GENERAL MANAGEMENT GUIDE

BOVANS BROWN
COMMERCIAL LAYER

FOUNDERS OF FUTURE GENERATIONS

ISA
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INTRODUCTION

Many years of genetic research have developed layers with excellent production traits like live ability, production and egg quality.

These highly favourable genetic characteristics can only be fully realized when the bird is provided with good management, which includes, but is not limited to, good quality feed, housing and proper management practice.

The purpose of this management guide is to help the producer to gain the best possible results for their investment. This will be achieved by providing conditions in which the layers can thrive. The information supplied in this publication is based on the analysis of extensive research and field results, produced over time and with many years of experience.

We do recognize that over time, many egg producers have developed their own management program, based on specific housing types, climate, feed, market conditions and other factors. These individual management techniques will also be the result of experience and many of these techniques will work for our layers as well.

Therefore do not hesitate to use your own experience in conjunction with the guidelines in this guide. And of course, do not hesitate to consult our distributor who will be happy to help in any way they can.

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Rearing period:

Good brooding conditions for the best starting of the chicks

The period from one day old to the point of first egg production is a critical time in the life of the laying hen. It is during this time that the physiological capability of the hen is developed.

Success in the rearing period leads to the success in the laying house and it starts from chick arrival. All the standards and programs set forth in this section have been proven to give excellent performances in production.

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 or a delay in start of lay in hot climates near the Equator.

Equipment and environment

		Floor		Cages	
Age (wks)		0 – 2	2 – 5	0 – 3	3 – 5
Ventilation	Minimum per hour / kg	0,7 m^3	0,7 m^3	0,7 m^3	0,7 m^3
Stocking densities	Birds / m^2	30	20	80	45
	cm^2 / Bird			125	220
Water supply	Chicks / Chick drinker	75		80 (1)	
	Birds / drinker	75	75		
	Birds / nipple	10	10	10 (2)	10 (2)
Feed supply	Birds / Starting pan	50		(3)	
	cm of trough feeders	4	4	2	4
	Birds / Round feeder	35	35		

(1): Place one additional drinker per cage for the first week
(2): Make sure that all the birds have at least an access to 2 nipples
(3): Spread sheets of paper over the cage bottom to last for 7 days, remove one sheet every day

Notes:

- The removal of the supplementary starter drinkers should be done gradually, making sure that the chicks have acquired the habit of using the other drinkers.
- It is useful to monitor water consumption. To maintain litter quality, it is necessary to avoid water spillage, by carefully regulating the drinkers or the nipples.
- The drinkers should be cleaned daily for the first 2 weeks. From the third week they should be cleaned each week.

Standard of temperature and humidity

In order to ensure that the equipment and the litter are warm at chick arrival, it is advised to raise house temperature at least 36 hours at 28 to 31°C.

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

Notes:

- The heat losses incurred from contact with the litter are very important during the first days.
- Two (2) gas brooders or 2 radiant heaters of 1450 Kcal is advised for 1000 birds
- Temperature and relative humidity should be uniform throughout the building

Distribution of chicks as the best indicator:

- On floor system, the distribution of chicks in each pen or throughout the building will help you to manage the adapted temperature of the house.
- If the chicks crowd together under the brooder ⇨ temperature is too low.
- If the chicks are close to the surround ⇨ the temperature is too high

Lighting program to encourage feed intake and growth

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

During the first few days, it is important to maintain the chicks under a maximum light regime (22 to 23 hours) with a quite high intensity (30-40 lux) to encourage intake of water and feed. Afterwards, the light intensity should be gradually reduced to reach a level of about 10 lux at 15 days of age in dark houses. Light intensity will depend also on bird behaviour.

Feeding program to encourage growth

During this period from day old to 5 weeks old, the bird is not able to adapt its feed consumption to energy level. To encourage good growth, we recommend using a diet presented in crumb form, with an adequate concentration of protein and energy from 0 to 28 days in temperate climates and from 0 to 35 days in hot climates (in both conditions till a bodyweight of 290 g is reached).
Below are some key-points to provide day old chicks with a good start.

Key points:

- Flush the water lines prior to arrival, and make sure that no disinfectant is left in the water lines when the chicks arrive.
- Make sure that the nipples and round drinkers are on the correct height, nipples on eye level of the chicks, and round drinkers on the floor.
- Put paper under the nipples to attract the chicks & extra feed over the chick paper or paper trays.
- Check the nipples / round drinkers whether the water supply is sufficient. When nipples are used the chicks must see the water drop on the nipple.
- The feed should be distributed when the chicks have drunk enough water to restore their body fluid (about 4 hours after being placed in the brooding quarters)

All these recommendations will help to:

- **Get a good start and a low mortality level during the first 2 weeks**
- **A good frame and immune system**
- **A good uniformity from the beginning**

From 4 to 16 weeks, building the potential of the future layer

After a good starting, the objective of the 4-16 weeks period is to prepare the birds for egg production with an ideal development of:

- the frame
- the bodyweight
- the uniformity
- the digestive tract.

These objectives could be achieved by providing:

- a correct stocking density and housing conditions
- a lighting program adapted to rearing conditions
- a good standard of beak trimming
- a good management of the feeding program and feeding techniques

Housing and equipment

		Floor		Cages	
Age (wks)		5 – 10	10 – 17	5 – 10	10 – 17
Ventilation	Minimum per hour / kg	4 m^3	4 m^3	4 m^3	4 m^3
Stocking densities	Birds / m^2	15	10	15	10
	Birds / m^2 (hot climate)	12	9	12	9
	cm^2 / Bird			200	350
Water supply	Birds / drinker	100	100		
	Birds/drinker (hot climate)	75	75		
	Birds / nipple	9	8	10 (1)	10 (1)
Feed supply	cm of trough feeders	5	7	4	6
	Birds / Round feeder	25	23	25	23

(1): Make sure that all the birds have at least an access to 2 nipples

Feeding program

The range of diet advised for the rearing period could be adapted to the real evolution of the frame and bodyweight development of the pullets.

Starter diet recommended from day old till 4 weeks old could be **extended to 5 or 6 weeks** to secure the frame development. Frame development occurs mainly during the first 8 weeks of the rearing period.

