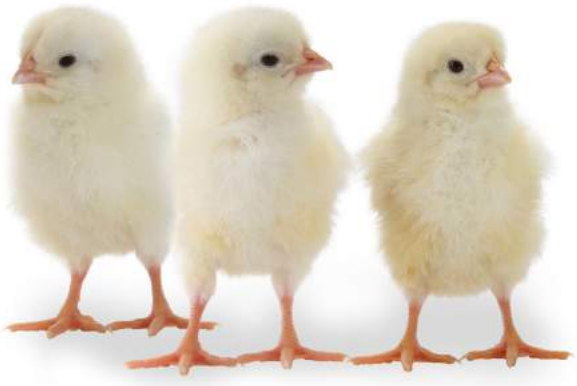
NICK CHICK

White Egg Layers

H&N INTERNATIONAL

The key to your profit!



NEW Management *Guide*

North American Edition

H&N® INTERNATIONAL

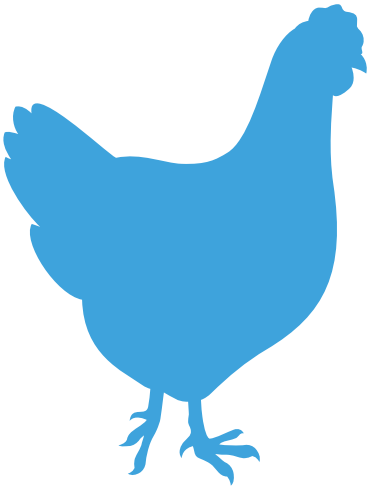
The key to your profit!

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, liveability, 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. 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 details 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
7.0 – 7.1 kg
15.4 – 15.6 lb

Daily feed intake in production
100 g
22 lb/100/day

Feed Conversion Rate (kg/kg or lb/lb)
until 80 weeks 1.82
until 90 weeks 1.84
until 100 weeks 1.88

EGG PRODUCTION

Age at 50 % Production
140 – 150 days

Peak Production
95 – 96 %

Period over 90 %
45 weeks

Eggs per Hen Housed
until 80 weeks 376
until 90 weeks 428
until 100 weeks 473

Cumulative Egg Mass per Hen Housed
until 80 weeks 22.9 kg | 50.5 lb
until 90 weeks 26.3 kg | 57.9 lb
until 100 weeks 29.1 kg | 64.2 lb

LIVEABILITY

Rearing
0 – 19 weeks 96 – 98 %

Production
19 – 100 weeks 90 – 95 %

BODY WEIGHT

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

EGG WEIGHT

until 80 weeks 60.9 g | 48.4 lb/case
until 90 weeks 61.3 g | 48.7 lb/case
until 100 weeks 61.6 g | 48.9 lb/case

CONTENT

CONTENT

HOUSE PREPARATION AND ARRIVAL OF CHICKS

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

CLEANING AND DISINFECTION PROCEDURE

STEP 1
Preparation

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

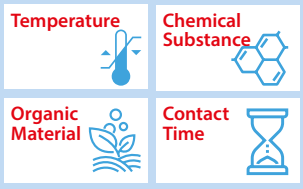
STEP 2
Dry Cleaning

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 appropiate PPE (personal protective equipment).

STEP 6
Sampling

Sample after cleaning and disinfection, check if the microbiological results are ok. 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.

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 bell 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 protection and clothing: masks, gloves, etc.
4. Maintain the cleaning equipment regularly.
5. Pests are under control and you have 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.

STOCKING DENSITY

An adequate 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,) and sufficient access to water.

Table 2: Stocking density in rearing farms

Age	Floor space		Feeder space		Drinker Space	
	Cage	Floor	Cage	Floor	Cage	Floor
0 – 3 weeks	140 cm^2/bird (22 in^2/bird)	21 birds/m^2	2.5 cm/bird (1 in/bird)	4 cm/bird (1.6 trough in/bird) 60 birds/pan	1.25 trough cm/bird (0.5 in/bird) 16 birds/nipple	1.4 trough cm/bird 16 birds/nipple 100 birds/fountain
3 – 16 weeks	285 cm^2/bird (44 in^2/bird)	16 birds/m^2	5 cm/bird (2 in/bird)	8 cm/bird (3.2 in/bird) 30 birds/pan	2.5 trough cm/bird (1 in/bird) 8 birds/nipple	2.5 trough cm/bird 8 birds/nipple 75 birds/fountain

This table is a general recommendation and you should adhere to your own country's recommendations.

HOUSE PREPARATION AND ARRIVAL OF CHICKS

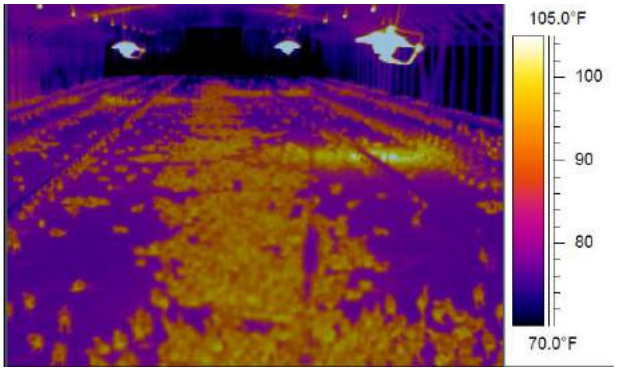
PRE-HEATING THE REARING HOUSE

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

Do not only heat the air, but also litter, soil and equipment. Chicks gain and lose temperature easily through conduction (see page 54). In case of floor rearing, bring in the litter after preheating to allow the concrete to reach the desired temperature (24 °C | 75 °F).



Courtesy of M. Czarick – UGA

REARING HOUSE PREPARATION (FLOOR REARING SYSTEMS)

Distribute litter and paper

Old litter from the previous flock should not be used. Using old litter increases the pressure 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 (20 – 25 °C | 68 – 77 °F). 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 draughts.

In conventional pancake brooders, use chick guards (i.e. new cardboard) to prevent drafts. Start with a diameter of approx. 2 m | 6.5 ft in cool weather and approx. 4 m | 13 ft in hot weather. Enlarge the ring every couple of days and remove by six or seven days of age.

Whole house brooding

Spot brooding

Feeder

Drinker

CAGE REARING PREPARATION (CAGE REARING SYSTEMS)

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 cages at the appropriate time and with the correct cage density.

Paper

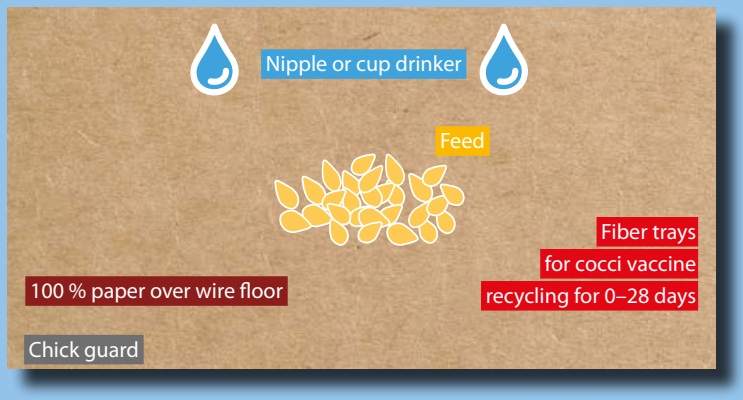
Cage wires should be covered with paper during the first week of life. Avoid covering the area directly under the drinking system, but cover the surrounding area.
In cases where the wire size is too large for day old chicks. Use plastic matting to aid the chicks in reaching the drinkers.

Feeding system

Abundant feed should be provided in the feeders and additionally on the papers inside the cages before the chicks are housed to stimulate feed intake.
When there is a feedchain inside the cage, fill this chain up to 100 % (Manual) to reduce mortality when you run the feedchain in the first day(s).

Drinking system

360-activated nipples in the brooding cages are preferred. 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.



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 also 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 luxometer.
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 one-day old chick quality. The correct temperature and ventilation levels should be guaranteed during transport. The transport time should be as short as possible. If transport exceeds more than 10 hours, the addition of a hydration product in the crates is recommended. For longer transport it is recommended to use temperature and humidity loggers.

Transport truck

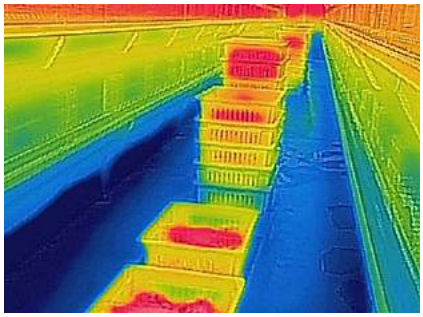

Truck unload

Unloading the chicks

Place the birds gently but quickly into the house and provide immediate access to water and feed. Crates should be taken into the farm and distributed as soon as possible. Never store crates in conditions that are too hot or cold, windy or in direct sunlight.

With floor brooding, place the chicks directly over the paper and feed. With cage brooding place the right number of chicks in each cage.


Crates distributed into the farm


Thermographic picture.
Keep in mind that floor is always cold.

Chick quality

On arrival the chicks must be warm and active. Check that there is no abnormal mortality in the crates. The chicks' bodyweight should be measured individually once housing has been completed. Check the body temperature as explained on page 14 and adjust the house temperature.

Record the mortality at housing and inform the hatchery. Also inform them about the chick quality.


Day old chicks sampling

KEY POINTS

- **Ensure the house has been cleaned and disinfected correctly 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 liveability during the first week of life.
- How to promote growth and development of key organs during the first three weeks of life.
- How to perform effective beak treatment without a detrimental effect on chick growth and welfare.

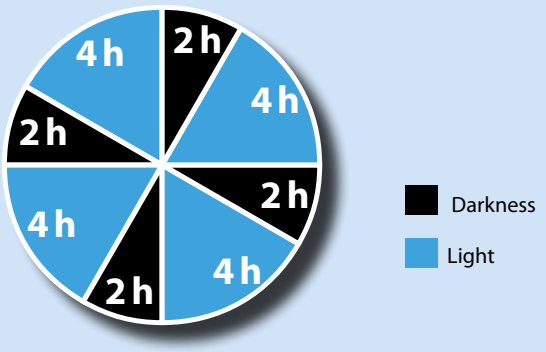
BROODING LIGHTING PROGRAM

INTERMITTENT LIGHTING PROGRAM

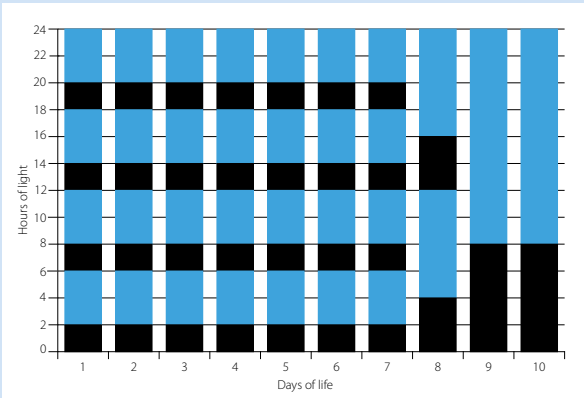
Dark houses only (< 3 lux)

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.



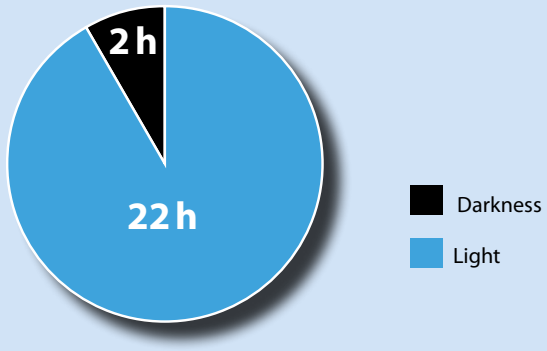
Intermittent lighting program



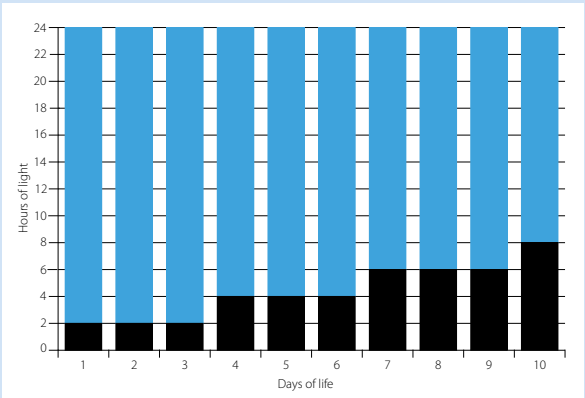
NON-INTERMITTENT LIGHTING PROGRAM

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 3 lux when the light-proof 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 34 – 36 °C | 93 – 97 °F for the first few days.

- **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.

Pasted vents may indicate a too high or too low temperature.

After two or three days, decrease the temperature by 0.5 °C | 1 °F every day. Be aware that the best indicator is chick behavior. Check the flock every time you change your settings.

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

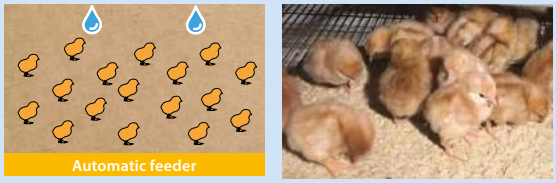
When housing the chicks, follow these recommendations:

- Place the smallest chicks in the warmest areas or cages.
- Place the youngest chicks in the warmest areas or cages (if the flock is arriving over several days).
- Avoid placing chicks in very hot spots (near the heaters) or in very cold spots during the first 10 days.

Table 3: Temperature recommendation

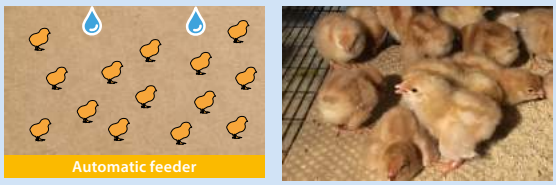
Type of brooding	Temperature at chicks arrival	Temperature decrease
Cage	34 – 35 °C 93 – 95 °F	Reduce 3 °C | 5 °F each week until supplementary heat is no longer needed.
Floor	35 – 36 °C 95 – 97 °F	

Correct temperature distribution



Low temperature distribution

Hot temperature distribution



HUMIDITY

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

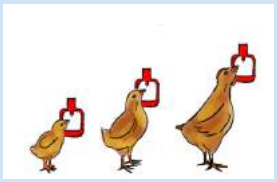
Be aware that temperature and humidity are related. The temperatures in this guide are set for a humidity between 60 – 70 %.

LIGHT

The light intensity should be between 30 – 50 lux during the first week. This should be measured at drinker level.

Light should be spread uniformly throughout the entire cage. It is important to avoid shady and dark areas in the brooding cage.

WATER



Set the height of the drinkers so the chicks can drink easily.
360-activated nipples are preferable in rearing houses. If not available, and especially with infrared beak treated chicks, we recommend using cups or other extra drinking systems during the first 5 – 7 days.
Reduce the water pressure in the drinking system to create a hanging drop at chick eye level.
Trigger the nipples or cups during the first 3 – 4 days to encourage chicks to drink.
Flush the lines just before housing the chicks and daily for the first 4 days. Chicks will refuse hot water (>25 °C | >77 °F).

FEED

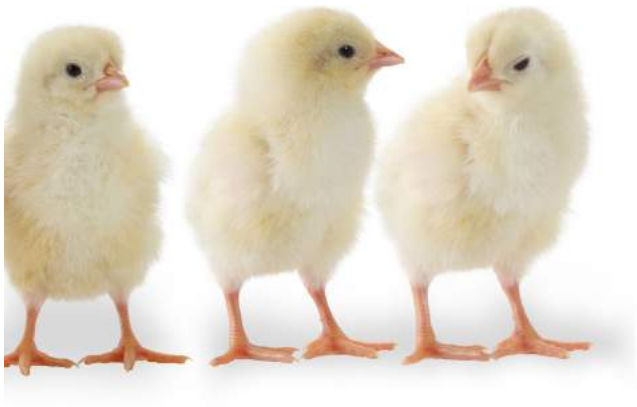
Good quality feed should be available for chicks immediately after placement.
Correct feed structure is also extremely important (see page 39).
Feed should be scattered on the cage paper and renewed during the first 3 – 5 days.
Place abundant feed in the feeders to attract the chicks.

VENTILATION

Supply sufficient volumes of fresh air to remove dust and undesirable gases. Ensure sufficient air movement even on cool days. Strong movements of air disturb the chicks, they will avoid using draughty areas. This can negatively impact on chick distribution and activity.
Adequate ventilation is especially important in hot weather.

Draft incorrect

Automatic feeder



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

BROODING (1 – 21 DAYS)

HOW DO YOU KNOW THAT EVERYTHING IS RUNNING SMOOTHLY?

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 the sound they are making
- **Check if they look comfortable!**

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 around 50 – 60 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 %

Cloacal temperature

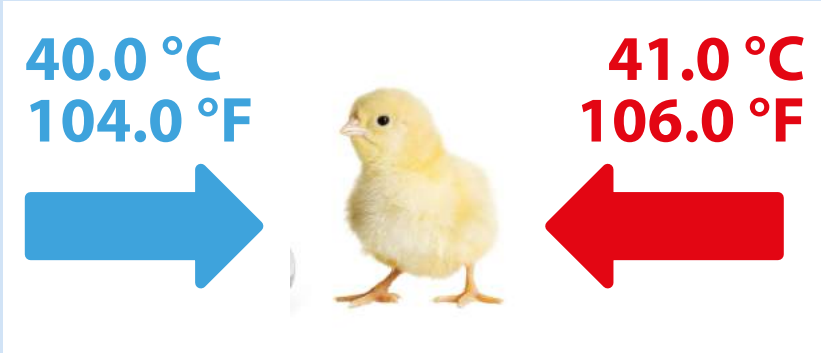
Chick temperature is between 40 – 41 °C | 104 – 106 °F after the moment of full homeothermy. During the first week of life chicks are unable to control their body temperature and it varies according to the ambient temperature. This information can be used to adjust house temperatures optimally.

Use modern ear thermometers (see picture).

1. Make sure you collect samples of chicks from different parts of the house. Sample chicks distributed throughout the house for reliable readings.
2. Check their cloacal temperature.
3. Collect the information, calculate the average and adjust the house temperatures accordingly to achieve optimal chick temperatures.

Important!

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



BEAK TREATMENT

Beak treatment is an important cannibalism/pecking 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 in a uniform manner that will permanently retard future beak growth. Improper beak treatment procedures may result in permanent damage to overall flock performance.

