

# Management *Guide*

LOHMANN TIERZUCHT

## Hot Climate



Heat stress under control









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# Introduction



**Most of the world's egg production takes place in tropical and semi-tropical regions under hot weather conditions. Africa, Asia and South America have shown a magnificent increase in egg production (see table 1) and still have a great potential for further growth.**

It should be noted that not only very warm countries suffer the consequences of hot climate like heat stress, but also temperate countries, where high temperatures in summer occasionally occur. Heat stress is produced when birds experience difficulties in achieving a balance between body heat production and body heat loss. This means, birds are not capable of maintaining a constant body temperature without having to exercise additional efforts. Heat stress interferes with the birds comfort and suppresses production.

Under good conditions, modern commercial layers are able to produce more than 310 eggs per hen housed and year, simultaneously maintaining a feed conversion rate of around 2 kg feed for 1 kg of egg mass. However production systems and environmental conditions are variable all over the world. Taking this into account, it is not surprising that countries affected by hot climatic conditions which are, in addition, normally not equipped with the latest technologies, can not reach the standards stated by the breeding companies.

At high temperatures of above 32 °C, the decline in performance and the loss of comfort of the birds is obvious. These detrimental effects already start before, but are overlooked many times. Without proper hot weather management, the negative impact of high temperatures on performance can be of great economical importance as it shown in table 2. Laying

flocks first undergo a reduction in feed intake, followed by a reduction on egg weight with a posterior reduction of production and reduced eggshell quality.

These management recommendations for managing pullets and laying hens under hot climates are intended to provide basic information and to help poultry farmers to fully exploit the genetic performance potential of Lohmann breeding products in locations dealing with hot climates.

This management programme is intended as a guide for newcomers while at the same time, assist experienced poultry farmers with suggestions oriented to optimise their work with Lohmann breeding products in hot climates. Since it is a very extensive issue, it cannot be exhaustively tackled here and this work is not intended as a substitute for expert advice. ■

**Table 1:**  
World production of eggs (in 1000 t)

Continent	1990 Production	(%)	2000 Production	(%)	2008 Production	(%)
Africa	1.542	4.4	1.916	3.7	2.438	4.0
N. & C. America	5.766	16.4	7.583	14.8	8.598	14.2
S. America	2.227	6.3	2.826	5.5	3.721	6.1
Asia	13.803	39.2	29.190	57.0	35.680	58.8
Europe	11.663	33.1	9.480	18.5	9.995	16.5
Oceania	0.244	0.7	0.199	0.4	0.247	0.4
<b>World</b>	<b>35.246</b>		<b>51.194</b>		<b>60.678</b>	

**Table 2:**  
Effect of high temperatures on different productive traits

Productive Trait	Effect of high temperatures
Egg Production	Decreases when the temperature achieves 30 °C
Egg Weight	Decreases: 0.4 % per 1 °C between 23 – 27 °C 0.8 % per 1 °C above 27 °C
Feed Intake	Decreases: 1.4 % per 1 °C between 20 – 25 °C 1.6 % per 1 °C between 25 – 30 °C 2.3 % per 1 °C between 30 – 35 °C 4.8 % per 1 °C above 35 °C

Source: FAOSTAT 2010



# Physiology of the birds

**Birds are homoeothermic animals that means, they keep their body temperature at a roughly constant level, regardless of the surrounding temperature.**

The normal body temperature of a hen varies between 40 °C and 42 °C. The environment temperature in which the birds do not need to modify its metabolism to generate or to get rid of heat is the so-called zone of thermo neutrality, ranging from 13 °C to 24 °C. However, the optimal environment temperature for the layers is between 18 °C and 24 °C.

The hen physiologically has no sweat glands for transpiration and losing the physical heat. Therefore, the transfer of the heat between the bird and the environment is carried out through different ways:

- **Convection**

Heat loss occurs due to the movement of the air which permit 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 stabilise body temperature by increasing the respiration rate through panting, which is very effective if the humidity in the environment is not too high. The chicken loses 540 kcal by evaporating 1 ml of water.

Sensible loss of heat is the cumulative heat transfer from the bird by radiation, conduction and convection. It is only effective at lower temperatures less than 35 °C since it is based on temperature differences. For increasing the sensible heat loss, birds extend their wings and body feathers to let more air circulate near the skin and to increase the contact surface with the air. Additionally, blood circulation through skin, wattles and comb are increased.

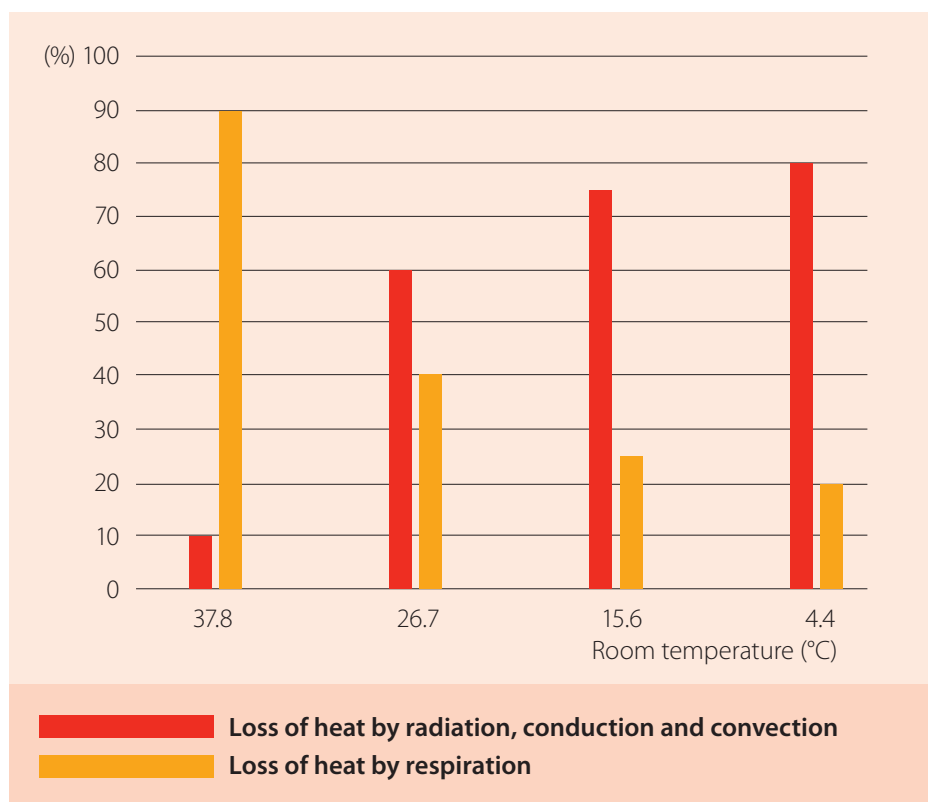
As it is shown in table 3, when the room temperature increases, the losses through respiration becomes more important since the percentage of heat which is lost by evaporation of water, increases. As long as air temperature is cooler than the birds' body temperature, heat might be dispersed to the air. As the temperature of air in the house increases, the amount of heat lost by convective heat loss decreases and the birds will start panting the-

reby increasing their respiratory rate (25 – 200 movements/min) and evaporative losses gain importance.

As relative humidity increases, the amount of moisture that can be evaporated, and consequently the amount of heat that can be removed through respiration decreases. Therefore, under high humidity conditions, reducing the temperature of the incoming air and moving it across the birds at high speed are the main actions to improve the loss of heat from the birds.

Poultry producers should continuously check the weather forecast to be informed of possible weather changes in advance in order to be able to take preventive actions before high temperatures appear. However, do bear in mind that the temperatures recorded for weather forecasts are taken in the shade. The farmer should therefore be prepared and not be taken by surprise with a heat wave.

**Table 3:**  
Effect of the room temperature on the different ways of losing heat



Source: Bell and Weaver, 2002



# Physiology of the birds



## Reaction of the birds to increasing temperatures

As the surrounding temperature increases above the comfort zone, chickens spend less time in walking and standing. During exposure to high temperatures, chickens consume less feed and more water in an effort to cool down.

The water to feed ratio at comfort temperature is around 2:1, but this ratio increases up to 5:1 at a temperature of 30 – 35 °C. Much of this water will be excreted in the faeces, resulting in wet and poorly formed faeces. If possible, the birds would splash water on their combs and wattles in order to improve evaporative cooling on these surfaces. They try to move away from other birds and tend to move to a cooler surface to alleviate from the heat.

The birds extend their wings away from their body and expose any areas of skin which have no feathers. The blood flow to the peripheral areas of the bird like wattles, comb, claws and wings increases. If these actions are not sufficient to keep the body temperature constant, the bird starts to pant. The additional respiration leads to an increased loss of CO<sub>2</sub>. This decreases the blood's concentration of bicarbonates, which negatively affects the eggshell formation. It also causes a rise of the blood's pH level, thus making the bird more vulnerable for respiratory alkalosis. If the body temperature reaches 46 °C, panting stops and death will occur when the body temperature exceeds 47 °C.

A summary of the negative effects of increasing house temperatures is given in table 4. ■

**Table 4:**  
*Negative effects of the increasing house temperature*

Temperature (°C)	Reaction
18 – 24	Ideal temperature for good performance and feed conversion.
25 – 31	Slightly reduced feed intake.
32 – 36	Further reduction of feed intake. Reduced activity and drop in egg production, egg weight and shell quality.
37 – 39	Severe reduction of feed intake. Increased of cracked eggs. Mortality of heavier hens or in full production.
40 – 42	Severe Panting and respiratory alkalosis. Increased mortality due to heat prostration.
> 42	Emergency measures are needed to cool down hens for survival.

## Summary and general remarks

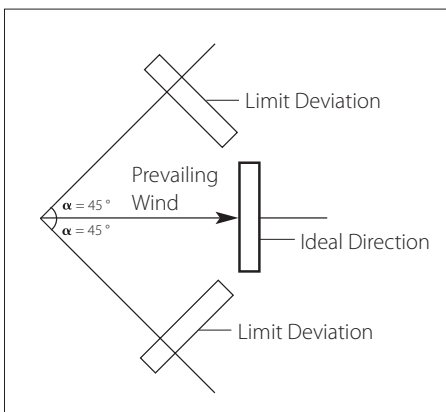
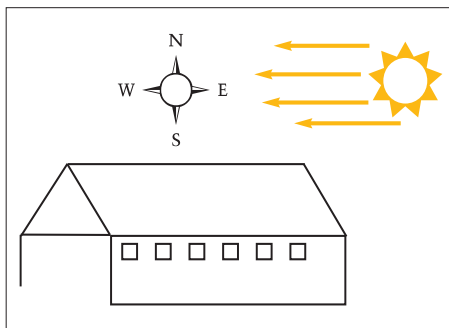
- Birds are homoeothermic animals; they keep their body temperatures at a constant 40 – 42 °C.
- The optimal environment temperature for layers is between 18 °C and 24 °C.
- High temperatures have negative effects on hens: reduced feed intake, decreased egg weight, drop in egg production, lower eggshell quality and increased mortality.
- The hen physiologically has no sweat glands for transpiration to lose the physical heat.
- Sensible loss of heat is the cumulative heat transfer from the bird by radiation, conduction and convection. It is more effective at lower temperatures and with higher air speed.
- When the room temperature increases, the heat loss by respiration becomes more important as long as the relative humidity does not exceed 70 %.
- With temperatures above 42 °C, emergency measures should be taken as the risk of death is high.
- Poultry producers should continuously check the weather forecast and not be taken by surprise with a heat wave.



# Practical recommendations for house construction

## General recommendations

The houses in hot climate areas should be located and constructed in such a way that heat is kept away from the birds. The buildings and/or the equipments support the release of body heat either by radiation, convection, conduction or evaporation. The construction of the building can differ as it is dependent on the weather conditions, i.e. hot and dry, or hot and humid, and of course, on the capital expenses available. One should keep in mind that any investments made to protect birds from heat stress will be later returned with better performance of the birds. Some main ideas on how to construct simple and more sophisticated houses in hot climate areas are provided below.



## Naturally Ventilated Houses

For naturally ventilated houses, make sure that they are built in an east-west direction to prevent the sun from shining directly into the building and that prevailing winds are advantageously used for ventilation.

Natural ventilation is most effective in houses of maximum 12 metres width. There should be a minimum of 10 metres space between houses and hindrances like bushes or small trees. They should not obstruct the airflow between the buildings as well.

Grass grown close to the house, when regularly and properly mown, will reduce the sun's reflection from the ground. When watered, this green lawn will have a cooling effect through evaporation. Tall trees, free from knots and leaves up to the height of the roof, can be beneficial in supplying shade to the house's roof. The faster the air flows between the houses, the better it can transport the heat out of this area.

When outside temperatures are beyond 40 °C, the effect of a good airflow turns into a negative effect. In such a situation, the hot air floating through the house is very dangerous for the birds and it should be kept outside.

Additional cooling by water evaporation (e.g. spraying or fogging, see next page) is then the only option to keep the birds alive.

The roof of a naturally ventilated house must have open ridges. They should be at least 1 metre wide. Through these openings, hot air can be released from the house and stale air will be substituted with fresh air from the outside.



*Roof with open Ridges*

A good and sometimes, very simple form of insulation are palm leaves, reeds or corn stalks as these help to reduce radiation. Instead of good insulation materials such as sprayed polyurethane or polystyrene board, which may be rather expensive or perhaps unavailable, one can also use simple solutions such as white wash to decrease the absorption of heat on the roof.



*Roof with Palm Leaves*



*Roof white washed*

Good mixtures are 10 kg of hydrated lime + 20 l of water, or 10 kg hydrated lime + 10 kg of white cement + 25 l of water.



# Practical recommendations for house construction



Water sprinklers on top of the roof can also help to reduce its temperature and the effects of radiation. This method is most effective in hot and dry climate situations. All the roofs should have an overhang. Depending of the height of a building and its location (latitude), this overhang must be designed in such a way that the sun cannot shine directly into the house. Tall houses and large side openings will benefit from roof overhangs which are larger than 1.25 metres. A steep-slope-roof is recommended since it receives less radiant heat as compared to a flat one. Additionally, heated air would be concentrated immediately under the ceiling, thus enabling it's rise away from the birds and exit through the ridge on the top.

Inside the house, everything possible should be done to have good ventilation. An unhampered flow of air assures good cooling. All obstructions which hinder air flow should be removed including cobwebs on the fences.

Additional equipment can be installed to control the house temperature. If natural airflow is not sufficient, fans should be installed. Slow speed, large industrial fans are recommended, installed 1 m above the ground to blow air horizontally over the birds. It is advantageous to operate the fans during the night as well to assist in the birds' recovery from heat stress during the day. The maximum ventilation rate recommended dictates the size and number of fans. As a simple rule of thumb, use 1 x 620 mm 900 rpm fan per 1.000 laying hens.

Foggers help to decrease house temperatures. The effect the foggers have depends on the number of nozzles installed. In open, naturally ventilated houses, the rule of thumb is to have a minimum of 0.35 l/h fogging nozzle capacity for every square metre of floor space. Fogging should not begin at below 28 °C and not

if the humidity exceeds 80 %. Small cycle fogging is better than long cycles (every 15 sec. for 8 sec. at 40 % RH) (every 22 sec for 8 sec. at 70 % RH).

The so-called Gunny is like a small sister of the cooling pad system. Simply, it is a cloth soaked in water (through a hose pipe) covering a part of the fence. This simple device can reduce the surrounding temperatures by up to 3 °C due to evaporation.

## Environmental Controlled Houses

An alternative to open, naturally ventilated, houses are closed, environmentally controlled houses. These are more expensive in terms of construction and maintenance, but are also more effective in controlling temperature. More predictable, consistently high production and reduced mortality should cover the added cost. Power ventilated houses can have positive or negative pressure systems. The type mostly used in hot climates is the negative pressure system where the air is extracted from the building with fans and enters through small inlets. Two different negative pressure systems can be used. The tunnel ventilation system in which the air enters the house at one end of the building and big exhaust fans are located at the other end, and the inlet ventilation system with which several air inlets and fans are distributed throughout the entire building. The tunnel ventilation system is considered more effective in heat management due to a higher rate of air exchange and faster air movement, which cools the birds more efficiently.

Open houses can be transformed into power ventilated houses by closing the side walls with curtains. This requires minimal investment. In case of power failures or technical problems, it must be possible to open the curtains to switch back to natural ventilation. It is important to note that cur-

tains do not insulate well and may sabotage the effects of the power ventilation. Roof and walls must be well insulated. Air-flow has to be sufficient to keep the birds cool. A critical figure is the temperature of the air leaving the house. Transporting the excess heat from the birds, the building and the motors, the outgoing air should not be more than 2.8 °C hotter than the temperature outside the house.

The following formula is used to calculate the required airflow in a power-ventilated house:

**Air flow rate = Cross-sectional area of the house x required speed desired.**

For the dimension of the air inlets, a minimum of 1 m<sup>2</sup> inlet area per 14.000 m<sup>3</sup> / h exhaust fan capacity is recommended. The inlet systems can be differentiated in 3 systems. There are the cross ventilation (fans on one side of the house and inlets on the other side – which works best in houses of less than 10 m wide), the side-wall ventilation (fans and inlets on side-walls) and the attic inlet ventilation (fans are distributed at the side-walls, inlets are in the roof).

