation to balance it with Calcium*

Tabel 19: Particle size distribution Recommendations in Layer Feed

Week	Fine*	Coarse**
18 – 25	35 %	65 %
26 – 45	30 %	70 %
46 – 70	25 %	75 %
> 70	15 %	85 %

**Fine Limestone: average 1 mm*

***Coarse Limestone: 85 % of the particles > 3.5 mm and less than 5 % < 5 mm*

Table 20: Ideal protein ratio in Laying Hens

	Lay
Lysine	100
Methionine	50
Met. + Cys.	90
Threonine	70
Tryptophane	24
Ile	80
Valine	88
Arginine	104

Amount express in % compared to Lysine.

FEED STRUCTURE

Mash feed is the most commonly used feed throughout the world. Laying hens tend to eat the larger particles avoiding the fine particles which hold most of the key nutrients. Therefore, it is vital for successful nutrition to have uniform particle structure. It is even more important in non-beak treated birds.

Crumble and pellet forms can be used as long as the structure holds in the feeding system of the birds, and it doesn't become a fine particle mash.

KEY POINTS OF THE UNIFORMITY OF FEED

- grinding of the raw materials
- particle size of the protein sources
- addition of liquids like oil that reduce the dustiness of feed
- reduction of fine particle raw materials
- See table 21 and 22 for guidelines

Table 21: Pullet feed particle size

Pullets	Media %
> 2 mm	28.2
> 1.4 < 2 mm	24.5
> 1 < 1.4 mm	12.8
> 0.71 < 1 mm	9.9
> 0.5 < 0.71 mm	8.8
< 0.5 mm	15.6

Table 22: Layer feed particle size

Layer	Media %
> 2 mm	26.2
> 1.4 < 2 mm	30.3
> 1 < 1.4 mm	14.4
> 0.71 < 1 mm	9.0
> 0.5 < 0.71 mm	7.1
< 0.5 mm	12.6

FEED QUALITY

Nutrients

Accurate information is needed to formulate a realistic diet. A combination of available literature, wet chemistry methods and/or NIR (Near-Infrared Spectroscopy) is necessary to generate an updated matrix of the raw materials used.

Microbiology

There are no specific guidelines in place, however the lower the contamination, the better the performance parameters. Ensure adequate control measures are in place to prevent microbiological risk factors in the diet.

Oxidation

Oils in the feed mill and fat in the diet are the most common components at risk of oxidation. The quality control plan for raw materials should include analysis of the oxidation status of oils, evaluating at least two parameters of the available methods.

Mycotoxins

Follow the guidelines available in your country and literature to prevent negative effects on layer hen health and production. Adapt the use of mycotoxin binders to suit the level of risk in the diet and the contamination load in the raw materials.

Antinutritional Factor (ANF)

Understanding the ANF will allow higher or lower inclusion levels of the raw materials.

Key Points

- **Adjust the feed to the needs of the birds based on the body weight and egg mass produced.**
- **Calcium and phosphorus requirements change as the laying hen matures.**
- **Excess and deficiencies have a negative effect on eggshell quality.**
- **Feed structure should be attractive for the laying hens, so they consume a complete diet.**
- **Thorough information of nutrient and microbiological quality is key for good performance.**

HOUSE ENVIRONMENT

- How to control the effect of temperature on the birds.
- How to provide excellent air quality to the birds.
- How to provide optimum water quality to the birds.
- How to control the effect of light on the birds.

To optimize bird performance and health we need proper environmental controls:

COLD WEATHER VENTILATION SYSTEM

Capable of bringing in small amount of fresh air during cold weather without resulting in excessive drops in house temperature or losses in temperature uniformity:

- **Air quality control**

MODERATE WEATHER VENTILATION SYSTEM

to control house temperature during moderate times of the year

- **House temperature control**

HOT WEATHER VENTILATION SYSTEM

Capable of removing heat from the house as well as the birds.

- **Heat stress control**

HEN THERMOREGULATION

In chicks the thermoregulation starts around 4 days of age, therefore for the first 10 days of life, temperature is a critical factor. The chick cannot sustain an optimal body temperature without an external source of heat. For this reason, it is also important to know how the birds lose heat:

Convection

Heat loss occurs due to the movement of the air which permits the transfer of heat from the hen's body to the air. This process can be promoted by providing rapid air movement around the hen.

Conduction

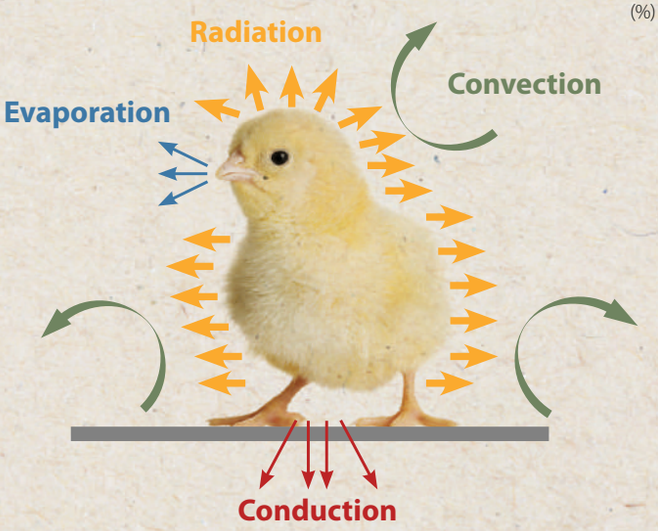
Heat transfer from surface to surface. Normally, it is relatively unimportant as the contact surface is small and the temperature of the litter or of the system is not significantly different from the body temperature.

Radiation

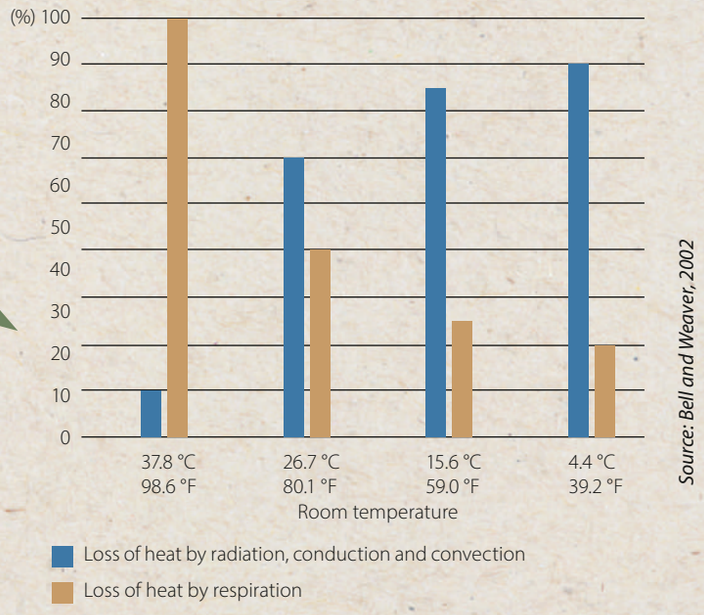
This is the transmission of heat from a warm object to a cold one. Heat loss is proportional to the temperature difference between the body surface and the surrounding air.

Evaporation

Birds use evaporation to stabilize their body temperature by increasing the respiration rate through panting, which is very effective.



Effects of the Barn Temperature on Heat Loss



Source: Bell and Weaver, 2002

TEMPERATURE

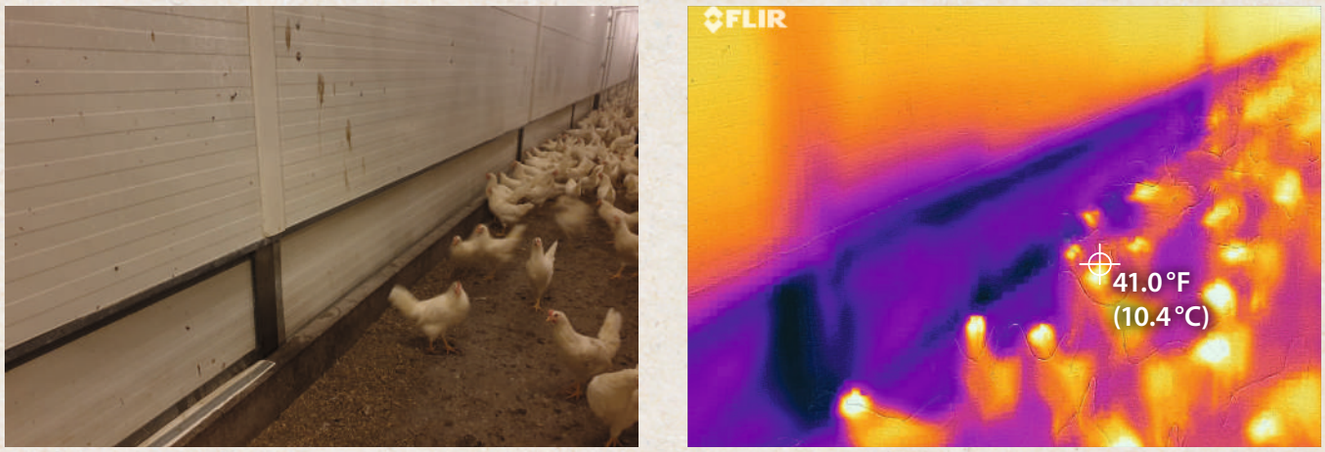
The ambient temperature has a great influence on egg production. Layers perform well over a wide range of temperatures. Temperature fluctuations between 69.8 °F and 80.6 °F (21 °C and 27 °C) have a minimal effect on egg production, egg size and shell quality. Feed conversion improves with higher house temperatures, and maximum efficiency is attained in the 69.8–80.6 °F (21–27 °C) range.

As the temperature rises, however, the following parameters could be affected:

- Feed intake
- Egg weight
- Egg production
- Eggshell quality
- Mortality

A uniform temperature throughout the house is important. Good ventilation management and thermal insulation should help to reduce or eliminate temperature variations, especially between day and night.