Please remember that country-specific regulations should be observed.

Infrared beak treatment of day-old chicks

The beaks of day-old chicks can already be treated at the hatchery using infrared technology. This method can provide more uniform beak treatment because it is performed by a machine and not by different crews.

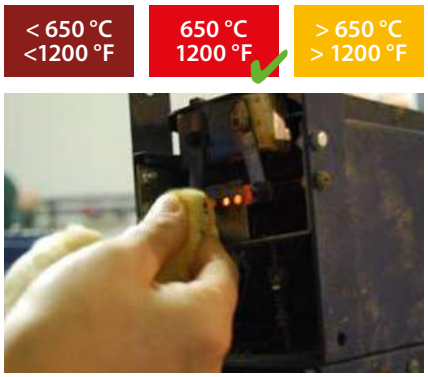
The beak remains intact until 10 – 21 days and then the treated portion separates. Because of this process, chicks will need extra care during the brooding period. Pay attention to:

- **Drinking water:** It is vital to encourage the water intake in the first days. Preferably use 360-activated nipples as they are easy for chicks to use. Additional cup drinkers are also preferable. If bi-directional nipples are the only option, providing additional cup drinkers is obligatory.
- **Light:** Ensure the light level in the drinker area is 30 – 50 lux.
- **Feed:** Scatter feed on paper until day 7.

7–10 day beak treatment

The conventional method of beak treatment is to treat the beaks with a hot blade.
Beak treatment should ideally be performed in the first 7 – 10 days. It is a delicate and precise manual procedure. Ensure these conditions are fulfilled before starting the process:

- **Healthy birds:** If birds are sick or in poor condition, treatment should be delayed until the flock has recovered. Beak treatment in an unhealthy flock can severely damage its viability.
- **Trained crew:** Due to the delicate and precise nature of this procedure, proper crew training is of the utmost importance. Only allow well-trained crews to perform this procedure. Never hurry the crew especially if they are inexperienced.
- **Adapted equipment:** Hot blade machines are available on the market. For correct beak treatment, the blade temperature should be approximately 650 °C | 1200 °F. The blade color may be used as an indicator. The use of a template with guide hole is recommended to make treatment easier and more uniform. Keeping the machine clean and in good maintenance is vital for good results.



And the days after beak treatment …

Special care should be provided to the chicks in the days following beak treatment:

- Monitor water intake. It will be reduced for 2 or 3 days but then the previous intake should be recovered. Reducing the water pressure in the nipple drinker lines could be useful.
- Use additional drinkers if necessary.
- Increase the house temperature until the chicks seem comfortable.
- Increase the feed level in the feeders.
- Add Vitamin K to the diet or drinking water a few days before and after beak treatment.

KEY POINTS

- **Focus on water, feed, light intensity, air temperature and humidity during the first week.**
- **Check chick behavior to enable better settings of the brooding conditions.**
- **Implement an intermittent light program if possible.**
- **Perform beak treatment properly and apply special management immediately after treatment.**

GROWING (3 – 9 WEEKS)

- How to set the correct light program in rearing according to your geographical situation, house type and production objectives.
- How to promote correct pullet growth during this period.
- How to use the chicks feathering and natural molting pattern to monitor chick development.

LIGHT PROGRAM

BASIC PRINCIPLES

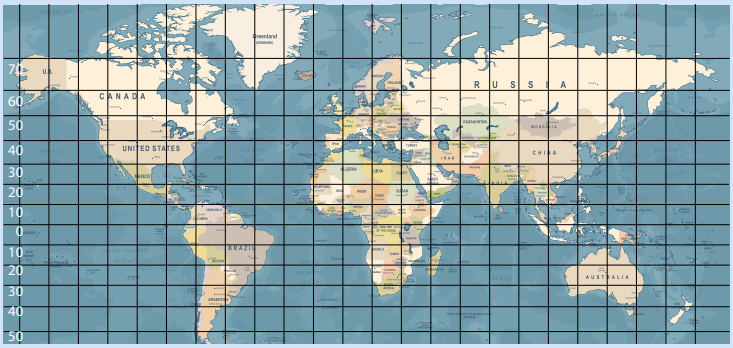
- The hours of light at the end of rearing should equal the hours of light at the production house before the start of light stimulation.
- The light intensity should be similar to what pullets will find in the production house.

DESIGN YOUR LIGHT PROGRAM IN FIVE STEPS

STEP 1

WHAT IS THE DESTINATION OF THE PULLETS?

- How many hours of light do you have in your country when the pullets will be moved to the production house?



- 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	22:07	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	12:7	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	14:9	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	11:7	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.

Rearing house	Production house	What to do
Open	Open house*	End hours = or > to natural daylight at end of rearing
	Closed house**	Laying house hours = end rearing house hours
Closed	Open house*	End hours = or > to natural daylight at end of rearing
	Closed house**	Laying house hours = no limitation

** Open house: any contruction where you have > 3 lux. House with curtains or nothing at all.*

*** Closed house: any construction where you have < 3 lux. House made of panels or bricks.*

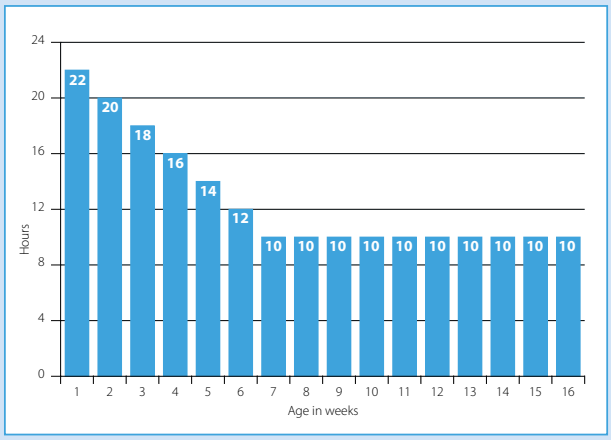
STEP 3

NUMBER OF HOURS IN THE REARING HOUSE

▶ Depending on limitations in step 1 and 2, determines the optimum end hours for your type of production.

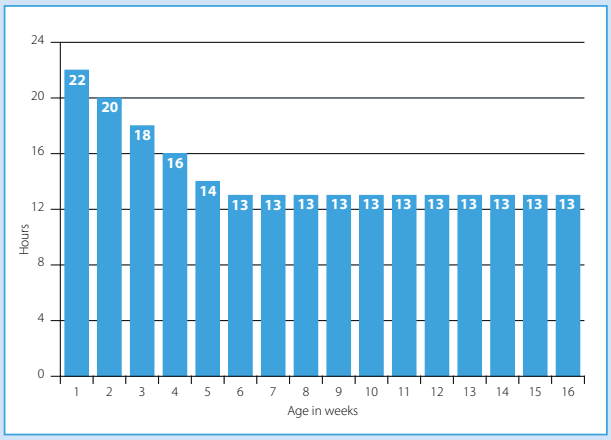
Short: ending at 9 – 11 hours / day

- Only in closed house
- Electricity savings
- Concentrate feed intake
- Feed intake challenge



Long: ending at 12 – 14 hours / day

- Open and closed houses
- More time for feed intake
- High electricity cost in closed houses



GROWING (3 – 9 WEEKS)

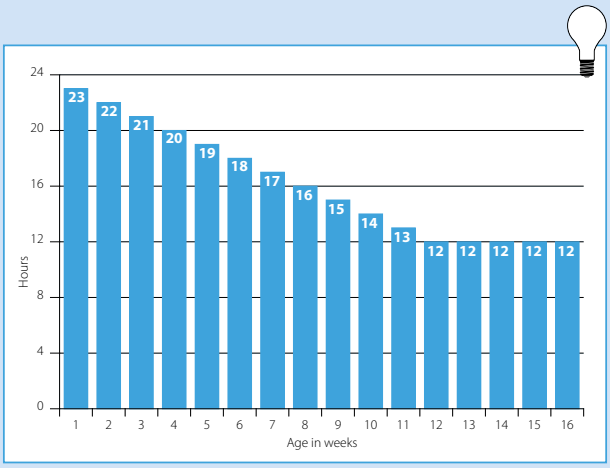
STEP 4

SPEED OF LIGHT REDUCTION

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

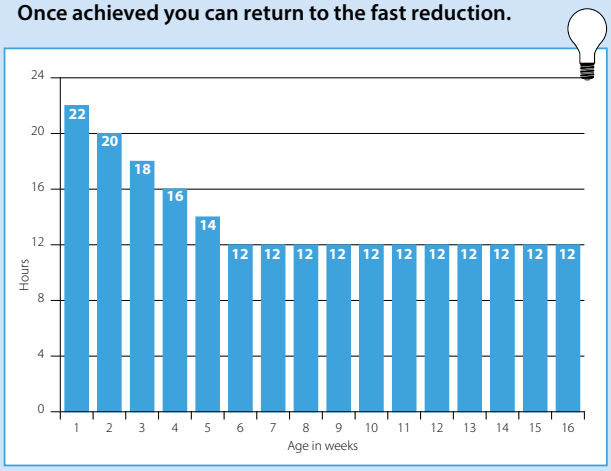
Slow: 1 hour reduction / week

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



Fast: 2 hours or more reduction / week

- Higher sensitivity to light, faster start in production
- Energy savings
- **If it doesn't appear that body weight targets will be met at week 5, it is highly recommended to change to a slower reduction to allow body weights to improve. Once achieved you can return to the fast reduction.**



STEP 5

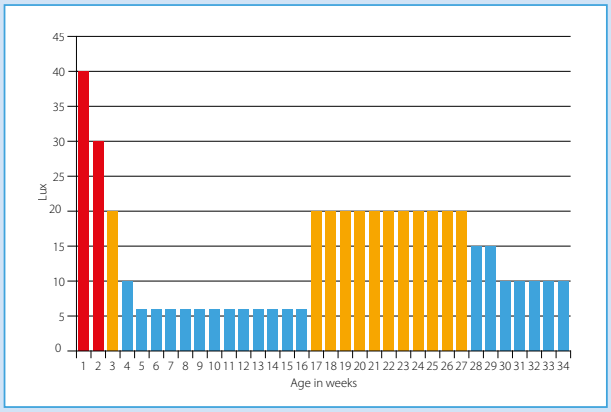
LIGHT INTENSITY AT THE DESTINATION

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

During the first week a higher intensity is needed to activate the birds.
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.

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.



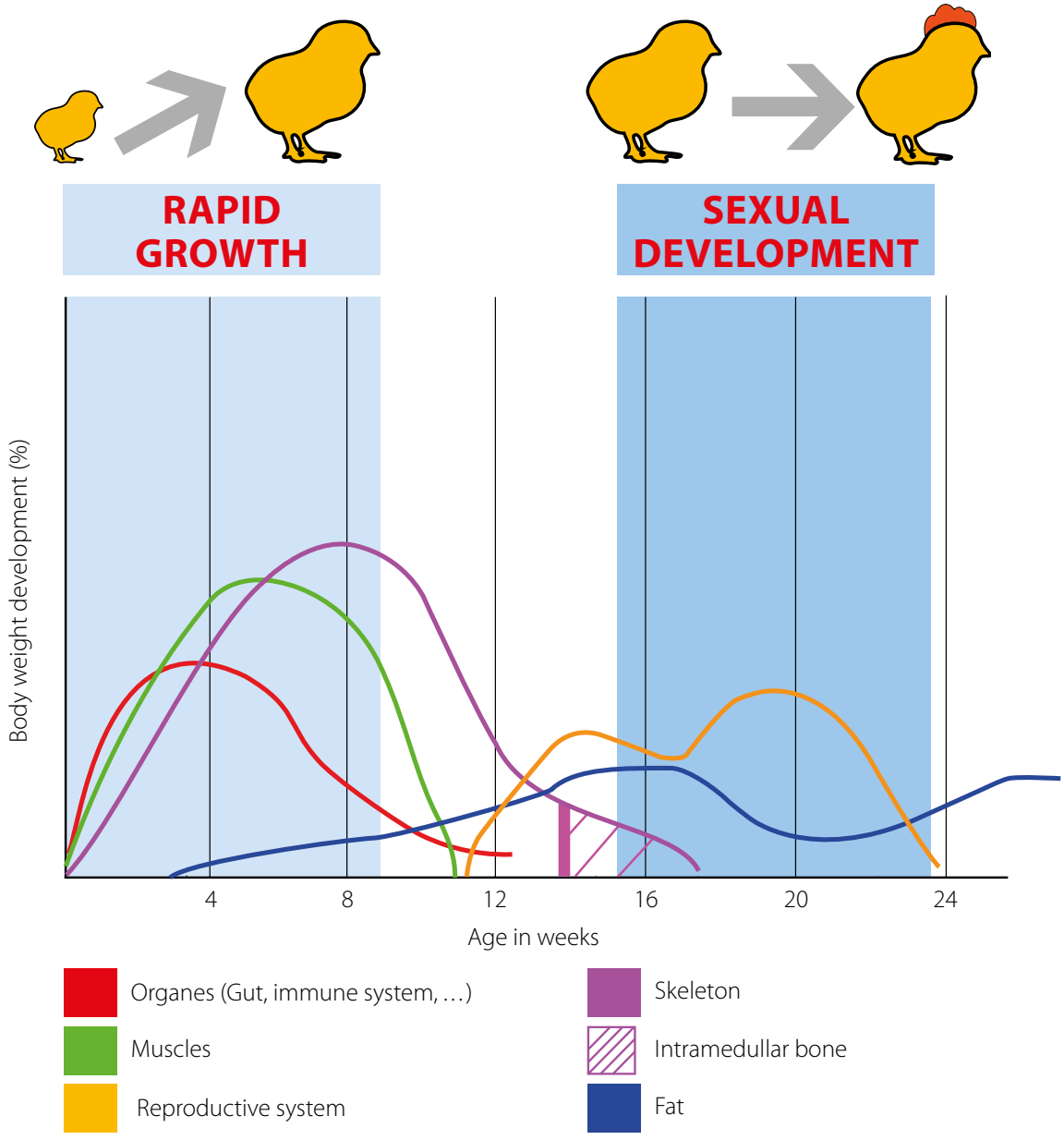
PULLET DEVELOPMENT

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.

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

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



GROWING (3 – 9 WEEKS)

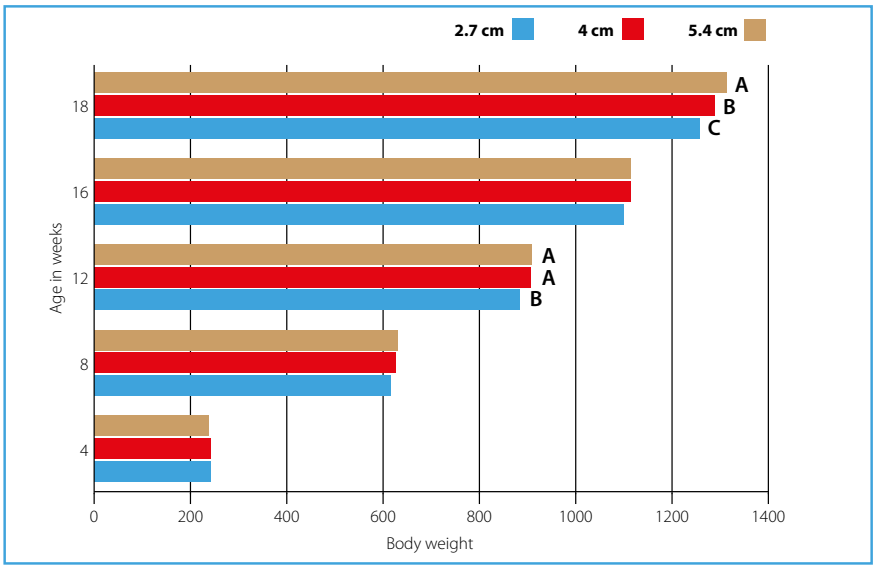
FEED INTAKE

It is very important to promote good feed consumption to maintain correct development:

- Temperature at week 3 should be 22 – 23 °C | 72 – 73 °F. This can be slowly reduced over the next few weeks to around 19 at 9 weeks of age.
- Maintain a low stocking density. In cage rearing systems birds should distributed along all the cages as soon as possible.
- Maintain the adequate feeder space.
- Never restrict the feed intake.
- Provide a "midnight snack" if the standard weight described on page 34 is not reached. In floor system rearing keep an eye on your bird's behavior during its implementation.

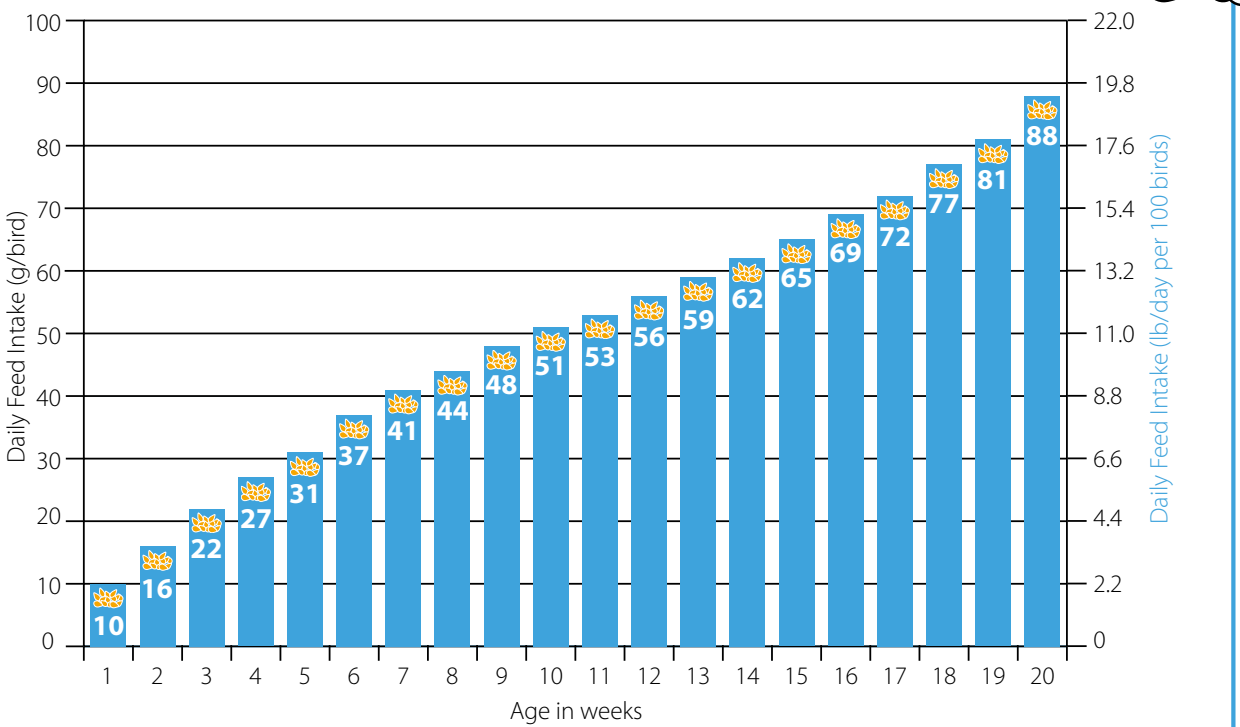
Providing good quality feed is also key to good bird development as described on page 39.