Grower diet recommended from 4 weeks till 10 weeks old could **be extended to 11 or 12 weeks** of age in order to secure growth. As the rearing period objective is also to develop the digestive tract, this grower diet is usually high in energy content could not be given after 12 weeks of age. The risk of using too high energy content feed is the reduction of the development of the digestive tract and the feed intake at start of lay by.

The distribution of a **developer diet till 16 weeks of age** will help the development of the crop capacity because of a lower energy level than grower feed and slightly lower than the pre-lay or layer feed.

In order to secure the development of the medulary bone which acts as a reservoir of mobilisable calcium for egg shell formation, we advise the to use a **pre lay feed from 17 weeks of age till the first eggs appear.**

The details of the specifications for each of those diets are developed in a following section.

Feeding technique

The feeding techniques used between 4 and 16 weeks are designed to:

- avoid the build up of fine particle residues
- encourage crop development by having rapid feed consumption

The Build Up of Fine Particle Residues

Birds are by nature grain eaters. They always start by eating the larger particles and leave the finer ones. The accumulation of fine particles in the feeding system leads to under-consumption. Therefore, it is essential that the feeders are emptied every day. This rule applies equally to pullets and layers.

Rapid Feed Intake

The crop is a storage organ. It allows the bird to eat enough feed in the evening to satisfy its energy needs throughout the night. The increase in consumption at start of lay is dependent on the development of the crop and on the feeding behaviour acquired during rearing

Rapid feed consumption during rearing leads to the development of the crop. The speed with which feed is eaten depends on when it is fed and on the form in which it is offered.

Feeding Times and rapid feed intake

Birds naturally eat more in the morning and evening. For that reason the feeders ought to be empty in the middle of the day.

To encourage rapid consumption, we recommend that the complete daily ration should be given about 2 to 3 hours before the lights go out. The actual time of feed issued should be chosen so that about 50 % is eaten the following morning. At "lights on", because the digestive system is empty, the birds will eat up the finer particles better. This feeding routine can be started between 4 and 8 according to the feeding equipment. The length of time, during which the feeders are empty, should be gradually increased, so that by around 10-12 weeks of age the feeders are empty for a minimum of 2 to 3 hours per day. It is, however, possible according to the feeding equipment to give either a single feed distribution in either the morning or evening, or two 2 distributions, provided that the feeding periods are kept short.

Weekly bird weighing is essential, so that the appropriate quantity of feed to issue can be calculated.

The gizzard development could be encouraged by a good feed presentation and the use of insoluble grit. You will find more details on these points in the “nutrition in rearing” bulletin.

A good follow up with a weekly control of the growth

A weekly control of the growth is a must to check the real evolution of the flock: the earlier you know the earlier you can correct.

Targets in rearing:

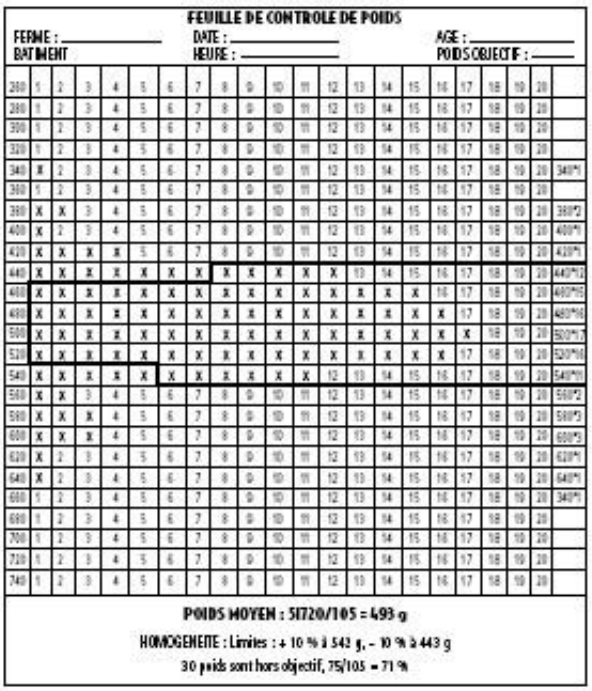
- To produce a uniform flock and a weight, which is compatible with the intended age at sexual maturity
- To obtain the correct bodyweight at 4 weeks to secure frame development
- To achieve steady growth between 4 and 16 weeks with a good development of the digestive tract

Targets in production:

- To make sure that between 5% lay and peak production the bodyweight increase is at least 300 g. For these reasons it is essential to exercise control over bodyweight on a weekly basis from 0 to 30 weeks.
- Controlling the quantity of feed issued will not on it's own ensure good growth because the requirements vary according to:
    - the energy level of the diet
    - the house temperature
- the health status of the flock

Method of weighting

The time of weighing should be fixed, preferably in the afternoon. We advise carrying out individual weighing. A practical method is to use weighing sheets, which allow us to put the weights straight into a histogram. This shows at glance the weight distribution within the population.



FEUILLE DE CONTROLE DE POIDS

FERME : _____ DATE : _____ AGE : _____

BATIMENT HEURE : _____ POIDS OBJECTIF : _____

POIDS MOYEN : 51720/105 = 493 g

HOMOGENEITE : Limites : + 10 % à 542 g, - 10 % à 443 g

30 poids sont hors objectif, 75/105 = 71 %

Sampling Technique

For floor rearing situations, make a lightweight wire netting pen, and then walk into the middle of the flock and surround a group of birds. Individually weigh all the birds in that pen.
A sample with a minimum of 100 birds gives a good estimate of mean bodyweight and uniformity. However, if the flock is divided into separate pens, it is necessary to take a sample of 50 birds from each pen and then to calculate the overall mean.

When rearing in cages, one should weigh all the birds from 5 or 6 cages chosen at random in different parts of the poultry house to make up a sample.

