ISA

A Hendrix Genetics Company

Management Guide

Alternative production systems

Introduction

The cage system remains the most common production system in use globally, however use of alternative production systems is expanding across the world. In recent years ISA has been developing pure line breeds, which take into account all breeding goals - from productivity and parent stock performance, to commercial stock performance and shell quality. ISA R&D effort has also been working on behaviour, robustness and liveability, both internally, and in collaboration with universities and research institutes.
Welfare is also a focus of attention in the ISA breeding program. For instance, video recording, feather scoring, body temperature recording, behaviour testing, in rear and in production are performed on birds which are on floor systems in an ISA R&D farm.

In order to improve commercial stock performance resulting from crosses between non related lines, the ISA R&D department have conducted studies on pure line birds which are bred in a safe environment and also with cross line offspring which are tested in field conditions and production systems. This is a key stage in bringing the power of hybridisation to the crosses, which have to perform on alternative production systems. However, regardless of the intensity and efficiency of selection, genetic potential cannot be realised without the experience and know-how of the stockperson managing the flocks. Good rearing is needed to reach the best genetic potential as it directly affects the flock's performance

This guide highlights management factors, which can help to achieve maximum profit from ISA egg layers. Results obtained during the rearing period will be decisive for the production period of the layers. A good growing period will enhance viability and production levels during the laying period.

This management guide describes the recommended programs for each period of the bird's life cycle from hatching until depletion, which will keep flocks healthy and highly productive in alternative production systems. We hope that you find this management guide useful and a positive contribution to making continuous performances improvement of your hens.

Contents

Warranty disclaimer

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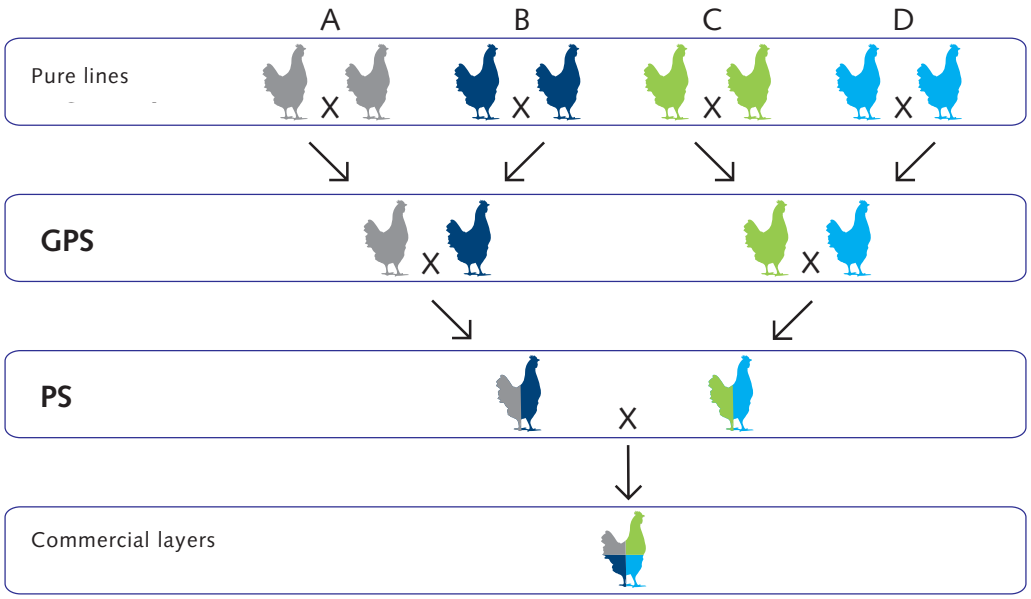
Hybridization



Definition of the different systems

Alternative production systems can be defined as a non-cage system with nests, adequate perches and a scratching area.

Within alternative production systems different housing sub systems can be defined as:

- A barn (deep litter) system is a house where birds have access to a litter area, and are able to practice natural behaviour like dust bathing and scratching. A barn house also provides nest boxes and can have a slatted area where water and feed are presented.
- An aviary house (multi tier) is like a barn house, in addition, birds are able to move among different levels. Feed is presented on different levels and water is mainly presented in front of the nest box. Birds need to move through the system to eat, drink, rest and produce eggs.
- Free range is either a barn or an aviary house from which birds have access to an outside range area.

White ISA layers in aviary system

Brown ISA layers in barn system

Rearing period

Building and equipment

For birds destined to produce eggs on an alternative system (litter, slatted or aviary), it is strongly recommended that the same type of housing system is used in rearing and production. This enables the birds to become familiar with the production house and its equipment after transfer, overcoming this stressful period smoothly.

For aviary houses it is strongly recommended that birds are reared on a system which teaches them to jump to water lines, ideally located at a higher level. Providing perches in rearing helps to get a better distribution of birds in the production house.

In aviary rearing systems, where birds are closed in during the first weeks, it is important to release the birds at a young age to promote searching behaviour.

Feed and water

We recommend the use of a feeding system which distributes the feed rapidly throughout the house and enables the birds to finish all the distributed feed each day. This encourages the birds` intake capacity and avoids fine particle accumulation. Rapid floor mounted chains are the best option, with the easiest feed intake control.

If pan or tube feeders are used they should be adapted specifically for this technique.
The feeders as well as drinkers should be easily accessible and visible for the birds, their height adapted to the size of the chicks throughout their life. They should not form a big obstacle to the movement of the birds throughout the house. They should be placed on slats if slatted areas are used in the house so that the birds are encouraged to use them.

Birds must use the same drinking system in the production houses as the one they are already familiar with in the rearing houses. Nipples must be suitable for day old chicks. For infra red beak treated birds it is recommended to use a 360° nipple or provide open water for the first week.

It is a good management practice to provide supplementary drinkers during the first days of life to promote water consumption.
In aviary rearing houses it is recommended to check whether birds are moving in the system - to avoid dehydration
Follow the standards for drinking and feeding space given in the section on stocking densities and environment - from day old to depletion.
Remember: if the chicks do not drink enough for any reason, they will not eat enough. Therefore the growth and uniformity of the flock will be compromised.
For further details check table 2: Equipment requirement for rearing

We recommend the installation of feed and water monitoring equipment.

It is necessary to measure daily water and feed intake. The consumption/empty feeder time is also a practical tool if accurate measurements are not possible. Any strong deviations from the previous day's consumption might indicate the onset of diseases or technical problems. A regular inspection of the flock helps to avoid big surprises in the development of the flock.

Partitioning

Facilities within the poultry house must be designed for maximum comfort and must allow birds to express their natural behaviour. Partitions within the house can be provided to avoid competition and allow birds to have separate areas/pens for feeding and drinking. This will also have a positive effect on bird's behaviour in terms of smothering, cannibalism, feather pecking and mortality.

The design should incorporate as many lightweight materials as possible. This gives better flexibility when moving and helps in cleaning and disinfection. Lightweight materials can be either metal, wood or plastic. The design also requires a none solid wall such as wire mesh (large gauge) to allow airflow through and to avoid restrictions due to dust accumulation. To prevent birds on either side of the partition from seeing each other, it is often recommended the bottom part should be blanked off to a height of 30 cm.

Heating systems

Heating system must be sufficient to meet the requirements of the chicks. It is best to use a closed heating system, without an open fire, because heaters (burners) consume oxygen and produce large amounts of CO_2, which must be ventilated out of the rearing house.

Different heating system could be used, brooder for spot heating, canon for whole house heating or floor heating for modern rearing poultry houses.

We advise to use 2 gas brooders or 2 radiant heaters of 1450 kcal / 1000 birds.

Perches

Perches improve welfare by allowing the bird to express its natural behaviour.
Perches are useful:

- To increase the usable surface per bird and decrease floor density
- To train the bird to jump in the system
- To offer an escape to aggressed birds

The recommended perch surface per bird is 5 cm. The first accessible level must be at 20 cm height. Perches must be introduced before 4 weeks of age.

Ventilation

A good ventilation system in rearing house is essential to obtain good pullets and avoid common problems.

Ventilation must allow:

- Provision of fresh air to the stock
- Temperature control
- Consistent house climate without draughts
- Evacuation of moisture, dust and noxious gases
- Reduction of air borne pathogens level
- Minimizing the risk of conjunctivitis and blind pullets due to ammonia
- Minimizing the risk of respiratory disease and colibacilosis

The minimum ventilation requirement is 0,7 m^3/kg bodyweight and the maximum ventilation requirement is 3,6m^3/kg bodyweight.

During the coldest winter period, it is sometimes useful to heat the house after 6 weeks of age to maintain a good environment in the rearing building, otherwise the problems mentioned above can occur. Cyclic ventilation could be a way to ensure a minimum ventilation rate.

Litter

Litter is used to cover the floor in a rearing/brooder house. It usually consists of wood shavings or chopped straw. Litter is an important component of the rearing input that must be well managed to prevent unhealthy environment and potential disease conditions. Good quality shavings must be used as litter to avoid the risk of introducing various diseases to the site.

The following advice may assist in good litter management:

- Fresh shavings must be dried and friable
- Must be a suitable material and particle size
- Be stored in dry, hygienic, rodent-proof premises
- Avoid introducing wet or damp shavings into rearing house
- Do not use saw dust, as this could cause respiratory issues with chicks
- Avoid wet or caked litter

Good litter when pressed in the hand should stick together slightly and break up as the hand is released.

Litter is important in the regulation of floor temperature and subsequently the chick's body temperature. The litter temperature should be approx 30°C at the time the chicks are placed onto the floor. This is very important for the development of the chick in the first few days as they cannot self -regulate their body temperature until approxiately 7 days.

Concrete floor houses with significant litter depth can lead to moisture problem.

Lighting systems

Lighting systems in rearing must be dimmable and programmable. Lights must be placed in different strategic places, above the perches, slatted area and above the floor. Lighting system must be independent and must allow for the programming of each line individually. To promote a good behaviour in lay, birds must be trained from a young age to climb on to perches before the lights are switched off, by switching off the floor lines first and then the perch lights.

Light intensity must be uniform inside the building. If not, it is strongly recommended to increase bulb numbers. Use of low frequency light could lead to flickering light, which increases stress in the flock.

Rearing pullets

Basic growth concepts - body weight development & uniformity

It is extremely important to follow ISA body weight recommendations during the whole life of the birds. From day old to transfer, the bird will grow slowly and organ development occurs at various ages. A lack of growth during a stage could have a detrimental impact on pullet quality. Two birds with the same body weight haven't necessarily developed the same body composition. Good growth curves lead to good pullet development.

Growth is split in the following stages:

- The first 3 weeks are devoted to immune system and the organ development
- From week 3 to week 6, skeleton and muscles are growing

Body weight at 5 / 6 weeks is the most important determinant of pullet quality. Growth delay at this stage is harmful to the birds.

The next step is characterised by ovary development and rapid growth of these organs. Sexual hormonal regulation takes place around 18 weeks and leads to sexual maturity around 18 weeks.

At all stages flock uniformity has to be followed up to. The objective is to have a very high uniformity in order to facilitate flock management and stimulation. Too low uniformity leads to poor laying performance. Number of feeders and drinkers, feed distribution, feed presentation, management, etc... are strong contributors to ensure uniformity. Heterogeneity at early age has a negative impact on uniformity during transfer.

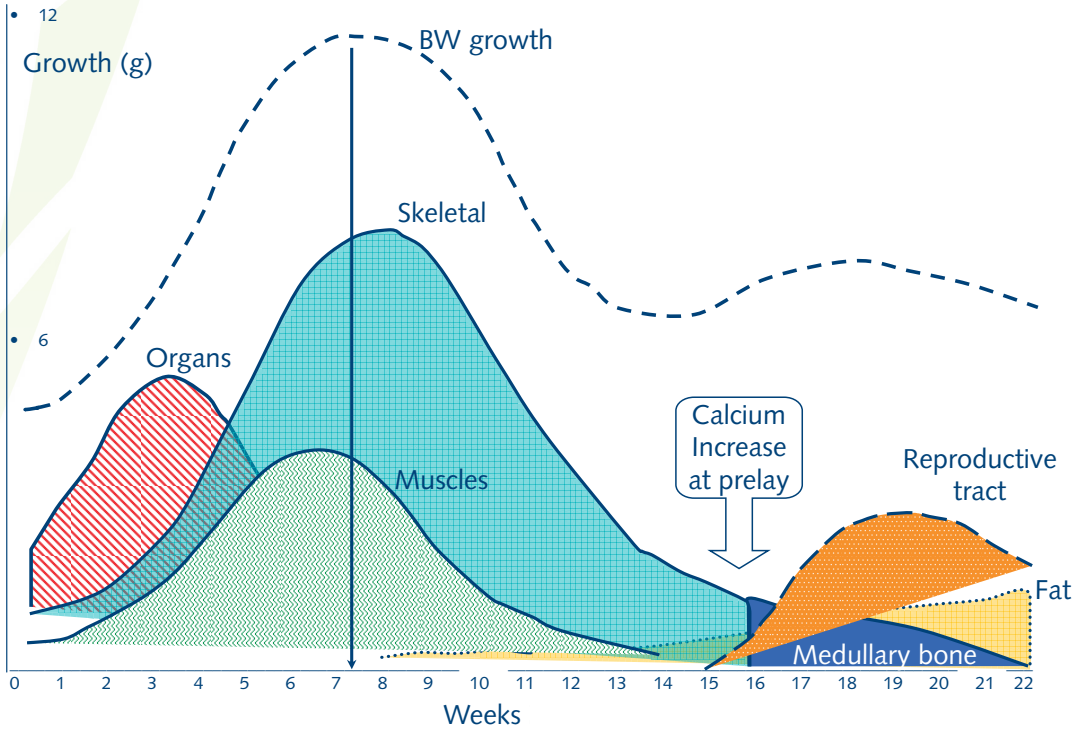


Figure 1: Bodyweight development

Preparing for chick arrival

When chicks are destined for the alternative system, we strongly recommend a similar rearing system. The house should be empty for at least 14 days after all the traces of the previous flock (droppings, feathers, litter and feed) have been cleaned out. The walls, ceiling, floor and equipment should be washed thoroughly and disinfected. The building and its contents should be dry before the next use.