Effect of the feeder space on body weight



Anderson et al. Poultry Science 1994 73: 958-964

Daily feed intake pattern

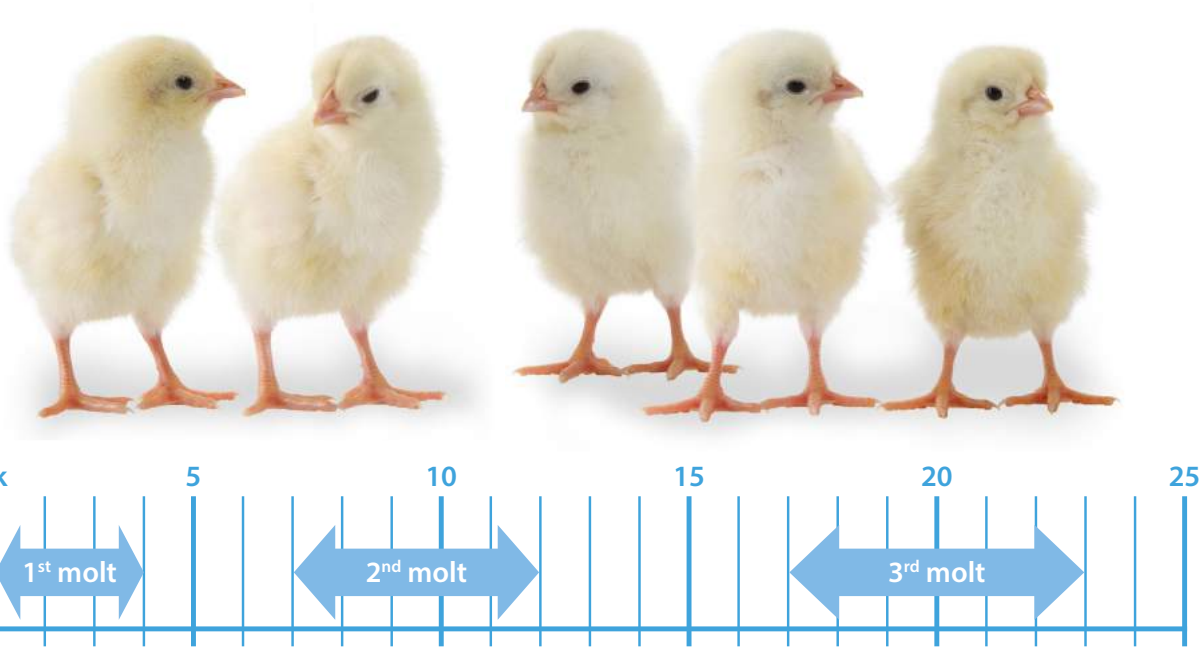


▶ Daily intake can vary depending on feed composition.

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. It is important that molting occurs in the indicated periods, otherwise it may signal delayed physiological development of the birds.

Feathering and molting across the rearing period



KEY POINTS

- **Implement the lighting program according to your house conditions.**
- **Never allow day length to increase during the rearing period.**
- **Achieve the required body weight at weeks 5 and 6 of age.**
- **Provide enough feeder/drinker space as soon as possible.**
- **Follow the feathering and natural molting timeline to monitor physiological development.**
- **Provide some alfalfa in floor rearing during this period.**

REARING PERIOD (9 – 15 WEEKS)

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

BODY WEIGHT

Weight gain as a percentage will slow in this period, but the chicks will continue to grow and develop. Most of the skeleton and muscular systems have already been formed by now and fat disposal will now begin to improve. A correct fat level in the body is necessary to achieve the production peak. Overweight birds will face issues in production.

The feed intake is higher than in previous weeks. The birds may be given a more diluted 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 weight standard:

- 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.

For weighing protocol see page 57.

Table 4: Pullet Feed Consumption

Age	Body Weight		Feed		Feed Cumul.		Diet
weeks	g	lb	g / bird /day	lb/100 birds	g / bird	lb/bird	
1	65	0.14	10	2.2	70	0.15	STARTER
2	116	0.26	16	3.5	182	0.40	
3	175	0.39	22	4.9	336	0.74	
4	245	0.54	27	6.0	525	1.16	
5	325	0.72	31	6.8	742	1.64	
6	410	0.90	37	8.2	1001	2.21	GROWER
7	496	1.09	41	9.0	1288	2.84	
8	582	1.28	44	9.7	1596	3.52	
9	665	1.47	48	10.6	1932	4.26	
10	745	1.64	51	11.2	2289	5.05	
11	822	1.81	53	11.7	2660	5.86	DEVELOPER
12	896	1.98	56	12.3	3052	6.73	
13	967	2.13	59	13.0	3465	7.64	
14	1035	2.28	62	13.7	3899	8.60	
15	1101	2.43	65	14.3	4354	9.60	
16	1168	2.57	69	15.2	4837	10.66	
17	1235	2.72	72	15.9	5341	11.77	
18	1300	2.87	77	17.0	5880	12.96	PRE-LAY
19	1358	2.99	81	17.9	6447	14.21	
20	1408	3.10	88	19.4	7063	15.57	

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 deal with this challenge it is beneficial to train them to increase their feed intake during the end of the rearing period.

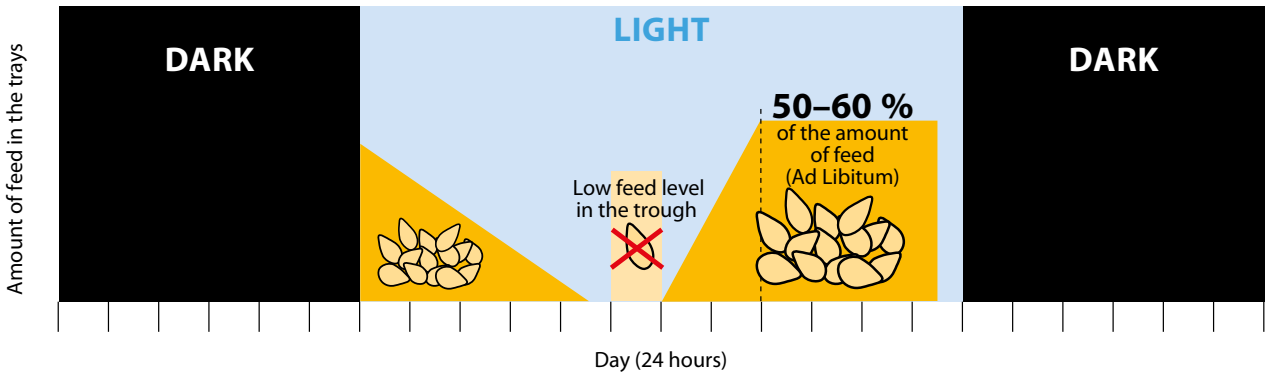
To do this, try:

- **Low density feed.** From 10 to 15 weeks, it can be useful to switch to a feed (1225 Kcal/lb, 15 % CP, 4.5 % fiber) that promotes feed intake.
- **Feed distribution program** allow hens to empty the feeders completely during the day (see below diagram).
- **Move feed for the next day.** Once a week, you can withhold feed in the afternoon (20 – 30 % daily ration) and feed it the next morning instead. Check for uniform distribution and do not reduce the two-day ration and refill the feeder as many time as needed.

Attn: this is only possible if the hens are kept at the right stocking density and there is enough feeder space.

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

Feed distribution in rearing from 10 to 16 weeks



KEY POINTS

- Ensure body weight gain and correct development by maintaining feed consumption.
- Train hens to develop a good feed intake capacity by working with diluted feed and adapted feeding times.
- Remove non-productive birds from the flock.

TRANSFER (15 – 18 WEEKS)

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

PREPARING THE FLOCK TO MOVE TO THE LAYING HOUSE

It is recommended to transfer the birds between 15 and 18 weeks. 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 make a smooth transition. The same light program as in the rearing house should be applied. As the page 25 graph shows, good communication and coordination between the rearing and the laying house is necessary to synchronize flock management.

It is good management practice to visit the pullets several times during the rearing period.

Complete the vaccination program before transfer.

Where possible do not administer vaccine during the transport or in the catching process.

PRODUCTION HOUSE 	▪ All maintenance completed ▪ House clean and disinfected ▪ Feed in the silos ▪ Correct temperature ▪ Sampling of C&D process performed and satisfactory laboratory results received.
FLOCK 	▪ Pullets on body weight ▪ Vaccine program administered ▪ Approved Sanitary certificate ▪ Flock information sent to production house (lighting program, feeding times, type of feed, body weight, …)
TRANSPORT 	▪ Transport truck ready ▪ Catching crew ready ▪ Housing crew ready ▪ Weather condition checked

STOCKING DENSITY IN THE LAYING HOUSE

The bird should have enough space, especially in hot climates. Important is not only cm^2 of cage floor/bird, but also the height of the cage and how many cm of feeder and how many drinkers are available per bird (a minimal recommendation is given in table 5).
Overstocking has a strong impact on mortality, body weight, body weight uniformity, feathering status and in eggs laid per hen. In addition, local legislation should be respected.

Table 5: Stocking density at production house

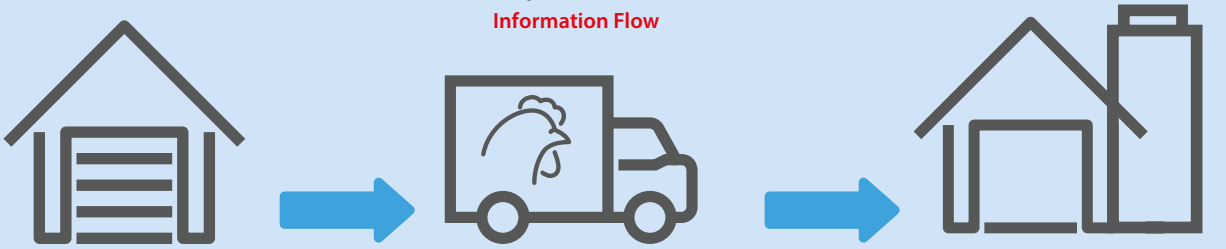
Equipment	Requirements*
Stocking Density	450 – 750 cm^2/hen (73 – 116 in^2/hen)
Drinkers	
Round drinkers	1 drinker (Ø 46 cm | 18 in) for 125 hens
Linear drinkers	1 running meter (3,3 ft) for 80 – 100 hens
Nipple drinkers	1 nipple for 6 – 8 hens (access to 2 nipples/hen)
Feeders	
Round feeder	1 feeder (Ø 40 cm | 16 in) for 25 hens
Chain feeder	10 – 15 cm/hen (4 – 6 in/hen)

** These recommendations should be adjusted to the local specific regulation.*

TRANSPORT TO THE LAYING HOUSE

REARING FARM ⟷ **PRODUCTION FARM**

Information Flow



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
- 24 h light first day
- Follow regulations
- Pre-heating in cold areas

Preparation

Transport should be planned well in advanced and all staff involved should be informed. Withhold feed for a few hours before loading but continue to provide fresh water. 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 regulations, wear clean clothing and footwear that have not been exposed to poultry. Choose the best time of the day for transportation (especially in hot climates).

Loading

Load quickly but with care and maintain an adequate stocking density in the transport racks. Continue to ventilate the house during the procedure. The staff should be well trained and should handle the birds according to animal welfare regulations, 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. Avoid moving the birds during the part of the day with more extreme temperatures, or when climate conditions could have a negative effect on the birds.

In all cases

- **Do not catch hens by one wing or one leg or the neck.**
- **Do not overstock transport racks.**
- **Do not leave hens in racks in sunlight or unventilated areas.**
- **Do not load racks in closed and unventilated trailers.**

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

When to move the birds?

During midday

During the night or early morning

TRANSFER (15 – 18 WEEKS)

HOUSING IN THE LAYING HOUSE

Applying an "all-in all-out" system is recommended to break disease cycles and improve the health status. The laying 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 be well prepared for the start of laying. The temperature in the laying house should be between 18 – 24 °C (64 – 75 °F). Cool water and feed must be available when the pullets arrive at the house.
When possible use the containers/crates also ones a day, and/or clean in between.
In this way you prevent infection from layer to rearing house!

Water

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.

Feed

Feeders should be filled when the pullets arrive so it is easy for them to locate the feed. Also encourage the birds to eat by running the feeding lines more frequently. If pullets are reluctant to eat after a couple of days, corrective measures should be taken at once.
Continue with the same feeding program and let them also empty the feeders ones a day. Avoid changing the feed presentation between the rearing to the production house.

Light

24-hour light can be set during the first day, so the birds can become familiar with the new environment. After that try to continue with the lighting program that was set in the rearing house. Light intensity can be a little higher during the first week (20 lux) to encourage hens to explore the house. Avoid over-stimulating hens by a higher light intensity.

Weight

Weight lost during transport should be recovered in the first days in the 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 birds carefully and take actions if needed.

KEY POINTS

- **Transfer the birds at least two weeks before the onset of lay.**
- **Only transfer flocks that are healthy and in good condition.**
- **Plan transport in advance and organize it well to ensure optimal comfort for 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 consumption during the week after arrival at the laying house.**
- **No vaccinations during transfer where possible.**

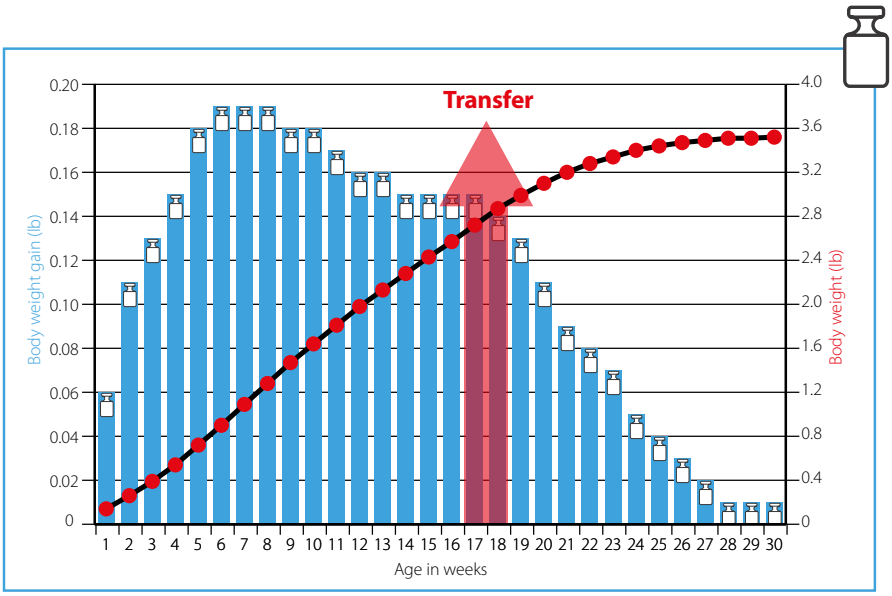
ONSET OF PRODUCTION (18 – 25 WEEKS)

- **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 good production peak.**

PERIOD AFTER TRANSFER

During the first days after housing, it is important to stimulate sufficient feed intake. The hens should increase their feed intake as fast as possible and continue gaining weight (see figure 1). Some useful recommendations:

- Provide attractive feed with a good structure that avoids fine particles.
- Provide good quality, fresh water.
- Run the feeding lines frequently during the day.
- Feed on an empty feeder.
- Ensure there is enough light at the feeder.
- Light intensity should be higher in the laying house than in the rearing house.
- Avoid excessive stimulation when transferring birds to open houses.



LIGHT AND LIGHT PROGRAMS

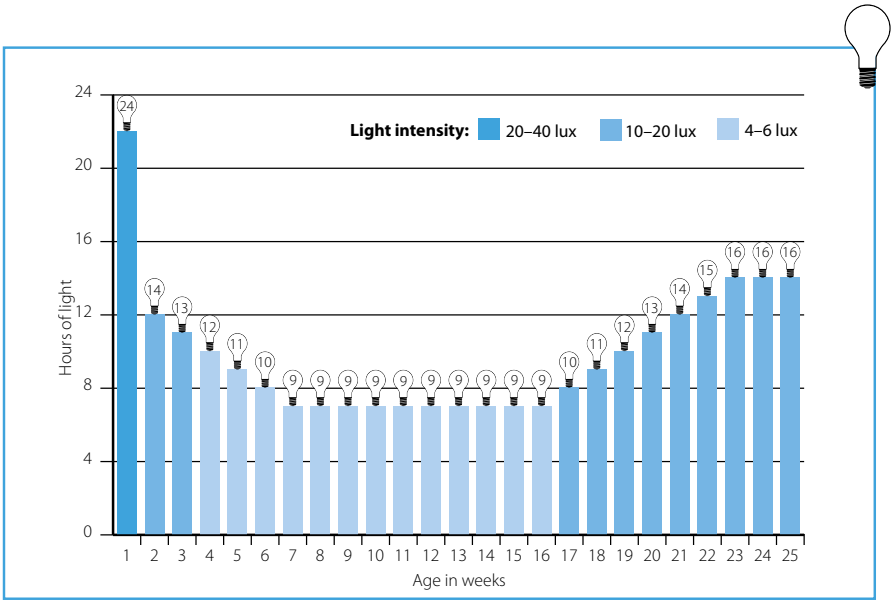
There are two main factors that stimulate the onset of laying in the flock:

- 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 follow:

- 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.



ONSET OF PRODUCTION (18 – 25 WEEKS)

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 of life. 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 CV is very high 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 get heavier birds in the production onset is to delay light stimulation. Age at 50 % lay and body weight at 50 % lay are two values that can greatly help to forecast the egg weight.

TAKE THE NATURAL DAY LENGTH INTO ACCOUNT

How to deal with natural day length

The light program in open houses should take the natural day length at the stimulation age into account. Determine the light program during rearing as explained in chapter growing (page 17). Stimulation should differ depending on the day length.

- **Increasing day length period:** flocks risk 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 light 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.