- Global weighing between 0 and 4 weeks old. As Uniformity is very difficult to measure during this period
- Weekly individual weighing from 4 till 26 weeks old
- From 26 till 35 weeks old, weigh every 2 weeks
- From 35 weeks old, once a month

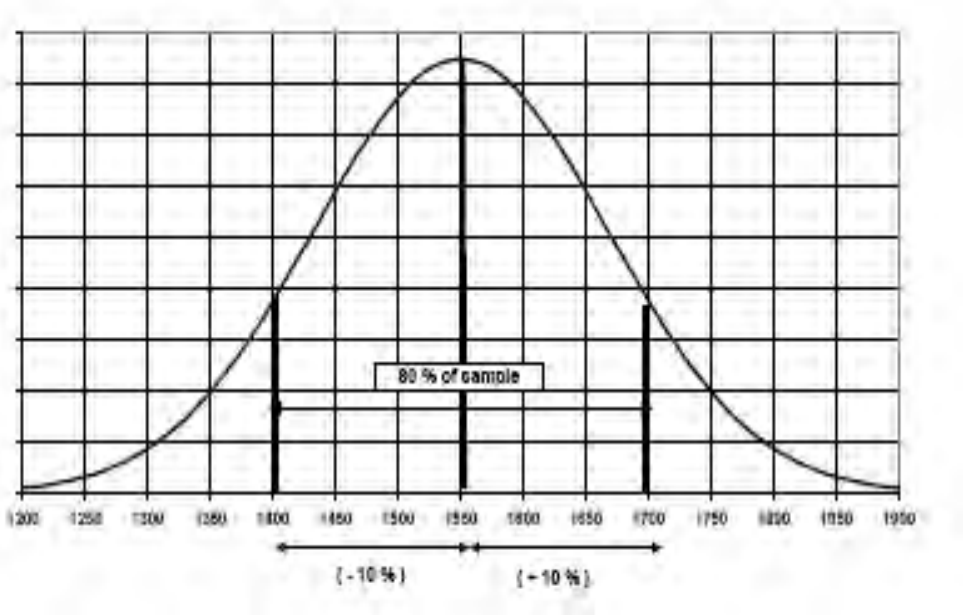
Uniformity

The quality of a flock is judged, as much as anything else, by its uniformity. A batch is uniform when all the weights within the sample fall between plus and minus 20 % of the mean or, when 80 % of the weights lie within + 10 and -10 % of the mean.

Within the limits of plus or minus 20 % of the mean, the smallest and the heaviest pullets are of the same quality. Only those birds which are too small should be culled. If uniformity is outside the target range, it is necessary to identify the causes and to chec:

- the feeder space and position
- the speed of the feed chain
- the quality of beak trimming
- the vaccination status
- for disease and parasitism.. etc.

In all cases underweight birds should be corrected or culled by eight weeks of age. In cages, we recommend that the lightest birds be sorted out frequently from six weeks and be put in the top row and that checks are made that there is the same number of birds in each cage.



Beak trimming: A delicate operation

This operation is normally carried out for two main reasons:

- to prevent feather pulling and cannibalism
- to reduce feed wastage

Beak trimming is a delicate operation: only specially trained personnel should perform it. When it is improperly done, the result may be birds having difficulties with eating and drinking and unevenness in the flock.

Age of beak trimming

The decision about age of beak trimming depends mostly on the housing system:

- Production in cages, in dark houses, when the intensity of artificial light is low, beaks should be trimmed at day-old or at about 10 days.
- Production in cages or floor system, in open-sided houses, giving exposure to high natural light intensity, one single beak tipping at 10 days will not prevent pecking entirely. Under these conditions, beak trimming should be carried out twice: a light tipping at 10 days and then a second operation between 8 and 10 weeks of age.
- Production in alternative systems that allow access to outdoor natural light areas: beak trimming should be conducted twice also as above.

In addition to technical recommendations, any codes and local regulations concerned with animal welfare should be observed.

Beak trimming at day old

The biggest advantage of beak trimming at day old in the hatchery before delivery of the chicks is that it is convenient and has quite low costs. It should be properly performed to avoid start up problems and to minimize excessive later growing out of beak.
The beak of the chick trimmed at day old is still sensitive; to ensure an easy access to drinking water in the rearing farm, it is important to use sideways activated nipples, nipple drinkers with cups or starting mini drinkers.

Main methods utilised for beak trim birds at day old are:

- Robotic beak trimming machine
- Laser technique

Beak trimming at 7 - 10 days

Early precision beak trimming at 7-10 days has the advantage that when carried out properly, there is just a minimum effect on bodyweight development. Also it is not necessary in most circumstances to beak trim the birds a second time in the rearing period.

Method

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

Beak trimming at 8 – 10 weeks

A late beak trimming is recommended under certain conditions, especially when light intensity can not be controlled (open-sided houses). The advantage of this method is that a very precise beak trimming can be carried out. The main disadvantage is that when it is improperly done, it can take too long for the birds to regain bodyweight development.

Female where the beak has been trimmed at 8-10 weeks of age for floor housed laying systems or in cages in naturally lit houses

Method

- Insert a finger between the 2 mandibles
- Cut the beak perpendicularly at a right angle to its long axis, so that after cauterization about half of the length of the beak between the tip and nostrils is left
- Cauterize each mandible with care, particularly at the sides of the beak, so as to round off the sides of the beak and avoid lateral re-growth
- Check regularly the temperature of the blade (650 º - 750 º C)

Beak trimming at transfer

A very late operation is not recommended since the pullets are very close to maturity and will have short time to recover to normal feed intake and body weight. However, during transfer it is advisable to re-check the beaks and, if necessary, to touch up the beaks of any birds which require it, when it is allowed by the regulations of the particular country.

Before beak trimming: attention points:

- Do not beak trim birds if the flock is not in good health or if it is suffering from vaccine reactions
- Add vitamin K to the drinking water 48 hours prior to trimming and after to prevent haemorrhages
- Check the equipment and make sure that the trimming blade has the right temperature to cauterize but not so high to form a blister on the beak later

During beak trimming: attention points:

- Operator should be seated comfortably in such a way as each beak will be cut in the same manner
- Do not rush the process: a too high rate (number of birds/minute) could lead to a higher chance of errors and poor uniformity.
- Clean the blades with sandpaper after use of 5.000 chicks, and renew them after 20.000 to 30.000 chicks
- Make sure the tongue of the bird does not get burned

After beak trimming: attention points

- Increase the water level in the drinkers and the pressure in the pipes to make it easy for the birds to drink
- Make sure that the depth of the feed is adequate, do not empty the feeders for a week following beak trimming

Beak trimming is a very delicate operation and it is important enough to be done right. Failure to beak trim properly can damage bird liveability and uniformity and consequently affect negatively to overall flock performances.