Start the heating system 24 to 36 hours before chicks arrive, depending on climatic conditions, so that the brooder area and litter are warm enough and their temperature is steady. Adjust the heating system to 31-33°C in the house (or 35°C at the edge of brooders if these are used for the chicks' arrival). Look for a uniform temperature and humidity throughout the house. Place enough drinkers and feeders evenly through the house.

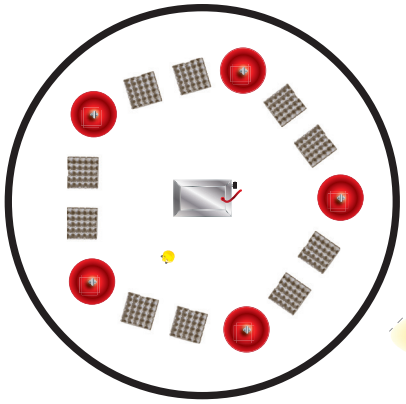
Table 1: Standards for temperature and humidity

Age(Days)	Brooding temperature at the edge of the brooders	Brooding temperature at 2/3m from the brooders	Room temperature	Relative humidity optimal & maximal in %
0 – 3	35°C	29 - 28°C	33 - 31°C	55 – 60
4 – 7	34°C	27°C	32 - 31°C	55 – 60
8 – 14	32°C	26°C	30 - 28°C	55 – 60
15 – 21	29°C	26 - 25°C	28 - 26°C	55 – 60
22 – 24		25 - 23°C	25 - 23°C	55 – 65
25 – 28		23 - 21°C	23 - 21°C	55 – 65
29 – 35		21 - 19°C	21 - 19°C	60 – 70
After 35		19 - 17°C	19 - 17°C	60 - 70

The chicks' behaviour is the best indicator of their comfort. If they crowd together or close to the heater, it is too cold, if they tend to escape from it and are close to surrounding or wall, it is too warm.

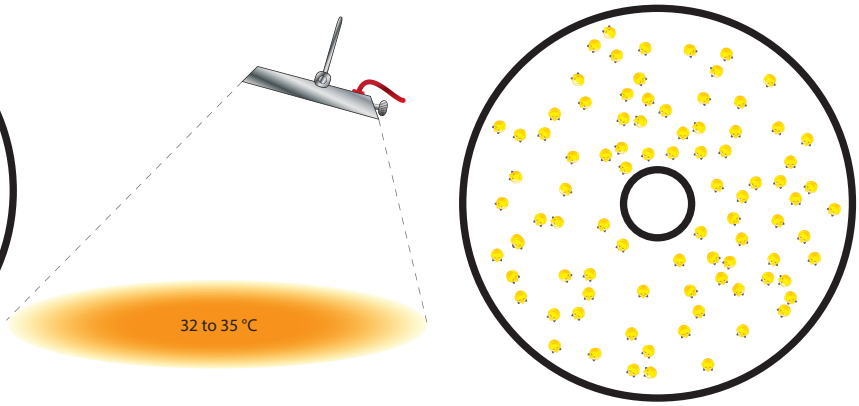
Starting conditions

Figure 2: Recommendended layout for 500 chicks



A: radiant heater of 1450 kcal capacity
B: drinkers (5) but (7) for hot climate
C: feed trays (10)
D: 75 watt bulb at 1.5M above floor level
E: surround: 4m diameter – 0.6 m high

Figure 3: Radiant heater position and ground temperature



Brooding period (0-5 weeks)

The main goal of this period is to reach the bodyweight standard at 5 weeks of age. The starting conditions in the house – recommended temperature, humidity, light intensity and duration, air exchange, enough space and an easy access to good quality water and feed - will provide the chicks with the necessary comfort to get to this target.

Any delay in growth at 4-5 weeks will be reflected in a reduction in bodyweight at 16 weeks and then in performance, particularly in mean egg weight in temperate climates.

Brooding at high density (double brooding) requires special attention to the following points:

- Adjust the equipment to the bird number
- Do not release birds too late (4-5 weeks)

Otherwise, it will:

- Affect growth and uniformity
- Increase disease challenge
- Affect litter quality

Temperature

Keep in mind that during the first few days the chicks have to rely on the temperature that we maintain, before their own thermoregulation starts to work properly. The best way to check if the house temperature is correct during this period, is to measure cloacal temperature of the chicks (40°C/104°F).

As a general rule we start with room temperatures of 31-33°C during the first week and decrease then gradually to reach around 20°C at 5 weeks of age.

We give the temperature standards in Table 1 but again, the observation of the flock is the best indicator of real needs. When birds are crowding, temperature is too low. When birds are inactive, lethargic and spreading away from the heat source, temperature is too high.

Some events in the flock (e.g. Post vaccine reaction) might require an increase in the temperature temporarily, to help the chicks to cope with the stress.

On the other hand, high temperatures could limit good feathering, feed intake and consequently the birds growth. It is also important to prevent floor draughts. Adjust ventilation to achieve an even room temperature without sudden changes. Draught proof circular "chick guards" of a clean and flexible material could be used. They serve to keep chicks comfortable.

In cases of multi age rearing, which we do not recommend, temperature settings must be based on youngest chicks. Chicks have to be reared in separate pens to maintain uniformity.

See table 1: Standards for temperature and humidity

Light

Maintain 23-22 hours of light for the first few days with a light intensity 30-40 lux to encourage the activity of chicks and feed and water intake. Use the normal decreasing lighting programme with 10-15 lux afterwards (in dark houses – rearing or production). Later on adapt the light intensity to the birds' behaviour and designated production system.

Note: a cyclic program could be applied for the first 2 weeks (4h of light /2h of dark, repeated 4 times to equal 24h) and then follow recommended lighting program, so 18 hours of light on third week.

See table 3: Lighting program for alternative production according to day length at 15 weeks

Light intensity

It is recommended to keep a high light intensity for the first few days to encourage water and feed intake.

See table 4 : Recommended light intensity for rearing period

Water supply

Do not forget to wash the drinking system after disinfection, use tepid water for the first 2 days (20-25°c).

Start to use the automatic drinking system from the arrival of the chicks. The use of supplementary drinkers during the first day will improve the health of the chicks (remove them gradually from day 4).
Clean the drinkers daily during the first 2 weeks, then once a week.When nipple drinkers are used, use the strips of embossed paper under the drinkers' lines.
Adjust the lines height to that of chicks, so that all of them have a chance to start. Enough drinking space easily accessible is a very important tool to prevent non-starting chicks and uneven flock.

Use a suitable water quality (see Table 17: Water quality parameters).

Feed supply

A good quality starter feed should be distributed when chicks have drunk enough water to restore their body fluid (4 hours after delivery) where it is possible to do so.

Feed with 2950 kcal/kg and 20.5% of protein presented in crumbs and also easily accessible for the chicks is recommended. You can use the small additional feeders or non-smooth paper to increase the feeding space for the first few days. We recommend distributing smaller quantities of feed several times per day during the first 4 weeks. Start to use the automatic feeding system from the very beginning so that chicks get accustomed to it. Let the chicks empty the feeders once or twice a week to avoid the accumulation of the fine particles in the feeders.

Stocking density

This is one of the most important parameters of the starting conditions. Overcrowded flock tends to have higher mortality and culls, slower growth and lower uniformity. Keep to the optimum stocking densities from the early arrival of the chicks.

Standards of stocking densities

Table 2 : Equipement requirement for rearing

Stocking density (maximum)		12-14 birds / m²
Minimum ventilation rate		0.7 m³ / h / kg
Heating		2 gas brooders or 2 radiant heaters of 1450 Kcal / 1000 birds
Drinkers		
	Starters	
	Temperate climate	1 starter / 100 birds
	Hot climate	1 starter / 80 birds
	Bell drinkers nipples	150 birds / Hanging bell drinker (80 to 100 for hot climate)
	Temperate climate	16 birds / nipple
	Hot climate	10 birds / nipple
Feeders		
	Per starting pan	50 birds / starting pan
	Linear chain	4 cm / bird
	Per feeder	1 unit / 50 birds

Growing period after 5 weeks of age

Lighting during rearing

Pullets are sensitive to changes in the lighting regime, and these will influence the age of sexual maturity. In addition feed consumption is greatly influenced by the duration of day length. During rearing, the main objectives of lighting programs are encouraging growth and controlling the birds' sexual maturity.

Lighting programs should be adapted to rearing facilities (dark or open house systems), conditions of production, climate and the egg weight profile required by the market.

Irrespective of the type of building (natural or artificial light) never increase day length between 6 weeks of age and the moment of light stimulation. Time of light stimulation should always be based on body weight, not on age. Premature light stimulation and/or too low bodyweight can lead to poor performance later in production (peak and persistency), as well as higher mortality and poor egg shell quality.

When pullets are reared in dark houses a slow step down lighting program is recommended in order to maximize growth during the first weeks and then a constant light duration adapted to the growth performance or sexual maturity expected.

When pullets are reared in open system houses, control of sexual maturity is difficult to achieve. It is recommended to darken the poultry house and to use a lighting programme taking into account the natural day length at the moment of transfer. Total light duration must never be shorter than the longest natural day length in the period between 6 weeks of age and light stimulation.

Figure 5: Guide line for lighting programme for rearing in a dark poultry house

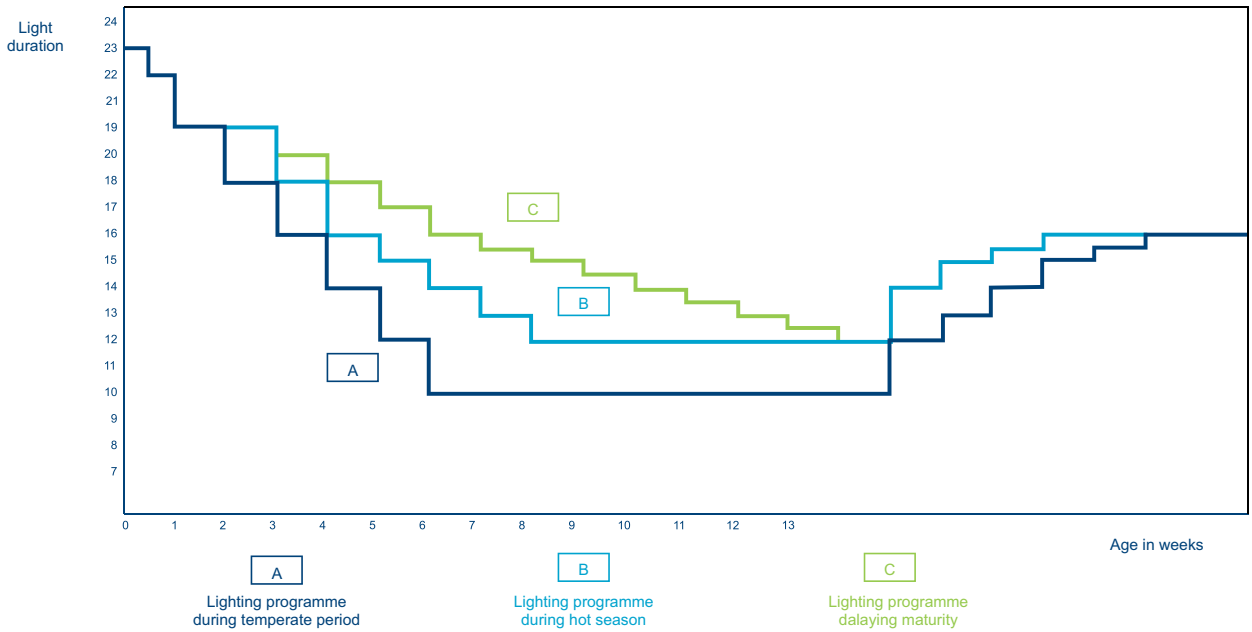


Table 3: Lighting program for alternative production according to day length at 15 weeks

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

Light intensity:

Light intensity should be gradually reduced to reach a level adapted to the conditions of the production house. Light intensity is a good tool to modulate bird behaviour and feed consumption.

Table 4 : Recommended light intensity for rearing period

Age (days)	Light intensity Rearing & production in dark house	Production in houses exposed to natural light
1 – 3	20 – 40 lux	40 lux
4 – 7	15 – 30 lux	40 lux
8 – 14	10 – 20 lux	40 lux
15 – Transfer	5 – 10 lux	40 lux

Beak trimming

This operation is usually carried out to prevent feather pecking and cannibalism. In addition to technical recommendations, any codes and local regulations concerned with animal welfare should be followed.

Different methods for beak trimming are used, for example cauterization by hot blade or infra-red treatment.

Cauterization by hot blade is a delicate operation, which should only be performed by specially trained personnel. If it is improperly done it will result in birds having difficulties with eating and drinking leading to unevenness in the flock and therefore poor performances and higher mortality later in production. This treatment can be carried out in both the hatchery or the rearing house.

Beak trimming by hot blade is a stressful operation: it is not recommended to beak treat birds if the flock is not in good health or if it is suffering from vaccine reactions. In rearing house, adding vitamin K to the drinking water 48 hours prior to beak trimming is helpful to prevent haemorrhages.

The equipment must be checked and properly set to make sure that the blade is at the right temperature to cauterize and prevent bleeding.

It is important to select the correct diameter hole for the chick age on the beak-tipping machine and to hold the head of the chick firmly. The chick's beak should be held upwards at an angle of 15 ° above horizontal and the reinforced side edges of the beak cauterized, to avoid unequal re-growth of the 2 mandibles.