**Table 5:**  
*Relation between air velocity and tunnel fan capacity*

Section (m <sup>2</sup> )	33 m <sup>2</sup>	50 m <sup>2</sup>	70 m <sup>2</sup>
Fan capacity (m <sup>3</sup> /h)			
40000	0.33	0.22	0.16
80000	0.66	0.44	0.32
120000	0.99	0.66	0.48
160000	1.32	0.88	0.64
200000	1.68	1.10	0.80
240000	1.98	1.33	0.96



# Practical recommendations for house construction



The tunnel ventilation does not only depend on the correct air exchange rate, but also on air speed. For layers, an air speed of 2.5 – 3 m/sec is recommended. The fans can be located either at the end of the building or on the side walls at the end. To be effective, a power-ventilated poultry house must be well insulated and tightly constructed.

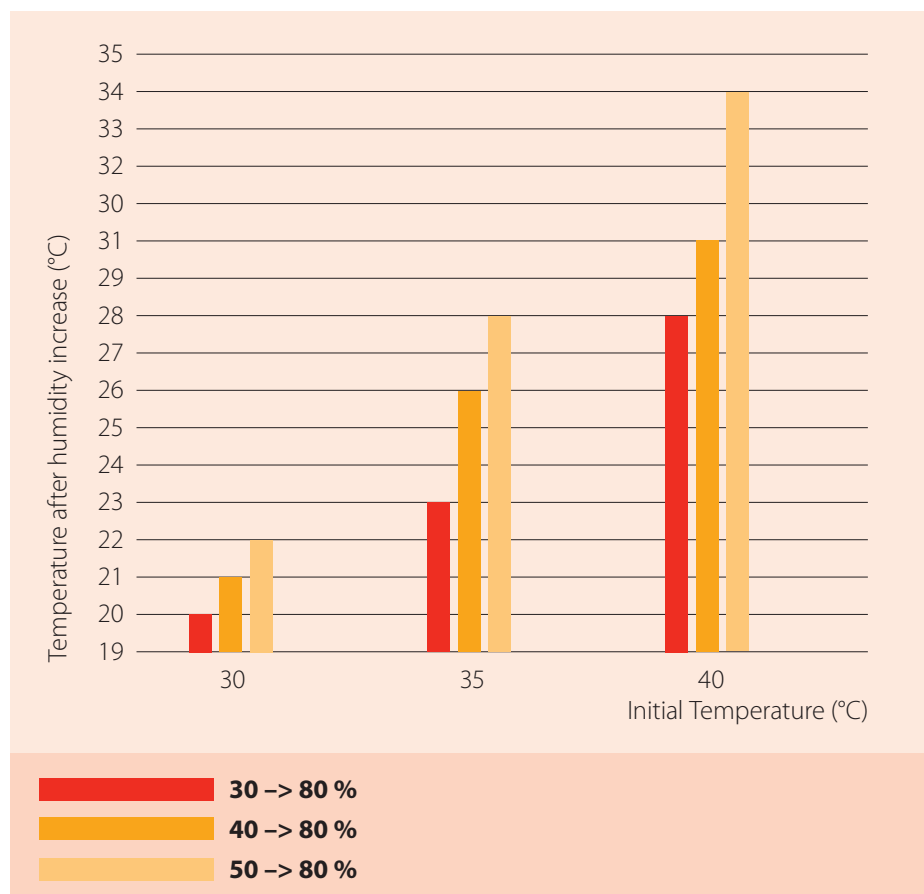
## Evaporative cooling

The principle of evaporative cooling is based on the fact that humid air contains more thermal energy than air of the same temperature, but with lower humidity. By spraying water or passing incoming air through cool cells (wet pad), humidity is increased and air temperature decreases. The cooling effect by evaporation would be best if the humidity of the initial air is low (Table 6). This system is widely used in desert areas. Normally, a house with tunnel ventilation is used and the walls opposite the fans are equipped with cooling pads. Cooling pads have to be in proportion to the fans installed. ■

## Summary

Thought should be given to climate control when constructing houses in hot climate areas. Simple measures can be taken to help the birds keep their bodies cool. If capital is available for investment in controlled housing, the expected return on investment should be calculated from the differences between the outside and inside temperature, humidity of air outside and the expected income from additional eggs produced. Birds placed in environment-controlled houses in hot climate areas can achieve outstanding results despite high temperatures.

**Table 6:**  
Effect of evaporative cooling depending on initial temperature and humidity







# Feed and Feed Formulation in Hot Climates

## General remarks

Most of the birds which produce eggs for human consumption, are living and producing in hot climate regions of the world.

A lot of layer farms all around the world have been designed as closed houses with a fully-controlled house climate. In these surroundings, everything should work as it does in all the other parts of the world with moderate climate. Feed formulation does not have to adhere to special requirements as these differ according to the availability of raw materials and the techniques used for feed production.

In hot climates, birds reduce their daily feed intake to help to reduce the production of metabolic heat.

The energy required for maintenance decreases to a certain temperature and will increase as the temperature increases as the birds start to pant severely. This will be combined with a generally lower feed intake as compared to the intake in temperatures within a comfort level.

It is common knowledge for every nutritionist that a certain feed formula has to be designed based on daily feed intake. This means that the nutrient content – the density of the feed – has to be increased when daily feed intake decreases so as to maintain the daily intake of nutrients. The information of daily feed intake is a mandatory prerequisite for the formulation of feed.

Without this, nutritionists will never be able to compose a recipe which will fulfil the nutritional needs of the bird. Recommendations for daily nutrient intake are provided by Lohmann and have to be the basis for the formulation of feed and recipe. In addition, special changes in the diet formulation should be enhanced to reduce the metabolic stress under hot temperatures in order to maintain production and egg quality.

## Raw material – availability and quality

The most common basic raw materials in hot climate areas of the world are corn and soya products as well as limestone, some supplements and premixes. In addition, there are some countries with a big variety of other cereals, by-products of cereals and different oil seeds. The most essential factor in terms of raw material quality, is an optimal harvest and adequate storage conditions to produce, maintain and safeguard the hygienic and microbial quality of the raw materials. This is a big challenge especially in conditions where high humidity prevails. Additionally, there should be absolutely no access for dogs, cats, mice, rats and all kinds of birds in the storage room of raw materials. The second mandatory factor is to safeguard the quality of raw materials with the target of having no – or as low as possible – mycotoxin contamination. This may not be possible in a lot of countries but it has to be set as a target which everybody has to strive for. Mycotoxins will harm all kinds of poultry in different ways, therefore, it has to be a challenge for everybody to work on this topic. If it's not possible to use raw materials which are free of, or with low mycotoxin contamination, raw materials should be sorted according to materials of lower and higher contamination, with the target of achieving lower contamination for higher susceptible birds and more valuable birds, in particular, breeders and chicks. There are testing sets available to check for mycotoxin contamination in raw materials. These are easy to use and thus, a well established laboratory will not be required to carry out testing. It's worthwhile to implement an easy to manage mechanical cleaning of all raw materials which will boost the overall quality of raw materials. This will protect the production facilities as well. The second topic in terms of raw material quality is to know the nutrient content, based on randomly conducted analysis. It's not

possible to google a raw material matrix. This will always fail even when only corn and soya products are used as the nutrient content may be highly variable. Especially when more, only regionally-available raw materials are used for poultry feed production, it's absolutely necessary to analyse these raw materials regularly for nutrient content. The analysis should be done not only for the major nutrients, fibre and amino acids, but also for the most important minerals (e.g. calcium, phosphorus, sodium, chloride and potassium).

A major raw material, especially for egg-producing birds, is the source of calcium, mostly from limestone. Limestone can vary highly in terms of solubility and contamination with other minerals. Running an analysis to find out is a worthwhile idea. Very often oyster shells are used as a coarse, slowly soluble source of calcium source. They should be of good hygienic quality and free of sand, which is quartz with no nutritional value. For layer birds to produce hatching and table eggs, a coarse and slowly soluble source of limestone should be used as this is the most important and cheapest tool for good egg shell quality.

If someone travels around the world and visits feed mills or feed production units paying special attention to what he sees, it'll be quite obvious that premixes are often not very well stored and handled according to their high value (costs) and significance for good feed quality. In general, everybody should understand, in terms of feed supplements, that the lower the inclusion into the recipe, the higher the importance (and price per kg) will be. Most of these supplements and premixes are delivered in paper bags which may be easily destroyed and/or absorb moisture from the surroundings. Under such conditions, a lot of supplements and premixes will be destroyed within a short period of time and can thus, not function successfully when used in the feed. As a result, the birds will, for example, consequently show symptoms of deficiency of vitamins.



# Feed and Feed Formulation in Hot Climates

Ingredient	Quality Feature	Notes
Cereals	Mycotoxins Contaminants, weed seeds	
Maize	Mycotoxins	
Wheat	Viscosity (soluble NSP*) Ergot contamination	Modified by enzymes
Barley	Beta glucans	Modified by enzymes
Sorghum	Tannins	
Rice	Trypsin inhibitor	Heating effective
Cereal byproducts	Freshness	
Root crops	Contamination	
Tapioca	Cyanide levels	
Legume seeds		
Peas	Tannins Protease inhibitors	Use white-flowered varieties De-hulling effective Select suitable varieties Heating effective
Beans, fava	Tannins	Use white-flowered varieties De-hulling effective
Lupin seed	Glycosides	Use sweet varieties only
Oil seeds	Stability of oil content	
Toasted soybeans	Urease levels Trypsin inhibitors Fat digestibility	Ensure proper processing
Repeaseed	Glucosinolates	Use low erucic acid, low glucosinolate varieties only
Soyabean meal	As for soybeans	Use high pro (49 %) if possible
Rapeseed meal	Glucosinolates	Double zero varieties only
Sunflower meal	Fiber' (hul removal)	Use decorticated meals
Cottonseed meal	Gossypol	Iron addition can be used
Animal Products	Microbial quality Amino acid availability	Proper processing is essential
Meat and bone meals	Calcium/ Phosphorus level Fat content	Saturated fatty acid levels
Poultry byproduct meals	Pathogen control Feather content	
Feather meals	Amino acid availability	
Fats and oils	Gizzerosine	
Fats and oils	Moisture, impurities and unsaponifiables Max. of 5 % Peroxides - Stabilized with antioxidant Free fatty acids - Max. of 50 %	

## Ideas for hot climate feed formulation

The most important aspects in feed formulation under hot climate conditions are:

- to support daily feed intake
- to limit the heat increment of feeding
- using fat and oil
- to use special supplements

The daily feed intake can be supported by the feeding management, optimal feed structure and palatability, especially if mash feed is used, which is common. Sufficient daily feed intake is a basic requirement to achieve the daily nutrient intake according to the demands in rearing and the production period. The lower the daily feed intake, the more difficult and more expensive it will be to reach sufficient nutrient intake for growth and the production of eggs.

An important aspect in the composition of feed for poultry in heat stress conditions is to limit the heat increment of feeding. This is the increased heat production following consumption and digestion of feed. The different major nutrients cause different quantities of metabolic heat production. The highest increment is caused by the digestion of crude protein, especially if it is used as a source of energy. Crude protein should be adjusted as low as possible, based on the usage of synthetic amino acids and a formulation procedure which is known as the generic term Ideal amino acid nutrition. This is currently being researched by Lohmann together with other research institutes and is being implemented in the nutritional recommendations for Lohmann varieties. This tool makes it possible to reduce crude protein in the diet without harming production and in addition, it helps to reduce feeding costs. The digestion of carbohydrates, which is mainly starch, causes a relatively high heat increment as well. It can be limited





# Feed and Feed Formulation in Hot Climates

to some extent by using fat and oil as a source of energy in poultry diets instead. On average, fat and oil have thrice as much energy content as cereals and cause much lesser metabolic heat increment.

Therefore, it is absolutely necessary to use fat and oil as raw materials for feed formulation in hot climate regions. The fat and oil have to be of certified and of well-known quality. The easiest way would be to use pure fat or oil, for instance, soybean oil or palm oil. Blended sources of fat/oil may be used as well, but only of proven quality. To safeguard the quality of fat and oil, antioxidants should be used as a standard supplement. The storage and dosage of fat and oil needs additional equipment as compared to that for dry, raw materials, but this investment will always be returned as it is the major tool/source to improve nutrition of poultry in hot climates.

In addition, the fat and oil added will increase the palatability of mash feed to a high extent. Fat and oil bind the fine particles in a mash structure – e.g. the premix – and safeguard a regular intake of the complete feed. This reduces selective feed intake which causes problems as well.

The use of diets with a higher content of crude fat/oil will support liver health and decrease the so-called fatty liver syndrome. As the liver is also needed for good egg shell quality, it serves as an additional tool to support egg shell quality for layers.

The benefits of adding extra fat and oil to the diet, can be summarized as follows:

- increased content of metabolizable energy
- due to the fatty acid profile (linoleic acid), adjustment of egg weight
- improved liver health
- improved palatability of (dusty) mash feed

Based on this, feed without any added fat and/or oil will be considered as a deficient diet – especially under heat stress conditions and with mash feed structure.

Vitamin C or ascorbic acid is considered as one of the most important supplements under heat stress conditions. Normally, birds synthesize sufficient vitamin C, but due to heat stress and severe panting, the balance of electrolytes is affected. Negative effects can be reduced with higher levels of vitamin C. In addition, it will support egg shell quality. The recommended dosage is 100 – 200 mg/kg. With the same target in mind, the use of sodium bicarbonates should be kept as a standard. Sodium bicarbonates or sodium carbonates, should be applied as a standard supplement to achieve a ration of sodium to chloride by 1:1. This is highly beneficial not only for a good egg shell, but also when a higher level of sodium has to be achieved as a result of low daily feed intake.

Vitamin E, which also serves as a natural antioxidant in addition to its nutritional value, should be increased to at least 50 mg/kg. For breeders, a level of 100 mg/kg has been proven to support hatchability and chick quality.

Supplements which will increase the nutritional value of all raw materials are the Non-Starch-Polysaccharid – Enzymes and Phytase. They increase the biological nutritional value of the raw materials which will support nutrient intake under heat stress and/or make it possible to decrease nutrient density of the diet without harming the production.

As birds under heat stress have a much higher water intake as compared to those in moderate climate situations, the fluid content of the faeces will sometimes increase, thus decreasing the quality of litter. All supplements which support gut health, are worth using under those conditions.

## Handling of premixes

Since many countries in hot regions import their vitamin and trace mineral – mixes, and since there are often delays in the transport of ingredients, the problem of vitamin stability is of primary concern. Temperature, moisture, and oxidation by polyunsaturated fatty acids, peroxides and trace minerals are the most critical factors affecting vitamin stability. Therefore, vitamin activity in feeds should be preserved with the incorporation of antioxidants, selecting gelatine encapsulated vitamins, having appropriate storage conditions, adding choline separately from the vitamin and trace mineral premix, delaying the addition of fats until just before the use of the feed and using feeds as soon as possible after mixing.

As feed intake always decreases under hot climate conditions, it is worth increasing the inclusion of the vitamin-trace-mineral premix by 10 %, compared to the normal recommended inclusion rate. The overall target should be to maintain the daily intake of vitamins and all the other micro-nutrients, even with lower daily feed intake.

## Feed structure

As already mentioned before, the overall target of feeding poultry under heat stress is to maintain and safeguard daily feed intake. As the feed intake of poultry is mainly influenced by the particle size, it should be obvious that feed structure is the basis for good and consistent daily feed intake. Layer birds all around the world are fed mainly with mash or meal feed structure as it's the cheapest and easiest structure to produce, not to mention, the optimal structure for layer birds. Sometimes pelleted or crumbled feed is used as well, but it is more costly and in many circumstances, the second best option. Pelleted or good





# Feed and Feed Formulation in Hot Climates

crumbled feed (without a part of fine and powdery texture) may be an option that is, if the raw materials are not suitable to produce a coarse mash structure. In this situation, it may be the only solution to safeguard sufficient daily feed intake.

Mash feed should have a homogenous coarse-grained structure. It may be a little more fine or a little more coarse – but it must be homogenous. The structure depends highly on the grinding equipment which is used. The standard equipment will be hammer mills. The biggest disadvantage of these mills is, that if they are not well adjusted, they will produce a very fine texture, sometimes even in the form of powder. No bird likes eating powder. They will try to avoid it and will wait until something more coarse or structured food comes along. Modern hammer mills are suitable to produce good coarse mash feed, but the optimal equipment to produce mash feed for layer birds are roller mills. The more coarse the basic structure of the mash, the more added fat and oil the feed can carry, without harming the technical quality or harming the flowability of the feed.

The importance of optimal feed structure is highly underestimated. It is, actually, the basic prerequisite to support and maintain daily feed intake of poultry under heat stress.