The temperature should not be seen as an isolated parameter but always considered in combination with humidity. In addition, air speed is also an important element of the perceived ambient temperature.



As you see in the infrared image, pop-holes present a big challenge when trying to keep an optimal temperature and well managed litter in the areas near them.

Tabel 23: Temperature and its effect on the birds

Temperature		Effects
< 20 °C	< 51.8 °F	Increased feed consumption
20–27 °C	51.8–77 °F	Ideal temperature for good performance and feed conversion.
27–31 °C	77–87.8 °F	Slightly reduced feed intake.
32–36 °C	89.6–96.8 °F	Further reduction of feed intake. Reduced activity and drop in egg production, egg weight and shell quality.
37–39 °C	98.6–102.2 °F	Severe reduction of feed intake. Increase in cracked eggs. Mortality of heavier hens or those in full production.
40–42 °C	104–107.6 °F	Severe panting and respiratory alkalosis. Increased mortality due to heat stress.
> 42 °C	> 107.6 °F	Emergency measures are needed to cool down hens for survival.

HOT CLIMATE

High temperatures, especially over a long period, can cause serious losses to the poultry farmer. The effects of heat stress are delayed onset of lay, lower performance, decreased feed intake and increased mortality. Therefore, to minimize financial losses, every effort should be made to maintain an ambient temperature in the house within the bird's comfort zone. If this is not possible, corrective measure should be taken.

Water Quality

When birds are heat stressed, they increase consumption of water in an effort to cool down. The ratio of water to feed increases from 2:1 under normal conditions to over 5:1 under hot conditions.

Fresh good quality water should be supplied so that birds can find relief from the heat. To ensure that all the birds have access to water, provide the minimum of water space and adjust it according to the climate conditions.

During periods of hot temperature, the drinker lines should be flushed every day and at least one time per day at the start of lighting program, to get fresh water into the system. Water reservoir must be insulated, and shaded to keep water cool.

Ventilation

The ventilation system should be checked before the hot weather arrives. Fans should be cleaned, and fan belts should be tightened and replaced if necessary. The inlets must be adequate to supply the air flow needed, they should be clean and not obstruct the flow of the incoming air. Tunnel ventilation and cooling pads are the preferred ventilation system. Along with the ventilation system, the tightness of the house must be checked.

In free range houses with pop-holes, tunnel ventilation and cooling pads are not the best combination. Therefore, a good option is having high pressure fogging system to cool down the birds when experiencing hot weather conditions.

Feeding Times

Do not feed at the hottest time of the day. Consider adjusting feeding times to avoid feeding 5–8 hours before the anticipated time of peak temperature.
Feeder chains should be run frequently to stimulate feed intake. The feeder should remain empty for at least 1 hour but no more than 2 hours during the hottest time of the day, to promote feed intake and ensure that the fine particles are consumed, which usually consist of minerals, vitamins, and amino acids. To increase feed consumption, a midnight feeding can be implemented.

Low Stocking Density

The stocking density should be in accordance with the environmental conditions.
If the housing density is too high, the radiant heat between the birds will accumulate, the temperature will increase, and air will not circulate around the birds properly.

There must be enough space for the birds to separate, allowing them to pant, droop and slightly lift their wings away from the body to maximize the heat loss.

Feed Formulation

Since feed intake is reduced during hot weather periods, the general feeding approach is to increase the energy content in the feed to keep daily energy intake at the necessary level for optimum performance under these conditions

Heat Stress

Temperature		Relative Humidity (%)																		
°F	°C	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
72	21	OPTIMAL																		
74	24																			
76	25																			
78	26																			
80	27										ALERT									
82	28																			
84	29																			
86	30																			
88	31									DANGER										
90	32																			
92	34																			
94	35																			
96	36																			
98	37																			
100	38																			
102	39																			
104	40													EMERGENCY						

Adapted from Hongwei and Harmon, 1998

Heat Stress Index

Temperature + Relative humidity of air
= Effective temperature

Heat stress index combines the effects of both temperature and relative humidity and is classified in optimal, alert, danger, and emergency.

Alert

Prepare to take necessary cooling measures; increase ventilation rate; turn on cooling fans where applicable; monitor animal behavior for signs of heat stress such as panting or open mouth; make plenty of drinking water available.

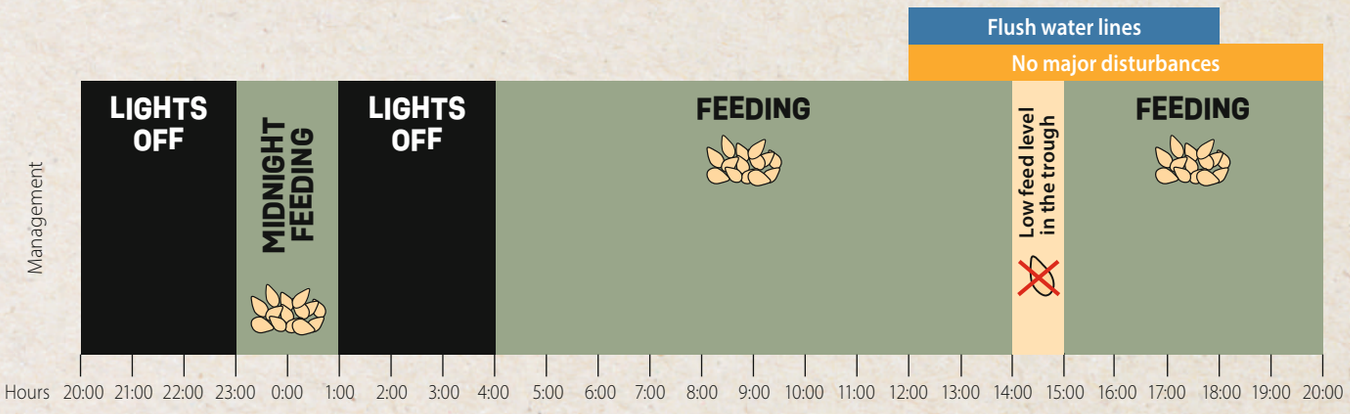
Danger

Apply additional cooling by spraying or misting the animals with water (make sure that there is plenty of air movement during this phase). Start evaporative cooling pads and tunnel ventilation where applicable. When possible, move air over the animals at a velocity in the aisle of 172 to 214 m per minute (500 to 700 ft per minute). Flush the water lines periodically. Closely monitor the animals.

Emergency

Avoid transporting market weight animals. In addition to measures listed for the Danger category, withdraw feed during the hottest part of the day; reduce light intensity in light-controlled houses to reduce animal activity and thus heat production.

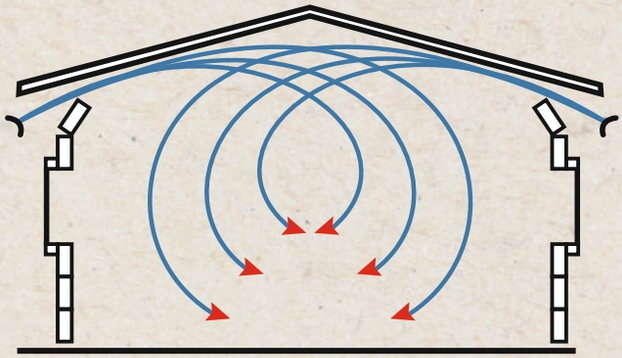
Example of 24-hour Management during Heat Stress Conditions

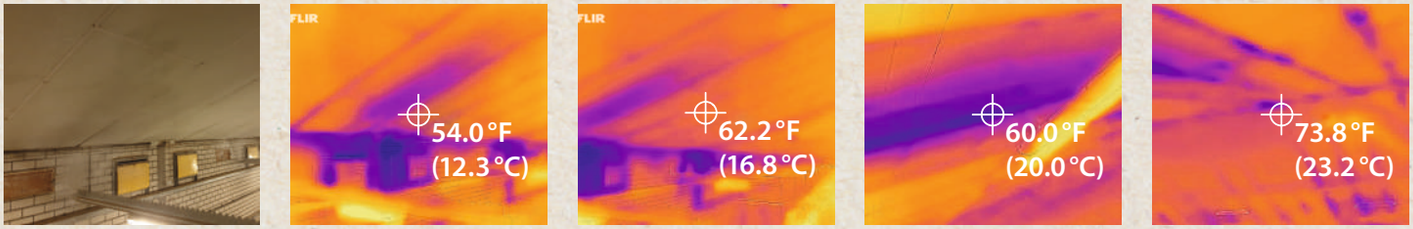


VENTILATION SYSTEMS

Transverse Ventilation

1. Most commonly used during brooding or in cold weather.
2. Cold air is directed to the roof to be warmed up. Air movement is very important for avoiding cold drafts at the bird level.
3. The space between the top tier and the ceiling (at least 6.5 ft / 2 m) and the inlet design is very important.
4. Fans should be driven by temperature controls or timer, not set permanently on or off.

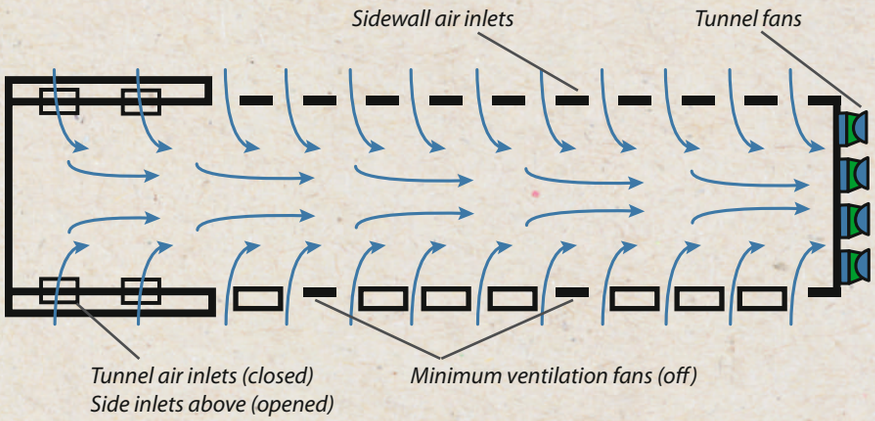




A good transverse ventilation system is intended to warm up the incoming air by directing it to the roof where the air temperature is higher. This sequence of thermal images is showing the effect of optimal transverse ventilation.