After beak trimming, we recommend increasing the water level in the drinkers and lowering the pressure in the pipes for some days to make it easier for the birds to drink, as well as increasing the depth of the feed to avoid the feeders from becoming empty. Beak treatment can also be carried out at one day old in the hatchery, before delivery of the chicks. As the beak of the chick treated at day old is still sensitive, it is recommended to use sideways activated nipples (360°) or nipple drinkers with cups and using supplementary starting mini drinkers in the rearing farm for the first few days.

Infrared treatment is done at one day old at the hatchery and is a less stressful process then beak trimming.

Feeding in rearing

Basic principles concerning feeding for chicks are:

- Do not change the feed if birds do not reach the standard bodyweight
- Promote early growth, skeleton and organ development by providing feed in crumble form for starter diet
- Use a good coarse mash grist for grower, pullet and pre lay feed
- Develop digestive tract and eating capacity (feeding management / grit)
- Feed specifications for alternative production pullet do not differ from intensive system recommendations

Feed specifications during rearing period for commercial layers

Those requirements are based on the "european amino acids table" (WPSA, 1992) of raw materials composition and expressed as digestible amino acids by using the digestibility coefficients mentioned in the "Tables de composition et de valeur nutritive des matières premières destinées aux animaux d'élevage"INRA edition 2002.

Table 5: Feed specifications during rearing period for commercial layers

Between 18 - 24 °C	Diet units	Starter 0-4 weeks 1-28 Days	Grower 4-10 weeks 28-70 days	Pullet 10 - 16 weeks 70 - 112 days	Pre - lay 112 days to 2 % lay
Metabolisable energy	kcal/kg	2950-2975	2850-2875	2750	2750
	Mj/kg	12.3-12.4	11.9-12.0	11.5	11.5
Crude protein	%	20.5	19	16	16,8
Methionine	%	0.52	0.45	0.33	0,40
Methionine + cystine	%	0.86	0.76	0.60	0.67
Lysine	%	1.16	0.98	0.74	0.80
Threonine	%	0.78	0.66	0.50	0.56
Tryptophan	%	0.217	0.194	0.168	0.181
Digestible amino acids					
Dig. Methionine	%	0.48	0.41	0.30	0.38
Dig. Meth. + Cystine	%	0.78	0.66	0.53	0.60
Dig. Lysine	%	1.00	0.85	0.64	0.71
Dig. Threonine.	%	0.67	0.57	0.43	0.48
Dig. Tryptophan	%	0.186	0.166	0.145	0.155
Major minerals					
Calcium	%	1.05-1.10	0.90-1.10	0.90-1.00 (1)	2-2.10 (1)
Available phosphorus	%	0.48	0.42	0.36	0.42
Chlorine minimum	%	0.15	0.15	0.14	0.14
Sodium minimum	%	0.16	0.16	0.15	0.15
Above 24° C					
Metabolisable energy	kcal/kg	2950-2975	2850-2875	2750	2750
	Mj/kg	12.3-12.4	11.9-12.0	11.5	11.5
Crude protein	%	20.5	20.0	16.8	17.5
Methionine	%	0.52	0.47	0.35	0.42
Methionine + cystine	%	0.86	0.80	0.63	0.70
Lysine	%	1.16	1.03	0.78	0.84
Threonine	%	0.78	0.69	0.53	0.59
Tryptophan	%	0.217	0.207	0.175	0.190
Digestible amino acids					
Dig. Methionine	%	0.48	0.43	0.32	0.40
Dig. Meth. + Cystine	%	0.78	0.69	0.56	0.63
Dig. Lysine	%	1.00	0.89	0.67	0.74
Dig. Threonine.	%	0.67	0.61	0.45	0.50
Dig. Tryptophan	%	0.195	0.175	0.152	0.163
Major minerals					
Calcium	%	1.05 - 1.10	0.95 - 1.10	0.95-1.05(1)	2.1-2.2 (1)
Available phosphorus	%	0.48	0.44	0.38	0.44
Chlorine minimum	%	0.16	0.16	0.15	0.15
Sodium minimum	%	0.17	0.17	0.16	0.16

(1) : To avoid falls in food consumption, 50% of the calcium should be supplied in granular form (diameter = 2 to 4 mm)

Use of insoluble grit

We recommend the distribution of grit for pullets. The grit must be coarse and insoluble in order to develop the crop and gizzard. The effect of this action on the digestive tract will promote a good feed intake, which will be beneficial at the start of lay.

Grit can be provided in a round feeder or spread on the floor by hand. The birds will scratch the floor and look for the grit. This will contribute to improve litter quality by aerating it. In addition, the flock is then distracted, aggression is decreased and feathering improved.

Between 3 and 10 weeks, we recommend that 3 g per pullet per week (particle size 2 to 3 mm) are available. After 10 weeks this can be increased to 4 to 5 g (particle size 3 to 5 mm). It is also possible from 10 weeks onwards to use a diet where 50 % of the calcium is supplied in carbonate form with a particle size of 2 - 4 mm.

Litter management

Litter management points:

- The top priority is to keep the litter dry. Well managed ventilation and good gut health are key points.
- The litter should be neither too wet nor too dry (about 25 to 30% of water)
- Litter should be friable and 'moveable'. The birds help to maintain this condition by scratching and dust bathing. Providing a small daily 'scratch feed' of whole grain, preferably good quality wheat or insoluble grit may encourage scratching
- Water pressure in drinker supply lines should meet suppliers specification to avoid leakage
- Drinkers should not be overfilled. Hanging plastic drinkers of the 'bell' type should contain no more than 1.5 cm depth of water. Furthermore these drinkers should be suspended at such a height as to minimise the problem of spillage resulting when birds collide with them. If the birds can just reach to drink, and also be able to walk underneath these drinkers, the height is ideal.
- Where nipple drinkers are provided, they should be suspended so that the birds have to reach up to drink. They should also be provided with (large) drip cups, in order to reduce spillage directly from the nipples on to the litter.
- Litter depth should be 5 to 10 cm depending on type of floor
- Additional litter should be added, on top of the existing, in order that moisture content is kept low. The requirement for additional litter is very low during the summer, but high during cold wet weather.
- Wet patches resulting from water spillage should be promptly removed, and additional litter provided.
- During cold and / or wet weather, it is important to regularly work the litter with a fork, in order to break up accumulating droppings, and to 'open up' any compacted litter. Usually some fresh material will be added at this time.

Transfer to laying house

This is a stressful period for the birds. In effect they experience two stresses, the handling and transport involved in movement from rearing to laying facilities, plus the change from rearing to laying environment.

Transfer requires careful planning and management.

Transfer should ideally be done 4 weeks before production and certainly no later than two weeks before egg production starts. The purpose is that recovery from the stress is completed, and does not depress the rapid ovarian development, which occurs prior to, the commencement of egg production.
Late transfer bears the real risk of damage to the birds, in particular to the ovaries. It is ideal to transfer when the birds are 16 weeks of age, this will enable them to be fully adapted to the layer housing and facilities well in advance of the onset of lay. If birds are transferred too close to the onset of lay, the subsequent risk of egg peritonitis is high. The movement of birds with mature ovaries may cause rupture of yolk follicles, which are then deposited in the body cavity.

Late transfer may also result in floor egg laying, as the birds have not had sufficient time to become accustomed to their new surroundings.

When transferred, the stock should be fed a pre-lay or a layers ration – grower or pullet rations must not be used, as the nutrient density of these feeds is too low.

Preparation – rearing farm

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

- The birds must always conform to the breed bodyweight. This should not simply be according to the age of the birds but also according to age of sexual maturity. Note that due to the effects of transfer, birds weight can be reduced by 10% to 15% due to moisture loss.
- Light intensity should be increased, over a period of 2 to 4 weeks, and must be equal to the level in the laying house.*
- Rearing house temperature should also be adjusted (usually to a lower level), over a period of 2 to 4 weeks, in order to become similar to laying facilities temperature.*
- These two changes should be no less than 1 week before transfer, hence the stock is well accustomed to the laying house conditions.
- Two weeks prior to transfer the birds should not be handled, except for routine uniformity and bodyweight checks. Birds must have every opportunity to grow, even during this critical period.
- Insoluble grit should have been provided for the flock, ideally during the entire rearing period, but at least 2 weeks prior to transfer. At this time the grit should be 3 to 5 mm in size, and provided at a rate of 4 g/bird/week.

- Feed withdrawal before departure should not exceed 6 hours and should be adapted to transport duration and climatic conditions.

Preparation – laying farm

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

- An appropriate terminal hygiene programme, must be implemented to avoid disease transmission.
- Maintenance and repairs completed before arrival of stock.
- Flush the water system and provide fresh water the day before arrival of new stock. This is critical, as the key to the successful start of the incoming flock is provision of water. The better the water quality, the less the depression in feed intake following transfer.
- Where nipple lines are used ensure the height is slightly above the back of the birds (for the first 7 days), then raised to ensure birds "comfortably stretch" to use the nipples. Bell drinkers should be filled to double the normal depth, and lowered to a height of 20 cm above floor level, for the first two or three days.
- The house should be dried prior to the arrival of the new flock. Not only are wet houses very humid, (a condition which is depressing for the birds), they are also cold – which is particularly noticeable during winter. Straw could be added below the slats to absorb excessive humidity and improve the environment.
- The house should be preheated in cold season

Transfer

An ideal time for transfer is during the early morning. Disturbance to routines of drinking and eating is minimised if the stock are unloaded and housed by the time their day started on the rearing farm.

Transport vehicle and equipment must be clean and disinfected.

The flock should be transferred within the same day, as this causes less stress, and avoids possible problems of low temperatures in partially filled rearing and laying houses. Every effort should be made before and after transfer to maintain water and feed intake according to the normal routine of the stock.

Precautions should be taken to minimise undue exposure to wind and rain/sun during transfer procedure as these factors are very stressful.

Arrival at the laying site

Unloading is a delicate procedure, it should be done as quickly as possible into the laying house with the following provisions:

- A dry house (and equipment) at a temperature of not less than 15°C (60°F), 18°C (65°F) is the optimum, especially in cold weather.
- In order to encourage water intake, drinking water must be clean and fresh from the pullets arrival. Ideally feed should not be available at the time of the birds' arrival and it should be given about 2 hours later, when the flock has had the opportunity to drink. During transport and handling the birds lose moisture, and it is essential that this is restored as soon as possible after arrival
- In order to improve appetite, it is better to use meal feeding instead of *ad-libitum* (see Feeding management).

After housing

The period of the first 48 hours after housing is a critical period so close supervision and observation are required to ensure the normal behaviour of the entire flock.

The following points should be noted:

- Water consumption – normal drinking habits, within 6 hours after arrival.
- Temperature: ideally 15°C but with a maximum of 18°C. It is important that birds do not become chilled but they must have fresh air.
- Feed consumption – increasing appetite / intake.
- General attitude of the flock. At first it will be quiet, but should gradually become more active and 'talkative', but not frenetic or hyperactive.
- If slats are incorporated in the house, the birds have to be encouraged to perch during the dark night period. This may take some time initially, prior and during lights off. This will take 3 to 7 days to take effect and birds will then routinely perch naturally.
- Nest boxes must be closed until you see the first egg. Open them almost 2 hours before the main house lights and keep open until late afternoon
- Light intensity must be high (refer to lighting chapter),
- Dim the light gradually at light off (refer to lighting chapter)
- It is recommended that birds are kept on the system for few days if they are not reared on a partly slatted house (according to local regulation)

During the first two days, the farm worker should spend time with the birds, observing behaviour and monitoring water and feed consumption. At the same time the birds will identify with this person. This is beneficial to the relationship between the flock and the stock person.

Inspection of the flock at any time (but especially at the start) should not be limited to the daytime. Listening to the birds after turning off the lights can be very useful. Although unlikely at this stage, snicking as a result of a respiratory infection can readily be detected when the flock is resting. Are they going up in the system? (Refer to: working with birds).

For systems using slatted and litter area, it is recommended to place and keep birds on slats for 3 to 4 days to allow them to familiarise with feeders and drinkers.

It is recommended to move the remaining birds from the litter to the slats immediately after turning off the lights.

Minimum measurements and record keeping

Aim: quick problem detection, quick reaction on problems or abnormalities.

Table 6: Minimum measurements and record keeping

Traits	Optimal advised practices
Feed consumption	weekly
Water consumption	daily
Hen bodyweight	weekly
Mortality	daily
Climate	daily

NOTES

Laying period

Building and equipment for production

Housing equipment

It is strongly recommended to rear birds using the same system that will be used in production

Table 7 : Standard stocking densities and environment.

Stocking density		7 birds / m²*
Minimum ventilation rate		0.7 m³ / h / kg
Drinkers		
	Bell drinkers	100 birds / Hanging bell drinker (80 in hot climate)
	Nipple	10 birds / nipple
Feeders		
	Per feeding pan	25 birds / round feeder - pan
	Linear chain	minimum 10 cm / bird
Nest boxes		5-6 birds per nest / 120 birds per 1m² of collective nest
Perches		10 cm of perches / hen (distance 40 cm from each other)
Pop hole (access to free range)		1 / 600 hens

**Stocking densities are given for the deep litter systems. Stocking densities for aviaries could be higher – follow the manufacturer recommendations. Do not forget to provide always enough drinking and feeding space according to the given technical requirements and local regulations.*

Slats

Slats can be manufactured using different materials (plastic, wood or metal). The slat level should be adapted according to building design and production duration. The slat height must be sufficient to store the manure for the whole production cycle. However, if the slats edge is too high (>90cm), birds will have difficulty accessing the slatted area.

To assist the birds to move from the litter to the slats/system the provision of perches is required. Perch rails are generally preferable to 'ladders', as birds may choose to lay their eggs, or even to crowd and smother in the area under ladders. A gradual (enclosed) slope from floor to slatted area can also be used – angle to be at a level in which to avoid birds from perching/resting on it. If the slope is too steep, it could lead to an increase in floor eggs and make the access to the feeding and drinking system difficult for the bird.