## Importance of feed intake capacity

Breeding companies offer information of the nutrient requirements based on the daily nutrient intake of their breeds. The nutrient density of the feed must increase if daily feed intake decreases and vice-versa. Modern feed formulation will be done by means of a low-cost optimisation programme worldwide. Anyone who has experiences with such programmes would

be familiar with the lack of space in the formulation of layer diets, mainly due to the high amount of limestone (7.5 – 9.5 %) as the major source of calcium. Limestone offers almost only calcium for the formulation. The rest of the space of up to 100 % should provide energy, protein, phosphorus, fat and oil as well as premix.

By increasing the restrictions of all nutrients for a feeding situation with low daily feed intake, the software will respond with not solvable. This means that a higher density of this formulation is not possible. The consequence for the birds is an undersupply of nutrients.

The only way to solve this dilemma would be to increase or maintain daily feed intake. As already mentioned above, a lot of factors support daily feed intake. In another chapter of this guide, it is mentioned that feed intake capacity can be trained during rearing in the developer phase. This can be done by feed formulation and/or by feeding management.

Special focus should be placed on a reduced dense diet with increased/enriched content of crude fibre in the feed formulation of a developer diet during this period. This makes it possible to create a more bulky feed, which will train the pullets for a good feed intake capacity based on a bigger crop accompanied by a good appetite. This can be supported by a meal feeding regime which forces the birds to temporarily empty the trough completely and stimulate more hunger when new feed is provided. Birds which are reared under these conditions will maintain a much better daily feed intake during and after transfer to the layer houses and when reaching the peak production. Especially before peak production, a lot of layer flocks suffer from very low feed and nutrient intake followed by decrease in performance, making them vulnerable to health problems too.

## Feeding management and feed handling

Feeding management can and should support the overall target of feeding poultry under heat stress and support daily feed intake as well. Mash feed of all kinds of quality will have more or less fine particles, which at least the premix will be.

As birds do not really like eating fine-textured or powdery feed, it has to be considered. Therefore the best mash feed will be one of a good structure with added fat and / or oil. Feeding once a day on an empty trough makes sure, that birds eat all, also the fine particles and can be seen as an additional tool to support an even nutrient intake. During noon time or during the period of highest temperature, birds are not really interested to eat. This is the best time to let them empty and clean up the trough. This feeding regime enables every bird to eat the important ingredients which are incorporated in the finer part of the feed. When new feed is later provided, the birds will be much more interested in having an immediate and good feed intake. Finally, this feeding system will result in a higher daily feed intake, better performance and even better egg shell quality. Feeding management involves the storage and handling of the feed. If feed is delivered in bags, a dry and cool storage facility is a must, with no access for dogs, cats, rats, mice and birds. The area or room should be kept closed and disinfected regularly. If feed is delivered as bulk into silos, they have to be checked on the inside regularly and cleaned as well. Especially under varying temperatures and humidity levels inside the upper, already empty part of the silo, mould will grow and destroy the hygienic quality of the feed. The optimal situation is to use two silos, with alternating filling from the delivery on to the next and conducting inspections and cleaning in between. ■



# Rearing of pullets



***A pullet of good quality is the predisposition for the utilisation of the modern layer hybrids genetic potential. This is the case for all environmental conditions and housing systems. The key to success is to optimise the rearing period.***

## Isolation and sanitation

Isolation and restricted access to the brooding area are of prime importance for the control and prevention of poultry disease. The *all-in all-out* rearing programme is recommended as it provides an excellent means for isolation and allows for proper clean-up in the event of a disease outbreak. Traffic between the rearing area and lay houses should be avoided.

An important part of isolation is keeping poultry houses free from outside birds, rodents and other wildlife as these can be a major source of disease-causing agents and parasites. Houses for adult and growing flocks should be separated by a minimum distance of 100 m. Caretakers should be assigned to one house and should not go back and forth between houses. Managers inspecting the flocks should visit the youngest flock first and the oldest last.

A foot bath containing fresh, clean disinfectants should be placed at the entrance to each house. The disinfectant solution needs to be checked at least once a day and changed frequently. Only authorised personnel should be allowed in and around the poultry houses. Do not allow drivers of off-farm vehicles to enter any of the poultry houses.

## Getting chicks off to a good start

### Before the chicks arrive

1. Make sure that the correct temperature is being maintained uniformly inside the building.

2. Check the settings of the time clocks and dimmers for the lights.
3. Have automatic feed and water systems checked for proper settings and uniform distribution of feed and water.
4. Trigger nipples and cups to ensure proper working conditions and to stimulate drinking by the chicks.
5. Co-ordinate the arrival time of the chicks with the hatchery and confirm the number and conditions of the chicks being delivered.

### Transportation of the chicks

Ensure that chicks are delivered in an environmentally controlled vehicle and if possible, either in the late afternoon or at night in order to avoid the higher temperatures of the day. Evaluate the possibility to add some feed with a high content of water and electrolytes.

### Electrolytes

Some producers have found that the addition of electrolytes to the drinking water improves the performance of the chicks. This step should be taken after consulting with a qualified veterinarian who is familiar with local conditions.

## Brooding

When chicks are hatched in nature, mother hen takes care of her chicks. In a poultry business, however, the farmer has to take over her responsibility.

Up until two weeks of age, chicks have difficulty controlling their body temperature and react similarly to a cold-blooded animal during the first few days. Since these young birds are not able to maintain the body temperature on their own, artificial heat has to be provided. Furthermore, they need good feed and water. As soon as the chicks start eating, drinking and digesting, the thyroid, intestinal tract, immune and other essential systems of the

body will start to develop. Good brooding conditions are a necessity for a successful start into the chick's / pullet's life.

### Body temperature of chicks

Scientific studies have shown that the optimal body temperature of chicks lies between 40 °C to 41 °C. If this is measured with suitable thermometers, house temperatures can be adjusted accordingly.



Chicks from young parent flocks require a 1 °C higher house temperature on arrival. The heating should be turned on as soon as the exterior temperature drops to ensure that the recommended temperatures are maintained at bird level. A uniform house climate can be maintained by proper regulation of the heating and ventilation facilities.

The chicks' behaviour gives clues to proper climate management:

The chicks are dispersed evenly and move around freely	→ Temperature and ventilation are just right
The chicks huddle together or avoid certain parts of the building	→ Temperature is too low or there are draughts
The chicks are prostrate with wings spread out and gasping for air	→ Temperature is too high



# Rearing of pullets



When controlling the temperature by ventilation, it is important to ensure that sufficient fresh air is provided. Supply sufficient volumes of fresh air to remove dust and undesirable gases. Provide movement of air even on cool days. Adequate ventilation is especially important in hot weather.

## Floor brooding and rearing

Floor rearing systems for chicks and pullets should consist of a well-littered, climate-controlled, illuminated shed which provides feeders and drinkers. Until chicks are fully homeothermic, brooding pens or compartments can be designed within these houses to keep the chicks around the heaters, feed and water. Additional heating systems in these brooding pens are a necessity, even in hot climate countries.

After chicks get access to the complete house, roosting places should be provided. Chicks learn and want to fly up to rails or perches at an early age. If perching or flying is learnt too late, this can result in reduced mobility of the individual hens in the future laying house. Rails or perches should therefore be made available to chicks before the age of 6 weeks.

## Litter

The type and quality of the litter are especially important for young chicks. Straw must be clean and free of mould. To reduce dust formation, the straw should not be chopped but should be put down as long straw. Wood shavings are good litter material provided that they are dust-free and come from softwood varieties that have not been chemically treated. Minimum particle sizes of  $\geq 1$  cm are recommended. Chicks must on no account ingest fine particles such as these. When combined with water, the oesophagus will swell up causing illnesses and a reduction in feed intake. Whenever using hulls as litter material, keep in mind that remaining seed can be eaten by the chicks. Some seeds con-

tain ingredients which can harm the birds metabolism (cotton hulls contain Gossypol for example) and restrict their growth and development.

Litter should be placed after heating the shed, i.e. when the floor has reached the correct temperature. Significant differences between floor and room temperature if litter is spread too early, it can cause condensation. The litter becomes wet from below and sticky.

## Placement of chicks – floor

Bring the temperature of the house up to 36 °C (at chick level) before the chicks arrive. Do not brood in a non-ventilated environment. Once the correct house temperature has been reached, switch on fans to minimum ventilation and adjust the heating system to maintain correct temperature. Failure to provide adequate air exchange during brooding increases the risk of higher first week mortalities. Switch on lights at the highest intensity, either on 23 hours or run an intermittent lighting programme. It is advisable to place the chicks close to the drinkers and feeders in the building. If an even temperature distribution within the house cannot be guaranteed or if radiant heaters are used, the use of chick guards or similar devices for keeping the chicks together have proven to be effective. These restrict the chicks to the areas of the building where the climate is optimal and where feeders and drinkers are located.

The shed can also be furnished with chick feeding bowls to ensure a better feed intake in the first few days. Both standard feeders and these additional chick bowls should be filled with a layer of about 1 cm of coarse starter feed. As soon as the chicks are able to eat from standard feeders, the bowls should be gradually removed.

If radiant heaters are used, chick guards or similar devices for keeping the chicks

in the warm area should be installed underneath. This provides a draught-free and comfortable microclimate for the chicks during the first two to three days after hatching.

When running brooding facilities at high temperatures, the drinking water will be heated up. For proper water and feed consumption, maintain the drinking water temperature at below 25 °C.

## Placement of chicks – cages

Bring the temperature of the house up to 36 °C (at chick level) before the chicks arrive. Do not brood in a non-ventilated environment. Once the correct house temperature has been reached, switch on fans to minimum ventilation and adjust the heating system to maintain the correct temperature. Failure to provide adequate air exchange during brooding increases the risk of higher first week mortalities. Switch on lights at the highest intensity, either on 23 hours or run an intermittent lighting programme.

Place the chicks on tiers to provide the best climate for the young animals. Put sheets of paper on the cage floor for starting chicks but remove paper within 7 days to avoid problems with coccidiosis. Place a handful of feed on the paper in each cage to encourage chicks to eat. Trigger the nipples and/or the water cups to encourage drinking. Observe the chicks carefully for signs of temperature, humidity, feed, water or disease problems. Water cups must be full when chicks arrive. For the first few days, the cups or nipples should be checked and triggered several times each day. Too often, chicks depend on one cup or nipple for their water supply and when this is not working, dehydration sets in fast. The water system should be the same in both the growing and laying houses.

Start the day-old chicks on crinkled paper or newspaper laid over the wire floor. Place



# Rearing of pullets



this in such a way that chicks can walk right up to the feed and water. A small amount of high quality feed placed on the paper floor or feed trays, and having the feed trough as full as possible, will also help get the chicks off to a good start.

Be sure that there is sufficient feeder space to assure proper growth and uniformity. When running brooding facilities on high temperatures, the drinking water will be heated up. For proper water and feed consumption, maintain the drinking water temperature at below 25 °C.

## House climate

**Table 7:**  
Desired temperatures at bird level are at a relative humidity of at least 40 – 45 %:

Temperature when birds are placed	36 °C
day 1 – 2	34 – 36 °C
day 3 – 4	32 – 34 °C
day 5 – 7	31 °C
2 <sup>nd</sup> week	30 °C
3 <sup>rd</sup> week	28 – 29 °C
4 <sup>th</sup> week	26 – 27 °C
5 <sup>th</sup> week	22 – 24 °C
> 6 <sup>th</sup> week	18 – 20 °C

## Humidity

Humidity is an important aspect of successful brooding. The relative humidity level (determined with a wet bulb thermometer), should be maintained on an optimal level, i.e. between 60 and 70 %. Bear in mind, that humid air has a much higher heat transport capacity as compared to dry air. If the humidity is too low, an evaporating effect can occur which can cool down the body of the young chicks. Humidity is usually not a problem after six

weeks of age as it is easier to maintain a satisfactory moisture level at lower temperatures. Besides, the older, larger birds also exhale a considerable amount of moisture into the atmosphere.

## Signs of distress

Be alert to distress signals produced by the chicks. React appropriately to the following chick behaviour:

- Listless and prostrate chicks indicate excessive heat.
- Loud chirping indicates hunger or cold.
- Grouping (huddling) together indicates excessive cold or draughts.
- Pasted vents which may indicate excessive heat or coldness.

## Intermittent lighting programme for chicks

Young chicks arriving at the rearing farm have already endured a long transport after hatching. The general practice is to provide 24-hours of light for the first two to three days after arrival to give the chicks time to recover, eat and drink ad libitum.

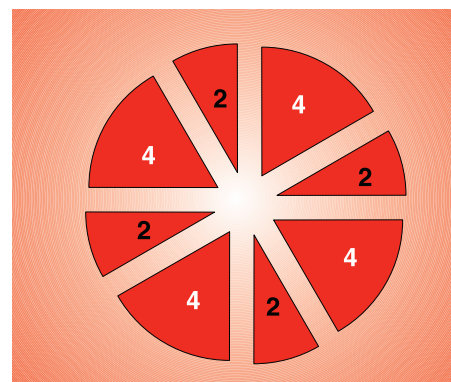
In reality, however, it has been observed that some chicks continue to rest after arrival while others seek out food or water. Flock activity will therefore always be uneven. During this phase of rearing, attendants find it particularly difficult to accurately assess chick behaviour and condition.

An intermittent lighting programme, especially designed for this period and tested in practice, divides the day into resting and activity phases. The objective of such a programme is to synchronise chick activity in order to make it easier for the staff to assess the condition of the flock more accurately and to stimulate food and water intake through group behaviour.

It is recommended to allow the chicks a brief period of rest upon arrival at the rea-

ring farm and then start the intermittent lighting programme of 4 hours light followed by two hours of darkness.

## Lighting programme for chicks during the first 10 days of life:



4 hours light  
2 hours darkness  
4 hours light  
2 hours darkness  
4 hours light  
2 hours darkness  
4 hours light  
2 hours darkness

This programme can be applied up to day 7 or day 10 post arrival, followed by a switch to the regular programme with a reduction of the day length. Working in open house conditions, the programme can only be used during the night time. This, however, has proven to be effective even under these conditions.

The benefits of using this programme are:

- Chicks rest or sleep at the same time. Chick behaviour is synchronised.
- Weaker chicks are stimulated by stronger ones to be active and ingest feed and water.
- Flock behaviour is more uniform thus making chick assessment easier.
- Losses in the first week are reduced.



# Rearing of pullets

**Table 8:**  
Stocking density

Age		Cage Rearing		Floor Rearing	
		0 – 4 weeks	5 – 17 weeks	0 – 4 weeks	5 – 17 weeks
Chicks/Hover				500	
Floor Space		140 cm <sup>2</sup> /bird	285 cm <sup>2</sup> /bird	20 birds/m <sup>2</sup>	10 birds/m <sup>2</sup>
Feeder Space	Trough (cm/bird)	2.5	5	4	8
	Pan (birds/pan)	24	12	60	30
Water Space	Birds/Nipple	16	8	16	8
	Birds/Fountain	50 (mini)	–	100	75
	Trough (cm/bird)	1.25	2.5	1.4	2.5

**Table 9:**  
Recommended Nutrient Levels per kg of Feed for different daily Feed for Lohmann Brown Chicks / Pullets

Diet type*		Starter**		Grower	Developer	Pre-Layer
Nutrient		weeks 1 – 3	weeks 1 – 8	weeks 1 – 8	weeks 9 – 16	week 17 – 5 % prod.
Metabol. Energy	kcal	2900	2750 – 2800	2750 – 2800	2750 – 2800	2750 – 2800
	MJ	12.0	11.4	11.4	11.4	11.4
Crude Protein	%	20.0	18.5	18.5	14.5	17.5
Methionine	%	0.48	0.40	0.40	0.34	0.36
Dig. Methionine	%	0.39	0.33	0.33	0.28	0.29
Meth./Cystine	%	0.83	0.70	0.70	0.60	0.68
Dig. M/C	%	0.68	0.57	0.57	0.50	0.56
Lysine	%	1.20	1.00	1.00	0.65	0.85
Dig. Lysine	%	0.98	0.82	0.82	0.53	0.70
Valine	%	0.89	0.75	0.75	0.53	0.64
Dig. Valine	%	0.76	0.64	0.64	0.46	0.55
Tryptophan	%	0.23	0.21	0.21	0.16	0.20
Dig. Tryptophan	%	0.19	0.17	0.17	0.13	0.16
Threonine	%	0.80	0.70	0.70	0.50	0.60
Dig. Threonine	%	0.65	0.57	0.57	0.40	0.49
Isoleucine	%	0.83	0.75	0.75	0.60	0.74
Dig. Isoleucine	%	0.68	0.62	0.62	0.50	0.61
Calcium	%	1.05	1.00	1.00	0.90	2.00
Phosphor, total	%	0.75	0.70	0.70	0.58	0.65
Phosphor, avail.	%	0.48	0.45	0.45	0.37	0.45
Sodium	%	0.18	0.17	0.17	0.16	0.16
Chlorine	%	0.20	0.19	0.19	0.16	0.16
Linoleic Acid	%	2.00	1.40	1.40	1.00	1.00

\* The basis for switching between diet types is the hens' bodyweight development. The correct time for changing the diet is determined not by age but by bodyweight. Chicks and pullets should therefore be weighed at regular intervals.