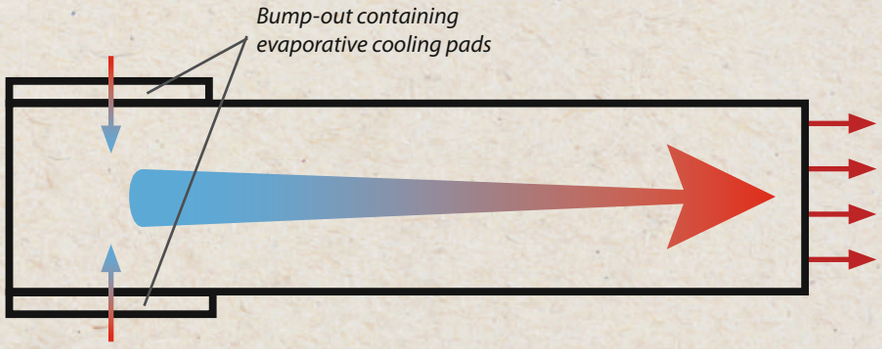
Transition System

1. Used when temperature rise but tunnel ventilation cannot be used (moderate or cold weather conditions, tunnel entrance not installed, young chicks).
2. Air is still directed to the roof.
3. Main function is to reduce the house temperature.



Tunnel System

1. Used in hot weather and fully feathered birds.
2. It generates a high-speed flow at bird's level. It helps to cool the birds by the wind chill effect
3. Most important driver for this system is the air velocity at bird's level.
4. Best option is to install cooling pads in a room at the front of the house



THE KEY TO ANY VENTILATION SYSTEMS BASED ON NEGATIVE PRESSURE IS THAT THE HOUSE NEEDS TO BE TIGHT, SO ALL THE AIR ENTERS THROUGH THE INLET SYSTEM DURING BOTH COLD AND HOT WEATHER.

NATURAL VENTILATION

Characteristics of natural ventilation:

1. Bring in adequate fresh air into the house. However, it is difficult to control the amount entering and how it moves inside the house.
2. Depends on the external conditions.
3. An internal air distribution system will help to create and even air flow and to provide a cooling effect during hot weather.
4. Critical points are the house orientation (west to east), prevailing wind direction, roof insulation, prevent direct sun light onto the birds, among others.
5. Extremely difficult to provide the optimal conditions when outside temperature is not within the optimal range for birds. It is important to control dust and ammonia, remove humidity from litter, and keep optimal temperature during minimum ventilation conditions or cold temperatures. Cooling the birds is a difficult challenge with hot and humid weather.

How to deal with large nest space in block system aviaries

- Avoid narrow aisles because they make it difficult to create uniform air conditions. They must be at least 6.5 feet (2 m) wide.
- Distance between the top tier and ceiling must be at least 6.5 feet (2 m) to give enough space to the incoming cold air to mix and warm up without affecting the birds.

There is always better air conditions and circulation in aviaries with wider aisles rather than narrow ones.

Tips for Ventilation in Free-Range Houses

- **When pop-holes are open run the house at low level of negative pressure.**
- **Use natural or curtain ventilation during mild weather.**
- **Evaporative cooling pads may not be the best option for a free-range house in hot weather. Options could be using high pressure fogging systems and / or circulation fans.**
- **Wide houses could be problematic (> 130 feet / 40 m wide)**
- **Negative pressure is not the only option for cold weather ventilation: positive (blowing air inside the house) or neutral pressure systems (blowing in and out air at the same time).**

AIR QUALITY

Good air quality should be guaranteed in the house by using proper ventilation, so there is a low concentration of gases and dust. At the same time, the temperature in the house should be optimally maintained between 18–24 °C with a relative humidity of 40–60 %. To achieve this, fresh air must be brought in. Calculating the ventilation needs are not difficult, the challenging aspect is to bring fresh air uniformly throughout the house without causing an excessive drop in temperature or causing drafts. Therefore, the design of the inlet system is fundamental.

The rate of ventilation is determined by the temperature, however when this parameter has been met, a minimum ventilation level must be guaranteed. This minimum is normally calculated in m^3 (cubed feet) / body weight / hour, but the important target is correct management of these parameters:

- Relative humidity (40 to 60 %)
- Carbon Dioxide (CO_2) < 5000 ppm
- Carbon Monoxide (CO) < 50 ppm
- Ammonia (NH_3) < 25 ppm
- Dust concentration

Table 24: Air Movement (m^3 / hour / 1000 birds)

Weeks of age	Ambient Temperature					
	32	21	10	0	–12	–13
1	360	180	130	75	75	75
3	540	270	180	136	110	110
6	1250	630	420	289	210	210
12	3000	1500	800	540	400	400
18	7140	3050	2240	1500	600	600
19+	9340–12000	5100–6800	3060–4250	1020–1700	700–1050	700–850

Circulation fans are an excellent option to create uniform conditions (temperature and air quality) between top and bottom tiers.

WATER QUALITY

Water is the most important and critical nutrient for hens. Any water deprivation will directly impact feed consumption and production. If lack of water exceeds 24 hours, egg production will be severely affected. If deprivation exceed 48 hours, high mortality will occur in the flock. It is therefore essential to provide a good quality, stable and reliable source of water. Always choose a well water source over a surface water source.

Microbiological Quality

Water can act as a disease carrier if it is contaminated at the source. Moreover, poor water quality can affect gut health and lead to pathologic issues that affect production.

The microbiological quality at the water source must be monitored and samples should be taken at least once per year. The best option is to have in place a good monitoring program. This is even more important if water comes from surface sources. The sampling program should consider not only drip sampling but swab sampling to evaluate the biofilm presence.

Even if the water source is of excellent quality, chlorination or an alternative treatment is highly recommended. Treatment of surface water is mandatory.

Physical Quality

The content of minerals and other elements can greatly impact egg production and hen health. Even if corrective measures can be taken, it is very difficult and expensive to alter the chemical characteristics of water. A good quality water source is a huge advantage when a new farm is under construction. The physical and chemical water quality must be monitored, and samples taken at least every year.

Refusing Water

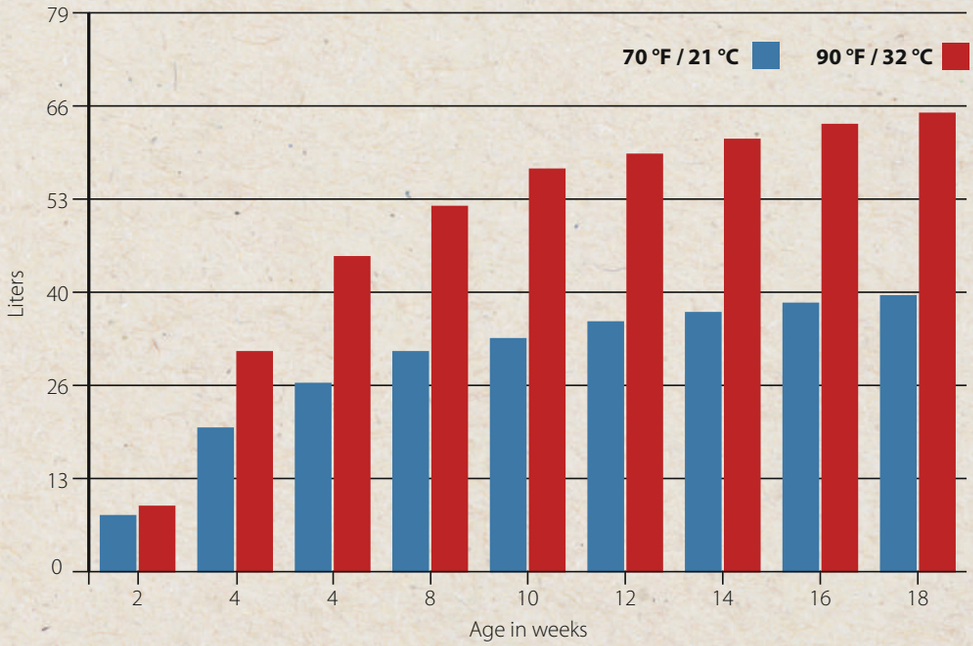
In some cases, hens can refuse water. This situation is the same as water privation:

- **Temperature:** hens will decrease their water consumption when water is above 75 °F, but will refuse it above 90 °F.
- **Taste:** hens do not have a very developed sense of taste but will refuse to drink water with an unpleasant taste. Some minerals in high quantity, water additives or antibiotics can produce this effect.

Water sanitation station

Every time a product is applied through the water lines you must check that the water flow isn't impaired and after the administration always flush the water lines.

Water consumed / 1000 birds / day



Drinking Water Parameters

Mineral	Recommended level in poultry	Effects	Treatments
Calcium	< 75 mg / l	There is no maximum limit. However, > 110 mg / l could cause scale buildup.	Same treatment as for water hardness.
Copper	< 0.6 mg / l	Its origin is probably by corrosion of pipes and joints. High levels could change the taste of water, produce oral or gizzard lesions.	
Iron	< 0.3 mg / l	Metallic taste of water, gastrointestinal disorders, decreases efficiency of vaccine and medications. Blockage of water pipes, bad smell and/or taste, encourages bacterial growth.	Treatments include the addition of some oxidant such as chlorine, chlorine dioxide or ozone then aerate and filter through an appropriate mechanical filtration process.
Magnesium	< 125 mg / l	>125 mg/l could cause wet manure due to its laxative effect. Level above 50 mg/l in conjunction with high levels of sulfate or chloride could also produce a laxative effect.	Same treatment as for water hardness.
Manganese	< 0.05 mg / l	Can be deposited in the form of black granules in filters and drinkers.	Similar to iron but can be more difficult to remove due to the slow reaction it has with chlorine. Therefore, It needs a long contact time with chlorine prior to filtration unless an iron ion exchange resin is used when pH is 6.8 or higher. The filtration should be done at a pH around 8.5. Another option is green sand filters with a pH greater than 8.0.
Nitrate	< 15 mg / l (nitrites < 1 mg / l)	Very high levels reduce the absorption of oxygen (apathetic birds, violaceous combs and wattles), low fertility, lower feed intake, lower weight gain and production.	Reverse osmosis; ion exchange.
pH	5 – 8	Less than 5 can produce metal corrosion. Higher than 8 can affect the performance of disinfectants and the taste of water.	Organic or acid minerals to lower the pH. Basic agents to raise pH.
Phosphorus	0.1 mg / l		
Potassium	< 300 mg / l	Effects will depend on water alkalinity and pH.	
Chlorides-chlorine	< 250 mg / l	Laxative effect, wet manure, reduced feed intake and increased water consumption. Keep in mind that levels of 14 ppm can cause problems if sodium is > 50 ppm.	