General principles of the lighting programs in rearing period

Chickens are sensitive to changes in the duration of illumination, and these will influence the age of sexual maturity. In addition, feed consumption is greatly influenced by the duration of day length. Lighting programs have, therefore, different objectives.

During rearing, they allow us to encourage growth and to control the birds' sexual maturity. For this reason, we consider it to be essential to achieve the recommended bodyweight at 5 % lay, in order to obtain an egg weight which conforms with the target from start of lay, and to achieve high overall production.

Lighting program and growth:

In addition to the influence of growth, the light program plays a determinant role for 3 essential reasons:

- progressive growth of the digestive system
- gradual adaptation to a body clock (above all , anticipation of a dark period).
- lack of night time energy supply when dark periods are too long

The observation of the feeding behaviour with the water consumption shows a first peak of food intake in the 2 to 3 hours that precede a dark period, and a second peak shortly after lights come on. The crop is used during these peaks of consumption as a storage organ.
The introduction of a dark period from start of the rearing period is important to progressively develop the crop capacity, which plays a role of food reserve. However the amount of food stocked remains insufficient for the nocturnal energy needs.
Buyse (1993) found that with pullets subjected to a 10-hour dark period, the amount of food stored in the digestive tract was only 75% of the energy needs for those 10 hours. Other authors have found similar results. Thus the feeding behaviour of poultry is an attempt to satisfy night time energy needs. It is a reasonable to suppose that the night energy deficit is proportional to the length of the dark period.

Light duration and growth:

A rapid decrease in light length is used to slow the growth of broilers and broiler breeders when young. Conversely any increase in light duration will favour growth.

The trial (24th Random Sample Test- Eickelborn) shows clearly show the relation - Light length/Food intake/Growth.

Influence of a decreasing light pattern on growth.

	Age	Light duration (hours/day)	
	4 – 7 days	20	20
	2nd week	16	16
	3rd week	12	15
	4th week	8	14.5
	5th week	8	14
	6th week	8	13.5
	7th week	8	13
	8th week	8	12.5
24th. R.S.T. Eikelborn	**Weight at 56 days (g)**	**678**	**731 (+ 8%)**

The duration of light must be taken into account when planning light programs while bearing in mind that the objective is not to break records for growth but to follow the established growth curve.

Control of sexual maturity

The purpose of light programs is to control the age at point of lay and above all to avoid the influence of the variations in natural day length.

Role of bodyweight

- Photo stimulation is not necessary to stimulate production even when the pullets are reared under very short day lengths.
- A trial carried out by Lewis (1996) shows that with a light length greater or equal to 10 hours, the age at 50% lay does not vary, or only a little. On the other hand, a light length held at 8 hours appears to delay sexual maturity by one week. This delay of maturity with 8 hours at the plateau is explained by the lower growth obtained compared to 10 or + hours of light program.
- These observations are confirmed in latitudes close to the Equator. With very little change in day length, we have seen that sexual maturity is mainly activated by obtaining adequate body weight.

According to the latitude, differences in sexual maturity between summer and winter are more and more important when latitude is important.

Light stimulation

- The variation of light duration greatly influences sexual maturity. Under certain conditions, we can observe a response to a light stimulation from 6 weeks old. The more sensitive period is between 10 and 12 weeks old.
- According to the program used, the age at 50 % can vary by at least 6 weeks.

Light stimulation will change bird weight at sexual maturity and adult weight, as a consequence the egg weight, which is directly related to the bodyweight of the bird at first egg.
Bird weight at sexual maturity will be 75 g lower when light is advanced one week. Egg numbers will be greater but egg weight will be reduced by about 1 g. Total egg mass produced does not seem to be affected by reasonable variations in the age of sexual maturity (Lewis 1997).
For this reason, it is suitable to determine time of light stimulation according to bodyweight instead of age of the bird.

Influence of bird weight at 127 days upon the performance from 27 to 47 weeks.

Bird weight	Age at 50 %	Rate of	Egg weight	F.C.R.
	(days)	lay	(g)	
1535 g	141	91.3	60.50 a	2.018
1585 g	141	92.1	60.65 a	2.014
1620 g	143	91.0	61.80 b	2.012
1665 g	142	91.0	61.65 b	2.027

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Light intensity in rearing

Little information is available. However some work has shown that light intensity can be very low. Morris (1996) showed that intensity greater than 1 lux did not modify sexual maturity.

Ideal light intensity will be determined in practice by the following needs:

- Light required to inspect the birds well.
- The degree of darkness of the building (light leaking in)
- The intensity to be used during laying period.

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

Lighting program in dark houses

We consider a dark house to be a building in which the light penetrating from outside of all sorts produces an intensity of less than 0.5 lux, at above 20° latitude. In these buildings one should use the program for dark houses.

With this level of light intensity coming from outside, there is little interference with the artificial lighting program. The birds react very well to any variation of light duration during the rearing period.

Even if it is always important to take into account the performances previously obtained, the sexual maturity is more predictable.

Light duration during the first weeks

In order to control and maximize the growth of the pullets during the first weeks, it is recommended to use a slow step down lighting program.

This slow step down lighting program could be adapted to growth performances or sexual maturity expected.

Light duration and growth performances

The normal or classic step down lighting program is a light program coming from 23 hours the first 3 days after arrival to a plateau of light of 10 hours from 43 days. During this period, the light duration is decreased step by step of about 2 hours per week during 6 weeks.

The speed of decrease of light duration could be done slower if growth performances are not as expected. The 10 hours plateau of light could be started from 8 or 10 weeks old without any major delay of maturity. The delay of sexual maturity being compensated by the better growth observed with longer light duration.

Duration of light at the plateau and growth performances

As described in a previous article, it is always preferable to encourage growth than encourage sexual maturity.

- In order to compensate the lack of growth which could be observed during the rearing period in some specific conditions or during the hotter season of the year, it could be better to maintain 12 hours light at the plateau instead of 10 hours. As showed by Lewis (1996), the light length greater or equal to 10 hours doesn't modify or only a little the age at 50 % production.
- If the market demand is high for high average egg weight, a very long step down lighting program will encourage the growth and will delay maturity. The addition of these two factors will lead to an increase in the average egg weight through the increase of bodyweight and delay of maturity.