\*\* Chick Starter should be fed if the standard body weight is not reached by feeding chick grower or if the daily feed intake is expected to be low.

## Stocking Density

The figures mentioned in Table 8 can be taken as a general guide. The optimal bird density depends on management conditions and to which extent the climate can be controlled. Use the information about the body weight development of the chicks to adjust stocking densities. Lower densities will allow chicks to grow and develop better, a pre-requisite for a good laying performance in hot climate situations.

## Feeding chicks / pullets

The Lohmann varieties will grow and develop properly on feeding programmes and diets provided by various feed suppliers. The recommended nutrient levels in Table 10 are necessary to produce a pullet with good skeletal and muscular development. The birds should carry a minimum of fat since excess fat may be detrimental to the performance of the pullets. Birds reared in cages may require a slightly different feeding programme than birds grown on the floor. Pullets in cages get less exercise and are, therefore, generally heavier than floor-raised birds.

## Brood/Grow

Four diets (starter, grower, developer and pre-layer in Table 9) during the brood/grow period are very adequate for the chicks / pullets. Each diet should be supplemented with vitamins and minerals as indicated in Table 10. **Each diet should be fed until the appropriate target weight is achieved** (see management guides for Lohmann varieties). At that point the next diet should be fed. The birds will benefit from a pre-lay diet. This diet can be a developer with additional calcium or the first layer diet (e.g. peaking diet) with lower calcium. If used, the pre-lay diet containing 2 % calcium should be fed at 17/18 weeks of age (see chapter management of laying hens). The calcium source should be small particle limestone so that calcium intake is mandatory.



# Rearing of pullets



**Table 10:**  
Recommended Micro-Nutrient Specification

Supplements per kg Feed		Starter/ Grower	Developer	Pre-Layer/ Layer
Vitamin A	I.U.	12000	12000	10000
Vitamin D3	I.U.	2000	2000	2500
Vitamin E	mg	20 – 30**	20 – 30**	15 – 30**
Vitamin K3	mg	3***	3***	3***
Vitamin B1	mg	1	1	1
Vitamin B2	mg	6	6	4
Vitamin B6	mg	3	3	3
Vitamin B12	mcg	20	20	25
Pantothenic Acid	mg	8	8	10
Nicotinic Acid	mg	30	30	30
Folic Acid	mg	1.0	1.0	0.5
Biotin	mcg	50	50	50
Cholin	mg	300	300	400
Antioxydant	mg	100 – 150**	100 – 150**	100 – 150**
Coccidiostat		as required	as required	–
Manganese*	mg	100	100	100
Zinc*	mg	60	60	60
Iron	mg	25	25	25
Copper*	mg	5	5	5
Iodine	mg	0.5	0.5	0.5
Selenium*	mg	0.2	0.2	0.2

\* So called organic sources should be considered with higher bioavailability.

\*\* according to fat addition

\*\*\* double in case of heat treated feed

## Remark Vitamin C

Vitamin C is synthesised by poultry. This vitamin is not considered as essential, but in some circumstances, like heat stress or hot climate it may be important/beneficial to add 100 – 200 mg/kg complete feed during production period.

## Grit

The provision of insoluble grit for free access is recommended. This stimulates the development of the crop and the gizzard, which in turn has a positive effect on feed intake capacity. The following are reference values for the granulation and amount of grit to be supplied:

1 – 2 weeks of age:	once weekly 1 g/bird (size 1 – 2 mm granulation)
3 – 8 weeks of age:	once weekly 2 g/bird (size 3 – 4 mm granulation)
From 9 weeks of age:	once a month 3 g/bird (size 4 – 6 mm granulation)

## Beak treatment

Beak treatment is one of the most important aspects of poultry management, especially in open-type houses with high levels of light. 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.

Since pullets reach sexual maturity at an earlier age, it is best to treat the beak at a young age. This will allow sufficient time for the pullets to recover from any body weight losses which may occur.

### Since beak treatment is one of the greatest single stress events in pullet rearing, do observe the following precautions:

- Treat only healthy, unstressed birds at the age of 7 – 10 days
- Allow only experienced personnel to do the work
- Work slowly and carefully
- Do not feed for 12 hours before treatment
- Offer free feeding immediately after treatment
- Use only equipment and blades which are in perfect working order and adjust the blade accordingly
- Control the temperature so that cauterisation is guaranteed and the beak is not damaged
- Increase the level of feed in the troughs
- Giving vitamins via the drinking water can also help to alleviate stress
- Increase the temperature in the house for a few days after treatment
- Add Vitamin K to the diet or drinking water a few days before and after the beaks are treated
- For 3 – 5 days after beak treatment, provide an extra hour of light and supply feed in the late evening or at night



# Rearing of pullets

## 7 – 10 Day beak treatment

The best age for a one-time beak treatment is between 7 to 10 days of age. A precise beak treatment guide with three different sized holes (3.5 mm, 4.0 mm and 4.3 mm) is attached to the beak treatment machine. The upper and lower beaks are treated at the same time using the guide hole that will result in the beak being treated and cauterised 2–3 mm from the end of the nostril. It may be necessary to increase the hole sizes slightly, especially on older chicks, to ensure the correct beak length. The beak should be treated carefully and precisely and cauterised for one second. Gentle pressure on the bird's throat with the index finger on the neck will retract the tongue of the bird to prevent it from burning. Make sure that the chicks' beak is placed at an angle of 15 to 20 ° into the hole. The beak will not be cut and cauterised properly unless the blade is heated to a dull red (approximately 590 – 595 °C).

As beak treatment is stressful for the chicks, they must be conditioned for the procedure. A vitamin supplement of the A,

D<sub>3</sub>, E and K<sub>3</sub> groups on the day before, a 6 – 8-hour fast prior to the procedure and raising the room temperature by 1 °C at the time of the beak treatment procedure, are recommended to ensure that the birds recover quickly from this operation.

Prior to the beak treatment operation, all equipment, including the beak treatment machine, should be thoroughly cleaned and disinfected. It is important that the beak treatment machines be properly adjusted and that they work correctly. Blades should be changed as necessary. Dull blades will crush and tear the beak rather than cut cleanly through it. The quality of the beak treatment operation will depend on the care and maintenance of the equipment used. Correct maintenance of the beak treatment equipment is as important as adhering to the treatment procedures. If the growth of the chicks is retarded after the beak treatment at this young age and pecking is not a big problem during the first weeks in a farm, one can skip the early beak treatment and do it only once at 6 – 10 weeks.

## 6 – 10 week beak treatment

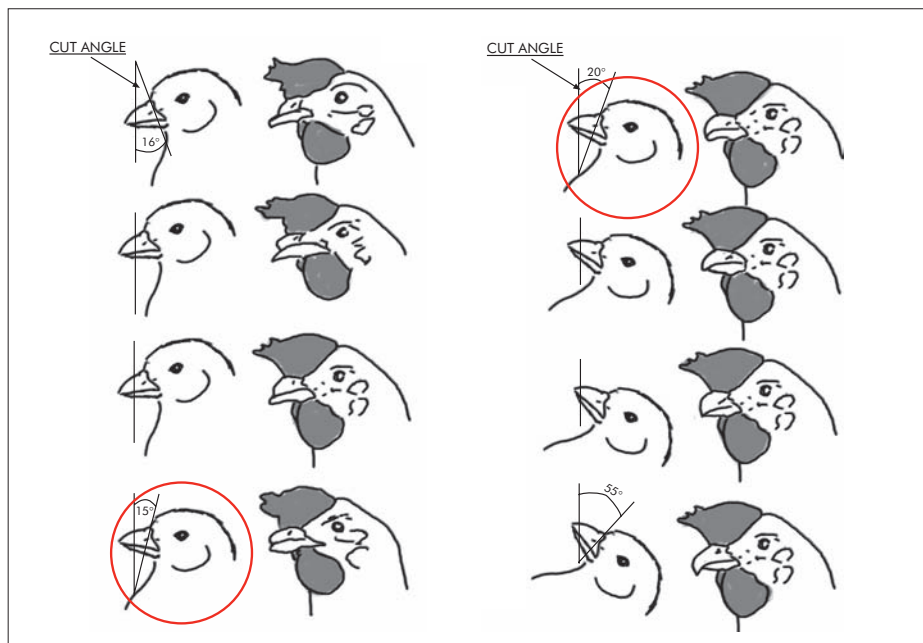
At six to ten weeks, the upper beak should be trimmed 6 mm beyond the end of the nostril. The lower beak should be trimmed 3 mm shorter than the upper beak. It is important that the beak trimming operation be as stress-free as possible. Immediately after trimming, increase the depth of the feed in the pans or troughs to encourage the birds to eat and to prevent additional stress caused by the tender beaks hitting on the bottom and sides of the feeder. The protein level of the feed may be increased slightly to compensate for a decrease in feed consumption during the beak trimming period. Do not change to a lower density feed until the pullets have recovered.

In special situations, pullets can be beak-treated up to an age of 12 – 14 weeks using methods and equipment suitable for the birds of that age.

**However, beak treatment should never be done after the age of 16 weeks.**

**Subject to national regulations, beak treatment must be performed with utmost care! A poorly treated flock grows unevenly, resulting in lack of uniformity at the end of rearing.**

## Beak positioning during beak treatment



## Body weight and uniformity

Lohmann commercial layers exhibit rapid growth and feed efficiency. Developing and continuing good management practices throughout the flock's life cycle (0 – 80 weeks), will be essential to achieve optimum performance, including proper body weight, good flock uniformity and satisfactory physical conditions. During the rearing period, growing the layer pullets to the targeted growth curve is required to achieve optimum physiological development and uniformity in preparation for the laying period. During the laying period, it is essential to maintain the strict



# Rearing of pullets



monitoring programmes begun during the rearing period to achieve and extend optimum reproductive performance. Monitor body weight every one to two weeks during the four to 18 week age range so that feeding programmes can be altered if flocks are not maturing properly.

## Measuring body weight and uniformity

### Key points

- Use an accurate scale of 10 or 25 grams units. Using an electronic weighing scale is always preferred as this provides better accuracy.
- Weigh birds weekly (at the same time of day) beginning from the first week of age.
- Avoid leg damage by holding the birds by both wings during weighing. Never hold birds by one leg.
- Record weights on a body weight recording chart and calculate average body weight and uniformity.
- Transfer average body weight to the appropriate body weight chart. Compare average body weight with the target body weight.
- Poor uniformity is one of the first indications of abnormal performance or health problems. Make management practice changes based on differing flock uniformity.
- Poor uniformity can often be attributed to inadequate feeder space and poor feed distribution.

### Sample weighing

A highly productive flock can only be achieved by maintaining accurate measurements of body weight and uniformity throughout the growth curve. Growth and development within a flock are assessed and managed by weighing representative samples of birds and comparing them with target uniformity and body weight standards.

A representative sample of the flock, or a minimum of about 100 birds taken throughout the house, should be weighed each time the weights of a flock are checked. This should be done by weighing each pullet caught in a catching panel from several areas of the house, or by weighing all birds individually in a cage from several areas of the house. Reweigh the pullets immediately if the average body weight is suspicious (e.g. higher or lower than expected).

If an electronic recording scale is not used, individual body weights should be recorded on a body weight recording chart to calculate the average body weight and flock uniformity. The average body weight should then be transferred from this chart to the commercial layers body weight guide.

Chart the flock's progress, comparing actual averages to the targets on the graph. Make arrangement adjustments as needed. With today's layers, it is important that the average body weight at 17 weeks remains on target.

### Uniformity calculation methods

Achieving good flock uniformity is a major objective during rearing. The uniformity of a flock is determined by mathematically analysing the variability of weight of the individual birds within that flock. There are two basic methods for calculating the uniformity of a flock, i.e. the calculation of the coefficient of variation (CV %) and the  $\pm 10\%$  uniformity method.

### $\pm 10\%$ Method for uniformity calculation

Example:

- 95 pullets weighed a total of 86260 kg.
- 86260 kg divided by 95 birds = 908 grams per bird.
- $908 \times 10\% = 91$
- $908 + 91 = 999$  (Upper value)
- $908 - 91 = 817$  (Lower value)
- 81 birds weighed within the 817 – 999 range.
- 81 divided by 95 times 100 = 85 % uniformity.

### Evaluating flock uniformity

Excellent	Good	Fair	Poor
> 85	> 80–85	70–80	< 70

Once calculations for uniformity have been determined, compare the shape of the curve on the body weight recording chart to the diagram.

## Training eating capacities

Parallel to the body weight and uniformity, a good appetite, resulting in sufficient feed intake, is of highest importance especially at the onset of lay. Since pullets often struggle with a low intake at this time, a good appetite or eating capacity has to be developed during the rearing period already. The good appetite can be seen as a quality sign of the Lohmann birds. However, especially in hot climates, the development of their eating capacities can help birds to show their high genetic potential already at the onset of lay and will help them to reach highest peak rates.

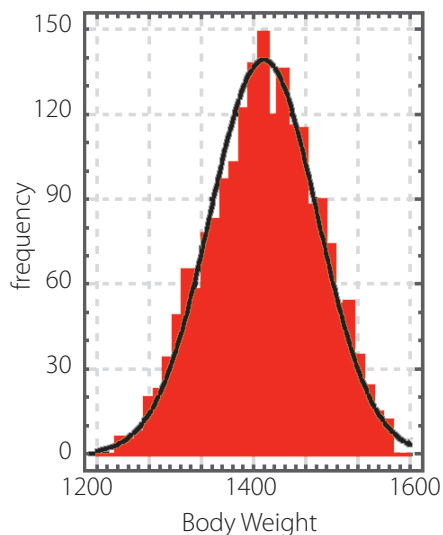
When the body weight of pullets is on target at 8 – 9 weeks and developer feed is supplied to the flock, the birds should be fed once during the day on an empty trough. This will develop a feeding pattern and helps to enlarge the crop size and the capacity of the whole digestive system. It's sufficient to leave the trough empty for 1 hour but make sure that this doesn't happen during the cool hours of the day.



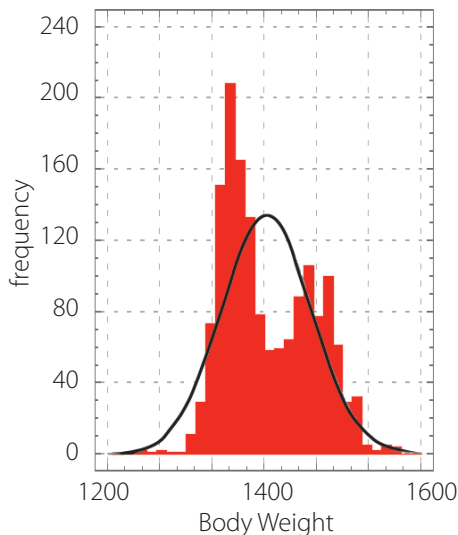
# Rearing of pullets

## Flock uniformity curve

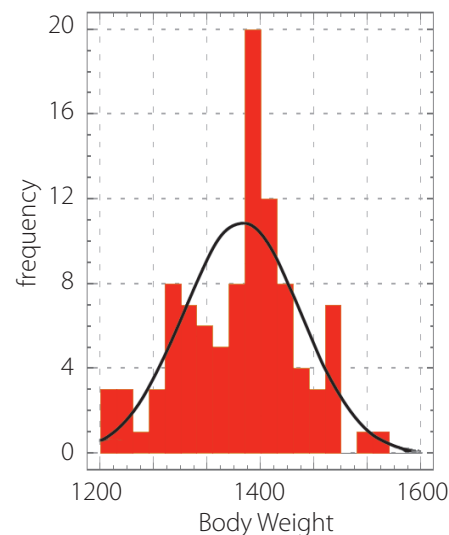
**Good Uniformity**



**Bad Uniformity  
(some birds too light)**



**Bad Uniformity  
(big variation)**



## Midnight snack

A midnight snack is an additional period when birds are exposed to artificial light during the night and can eat. It depends on the individual lighting programme weather the midnight snack is provided at twelve o'clock at night or some time earlier or later. This is of no importance. Midnight feeding improves the overall feed intake and can help during the rearing period to increase the body weight and/or help to fulfil the high nutrient demand of commercial layers in full production.

- Midnight lighting and feeding enables to provide extra feeding time.
- After sleep and rest, birds can restore their appetite.
- Daily feed consumption can be increased up to 10 – 15 g.

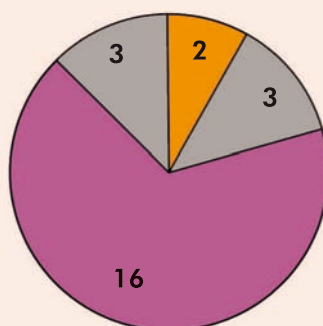
### As precautions for successful mid-night feeding, the following points should be kept in mind:

- Duration of midnight lighting and feeding should be at least 1.5 – 2 hours.
- Feeders must run to stimulate the bird to eat as soon as the lights are turned on.
- A minimum of 3 hours of darkness is required on both sides of midnight lighting and feeding.
- Lighting programmes of more than

16 hours are not adequate for mid-night lighting and feeding.