Feed and water

We recommend the use of a feeding system that distributes the feed rapidly throughout the house and enables the birds to finish all the distributed daily feed. It will continue to support the birds` intake capacity, developed in rearing and lead to fast and continuous increase of feed intake from point of lay to its` peak of production. Rapid floor mounted chain feeders are proving to be the best option and have the easiest feed intake control. If pan or tube feeders are being used they should be adapted properly to this technique.

It is very important that birds find the same type of drinkers already accustomed to in the rearing house (for example nipples to nipples).

The feeders, as well as drinkers, should have their height adapted to the size of the birds so they are easily accessible and seen by the birds. They should not form a big obstacle to the movement of the birds throughout the house. They should be placed on slats (preferably in front of the nests), in case slatted areas are used in the house so that the birds are encouraged to use them. The drinker line attracts the birds to the nest boxes.

As already stated, the standards for drinking and feeding space given in the section on stocking densities and environment must be followed from transfer till depletion.

Remember: if the bird does not drink enough for any reason it will not eat enough and so the growth, uniformity and production of the flock will be compromised.

Nests

One comfortable individual nest should be available for 5 – 6 birds or 1 m² of collective nest for 120 birds (in some specific situations 100 birds / m² can be beneficial, see floor eggs section). If an individual nest is used, nests should be strawed to encourage the birds to use them. Nests must always be clean and well maintained. A good practice is to fit the nests with a dim (0.3-0.5 lux) light that allows the birds to find the nest before the normal day starts. If this is not possible a dim light placed over the slats and close to the nest must be switched on 1.5 h before lights on to avoid floor eggs.

Perches

Perches improve the welfare by allowing the bird to express its natural behaviour.
Perches are useful to:

- increase the usable surface per bird and decreasing floor density
- train the bird to jump on the system
- offer an escape to aggressed birds

Recommended perch length per bird is a minimum of 10 cm. The first accessible level must be at 20 cm high. These values may be adjusted according to local regulations.

The perches should be situated on the slats to maintain good litter conditions. Distance between perches should be 40 cm and a slope of 45°.

Partitioning and fencing

Pen size must be adapted according to local regulation. Partitioning the house in different pens has two advantages:

- better distribution of the birds
- easier flock management

Fencing – outside

Perimeter fencing is needed to protect birds from foxes, domestic pets, feral cats, mink, badgers, other predators and to reinforce security and bio security.

A typical fencing example could be a wire type mesh construction, 2 metres with an overhang of 30cm, placed at an angle of 45 degrees to the vertical on the outside of the fence. The bottom of the fence would be approx 30 cm underground to act as an anti-tunnelling barrier. Alternatively commercially available safety electric fencing can be used.

In addition to reduce entry by foxes or similar predators electric wiring could be placed on the top of the fence. To avoid gaining access under the fence it is recommended to go approximately 50 cm underground (horizontal) with the fence.

Heating

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

Throughout the winter season, temperatures in the rearing houses before and during transfer must be adjusted to those in the production houses. Moreover, to avoid temperature stress in wintertime, it is advisable to preheat the production houses up to 18°C before transferring point of lay pullets and to respect minimum ventilation (cf. Ventilation part) requirements to avoid damage caused by high CO_2 and NH_3 levels. It is however preferable to go down in temperature than to go up in CO_2/ NH_3 levels. If necessary, use heaters.

Ventilation

An important priority is the provision of fresh air. If the air inside the poultry house is stuffy, humid, smelly or laden with dust, then the rate of air change is too low.

The minimum air exchange rate is 0.7 m³ / hour / kg live bird.

Besides supplying the poultry house with fresh air, these points must be taken into consideration:

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

Ventilation system

A free range house may be ventilated mechanically, naturally, or by a combination of both systems. Fundamental to any system is the need for finely adjustable air inlets, usually at eaves level on both sides of the house, and outlets in the apex of the roof – the ridge. However, some houses may be cross ventilated, with inlets one side of the building and the extractor fans on the other side.

Air circulation

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

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

There are a number of ways to make air circulate within the house, one of the least expensive is to purchase an axial fan or air distribution fans.

Air quality recommendations

Table 8: Air quality levels

Trait	Recommended level
Ammonia (NH_3)	20 ppm max
Carbon dioxide (CO_2)	2500 ppm max

Frequent problems associated with poor ventilation

Table 9: Air quality recommendations

Too little ventilation	Too many	Uneven
E coli	E coli	E coli
Respiratory diseases	Respiratory diseases	Respiratory diseases
Feed intake	Feed intake	Feed intake
Ammonia blindness	Floor eggs	Floor eggs
Poor internal and external egg quality	Nervousness	Nervousness
Poor production		Poor production
	Crowding	Crowding
Litter quality		Litter quality

Litter

Litter enables the birds to perform the natural functions of scratching and dust bathing, which most welfare authorities deem necessary for bird wellbeing. There is no doubt that the presence of litter enables the birds to be more relaxed.

Slatted areas cover an enclosure, to which the birds are denied access, for storage of manure. This separation of manure from the litter makes the task of maintaining the litter in good condition much less onerous, particularly during wet and cold weather.

The litter adjoining the slatted area should be well lit, in order to deter floor egg laying.

Litter management

The objective of litter management is to maintain a dry, friable and almost odourless material, which is attractive to the birds for scratching, and dust bathing.

The type and quality of the litter are important for the hens and the house climate.

Different materials, which may be used:

- Sand or gravel up to 8 mm granule size
- Wood shavings
- Wheat, spelt, rye straw
- Bark mulch
- Coarse wood chips

There are two materials, which are popular - soft wood (white) shavings and chopped straw. Sawdust is not a suitable material, as once moistened it compacts and becomes immovable, and consequently does not release moisture to the atmosphere.

Litter material shouldn't be contaminated, or stored on site from flock to flock of birds. Both materials should be dry and uncontaminated when spread in the poultry house. Straw should be chemically treated in order to ensure freedom from moulds, in particular aspergillus species.

If the system allows it, it is recommended to remove frequently accumulated litter/manure. This prevents floor eggs and improves environment. Avoid wet and caked litter.

Lighting systems

The lighting system in lay must be designed to ensure independent lighting control of the different areas. We suggest the creation of at least two zones, one lighting line above the nests and one lighting line above the scratching area. Three types of lighting line is the optimum, one for scratching area, one for slats area and one above the nests.

All lighting lines must be dimmable and programmable. The dimming ability of the system will allow the control of behaviour inside the building and avoid dark areas where birds may lay on floor.

An independent programmable lighting row encourages birds to climb/move on to slats and not to sleep on the scratching area. This point is important to avoid floor eggs.
Nest lights can be used with brown birds to attract them into the nest before the general lighting is on. Lighting systems using bulbs of too low frequency will result in flickering light which will stress birds. Warm colour type (yellow-orange spectrum) must be used. In the event of negative bird behaviour, the use of lampshades and red painted light covers can help.

Basic growth concepts

From transfer, birds continue their growth towards achieving their physical maturity around 30 weeks of age, the body weight gain must be at 300 g. After 30/35 weeks most body weight gain is fat and its excess has a negative impact on lay and feed conversion.

A lack of bodyweight gain after transfer makes hens vulnerable and less robust against environmental variation (disease, heat, etc...).

Flock uniformity has to be followed up to avoid extremes of bodyweight, which can lead to poor laying performance.

Pre-lay key targets

Increase layer bone mineralisation

From a nutritional point of view the prelay period is characterised by an increase of the calcium concentration of the feed.

The first objective of the higher calcium levels is to reinforce the mineralisation of medullary bone, layer calcium storage, before the beginning of the lay.

The second objective is to prevent demineralisation of early sexual mature birds. With a classical grower feed, feed calcium concentration is not sufficient to compensate the calcium exported for the eggshell.

This leads to the decrease in the medullary bone calcium reserve. Layers without adequate calcium content on prelay will have poor eggshell quality during the last period of lay.

In summary, higher calcium level on prelay diet will prevent layer demineralisation of early birds, reinforce medullary bone mineralisation before transfer and ensure good eggshell quality in the last phase of lay.

Transition to layer feed diet

The prelay diet constitutes a step, in terms of feed, between rearing and laying feed. Coarse carbonate particles represent at least 5% of the layer feed, instead of 0% for rearing feed. Prelay diet has a minimum 2% of coarse carbonate particles. Coarse calcium carbonate has a strong influence on feed presentation. If prelay diet is not used the risk of low feed consumption after transfer is higher. For this reason it is strongly recommended to use a prelay diet to accustom bird to layer feed.

Growth continuation, lightest bird catch up and maintaining uniformity

During the prelay phase, bird growth continues. It is the last period, when the lightest birds have the opportunity to improve and adjust their bodyweight. Mature birds could begin to lay.

Both of these birds require a high nutritional feed to assist correct growth and production. Protein and amino-acids levels must be high at this time to meet the nutritional requirement. Without using an adapted feed, the uniformity of the flock could be jeopardized.

Working with the birds after transfer

- The birds should be put close to drinkers and feeders at transfer
- Maintain the flock on slatted area for a few days helps birds to get used to slats, find drinkers, feeders, perches and nests.
- Light intensity must be higher compared to rearing building
- Lighting management encourages the birds to move on to the slatted areas to rest and sleep. At dusk switch off the lights above litter or from the bottom tier of aviary and then switch off the lights above slats or gradually towards the top tiers around 30 minutes later.
- In the first week, birds that are found on litter just before dusk should be placed on to the slatted area
- At start of lay, floor eggs should be collected several times until the level becomes acceptable
- Automatic nests must be open at least 2 hours before lights are on. Nests should be closed once a day after all the eggs are laid (to be adapted according to the flocks laying behaviour). It helps to keep the nests clean and to remove all birds from the nest.
- Maintain continuous monitoring of the growth by measuring bodyweight
- Monitor feed and water intake
- Special attention must be given to birds having difficulty finding the drinking/feeding points. These birds could be found on top level of aviary system, on the scratching area or perches and they need to be moved close to drinkers and feeders

Training caged reared birds

As stated in previous sections, it is strongly recommended to rear birds using the same system that will be used in production.

In some countries it might be illegal to transfer birds reared in cages to a non caged system in production. Always follow local legislation in this regard. However it could still happen that birds reared in cages are transferred to the production house with a floor or aviary system.

There are high risks associated with any such flocks. Birds reared in cages are accustomed to the restricted environment, they know where to find water and feed, they know more or less all the group within a cage. Cage reared birds might be "lost" at transfer to the floor or aviary system, will not easily find their way to drinkers and feeders, are not accustomed to

jump and mount on slats and into the system. Several days following transfer an increased incidence of weakened birds and mortality might occur, the flock also can tend to have a low peak with many eggs laid on floor.

If you are forced to transfer the caged reared birds to floor or aviary system of here are some tips to help you and the birds to cope:

1. Try to transfer the flock as soon as possible (at a younger age for example 12 weeks) so that the birds have a better chance to get acquainted with this new environment
2. Allow them enough slatted space so that they can be maintained there (use a temporary fence) for some time (7-10 days) without a risk of overcrowding.
3. All the drinking and feeding equipment must be placed on slatted areas.
4. Use different ladders and steps so that the birds are not forced to jump too high to get back to slats.
5. Start to release the birds from slatted area to litter gradually after you are sure they all have found water and feed.
6. Inspect the flock more frequently and do not hesitate to help the "lost" individuals to find water and feed.
7. When released, encourage the flock to get back to slatted area or aviary system in the evening to sleep there (using the tips described in previous chapter like lighting management, feed distribution times).
8. Do not forget that this type of transfer needs much more physical work by skilled workers.
9. Special attention is needed for coccidiosis prevention or treatment.

Stocking density

The control of this parameter in lay is as important as in rearing period. Flocks with enough living comfort in the sense of total available feeding and drinking space will express their genetic potential much easier.

Stocking density should be followed in accordance with local legislation. However, if no slats are used, the density should not be higher than 7 birds per usable m², in slatted houses this should not exceed 9 birds per usable m², the use of aviary system enables an increase in the stocking density up to 18 or even more birds per m² of the floor of the house.

In any of these cases it is important to consider enough easily accessible drinking and feeding space per bird. Overcrowded flocks tend to have higher incidence of suboptimal feed and water intake, pecking, cannibalism, suffocation, mortality, culls and finally a compromised performance.

Drinking and feeding

Comply with local legislation, however, when nipple drinkers are used, ensure 1 nipple per 10 birds. If you use bell drinkers, then 1 is sufficient for 100 birds in temperate and for 80 birds in hot climate. As for the feeders, we consider the linear chain feeder system is the best because it is easily emptied by the birds. 10 cm of linear space should be assured per each bird. When pans are used you can allow 25 birds per pan (if their mutual distance allows the access from all sides). The height of the feeders and drinkers should be adjusted for easy access by all the birds and so that they do not impede movement or encourage floor laying under them.

Measuring daily feed and water intake

It is very useful to monitor the daily water and feed intake. The consumption/empty feeder time is also a practical tool if precise measurements are not possible. Any strong deviations from the previous day's consumption might indicate a start of some disease or technical problem. Together with a regular inspection of the flock it helps to avoid big surprises in the development of the flock.

Feed intake stimulation

Feed presentation

Birds have a strong preference for coarse particles - fine particles are difficult to take and it consumes more energy for the same quantity intake. Consequently, the feed needs to be uniform with a maximum of 10% coarse particles above 3.2 mm and 15% maximum of fines particles below 0.5 mm. A higher percentage of coarse particles will lead to feed sorting, uneven bodyweight and laying performance. However, too high proportion of fine particles will decrease feed consumption.

Particle size is very important, but the most important variable is feed consistency. Birds do not respond well to variations in feed regimes.

The addition of 1% oil to mash layer feed, is recommended to improve feed presentation. Oil adheres to the finest particles binding them together and making them easily 'eatable'.

In some specific conditions, such as a very low feed intake or poor feed quality and consistency, crumbs can be used. Crumbs are easy to peck and each feed particle taken is balanced. However a few precautions are needed with crumbs. Crumbs increase water consumption and wet droppings. Transition from crumbs to mash can temporarily decreases feed consumption.