From 6 to 15 weeks, in all latitudes and irrespective of the type of poultry house, it is very important to never increase the day length.

Light stimulation according to: …

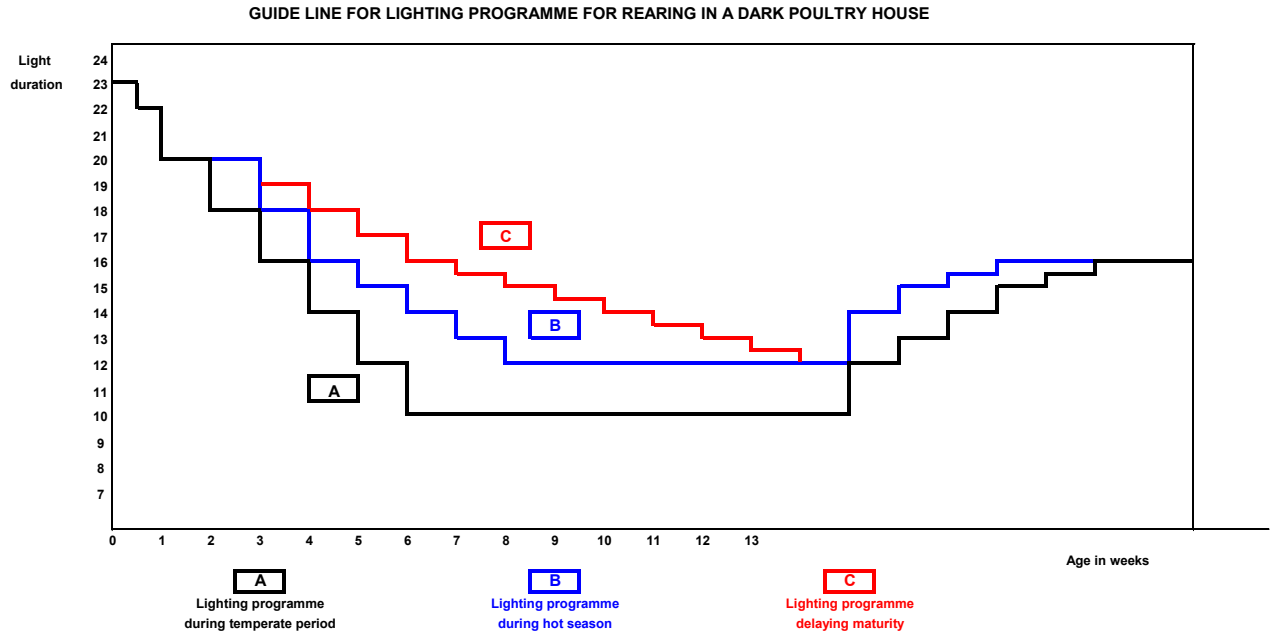
As the bodyweight plays a major role in the determination of the egg weight profile during all the laying period, the light stimulation has to be done according to the bodyweight observed. The bodyweight references are:

- **1 250 to 1 300 g for the Brown egg layers**
- **1 100 to 1 150 g for the White egg layers**

In order to get an efficient light stimulation, the light increase of light at photo stimulation has to be done in the morning.

For rearing in dark houses system and production in a Naturally Lit house, it is necessary to maintain a high light intensity through out all the rearing period in order to avoid a sudden increase of light intensity.

The following lighting programs suggested below are only guides. They have to be adapted to real situation of the rearing farm and according to performances previously obtained.



We consider essential to achieve the recommended bodyweight at light stimulation and at 5 % lay, in order to obtain an egg weight which conforms with the target from start of lay, and to achieve high overall production.

Lighting program in hot climate houses

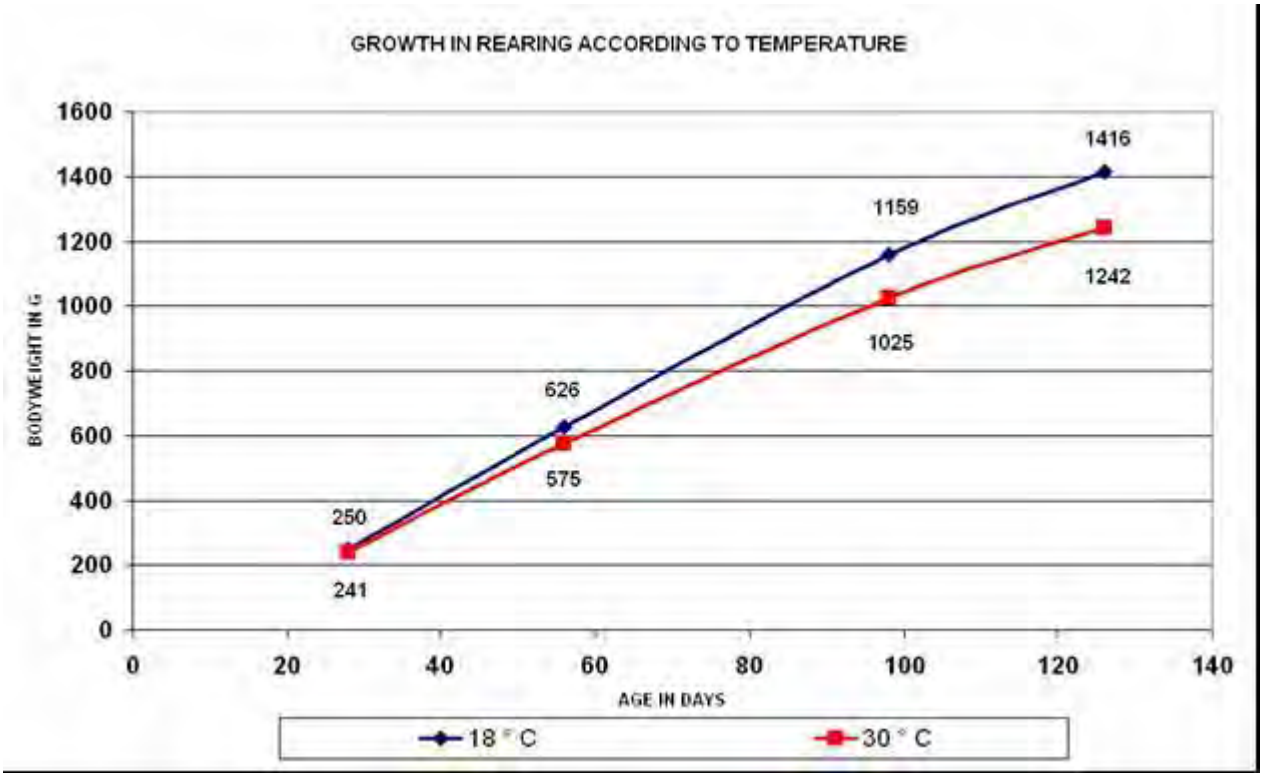
Between Latitudes 20° north and 20° south