- It must be set according to the normal lighting programme when lights are turned on and off.
- No changes should be made to the regular lighting programme when midnight lighting and feeding is introduced or withdrawn.
- Experience has shown that a midnight snack can be withdrawn any time, either at once or gradually.

**Midnight lighting and feeding**



Midnight Snack

Darkness

Light



# Rearing of pullets



## Lighting programmes

### Lighting programmes – closed houses

The lighting programme (day length and light intensity) to which a flock of laying hens is subjected during the growing and production phase, is a key factor in determining the onset of sexual maturity and egg production. Lighting programmes for pullets kept in windowless barns can be designed so as to guarantee optimal growth and efficient preparation for the laying period, largely independent of the season.

The golden rule to follow in designing lighting programmes for pullets is that they should never experience an increase in day length until the planned light stimulation starts and never experience a decrease in day length during the production cycle. Following this principle, the day length is gradually reduced after placement of the day-old chicks in the rearing farm. After the minimum is reached, a phase of constant day length follows and finally, light hours can be gradually increased to stimulate the onset of lay.

The so-called step down procedure in the early days of the chick's life can be used to make the pullets more sensitive to light. After reaching 8 to 10 hours per day, the birds are kept on constant day length for some weeks. The length of the day during this constant period, determines the step-down and the following step-up programme which is of minor importance for the pullets' sensitiveness to light. The more time the birds have during this constant phase, the more they will eat and grow. In situations where farmers have difficulties to achieve the targeted body weights, a longer constant day can help to improve the quality of the pullet. Any step-up procedure or increase in day length when birds get to an age of 14 to 15 weeks, will stimulate sexual maturation. A quick step-

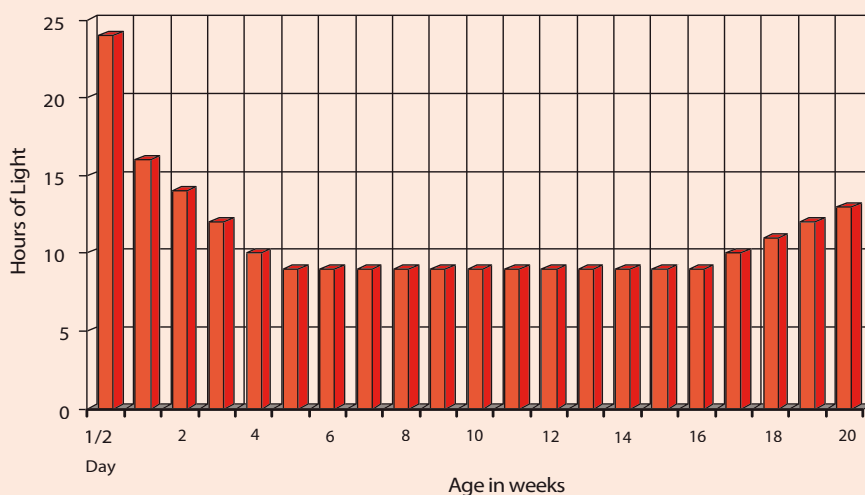
up will induce an earlier onset of egg production, while a slow step-up will delay the onset of lay. The combination of quick step-down and quick step-up lighting, is most effective for achieving an early onset of lay; slow step-down and slow step-up will delay it. Many scientific trials and practical experience with different strains of layers have confirmed that the number of eggs and egg weight can be easily influenced by utilising this tool. If a producer wants early egg production, high total egg number and a moderate egg weight, he should use the quick step-down / step-up variant. To get fewer but larger eggs, a slow step-down / step-up variant should be selected.

**Parent flocks** should never be exposed to the quick step-up/step-down programme because small eggs at the beginning of the laying period, cannot be used as hatching eggs and are therefore undesirable.

Our experience shows that day length should first be increased in the afternoon hours, followed by further increments in the morning hours. This can be done in steps of 30 or 60 minutes as shown in the lighting programme for Lohmann Brown layers. Sometimes modern layer hybrids, even if selected for sufficient feed intake / appetite like the Lohmann strains, have difficulties to consume enough feed shortly before and during the onset of lay. Increasing the day length by two hours in the initial step-up will not only push them more quickly into lay, but also offers two additional hours to eat. This can be taken into consideration when designing lighting programmes for special flocks or housing conditions.

After stimulating flocks properly into lay, there is no need to prolong the day beyond a 14-hour day length. Depending on the length of the day during the constant period, even 12 hours are sufficient for top egg production.

Standard Lighting Programme for Lohmann Brown Commercials





## Rearing of pullets



### Lighting programmes – open houses

A controlled photo-stimulation of hens should not be abandoned as a management tool in houses with windows. The rearing unit should either be dark-out or the windows should have a facility for blocking out daylight to maintain the lighting programme. Shutters can be synchronised with the lighting programme and must be seen as very valuable tools.

Even under open house conditions, a darkening programme can improve the performance of flocks significantly.

If the hens are placed in open houses or if windows, ventilation shafts and other openings cannot be light-proofed to keep out natural daylight, these factors need to be taken into account when designing the lighting programme. If flocks are moved to open production facilities, the lighting programme must be adjusted to match the natural day length at the time the flock is moved and must be kept constant throughout the rearing phase. It is important to be able to distinguish between pul-

lets from a light-proof growing facility and pullets which have been fully exposed to natural daylight throughout the growing period. When pullets, which are unaware of the natural day length during the growing period are moved to open laying houses, it is essential to prevent stress due to excessive light stimulation by an abrupt lengthening of the day. Light hours should not be increased by more than 2-3 hours. This means that day length should not be reduced to 8 or 9 hours during the rearing of such flocks. For more information on this topic, please contact the technical service department at Lohmann Tierzucht.

### Light Intensity

Light intensity is an important aspect of a lighting programme. With the proper types of controls, light intensity can be easily adjusted. Low intensity lights reduce power consumption. Little or no harm will be done if light intensity is increased for short periods of time when the caretaker needs bright light in the houses. Lohmann layers also reacts very well to the stimulation of the increase in light intensity at 17 weeks

of age. A minimum of a one foot-candle or 10 Lux should be maintained in the pullet barn. When the flock is moved to the lay house, the light intensity should be at least equal to the light intensity in the pullet barn.

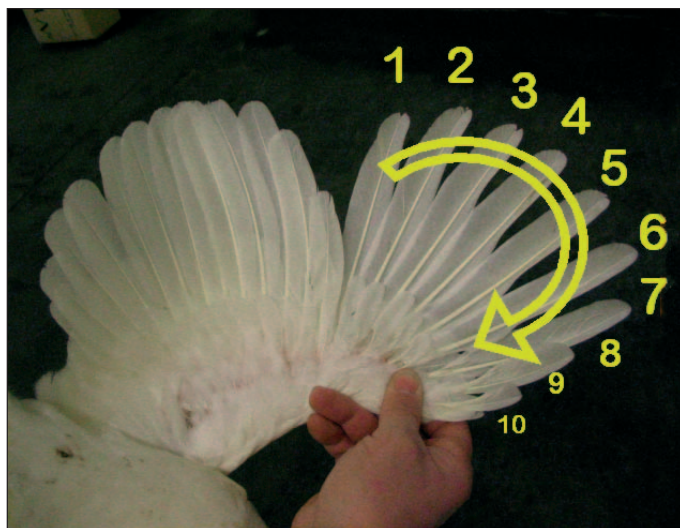
### Molting

Growing pullets change their plumage several times. The growing chick replaces the down of the day-old with the first full feather coat. This process is basically completed at 5 weeks of age. The birds' growth slows down during molting.

At 8 to 9 weeks old, a further slight but incomplete molting takes place. At that age, more feathers than usual can be found in the litter of floor-reared or perchery hens.

An intensive and complete change of plumage is observed from 13/14 weeks of age. This molt also involves the successive changing of flight feathers. At 15 weeks, numerous feathers can be found on the floor of the poultry house of a well developed flock. The absence of molting at

### Wings of a pullet aged about 18 weeks:





## Rearing of pullets



13 weeks indicates poor weight development or lack of flock uniformity. Body weight and uniformity should then be determined as a matter of urgency. If the flock is found to be underweight, it is advisable to check for viral or bacterial infections (coccidiosis is a common cause of growth depressions) and to examine whether the quality of the feed is satisfactory.

Only when the final molt is almost complete (normally at 14/15 weeks of age), light intensity and the length of illumination are increased in preparation for the impending start of lay. Practical experience has shown that this is the best time for moving the birds to the layer house.

Birds raised from a young age in high environmental temperatures might, to some extent, acclimate to high temperatures and recover earlier, thereby maintaining an acceptable performance. The hens develop larger wattles and combs and have less fat and feather cover. For layers, this should be done approximately one week before they start to lay by raising the temperature for four hours to the expected high temperature during lay. Adult birds take about five days to acclimatise to high temperatures. Anyway, if the change in temperature takes place abruptly, the capacity of acclimation is very limited.

Raising house temperature prior to the onset of a heat wave, has been shown to reduce mortality. The exposure to high temperatures for a limited period of time at an early age (for example 24 hours of heat exposure on 5-day-old chicks) or even during incubation, apparently improves the birds' tolerance to heat stress. This practice of acclimatisation is still at an experimental stage, but it has a strong potential.

### Moving to the laying house

The move from the growing facility to the laying house should be done gently but

quickly. Being caught and transported is stressful for the birds. They also have to adapt to a strange environment. A stress-free transfer and careful acclimatisation of the flock to the new management system are crucial and ensure good production results.

It is advisable for pullets from non cage rearing systems to be moved in good time before the proposed onset of lay. This ensures that the pullets become familiar with their new surroundings before they start laying.

It is normal for pullets to lose weight after transport and rehousing. It is therefore important that the birds are quickly able to locate feed and water to ensure a sufficient feed intake. Effective ways of encouraging pullets to eat include moistening the feed, running the feeding lines more frequently, or vitamin supplements.

It is important to plan in advance, taking into account the meteorological forecasts of predicted temperatures for the next few days in order to choose the best conditions to undertake this action. The person responsible for the supply should always be present and available to take the necessary actions to guarantee the welfare of the birds.

It is of major importance to carry out the actions of catching, loading and transporting at the coolest hours of the day. The staff should be well trained and the equipment should be in working order. These should be checked beforehand. A team leader should be appointed who coordinates and assumes all decisions. Water and proper ventilation should be provided to the birds which are not caught. Furthermore, stocking densities in the trolley should be according to their design and the temperature. If there is some delay, the birds should be provided with enough

ventilation. Therefore, in cases of non-ventilated lorries, the birds should be off-loaded and given enough ventilation. It is very advantageous to transport the birds in appropriate vehicles, which can also control the temperature and the humidity.

An increase in temperature, fundamentally at the end of the rearing, has a depressive effect on the body weight which is combined with a low feed intake in this period. A typical situation, especially in summer, is that the birds start to lay and before reaching the peak of lay, birds would have completely depleted their reserves. At this point, the laying performance could suffer a significant decline, which will be difficult to compensate. Additionally, these situations are commonly accompanied by an increased mortality rate due to the sudden fall of calcium in blood. Thus, it is of major importance that the birds reach the standard body weight with a good uniformity in the flock to avoid problems at the start of laying. ■



# Management of Laying Hens

## General recommendations

High temperatures, especially over a long period can cause serious losses to the poultry farmer. The effects of heat stress are a retardation of the lay begin, lower performance, decreased feed intake and increased mortality. Therefore to minimise economical losses, every effort should be done to maintain the environment temperature in the house within the bird's comfort zone.

## Housing Birds

The all-in all-out housing system is recommended because it helps break the disease cycles which so often accompany a continuous multiple age replacement system. Pullets should be moved to thoroughly cleaned and disinfected laying houses before 18 weeks of age.

### Preparation and conditioning of the farm

The ventilation system should be checked before the hot weather comes. Fans should be cleaned and fan belts should be tightened and changed if needed. The inlet must be adequate to supply the airflow needed, they should be clean and should be free for the flow of the incoming air. The auxiliary power system should be continuously tested, so that it works properly in case a power outage occur. In case of cooling pads, the pads should be clean and maintain properly. They should be replaced when they become old. The

drinkers system should be tested and the water supply must be guaranteed before the pullets arrive.

A properly maintenance and cleaning work is a major issue to keep the corresponding systems ready to use with the maximal efficiency.

### Equipment

Each pullet should be provided with at least 400 cm<sup>2</sup> of cage space at 18 weeks of age and throughout the lay cycle. Using a floor housing system not more than 9 birds should be kept per m<sup>2</sup> floor space. This is a compromise between maximum performance and the economics of facility cost. Maximum egg production and egg size require that ample feed and water space be provided. Cages should be designed to allow each bird a minimum of 10 cm of access to the feed trough. Provide a minimum of one cup or nipple drinker at the cage partition or 2.5 cm of water trough per bird.

### Stocking density

The stocking density should be according with the environmental conditions. If the housing density is too high, the radiant heat between the birds accumulates, the temperature will increase and the air will have more problems to move between the birds. They should have enough place to distance themselves from each other, in order to pant and expand their wings dropped and lifted slightly from the body

to maximise sensible heat loss. Recommended stocking densities are listed in the following table.

In case of non-cage housing it is very important not only to have the correct stocking density, but also to maintain a uniform density throughout the house. As bird density increase, additionally to the increased competition for feed and water, it is more difficult to pull air between them, and air temperature will increase. Delimiting the house in small departments (about 500 – 1.000 hens) with migration fences is always a good idea.

At the time of making a decision for the migration fences it should be taken into account, that some material might cause dead air spots on the downwind side of the fence, resulting in heat stressed birds and increased mortality. Wire shelving materials works best with relatively no air/wind resistance.

### Temperature Control

Laying hens perform well over a wide range of temperatures. Temperature changes between 21 °C and 27 °C have a minimal effect on egg production, egg size and shell quality. Feed conversion improves with higher house temperatures, and maximum efficiency is attained in the 21 – 27 °C range. As temperature rises, however, feed consumption decreases and it is necessary to provide a properly fortified diet to achieve adequate daily nutrient intake in a warm house (see section Feeding in the lay cycle).

Hot regions might have also low temperatures in winter. In environmentally controlled houses, warm temperatures may be maintained during cold weather by utilising the body heat produced by the birds. Proper management of the ventilation system will conserve heat and eliminate moisture. A proper blending of air intake and exchange rates is needed.

*Recommended equipment and stocking density at elevated house temperatures*

Temp.	Floor Space		Feeder Space	Water Space	
	Litter (birds/m <sup>2</sup> )	Cages (cm <sup>2</sup> / birds)	Trough (cm/Bird)	Birds/ Nipple	Birds/ Round drinkers
25 °C	5.5	450	10	20	75
30 °C	4.5	550	15	10	60
35 °C	3.5	650	20	5	50



# Management of Laying Hens

## Water Quality

Fresh, clean, potable water must be available at all times for the layers. Adequate consumption must be assured.

When birds are heat stressed, they increase consumption of water in an effort to cool down. The ratio of water to feed increases from 2:1 under normal conditions to over 5:1 under hot conditions. Cool water of good quality should be supplied, so that the birds can be alleviated from the heat. In case of floor housings, additional drinkers can be supplied. Water should not have a bad smell or taste. Clean water is just as important as good feed for top performance. If you are using your own water supply, have the quality checked regularly. Excessive salt levels in drinking water can cause persistent damage to shell quality. Moreover in areas where water sodium levels are elevated, it is important to take into account this factor at the time of formulating the diet. Regular samples and assessment of water quality are necessary for monitoring microbial load and mineral content.

The water tank should be filled keeping up to 80 % capacity to keep the water cool. The pipe line should be insulated and laid far away from the roof or buried underground to avoid that the water becomes warm. The water system should be good dimensioned to have the required capacity to fulfil the high demands of the birds and the operation of optional evaporative cooling and fogging systems. Use a known brand of drinkers, which supply a constant water flow and are easy to handle.

The necessary flow in the pipe line should be guaranteed and regularly revised, as well as the height of the drinker, so that the birds have continuously access to water. In cages all the birds should have access at least to two drinkers. Stored water tends to be at a similar temperature to that

of its environment. In hot climates water consumption will be reduced as the water temperature increases, therefore, the lines in the house should be cooled by flushing waterlines with fresh cool water at least twice a day. The water filters should be periodically changed to guarantee the needed flow.

Nipple drinkers keeps the water cleaner and prevents sharing the water in comparison with troughs or bells, which easily collect bacteria and contaminants and spread diseases among the birds. Furthermore nipple drinkers reduce the labour requirements for clean out and contribute to drier conditions in the poultry house, dry litter support the overall health of the birds. Wet litter results in ammonia releases. Water troughs and bell drinkers give the birds the chance to cool their wattles in the water and may be therefore more suitable than cups or nipples in areas with high temperature.

If round drinkers are used, water should be changed 2 – 3 times a day. A slight acidification of the water, through the addition of  $\text{NH}_4\text{Cl}$ ,  $\text{HCl}$  or  $\text{KCl}$  will increase the water intake. Supply of carbonated water during hot periods improves the quality of the shell.