Feed distribution

When birds are not eating enough the classic response is to increase the number of feed distributions. However, this practice encourages feed selection and does not solve feed intake problem.

The feeder needs to be empty once a day. It is recommended to have empty feeders by the beginning of the afternoon. This leads to decreased feed selection and to increased mineral and vitamin consumption - usually found in the fine particles of feed.

Early feed distribution during the laying period increases dirty eggs and floor eggs.

For eggshell quality reasons, a minimum of 60% of the feed, needs to be distributed in the afternoon. This program needs to be adapted depending on observations and the type of feed distribution equipment.

For more details, consult the 'feeding management' section.

Lighting program

- High intensity after transfer

Just after transfer, light intensity needs to be high. This encourages hens to discover their new environment (nipples, feeder and nest location). Light intensity stimulates feed consumption too. When feed consumption is sufficient, it can be reduced.

- Night flash (midnight feed)

When local legislation allows it, a maximum of two hours of light could be given to hens 3 hours after lights are turned off. During that time, feed distribution is provided. This technique is very useful, mainly during hot season, to encourage birds to consume feed.

Temperature

In comparison with the rearing period, temperature can be decreased by 1 or 2°C to stimulate feed consumption.

Prelay diet

Prelay diet use will facilitate feed consumption after transfer. Layer diets contain high amounts of coarse carbonate particles and leads to strong feed texture differences compared to rearing diets. Prelay diet minimises the negative transition effect and increases layer feed palatability.

Digestive tract development

Feed management in rearing has an effect on layer feed consumption. The idea is to develop the digestive tract during the rearing phase to prepare the bird to eat enough during the laying phase.

- Crop

The crop is the birds' feed storage organ. After transfer, the hen increases consumption from 80 to 120 g. If the crop is not developed enough, this reduces feed intake capacity after transfer. Crop development is achieved by introducing the concept of meal in pullet. Feed consumption during the rearing phase needs to be fast to develop the crop and feeders should be empty daily . (refer to 'feeding mangement' section).

- Gizzard

Pullet feed presented in coarse particles helps gizzard development. Other factors like coarse limestone particles in prelay feed or the use of grit during the rearing period is useful to develop gizzard.

Insoluble grit

Grit particle sizes large enough to act as a grinding surface in the gizzard, but small enough to be easily swallowed, yet hard enough not to break up under pressure and above all insoluble in the bird's digestive juices was once considered essential. Though research has shown that especially with the use of a mash feed, grit is not necessary to achieve maximum feed efficiency and production rate, there is still evidence that grit stimulates the gizzard muscle development in rearing, stimulates digestion and improves feed intake capacity. Certainly, where the hens eat litter and feathers and have no grit, physical damage of the intestinal tract may occur. It is recommended to supply 3 g of insoluble grit per hen once a month of the particle size between 4 and 6 mm.

Lighting during lay

The objective of the lighting programmes during production period is:

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

Whatever the type of laying house (natural or artificial light), the golden rule is to never decrease daylength (interval between lights on and lights off) after start of lay.
The lighting programme in production should be the continuation of the lighting programme used during the rearing period. It is essential to make sure that the light duration in production house is as long as the light duration the birds have already experienced in the rearing house just before transfer.

As the bodyweight plays a major role in the determination of the egg weight profile during all the laying period, the light stimulation has to be done according to the observed bodyweight. The minimum bodyweight reference is:

- 1 250 to 1 300g for the brown egg layers
- 1 100 to 1 150g for the white egg layers

Uniformity is also an important parameter to consider. If uniformity (+/-10%) is below 80% for brown and 85% for white, delay the light stimulation.

The bodyweight reference must be fixed according to country and egg size requirement.

Dark laying houses

When pullets are transferred from a dark rearing house to a dark production house, control of sexual maturity is easier to be achieved by using the suitable lighting programme. The following lighting programme should be used as a guide and can be adapted to breeding product and to farm conditions according to performances previously obtained.

Table 10: Lighting program for dark laying houses

Age and/or Bodyweight	Standard program brown egg layers (hours)	Standard program white egg layers (hours)	Delaying maturity/hot season program (hours)
End of rearing to light stimulation	10	10	12
At bodyweight reference (BWr*)	12	11	14
BWr + 1 week	13	12	15
BWr + 2 weeks	14	13	15.30
BWr + 3 weeks	15	14	16
BWr + 4 weeks	15.30	15	16
BWr + 5 weeks	16	16	17

**BWr : bodyweight reference must be fixed according to country and eggsize requirement*

It is worth noting that moving birds from a naturally lit rearing house to a dark laying house is not recommended since it slows down the sexual development of the bird and causes a delay in the onset of lay.

Production in open house system

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

End of rearing /start of lay during a period of decreasing day length

To reduce the delay in sexual maturity induced by decreasing day length, we recommend:

- Starting light stimulation when the body weight is on target by increasing the day length period by:
  - 2 hours in the morning for brown egg layers
  - 1 hour in the morning for white egg layers
- Then add 1 hour per week in order to get 13-15 hours of light at 50 % production

Note: this advice needs to be adapted according to white or brown breed, feed intake and bodyweight observed

End of rearing /start of lay during a period of increasing day length

To avoid a premature sexual maturity, which could lead to poorer overall performances (in egg number, egg size, shell quality and liveability), we recommend:

- starting light stimulation when the body weight is on target by increasing the day length period by 1 hour in the morning (brown and white egg layers)
- adding 1 hour per week

Table 11: Lighting duration for a given daylength

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

**BWr : bodyweight reference must be fixed according to country and eggsize or grading requirement*
*** NL = natural light*

In aviary systems it is important to be able to control lighting system in different groups. In the evening, light should be turned off in stages, first lights in the aisles, then lights in different levels of the system, from bottom to top, to encourage the birds to move to the resting areas before lights are turned off.

In the morning, lights should be switched on at once, but if floor eggs are found, a dim light can be turned on one hour before the main lights are switched on.

Light intensity

A low light intensity from 5 to 10 lux is required for production. The most important thing to achieve is the best uniformity of light spread possible.
Standard light bulbs with dimmers are preferable to fluorescent lights that can be perceived as flickering by birds.

It is advisable to use higher light intensity at the start of production to stimulate feed intake. Once feed intake meets the desired level and the peak of production is achieved, light intensity can be decreased.

There is a strong correlation between bird activity and feather loss during production. Too high light intensity can encourage pecking and result in increased mortality.

Floor eggs prevention

Prevention of floor eggs is a key factor for flock success. Avoiding this behaviour requires a lot of attention at the beginning of the lay.

In this section, we define floor eggs as all eggs laid out of the nest; it could be floor, slats, system eggs.

The two main points are:

- The nest must be more attractive and comfortable than other parts of the hen house
- Access to nest has to be easy for birds

Light

Light management is one of the key factors to prevent floor eggs.

- Light has to be well spread in the laying house, shadow areas need to be avoided. Birds naturally lay in darkened areas. A simple action like replacing broken bulbs, can prevent it.
- When it is possible, a progressive light off process should be done. Lateral light should be turned off first, this will encourage birds to go close to the nest and to sleep on slats and lastly, the central light should be switched off.
- According to the breed used and the lighting program applied, a variable percentage of birds will lay before lights on; the propensity to lay on the floor is higher for these birds. Night light in the nest encourages these early birds to go into the nests for laying before the general lights come on.
- Where the legislation allows it, a night flash during the dark period (for example 1h30 of light, 3 hours after light off), will delay the lay of one part of the flock and reduce the competition in the nest. This will be more efficient if the number of birds per nest is high. In this case, all hens will get easy access to the nest.
- In some situations adding one extra hour of light in the morning could solve floor eggs problem

General management advices

- All the corners caused by the equipment or the building design are potential areas for eggs to be laid. Therefore limiting corners access prevents floor eggs.
- It has been observed that keeping the birds too long on the slats may increase the incidence of floor eggs. The floor scratching area needs to be accessible when the flock has discovered the upper area (nest, feeder, drinker).
- At the beginning of the lay, frequent floor egg collection has to be done (several times per day). A floor egg will encourage other birds to lay in the same place.
- Ensure all the birds are sleeping on the slatted area or system
- The observation of where and when the floor eggs are laid can give the reason for this behaviour. This information could be very useful to understand the problem and apply solutions to solve it.
- Grit distribution on floor discourages floor eggs by eliminating the building of potential nests in the litter
- Installation of a deflection barrier between the nest boxes enables the birds to be evenly distributed, diluting the pressure in the nest boxes. This also helps prevent overcrowding of nests located near to partitions.
- In order to prevent the floor to seem too comfortable, frequently remove the manure.

Behaviour

Just before laying (approximately 30 minutes), birds express a specific behaviour called «pre-laying behaviour» which consists of 3 phases:

- Active nest searching
- Choice of nest
- Nest creation

Birds shouldn't be disturbed during the process of searching for a nest otherwise they stop the search. Disturbances induce

them to lay where they are and increases floor egg numbers. For instance feed distribution or egg belt running can also disturb the process of searching for a nest. Therefore, it is not recommended in the case of floor eggs to disturb birds with feed distribution or egg collection during the lay.

Ventilation

Nests have to be comfortable, to encourage birds to lay there. During winter, prevention of direct cold draughts around the nest is recommended, while during summer, nests should be well ventilated. Specific ventilation adjustments should be done to increase air flow on floor or lateral areas. The purpose of ventilation is to create a comfortable area close to the nest, more comfortable than the other part of the laying house. Ventilation has to be adjusted according to the season.

Rearing

The rearing system should be as close as possible to the laying system to avoid the risk of increased floor eggs. It is recommended to install perches in the rearing house before 4 weeks of age. Light intensity does not need to be to high, because high intensity increases the sensitivity to dark areas in the laying house. Early transfer is strongly recommended in order to avoid the onset of lay in the rearing house, which can encourage the birds to lay on the floor in the laying house.

Equipment

Equipment position and stocking density can affect floor eggs.

- Feeder / drinker
  - Not too close to the nest (no bird accumulation in front of the nest)
  - Take care of feeders and drinkers height (no creation of physical barrier between bird and nest)
  - Enough feeders and drinkers to avoid competition and stagnation near to them
- Nest
  - Clean (without broken eggs, manure, etc...), attractive
  - Adequate number (120 birds / m² communal nest or 5-6 hens/single nest)
  - Nest access management: close the nest before light off; open the nest before light on.
- Slats
  - Not too high, installation of ramp / ladder: easy access from scratching area to slats
  - Slat slope not too sharp: comfortable area, facilitate nest access
- Electric fence
  - Installed next to the walls and corners

Systems eggs for aviary houses

Eggs laid on the system is a common problem in aviary systems. To avoid it we recommend:

- To promote birds perching as high as possible during night, this avoids crowding in front of the nest box in the morning.
- High perching can be promoted by using a longer dimming period.
- A light intensity in the system close to the light intensity in the rest of the house helps to create a space in the system not comfortable to lay eggs.
- Avoid lights in the system that also light the nest box.
- It is essential to promote birds use of perches and plateau's to move up and down in the system or in between systems.
- Vertical movement can be stimulated by limiting access to water or feed on certain levels. When this is practised it is at the utmost importance to check if birds living on these levels eat and drink sufficiently.

When eggs are produced on the top level in most occasions this is due to the fact that birds are afraid to move down. Placement of extra perches can help vertical movement and avoid mislaid eggs on the top level. It also can help not to feed on the upper level for the first feed distribution.

In many occasions eggs are produced on the middle level of the system, the reason for this is feed and water intake at the middle level. Closing the drinker line in the middle level during the morning can promote the birds movement to the drinker line in front of the nest.

A floor / system egg collecting scheme can help to understand what happens after changing feed, water or light management.

Prolapse prevention

Prolapse refers to a condition seen in laying hens characterized by part of the oviduct remaining outside of the vent after the hen has laid an egg. Prolapse is very often combined with pecking of the vent and cloacal area or at the everted oviduct, leading to a rapid death.

The main causes of prolapse are the following:

- Improper body weight and frame development: underweight pullets at point of lay, before the reproductive tract is completely mature and oviduct muscles have developed elasticity and strength. Pullets with excess fat are also more prone to prolapse since fat excess contributes to lower elasticity and tone of the tissues involved in egg laying.
- Lighting program: too early light stimulation, before complete development, or giving excessively large light increments, leading to an increased incidence of double yolks.
- Any condition encouraging pecking behaviour : high light intensity, unbalanced feed, poor quality beak trimming, enteritis... increasing the chances of physical damage to oviduct tissues.

To control prolapse we advise:

- Making sure the flock is uniform during rearing
- Ensuring body weight is on target by getting a steady growth since early age
- Avoiding excess weight (i.e. fattening) during rearing
- Avoiding any sudden increase in light period
- Applying a proper lighting program to compensate natural light and avoiding unwanted early light simulation

Bird behaviour

Individual or flock behaviour is influenced by many factors, singly but more usually in combination.

Normal behaviour

In general the bird can cope with moderate stress, such as temperature rise or fall, transfer from rearing to laying facilities, or change of ration, etc...
It is important to recognise any change in behaviour, as this may indicate some problem, and it is better that this is both recognised and remedied sooner rather than later. The most important behavioural characteristics to recognise are aggression and crowding.

Abnormal behaviour

Pecking

We recognize different kinds of pecking. Gentle pecking we consider as normal behaviour and severe pecking as abnormal behaviour.

Gentle pecking: careful pecks, not resulting in feathers being pulled out and usually without interaction from the recipient bird. This is a social and explorative behaviour

Severe/injurious pecking: forceful pecks, sometimes with feathers being pulled out and with the recipient bird moving away. This is clearly an aggressive behaviour.