In tropical and subtropical countries, the layers are often subjected to severe heat stress. This heat stress can occur during long periods of high tropical or subtropical climatic conditions. The lower feed intake noticed during these periods is the result of the bird's reduced ability to lose heat.

The lower growth rates during rearing and the reduced production during lay are only consequences of the reduction in feed consumption when the birds are incapable of regulating their internal body temperature.

High temperature and growth

The growth is affected when the birds approach full plumage. The growth is mainly affected after 6 weeks old.



Leeson S., and J.D. Summers - 1997

The deterioration of the growth rate usually observed lead to a delay of the sexual maturity. Indeed, without any light stimulation, the pullets start production when they reach their ideal bodyweight. The later this bodyweight is achieved, the later will be the start of production.

Therefore, it is essential in these conditions of rearing and production to encourage growth during all the rearing period starting with:

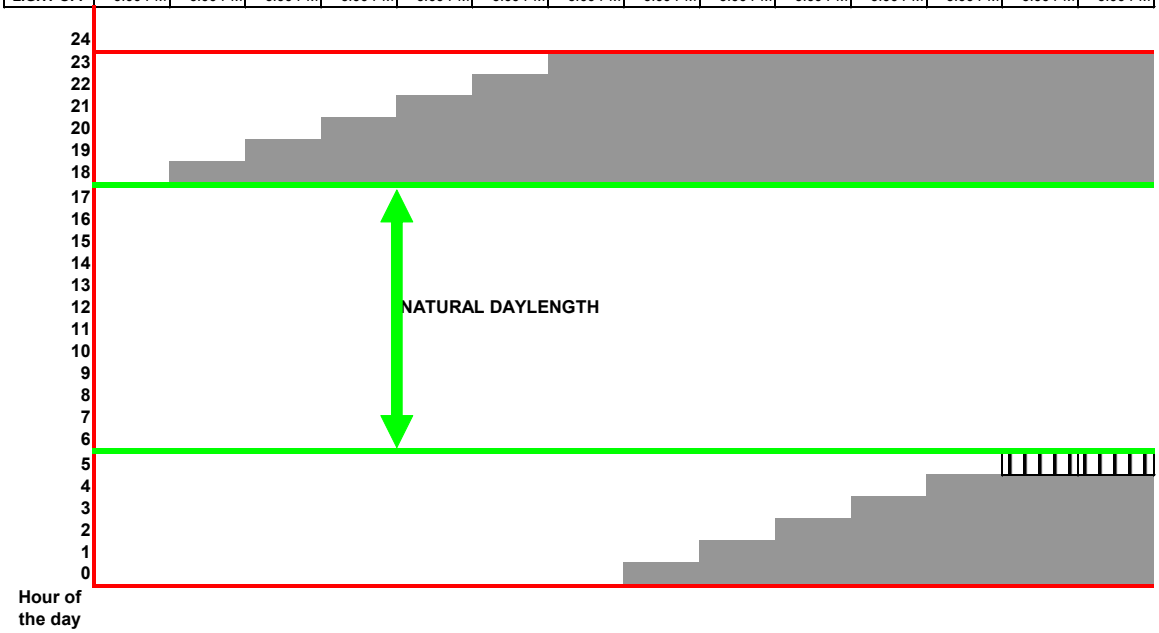
- Good brooding conditions in order to get the best bodyweight as possible at 5 weeks of age and a good uniformity
- As the growth rate is related to light duration, we advise to use a slow step down lighting program which will help to boost feed consumption and growth.
- The reduction of light duration done in the evening will allow the birds to eat early in the morning during the cooler part of the day and help the bird to lose easily the specific heat of digestion before hotter part of the day.
- After 6 weeks, giving the feed early in the afternoon will encourage feed consumption of large particles size (low energy needed) before the light off. Fine particles will be easily eaten in the morning. This meal feeding will encourage the development of the digestive tract and help the increase of consumption at start of lay.

It is primordial to encourage growth instead of sexual maturity.

- A too low bodyweight at start of lay will lead to post peak dips, risks of high mortality in production with some prolapse, and poor quality and persistency later on in production.
- A too early light stimulation will lead to post peak dips. No light stimulation is necessary before 2 % of production. Increase of light stimulation from 2 % of lay could be done in the morning to boost feed consumption during the cooler part of the day.

Please find herewith a lighting program for rearing in hot climate (Between Latitudes 20° north and 20° south). It is only a guide that could be adapted to local conditions.

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total light	24	23	22	21	20	19	18	17	16	15	14	13	12	12
LIGHT ON	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	12:00 PM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	6:00 AM
LIGHT OFF	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM	6:00 PM



Remark: in very difficult conditions, a plateau of 13 hours light, with lights on at 5 am will give a better growth

We consider essential to achieve the recommended bodyweight at light stimulation and at 5 % lay, in order to obtain an egg weight which conforms with the target from start of lay, and to achieve high overall production.

Lighting programs for semi-dark houses

Before defining the lighting program to be used during the rearing and production period, it is essential to consider the following points:

- Type of building to be used in rearing and laying : dark houses, semi-dark (brown-out) houses or open houses
- Location : duration of natural day length depends on the latitude, which determines sunrise and sunset times throughout the year
- Hatch date: flocks hatched “on season” (increasing day length) tend to be earlier into production than flocks hatched in the “off season” (decreasing day length).
- Sexual maturity usually obtained at the same season on the previous flocks.