The birds should have unlimited access to water, and water pressure should be correct. If water consumption is reduced the reduction of feed consumption will be greater. It is of major importance to know the real consumption of water from the birds, that means that the corresponding measurement devices should be installed. Leaking drinkers should be detected and corrected.

## Electrolytes

The blood acid/base balance is disturbed by hyperventilation and results in respiration alkalosis. During periods of heat stress, birds will deplete electrolytes very fast.

**Table 11:**  
*Recommendations for water quality*

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



# Management of Laying Hens

Therefore it is a good idea to provide birds with electrolytes in the drinking water, mainly potassium, chlorides and sodium. This will improve also the water consumption and prevent the dehydration of birds that are panting. The use of electrolytes can be used in anticipation of high temperatures.

Since heat stress always depresses appetite and therefore reduces nutrient intake, the use of a vitamin and electrolyte pack in the drinking water for 3 to 5 days during heat wave can be very helpful.

## Management during the early days

During the first few days after housing it is important to stimulate feed intake, e.g. by

- Providing an attractive meal type ration with good structure
- Running the feeding lines more frequently
- Feeding when the trough is empty
- Lighting of feeding equipment
- Moistening the feed (beware mould)
- Vitamin supplements

Pullets should never lose weight after transfer. They should continue to gain weight, or at least maintain their body weight.

### Feeding time

Feeding at the right time of the day is of major importance. Do not feed in the hottest time of the day. A good strategy is to withdraw feed 5 to 8 hours prior to the anticipated time of peak temperature.

Feeder chains should be run frequently to stimulate feed intake. The feeder should remain empty for around two hours 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. A good

feed texture, coarse and homogenous, should be used (75 % between 0.5 and 3 mm). Provided it is of good quality, pelleted or crumbled feed may be supplied as a tool for promoting feed consumption. To increase feed consumption a midnight snack can be implemented.

### Feeding during laying

Lohmann layers can achieve their genetic performance potential using many different feeding programmes. However, there are some precautions with regard to the lay diet that should be kept in mind. All layers require a minimum quantity of daily nutrients regardless of their consumption rate, but their actual intake is primarily governed by their energy requirements.

Energy requirements are in turn determined by body weight, production rate, egg size, ambient temperature, air movement and feathering. **In general an energy level of 11.4 – 11.6 MJ ME (2725 – 2770 Kcal) should be achieved for all layer feeds.** Lohmann layers are easy to handle. Feed intake capacity is genetically well established. After a correct rearing nutrition which ends up with the application of a Pre Layer Diet a change to a **phase-feeding schedule with nutrient contents based on daily feed intake and egg mass output per day** is recommended. The application period of the different feed types in weeks can be slightly modified depending on the production development of a flock. Nevertheless, it must be considered that hens with outstanding production require higher calcium and lower phosphorus levels with foregoing age, which is a key aspect for changing phase feeds.

Since feed intake is reduced during hot weather periods the general feeding approach is to increase the energy content in the feed in order to keep daily energy intake on the level for optimum perfor-

mance under these conditions. Fat has the lowest heat increment compared to the digestion of other energy nutrients, as carbohydrates or protein, so it might be advisable to replace other dietary energy with dietary fat.

### Oil and Fat

Oil can be used to bind particles and avoid dusty feed, additionally oil increases feed intake. Furthermore the digestion of fat produces less heat than the digestion of proteins or carbohydrates. With the use of oil in the ration the energy level of the feed can be increased, which might compensate the reduction of feed intake under hot climates. Fat has also been shown to slow down feed passage through the gastrointestinal tract, increasing in this way the nutrient utilisation. Up to 5 % oil can be added in the ration, with the additional effect over egg weight and egg production.

Regarding feed formulation, nutrient density should be increased as feed intake decreases in order to maintain daily nutrient intake. Starch content should be decreased and crude fat content increased as a means of reducing metabolic heat production. Up to 7.5 % crude fat in the diet suppose no problem for the birds, however due to technical reasons in the feed mill the proportion would be more limited. When adding fat into the feed special attention should be put to protect them from getting rancid by adding antioxidants.

### Protein

It should be borne in mind, that the protein that is not used for production is metabolised in a process that generates heat and consequently means an increased stress for the birds. Reducing the content of crude protein, while maintaining a balanced amino acid content by adding synthetic amino acids, will decrease metabolic heat production. The key to good nutrition should be focus on daily intake of essential



# Management of Laying Hens



amino-acids, while reducing total digestible protein intake within the constraints of available raw materials.

An imbalance diet in amino acids increases the excretion of nitrogenous substances in faeces, which results in the accumulation of aerial ammonia, causing detrimental effects on performance and welfare of chickens.

## Vitamins

Loss of vitamin activity can occur if the vitamin premix is stored inappropriately, so special attention should be kept in storing feed. Heat treatment of feed for conditioning or pelleting can result in degradation of some vitamins. Vitamin and mineral deficiencies affect embryo mortality and malformations. Although vitamin and mineral deficiencies are relative unusual nowadays because premixes are quite reliable, occasional problems can arise.

Due to a lower feed intake at high temperatures, a sufficient supply of vitamins has to be guaranteed. Adding 100 – 200 mg/kg of Vitamin C, 9000 IU/kg vitamin A, 500 IU/kg vitamin D<sub>3</sub> and 50 mg/kg of vitamin E will help the birds to overcome high temperatures.

## Correct use of pre-layer feed

Pre-lay feed should be used for a short period of time before a flock starts being supplied with phase 1 layer feed. This leads to a smooth transition from the developer feed (low calcium and low nutrient density) to a diet with high calcium and nutrient levels. It helps to avoid the often reduced daily feed intake during early production. Pre-lay feed has proven to be a very good tool in supporting the optimal nutrition of a layer flock.

Typically, pre-lay feed contains about 2.0 – 2.5 % calcium. This is too much for a typical feed for rearing but not enough for a bird

starting to produce eggs. From a nutritional point of view, it's therefore considered a compromise and never as optimal feed. Nevertheless, it's worthwhile to use a pre-lay feed for a short period of time. Correct use can enhance the uniformity of a pullet flock. It's especially beneficial for flocks with very low uniformity and also aids the development of Ca- metabolism in medullar bones. Since pre-lay feed is a compromise feed for the short transition period, it cannot supply a bird in full lay sufficiently. Therefore, it can't be used when feed logistics and correct timing do not work.

Please consider the following recommendations while using pre-layer feed:

- **Start using pre-lay feed dependent on to the birds' sexual maturity, age and their standard body weights.**
- **Use pre-lay feed for about 10 days with a maximum of 1 kg per bird**
- **The wrong way to use pre-lay feed is either to start using it too early and / or use it too long.**

For example if the onset of lay is scheduled for the 19<sup>th</sup> week of age, you may start feeding the birds with pre-layer feed only after they are 17 weeks old. In case of an earlier or later production, adjust this schedule accordingly.

## Feeding at onset of production and through peak

Aiming at an optimal start of production with feed intake around 90 – 100 g/day/hen it is recommendable, to use a phase 1 feed with 11.6 ME MJ/kg for a duration of 5 – 6 weeks at start of production.

At around 26 weeks of age a normal phase-feeding programme with 11.4 ME MJ/kg should be introduced. The basis for the feed formulation in terms of nutrient- and mineral content in each phase is the daily

nutrient requirement **and** actual feed consumption.

Flocks in hot climates may not be able to consume normal amounts of feed. Such flocks should be fed denser diets (higher in nutrient concentration) as a mean of compensating for low feed consumption.

## Feeding after peak

Adjustments in the feed formula for laying hens must be made, depending on the quantity of feed consumed and rate of lay, to assure adequate nutrient intake for maximum production and egg size. Review the information in Tables 12 through 14. After peak (about 36 weeks of age) change the diet a couple weeks after production has gone below the next 5 % production level.

Do not make the mistake to go down with the energy content in the diet as the hens are getting older, otherwise their performance might be reduced. The fact is that although the laying rate is going down as hens are getting older, their capacity to assimilate nutrients from the diet is reduced as well.

Try to maintain an appropriate energy level along the whole laying period in order to avoid drops in production.



# Management of Laying Hens

**Table 12:**

*Recommended Nutrient Levels per kg of Feed for different daily Feed for Lohmann Brown – Consumption in Phase 1 (19 to approx. 45 week ≈ above 56.9 g Egg Mass/Hen/Day)*

Nutrient		Requirement	Daily Feed Consumption			
		g/Hen/Day	105 g	110 g	115 g	120 g
Protein	%	18.70	17.81	17.00	16.26	15.58
Calcium	%	4.10	3.90	3.73	3.57	3.42
Phosphorus*	%	0.60	0.57	0.55	0.52	0.50
Av. Phosphorus	%	0.42	0.40	0.38	0.37	0.35
Sodium	%	0.18	0.17	0.16	0.16	0.15
Chlorine	%	0.18	0.17	0.16	0.16	0.15
Lysine	%	0.88	0.84	0.80	0.76	0.73
Dig. Lysine	%	0.72	0.69	0.65	0.63	0.60
Methionine	%	0.44	0.42	0.40	0.38	0.37
Dig. Methionine	%	0.36	0.34	0.33	0.31	0.30
Methionine/Cystine	%	0.80	0.76	0.73	0.69	0.67
Dig. M/C	%	0.66	0.62	0.60	0.57	0.55
Arginine	%	0.91	0.87	0.83	0.80	0.76
Dig. Arginine	%	0.75	0.71	0.68	0.65	0.63
Valine	%	0.74	0.71	0.67	0.64	0.62
Dig. Valine	%	0.63	0.60	0.57	0.55	0.53
Tryptophan	%	0.18	0.17	0.17	0.16	0.15
Dig. Tryptophan	%	0.15	0.14	0.14	0.13	0.13
Threonine	%	0.61	0.58	0.55	0.53	0.51
Dig. Threonine	%	0.50	0.48	0.45	0.43	0.42
Isoleucine	%	0.70	0.66	0.63	0.60	0.58
Dig. Isoleucine	%	0.57	0.54	0.52	0.50	0.48
Linoleic Acid	%	2.00	1.90	1.82	1.74	1.67

*\*without Phytase*



# Management of Laying Hens



**Table 13:**  
Recommended Nutrient Levels per kg of Feed for different daily Feed for Lohmann Brown –  
Consumption in Phase 2 (approx. week 46 to 65 ≈ above 55 g Egg Mass/Hen/Day)

Nutrient		Requirement	Daily Feed Consumption			
		g/Hen/Day	105 g	110 g	115 g	120 g
Protein	%	17.95	17.10	16.32	15.61	14.96
Calcium	%	4.40	4.19	4.00	3.83	3.67
Phosphorus*	%	0.58	0.55	0.52	0.50	0.48
Av. Phosphorus	%	0.40	0.38	0.37	0.35	0.34
Sodium	%	0.17	0.16	0.16	0.15	0.14
Chlorine	%	0.17	0.16	0.16	0.15	0.14
Lysine	%	0.84	0.80	0.77	0.73	0.70
Dig. Lysine	%	0.69	0.66	0.63	0.60	0.58
Methionine	%	0.42	0.40	0.38	0.37	0.35
Dig. Methionine	%	0.35	0.33	0.31	0.30	0.29
Methionine/Cystine	%	0.77	0.73	0.70	0.67	0.64
Dig. M/C	%	0.63	0.60	0.57	0.55	0.52
Arginine	%	0.88	0.84	0.80	0.76	0.73
Dig. Arginine	%	0.72	0.69	0.65	0.63	0.60
Valine	%	0.71	0.68	0.65	0.62	0.59
Dig. Valine	%	0.60	0.58	0.55	0.53	0.50
Tryptophan	%	0.18	0.17	0.16	0.15	0.15
Dig. Tryptophan	%	0.14	0.14	0.13	0.13	0.12
Threonine	%	0.59	0.56	0.53	0.51	0.49
Dig. Threonine	%	0.48	0.46	0.44	0.42	0.40
Isoleucine	%	0.67	0.64	0.61	0.58	0.56
Dig. Isoleucine	%	0.55	0.52	0.50	0.48	0.46
Linoleic Acid	%	1.60	1.52	1.45	1.39	1.33

\*without Phytase



# Management of Laying Hens

**Table 14:**

*Recommended Nutrient Levels per kg of Feed for different daily Feed for Lohmann Brown – Consumption in Phase 3 (after week 65)*

Nutrient		Requirement	Daily Feed Consumption			
		g/Hen/Day	105 g	110 g	115 g	120 g
Protein	%	17.02	16.21	15.47	14.80	14.18
Calcium	%	4.50	4.29	4.09	3.91	3.75
Phosphorus*	%	0.55	0.52	0.50	0.47	0.46
Av. Phosphorus	%	0.38	0.36	0.35	0.33	0.32
Sodium	%	0.16	0.16	0.15	0.14	0.14
Chlorine	%	0.16	0.16	0.15	0.14	0.14
Lysine	%	0.80	0.76	0.73	0.69	0.67
Dig. Lysine	%	0.66	0.62	0.60	0.57	0.55
Methionine	%	0.40	0.38	0.36	0.35	0.33
Dig. Methionine	%	0.33	0.31	0.30	0.28	0.27
Methionine/Cystine	%	0.73	0.69	0.66	0.63	0.61
Dig. M/C	%	0.60	0.57	0.54	0.52	0.50
Arginine	%	0.83	0.79	0.76	0.72	0.69
Dig. Arginine	%	0.68	0.65	0.62	0.59	0.57
Valine	%	0.67	0.64	0.61	0.59	0.56
Dig. Valine	%	0.57	0.55	0.52	0.50	0.48
Tryptophan	%	0.17	0.16	0.15	0.14	0.14
Dig. Tryptophan	%	0.14	0.13	0.12	0.12	0.11
Threonine	%	0.55	0.53	0.50	0.48	0.46
Dig. Threonine	%	0.46	0.43	0.41	0.40	0.38
Isoleucine	%	0.63	0.60	0.58	0.55	0.53
Dig. Isoleucine	%	0.52	0.49	0.47	0.45	0.43
Linoleic Acid	%	1.30	1.24	1.18	1.13	1.08

*\*without Phytase*



# Management of Laying Hens



## Mycotoxins

Contamination by mycotoxins may have a harmful effect on flock performance and will likely threaten the bird's immunity. They are present in more than 30 % of the cereals world-wide. It remains a challenge to detect mycotoxins in poultry feed that cause immune suppression, poor performance or lesions.

But not only affect the birds per se, additionally there is a nutritional quality lost, the fat content is markedly reduced and so the available energy. Spores can infect seeds before harvest while the crop is still in the field, during storage time at the feed mill or whilst being processed. Specially when the grain is exposed to warmth and humidity, which favours fungal growth. The higher the percentage of damaged grains, the higher the probability for mycotoxin contamination and the lower the nutritional value of the grain.

The first point of control is to avoid fungi growth in feed ingredients or feed.

Affected ingredients should be rejected to prevent contamination within stores, mills or feeders. Identifying potential contamination should not only rely on analysis of the mycotoxin levels present, but should also include the physical condition of the grains before accepting them.

During storage of grains, it is important to monitor temperature and humidity inside the bins. The inclusion of fungal inhibitors, such as organic acids, can suppress fungal growth. Dilution of contaminated grain with clean grain, which is often used to reduced the level of mycotoxins to below toxic levels is risky and may contaminate the whole batch, therefore it is not an acceptable practice. Many methods have been tested to remove mycotoxins from commodities, the problem is that they are costly and can reduce the palatability and the nutritional value of the raw materials.

## Feed restriction in the lay cycle

Lohmann layers are not normally prone to put on fat with correctly formulated feeds. Therefore, feed restriction is not recommended during the lay period. If a restriction programme is used, watch egg size, body weight and percent production very closely. These traits will decline first if birds are being under fed.

## Calcium

Laying hens need adequate calcium in their diets for eggshell formation. Layers will have more available calcium if the dietary calcium sources are in two different forms. One form may be finely ground such as limestone. The other should be fed as large particle size (> 4 – 6 mm) or crude lime such as oyster shell or hen-size limestone.

The bird's system is not as efficient at utilising calcium sources after 40 weeks of age. Also, older flocks produce larger eggs and more calcium is needed to produce a strong shell on these bigger eggs. For these reasons higher levels of calcium should be formulated into the diet as the flock ages.

Hens preferably consume calcium late in the day.

Additional calcium in the digestive tract during the time of shell formation (typically evening, night) will improve shell quality.

Additionally up to 5 g/bird oyster shells or limestone chips can be offered daily, in the afternoon and evening hours. Feeders should be run periodically during the four hours before dark to encourage calcium consumption.