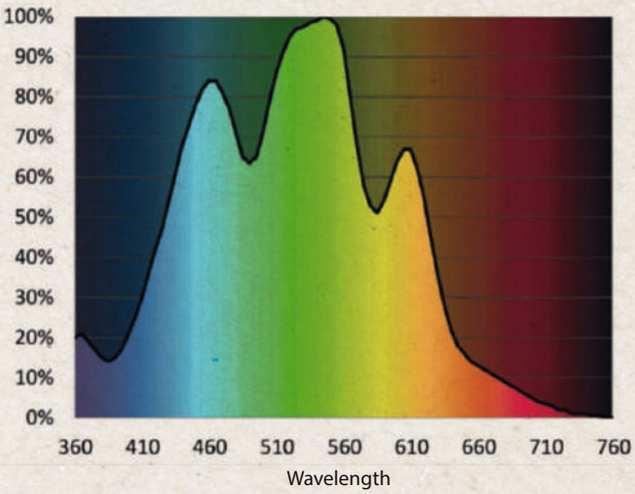
Mineral	Recommended level in poultry	Effects	Treatments
Sodium	50 – 300 mg / l	Together with high levels of chlorine or sulfate can cause diarrhea. In addition, it can promote the growth of Enterococci. Level > 600 mg / l could produce alterations in eggshell quality. There may be problems when lower concentrations (< 50 mg / l) are accompanied by chlorides ≥ 14 ppm or sulfates > 50 ppm.	Reverse osmosis, lower dietary salt level blend with non-saline water, keep water clean and permanently use sanitizers such as hydrogen peroxide or iodine to prevent bacterial growth.
Sulfate	< 200 mg / l	Laxative effect. If high levels of magnesium and chloride or sulfate are also present (> 50 mg/l), a decrease in performance can occur. The presence of rotten egg odor can mean that there is a high concentration of hydrogen which is a byproduct of sulfate-reducing bacteria.	Aerate water in a storage tank to prevent air bubbles from entering water lines. Apply chlorine shots into the well, without stopping the normal disinfection program.
Alkalinity	< 100 mg / l	It is a value associated with bicarbonate, sulfates, and calcium carbonate. It can give a bitter taste to water which can reduce water intake and be corrosive to evaporative panels. High alkalinity levels make more difficult to lower the water pH.	Acidification (pH target < 6,5), anion exchange to reduce the water alkalinity and aeration.
Water hardness	< 150 mg / l	Water hardness can produce scale that deposit on the inner surface of pipes. Main factors are calcium and magnesium. Iron and manganese can also contribute but in lesser extent. Very high levels can also impact on medications and vaccines.	Water softeners (do not use if sodium levels are high unless potassium chloride is used instead of sodium chloride). Polyphosphates sequester the ions involved in hardness and keep them in solution. Acidify to a pH < 6,5.
Zinc	< 1.50 mg / l	Higher levels are toxic.	Filtration methods.
Fluor	< 2 mg / l	High levels can induce soft bones.	
Total dissolved solids	< 1500 ppm (< 3 weeks of age) < 3000 ppm (> 3 weeks of age)	Levels between 4000 to 7000 ppm can produce diarrhea. Concentration > 7000 ppm isn't recommended for drinking water.	Filtration methods.

LIGHT

Birds vision differs from our visible light spectrum. Hens can see ultraviolet and infrared light. This fact should be considered when creating lighting programs and the light color choice.
Hens need proper light with an adequate light intensity and the correct photoperiod. The best source of light for production is a high frequency (at least 120 Hz) bulb emitting light within the warm color spectrum (2,500–3,500 K). Low frequency fluorescent tubes or energy saving bulbs (50–100 Hz) have a strobe light effect on hens and encourage feather pecking and cannibalism. In addition, hens can see perfectly in a low light intensity ambiance. Light intensity will vary during the different production stages but keep in mind that the higher the light intensity, the more active the hens will be. It can be positive (as in the case of brooding) or negative (as in the case of cannibalism during laying). In any case, light intensity variation during the day should be avoided as it can cause high stress level in the hens. Direct sunlight should also be avoided for the same reason.

Light not only can be used to stimulate and maintain production but also used to prevent problems (like mislaid eggs) and train birds to use the different equipment in cage free houses (see below pictures).

Avian Light Vision Spectrum



LED light to prevent mislaid eggs under the system

Good light distribution and intensity to reduce mislaid eggs

LED light to help find water line

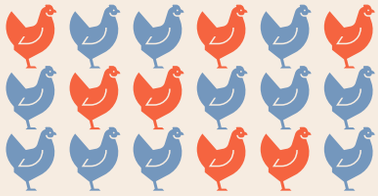
Key Points

- Key environmental factors: air movement, air temperature and relative humidity.
- Temperature has a critical impact and must be well managed to achieve good production.
- In warm weather, take corrective measures to reduce the impact of high temperatures.
- Water is a key nutrient. Ensure that a quality water supply is accessible to the hens.
- Maintain air quality and distribution through correct ventilation.
- Maintain litter quality (not too wet and not too dry).
- Remember that light has a significant effect on hen behavior.

BIRD ASSESSMENT

▶ How to get reliable information to make informed decisions.

PULLET PHASE



BODY WEIGHT AND UNIFORMITY

Weigh minimum 100 birds

Select from different tiers and also from the front, middle and back part of the house.
All the birds of the selected cage need to be weighed.

Weigh weekly

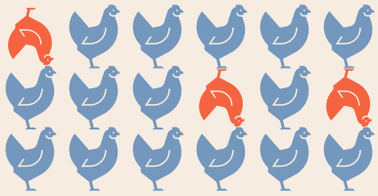
Formula

UNIFORMITY

$$= \frac{\text{all weighed birds} - A1 - B2}{\text{all weighed birds}}$$

A1 =
No. of birds >= average BW x 1.1

B2 =
No. of birds <= average BW x 0.9



MORTALITY

Daily Mortality (%)

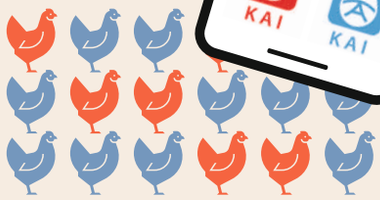
$$= \frac{\text{No. of mortality today x 100}}{\text{No. of live birds yesterday}}$$

Weekly Mortality (%)

$$= \frac{\text{No. of mortality in last 7 days x 100}}{\text{No. of live birds on day before the week starts}}$$

Accumulated Mortality (%)

$$= \frac{\text{No. of mortality so far x 100}}{\text{initial No. of housed birds}}$$



SHANK LENGTH OR KEEL LENGTH

Measure minimum 50 birds

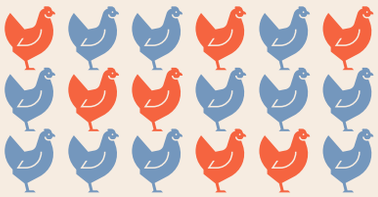
All the birds of the selected cage or area need to be measured.

Measure 5 weeks before transfer

How to do shank measurements

How to do keel measurements

LAYING HENS



BODY WEIGHT AND UNIFORMITY

Weigh minimum 100 birds

Select cages from different tiers and also from the front, middle and back part of the house.
All the birds of the selected cage need to be weighed.

Frequency

Weigh weekly up to 30 weeks of age

Weigh every 2 weeks up to 40 weeks of age

Weigh monthly after 40 weeks of age

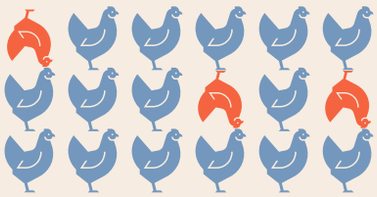
Formula

UNIFORMITY

$$= \frac{\text{all weighed birds} - A1 - B2}{\text{all weighed birds}}$$

A1 =
No. of birds >= average BW x 1.1

B2 =
No. of birds <= average BW x 0.9



MORTALITY

Daily Mortality (%)

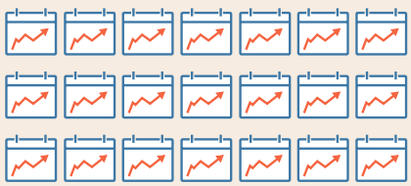
$$= \frac{\text{No. of mortality today x 100}}{\text{No. of live birds yesterday}}$$

Weekly Mortality (%)

$$= \frac{\text{No. of mortality in last 7 days x 100}}{\text{No. of live birds on day before the week starts}}$$

Accumulated Mortality (%)

$$= \frac{\text{No. of mortality so far x 100}}{\text{initial No. of housed birds}}$$



EFFICIENCY PARAMETERS

FCR* kg/kg

$$= \frac{\text{kg of feed consumed}}{\text{kg of eggs produced}}$$

(No. of eggs x average egg weight)

FCR kg/egg

$$= \frac{\text{kg of feed consumed}}{\text{No. of eggs}}$$

Egg per Hen Housed

$$= \frac{\text{No. of eggs produced}}{\text{No. of hens in the production house after the transfer}}$$