Definition of building types

We consider a dark poultry house to be a building in which the light penetrating from outside, through all kinds of openings, produces an intensity of less than 0.5 lux. That means that houses not completely light-proof, should be considered as semi-dark if light leakage is producing an intensity of above 0.5 lux.

Even low light intensity tends to affect bird performance. It has been shown that light as dim as 0.05 lux provided 3 hours before and 3 hours after an 8-hour light period can advance maturity by about a week compared with pullets held on 8 hours (Lewis, 1999). It is therefore necessary, for a semi-dark house, to adapt the lighting program to the natural day length.

Rearing in semi-dark houses

Complete control of sexual maturity is difficult to achieve in this type of buildings since the seasonal fluctuations of day length still interfere with sexual development as mentioned above. Sexual maturity usually observed in the flocks coming from this type of rearing house at the same season has to be taken into account.

The lighting schedules used should take into account **the natural day length at the moment** of transfer in order to get an effective photo stimulation. Total light duration must never be shorter than the longest natural day in the period between 8 weeks of age and light stimulation to avoid any increase of the light duration before 14 weeks old.

Rearing during a period of decreasing day length

To reduce the delay in sexual maturity induced by the 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 adding 1 hour per week in order to get 15 hours of light at 50 % production

Rearing during a period of increasing day length

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

- reaching a plateau of constant light equal to the natural day length which the pullets will be exposed at the planned age of light stimulation
- starting light stimulation when the body weight is on target by increasing the day length period by 1 hour in the morning (brown an white egg layers)
- then adding 1 hour per week

Regarding light stimulation it is very important to keep in mind the following points:

- timing of light stimulation should always be based on body weight, not on age
- effective stimulation is always difficult when the natural day length is near its longest
- to get an efficient light stimulation we advise adding light in the morning instead of in the evening.

Adapting rearing programs to production facilities

Production in Naturally Lit houses

Transferring the birds from a semi-dark rearing house to a windowed house can bring about an advanced sexual maturity. Under these conditions, there is an increased risk of having light birds at the point light intensity is increased.

To have an effective lighting program and to reduce this risk, in these situations we recommend working with a light intensity of 40 lux as a minimum in rearing.

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 :					
after 49 days	10	NL	NL	NL	NL
at bodyweight reference (1)	12	13	14	15	16
at BW R + 1 week	13	14	14.30	15.30	16.30
at BW R + 2 weeks	13.30	14.30	15	16	16.30
Increasing daylengths :					
after 49 days	10	11	12	13	14
at bodyweight reference (1)	11	12	13	14	15
at BW R + 1 week	12	13	14	14.30	15.30
at BW R + 2 weeks	13	14	14.30	15	16
After	+ ½ hour per week in order to have between 15 h and 16 h 30 at 50 % production				

(1): Bodyweight reference is :

- **For Brown egg layers is between 1 250 and 1 300 g.**
- **For White egg layers is between 1 100 and 1 150 g.**

Production in a Dark Poultry House

The advice given above is just as applicable to rearing for this purpose. It is worth noting that moving from a naturally lit rearing house to a dark laying house slows down the sexual development of the chicken and causes a delay in the onset of lay. It is necessary to avoid this as far as possible and to have a light duration on entering the laying house which is longer than the day length at the time of transfer and to adjust the light intensity after transfer.

We consider it essential to achieve the recommended bodyweight at light stimulation and at 5 % lay, in order to obtain an egg weight which conforms with the target from start of lay, and to achieve high overall production.

Production period:

Transfer and start of lay

The transfer from the rearing farm to the laying facilities is a major stress, accompanied by changes in environment (temperature, humidity…) and equipment. It should be carried out as fast as possible, ideally being completed within a day.

Then, between transfer and the peak of production, a rapid increase in feed intake is necessary since the bird has to cover:

- its growth till adult bodyweight
- its requirements to achieve peak of production
- its requirements to get a rapid egg weight increase

Age of transfer

We advise transferring the birds at 16 weeks, maybe even at 15 weeks, but never after 17 weeks.
Because of stress to which birds are subjected during transfer and immediately afterwards:

- It is extremely important that transfer has been completed before the appearance of the first eggs: most development of reproductive organs (ovary and oviduct) occurs during the 10 days prior to the first egg.
- We advice that vaccinations are given at least a week before transfer, so as to obtain a good vaccine take.
- De-worming of the flock, if necessary, is best done 3 days before moving
- A late transfer or a too long transfer often leads to delayed start of lay and higher mortality and increases the risk of floor laying in non-cage systems.

Points of attention at loading and transport

The following rules should minimize stress at handling of the birds at loading and during later transport:

- The birds should have an empty digestive tract at the moment of loading, but they must have access to fresh drinking water up to the time of being loaded.
- Chose the best time for transport during the day of night depending on the weather.
- Crates or containers, equipments, trucks etc. must be thoroughly cleaned and disinfected
- Make sure that air may circulate freely around the crates, but protect pullets from direct air flow. Containers or crates should not be overloaded, particularly in hot weather on long distance hauls.
- Avoid unnecessary stops during transit of the birds.

Lighting as a tool for encouraging a rapid adaptation to a new environment

Immediately after the birds arrive to the laying unit, it is very important to put into practice the following techniques to help the birds to become adapted to the new environment, particularly to cages and nipple systems.

- Give 22 hours of light the first day
- Light duration should be decided according to what has been used during rearing
- Increase the light intensity for 4 to 7 days to help the birds in the darkest cages to find nipples.
- Then reduce light intensity gradually while ensuring that normal water intake continues. A high light intensity for longer than 7 days can increase the risks of pecking

Encouraging water consumption

Birds can become dehydrated during transfer. The water loss rate ranges between 0.3 % and 0.5 % per hour according to atmospheric conditions.