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:

- Increase the day length at least one hour after sunset, or after switching off the lights.
- Light intensity in the laying house should be slightly higher than in the rearing house.
- Light distribution should avoid dark and shady areas
- Keep light sources clear.

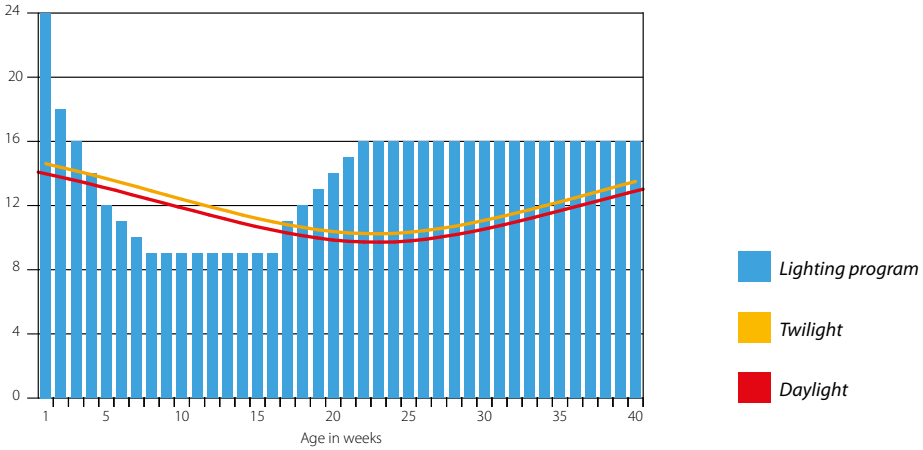
Subsequently, the photoperiod must be increased weekly. Light increases should be at least half an hour, although a higher increase is possible if the laying percentage increases rapidly. The more light hours the hens have, the more time they will use to consume feed. It is therefore important to achieve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

SEXUAL MATURATION AND ONSET OF LAY

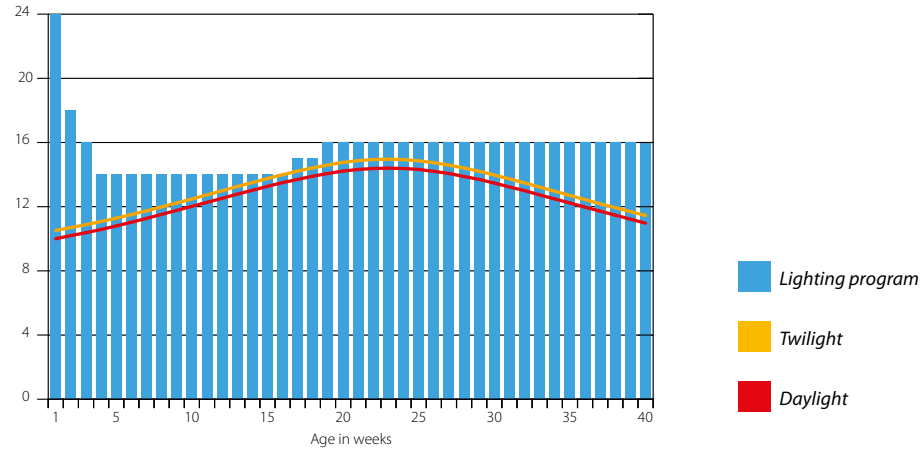
At the start of their productive life, hens develop their secondary sexual characteristics. This is a good indication that the bird's hormone development is correct. In addition to the start of the reproductive capacity (and therefore production of eggs) other changes occur in the bird's metabolism.

One of the most important is the ability to capture calcium to create intramedullary bone. It is very important that the birds develop this type of bone to ensure good quality eggshells during the late lay period. Good practice is to use a pre-lay feed as explained in the chapter nutrition.

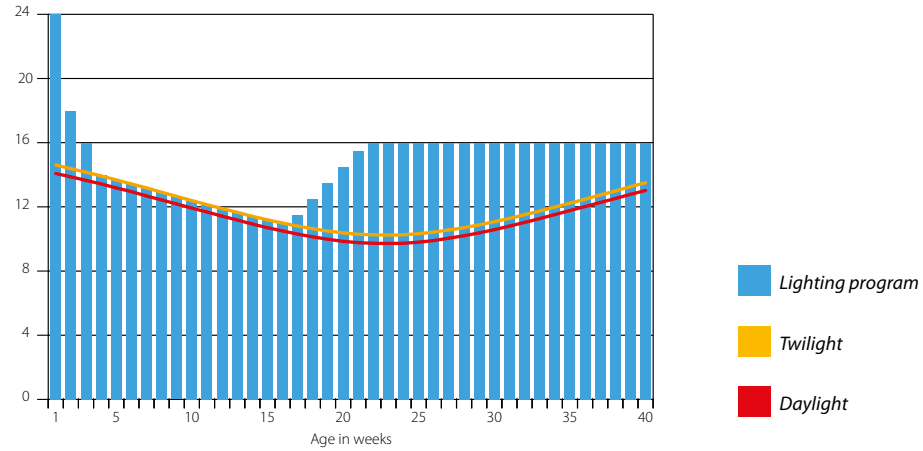
Closed house decreasing days



Open house increasing days



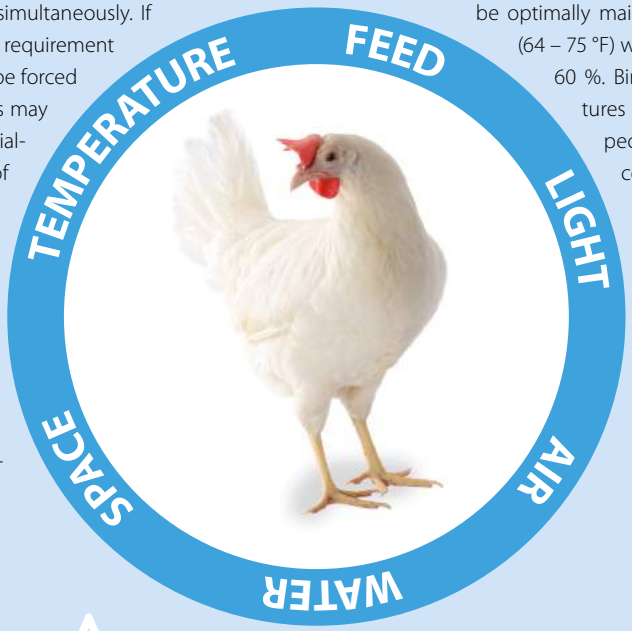
Open house decreasing days



MANAGEMENT TO PEAK PRODUCTION PERIOD

FEED

The birds need a good quality feed, with the structure and nutrient density necessary to suit 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 met 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.



VENTILATION AND TEMPERATURE

Proper ventilation should be used to guarantee good 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 18 – 24 °C (64 – 75 °F) with a relative humidity of 50 – 60 %. Birds do not tolerate temperatures above 30 °C (86 °F) 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 coolers should be considered to reduce the house temperature.

WATER

Cool water of good quality (see page 55 for details) 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 highly 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.

SPACE

The birds should have enough space, especially in hot climates. Important aspects are not only cm^2 (in^2) of cage floor/bird, but also the height of the cage and how many cm of feeder, and how many drinkers are available per bird (a minimal recommendation is given in page 24). The temperature should be between 18 – 24 °C (64 – 75 °F).

ONSET OF LAY

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

% 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.

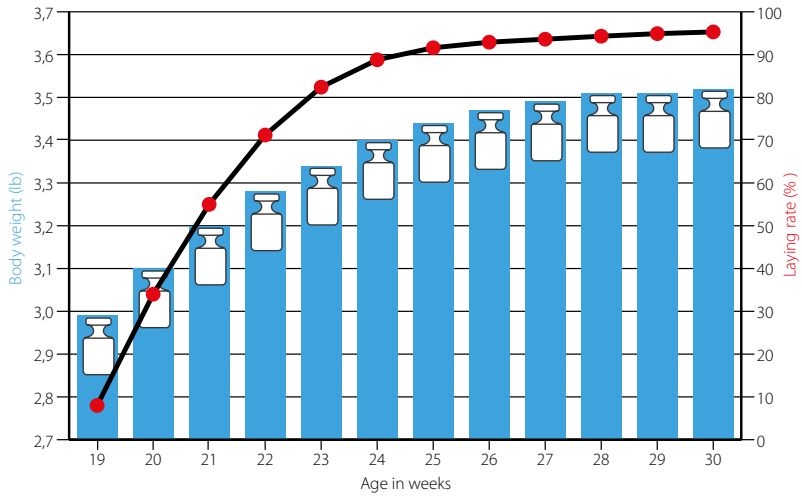
BODY WEIGHT

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.

FEED AND 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



KEY POINTS

- **Monitor how well the flock has adapted to the laying house by measuring water and feed consumption daily and body weight weekly.**
- **Control the onset of lay and egg weight by correctly applying light stimulation.**
- **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.**

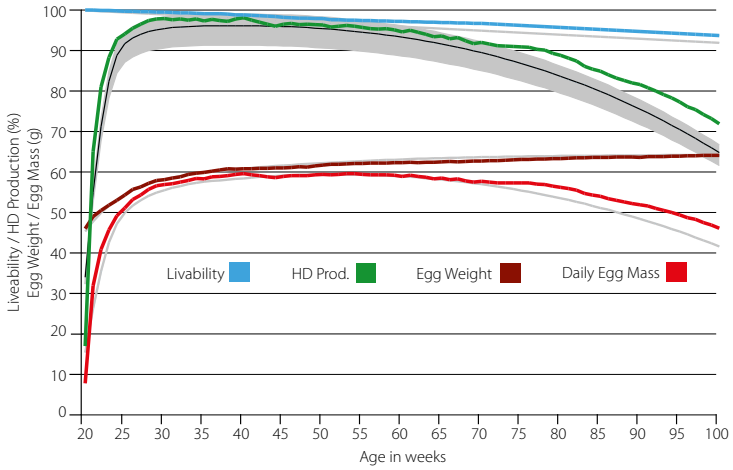
PRODUCTION PERIOD (25 – 100 WEEKS)

- **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 good production peak, H&N hens should enter a production plateau. Their genetic potential allows them to maintain a high production level and good eggshell quality for some weeks but to achieve this, pay close attention to certain aspects:

- Feed quality
- Daily intake
- Absence of diseases
- Body weight



	Weeks > 90 %	Eggs/HH	Liveability	Cum. EW (g)	Cum. EM (kg)
	55	494.6	93.7	61.2	30.3
Standard	45	473.0	91.9	61.6	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 and mortality are necessary. This information will allow you to calculate very 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, accurate cage and/or 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 Consumption			Feed Conversion	
Date	Age	Mortality (No.)	Hens remaining	% Liveability cum.	Eggs produced	% Production	% Standard	Cum. Egg production	Eggs / HH	Standard	In the week	Standard	Cumulative	Standard	In the week	Standard	Cumulative	Standard	In the week	Grams / bird / day	kg / feed / HH	In the week	Cumulative
		B	C	D	E	F		G	H		I		J		K		L		M	N	O	P	Q
			C (or A) – B	C / A *100		E / C / 7 *100		G + E	G / A				L / H		E * I / A		L + K				O + M	M / E / I *1000	O / G / J *1000

TROUBLESHOOTING

Problem	Possible cause
Lay drop	Low feed intake, low water intake, stress factors, feed quality, decreasing light program, pathology
Low feed consumption	Temperature, water supply, feed quality, inadequate feeder space, incorrect feed supply, pathology
Low egg weight	Temperature, low feed consumption, low body weight at light stimulation, incorrect feed formulation
Mortality	Flock uniformity, light intensity, stress factors, pathology
Low body weight	Incorrect feed formulation, low feed intake, high stocking density
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
Stained eggs	Water quality, pathology, incorrect egg collection management, incorrect feed formulation, incorrect grading machine maintenance, high stocking density, pest/diseases

FEATHER COVERING

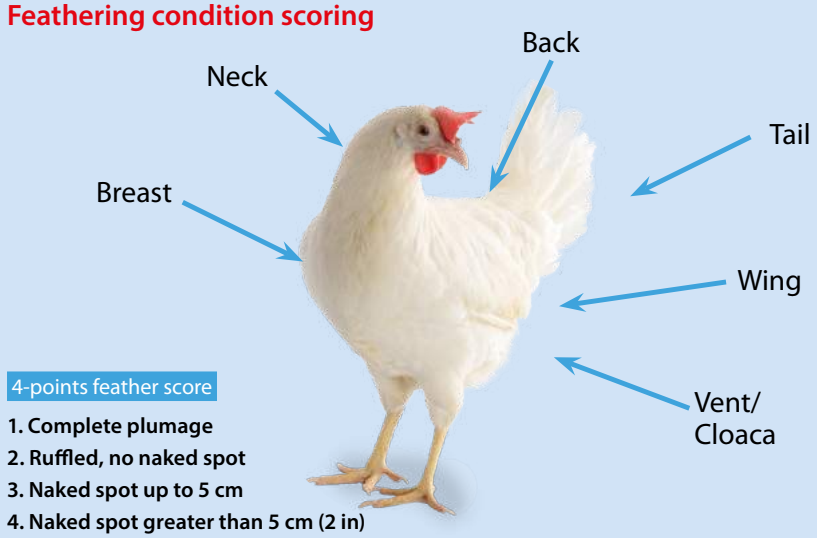
Feather coverage is a key indicator of the hen's body condition. If hens lose their feathers, their thermal insulation capacity will remain seriously impaired. This impacts directly on feed intake and maintenance energy needs. It therefore means an increase in the production feed costs. Poor feathering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

Excessive feather loss can be due to various factors including:

- Poor nutrition
- Pecking or social aggression
- High stocking density
- Poor feed distribution
- Harsh housing conditions

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 5 cm
4. Naked spot greater than 5 cm (2 in)

AGGRESSION

Occasionally, aggression and cannibalism can occur in the flock. This can affect hen welfare and their production performance. Behavior-related issues can have multiple causes, but certain management practices can be applied to help prevent aggression and cannibalism:

- Control light intensity and reduce it after production peak (see page 16).
- Correct rations, especially amino acids, sodium and fiber content.
- Correct beak treatment – if permitted in your country.
- Stress avoidance (noises, direct sun rays, light intensity variation, etc.).
- Enrich the hens' environment.

PRODUCTION PERIOD (25 – 100 WEEKS)

FEEDING LAYERS DURING PRODUCTION

Layers do not consume equal amounts of feed during the whole day. 70% of feed consumption occurs in the early hours of the morning and the last four hours in the afternoon. They also have a predilection for calcium during the last hours of light.

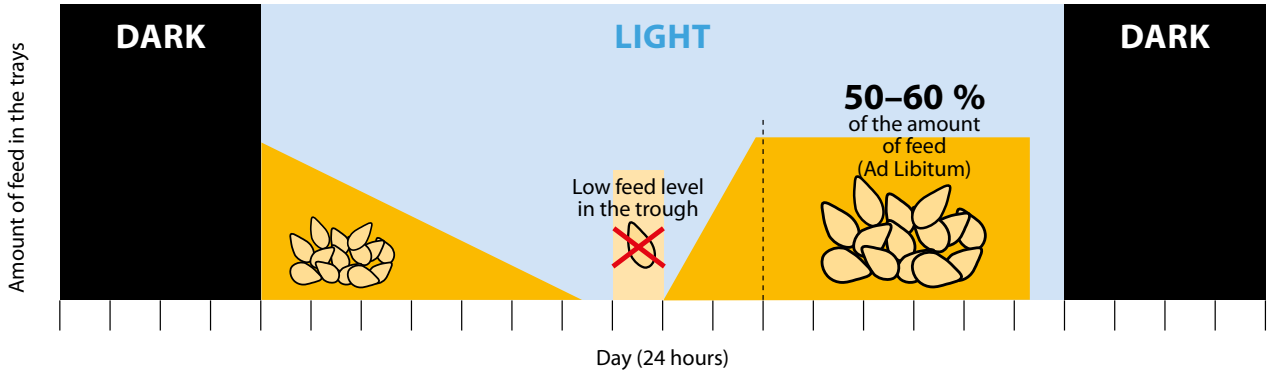
To mirror this behavior better, feed times should be adapted to get a low level on the feeders for eight hours after switching on the lights. Under normal conditions ⅔ of the daily feed should be supplied in the last eight hours. Ensure this afternoon feed is effectively distributed to the hens.

Normal level

Low level

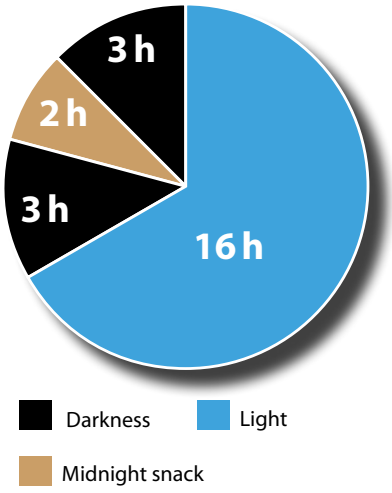
H&N "Nick Chicks" are not normally prone to put on fat with correctly formulated feeds. **Therefore, feed restriction is not recommended.** Monitor egg size, body weight and production percentage very closely. These traits will decrease first if birds are being under fed.

Feed distribution in production



MIDNIGHT LIGHTING

Midnight Snack



This management technique is used to increase feed intake and allow calcium availability in the hours when the eggshell is formed, and its absorption is increased. It consists of lighting in the dark period to allow hens to feed and refill the crop.

The following guidelines should be followed for 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 switch on.
- Water must be available

Midnight lighting can be used with different objectives:

- Increase in 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 in day time.
- Improvement of eggshell quality. The availability of extra calcium in the intestine allows better calcification and reduces bone decalcification.

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 most of the time (18–21 hours).

Lay is a critical moment for hens. If possible, they prefer a protected and dark area. The cloaca could 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 dead birds, feed distribution, inspecting cages …

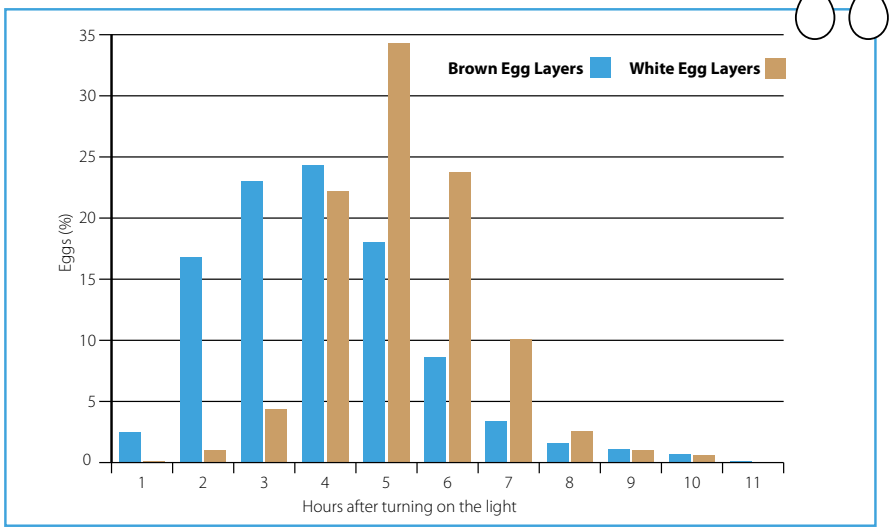
Laying window

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.