FCR kg/12 eggs

$$= \frac{\text{kg of feed consumed x 12}}{\text{No. of total eggs produced}}$$

IOFC**

=
egg mass hen housed x 0.8
–
feed intake per hen housed x 0.2

***Feed Conversion Ratio**
****Income Over Feed Cost**

LAYING HENS

EGG PRODUCTION

Daily Laying Rate (%)

=

$$\frac{\text{all produced eggs} \times 100}{\text{daily birds in the farm}}$$

Weekly Lay (%)

=

$$\frac{\text{Sum of all produced eggs within 7 days} \times 100}{\text{Sum of all the birds within 7 days}}$$

Accumulated Lay (%)

=

$$\frac{\text{Sum of all the produced eggs}}{\text{No. of birds housed} \times \text{Days in production}}$$

Daily egg size

=

$$\frac{\text{Total weight of produced eggs}}{\text{Total No. of produced eggs}}$$

Weekly egg size

=

Average egg size of the last 7 days

Accumulated egg size (g)

=

Average of the weight of all produced eggs

Daily egg mass

=

$$\frac{\text{Daily \% lay} \times \text{Daily egg size}}{100}$$

Weekly egg mass

=

$$\frac{\text{Weekly \% lay} \times \text{Weekly egg size}}{100}$$

Accumulated egg mass

=

$$\frac{\text{Produced eggs} \times \text{Egg weight}}{\text{No. of birds housed}}$$

Under grade

1. No. of broken eggs (BE)
2. No. of cracked eggs (FE)
3. No. of dirty eggs (DE)
4. No. of eggs with suboptimal size, either too big or too small (ES)

Daily Under grade (%)

=

$$\frac{\text{No. of daily BE, FE, DE, ES} \times 100}{\text{No. of all daily eggs}}$$

Accumulated Under grade

=

$$\frac{\text{No. of all BE, FE, DE, ES so far} \times 100}{\text{No. of all eggs so far}}$$

HEALTH & BIOSECURITY

- **Understanding the importance of health programs in modern egg production.**
- **How to implement a biosecurity program.**
- **How to develop and monitor a vaccination program.**

WHAT IS A HEALTHY HEN?

Knowing a hen's health status is essential to achieve production goals. Sick birds cannot develop to their full genetic potential, so health programs play a central role in the production schedule.

Healthy hens are disease-free or, at least, can support and deal with the diseases that are present in their environment. Biosecurity is key to keeping the flock free of pathogen agents or to reduce their presence. Flock immunity is the corner stone that prepares hens to handle the threat of disease. This relates not only to the vaccination program but also to the hen's physical status. If hens are immuno-suppressed due to underfeeding, stress, or other reasons (mycotoxins, chemicals) it will be difficult to cope with diseases even if the hens have been vaccinated. Certain avian diseases (such as Salmonella enteritis or Campylobacter) are zoonoses which can spread between birds and humans. So even if a disease does not directly affect poultry, it should be included in the health program.

Healthy Hens

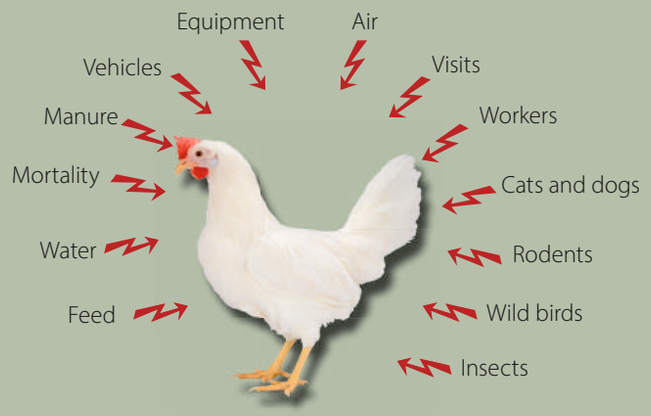
- No respiratory signs
- No nervous signs
- No fever

- Good physical status
- Good bone calcification
- Good feathering status

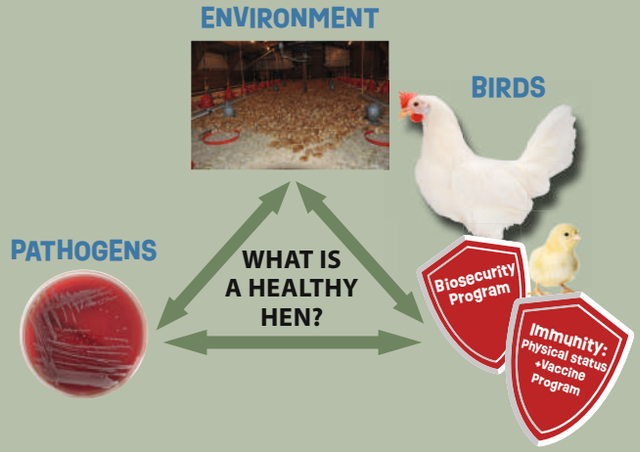
- Alert and active birds
- No abnormal behavior

- Good production
- No abnormal eggs

Possible Infection Routes



Health Balance



BIOSECURITY PROGRAM

A biosecurity program plays a key role in maintaining bird health and, therefore, profitable production. Biosecurity can be defined as all the procedures put in place to prevent pathogens from infecting hens and spreading to other poultry farms.

To be effective, a biosecurity program should be implemented in a very practical and structured way. An effective biosecurity program is well-adapted to the production structures and well-understood by all the personnel (staff, production managers, external suppliers, veterinarians, general manager etc.) at the farm. If certain personnel do not take biosecurity seriously and fail to follow the procedures, the efforts of the others will not be rewarded.

It is essential to apply procedures systematically. Sporadic application of a biosecurity program will not work.

BIOSECURITY TYPES

Conceptual Biosecurity

- **This is the biosecurity related to the farm design and its location of the farm and its surroundings.**

Ideally farms should be situated away from:

- Other poultry farms (including backyard farms)
- Other farms (other species)
- Live bird markets
- Hatcheries
- Slaughterhouses

If these kinds of facilities are near the farm, structural and operational biosecurity should be improved. If possible, new farms should be constructed in biosecure locations.

Isolated location

High-density farm location

Structural Biosecurity

- **This is the biosecurity related to the physical structures used at the farm to prevent the introduction or spread of diseases.**

Important components include:

- Perimeter fences
- Surrounding buffer zone
- Bird-proof elements
- Entrance doors
- Disinfectant system in entrance door
- Shower, dirty/clean room or Danish Entry
- Boot baths
- Work clothing and footwear
- Feed storehouse or silos
- Mortality disposal

Sink

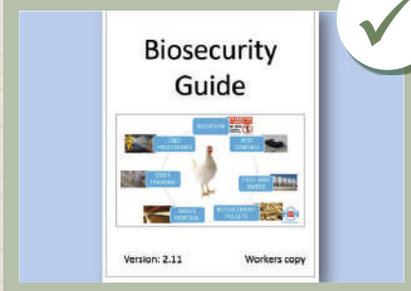
Surrounding concrete zone

Operational Biosecurity

- **This is the biosecurity related to how work on the farm should be done to prevent the introduction or spread of diseases.**

People are the key element to success here. Good communication, which implies training, is essential to improve operational biosecurity.

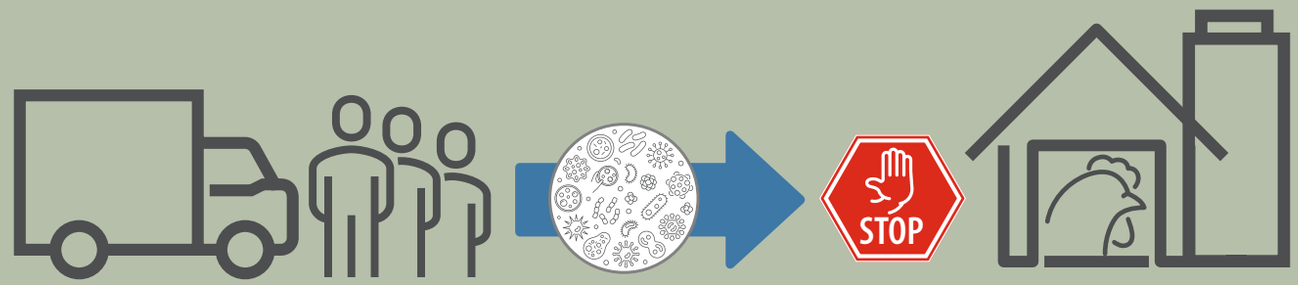
Clear and written biosecurity protocols should be available for all the staff having contact with the farms. Normally the simplest rules work better than more complex solutions.



Written biosecurity protocol

Farm meeting room

BIOSECURITY PROGRAM – STEP 1



ISOLATION

▶ This includes all measures taken to prevent the introduction of pathogens by visitors or material entering the farm.

Some basic rules:

Restrict Visitors
Only essential visits with a clear purpose should be permitted. All visits/visitors should be considered as a risk for the flock.

Visitor Register
A logbook should be available for visitors. All visitors must fill in their name, date of visit, purpose of visit, last visited farm and vehicle license number.

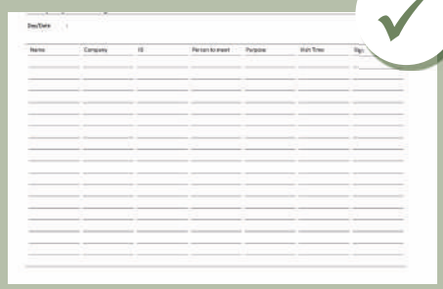
Visitor Policy
Visitors coming from another external farm on the same day must not be permitted entry. Visitors from sites of a disease out-break are absolutely forbidden entry. If several company farms are visited on the same day, the sequence must be from younger flocks to older ones.

Work Clothing
Specific work clothing must be available for staff and visitors.

Vehicle Disinfection
Vehicles must be disinfected prior to their entry to the farm. If vehicle access to the farm is not a necessity, preferably park vehicles outside the farm.