There are stressful circumstances, which may result in aggression. If some of the birds start pecking aggressively (not all pecking is aggressive, much is occupational and non-damaging) it is usual to hear squawks of pain from the pecked birds. This needs early identification, as it is abnormal. It is an indication that there is a serious stress affecting the flock, and prompt remedial action is essential.

Loss of feather cover leads to increased heat loss and consequently to higher feed consumption.

Possible causes are as follows:

- Parasitic infection:
  - Red mite.
  - Worms, ascarid, capillaria infestation.
- Enteritis and diarrhea
- Ventilation
  - Inadequate ventilation, leading to higher levels of humidity and smell (ammonia)
  - Drafts.
- Non respect of density and equipments specification
  - Insufficient floor space
  - Stress of overcrowding
  - Limited access to drinkers and feeders (insufficient number/ poor distribution).
  - Inability to access nests, resulting in floor laying – leading to pecking of exposed vents.
- Shortage of water or feed:
  - Drinkers / feeders empty.
  - Water or feed unpalatable
  - Too low pressure / leakage
  - Shortage
- Feeder and water equipment not earthed properly
- Poor beak trimming
- Feed not suitable:
  - Sodium deficiency
  - Amino acids deficiency
  - Lack of insoluble fibre
  - Sudden change of grist presentation
  - Too high energy level, due to a reduction in consumption time
  - Faulty manufacture – for instance, incorrect salt inclusion.
- Intensity of light too bright:
  - Light source generally too powerful.
  - Direct light from fluorescent bulbs (especially) or tubes; depending on the type.
  - Entry of direct sunlight into the poultry house.
  - Flickering bulbs
  - Sudden increases in light duration
- Nests brightly illuminated – bird's vents targeted during egg laying.

As pecking is difficult to control once it has started, the objective is to be ahead of the problem in order to prevent the outbreak, but if it does occur (bearing in mind that it is indicative of abnormal behaviour) the objective should be to identify the problem promptly, and remedy the cause as quickly as possible.

In case of a pecking outbreak, you need to react quickly to:

- Decrease light intensity*
- Paint bulbs or light covers in red
- Add salt into the water (0.5-1 kg/1000 l)
- Add extra vitamins / minerals / amino-acids in water
- Add a fibre source within the house (see fibre to layer)
- Add enrichment within the house (pecking blocks, fibre, plastic bottles, plastic toys, cd, beet...).

**Caution: floor eggs could appear and feed intake could be decreased*

Crowding

Floor-reared birds sometimes have a tendency to crowd together. This natural behaviour can be triggered by different situations:

- Panic reaction: when birds are frightened, they try to avoid danger
- Attraction: when they are attracted by something, as they are curious and want to find feed and discover their environment
- Sleeping behaviour: it enables them to reduce the loss of body heat during the night, maintain social links and protection against dangers.

Smothering may occur during lay in different parts of the poultry house and often the reason is not clear. However, in production flocks, it is most commonly observed around the peak of production, as it seems to be related to stress situations.

Although unpredictable, smothering is more frequently observed in different situations:

- In the evening at "lights off"
- At the moment of rest, after egg laying (noon)
- Along partitions, due to curiosity (e.g. presence of the stockperson in the house)
- Following a change in feeding times, in feed composition or due to lack of feeding or drinking equipment
- When flocks are restricted or feed intake is low
- When direct sunlight is getting in the poultry house
- Inadequate ventilation, uneven in-house temperature and draughts

To control the risk of smothering:

- Minimise the number of corners (e.g. feeder). It is sometimes better to sacrifice a little floor space, keeping a few less birds, in order to maintain straight line partitions.
- Ensure an even light distribution within the house. Install a light trap/deflector.
- Construct partitions with wire mesh; birds crowding against a mesh partition are still able to breathe
- Use wire mesh covered triangles in order to eliminate corners.
- Install electric wires along the walls, corners and partitions
- If crowding occurs during the evening, for example close to sunset, check that sunlight does not enter the house through the pop holes. This is almost certain to attract too many birds into a small area. Deflector installation in front of the pop holes could solve this issue.
- It is necessary to visit the birds at the end of the day or when lights go off to check behaviour, especially in the first few days after delivery.
- Install music in the houses so the birds react less to noises.
- Carry out a feed distribution one hour before lights go off. It will evenly distribute birds through out the building. The extra heat produced during digestion will avoid crowding before the night.
- Lighting program must be adapted to natural day length. Try to avoid switching off the lights before sunset, mainly during the longer day. This needs to be considered at flock placement.
- Ensure that available perch space is adequate
- Adapt the ventilation to obtain a uniform environment in the house and to avoid draughts
- Avoid any feed restriction at the critical periods
- Give scratching material (e.g. grain/grit) in the afternoon to keep birds occupied

Broodiness

Broodiness can appear in certain flocks in cases of stress or when they are generally underweight. Nutrient deficiency, heat stress and any factors related to poor growth can lead to broodiness. Floor laying leads to broodiness, preventing floor laying and frequent egg collection limits the amount of broodiness.

Broodiness can be identified by characteristic behaviour patterns such as staying in the nest, fluffed feathers, clucking and aggression. Therefore we advise closing nests at the end of the afternoon. Nests should not be closed until 4 hours before lights off to avoid loss of late laid eggs.

The pause in lay depends upon rapid action.

Table 12: Broodiness and lay link duration

Time broody (days)	Pause in lay (days)
1	7
2	9
3	12
4	18

According to B. Sauveur (I.N.R.A.)

We advise isolation of broodies from the moment they appear (in the evening). Place them in a spacious pen, on a concrete or slatted floor without a nest. Treatment is made more effective by dipping the broodies in cold water for 20 to 30 seconds and administering aspirin (a 125 mg tablet) before transfer to the broody pen. The density in the pen must not be greater than 6 per m². The birds must have feed and water permanently. At the end of 4 days, those which respond (widening of pelvic bones) can be placed back with the flock.

The best system is to have 2 broody pens. The birds picked up on Monday, Tuesday and Wednesday are put in the first pen where they stay until the following Monday. The other pen is used for the other days and follows a similar time lapse. Avoid leaving broodies to brood on the floor, to reduce the spread of the behaviour.

Fibre for layer

Birds have a specific requirement for fibre. They must find fibre in the feed or in their immediate environment. It has been shown that if birds are deficient in fibre, it can lead to feather pecking and then feathers are used by the bird as a fibre source. A poor feathering observed in a flock without feathers visible on the floor could be a sign of a lack of fibre.

It is clear that a good supply of fibre improves feathering, decreases mortality, improves gut health and digestion.

Fibre provided to layer flocks must be insoluble with as much as possible of a coarse texture. Fibre could be provided through the feed. According to the raw material available, total fibre content can be very variable. 2.5% of raw cellulose is considered as low level, above 5% as a high level. Most of the fibre can be provided by oilseed meal (sunflower / rapeseed), alfalfa (or lucerne), and oats. Cereal by-products could provide a good amount of fibre in the feed, but their texture is usually too fine to have 'structure effect' on the digestive tract.

Fibre should be provided directly in the building. We advise the use of a coarse fibre such as straw, alfalfa (lucerne), wood shavings, rice/oat husk, sillage, etc. These materials must be available in the building through round feeders or directly as a ball on the scratching area. Birds must have a free access to fibre sources at all times. We advise not spreading fibre directly on the floor. To prevent floor eggs, fibre supply must be introduced after the peak of production when the birds are well trained to use the nest.

Feed for birds in alternative production

Energy

The main difference between cage and alternative production feed is energy requirement. Birds in alternative production system are much more active and when they have access to the range are confronted by temperature variations. These two factors lead to an increase in their energy requirement. To cover their higher energy requirement, birds eat more. According to the housing system used, temperature and bird feathering, feed consumption can be increased by 3 to 20%.

In alternative production, it is essential for point of lay pullets to reach their mature body weight quickly. Energy intake is usually the limiting factor for production and growth when lay is starting. It is highly advisable to use a higher energy diet from 18 to 30/35 weeks of age. Birds are able to adapt on wide range of energy values. However, observations show energy levels of 2750 to 2850 kcal/kg are adapted for start of lay diet.

For the second part of the production until depletion, energy concentration must be decreased to prevent fattening, improve feathering and livability. Lower energy diets contain more insoluble fibre, increase consumption time and affect bird behaviour (see 'Fiber for laying hen' section). However diets with lower energy values increase feed consumption. Observing local regulations and raw material availability, a compromise between feed intake/FCR, bird behaviour and bird bodyweight must be found. Classical energy feed range, observed after 35 weeks of age, are from 2600 to 2750 kcal/kg.

All the other nutrients requirements in alternative production are very close to those used for cage system.

Protein and amino acids requirements

The daily amino acids and protein requirement values are estimated from the last review we carried out on amino acids requirement:

Table 13: Recommendations for amino acids expressed in total or digestible and ideal proteins established for a production of 59.5 egg mass per day

Limiting amino acids	Based on European table 2002				
	Ideal protein	Requirements in mg per g of egg		Daily Requirements in mg per day	
		Dig. AA	Total AA	Dig. AA	Total AA
LYS	100	13.34	15.0	795	895
MET	53	7.1	7.56	420	450
MET + CYS	82	10.9	12.1	650	720
TRY	22.5	3.00	3.50	178	208
ILE	91	12.2	13.35	725	795
VAL	97	13.0	14.35	775	855
THR	70	9.4	11.0	560	655

These daily amino acids requirement must be adjusted according to the feed consumption:

Daily amino acids requirement in mg/day / feed consumption observed in g / 10 = % of amino acids in the feed

Formulation of layer diets can be carried out by introducing ISOLEUCINE and VALINE as nutritional constraints, replacing protein as a constraint. If this is not possible, these are recommendations for a minimum of protein for feed containing or not containing Meat and Bone Meal (MBM).

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

Table 14 : Amino acid concentration for an eggmass of 59.5g according to feed consumption

Average feed intake observed before 28 wks in g / day	105	110	115	120	125
Protein w/o MBM %	(18.2-18.7)	(17.7-18.2)	(17.2-17.6)	(16.7-17.2)	(16.2-16.7)
Protein with MBM %	(19.5-20.0)	(18.9-19.4)	(18.2-18.8)	(17.9-18.4)	(17.4-17.9)
Total amino acids %:					
Lysine	0,90	0,86	0,82	0,79	0,76
Methionine	0,45	0,43	0,42	0,40	0,38
Methionine + Cystine	0,73	0,69	0,66	0,64	0,61
Tryoptophan	0,210	0,201	0,192	0,184	0,177
Threonine	0,66	0,63	0,60	0,58	0,56
Isoleucine	0,80	0,77	0,73	0,70	0,67
Valine	0,86	0,82	0,79	0,75	0,72
Digestible amino acids % :					
Lysine	0,80	0,77	0,73	0,70	0,67
Methionine	0,43	0,41	0,39	0,37	0,36
Methionine + Cystine	0,66	0,63	0,60	0,57	0,55
Tryoptophan	0,180	0,172	0,165	0,158	0,151
Threonine	0,57	0,54	0,52	0,49	0,47
Isoleucine	0,73	0,70	0,67	0,64	0,62
Valine	0,78	0,75	0,71	0,68	0,66
From 28 weeks to end of lay					
Protein w/o MBM %	(17.4-17.9)	(16.9-17.4)	(16.4-16.9)	(15.9-16.4)	(15.4-15.9)
Protein with MBM %	(18.7-19.2)	(18.1-18.6)	(17.6-18.1)	(17.1-17.6)	(16.6-17.1)
Total amino acids % :					
Lysine	0,85	0,81	0,78	0,74	0,71
Methionine	0,43	0,41	0,39	0,38	0,36
Methionine + Cystine	0,69	0,66	0,63	0,60	0,58
Tryoptophan	0,198	0,189	0,181	0,174	0,167
Threonine	0,62	0,59	0,56	0,54	0,52
Isoleucine	0,76	0,72	0,69	0,66	0,64
Valine	0,81	0,78	0,74	0,71	0,68
Digestible amino acids % :					
Lysine	0,76	0,72	0,69	0,66	0,64
Methionine	0,40	0,38	0,37	0,35	0,34
Methionine + Cystine	0,62	0,59	0,57	0,55	0,52
Tryoptophan	0,170	0,162	0,155	0,149	0,143
Threonine	0,53	0,51	0,49	0,47	0,45
Isoleucine	0,69	0,66	0,63	0,61	0,58
Valine	0,74	0,70	0,67	0,65	0,62

Mineral nutrition

Table 15: Daily mineral recommendations

DAILY REQUIREMENT	From 17 to 28 WEEKS	From 28 to 50 WEEKS	From after 50 WEEKS
Available phosphorus (1) mg	400	380	340
Available phosphorus (2) mg	440	420	380
Total Calcium g	3.9 – 4.1	4.1 – 4.3	4.3 – 4.6
White birds			
Coarse Calcium (2 to 4mm) g	2.0	2.1	2.2
Brown birds			
Coarse Calcium (2 to 4mm) g	2.6	2.7	2.9
Sodium minimum mg	180	180	180
Chlorine mini-maxi mg	170 - 260	170 - 260	170 - 260
Oil Mini-maxi (3) %	2 - 3	1 - 2	0.5 – 1.5
Fibre	A minimum of coarse fibre or lignin is required to prevent feather pecking and improve the feed digestibility		

(1): When coarse limestone is supplied as particles of 2 to 4 mm, it is possible to use these values.

(2): We advise using these values when the calcium is supplied in powder form.

(3): Vegetable oil rich in unsaturated fatty acid improves egg weight, according to the requirement of the market and the appetence a level of 2 to 3% is required. To avoid egg size becoming too large at the end of lay, we advise reducing the quantity of vegetable oil being used.

All these daily mineral recommendations must be divided by the observed feed consumption, to get the ideal percentage in the feed.