50 % of the lay takes place around 4–5 hours after switching on lighting or after the sunset. It is useful to know when most of the eggs have been laid.

This information can also be used to advance or delay the time of sunset, although periods of 16 hours of light are used routinely.

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 cool (max. 18 °C | 64 °F) and dry place.
- Collect the eggs twice a day, especially in hot climates.
- Avoid overstocked nests or egg belts. This may increase the number of cracked and soiled eggs.
- Prevent hens from eating or pecking the eggs.

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.**

LATE PRODUCTION (UP TO > 75 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 carcass 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.

Correct use of pre-lay

Incorrect use of pre-lay feed might induce damage to the medullary bone, affecting the capability of the layer hen to utilize Ca from the bone.

Feed intake development using a developer feed

At the start of lay a lack of feed intake will force the layer hen to exert metabolic effort that will compromise the longevity of the hen (see more in chapter on nutrition).

Calcium sources

60 – 70 % of Ca in the eggshell derives from the diet and 30 – 40 % from the bones, specially the medullary bone. The availability of Ca during eggshell formation will improve eggshell quality. **The midnight snack (see page 34)** and particle size and solubility of the Ca sources (see more in chapter on nutrition) are strategies to improve eggshell quality.

Balanced Ca, P and Vit D in diet

Excess or deficiencies 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

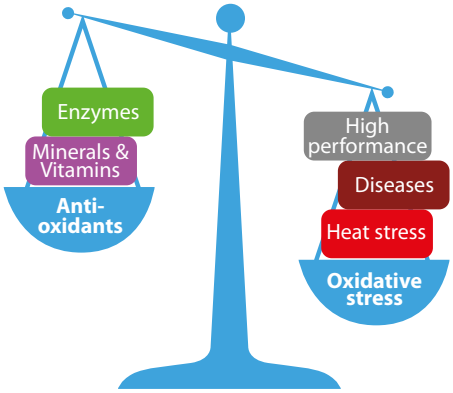
GOOD LIVER HEALTH

- Adding fat and oil or crude fat in layer diets is a well-known tool to reduce the incidence of "fatty liver syndrome".
- Added choline chloride in layer diets to support liver metabolism.
- Methionine and betaine are used to relieve liver metabolism.
- Vitamins like K_3, E, B_{12}, B_1 and folic acid.
- Mycotoxin control is a must.

List of mycotoxins

Aflatoxins	Fatty liver, liver necrosis and bile duct hyperplasia
Fumonisin	Multifocal hepatic necrosis; hepatocellular hyperplasia
Aflatoxin + T2	Pale enlarged liver

REDUCE THE METABOLIC CHALLENGES



Oxidative stress

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

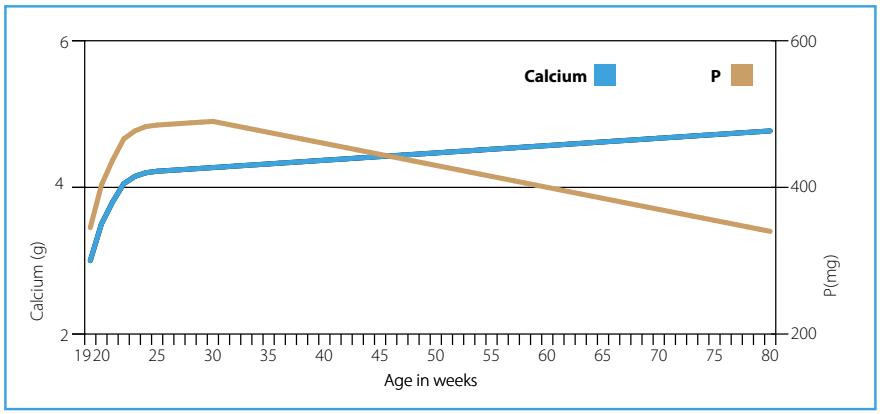
- **Free radicals:** they are produced during metabolism when ATP is produced, as part of the inflammatory response, heat or cold, stress, high levels of ammonia, oxidized fat in diet.
- **Antioxidant system:** it is a complex system involving enzymes, as glutathione dependent of Cys availability or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

Cage fatigue

It is a decalcification of the bones of the hens 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 deficiency

Needs of Ca and available P in production



IMPROVE GUT HEALTH

Feed hygiene

Try to reduce contamination as much as possible.

- HACCP 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 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

Find the best combination of gut health additives 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 (115 °F)	< 1	< 1
Salmonella	0	0
Molds	< 3	< 1.5
Yeast	< 3	< 1.5

LATE PRODUCTION (AFTER > 75 WEEKS)

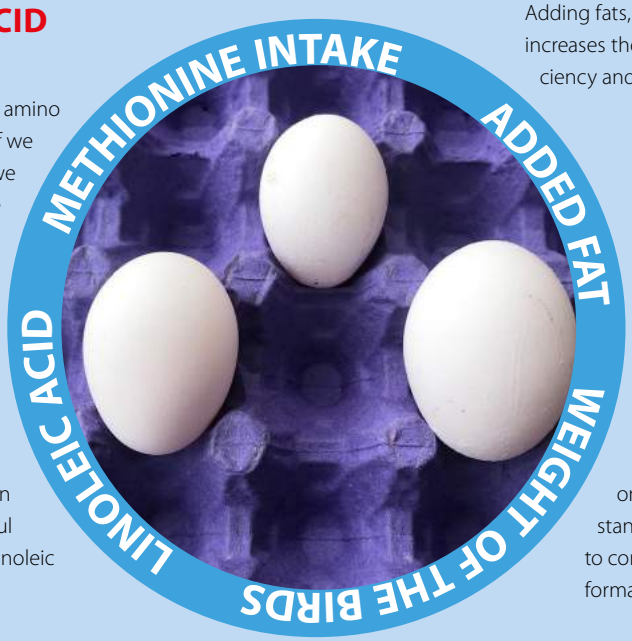
FACTORS INFLUENCING EGG SIZE

METHIONINE AND OTHER AMINO ACID INTAKE

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 isn't broken.

LINOLEIC ACID

There is a minimum requirement of linoleic acid so the egg yolk size isn't a limitation in the egg size. Need to 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 isn't recommended to have birds below the standard at week 5 (no more than 3 %) to control egg weight in production, performance will be compromised.

KEY POINTS

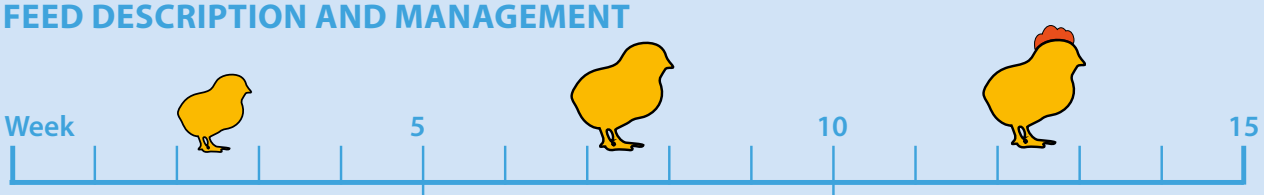
- **When keeping hens for a longer lay-cicle, be proactive at an early age.**
- **Poor eggshell quality is a major cause for lower saleable eggs output in the late production period. Take corrective measures in advance.**
- **Avoid immunosuppression by avoiding mycotoxins, stress or poor nutrition.**
- **A healthy liver offers excellent egg production. Take care of it.**
- **Good gut health is needed to properly asimilate the nutrients, pay attention to it.**

NUTRITION

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 interesting to invest in highly digestible raw materials if they are available.
- Soya oil or coconut oil are better sources of energy than palm oil: at least during the first three weeks of age.
- 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 don't allow you to follow the recommendations below. Your 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 developing a pullet ready to lay. The feed intake capacity is related to the gut size, the addition of fiber in the diet expands the size of the gut and improves the feed intake capacity.
- The fiber concept is getting complex in poultry. There is new knowledge showing how different types have a different effect.
- Fiber can be classified like:
  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 level of fiber since early ages 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
- They follow the recommended Ideal Protein Ratio (table 7)

Vitamins and minerals
- See table 8

Table 6: Nutrient recommendations for rearing period

Nutrient		Starter	Grower	Developer
		0 – 5 weeks	6 – 10 weeks	11 – 17 weeks
M Energy	Kcal/kg Kcal/lb	2825 – 2950 1280 – 1340	2725 – 2850 1235 – 1295	2600 – 2750 1180 – 1250
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
Argenine	%	1.21	0.99	0.67
Dig. Argenine	%	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
Metethionine	44 %	45 %	47 %
Met. + Cys.	75 %	80 %	85 %
Threonine	66 %	70 %	70 %
Tryptophan	19 %	21 %	24 %
Ile	69 %	76 %	76 %
Valine	78 %	78 %	80 %
Arginine	105 %	105 %	106 %

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	100
Zinc	mg	60	60
Iron	mg	25	25
Copper	mg	5	5
Iodine	mg	0.5	0.5
Selenium	mg	0.25	0.25

* *Higher level might 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
Copra meal	5 – 10
Palm kernel meal	2 – 8
Sunflower meal	5 – 15
Lupins	5 – 10
Oat hulls	2 – 4
Soya 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 %

NUTRITION

PRE-LAY NUTRITION

▶ **How to feed for layer development and the start of egg production**

FEED DESCRIPTION AND MANAGEMENT

- A transition feed that supports the final development of the pullet and the nutrient requirements.
- The feed must be managed carefully (see table 14).
- **Negative impact of incorrect use of pre-lay:**
  - decalcification of layer
  - slow peak of lay
  - double peak
  - low eggshell quality at end of production

NUTRIENT REQUIREMENTS

- See the energy, amino acids and calcium & phosphorus recommendations, table 11.
- The AA and MEn can be calculated based on the available scientific literature. In that case we recommend following the table 13 Ideal AA profile for pullets.
- See vitamins and minerals in table 12.

FORMULATION TIPS

- Minimum of added fat will reduce the dustiness of the mash feed (1 – 2 % based on cost impact).
- Calcium carbonate particle size should follow layer guidelines.

Table 11: Nutrient recommendations for Pre-lay period

Nutrient		Pre-lay
Energy	kcal/kg kcal/lb	2750–2800 1250–1275
Crude protein	%	17.5
Methionine	%	0.42
Dig. Methionine	%	0.35
Met. + Cysteine	%	0.76
Dig. Met + Cys	%	0.63
Lysine	%	0.84
Dig. Lysine	%	0.7
Threonine	%	0.59
Dig. Threonine	%	0.49
Tryptophane	%	0.18
Dig. Tryptophane	%	0.15
Isoleucine	%	0.67
Dig. Isoleucine	%	0.56
Valine	%	0.74
Dig. Valine	%	0.62
Arginine	%	0.87
Dig. Arginine	%	0.73
Calcium	%	2
Total Phosphorus	%	0.6
Avail. Phosphorus	%	0.4
Dig. Phosphorus	%	0.35
Sodium	%	0.16
Chloride	%	0.16
Potassium	%	0.5
Linoleic acid	%	1
Crude fiber	%	4

Table 12: Vitamin and trace mineral recommendation in Pre-lay

		Pre-lay
Vitamin A*	IU	10000
Vitamin D_3	IU	2500
Vitamin E	IU	15 – 30
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
Antioxydant	mg	100 – 150
Coccidiostat		–
Manganese	mg	100
Zinc	mg	60
Iron	mg	25
Copper	mg	5
Iodine	mg	0.5
Selenium	mg	0.25

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

*** double in case of heat treated feed*

Table 13: Ideal Protein Ration in Pre-lay

	Pre-lay
Lysine	100 %
Methionine	50 %
Met. + Cys.	90 %
Threonine	70 %
Tryptophan	21 %
Ile	80%
Valine	88 %
Arginine	104 %

Table 14: Feeding during and after transfer

Age at Transfer	Feeding Program		
	Developer Feed	Followed by	Pre-lay Feed
week	kg feed	→	kg feed
15	1.0	→	1.0
16	0.5	→	1.0
17	–	→	1.0
18	–	→	0.5
after 18	immediately supply layer Phase-1-feed		

ONSET OF LAY NUTRITION

▶ **How to develop feed intake as the bird is growing and laying its first egg**

FEED DESCRIPTION AND MANAGEMENT

- A transition feed that supports the final development of the pullet and the nutrient need for the start of lay.
- This feed is recommended to use until you reach 50–70 % of laying rate and have an increasing feed intake curve.
- This feed could be given since week 17 as replacement of the pre-lay.

NUTRIENT REQUIREMENTS

- The ideal protein profile is the same as in the layer rations.
- The vitamins and minerals are the same as in the layer rations.
- Crude fiber: keeping high levels as in the developer feed supports the feed intake development.
- Try to have a level minimum of 3.5 % or higher.

FORMULATION TIPS

- The addition of fats will give the formulation room for the requested calcium and fiber.
- A minimum of salt, 0.28 %, will help in the feed intake stimulation.

Table 15: Nutrient recommendations for the Onset period

Nutrient						
Energy		265 – 275 kcal/hen/day 1.109 – 1.151 MJ/hen/day				
		mg / hen / day	85	90	95	100
Crude protein	%	16000	18.82	17.78	16.84	16.00
Lysine	%	847	0.997	0.941	0.892	0.847
Dig. Lysine	%	720	0.847	0.800	0.758	0.720
Methionine	%	424	0.498	0.471	0.446	0.424
Dig. Methionine	%	360	0.424	0.400	0.379	0.360
Met. + Cysteine	%	762	0.897	0.847	0.802	0.762
Dig. Met + Cys	%	648	0.762	0.720	0.682	0.648
Threonine	%	593	0.698	0.659	0.624	0.593
Dig. Threonine	%	504	0.593	0.560	0.531	0.504
Tryptophane	%	186	0.219	0.207	0.196	0.186
Dig. Tryptophane	%	158	0.186	0.176	0.167	0.158
Isoleucine	%	678	0.797	0.753	0.713	0.678
Dig. Isoleucine	%	576	0.678	0.640	0.606	0.576
Valine	%	741	0.872	0.824	0.780	0.741
Dig. Valine	%	630	0.741	0.700	0.663	0.630
Argenine	%	881	1.036	0.979	0.927	0.881
Dig. Argenine	%	749	0.881	0.832	0.788	0.749
Sodium	%	180	0.212	0.200	0.189	0.180
Potassium	%	500	0.588	0.556	0.526	0.500
Chloride	%	180	0.212	0.200	0.189	0.180
Calcium	%	3600	4.240	4.00	3.79	3.60
Phosphorus	%	600	0.706	0.667	0.63	0.60
Avail. Phosphorus	%	420	0.494	0.467	0.44	0.42
Dig. Phosphorus	%	360	0.424	0.400	0.38	0.36

NUTRITION

LAYING NUTRITION

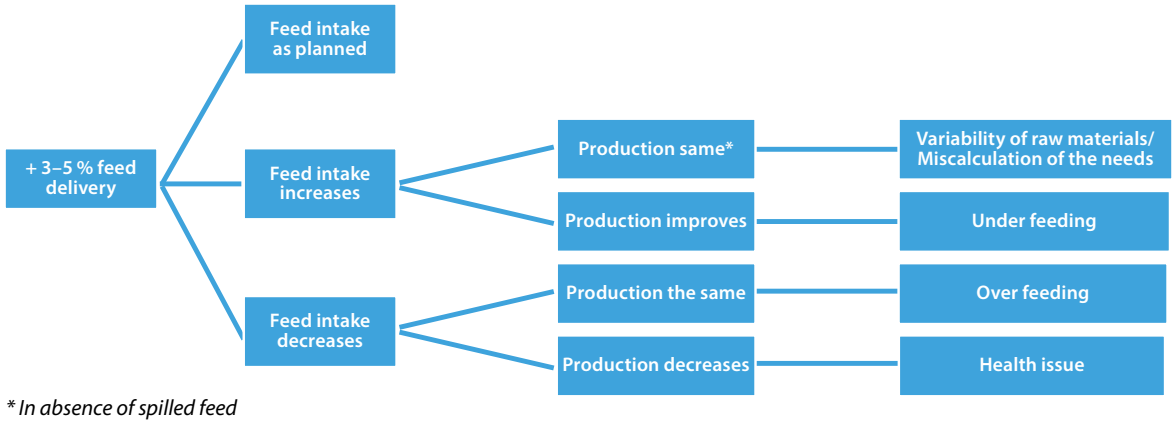
▶ **How to feed hens for achieving as many as saleable eggs as possible during the laying period**

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 weigh 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 temperature reduces the 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*

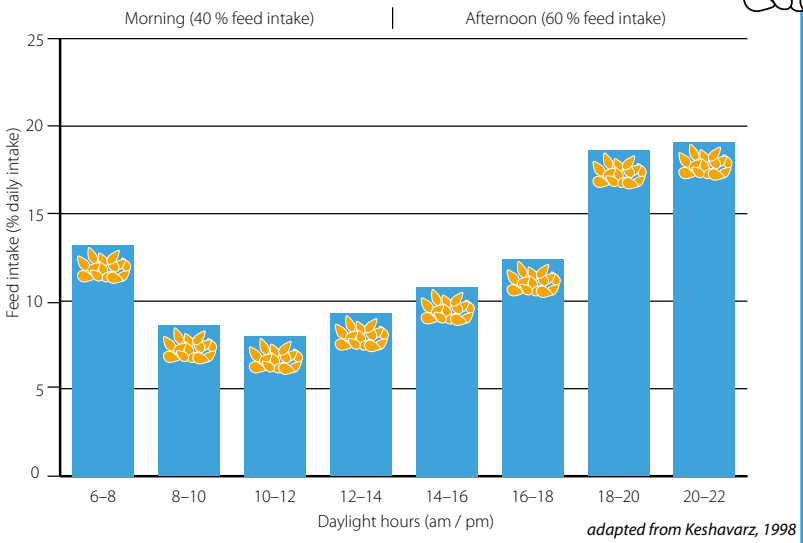
Feed management on farm

- Due to the variability of the raw materials the nutrient composition of the feed varies, to avoid this challenge we recommend to follow the Chart 1 decision tree:

Feed recommendation

- 40 % in the morning and 60 % in the afternoon (chart 2).
- Layer hens should clear 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



adapted from Keshavarz, 1998

NUTRIENT REQUIREMENTS

- Recommendations below are based on egg mass production.
- After the Onset 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 layer hen gets older.