Material / Equipment Disinfection
All material must be disinfected prior to entry to the farm. This is even more important if the material or equipment comes from another farm.


Closed gate with biosecurity signs


Visitor register

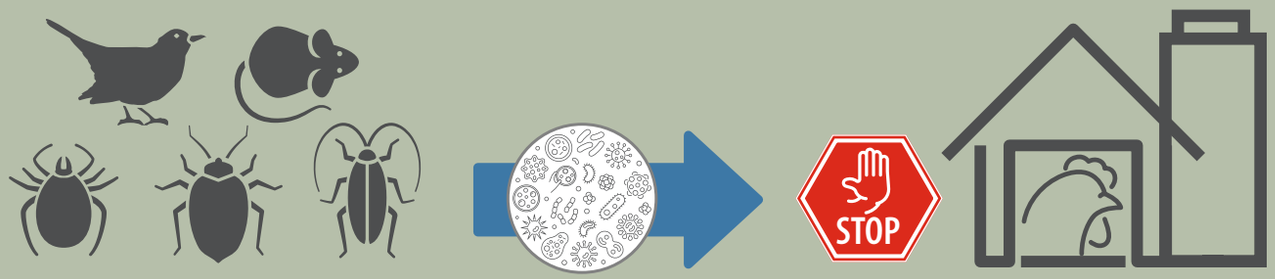

Farm clothes and shoes


Disinfection tunnel for vehicles


Showers


On farm washing machine and clothes dryer

BIOSECURITY PROGRAM – STEP 2



PEST CONTROL

▶ This includes all measures taken to prevent the introduction and spread of pathogens by vermin (esp. rodents and birds) and insects.

Rodents

The flock health status will be severely damaged in the event of infestations of rats or mice.

Passive measures:

- Keep the perimeter around the house free of grass and other organic material.
- Maintain integrity of walls.
- Keep feed free of rodents.
- Remove any spilled feed.

Active measures:

- Install bait stations.
- Have an active Rodent Control Program.

Wild Birds

It is very important to exclude other birds from entering hen houses. Bird-proof houses can be constructed using special netting. Wild bird feces are also very infectious material. Direct or indirect contact should be completely avoided.

Insects and other

Establish an insecticide program.

Manure management is also very important to prevent flies.

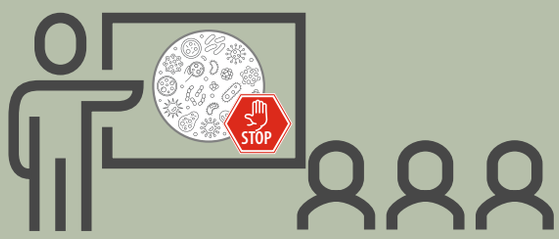
Mites can be very damaging to the hen's overall health status. This is particularly the case with Red Mite and Northern Fowl Mite. See its control in the Technical Tips.

Bait station

Pavemented area

Grass and abandoned stuff

BIOSECURITY PROGRAM – STEP 3



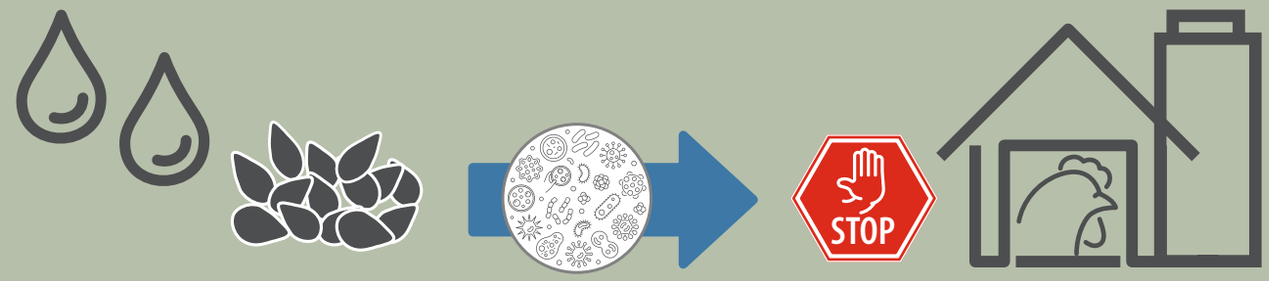
STAFF TRAINING

▶ This includes all measures related to training workers to do their jobs properly and observe biosecurity programs.

Information, meetings and training days should be provided to staff and other people working on the farm to ensure that they understand, respect and collaborate in the biosecurity program.

It is also very important to ensure staff do not raise poultry at home or come into contact with other birds (pigeons, hawks, ducks, pheasants, turkeys…).

BIOSECURITY PROGRAM – STEP 4



FEED & WATER

▶ This includes all measures taken to avoid the introduction and spread of pathogens by water and feed.

Feed

The quality of raw materials and hygiene measures at the feed mill are vital to produce pathogen-free feed.

Adding disinfectants is also recommended. Feed transport and feed storage should be controlled to avoid contamination after feed mill delivery.

Water

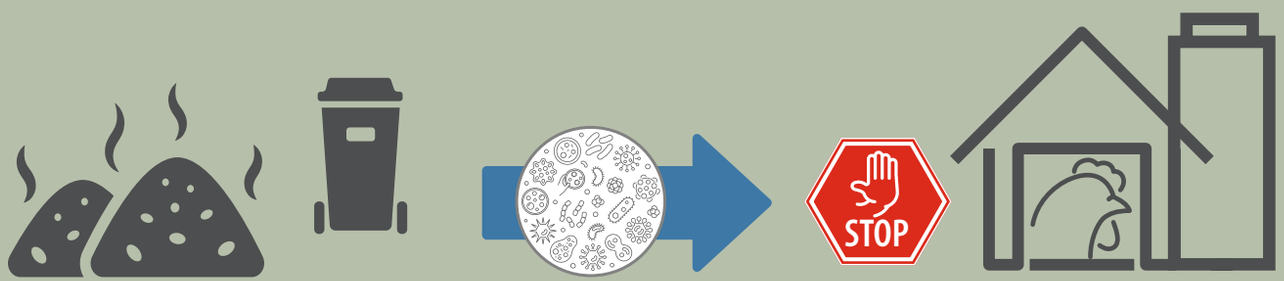
Chlorine or an alternative disinfectant should be added to drinking water. It has a dual purpose:

First to prevent the introduction of pathogens by water and second to reduce water recontamination while it is in the house pipeline.

See page 79–81 for more information on water quality.

Silos in good conditions

BIOSECURITY PROGRAM – STEP 5



WASTE DISPOSAL

▶ This includes all measures to prevent the introduction of pathogens during waste removal.

Waste removal and disposal is critical because waste material can be heavily contaminated.

Manure

Manure should be removed and disposed away from the layer or rearing site. Make sure that no other farms dispose of their manure near of your farm.

Mortality

Mortality should be removed from houses on a daily basis and stored away from the poultry houses.

Various methods are available to dispose of mortality hygienically. If mortality is moved from the farm, take extreme care during transport:

- Never permit transport of mortality to enter the farm.
- Only permit mortality to be collected outside the farm.
- Never have personal contact with people handling mortality.

Mortality container

BIOSECURITY PROGRAM – STEP 6

CLEANING & DISINFECTION PROTOCOL

▶ This includes all measures to prevent pathogens being transferred from one flock to the following.

If a severe infestation of mites or other parasites has occurred, take extra precautionary measures to eliminate or exclude the presence of pests. See more details about the procedure in page 14 and 15.

Table 25: Common disinfectants used in farms

Chemical disinfectant	Mycoplasma	Gram + Bacteria	Gram – Bacteria	Enveloped virus	Non-enveloped virus	Fungal spores	Coccidia	Characteristic
Aldehydes	++	++	++	++	++	+	–	Efficacity reduced by organic material, soap and hard water. Irritative
Alkalis	++	+	+	+	+–	+	+	Corrosive, irritative
Biguanides	++	++	++	+–	–	–	–	pH dependent, inactivated by soaps
Chlorine Compounds	++	++	+	+	+–	+	–	Inactivated by sunlight and soap, corrosive, irritative
Oxidant agents	++	+	+	+	+–	+–	–	Corrosive
Phenolic Compounds	++	+	++	+–	–	+	+–	Irritative
Quaternary Ammonium Compounds	+	+	+	+–	–	+–	–	Inactivated by organic material, soap and hard water

BIOSECURITY PROGRAM – STEP 7

CHICK REPLACEMENT

▶ This includes all measures to prevent the introduction of vertically transmitted pathogens.

In order to achieve this, the replacement flock should remain disease-free.
H&N parent stock are free of lymphoid leukosis, Mycoplasma gallisepticum, Mycoplasma synoviae, Salmonella pullorum, Salmonella gallinarum, Sallmonella enteritidis.

VACCINATION PROGRAMS

Specific recommendations for individual farms are not possible, but the sample vaccination program (table 26) is intended as a very general guideline for vaccinations which are needed on most farms worldwide. Additional vaccinations for Coccidiosis, Escherichia coli, Avian Influenza and the variant strains of other disease-causing agents may also be needed. These decisions, however, need to be made on a farm-by-farm basis after careful consideration of the risk factors involved which include, but are not limited to: previous exposure, geographic location, vaccination and exposure of neighboring flocks, state regulations and endemic disease-causing factors.

Ask for an adapted vaccine program from your veterinarian.