**Table 15:**  
Calcium requirements (%) of different levels of feed intake

Daily Feed consumption (g/hen/d)	Age in weeks		
	19/20–45	46–65	> 65
105	3.90	4.19	4.29
110	3.73	4.00	4.09
115	3.57	3.83	3.91
120	3.42	3.67	3.75

**Table 16:**  
Calcium Supply / Recommended relation in Feed

Feed type	Fine Limestone 0–0.5 mm	Coarse Limestone * 1.5–3.5 mm
Pre-Lay + Phase 1	35 %	65 %
Phase 2	30 %	70 %
Phase 3	25 %	75 %

\*can be partly replaced by oyster shells



# Management of Laying Hens

Dietary calcium is stored during the day in medullary bone and later release for egg shell formation. Since bone consist of calcium phosphate, a deficiency of dietary phosphorus can disturb the deposition of the dietary calcium into medullary bone and consequently and consequently reduce shell quality. Phosphorous deficiency can appear through a reduced feed consumption during hot periods, therefore it would be wise to increase the margins of safety during this periods. Phytases will play a major role to make phytate phosphorus available.

The calcium content in the feed must be adapted to the reduced feed intake to preserve shell quality. This should be calculated according to the daily feed intake and the daily need, which will be determined by daily egg production and maintenance requirements, that depend between other factors on age, breed and environment conditions.

A general recommendation is given in table 15.

## Available phosphorus

There is little change in the available phosphorus requirements during the life of the flock. Be careful to provide only the level of available phosphorus intake necessary (about a half gram per bird per day). Too little or too much available phosphorus consumption can lead to shell quality problems.

## Post-peak body weights, production and egg weight

Body weight change, especially early in lay, is an indicator of proper or improper nutrient intake and should be considered as a part of the feeding programme of the layer. From 20 weeks of age to about 36 weeks of age body weights should be taken every two weeks and compared to

the goals. The objective is for continued increases in egg weight and body weight. If body weight does not increase slightly, production and egg weight may suffer. After a flock is 36 weeks old, the body weight average should be relatively stable with only a very gradual increase. A slight gain in body weight indicates that sufficient nutrients are being consumed for maximum performance.

**Excessive gains indicate excess amounts of nutrients. Adjust nutrient intake if excessive weight gain is present. If the body weight average should drop, the cause should be found immediately to avoid losses in production and egg mass. ■**

## Summary

- Reduce stocking density
- Unrestricted supply of good quality cool water should be available
- Monitor feed and water intake
- Feed during the coolest hours of the day, early in the morning and late in the afternoon
- Use a feed formulation with higher energy (added oil), lower total protein (but balanced amino acids) and higher levels of minerals and vitamins
- Stimulate daily feed intake (midnight snack)
- Nutritional strategies aimed to alleviate the disadvantage of heat stress maintaining feed intake, electrolytic and water balance as well as supplementing vitamins and minerals. A combination of a good management oriented to reduce the temperature in the house and a adjusted feeding will be the best solution under hot climates.





## Biosecurity

### General recommendations

Biosecurity is a management implemented system to help minimize the effect of infections and decrease the impact of diseases. It is an approach to safeguard the health and productivity of the flock. The challenge is to convince all poultry personnel of the impact of their actions on the risk of an outbreak of infectious diseases.

## Critical point for poultry operations

### Isolation:

A grower or layer farm should not be close to any other poultry operations. Any poultry related facilities close to the farm pose an increased risk. The all in/all-out principle is the best. It prevents the transmission of the disease from older flocks to younger flocks. It is recommended to build a fence around the farm area and to keep the gates closed at all times.

### Visitors, vehicles, equipment:

There should be only one functional entrance to the farm. Visitors should only be allowed to enter when absolutely necessary. All visitors (vaccination, moving crews) are required to strictly follow the same sanitary protocol as employees. They should not have been in any other poultry farm at least 48 hours before the visit. A log book should be used to document the visits at the farm. Cars of employees should not be allowed on the premises.

The entrance to the farm must include pressure washing equipment to clean the tires and undercarriage of the trucks that need to enter the premises. The movement of equipment from farm to farm should be avoided at all times. If absolutely necessary, make sure that they are cleaned and disinfected properly.

### Personnel:

Personnel working on a grower or layer farm should not own birds or work in another poultry farm. Clean clothes and boots should be available for everyone entering the premises. Best would be if shower-in/shower-out facilities are available. Always progress from younger to older and from healthy to sick flocks.

### Entrance to poultry house:

Poultry houses should be kept locked. Footbaths containing disinfectants should be available at each entrance. The disinfectant should be changed daily. Hands must be washed before entering the house.

### Bird disposal:

Dead birds should be considered as ideal carriers of diseases. Any form of contact between dead birds and humans, materials or rodents should be avoided. They have to be kept in sealed containers and should be buried, burned or disposed in an approved manner.

### Pest control:

Rodents are major vectors of many poultry diseases. They can effectively transmit the infection from house to house. It is crucial to prevent rodent from accessing feed, water and shelter by eliminating potential harbourage areas both inside and outside the house. It is important to have dedicated employees to inspect and manage bait stations. Good management practices and the careful selection of pesticide is essential for controlling insects. Fly and mosquito control includes checking for water leaks, stagnant water and ponds.

### Farm sanitation:

In order to reduce the infection pressure in a poultry house, it is essential to clean and disinfect between the flocks. A total downtime of at least 14 days is recommended. It is necessary to remove all organic ma-

terials such as feed, litter and manure because disease agents often dwell in these materials and are often able to survive the disinfection process.

Therefore, proper washing with warm water containing detergent, is the number one factor. There are several disinfectants available. To get the best performance out of a product, prepare a proper dilution with an adequate volume and contact time. Surfaces should be as dry as possible before starting so that the chemicals would not be already diluted by the water present.

## Vaccination

### General Recommendations

Only healthy flocks should be vaccinated. Check the expiry date of the vaccine batch used. The vaccine must not be used after this date. Keep records of all vaccinations and vaccine batch numbers.

Vaccination programmes vary with the area, disease exposure, strain and virulence of the pathogen involved and must be designed to meet the needs of specific local conditions. Competent poultry veterinarians should be regularly consulted for revisions of vaccination and medication programmes as well as for disease preventive management practices.

Medication practices such as the use of antibiotics and coccidiostats in the feed should also be under the direction of a specially-trained veterinarian with experience in avian pathology.

Vaccination is an important method of preventing diseases. Different regional epidemic situations require suitable and adapted vaccination programmes. Please contact your local veterinarian and poultry health service for advice and proper guidance.



## Vaccination Methods

Individual Vaccinations – injections, eye-drops – are very effective and generally well tolerated but also very labour intensive.

Drinking Water Vaccinations are not labourious but must be carried out with the greatest care in order to be effective. The water used for preparing the vaccine solution must not contain any disinfectants at all. During the growing period, the birds should not be given any water for approximately 2 hours prior to vaccination.

During hot weather, reduce this time accordingly. The amount of vaccine solution prepared should be calculated so that it will be completely consumed within 2 – 4 hours.

When vaccinating with live viral vaccines, add 2 grams of skim milk powder per litre of water or other protective products offered by vaccine suppliers in order to protect the vaccine virus.

Spray Vaccination is an efficient method for vaccinating large numbers of birds. Spray vaccination of day old chicks can be carried out at the hatchery or in the boxes upon arrival at the farm. Droplets of 250 micron are ideal for day old chicks as they result in a uniform coverage of the birds. For chicks of up to 3 weeks of age, only coarse spray should be applied. Coarse spray droplets (> 100 micron at bird level) can be used to target the areas around the upper respiratory tract. Fine spray (<100 micron at bird level) remain suspended in the air, are inhaled and penetrate deeper in the respiratory tract. The water used for spray vaccination should be fresh, cool (temperature 8 – 20 °C) and free of certain minerals and chlorine. If the volume of the water is too high, this can result in chilling of the birds. Follow the vaccine supplier's instruction accordingly regarding the quantity of water needed to spray the birds.

**Table 17:**  
Example of a Vaccination Programme

Disease	Appearance		Application Methods	Remarks
	worldwide	locally		
Marek	●		SC, IM	Day 1 – Hatchery
Newcastle	●		DW, SP, SC, IM	Number of vaccinations according to disease
Gumboro	●		DW	2 live vaccinations recommended
Bronchitis	●		DW, SP, SC, IM	Number of vaccinations according to disease
AE	●		DW, SC, WW	Vaccination of PS and Commercials is recommended
CAV	●		DW, SC, IM	Vaccination of PS and Commercials is recommended
Mycoplasmosis		●	SP, ED, SC, IM	Vaccination before transfer
Fowl Pox		●	WW	Vaccination before transfer
Pasteurellosis		●	SC	2 vaccinations approx. at week 8 and 14
Infectious Coryza		●	SC	2 vaccinations approx. at week 8 and 14
Salmonella		●	DW, SP, IM	Vaccination before transfer
ILT		●	DW, ED	2 vaccinations between 6 – 14 weeks
EDS		●	SC, IM	Vaccination before transfer

DW: Drinking Water

IM: Intramuscular Injection

SP: Spray SC: Subcutaneous Injection

Vaccination against Coccidiosis (F-W) is optional for floor rearing systems

F: Feed

ED: Eye Drop

WW: Wing Web



### Special Recommendations

Vaccination against Mycoplasmosis with live or inactivated vaccines is only advisable if the farm cannot be kept free from the infection. Infections with virulent *Mycoplasma* species during the production period lead to performance depression. The best performance is achieved by flocks which are kept free of Mycoplasmosis without vaccination.

Vaccination against *Salmonella* could be done with live and/or inactivated vaccines. In many countries today, vaccination against *Salmonella* serotypes of public health significance, especially *S. enteritidis* and *S. typhimurium*, is being practised. This is done in order to help improve the protection of consumers against food-borne *Salmonella* infections, but not to protect the birds themselves against clinical disease. Vaccination against *S. gallinarum/pullorum* is not recommended as farms should be free of this very significant poultry pathogen.

Applying Vitamins in the first two to three days after vaccination, can help to reduce stress and prevent undesired reactions. How far this is necessary depends on the specific situation on each farm.

### Serological Monitoring

Serological data obtained after the bulk of the vaccination programme is completed by 17 or 18 weeks of age, is a good method to evaluate the immune status of a flock of pullets prior to production. Such data also serve 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 lay 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 titre 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 programmes and flock conditions possible. ■

### General recommendations

As soon as the hens have been moved out, it is advisable to treat walls and ceilings with insecticides while the shed is still warm. This prevents insects of all kinds from crawling out of the litter into existing wooden structures or insulation materials as the building cools down.

All litter and manure should be removed from the building. The room should then immediately be thoroughly cleaned so that it is empty for as long as possible. The purpose of cleaning and disinfection is to eliminate pathogenic microorganisms which can jeopardise the health of the next flock to occupy the building.

### Removal of litter

Litter must be removed completely and spread as far away from the hen house as possible, the recommended distance being > 1km. If this is not possible the litter should be worked into the soil before the building is cleaned. This prevents recontamination through dust and flying feathers.

### Washing

One day before the washing operation, the entire interior of the building, including walls, ceilings and the remaining furniture, should be soaked. The use of fat- and protein-dissolving substances is recommended for this purpose. The room should then be cleaned with pressure washers, starting with the ceiling and working down to the floor. The exterior of the building, including concreted outdoor areas, should also be washed down.

### Drinkers

Drinkers are potential hazards unless they are included in the sanitation routine. They should therefore be cleaned and disinfected.





## Hatching eggs – Handling and Incubation

ted. Disinfection of water pipes can be carried out with disinfectants such as sodium hypochloride or chlorine bleach solution. Drinker lines should be thoroughly flushed out after disinfection.

### Feeders

All left-over feed should be removed from the farm. Cleaning and disinfection of all parts of the feeding system, including silos, is urgently recommended.

### Disinfection

When the facility has been completely re-assembled, the entire building should be disinfected again. ■

### Breeder Flock

In this chapter, we will not only deal with the incubation process, but also with the management of the hatching egg.

Environmental conditions during egg collection, egg shell disinfection, transport, storage and incubation should always be kept under control. Inappropriate treatment will result in reduced hatchability, poorer chick quality and can affect post-hatch performance.

High environmental temperatures will result in the following which will then have a depressive effect on hatchability: the fertility would be affected, the eggshell quality reduces and constantly good conditions during egg handling would be more difficult to achieve.

In order to maintain good fertility, it is absolutely necessary for the males to be in good condition. It is desirable to maintain a good environment in which birds are comfortable and actively mating. Special attention should be given to keep the correct ratio of healthy and robust males in the flock. Vitamin and water additives will help to maintain fertility during heat stress.

Egg weight also has a high correlation with the body weight of the chicks at hatch. Egg weight normally decreases under high temperatures which means, a low body weight of the chicks at hatch. These chicks normally have more problems to start and show higher mortality when brooding under hot climate conditions. Management practices oriented to maintaining good egg sizes in parent stocks, are of great importance. In relation to this point, the following recommendations are highlighted: the application of an adequate methionine and linoleic acid content in the diet to reach a good body weight at start of lay, which already begins in broo-

ding and rearing. The use of an adequate lighting programme should not accelerate the start of laying. Furthermore, an appropriate ventilation management should be carried out in order to reduce heat stress.

Egg shell quality must be guaranteed. If the shell is thin, it does not protect against the entry of micro organisms properly and the gas exchange will not be optimal for the development of the embryo. An eggshell of good quality is one of the main concerns in hot climates. Therefore, major efforts must be exercised to improve shell quality.

In cases of floor housing, keep the litter dry. If the litter is wet, there is a risk that the nest will get dirty and this will contaminate the eggs. Floor eggs should be separated from clean nest eggs. Floor eggs are not suitable for incubation, therefore do not wash and deliver them to the hatchery. To avoid having floor eggs, it is necessary to provide enough nest space and appropriate nests. Nests should be cleaned periodically and should be kept closed during the night so as to avoid birds roosting or sleeping in nests which leads to the nest becoming dirty. It is also good practice to maintain the egg collecting system clean and to disinfect it regularly.

It goes without saying that biosecurity in a breeder and hatchery operation is the basis for the subsequent production process and should be treated with first priority. The highest level of hygiene must be maintained in these facilities.

### Egg handling and storage

When an egg is laid, a small embryo with approximately 40000 cells is already present. The vitality of this embryo must be preserved until the point when the incubation process finally starts. To achieve this, the eggs have to be handled carefully and temperature fluctuations should be avoided.



## Hatching eggs – Handling and Incubation



Firstly, the further development of the embryo which started in the hen's body has to be stopped. The egg should therefore be cooled down to below *physiological zero* (26 – 27 °C), within four to six hours after being laid. This process usually happens inside the nest or on the egg belt. When the surrounding temperatures are high, cooling can be a problem. In such a situation, egg collection has to be done more frequently to prevent the embryo from experiencing temperatures between 27 °C and 37 °C for too long a time. This temperature range causes an unbalanced development and hence, early embryonic mortality. If the house temperature exceeds 30 °C, the eggs should be collected every hour!

Keep in mind that too rapid cooling can also weaken the embryo. Therefore, it can be beneficial to maintain the farm egg room temperature at 22 °C, if the barn temperature is very high. Under these conditions, the eggs need to be transported on a daily basis to the hatchery, if they are scheduled for storage beyond one week.

Once the cell division has stopped, the egg needs to cool down further. There are different optimal egg storage temperatures depending on the storage length. For eggs that will be set within the next 4 days, it is not necessary to keep them at a temperature below 20 °C. 21 – 22 °C is considered to be optimal. For storage of up to 10 days, which is common practice in most layer hatcheries, the recommended temperature is between 16 – 18 °C.

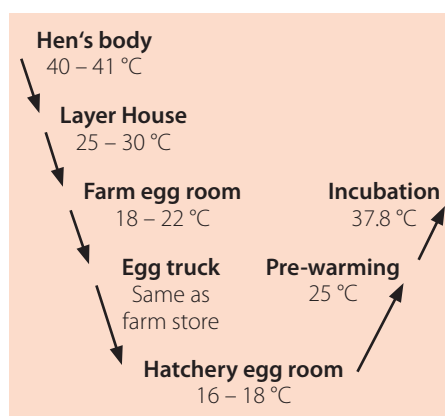
Eggs which have not cooled down properly, should not be placed on paper trays and stacked as this retards a further cooling of the eggs. It is advisable to use plastic trays which allow better air circulation and faster cooling. Do not pack the eggs too tightly together. Always allow free air movement.

Irrespective of the temperature, it is best if the hatching egg were to undergo only two temperature directions from the moment of lay until pre-warming and setting (see figure 1). The temperature history curve should look like a V and not like many W's, as already small temperature fluctuations of just 1 °C can cause hatchability losses. This can be checked by the use of temperature data loggers. Ensure that the doors of the storage room remain closed. The room should be well isolated and equipped with sufficient cooling capacity. Transportation should take place preferably during the cooler periods of the day. It is a good investment to have an appropriate egg collection vehicle in which the temperature can be controlled.

The humidity during storage is not as important as the temperature. However, when eggs are scheduled for a long storage period, higher humidity will help to avoid excessive moisture loss of the eggs. The target value should be 70 – 80 % relative humidity.

Hatchability and chick quality would improve if hatching eggs are set within the first week after being laid.

**Figure 1:**  
Optimal egg temperature flow chart under hot climate conditions



### Egg disinfection

Hatching eggs need to be disinfected to prevent micro-organisms from multiplying rapidly in the warm and humid climate of a hatchery. A widely used method is fumigation with Formalin. However, this is no longer recommended as it is hazardous to human health and harmful to the embryo. This is especially true if the division of the cells was not stopped properly or if the temperature during fumigation exceeds 25 °C. Both are likely to occur under hot climate conditions.