Energy

- The energy recommendation of this guide doesn't take into account the effect of the temperature in the needs of the layer hen. It needs additional adjustments by the nutritionist.
- Most of the energy intake will be used for maintenance. The body weight of the bird drives the energy requirement (see chart 3).
- There are different models to approach the energy evaluation, literature references (INRA, FEDNA, NRC …) usually in MEn and calculations based on formulas, whereby the different elements of the raw materials are taken into account. Due to the variability of the values given by different systems, the recommendation of energy is defined as a range.
- Energy recommendation is calculated for a specific body weight of the bird and might need adjustments (see foot notes of table 16).

Amino acids

- Most of the amino acid 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 24 for the Ideal Protein Ratio recommendation).

Minerals and vitamins

- The vitamin and mineral requirement is shown in table 21.

Ca/P

- Ca and P requirement is shown in table 20.
  - Adapt the data in table 11 to suit the feed intake target.
  - Example: Av P requirement after peak 380 mg: if feed intake is 100 g (22 lb/100/day), the minimum amount in feed should be 0.38 %.

Chart 3: Daily requirements of energy of the bird

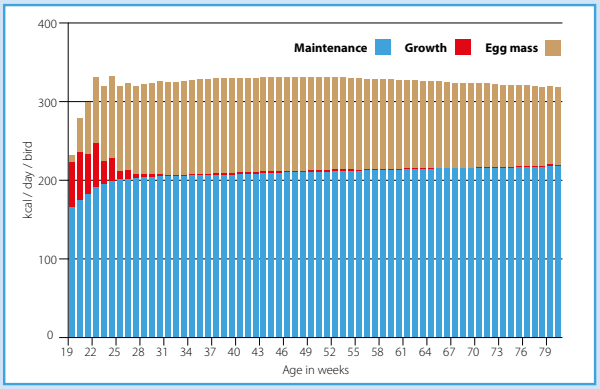
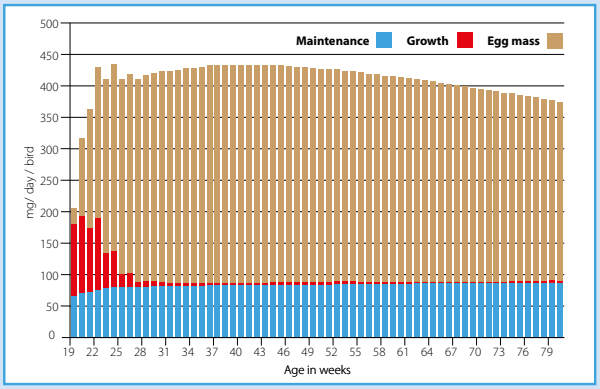


Chart 4: Daily requirements of digestible Methionine



FORMULATION TIPS

Crude Protein

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

Fat

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

Ca/P balance

- Levels of Ca and P must be adapted as the layer hen gets older.
- 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 23 indicates the limestone particle ratio in layers.
- Table 22 indicates how much grit 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 others in the diet.
- Organic minerals: provide additional benefits to the existing inorganics and may reduce the inclusion levels of the minerals.

Table 16: Nutrient requirement for a daily egg mass target of 58 – 60 g/hen (12.7 – 13.2 lb/100 hens)

Energy*	283 – 298 kcal/hen/day 1.185 – 1.248 MJ/hen/day					
		mg / hen / day	95	100	105	110
Crude Protein	%	17000	17.89	17.00	16.19	15.45
Lysine	%	941	0.991	0.941	0.896	0.856
Dig. Lysine	%	800	0.842	0.800	0.762	0.727
Methionine	%	471	0.495	0.471	0.448	0.428
Dig. Methionine	%	400	0.421	0.400	0.381	0.364
Met. + Cysteine	%	847	0.892	0.847	0.807	0.770
Dig. Met + Cys	%	720	0.758	0.720	0.686	0.655
Threonine	%	659	0.693	0.659	0.627	0.599
Dig. Threonine	%	560	0.589	0.560	0.533	0.509
Tryptophane	%	207	0.218	0.207	0.197	0.188
Dig. Tryptophane	%	176	0.185	0.176	0.168	0.160
Isoleucine	%	753	0.793	0.753	0.717	0.684
Dig. Isoleucine	%	640	0.674	0.640	0.610	0.582
Valine	%	824	0.867	0.824	0.784	0.749
Dig. Valine	%	700	0.737	0.700	0.667	0.636
Argenine	%	980	1.032	0.980	0.934	0.891
Dig. Argenine	%	833	0.877	0.833	0.794	0.758
Sodium	%	180	0.189	0.180	0.171	0.164
Potassium	%	500	0.526	0.500	0.476	0.455
Chloride minimum	%	180	0.189	0.180	0.171	0.164
Chloride maximum	%	325	0.342	0.325	0.310	0.295
Linoleic acid	%	1550	1.632	1.550	1.476	1.409

** The energy needs are calculated for a body weight of 1600 g (3.53 lb). Every 50 g (0.1 lb) of change will have an impact of +/- 4 kcal / bird / day.*

Table 17: Nutrient requirement for a daily egg mass target of 55 – 57 g/hen (12.0 – 12.6 lb/100 hens)

Energy*	277 – 292 kcal/hen/day 1.159 – 1.222 MJ/hen/day					
		mg / hen / day	95	100	105	110
Crude Protein	%	16500	17.37	16.50	15.71	15.00
Lysine	%	918	0.966	0.918	0.874	0.834
Dig. Lysine	%	780	0.821	0.780	0.743	0.709
Methionine	%	459	0.483	0.459	0.437	0.417
Dig. Methionine	%	390	0.411	0.390	0.371	0.355
Met. + Cysteine	%	826	0.869	0.826	0.787	0.751
Dig. Met + Cys	%	702	0.739	0.702	0.669	0.638
Threonine	%	642	0.676	0.642	0.612	0.584
Dig. Threonine	%	546	0.575	0.546	0.520	0.496
Tryptophane	%	202	0.213	0.202	0.192	0.184
Dig. Tryptophane	%	172	0.181	0.172	0.163	0.156
Isoleucine	%	734	0.773	0.734	0.699	0.667
Dig. Isoleucine	%	624	0.657	0.624	0.594	0.567
Valine	%	803	0.845	0.803	0.765	0.730
Dig. Valine	%	683	0.718	0.683	0.650	0.620
Argenine	%	954	1.005	0.954	0.909	0.868
Dig. Argenine	%	811	0.854	0.811	0.773	0.737
Sodium	%	170	0.179	0.170	0.162	0.164
Potassium	%	500	0.526	0.500	0.476	0.455
Chloride minimum	%	170	0.179	0.170	0.162	0.164
Chloride maximum	%	320	0.337	0.320	0.305	0.291
Linoleic acid	%	1550	1.632	1.550	1.476	1.409

** The energy needs are calculated for a body weight of 1600 g (3.53 lb). Every 50 g (0.1 lb) of change will have an impact of +/- 4 kcal / bird / day.*

Table 18: Nutrient requirement for a daily egg mass target of 52 – 55 g/hen (11.4 –11.9 lb/100 hens)

Energy*	272 – 286 kcal/hen/day 1.139 – 1.197 MJ/hen/day					
		mg / hen / day	95	100	105	110
Crude Protein	%	16000	16.84	16.00	15.24	14.55
Lysine	%	871	0.916	0.871	0.829	0.791
Dig. Lysine	%	740	0.779	0.740	0.705	0.673
Methionine	%	435	0.458	0.435	0.415	0.396
Dig. Methionine	%	370	0.389	0.370	0.352	0.336
Met. + Cysteine	%	784	0.825	0.784	0.746	0.712
Dig. Met + Cys	%	666	0.701	0.666	0.634	0.605
Threonine	%	609	0.641	0.609	0.580	0.554
Dig. Threonine	%	518	0.545	0.518	0.493	0.471
Tryptophane	%	192	0.202	0.192	0.182	0.174
Dig. Tryptophane	%	163	0.171	0.163	0.155	0.148
Isoleucine	%	696	0.733	0.696	0.663	0.633
Dig. Isoleucine	%	592	0.623	0.592	0.564	0.538
Valine	%	762	0.802	0.762	0.725	0.693
Dig. Valine	%	648	0.682	0.648	0.617	0.589
Argenine	%	905	0.953	0.905	0.862	0.823
Dig. Argenine	%	770	0.810	0.770	0.733	0.700
Sodium	%	160	0.168	0.160	0.152	0.164
Potassium	%	500	0.526	0.500	0.476	0.455
Chloride minimum	%	160	0.168	0.160	0.152	0.164
Chloride maximum	%	310	0.326	0.310	0.295	0.282
Linoleic acid	%	1550	1.632	1.550	1.476	1.409

** The energy needs are calculated for a body weight of 1600 g (3.53 lb). Every 50 g (0.1 lb) of change will have an impact of +/- 4 kcal / bird / day.*

Table 19: Nutrient requirement for a daily egg mass target of less than 51 g/hen (<11.3 lb/100 hens)

Energy*	266 – 280 kcal/hen/day 1.113 – 1.172 MJ/hen/day					
		mg / hen / day	95	100	105	110
Crude Protein	%	15500	16.32	15.50	14.76	14.09
Lysine	%	847	0.892	0.847	0.807	0.770
Dig. Lysine	%	720	0.758	0.720	0.686	0.655
Methionine	%	424	0.446	0.424	0.403	0.385
Dig. Methionine	%	360	0.379	0.360	0.343	0.327
Met. + Cysteine	%	762	0.802	0.762	0.726	0.693
Dig. Met + Cys	%	648	0.682	0.648	0.617	0.589
Threonine	%	593	0.624	0.593	0.565	0.539
Dig. Threonine	%	504	0.531	0.504	0.480	0.458
Tryptophane	%	186	0.196	0.186	0.177	0.169
Dig. Tryptophane	%	158	0.167	0.158	0.151	0.144
Isoleucine	%	678	0.713	0.678	0.645	0.616
Dig. Isoleucine	%	576	0.606	0.576	0.549	0.524
Valine	%	741	0.780	0.741	0.706	0.674
Dig. Valine	%	630	0.663	0.630	0.600	0.573
Argenine	%	881	0.927	0.881	0.839	0.801
Dig. Argenine	%	749	0.788	0.749	0.713	0.681
Sodium	%	160	0.168	0.160	0.152	0.164
Potassium	%	500	0.526	0.500	0.476	0.455
Chloride minimum	%	160	0.168	0.160	0.152	0.164
Chloride maximum	%	310	0.326	0.310	0.295	0.282
Linoleic acid	%	1550	1.632	1.550	1.476	1.409

** The energy needs are calculated for a body weight of 1600 g (3.53 lb). Every 50 g (0.1 lb) of change will have an impact of +/- 4 kcal / bird / day.*

Table 20: Ca and P needs during laying period

	Before peak	Peak to 45 weeks	45 – 70 weeks	> 70 weeks
Ca (g/bird/day)	3.80	4.00	4.30	4.50
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

Levels can be changed based on the use and the levels of phytase

Table 21: Vitamin and trace mineral recommendation in Lay

		Lay
Vitamin A*	IU	10000
Vitamin D_3	IU	2500
Vitamin E	IU	15 – 30
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	60
Iron	mg	25
Copper	mg	5
Iodine	mg	0.5
Selenium	mg	0.25

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

** *double in case of heat treated feed*

Tabel 22: Addition of Coarse calcium at farm in the afternoon

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

** Review the formulation to balance it in Calcium*

Tabel 23: Particle size distribution recommendation 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 24: Ideal protein ratio in layer hens

	Lay
Lysine	100 %
Metethionine	50 %
Met. + Cys.	90 %
Threonine	70 %
Tryptophan	22 %
Ile	80 %
Valine	88 %
Arginine	104%

FEED STRUCTURE

Mash feed is the most commonly used feed throughout the world. Layer hens tend to eat the larger particles avoiding the fine particle s which is where most of the key nutrients are. Therefore, it is vital for successful nutrition to have a 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 IN MASH DIETS

- grinding of the raw materials
- particle size of the protein sources
- addition of liquids like oil that reduces the dustiness of feed
- reduction of fine particle raw materials
- A good feed structure is even more important with non beak treated birds.
- See table 25 and 26 for guidelines.

Table 25: 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 26: 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

Good information is needed to formulate a realistic diet. A combination of available literature, wet chemistry methods and/or NIR is necessary to generate an updated matrix of the raw materials we use.

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 commonest components of oxidation. The quality control plan of 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

Good understanding of 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 layer hen gets older. Excess and deficiencies have a negative effect in egg shell quality.**
- **Feed structure should be attractive for the layer hens, so they eat a complete diet.**
- **Thorough information of nutrient and microbiological quality is key for a good performance.**

HOUSE ENVIRONMENT

- How to control the effect of temperature on the birds.
- How to provide good quality water to the birds.
- How to control the effect of the light on the birds.

HEN THERMO-REGULATION

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 fast air movement around the hen.

Conduction

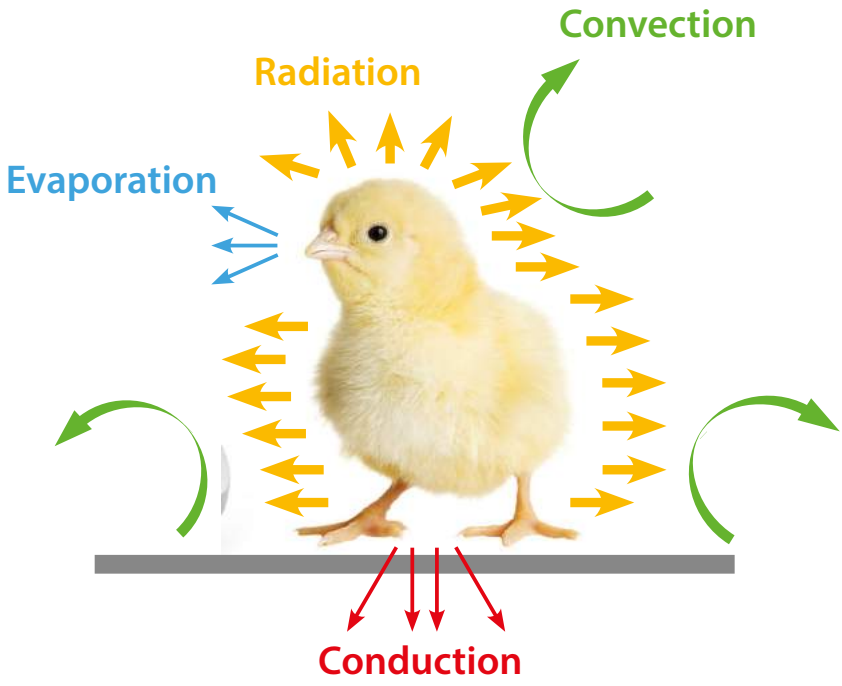
Heat transfer from surface to surface. Normally, it is relatively unimportant as the contact surface is small and the temperature of the litter or of the cage is not significantly different from the body temperature.

Radiation

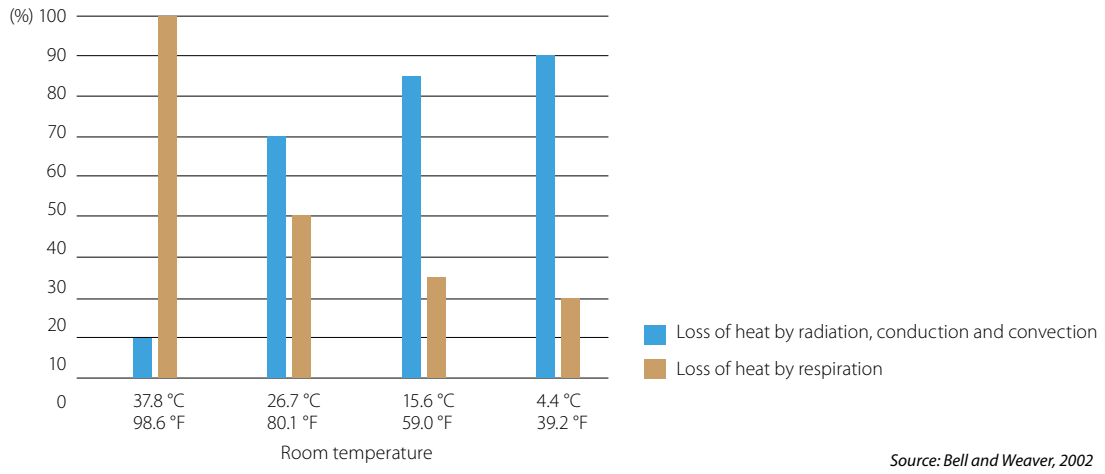
This is the transmission of heat from a warm object to a cold one. Heat loss is proportional to the temperature difference between the body surface and the surrounding air.

Evaporation

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



Effect of the room temperature on the different ways of losing heat



Source: Bell and Weaver, 2002

HOUSE ENVIRONMENT

TEMPERATURE

The ambient temperature has a great influence on egg production. Layers perform well over a wide range of temperatures. Temperature fluctuations between 21 °C and 27 °C (69.8 °F and 80.6 °F) 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 21–27 °C (69.8– 80.6 °F) range. As the temperature rises, however, the following parameters could be affected:

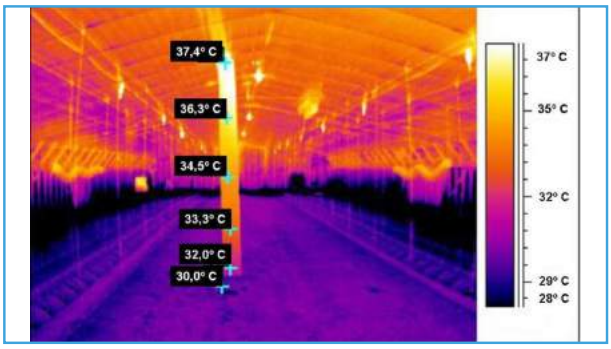
- Feed intake
- Egg weight
- Egg production
- Eggshell quality
- Mortality

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

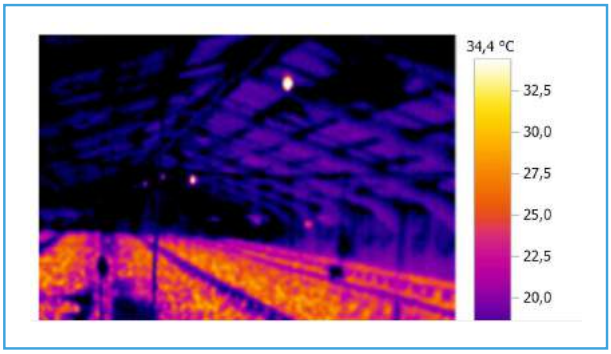
The temperature should not be seen as an isolated parameter but always considered in combination with humidity. In addition, air speed is also an important element of the perceived ambient temperature.