Table 26: Vaccination program in rearing

Weeks	Marek Disease	Coccidia	Gumboro Disease	Gumboro Disease (vectored vaccine)	Escherichia coli	Newcastle Disease	Newcastle Disease (high challenge)***	EDS 76**	Infectious Bronchitis*	Laryngotracheitis (TCO strain)	Laryngotracheitis (vectored vaccine)	Fowl Pox	Encephalomyelitis	Eysipela	Coryza	Fowl Cholera	Salmonella enterittidis	Salmonella typhimurium
0	1 SC	1 SP		1 SC	1 SP		1 SP, 2 SC		1 SP		1SC HVT							1DW
1						1 SP												
2			1DW				1 SP											
3			2DW						2 SP									
4			3DW			2 SP				1 ED		1WI	1WI or 1 DW					
5																		2 DW
6							2 SP				1SC POX			1IM	1IM	1IM	1IM	
7																		
8									3 SP									3 DW
9						3 SP				1 ED								
10							3 SP											
11																		
12					1 SP													
13														2 IM	2 IM	2 IM	2 IM	
14																		
15						1IM	1IM	1IM	1IM									
16							1 SP											

Recombinant vaccines *Live vaccines* *Inactivated vaccines*

SC = Subcutaneous Injection SP = Spray IM = Intramuscular Injection DW = Drinking Water ED = Eye Drop WI = Wing Inoculation

** Use more than one IB strain to produce a protectotype effect. The strains chosen should be highly immunogenic and as different from each other as possible. In any case the choice depends on the field strains circulating in the farm area and the commercial vaccines available.*

*** Only needed if EDS cases are detected in the farm area.*

**** Live boosting vaccinations every 5–8 weeks during production period may be needed to maintain high immunity.*

ADMINISTERING VACCINES IN PRACTICE

Administering the vaccines in practice is just as important as the vaccine program design. All this involves is simply following a procedure that is clearly defined by the vaccine manufacturer. However, mistakes are still often made. To avoid errors, check and verify these procedures regularly. Proper vaccination is essential for strong immunity and a healthy flock.

Transport and Storage

- Only accept vaccine in good condition.
- Always preserve the cold chain.
- Never freeze vaccine.
- Never expose to sunlight.
- Store vaccine correctly and check it regularly.

Reconstitution

- Follow manufacturer's instructions carefully when administering.
- Avoid contact with disinfectants during the reconstitution process.
- Use the vaccine immediately after.

Administering

- Use the appropriate technique to administer each vaccine.
- Vaccinate only healthy chickens.
- Do not dilute or "cut" the vaccine.
- Avoid contact with disinfectant when administering vaccine.
- Avoid using medication and antibiotics for three days preceding and one week after live bacteria vaccination.

Mass Administration

Drinking Water

- Most common vaccination technique.
- Assure the absence of chlorine or other disinfectant in the drinking water.
- A short period of water deprivation can assure that all birds are thirsty.
- Use dye in the drinking water for monitoring water consumption.
- Assure that water is consumed within 2 hours.

Spray

- Used for respiratory disease vaccination.
- Assure the absence of chlorine or other disinfectant in the sprayed water.
- Droplet size plays a key role in the vaccine reactions and immune response.
- Distribute vaccine evenly among the birds.
- Avoid drafts during the vaccine administration.

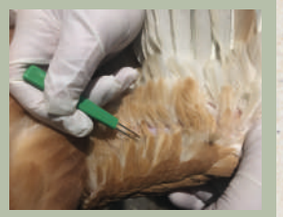
Individual Administration

Eye Drop

- Used for respiratory disease vaccination.
- Use dye in order to assess the efficiency of water and vaccine movement through the lines.
- Trained and committed crew and a well-organized program of work is essential.
- Ensure all chicks are vaccinated.

Injection

- Used for inactivated vaccines and certain live vaccines.
- Injection can be subcutaneous or intramuscular depending on the vaccine.
- Equipment should be correctly maintained.
- Trained and committed crew along with a well-organized program of work is essential.



Wing Inoculation

- Used mostly for Pox vaccination.
- Assure that needle is in contact with the vaccine before you inoculate every individual bird.
- Trained and committed crew and a well-organized program of work is essential.
- Check vaccine reaction 7 days after administering it in the case of pox vaccinations, 90 % of chicks should be positive.

VACCINE MONITORING

Serological data should be obtained after the bulk of the vaccination program is completed, normally by 15 or 16 weeks of age. This is an excellent time for evaluating the immune status of a flock of pullets prior to production. Such data also serves as an immune status baseline for determining whether a field infection has occurred when production drops are observed. It is recommended that the flock owner submit 25 good serum samples to a laboratory one or two weeks prior to the pullets being housed to establish immunity to certain diseases such as Mycoplasma gallisepticum (Mg) and Mycoplasma synoviae (Ms) prior to the onset of production.

Serological data can give valuable information on the serological titer levels for a number of disease-causing agents. Working with a poultry laboratory to set up a monitoring program will ensure the evaluations of vaccination programs and therefore healthy flocks.

Table 27: Serological monitoring

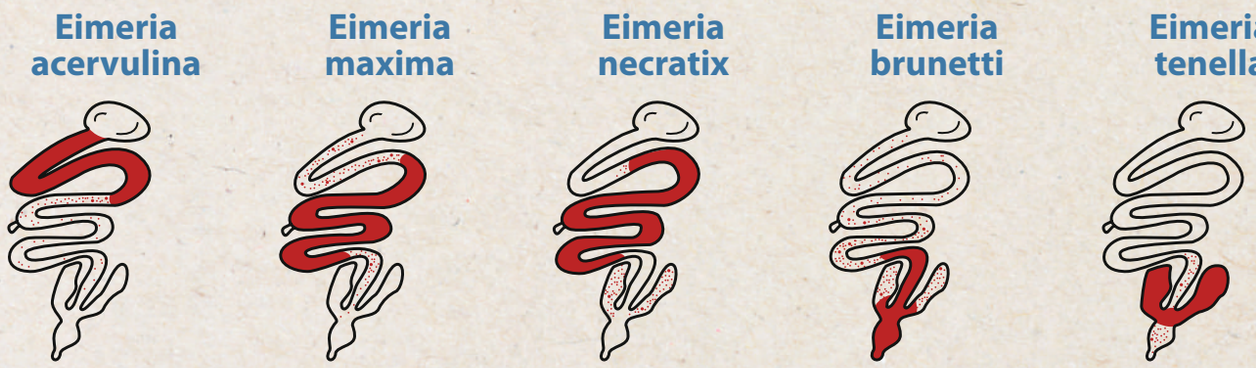
Disease	ND	IB	AmPV	EDS	AE	MG	MS	IBD
Technique	ELISA, HAI	ELISA, HAI	ELISA	ELISA	ELISA	ELISA, PRA	ELISA, PRA	ELISA
Week	15, 25, 45, 65, 85	15, 25, 45, 65, 85	15, 25, 45, 65, 85	15, 25, 45, 65, 85	15,25	1, 15, 25, 45, 65, 85	1, 15, 25, 45, 65, 85	1

COCCIDIA

Coccidiosis is a disease caused by protozoan species of the genus Eimeria. They are species-specific and those affecting hens replicate in different parts of the intestine. The severity of the disease produced depends on the species and the degree of infestation. In some cases, mortality will occur, while in others the birds will be stunted in their growth and are likely to have complications with necrotic enteritis.

In long-lived birds, control is based on the establishment of immunity against each of the Eimeria species. Cross immunity is very poor and does not provide good protection. For this purpose, coccidiostat control programs can be used if they allow partial cycling of the protozoa. In this way, lesions are reduced but immunity can be developed only if there is a challenge during rearing. Another simpler and more effective option is the use of vaccines. These are usually given in the first few days of life and must be cycled several times in the birds to produce a long-lasting and robust immunity. For this, not only their application but also the management of the birds in these early weeks must be well monitored. It should be noted that management is different depending on the type of vaccine used (attenuated or non-attenuated).

Lesion location in the gut for main Eimeria species in chickens



INTERNAL PARASITES

Internal parasites are a common finding in birds in free-range systems but may also be present when birds do not have access to outdoor ranges.

They cause a reduction in nutrient absorption by the birds. Depending on the level of infestation this can lead to a deterioration in bird body condition, decreases in production, egg quality and even promote cannibalism and mortality.

They usually cycle outside the bird's gut which may be direct or have another intermediate host. Different species also colonize different parts of the intestine or other parts of the bird's body.

Since it is very difficult to avoid contact with these parasites (especially in free-range), a population control program should be applied to avoid heavy infestations that cause damage to the birds.

- In those parasites that have cycles with an intermediate host, it is important to cut the cycle by controlling the population of these hosts.
- Rotation of outdoor flocks as well as proper drainage and maintenance are necessary to avoid areas with high parasite egg loads.
- C&D programs should include treatments to reduce the parasite egg load during the service period.
- It is necessary to monitor the presence of parasites either by fecal egg counts or by postmortem examinations.
- Flocks should be treated with deworming drugs repeatedly to keep parasite populations from growing out of control and minimize the damage caused.

The main parasites found in laying hens

Hair Worm
(Capillaria)

These nematodes (worms) parasitize the small intestine. They are small in size: males usually measure 7–13 mm while females are 10–18 mm, so they are difficult to visualize. Some species have the earthworm as an intermediate host.

Cecal Worm
(Heterakis gallinarium)

These nematodes (worms) are usually found in the cecum. They are tiny: males are about 7–10 mm long while females are about 10–15 mm. They have a direct cycle, but earthworms can act as carrier for them. They are not usually harmful in themselves but play a critical role as Histomona meleagridis carrier.

Round Worm
(Ascaridia galli)

This the most common infestation. These nematodes (worms) parasitize the small intestine although occasionally they can reach other organs. Occasionally found in eggs. Adults are large, thick, yellowish white worms. Male is 5–7 cm long and female is 6–12 cm, so they can be easily observed during necropsies or in feces. They have a direct cycle, but insects can play a role in their spread as carriers.

Tapeworm
(Amoebtaenia, Davainea, Raillietina …)

Various species of cestodes can parasitize long-living poultry. They do not normally cause damage except in the case of heavy infestations. They usually have cycles with intermediate hosts (ants, houseflies, beetles, snails, …).