There are modern chemicals available which are based on glutaraldehyde and different quaternary ammonia compounds or on stabilised hydrogen peroxide and peracetic acid which have the same effectiveness. These agents can be sprayed, fogged or vaporised. The most popular method is fogging as it is safe, the fog reaches all the eggs and the eggs will not get wet. Vaporisation requires less investment in equipment, but chemicals that can be used in a safe manner are not available everywhere. Before choosing any chemical, please make sure that it is labelled for use in hatcheries.

The disinfection of eggs on the breeder farm may reduce the microbiological load as soon as possible but keep in mind that this cannot exclude the risk of floor eggs or dirty eggs being contaminated. As some re-contamination is hard to avoid, the eggs should be disinfected again in the hatchery. In the hatchery, eggs are usually disinfected after grading/ traying before being put in the storage room or before setting. The storage room can be fogged daily but this will not be necessary if it is cleaned regularly.

### Hatchery – General rules

Given that the hatching egg quality is present, an embryo also needs five other con-



# Hatching eggs – Handling and Incubation



ditions to grow satisfactorily and develop into a healthy chick:

1. Correct incubation temperature.
2. Adequate supply of oxygen and removal of CO<sub>2</sub>.
3. Loss of a certain amount of water as moisture vapour.
4. Regular turning.
5. A hygienic environment.

This is true for every hatchery world-wide, but depending on the location and the equipment available, it can be more difficult to achieve. In hot climates points 1. and 5. require special attention.

An incubator can only maintain a stable desired temperature – and also humidity – if the incoming air meets special requirements. These are depending on the machine type. Usually, the room temperature should be within the range of 23 °C to 28 °C and the relative humidity close to 50 – 60 %. If the conditions differ from these recommendations, the incubator needs to act more which means more heating, cooling or humidification. This leads to an uneven incubation climate resulting in reduced hatchability and chick quality. When dealing with high air temperatures in existing hatcheries, an installation of air conditioners in the setter and hatcher rooms can be recommended. When planning a new hatchery, it is worth investing in a good central HVAC-system (Heating, Ventilation, and Air Conditioning) which is able to bring the incoming air to the hatchery under the desired conditions. This investment will be returned with better and more reliable incubation results. It should be borne in mind that it is impossible to hatch chicks properly in a hot climate without the use of a corresponding cooling system. Hatcheries located in dry climates require additional equipment to maintain the appropriate relative humidity of 50 – 60 %

As mentioned previously, it is an absolute must to minimise the microbiological load inside a hatchery. In hot climates, water quality is often not sufficient for hatchery purposes. This might lead to an infection of the chicks by the sprayer of the hatcher. To avoid this, chlorine can be added to the water at a concentration of 5 mg/kg. Another – but so far more costly method – is disinfection using UV-light which can also be applied to the incoming air or the egg storage room.

A constant supply of uncontaminated water of good quality, is of major importance, not only to guarantee the good hygienic and healthy condition of the chicks, but also the proper function of ventilation and cooling systems.

Waste should be removed as soon as possible from the hatchery to prevent contamination problems.

## Hatch day – Chick processing

The management on hatch day should minimise the risk of chick dehydration. High temperatures force the chicks to pant and thereby lose water by evaporation.

What can be done is:

Pay attention to the timing of chick pull. Some chicks should still be a little bit wet (approx. 5 % of the chicks) around the neck to prevent firstly hatched chicks from having to wait a long time in the hatcher.

If the chicks are too dry at pulling, set the next batch of eggs a few hours later. The freshness of the chicks can also be judged by weighing the chicks. Chick yield, which is chick weight divided by original egg weight, should be at approximately 66 %. Four hours of extra waiting in the hatcher will reduce the chick yield by one percentage<sup>1</sup>.

The chick take-off should be done in a well ventilated room with a temperature of 25 – 26 °C.

1. With the Marek vaccination, extra fluid can be given to the chicks. When the injection is done subcutaneously, the volume can be up to 0.5 ml. Intramuscularly, it should be not more than 0.2 ml to avoid damaging of the muscles. For the same reason, one should have a look at the temperature of the diluent. Temperatures of 15 – 25 °C are recommended. The prepared vaccine should therefore not be placed in a cold fridge.
2. Depending on the temperature and ventilation of the chick holding room and the truck, it can be beneficial to put less chicks in each box, e.g. reduce these numbers from 100 to 80.
3. Chick transport should be done during the colder periods of the day or at night. ■

<sup>1</sup> *Beside the time spend in the hatcher chick yield is also influenced by the weight loss of the eggs during incubation. More information about incubation can be found in the separate available Hatchery Management guide. There, all hatchery related topics are explained in detail.*





# Recommendations for egg producers for handling commercial eggs

## General recommendations

Adequate equipment and appropriate designs for layer houses, as well as good management practices to alleviate the heat stress of the birds and to improve their performance in hot climates, have already been discussed in previous chapters of this management guide. If the egg producer strictly follows these practices, he will obtain optimal egg production and egg quality under these conditions. Furthermore, a good hygienic and health status of the flock should always be guaranteed.

Additional care should be taken in the next steps to not let the entire good job which has been done before go to waste and to ensure that the consumer receives an excellent product in the best condition. Eggs should have the highest quality with an attractive appearance for human consumption. There is a general understanding that high ambient temperatures have negative effects on the quality of eggs.

Furthermore, the handling of the eggs also has an influence on their quality. For this reason, we would like to make some recommendations as well as some pointers in the following pages for you to observe so as to minimise the decline in egg quality which may occur with time after the egg is laid. An understanding of egg production practices will help the personnel to deal with product quality issues.

Production is either off-line or in-line. Off-line refers to processing operations which are not integrated with the laying facility. These eggs are gathered and moved from laying facilities to other locations. On the contrary, in-line production refers to processing operations where eggs are laid, processed, packed and distributed from one location. Most production facilities today are largely integrated in-line operations with environmentally-controlled

systems which are completely automated with conveyor belts that carry the eggs out of the laying house. The eggs must be handled properly throughout the processing and transportation to maintain its quality.

## Egg Collection

Immediately after it is laid, an egg begins to lose quality. Maintaining the right temperature and humidity conditions at an optimum level will help to retard the decline in quality considerably.

Egg collection is done either manually or mechanically. Several collections should be done during the day (even 5-6 times during hot weather) in order to bring the eggs to the correct temperature as soon as possible and to avoid the reduction of their quality. There is another advantage of gathering eggs frequently. By doing so, it is possible to avoid the excessive accumulation of eggs in the egg roll-outs trays, thereby preventing contact and crashing between eggs.

It is important to know when the eggs are laid in order to optimise collection times and to reduce the incidence of egg breakage during oviposition and/or in the subsequent transport process. Excessive build-up of eggs in the egg roll-out trays and on the collection belt, increases egg to egg contact resulting in higher incidences of shell fractures. Careful timing and frequent collections can help minimize this problem. As a rule of thumb, approximately 50 % of the eggs are laid within 5 hours after lighting is turned on and the peak takes place at about the same time. To minimize collision with other eggs, it is recommended that eggs be gathered two or more times each day. It is important to properly install and adjust mechanical collection, as well as to monitor and maintain the collection system to avoid additional

losses of eggs, which are crushed through the system.

The transport bands and nests should be cleaned regularly. Otherwise the eggs will become dirty. Moreover, dirtiness in hot conditions will produce the proliferation of germs and moulds.

Only clean eggs should be stored otherwise possible contaminations can occur. Therefore, the production of clean eggs is of major importance. A good and clean eggshell is one of the first factors which determine whether an egg is appropriate for human consumption or not.

Eggs with (micro-) cracks are not suitable for consumption. Classification should be done under observation of qualitative characteristics. Eggs with shape imperfections, broken or dirty eggs, and those with poor shells, should be removed.

Excessively large, broken or dirty eggs, or those with poor shell quality, should be removed as the eggs are gathered. If eggs are not washed, the production of clean eggs becomes even more important. If washing is carried out, it should be done according to the local regulations and in a way that it will minimise the chances of bacterial penetration of the shell, otherwise it might produce more damage than just leave dirt on the shell.

Continuously cleaning of nests, belts and roll-outs are strongly advised. Just one broken egg can soil a number of clean ones.

## Building and facilities

Maintaining a highly sanitised environment is an integral part of processing quality eggs. The design of the building and layout of the premises should provide suitable environmental conditions, allow adequate cleaning, minimise contaminati-



# Recommendations for egg producers for handling commercial eggs

on and provide the best space to accommodate the processing operation.

The premises should be kept clean and free of trash, debris, old equipment and supplies to not only prevent the presence of insects and rodents, but also to avoid cross-contamination.

The floors, walls and ceilings of the buildings should be constructed out of materials that are durable, smooth and easy to clean. Doors and windows leading to the outside should be closed when not in use. Adequate ventilation should be provided to control and ensure the temperature and humidity for properly working.

All rooms should be kept clean and sanitised at all times. Waste collection and immediate disposal of the same, is important to maintain an environment free of odours and pests. Waste containers should be emptied and cleaned each day and waste should be removed from the processing operation.

Separate areas should be provided for the storage of packing and packaging materials and chemicals. These should be properly identified to prevent any accidental contamination of the eggs. All equipment and processing rooms should be cleaned thoroughly at the end of each processing day and should remain very clean throughout the processing.

## Storage conditions

Storage rooms, adjacent facilities and equipment should be cleaned and disinfected regularly. No other material should be stored in the egg storage room. Avoid storing eggs close to strong smelling materials. Cooler rooms should be kept free from odours and mould and must be maintained in a highly hygienic condition. The coolers should be capable of maintain-

ing the temperature and humidity which is required for the preservation of the eggs. Coolers should be equipped with thermometers and hygrometers to monitor temperature and humidity, which should be regularly tested and calibrated. A good refrigeration capacity with a proper airflow pattern and the installation of ceiling and wall insulation, are crucial in hot climates.

It is advisable not to place the filler flats into unvented corrugated fibreboard boxes as this dramatically increases their required cooling time. In order to favour better and more uniform cooling, pallets should be arranged in two rows creating a narrow tunnel between them. Pallets should be distributed, maintaining an appropriate distance so that the cool air can be drawn through the eggs.

After eggs are graded and packed, they should be moved immediately to the shipping room and held there until ready for distribution. The way eggs are stored is just as important as for how long they are stored. Eggs can lose just as much quality in one day when stored at room temperature as they might after 5 days in a properly refrigerated room. After collection, eggs should be cooled down as quickly as possible in a well-equipped storage room. Storage temperature must be according to the respective regulations in each country, but the general recommendation is 10 – 15 °C. Relative humidity of 70 – 80 % in a storage room is recommended to prevent loss of moisture from the egg. If a humidifier is not installed in the cooling unit, it is advisable to put at least one open tray of water in the cool room to ensure the presence of enough humidity. During this conservation period, the refrigeration chain should not be interrupted and the storage conditions should remain constant. The highest quality of the egg is at the time when it is laid. After this point, a continuous and irreversible deterioration

process begins. However, carefully-controlled storage conditions can slow down the rate of quality reduction.

At this point, we would like to stress that eggs must not sweat and for this reason, special care should be taken when moving the eggs from one room to another.

Eggs usually sweat when cold eggs are moved out of the cooler into the hot and humid outside air, or when temperature fluctuations occur inside the cooler. Wet egg shells promote the growth and penetration of bacteria into the egg through the shell pores. Such conditions also promote the growth of mould.

The consistency of the albumen provides some information about the conditions during storage as well as the grade of freshness, i.e. how old an egg is. As the egg ages and carbon dioxide is lost through the shell, the contents become more alkaline and this causes the albumen to become transparent and increasingly watery. To be of top quality, eggs must have a high percentage of thick albumen. This consistency is important for the consumer as this is a determining factor at the time of cooking in terms of the presentation of the egg on many plates. To assess egg freshness the height of the thick albumen is measured with a micrometer and later on, the Haugh Units value is calculated based on this measurement and the egg weight. When an egg which is broken onto a flat surface is watery and has a widely spread albumen, this usually indicates that the egg is stale. There are several factors which influence the albumen height, for instance, the age of the hens, nutrition, high levels of ammonia due to improper ventilation, lighting programmes and genetics. Probably the most important effects, are the environment and storage conditions. The decline of freshness is increased by improper care of the eggs i.e.





## Recommendations for egg producers for handling commercial eggs

high storage temperature and low humidity. Furthermore, with time, the resistance of the vitelline membrane becomes weaker and this can easily cause the breakage of the yolk.

When the egg is laid, it is warmer than its environment. As it cools, the contents contract and a small air space is formed between the inner and on the outer shell membrane. As the egg ages, moisture and carbon dioxide continue to be lost through the pores, but in conditions with high temperatures, this loss is even higher. The air chamber of the egg becomes bigger as the egg gets older. The height of this air chamber can be used to assess the freshness of the egg. Under good conditions, the chamber of a first quality egg should not be bigger than 6 mm.

### Egg Handling

The monitoring of egg handling procedures is mandatory. Eggs should be handled with special care. Bumping or shaking of the eggs should be minimised to avoid breaks or cracks in the eggs. It is of special interest to monitor the occurrence of this problem in older flocks and in hot climate areas where the eggshell quality might be reduced. Moreover, it should be stated that whenever these problems occur, it is a problem which already might exist at the time of lay. This could be due to deficient nutrition, or a problem which surfaced during collection, transport to the classification centre, in the storage or in the subsequent transport to the commercialization centre. The problem can only be analysed with this knowledge and the corresponding solutions can be undertaken.

The egg boxes should be stored over pallets and not directly on the floor to avoid contamination and moisture. Moreover, by doing so, transporting the eggs would be made easier. Cartons or filler flats of eggs

should be gently and carefully placed on conveyors to minimise any additional breakage. Do not stack flats at more than six flats high. Packaging and packing is normally done in line with the grading operation. Clean packaging and packing materials should ensure adequate protection of the product in the egg handling required.

Commercialization or distribution to sales centres should be done with appropriate vehicles, i.e. refrigerated trucks with sufficient cooling capacity. This is mandatory to maintain the refrigeration chain. Truck beds should be equipped with racks to provide a uniform circulation of air throughout the load. Before loading, trucks must be cleaned and disinfected. Furthermore, it is advisable to pre-cool the vehicle prior to loading and transport so as to minimise the loss of moisture of the eggs during transportation. It is not recommended to wrap pallets of eggs in plastic, which egg handlers sometimes do in order to stabilize the pallet load for shipping. In such practices, the humidity of the air within the load will increase and if these conditions are maintained for a long period of time, this will result in the growth of mould.

Last but not least, we would like to stress the significance of appropriate training for the employees who handle the eggs, that the latter are aware of the importance of their job and also the negative effects on egg quality due to inadequate egg handling or storage conditions. Moreover, employees should comply with the sanitary and hygienic rules to avoid cross-contamination. ■

### Summary

- Management of the flock according to previous chapters.
- Frequent egg collection (at least 3 times a day), especially in summer.
- Cool the eggs quickly and store them under optimum conditions (temperature and humidity)
- Handle the eggs carefully to prevent breakage.
- Classification should be done under observation of qualitative characteristics, only clean eggs with an intact eggshell are appropriate for sale.
- Adequate refrigerated holding space and storage design.
- Avoid storage of eggs close to strong smelling food.
- Pack the eggs in clean, cool packing material.
- Keep eggs according to descending age in a storage room, so that older eggs leave the storage room before the young ones, thus all eggs are sold as fresh as possible.
- Minimise the storage time on the farm.





## Conclusion and remarks

Heat stress can result in significant losses to producers with all types of poultry. The most obvious loss is due to mortality. But there are other losses in production efficiency, such as reduced growth rate in rearing, losses in egg production, reduced shell quality and reduced egg size and hatchability, which have a high impact on the economics of the business. Farmers should be aware that losses in production efficiency will occur long before significant mortality rates are observed.

Even in countries with moderate climate conditions it's not uncommon during the summer months to have periods of high environmental temperatures often accompanied with high relative humidity. Acute heat stress can profoundly affect the productivity of a flock in those areas too and heat stress is often overlooked as a cause for subtle losses in egg production or poor growth.

In the booklet the authors gave information about this phenomenon and discussed

how to react concerning house construction, climate control and bird management. On this base poultry men can take actions minimizing the impact of heat stress on their business. ■







[illegible]



# Notes





## How Lohmann Tierzucht is calculating the energy content of feed and raw materials (International WPSA-formula):

$$\begin{aligned} \text{ME MJ/kg} = & \quad \text{g crude protein} \times 0.01551 \\ & + \text{g crude fat} \quad \times 0.03431 \\ & + \text{g crude starch} \times 0.01669 \\ & + \text{g sugar} \quad \quad \times 0.01301 \text{ (as Saccharose)} \end{aligned}$$

**ME = metabolizable energy in MJ/kg**      **1 Kcal = 4.187 kJ**

Consultation and diagnostics in all questions of poultry health through:

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