Tabel 27: Temperature and its effect on the birds

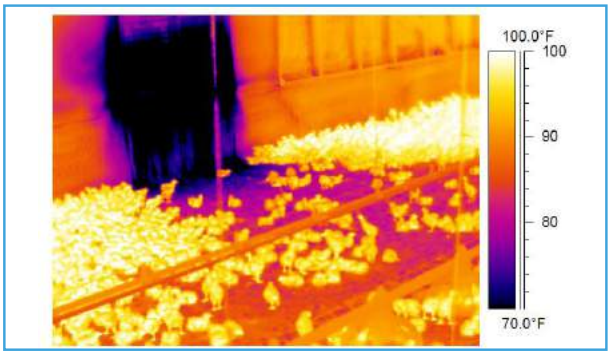
Temperature		Effects
°C	°F	
< 20 °C	< 51.8 °F	Increased feed conversion
20–27 °C	51.8–77 °F	Ideal temperature for good performance and feed conversion.
27–31 °C	77–87.8 °F	Slightly reduced feed intake.
32–36 °C	89.6–96.8 °F	Further reduction of feed intake. Reduced activity and drop in egg production, 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 prostration.
> 42 °C	> 107.6 °F	Emergency measures are needed to cool down hens for survival.



Temperature always has a height gradient. Careful consideration should be taken in cage systems. *Courtesy of M. Czarick – UGA*



Roof insulation is the corner stone for a correct house temperature and ventilation in hot or cold weather. *Courtesy of M. Czarick – UGA*



Fans or windows don't have the same insulation capacity as the walls. They can create uncomfortable areas for the birds. *Courtesy of M. Czarick – UGA*

HOUSE ENVIRONMENT

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 that is within the bird's comfort zone. If this is not possible, corrective measure should be taken:

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.
It is advised to check and update climat computer, fans, inlets, sensors every year.

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 be prevented from circulating around the birds properly. There should be enough space for the birds to separate in order to pant and droop and slightly lift their wings away from the body to maximize responsible heat loss.

Quality water

When birds are heat stressed, they increase their 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. Cool water of good quality should be supplied so that birds can find relief from the heat. To ensure that all the birds have access to water, provide a minimum of one cup or nipple drinker at the cage partition or 2.5 cm (1 in) of water trough per bird.

Feeding times

Do not feed at the hottest time of the day. A good strategy is to withhold feed five to eight hours prior to the anticipated time of peak temperature. Feeder chains should be run frequently to stimulate feed intake. The feeder should remain at a low feed level for about one hour per day in the afternoon, to promote a better appetite and ensure that the fine particles are consumed, which usually consist of minerals, vitamins and amino acids. To increase feed consumption, a midnight snack can be implemented.

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 level necessary for optimum performance under these conditions. See chapter on nutrition for more information.

Shades in open houses

Fans

Inlets

Water reservoir

Tabel 28: Stocking density in hot climate

Temperature	Floor Space				Feeder Space		Water Space	
	Litter		Cages		Trough			
	birds/m²	birds/ft²	cm²/birds	in²/bird	cm/bird	in/bird	Birds/Nipple	Birds/Round drinkers
25 °C / 77 °F	5.5	5.1	450	69.8	10	4	20	75
30 °C / 86 °F	4.5	4.2	550	85.3	15	6	10	60
35 °C / 95 °F	3.5	3.3	650	100.8	20	8	5	50

Always adhere to your own legislative requirements.

HOUSE ENVIRONMENT

WATER QUALITY

Water is the most important and critical nutrient for hens. Any water deprivation will directly impact feed consumption and production. If deprivation exceed 24 hours, egg production will be severely affected. If privation 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. Better still, ensure there are two water sources.

Microbiological quality

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

The microbiological quality at the water source should be monitored and samples should be taken at least once per year. This is even more important if water comes from surface sources.

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

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

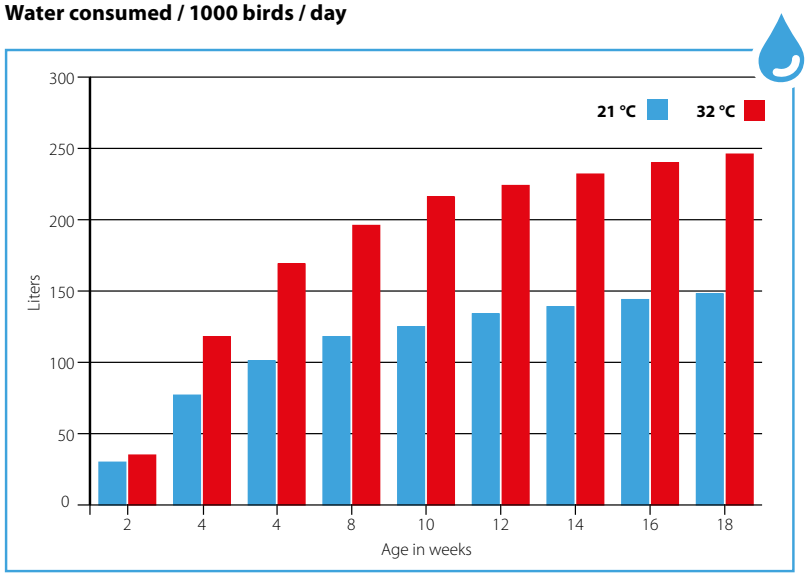
In some cases, hens can refuse water. This situation is the same as water deprivation:

- **Temperature:** hens will decrease their water consumption when water is above 24 °C (75 °F), but will refuse it above 32 °C (90 °F).
- **Taste:** hens do not have a very developed sense of taste but will refuse to drink water with a unpleasant taste. Some water additives or antibiotics can produce this effect.

Tabel 29: Drinking water parameters

Particulars	Maximum Light
No. of Bacteria per ml	10 – 15
No. of Coli forms per ml	0
Hydrometric Level	– 30°
Organic Substances	1 mg / l
Nitrates	0 – 15 mg / l
Ammonia	0 mg / l
Cloudiness / Turbidity	5 U
Iron	0.3 mg / l
Manganese	0.1 mg / l
Copper	1.0 mg / l
Zinc	5 mg / l
Calcium	75 mg / l
Magnesium	50 mg / l
Sulphates	200 mg / l
Chlorides	200 mg / l
PH value	6.8 – 7.5

Water consumed / 1000 birds / day



Water chlorination station

HOUSE ENVIRONMENT

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 – 20 °C (64 – 68 °F) with a relative humidity of 50 – 60 %.

The rate of ventilation is determined by the temperature, however when this parameter is reached a minimum ventilation level must be guaranteed. This minimum is normally calculated in m²/body weight/hour but the real aim is the correct management of these parameters:

- Relative humidity
- CO_2 less than 5000 ppm
- CO less than 50 ppm
- NH_3 less than 25 ppm

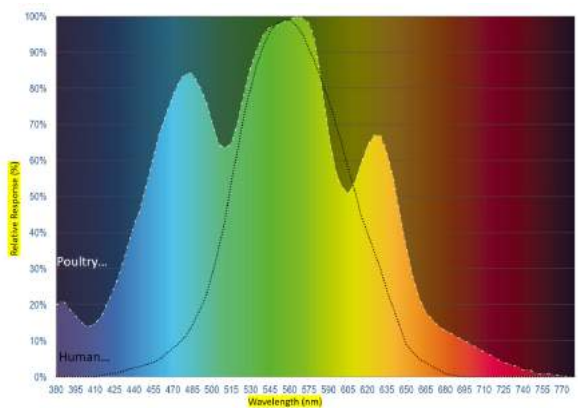
Table 30: Air Movement

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

m^3/hour/1000 birds

LIGHT

Birds vision differs from that of humans in vision spectra. Hens can see ultraviolet and infrared light. This fact should be considered when creating light 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 (> 2,000Hz) 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 environment. 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.

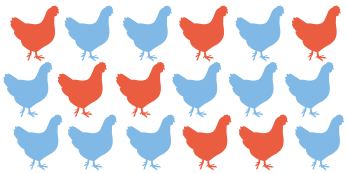
KEY POINTS

- **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 temperature.**
- **Water is a key nutrient. Ensure that a good quality water supply is accessible to the hens.**
- **Maintain good air quality and distribution through correct ventilation.**
- **Remember that light significantly impacts hen behavior.**

BIRD ASSESSMENT

▶ How to get reliable information to make good decisions

PULLET PHASE



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.

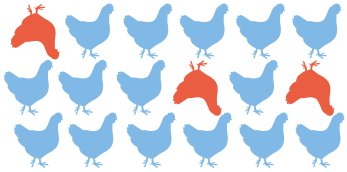
Weigh weekly

Formula

UNIFORMITY
=
(all weighed birds – A1 – B2) / all weighed birds

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

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



MORTALITY

Daily Mortality (%)

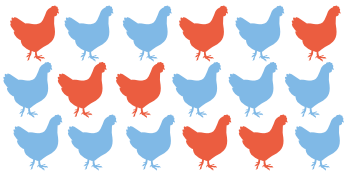
=
(No. of dead birds today x 100) / No. of live birds yesterday

Weekly Mortality (%)

=
(No. of dead birds in last 7 days x 100) / No. of live birds on day before the week starts

Accumulated Mortality (%)

=
(No. of dead birds so far x 100) / 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.

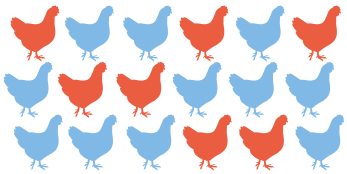
Measure 5th week before transfer

How to do shank measurements

How to do keel measurements

BIRD ASSESSMENT

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

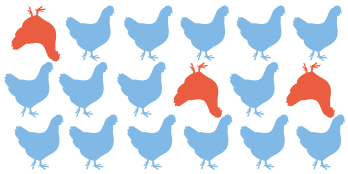
Formula

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 (%)

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

Weekly Mortality (%)

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

Accumulated Mortality (%)

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

EFFICIENCY PARAMETERS

FCR lb/lb

$$= \frac{\text{lb of feed consumed}}{\text{lb of eggs produced (No. of eggs x average egg weight)}}$$

FCR lb/egg

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

Egg per Hen Housed

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

FCR lb/12 eggs

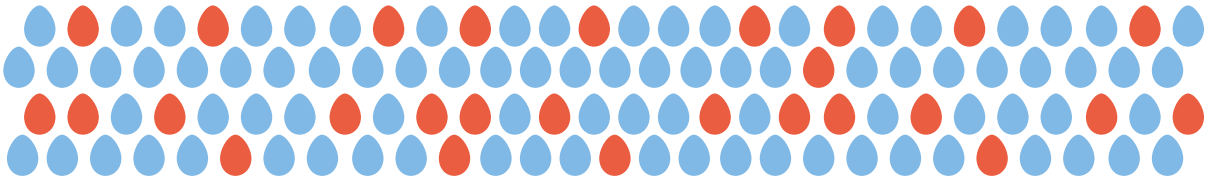
$$= \frac{\text{lb of feed consumed x 12}}{\text{No. of total eggs produced}}$$

IOFC

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

BIRD ASSESSMENT

LAYING HENS



EGG PRODUCTION

Daily Laying Rate (%)

=

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

Weekly Lay (%)

=

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

Accumulated Lay (%)

=

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

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

=

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

Weekly egg mass

=

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

Accumulated egg mass

=

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

Under grade

1. No. of broken eggs (BE)
2. No. of cracked eggs (FE)
3. No. of dirty eggs (DE)

Daily Under grade (%)

=

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

Accumulated Under grade

=

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

HEALTH AND BIOSECURITY

- **Understanding the importance of health programs in modern egg production.**
- **How to implement a biosecurity program.**
- **How to implement 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, at least, reducing 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 inmuno-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 the health program.

HEALTHY HENS

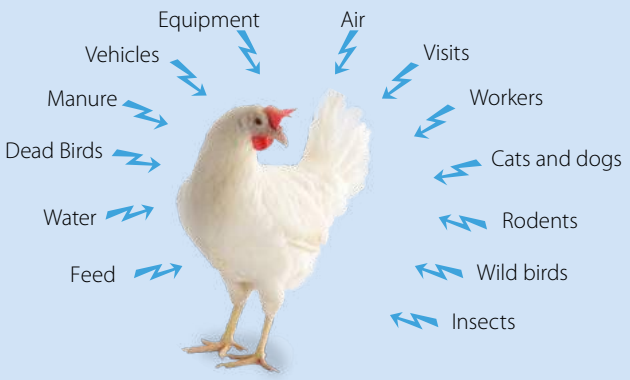
- No respiratory signs
- No nervous signs
- No fever

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

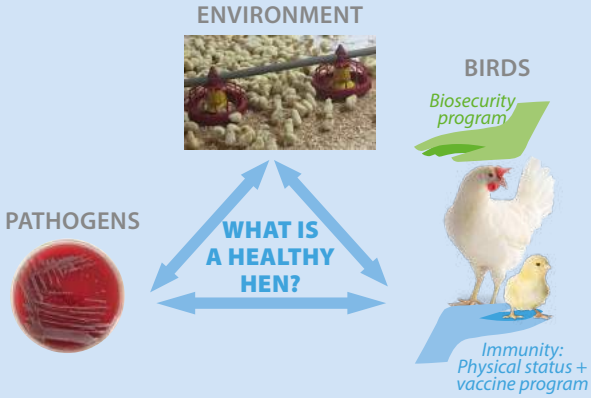
- Alert and active birds
- No abnormal behavior

- Good production
- No abnormal eggs

POSSIBLE INFECTION ROUTES



HEALTH BALANCE



HEALTH AND BIOSECURITY

BIOSECURITY PROGRAM

A biosecurity program plays a key role in maintaining hens in good health and, therefore, profitable production. Biosecurity can be defined as all the procedures put in place to prevent pathogens 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 actors (staff, production managers, external suppliers, veterinarians, general manager etc.) at the farm. If certain actors 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 kind of facilities are near to 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 or black/white room
- Booth baths
- Work clothing and footwear
- Feed storehouse or silos
- Dead bird disposal

Sink

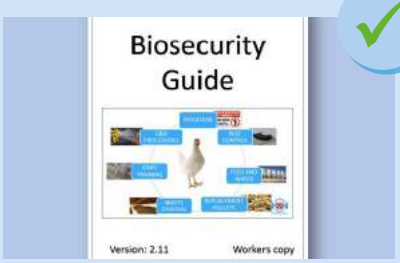
Surrounding concrete zone

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.

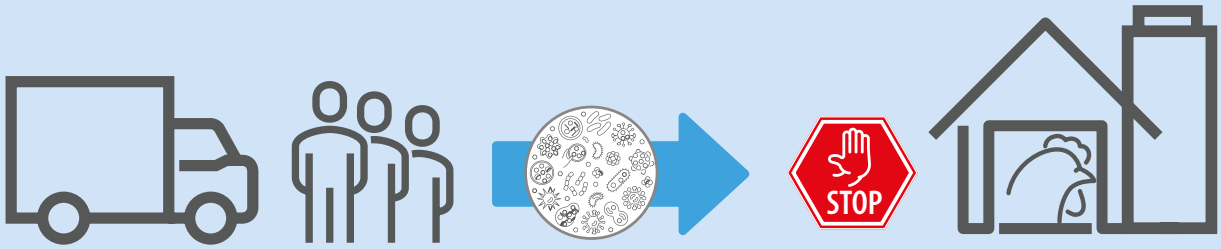
Clear and written biosecurity protocol should be available for all the staff having contact with the farms. Normally the simplest rules work better than the complicated.



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:

Visit restriction
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 comes from another farm.

Closed gate with biosecurity signs

Visitor register

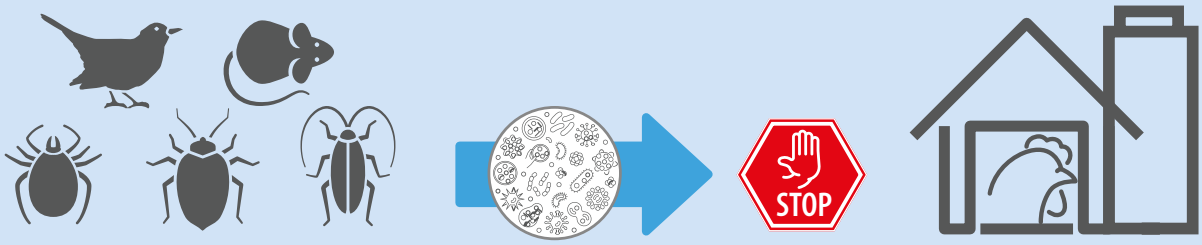
Farm clothes and shoes

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.

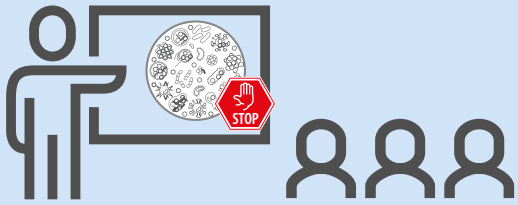
Birds

It is very important to exclude other birds from entering hen houses. Bird-proof houses can be constructed using special netting. Bird's faeces 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 hens overall health status. This is particularly the case with Red Mite and Northern Fowl Mite. See its control in the Technical Tips.

BIOSECURITY PROGRAM – STEP 3

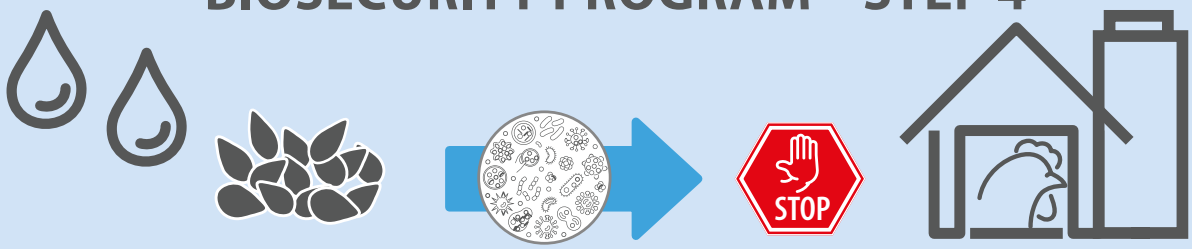


STAFF TRAINING

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

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, …).