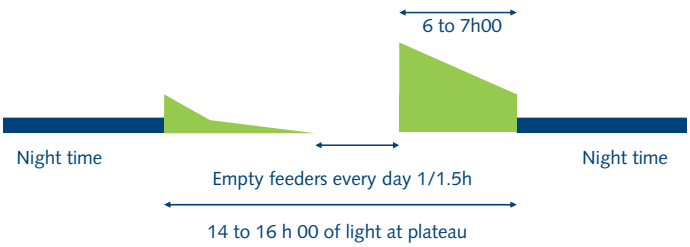
Daily requirement in mg/day	/	feed consumption observed in g	/	10	=	% in the feed

Feeding management

Feeding management during production should follow several simple rules:

- Hens are grain eaters and have a preference for bigger feed particles. They need to eat all the components of the formulated feed including the fine with higher concentration of aminoacids, minerals and vitamins.
- For this reason we recommend that the birds finish their ration every day so that the feeders rest empty for a while.
- In case of floor or dirty eggs, we recommend not disturbing the birds with feed distribution during their oviposition time, so we recommend not feed distribution during the first 5-6 hours of the day
- The birds should preferably eat a greater part of their daily ration during the second half of the day. The fast accumulation of calcium in the eggshell starts at this time and the birds can very effectively utilize the calcium from the feed to form a good eggshell. These are the reasons why the feed for laying hens in production should be distributed in the second half of their day.
- Make the least number of distributions possible to avoid selection of bigger particles (ideally 1-3 distributions in the afternoon – depending on the capacity of the feeding system). The whole daily ration should be distributed during this time. Besides the specific appetite for calcium that the hen shows during the eggshell formation, they also naturally eat more in the last hours of a day to meet energy needs for the night period.
- The last feed distribution 1-2 hours before lights off also encourages the birds to get to the house from range and to the system (slatted area and perches) and to sleep there. The amount of the feed distributed must be sufficient to cover the increased consumption during the next morning (the birds are hungry after the night period and will easily finish the less attractive fine part of the ration). As the feed is not distributed in the morning the hens have time to find a nest and lay the eggs there. The remains of feed from the previous day is eaten during this time and the feeding system may stay empty for one or two hours. The birds have finished their ration, all the feed is consumed, the eggs are laid and the feeding system is ready for the first feed distribution of the day. The birds have enough appetite to start the intensive feed consumption of the afternoon.

Figure 6: Feed distribution management



Pasture and range management

Good pasture management and range enhancement improves welfare of the birds.

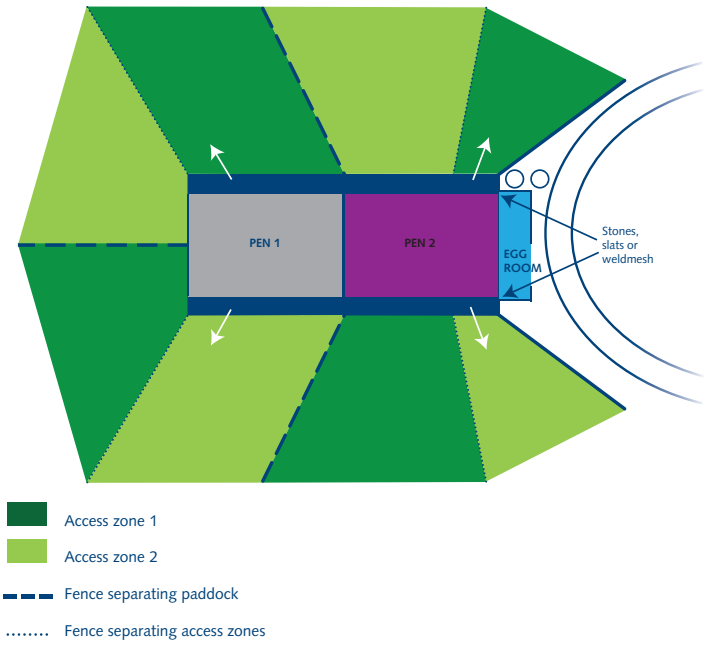
- Range enhancement

The most critical part of the range is the immediate access of the range (first 5/10 meters) in and around the -area of the popholes. It is recommended to place large stones or slats immediately adjacent to the popholes or the winter garden. The stones beside the house help to keep the birds' feet clean and assist to the drainage. Puddles surrounding the house can be a source of contamination and need to be avoided.

Trees and shelter provision on the range allows birds to utilize the range better and protect them against climatic conditions.

Pasture management:

Figure 7: Pasture management



Pasture comprises not only plants and grasses, but also includes soil – which should have a certain structure if the plant population is to flourish. The pasture has to be managed if firstly it is to thrive, and secondly the birds are to find it acceptable.

The 'paddock' grazing system, where the pasture is divided into 3 or 4 paddocks (or more) and grazed alternately for periods of 3 to 4 weeks, is most useful from several standpoints:

- The plants have a recovery period, during which in the appropriate season, it is possible to re-seed worn areas, in order to maintain good pasture quality.
- When paddocks are not stocked they may be cut and hay may be taken.
- It is possible to chain harrow the pasture, breaking up any mat of dead herbage – an essential feature of pasture management.
- Owing to the break periods, the ground does not become 'fowl sick'. In particular the development of parasitic worms is kept under control.

The areas close to (within 50 metres) the poultry house suffer heavy wear, and will need to be repaired from time to time. The ground may well need cultivating, prior to re-seeding, in order to improve soil structure. Grass does not flourish unless the soil conditions are correct.

It may be necessary to plough areas of ground, allowing exposure to frost and rain, during the winter period, in order to repair soil structure. Reseeding would then be during the early spring.

If reseeding can be carried out during early autumn, this is generally preferable to spring planting. Autumn sowing usually enables the plant population to become much better established, with deeper root growth, before the dry periods that often occur during late spring and summer.

Reseeding will normally be using hard wearing ryegrass species – these are the most durable[2].

- Decontamination of the range

In case of heavy contamination of the range, 500g/m² quicklime powder could be spread in this area. Other actions like using chain harrow, could be applied to allow sunlight (ultraviolet) to treat the infected soil.

Terminal hygiene

The absence of stock permits unhindered access to all parts of the building and equipment, facilitating the terminal hygiene programme of cleaning and disinfection. As soon as the stock have been depleted, work should commence.

The sooner the programme is completed, the greater the reduction in potential pathogens prior to restocking.

There are two basic tasks to be carried out:

1. Cleaning – the purpose is to remove organic matter and to make all surfaces visually clean.
2. Disinfection – the act of sanitising the 'clean' surfaces.

There are a number of suppliers of chemicals, and generally different products are needed for these two tasks, detergents are used for cleaning, and disinfectants for sanitising. Some detergents (detergent sanitisers) do have some disinfecting properties, but in the poultry house a suitably formulated disinfectant should still be used to follow a detergent (sanitiser). Chemical products must be handled carefully. Please refer to local regulations on waste disposal.

Find a full terminal hygiene program described page 32

Minimum measurements and record keeping

Record keeping is a management tool used to check the flock's performance compared to a standard. It also reveals any irregularities to enable you to react quickly.

Table 16: Minimum measurements and record keeping

	Minimal	Optimal
Feed consumption	weekly	daily (weekly records)
Bird weight	arrival ≤ 28 weeks: 1 every month > 28 weeks: 1 every 2 months	arrival transfer to 30 weeks of age: 1 on 2 weeks >30 weeks: 1 per month
Mortality	weekly	daily
Water consumption	weekly < 28 weeks of age	daily
Laying rate	weekly	daily
Egg weight	weekly	daily

Terminal hygiene program

Stage 1 – removal

1. Livestock.
2. Deadstock – any carcasses.
3. Feedstuffs – this can be minimised by careful planning.
4. Moveable equipment – to a hard surface area with suitable drainage.
5. Droppings and litter – to as far as possible from the farm.
6. Whilst the house is warm it is recommended to treat for red-mite/insects.
7. Bait extensively for vermin.

Stage 2 – preparatory

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

Stage 3 – washing

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

Stage 4 – re-assembly

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

Stage 5 – disinfection

Spray all previously washed surfaces of building and equipment with disinfectant solution.

Water lines must be cleaned first with an alkaline based detergent and
after, an acid based detergent and then flushed out thoroughly.

Stage 6 – disinfestation

Spray all surfaces (especially nests and slats) with appropriate chemicals for insect and mite control.

Stage 7 – fumigation

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

Stage 8 – sanitary break period

The building closed, ideally for no less than 2 weeks. If maintenance work is to be carried out, normal biosecurity precautions should be observed, and stages 5, 6 and 7 must be repeated before the new stock arrive.

Stage 9 – preparation for arrival of new stock

1. Check the function of all equipment.
2. Supply drinking system with fresh water.
3. Feeders should remain empty.
4. Building should be heated prior to arrival of growing pullets, if house temperature is less than 15°C.

Notes

Biosecurity and hygiene

A good health status is very important for two reasons. Healthy animals are efficient producers. Disease costs energy. A healthy flock brings profit. Secondly, we produce high quality food which is safe for human consumption, free from pathogens and other contaminations.
There are three different kinds of disease threats.

- Notifiable diseases like avian influenza and Newcastle disease must be kept away from birds.
- Normal poultry pathogens are controlled, mainly through vaccinations. We vaccinate against all kind of poultry pathogens to keep our flocks healthy, to minimize losses and to achieve good and efficient production results.
- The third category is food borne pathogens; salmonella is the most important one.

For ISA, the veterinary health status of its farms is crucial, because we are an exporting company. To be able to export layer breeding stock, our farms must meet with the veterinary health requirements globally.

Every individual farm should define, for itself, what should be the health status of its flocks.

Biosecurity programs are installed to maintain the desired health status -which is to be disease free. Biosecurity is the key to prevention of disease, together and in cooperation with custom made vaccination programs and disease eradication/ control programs.

What is biosecurity?

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

Airborne infections are difficult to control. The localisation of the farm, in a low density poultry area is important. Forced air positive pressure (FAPP) ventilation systems with absolute filtering can help preventing airborne infections.

Management of contact infections is the responsibility of the management; Salmonella is a real contact infection.
Avian influenza is a real contact infection.

Mycoplasma is a real contact infection, if the distance to neighbouring farms is more than a few kilometers.

The mycoplasma synovia status of a farm is a very good indicator for the level of biosecurity.

How to implement biosecurity?

- Make a risk assessment. Biosecurity means minimising direct (via poultry; direct bird to bird contact) and indirect (via people/visitors/workers/rodents/flies/truck/ materials/equipment) contact between farms.
- Only introduce birds with a guaranteed health status.
- Allow no visitors or make use of a stand still period (free of poultry contact) for visitors of at least 48 hours (and preferably 72 hours). Do not allow staff/ workers on the farm to have poultry at home. Mycoplasma's, for instance, can survive up to 72 hours in people's hair.
- Install and use shower facilities; change clothes and footwear.
- Poultry houses must be rodent and bird proof.
- Keep flies under control.
- Also feed storage must be rodent, bird and fly free.
- Use in farm equipment and tools.
- Do not allow trucks and cars on the clean part of the premises.
- Observe strict separation between the outside and inside of the farm premises (fences, clean road/ dirty road principle for delivery of feed and removal of manure and dead birds) is important in the prevention of indirect contact between birds of different farms.
- Also maintaining the strict separation between outside and inside of the houses is important.This can be implemented, quite simply, by changing clothes and footwear and washing of hands before entering a poultry house.
- Foot pans with disinfectant or disinfectant-treated pads are hard to maintain and therefore often useless.
- Feed is a risk factor (salmonella).
- Is the drinking water clean and free from pathogens? (The drinking water can be contaminated with E.Coli, yeast, moulds and, when surface water is used, with avian influenza!).

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

Every offence against the biosecurity rules is a serious threat to the health status of a farm. All people must be aware of this fact and be aware of the risks and the possible consequences of these risks. Biosecurity is the cheapest, most effective mean of disease control.

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

Vaccination

Poultry can be vaccinated to make the birds themselves less susceptible to poultry pathogens. Parent stock poultry can be vaccinated to make their offspring less susceptible for disease (providing them with maternal immunity via the yolk).

Poultry can be vaccinated to make them less susceptible for contamination with human pathogens, i.e. Salmonella species.

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

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

You must make a risk assessment.

- What is the risk of infection?
- What are the costs of infection and how do they relate to the costs of vaccination?
- What's the damage done by vaccination compared to the expected benefits of vaccination?
- Is protection needed during rearing and/or during lay and/or should the offspring be protected by vaccination?
- Should you use live or killed vaccines?
- What is the most suitable/ practical route of administration of the vaccine?

Take into account the principle of priming and boostering.

Take into account the minimum time distance between two vaccinations targeting the same organ system.

Monitoring

Monitoring can serve different purposes.

When you vaccinate it is important to monitor the vaccine take. Was the vaccine administered at the right time, in the right way?

You can monitor the endemic diseases on a farm.
Which pathogens are present and what is their behaviour/ dynamics?

You can use regularly taken serum samples for diagnostic reasons.
Can observed clinical signs be linked to a rise in antibody titre for a certain pathogen?

You can monitor the specific pathogen free status of a farm.

Frequency of sampling and amount of samples vary with the pathogen you are monitoring.
What is the estimated/ expected prevalence of this pathogen in the flock?
What is the risk of infection?
How crucial is it to find an infection as soon as possible?

Drinking water quality

- Water is a very important nutrient for all (production) animals.
- Water is used as a carrier for vaccines and antibiotics/ chemotherapeutics.
- Water can be a source of pathogens.

Good quality drinking water is clean, clear, fresh, tasteless and free from contaminants. The birds can easily find, reach and drink it, and they can drink it as much as they need.

Other salient points are the source of the water and the type of drinking water system used in the houses (storage vessels, pipelines, drinkers).

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

Surface water should never be used as a source for drinking water, because of the risk of contamination with poultry pathogens. Water fowl travel freely from country to country and from continent to continent, carrying diseases with them (i.e. avian influenza) and "dropping" large amounts of contaminated droppings on places where they stop to eat and drink.