Key Points

- **Health is vital to achieve the bird's full genetic potential.**
- **Act before diseases become a limiting factor for your bird's performance.**
- **Implement a real biosecurity program, not a paper biosecurity program.**
- **Adapt the vaccine program to your epidemiological situation.**
- **Administer vaccines according to the manufacturers' instructions.**
- **No vaccine program will work if vaccines are administered incorrectly.**
- **Monitor flock serology to verify the effectiveness of your vaccination program.**
- **Internal parasite control should be considered to avoid damage produced by heavy infestation.**

PERFORMANCE GOALS

Table 28: Performance of the H&N "Nick Chick" layer to 100 weeks of age under conscientious management and a moderate environment

Age	Livability	Prod. HD	Eggs/HH	Egg Weight		Cum. Egg Weight		Egg Mass		Body Weight	
weeks	%	%	eggs	g/egg	lb/case	g/egg	lb/case	kg	lb	g	lb
19	100.0	8.0	0.6	40.6	32.2	40.6	32.2	0.02	0.05	1358	2.99
20	100.0	33.9	2.9	43.5	34.5	42.9	34.1	0.13	0.28	1408	3.10
21	99.9	54.9	6.8	46.1	36.6	44.7	35.5	0.30	0.67	1450	3.20
22	99.9	71.0	11.7	48.5	38.5	46.3	36.8	0.54	1.20	1486	3.28
23	99.8	82.1	17.5	50.6	40.2	47.7	37.9	0.83	1.84	1516	3.34
24	99.8	88.5	23.7	52.4	41.6	49.0	38.9	1.16	2.55	1540	3.40
25	99.7	91.2	30.0	54.0	42.9	50.0	39.7	1.50	3.31	1559	3.44
26	99.7	92.4	36.5	55.2	43.8	50.9	40.4	1.86	4.10	1574	3.47
27	99.6	93.0	43.0	56.2	44.6	51.7	41.1	2.22	4.90	1584	3.49
28	99.6	93.6	49.5	56.9	45.2	52.4	41.6	2.59	5.72	1590	3.51
29	99.5	94.1	56.0	57.5	45.6	53.0	42.1	2.97	6.55	1594	3.51
30	99.5	94.5	62.6	58.0	46.0	53.5	42.5	3.35	7.39	1597	3.52
31	99.4	94.9	69.2	58.5	46.4	54.0	42.9	3.74	8.24	1600	3.53
32	99.4	95.2	75.9	58.9	46.8	54.4	43.2	4.13	9.10	1603	3.53
33	99.4	95.3	82.5	59.3	47.1	54.8	43.5	4.52	9.97	1606	3.54
34	99.3	95.4	89.1	59.6	47.3	55.2	43.8	4.92	10.84	1609	3.55
35	99.3	95.4	95.7	59.8	47.5	55.5	44.1	5.31	11.71	1612	3.55
36	99.2	95.4	102.4	60.1	47.7	55.8	44.3	5.71	12.59	1615	3.56
37	99.1	95.4	109.0	60.2	47.8	56.1	44.5	6.11	13.47	1618	3.57
38	99.1	95.4	115.6	60.4	47.9	56.3	44.7	6.51	14.35	1621	3.57
39	99.0	95.3	122.2	60.6	48.1	56.5	44.9	6.91	15.23	1624	3.58
40	98.9	95.3	128.8	60.6	48.1	56.8	45.1	7.31	16.12	1626	3.59
41	98.8	95.3	135.4	60.8	48.3	56.9	45.2	7.71	17.00	1628	3.59
42	98.7	95.3	142.0	60.9	48.3	57.1	45.4	8.11	17.88	1630	3.59
43	98.6	95.2	148.5	61.1	48.5	57.3	45.5	8.51	18.77	1632	3.60
44	98.5	95.1	155.1	61.2	48.6	57.5	45.6	8.91	19.65	1634	3.60
45	98.4	95.1	161.7	61.3	48.7	57.6	45.7	9.32	20.54	1636	3.61
46	98.3	95.0	168.2	61.5	48.8	57.8	45.9	9.72	21.43	1638	3.61
47	98.2	94.9	174.7	61.6	48.9	57.9	46.0	10.12	22.31	1640	3.62
48	98.2	94.8	181.2	61.7	49.0	58.1	46.1	10.52	23.20	1642	3.62
49	98.1	94.7	187.7	61.8	49.1	58.2	46.2	10.92	24.08	1644	3.63
50	98.0	94.6	194.2	62.0	49.2	58.3	46.3	11.33	24.97	1646	3.63
51	97.9	94.3	200.7	62.1	49.3	58.4	46.4	11.73	25.86	1648	3.63
52	97.8	94.2	207.1	62.2	49.4	58.6	46.5	12.13	26.74	1650	3.64
53	97.7	94.0	213.6	62.3	49.5	58.7	46.6	12.53	27.62	1652	3.64
54	97.5	93.8	220.0	62.4	49.5	58.8	46.7	12.93	28.50	1654	3.65
55	97.4	93.7	226.3	62.5	49.6	58.9	46.7	13.33	29.38	1656	3.65
56	97.3	93.4	232.7	62.6	49.7	59.0	46.8	13.73	30.26	1658	3.66
57	97.2	93.1	239.0	62.7	49.8	59.1	46.9	14.12	31.14	1660	3.66
58	97.0	92.9	245.4	62.8	49.9	59.2	47.0	14.52	32.01	1662	3.66
59	97.0	92.7	251.6	62.8	49.9	59.3	47.0	14.91	32.88	1664	3.67
60	96.9	92.4	257.9	62.8	49.9	59.4	47.1	15.31	33.75	1666	3.67

PERFORMANCE GOALS

Table 28: Performance of the H&N "Nick Chick" layer to 100 weeks of age under conscientious management and a moderate environment

Age	Livability	Prod. HD	Eggs/HH	Egg Weight		Cum. Egg Weight		Egg Mass		Body Weight	
weeks	%	%	eggs	g/egg	lb/case	g/egg	lb/case	kg	lb	g	lb
61	96.7	92.1	264.1	62.9	49.9	59.4	47.2	15.70	34.62	1668	3.68
62	96.6	91.8	270.4	63.0	50.0	59.5	47.2	16.09	35.48	1670	3.68
63	96.4	91.4	276.5	63.0	50.0	59.6	47.3	16.48	36.34	1672	3.69
64	96.3	91.1	282.7	63.1	50.1	59.7	47.4	16.87	37.19	1674	3.69
65	96.1	90.8	288.8	63.2	50.2	59.7	47.4	17.25	38.04	1676	3.70
66	96.0	90.4	294.8	63.2	50.2	59.8	47.5	17.64	38.89	1678	3.70
67	95.8	90.0	300.9	63.3	50.2	59.9	47.5	18.02	39.73	1680	3.70
68	95.7	89.6	306.9	63.3	50.2	60.0	47.6	18.40	40.57	1682	3.71
69	95.6	89.2	312.9	63.4	50.3	60.0	47.6	18.78	41.40	1684	3.71
70	95.5	88.7	318.8	63.4	50.3	60.1	47.7	19.15	42.23	1686	3.72
71	95.3	88.3	324.7	63.5	50.4	60.1	47.7	19.53	43.05	1688	3.72
72	95.1	87.9	330.5	63.5	50.4	60.2	47.8	19.90	43.87	1690	3.73
73	95.0	87.4	336.3	63.5	50.4	60.3	47.8	20.27	44.69	1692	3.73
74	94.8	86.9	342.1	63.6	50.5	60.3	47.9	20.63	45.50	1694	3.74
75	94.6	86.5	347.8	63.6	50.5	60.4	47.9	21.00	46.30	1696	3.74
76	94.5	86.0	353.5	63.6	50.5	60.4	48.0	21.36	47.10	1698	3.74
77	94.4	85.5	359.2	63.7	50.6	60.5	48.0	21.72	47.89	1700	3.75
78	94.2	84.9	364.8	63.7	50.6	60.5	48.0	22.08	48.68	1702	3.75
79	94.0	84.4	370.3	63.7	50.6	60.6	48.1	22.43	49.46	1704	3.76
80	93.8	83.8	375.8	63.7	50.6	60.6	48.1	22.78	50.23	1705	3.76
81	93.6	83.2	381.3	63.6	50.5	60.7	48.2	23.13	51.00	1706	3.76
82	93.5	82.5	386.7	63.7	50.6	60.7	48.2	23.47	51.75	1707	3.76
83	93.3	82.0	392.0	63.7	50.6	60.7	48.2	23.81	52.51	1708	3.77
84	93.2	81.4	397.3	63.7	50.6	60.8	48.2	24.15	53.25	1709	3.77
85	93.0	80.7	402.6	63.7	50.6	60.8	48.3	24.49	53.99	1710	3.77
86	92.8	80.1	407.8	63.7	50.6	60.9	48.3	24.82	54.72	1711	3.77
87	92.6	79.4	412.9	63.7	50.6	60.9	48.3	25.15	55.44	1712	3.77
88	92.4	78.7	418.0	63.7	50.6	60.9	48.4	25.47	56.16	1713	3.78
89	92.2	77.9	423.1	63.7	50.6	61.0	48.4	25.79	56.87	1714	3.78
90	92.1	77.1	428.0	63.7	50.6	61.0	48.4	26.11	57.56	1715	3.78
91	92.0	76.4	433.0	63.7	50.6	61.0	48.4	26.42	58.26	1716	3.78
92	91.8	75.7	437.8	63.7	50.6	61.1	48.5	26.73	58.94	1717	3.79
93	91.6	74.9	442.6	63.7	50.6	61.1	48.5	27.04	59.61	1718	3.79
94	91.4	74.1	447.4	63.7	50.6	61.1	48.5	27.34	60.28	1719	3.79
95	91.2	73.2	452.0	63.7	50.6	61.1	48.5	27.64	60.94	1720	3.79
96	91.0	72.3	456.6	63.7	50.6	61.2	48.6	27.93	61.58	1721	3.79
97	90.9	71.4	461.2	63.7	50.6	61.2	48.6	28.22	62.22	1722	3.80
98	90.7	70.4	465.7	63.7	50.6	61.2	48.6	28.50	62.85	1723	3.80
99	90.5	69.4	470.1	63.7	50.6	61.2	48.6	28.78	63.47	1724	3.80
100	90.3	68.4	474.4	63.7	50.6	61.3	48.6	29.06	64.07	1725	3.80

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