BIOSECURITY PROGRAM – STEP 4



FEED AND WATER

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

Feed

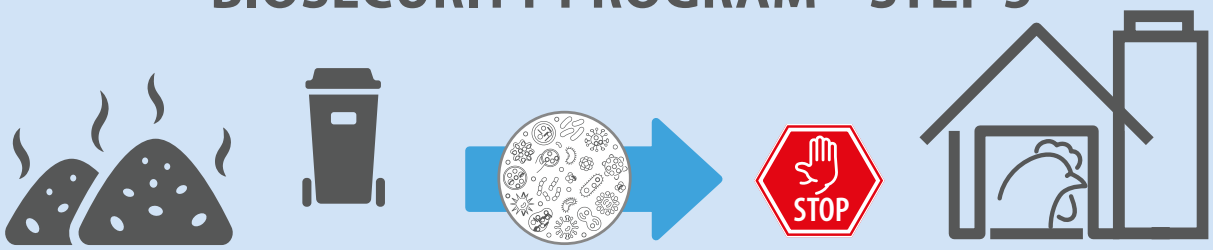
The quality of raw materials and hygiene measures at the feed mill are vital to produce pathogen-free feed.
Adding disinfectants is also recommended. Feed transport and feed storage should be controlled to avoid contamination after feed mill delivery.

Water

Chlorine or an alternative disinfectant should be added to drinking water. It has a dual purpose: firstly preventing the introduction of pathogens by water and secondly reducing water recontamination while it is in the house pipeline.
See page 54 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 of at least 3 km (~ 2 miles) away from the site. Make sure that no other farms dispose of their manure within a 3 km (~ 2 miles) radius of your farm.

Dead birds

Dead birds should be removed from houses on a daily basis and stored away from the poutry houses.
Different methods are available to destroy the dead birds hygienically. If dead birds are moved from the farm, take extreme care during transport:

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

Dead birds container

BIOSECURITY PROGRAM – STEP 6

CLEANING & DISINFECTION PROTOCOL

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

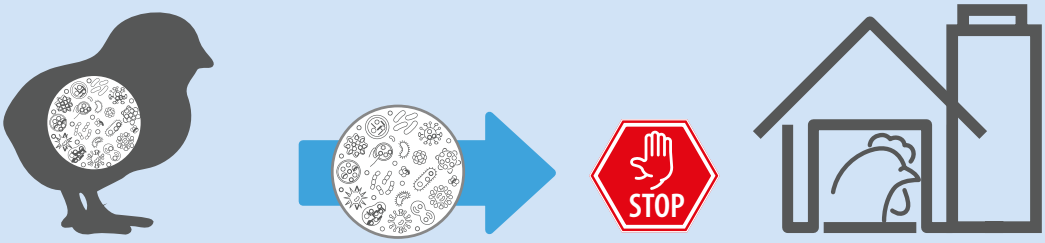
If a severe infestation of mites or other parasites has occurred, take extra precautionary measures to eliminate or exclude the presence of pests.

See more details about the procedure in page 6 and 7.

Table 31: 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



PULLET REPLACEMENT

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

In order to achieve this, the breeder flock should remain disease-free. Sampling and analysis should be encouraged to check that one-day old chicks are not contaminated.

H&N grandparent stock are free of lymphoid leukosis, Mycoplasma gallisepticum, Mycoplasma synoviae, Salmonella pullorum, Salmonella gallinarum, Sallmonella enteritidis, Salmonella thyphimurium and other Salmonella species.

Take into account that transport crates, trucks and other equipment can be infected with pathogens or infested with parasites. Previous cleaning and disinfection of all of them is strongly recommended.

VACCINATION PROGRAMS

Specific recommendations for individual farms are not possible, but the sample vaccination program (table 32) 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 local veterinarian

Table 32: Vaccination program

Weeks	Marek's disease	Infectious Bronchitis	Gumboro disease	Gumboro disease (vectored vaccine)	Avian Encephalomielitis	Newcastle disease	Newcastle disease (high challenge)	Newcastle disease (high challenge, vectored vaccine)	EDS 76	Metapneumovirus	Laringoracheitis	Laringoracheitis (vectored vaccine)	Fowl Pox	Coryza	Fowl Cholera	Escherichia Coli	Mycoplasma Gallisepticum	Mycoplasma Sinoviae	Salmonella gallinarum	Salmonella enteritidis
0	1 SC	1 SP		1 SC		1 SP	1 SP 2 SC	1 SP 2 SC				1SC								1DW
1																				
2			1DW			2SP/ DW	2SP/ DW	2SP/ DW												
3		2SP	2DW																	
4			3DW								1ED		1WI							
5										1SP/ DW							1SP			
6					1DW/ WI		3SP/ DW	3SP/ DW						1IM	1IM	1IM		1ED	1SC	2DW
7						3SP/ DW														
8		3SP																		
9																				
10							4SP/ DW	4SP/ DW												
11																				
12																	1SP			3DW
13														2IM	2IM	2IM				
14																				
15		4IM				6IM	5IM	5IM	1IM	2IM									2SC	
16																				

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

Inactivated vaccines *Live vaccines* *Recombinant vaccines*

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 audit these procedures regularly. Proper vaccination is essential for a good health status.

Transport and storage

- Only accept vaccine in good condition.
- Preserve the cold chain at all times.
- 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 previous water privation 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 homogeneously 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 instillation.
- Trained and committed crew and a well organized program of work is essential.
- Ensure all chick's 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 vaccine. More than 90 % of chicks should be positive.

HEALTH AND BIOSECURITY

VACCINE MONITORING

Serological data obtained after the bulk of the vaccination program is completed, normally by 15 or 16 weeks of age is a good method 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 submits 25 good serum samples to a laboratory one or two weeks prior to the pullets being placed in the laying house to establish freedom from certain diseases such as Mycoplasma gallisepticum (Mg) and Mycoplasma synoviae (Ms) prior to onset of production.

Serological data can give valuable information on the immune titer levels for a number of disease-causing agents. Working with a poultry laboratory to set up a profiling system will make better evaluations of vaccination programs and flock conditions possible.

Table 33: Serological monitoring

Disease	Technique	1	15	25	45	65	85
Infectious Bronchitis	ELISA, HAI		X	X	X	X	X
Gumboro disease	ELISA	X		X			
Avian Encephalomielitis	ELISA		X	X			
Newcastle disease	ELISA, HAI		X	X	X	X	X
EDS 76	ELISA		X	X	X	X	X
Metapneumovirus	ELISA		X	X			
Laringo tracheitis	ELISA						
Mycoplasma Gallisepticum	ELISA, PRA	X	X	X	X	X	X
Mycoplasma Sinoviae	ELISA, PRA	X	X	X	X	X	X

KEY POINTS

- **Health is vital to achieve the bird's full genetic potential. Act before diseases become a limiting factor for your birds 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.**

EGG QUALITY

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

EGG QUALITY

EGGSHELL QUALITY

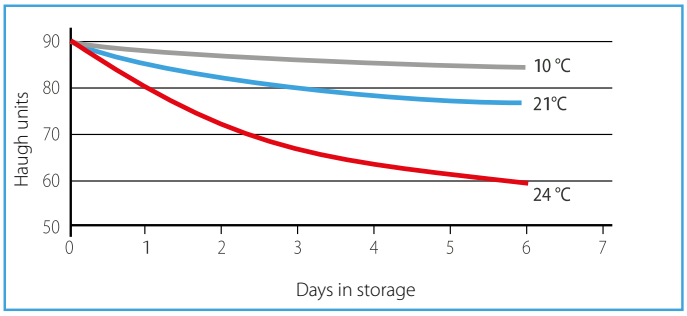
Problem	Causes	
Misshapen eggs: shell marred by flat sides or body checks (ribs or grooves) ▪ % in production: can rise to 2 % at start of lay and later almost disappear unless there is an issue	▪ Immature shell gland ▪ Diseases with ovary tropism ▪ Stress caused by hysteria and disruption ▪ Crowding	
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

Temperature



YOLK QUALITY

Problem	Causes	
Blood spots: blood spots on the surface of the yolk ▪ % in production: incidence varies, 1–2 %	▪ Deficiencies in vitamin A and K ▪ Fungal toxins ▪ Continuous light programs or intermittent light periods ▪ Hysteria and disruption ▪ Avian encephalomyelitis	
Meat spots: brown colored, pieces of tissue of the ovary or partially broken-down blood spots ▪ % in production: 1–3 %	▪ Deficiencies in vitamin A and K ▪ Fungal toxins ▪ Continuous light programs or intermittent light period ▪ Hysteria 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 tool 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.**

PERFORMANCE GOALS

Table 34: Performance of the H&N "Nick Chick" layer to 100 weeks of age under good management and moderate environment

Age	Liveability	Prod. HD	Eggs/HH	Egg Weight		Cum. Egg Weight		Egg Mass		Body Weight	
week	%	%	eggs	g/egg	lb/case	g/egg	lb/case	kg	lb	g	lb
19	100	8.0	0.6	40.8	32.4	40.8	32.4	0.02	0.05	1358	2.99
20	99.9	34.0	2.9	43.7	34.7	43.1	34.2	0.13	0.28	1408	3.10
21	99.8	55.0	6.8	46.3	36.7	45.0	35.7	0.30	0.67	1450	3.20
22	99.7	71.2	11.7	48.7	38.7	46.5	36.9	0.55	1.21	1486	3.28
23	99.6	82.4	17.5	50.8	40.3	47.9	38.1	0.84	1.85	1516	3.34
24	99.5	88.8	23.7	52.6	41.7	49.2	39.0	1.16	2.57	1540	3.40
25	99.4	91.6	30.1	54.2	43.0	50.2	39.9	1.51	3.33	1559	3.44
26	99.3	92.9	36.5	55.4	44.0	51.2	40.6	1.87	4.12	1574	3.47
27	99.2	93.6	43.0	56.4	44.8	52.0	41.2	2.23	4.93	1584	3.49
28	99.1	94.3	49.6	57.1	45.3	52.6	41.8	2.61	5.75	1590	3.51
29	99.0	94.9	56.1	57.7	45.8	53.2	42.2	2.99	6.59	1594	3.51
30	98.9	95.3	62.7	58.2	46.2	53.8	42.7	3.37	7.43	1597	3.52
31	98.8	95.7	69.3	58.7	46.6	54.2	43.0	3.76	8.29	1600	3.53
32	98.7	96.0	76.0	59.1	46.9	54.6	43.4	4.15	9.15	1603	3.53
33	98.6	96.1	82.6	59.5	47.2	55.0	43.7	4.55	10.02	1606	3.54
34	98.5	96.2	89.2	59.8	47.5	55.4	44.0	4.94	10.90	1609	3.55
35	98.4	96.2	95.9	60.0	47.6	55.7	44.2	5.34	11.77	1612	3.55
36	98.3	96.2	102.5	60.3	47.9	56.0	44.4	5.74	12.65	1615	3.56
37	98.2	96.2	109.1	60.4	47.9	56.3	44.7	6.14	13.53	1618	3.57
38	98.1	96.2	115.7	60.6	48.1	56.5	44.9	6.54	14.42	1621	3.57
39	98.0	96.1	122.3	60.8	48.3	56.7	45.0	6.94	15.30	1624	3.58
40	97.9	96.1	128.9	60.9	48.3	57.0	45.2	7.34	16.19	1626	3.58
41	97.8	96.0	135.5	61.1	48.5	57.2	45.4	7.74	17.07	1628	3.59
42	97.7	96.0	142.0	61.2	48.6	57.4	45.5	8.14	17.96	1630	3.59
43	97.6	95.9	148.6	61.4	48.7	57.5	45.7	8.55	18.84	1632	3.60
44	97.5	95.8	155.1	61.5	48.8	57.7	45.8	8.95	19.73	1634	3.60
45	97.4	95.8	161.6	61.6	48.9	57.9	45.9	9.35	20.62	1636	3.61
46	97.3	95.7	168.2	61.8	49.0	58.0	46.0	9.75	21.51	1638	3.61
47	97.2	95.6	174.7	61.9	49.1	58.2	46.2	10.16	22.39	1640	3.62
48	97.1	95.5	181.2	62.0	49.2	58.3	46.3	10.56	23.28	1642	3.62
49	97.0	95.4	187.6	62.1	49.3	58.4	46.4	10.96	24.17	1644	3.62
50	96.9	95.3	194.1	62.3	49.4	58.6	46.5	11.36	25.06	1646	3.63
51	96.8	95.1	200.5	62.4	49.5	58.7	46.6	11.77	25.94	1648	3.63
52	96.7	95.0	207.0	62.5	49.6	58.8	46.7	12.17	26.83	1650	3.64
53	96.6	94.8	213.4	62.6	49.7	58.9	46.8	12.57	27.71	1652	3.64
54	96.5	94.6	219.8	62.7	49.8	59.0	46.8	12.97	28.60	1654	3.65
55	96.4	94.5	226.2	62.8	49.8	59.1	46.9	13.37	29.48	1656	3.65
56	96.3	94.3	232.5	62.9	49.9	59.2	47.0	13.77	30.36	1658	3.66
57	96.2	94.0	238.8	63.0	50.0	59.3	47.1	14.17	31.24	1660	3.66
58	96.1	93.8	245.1	63.1	50.1	59.4	47.2	14.57	32.11	1662	3.66
59	96.0	93.6	251.4	63.1	50.1	59.5	47.2	14.96	32.99	1664	3.67
60	95.9	93.3	257.7	63.2	50.2	59.6	47.3	15.36	33.86	1666	3.67

PERFORMANCE GOALS

Table 34: Performance of the H&N "Nick Chick" layer to 100 weeks of age under good management and moderate environment

Age	Liveability	Prod. HD	Eggs/HH	Egg Weight		Cum. Egg Weight		Egg Mass		Body Weight	
week	%	%	eggs	g/egg	lb/case	g/egg	lb/case	kg	lb	g	lb
61	95.8	93.0	263.9	63.3	50.2	59.7	47.4	15.75	34.73	1668	3.68
62	95.7	92.8	270.2	63.4	50.3	59.8	47.4	16.15	35.60	1670	3.68
63	95.6	92.4	276.3	63.4	50.3	59.9	47.5	16.54	36.47	1672	3.69
64	95.5	92.1	282.5	63.5	50.4	59.9	47.6	16.93	37.33	1674	3.69
65	95.4	91.8	288.6	63.6	50.5	60.0	47.6	17.32	38.19	1676	3.69
66	95.3	91.4	294.7	63.6	50.5	60.1	47.7	17.71	39.04	1678	3.70
67	95.2	91.0	300.8	63.7	50.6	60.2	47.7	18.10	39.89	1680	3.70
68	95.1	90.6	306.8	63.7	50.6	60.2	47.8	18.48	40.74	1682	3.71
69	95.0	90.2	312.8	63.8	50.6	60.3	47.9	18.86	41.59	1684	3.71
70	94.9	89.7	318.8	63.8	50.6	60.4	47.9	19.24	42.42	1686	3.72
71	94.8	89.3	324.7	63.9	50.7	60.4	48.0	19.62	43.26	1688	3.72
72	94.7	88.8	330.6	63.9	50.7	60.5	48.0	20.00	44.09	1690	3.73
73	94.6	88.3	336.4	63.9	50.7	60.6	48.1	20.37	44.91	1692	3.73
74	94.5	87.7	342.2	64.0	50.8	60.6	48.1	20.74	45.73	1694	3.73
75	94.4	87.2	348.0	64.0	50.8	60.7	48.1	21.11	46.54	1696	3.74
76	94.3	86.6	353.7	64.0	50.8	60.7	48.2	21.48	47.35	1698	3.74
77	94.2	86.0	359.4	64.1	50.9	60.8	48.2	21.84	48.15	1700	3.75
78	94.1	85.3	365.0	64.1	50.9	60.8	48.3	22.20	48.95	1702	3.75
79	94.0	84.7	370.6	64.1	50.9	60.9	48.3	22.56	49.73	1704	3.76
80	93.9	84.0	376.1	64.1	50.9	60.9	48.4	22.91	50.51	1705	3.76
81	93.8	83.3	381.6	64.1	50.9	61.0	48.4	23.26	51.29	1706	3.76
82	93.7	82.5	387.0	64.2	51.0	61.0	48.4	23.61	52.05	1707	3.76
83	93.6	81.8	392.3	64.2	51.0	61.1	48.5	23.95	52.81	1708	3.77
84	93.5	81.0	397.6	64.2	51.0	61.1	48.5	24.29	53.56	1709	3.77
85	93.4	80.1	402.9	64.2	51.0	61.1	48.5	24.63	54.30	1710	3.77
86	93.3	79.3	408.1	64.2	51.0	61.2	48.6	24.96	55.03	1711	3.77
87	93.2	78.4	413.2	64.2	51.0	61.2	48.6	25.29	55.76	1712	3.77
88	93.1	77.5	418.2	64.2	51.0	61.2	48.6	25.62	56.47	1713	3.78
89	93.0	76.5	423.2	64.2	51.0	61.3	48.6	25.94	57.18	1714	3.78
90	92.9	75.5	428.1	64.2	51.0	61.3	48.7	26.25	57.87	1715	3.78
91	92.8	74.5	433.0	64.2	51.0	61.3	48.7	26.56	58.56	1716	3.78
92	92.7	73.5	437.7	64.2	51.0	61.4	48.7	26.87	59.23	1717	3.79
93	92.6	72.4	442.4	64.2	51.0	61.4	48.7	27.17	59.89	1718	3.79
94	92.5	71.3	447.0	64.2	51.0	61.4	48.8	27.47	60.55	1719	3.79
95	92.4	70.1	451.6	64.2	51.0	61.5	48.8	27.76	61.19	1720	3.79
96	92.3	68.9	456.0	64.2	51.0	61.5	48.8	28.04	61.82	1721	3.79
97	92.2	67.7	460.4	64.2	51.0	61.5	48.8	28.32	62.44	1722	3.80
98	92.1	66.4	464.7	64.2	51.0	61.5	48.8	28.60	63.04	1723	3.80
99	92.0	65.1	468.9	64.2	51.0	61.6	48.9	28.87	63.64	1724	3.80
100	91.9	63.8	473.0	64.2	51.0	61.6	48.9	29.13	64.22	1725	3.80

NOTES

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