Once the source is checked, look at the quality of the water at the point of delivery to the birds, at the end of the line, directly from the nipples or drinkers. Here, the water quality also depends on the hygiene of the water system.

The water system in the houses should be regularly cleaned and disinfected. It should always be cleaned and disinfected in-between the flocks and after in-water treatments. To keep the tubes clean, in longer production periods, the water system should be regularly checked and, if needed, regularly cleaned during production. Frequency of checking should be once every 3-4 months. If the system is disinfected during the production cycle, care should be taken to follow the sanitizer manufacturer's instructions, especially regarding adequate flushing and correct dosing.

Make sure the water system is closed and cannot be contaminated from the outside. Pay extra attention to storage vessels, when used.

Water quality parameters

Table 17: Water quality parameters

Parameter	Poultry Good quality	Do not use
pH	5 – 8,5	<4 and >9
Ammonium mg/l	<2,0	>10
Nitrite mg/l	<0,1	>1,0
Nitrate mg/l	<100	>200
Chloride mg/l	<250	>2000
Sodium mg/l	<800	>1500
Sulfate mg/l	<150	>250
Iron mg/l	<0,5	>2,5
Mangane mg/l	<1,0	>2,0
Hardness in German degrees	<20	>25
Oxidizable organic matter mg/l	<50	>200
H_2S	non detectable	non detectable
Coliform bacteria's cfu/ml	<100	>100
Total germ count cfu/ml	<100.000	>100.000

We are not in favour of water sanitisation during rearing. A good cleaning of the system in the empty period should be sufficient for the whole 16 weeks rearing period and the rearing birds should get the chance to build up some immunity against normal environmental bacteria's like E. coli. Semi-continuous use of water sanitisers can interfere with this.

Different products can be used for cleaning the system, both in-between flocks, when the houses are cleaned and disinfected, and during rearing or production. These products can contain (combinations of) acetic acid and hydrogen peroxide, chlorine, organic acids and inorganic acids.

Be careful of the percentages used when using these products in drinking water. Also be careful with the taste and with the acidity of the water. Using acids, pH should be below 4, to achieve the disinfecting effect and above 3.5, otherwise it becomes corrosive and the birds stop drinking. High levels of chlorine have the same effect on the birds. To have an efficient disinfection with chlorine, decrease pH, have no organic matter in water, and low iron and manganese concentration; if not, water disinfection with chlorine is not efficient. Using only organic acids as a water sanitizer for a longer period of time can be dangerous. You can see growth of yeast and molt in the water. It's better to use acids and chlorine alternatively.

Once the water supply is clean check that the birds easily find and drink the water. For day-old chicks, is there enough light to find the water from the start? Is the water fresh (was the system flushed shortly before the delivery of the day-old chickens)? Is the height of the drinkers correct and adjusted to the age of the birds? Is the system of drinkers used the same in the different phases of production (rearing versus lay)? Are bell drinkers used or nipple drinkers? What kind of nipples? Can the small birds easily activate the nipples? What is the nipple flow rate? Are there enough drinkers/ nipples per bird installed? What is the water pressure? How many hours is the water available? Most of these questions also apply to adult birds.

To monitor older birds, the water-feed ratio is an important parameter.

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

To conclude; birds must always have easy access to good quality drinking water, the quality of the drinking water should be regularly checked and contaminated drinking water can cause serious disease problems.

When birds don't drink, they won't eat and cannot produce.

Information about diseases

Colibacillosis

E coli in poultry

E. Coli infections are known under different names; colibacillosis, E. Coli peritonitis, E. Coli sepsis, E. Coli mortality, E. Coli arthritis.

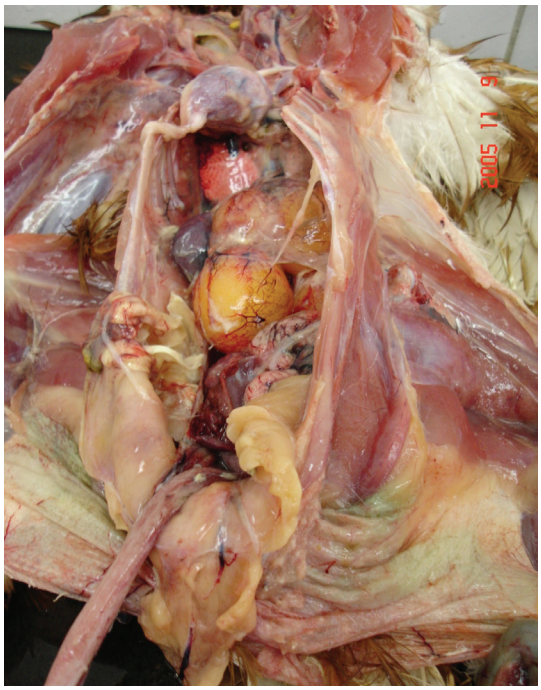
E.Coli can cause problems as a primary agent or as a secondary pathogen.

To act as a primary pathogen, the infection pressure must be high or other complicating factors must be present. In alternative housing systems, high levels of ammonia can damage the epithelium of the respiratory tract, thus opening the way for airborne E. Coli mortality. In combination with high levels of dust, the E. Coli, attached to dust, is able to colonize the air sacs and the lungs.
Both in cage systems and alternative housing systems, contaminated drinking water can be a source of e coli. Also in both systems, ventilation stress can be a reason for e coli mortality. Ventilation stress is caused by draught (fast movement of cold air).
Draughts occur mainly in Spring and Autumn, when the differences between day and night temperatures are significant . At the end of the afternoon/ beginning of the evening, the outside temperature drops fast. Most ventilation systems are temperature regulated; the inside temperature is still high, so the system pulls in this cold air with force, until the set temperature is reached.

E. Coli mortality can be secondary to viral respiratory infections like infectious bronchitis (IB) and avian rhinotracheitis (art), secondary to bacterial infections like ornithobacterium rhinotracheale (ORT) infections and secondary to parasitic infections like red mites infections. E. Coli mortality can also be secondary to pecking.

Peritonitis is not always related to E. Coli.
In layers there are two main types of mortality which involve peritonitis with deposits of fibrin, namely egg yolk peritonitis and E. Coli peritonitis.
With both types you find birds with a pale comb with blue points.
Birds with egg yolk peritonitis are not usually found dead. The symptoms can be observed in the flock. On post mortem, these birds are dehydrated and display pericarditis, perihepatitis and peritonitis with a lot of debris, which can be recognized as solid egg yolk.
E. Coli peritonitis is (per) acute mortality. The flock looks healthy and is performing well. The only problem is increased mortality and it can be quite difficult to see the signs.The follicles are always hyperaemic; sometimes this is the only visible pathological sign. Sometimes the only traces of fibrin are seen between the follicles.
An important difference between the two is the smell. Egg yolk peritonitis birds, when they are fresh,smell like boiled egg. E. Coli peritonitis birds have a very bad, rotten smell.

Egg yolk peritonitis



E.Coli peritonitis

Egg yolk peritonitis occurs in young flocks, at the start of production, when the flock shows a very fast increase in lay percentage. Often these flocks come out of rearing on bodyweight target, sometimes even 50-100 grams above bodyweight target but when these birds are light stimulated, they start laying very fast. In this situation, part of the follicles "miss" the oviduct and land free in the abdomen, with egg yolk peritonitis as result.
Nervous flocks can also show some egg yolk peritonitis as a form of internal trauma then. One other form of internal trauma causing egg yolk peritonitis can be seen in birds housed on a aviary system which suffered from leg weakness; they show too tough "belly landing".
To conclude, egg yolk peritonitis can be a complication of viral infections targeting the ovaries, like IB, ART and ND.

E. Coli vaccines are available, both inactivated (killed) vaccins and modified live vaccines. Especially the modified live vaccine shows promising results. Also autovaccines are used.

E. Coli mortality is difficult to treat. Antibiotic treatments are often very effective, during the treatment, but once you stop and the underlying, primary cause is still present, the mortality comes back. Use of antibiotics is not always possible, because of the withdrawal time of the products used. Especially in layers, a treatment becomes very expensive when you have to destroy all the eggs produced during 10-12 days.
Alternative treatments, like spraying with disinfectants, and drinking water sanitation, with H_2O_2/ per acetic acids combination, with organic acids or with chlorine are also widely used.

Coccidiosis prevention

Infestation pressure in the houses can be reduced by using disinfectant that destroy oocysts. Pay attention to the area surrounding the houses for free range birds. Coccidiosis may be responsible for enteritis and mortality. Sub-clinical infection will damage feed conversion and uniformity.

Anticoccidia during rearing should create immunity and avoid infection during lay. They should not be given after 14 weeks of age at the latest. Vaccination can also be
applied and provide a good protection against coccidiosis.

Worms

Worm infestation can be responsible for low weight intake, bad uniformity, egg quality trouble, increase of pecking and even death in case of heavy infestation.
We can frequently face infestations with ascaris worms, capillaria worms and heterakis worms. Heterakis may be responsible for contamination with histomonas. Control of heterakis contamination prevents histomoniasis.

The birds get infested by ingestion of parasite eggs from the environment. Control of worm infestation can be made by opening up a few birds every weeks or by the examination of droppings for worm eggs.

In free range systems, to prevent worm problems, grass enclosure should be used in rotation and may be treated with products able to destroy parasite eggs (calcium cyanamide, ferrous sulphate…).

All flocks should be systematically treated for parasites at transfer in the laying house. During production, infested flocks should be treated and followed up according to the parasite found and the product used.

A few products are allowed with no withdrawal period, which allows to sell the eggs produced.

Coccidiosis - Eimeria tenella

Helminthiasis - Ascaridia galli

Mites

Red mites are more common in cage or slat systems than in aviary systems where the birds can get dust baths and get rid of the red mites. Red mites may be responsible for nervousness, feather pecking (due to stress), a drop of production, anaemia, blood spots on the eggs, increase of floor eggs (birds don't want to go in the infested nests) and even for mortality. Red mites often hide in dark and innaccessible places such as nests, feeder legs, crossbars of slats or perches

Red mite management must be extensive and start from the empty period when the houses must be treated with insecticides. During the production period, several products can be used to treat red mite problems. The most important for treatment is to reach the places where the mites are hidden. Prevention treatments must be done before getting heavy contamination, as these are more difficult to manage and responsible for economic losses.

Fly control

Flies can be a source of several problems :

- Sanitary problems; by transmitting virus, bacteria or parasites (worms).
- Behaviour problems; by causing birds to become nervous resulting in aggressive pecking
- Environmental problems; by increasing ammonia level in the houses because of the development of larvae in the manure
- Unpleasant for people working in the houses and neighbour's in the local area.

Follow up of insects populations in the house is necessary to decide when is the best moment to use insecticides. To control fly population, avoid drinker systems from leaking or overflowing which can create ideal conditions for fly egg and larvae development.

Insecticides should be applied as soon as possible after departure of the birds, while house temperature is still warm. It is still better to use insecticides active on both adults and larvae than on adults only. Then at beginning of production, use an adulticide insecticide to kill as soon as possible early stages of flies developing in the house; this is the only way to stop the life cycle of the fly. It is still better to prevent and act early than let the number of flies increase , resulting in an over population and greater difficulty in controlling them.

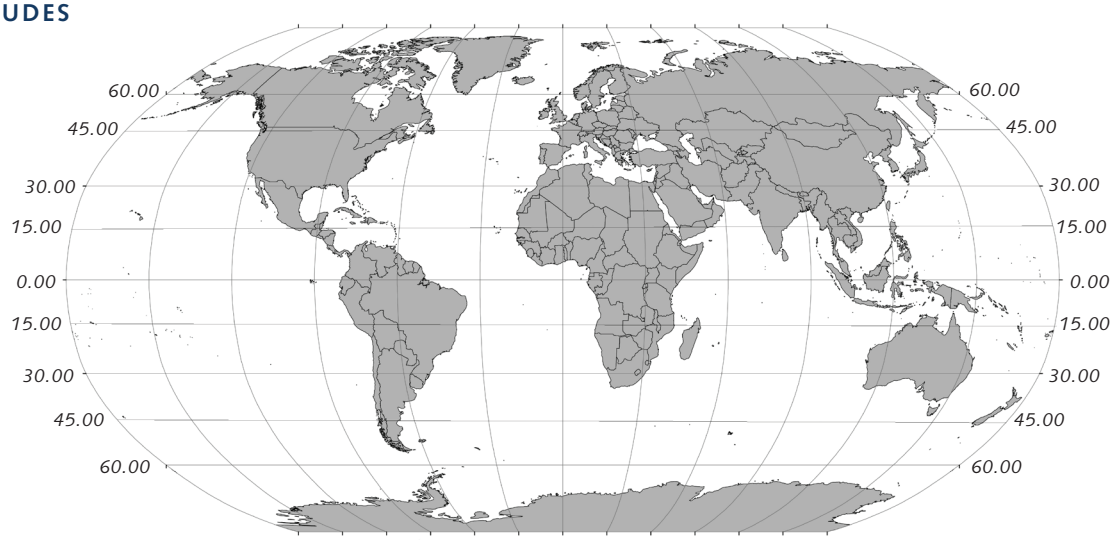
To avoid resistance development, it is highly recommended to get rotation between actives of both adulticide and larvicide insecticides in order to reduce the selection pressure on fly populations.Check also if the insecticides can be used in presence of the birds or not.

Appendix

Day length tables according to latitude

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

Latitudes



Conversion table

Energy
1 cal = 4.1868 J
1 kcal = 4.1868 kJ
Temperature
C=5/9 (°F-32)
F=(9/5°C) +32
Surface
1 cm² = 0.1550 sq. in
1 m² = 10.76387 sq.ft = 1.195985 sq. yd
Light
1 Lux =1 candela = 1 lumen/m²
Weight
115 g = ¼ lbs = 2 oz
1 kg = 2.2 lbs
Lenght
1 mm = 0.03937 in
1 m = 3.28083 ft
1m = 1.093611 yd

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