- Pullets should drink before feeding : the absence of feed helps them find the nipple drinkers more easily
- Make sure that the water pipe have been rinse before pullets arrival
- Wait for 3 or 4 hours before distributing feed and check if drinking system is working properly
- If the pullets have not been reared on nipples, decrease the pressure and allow some leakage of water during the first few days
- If nipples are foreseen in production, it is helpful to add at least one nipple for 200 birds to the other drinking equipment used in rearing, as a “nipples school”.
- A daily water consumption control is of paramount importance

Feeding for physiological needs

- About 2 weeks before the first egg is laid, the medullary bone, which acts as a reservoir of calcium for egg shell formation, develops. Therefore a pre-lay diet needs to be used, containing enough calcium and phosphorus, for this bone formation. This diet should be switched to a layer diet as soon as production reaches 2 % to avoid some birds’ demineralization.
- Then, an early lay feed with a high content of amino acids (about 7 % higher than after peak diet) should be used. This feed needs to satisfy requirements for early production, growth and reproductive development.

Encouraging feed consumption

From the start of lay to the peak of production, feed consumption should increase by about 40 % to allow the birds to meet their requirements for egg production and growth.

To encourage bird appetite and feed intake, the following advices should be put into practice:

- Maintain the temperature at point of lay as close as possible to which the birds have become acclimatised during rearing. Growth at point of lay is reduced above 24°C, and is extremely low above 28°C.
- Minimize house temperature variations and avoid draughts
- Use an adapted light duration, achieving 15 hours of light at 50 % of production
- Providing 1h30 to 2 h of supplementary light in the middle of the dark period will help to attain the correct body weight by allowing an extra feed intake ("midnight feeding").
- Limit the number of feed distributions according to equipment to avoid selective feeding and competition for large particles which could lead to lack of uniformity.
- Adapt the feeding times as to achieve 60 % of the feed eaten in the last 6 hours of the day and to have empty feeders for 2 to 3 hours in the middle of the day. This technique avoids building up of fine particles and its consequent negative effect on feed intake.
- Use a layer feed with the correct grist (80 % of particles between 0.5 and 3.2 of diameter)

Monitoring environmental and production parameters

A close control of the following parameters will help you to check the real evolution of the flock during this critical period for the future performances:

- Feed consumption (daily)
- Water consumption (daily) and water/feed ratio
- Temperature (min – max) and relative humidity (daily)
- Evolution of body weight (weekly until peak of lay), by weighing the birds up to 35 weeks of age
- Evolution of egg weight (daily for the first weeks of lay)

General principles of the lighting programs during the production period

In the production as well as the rearing periods, the lighting program greatly influences the feed consumption. In addition, during all its life, a chicken remains sensitive to changes in the duration of illumination.

The objective of the lighting programs 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
- to improve egg shell quality

Other lighting programs can also be introduced during the production period to adapt the egg weight to market demand, to improve egg shell quality or to control feed intake for some breeds.

Chickens sensibility to change of illumination

First at all, the lighting program in production should be the continuation of the lighting program used during the rearing period. We have to make sure that the light duration in production house is as long as the light duration the birds experienced the last day before transfer.

As chickens remain sensitive to decrease of light duration during all the production cycle, the day length (the interval between lights on and lights out) should not be decreased during lay.

- A day length of longer than 16 hours is not necessary in dark buildings.
- In naturally lit or semi-dark buildings, one should always avoid a decrease in the day length during lay by maintaining, during decreasing natural day length, a day length which is equal to that of the longest natural day experienced, by making “lights on” and lights out” coincide with the times of sunrise and sunset

Lighting programs at start of lay: 15 hours at 50 % production

From 17 weeks till peak of lay, feed consumption has to increase by 40 to 50 % according to rearing systems of production to cover requirements for growth, peak of production and increase in egg weight at start of lay.

- 350 g of growth between 18 and 28 weeks old
- from 0 to 58 g of daily egg mass produced at peak of production

The amount of feed eaten is dependent on the day length. A change in day length of one hour changes feed intake by about 1.5 to 2 g.
We recommend to adapt the increase of light duration at start of lay to get at least 15 hours of light at 50 % production to encourage increase in feed intake. For all the birds, production is determined by the amount of food intake at start of lay. The introduction of 1h30 or 2h00 of light could also be associated at the same time.

1h30 to 2h00 light in the middle of the night

This technique is widely used. It encourages feed consumption and growth at start of lay. This introduction of 1h30 or 2h00 of lights doesn’t interfere with the normal lighting program. This program can be introduced when we want at start of lay (usually from 5 % of lay) and discontinued at any time without affecting the production. The bird doesn’t perceive the stop of this program as a reduction of light duration.

Principle of the technique:

- The lights should be switched on about 3 hours after "lights out". It can be discontinued at about 30 weeks of age if bodyweight and feed consumption are on target.
- It could be maintained during all the laying period.
- When it is discontinued at 30 weeks, it could be introduced again at 45 weeks old to reduce the deterioration of the shell quality (and colour) at end of lay. Introduction at end of lay is not to increase feed intake but to give the possibility to the chickens to eat limestone (Calcium) during the shell formation.
- In a hot climate or during a hot spell, lighting during the middle of the night reduces the ill effects of heat by encouraging feed intake during cooler conditions.
- If it's possible, we advise giving a feed distribution a short time after the lights come on.

The influence of a 2 hours light interval during the night

	Lighted	Feed consumption (g/day)		Density of egg shell		
	period	**Exp. 1**	**Exp. 2**	**Exp. 1**	**Exp. 2**	
	6 - 22 h	**127.7**	**116.8**	**1.0722 a**	**1.0790 a**	
	4 - 20 h	**128.8**	**118.1**	**1.0714 b**	**1.0792 a**	
	6-20 h & 23-1 h	**131.9**	**122.0**	**1.0726 a**	**1.0806 b**	**Grizzle (1992)**

Cyclical lighting programs

These programs can only be used in buildings, which are totally light proof. The 24 hours of the day are split into cycles of 2, 4, 6 or 8 hours. Each cycle is made up of a period of light and a period of dark. The length of light in each cycle can be varied during the laying season.

These segmented lighting programs are well known for their positive effects on:

- Egg shell colour and egg shell strength
- Egg weight
- Control of red mite population
- Liveability and FCR management

The physiological effects of such programs are as follows: oviposition is desynchronised and laying is spread out over 24 hours. The length of time taken to form an egg is increased. This could allow an increase in egg weight by 2-3% but reduces the number of eggs laid by about the same proportion.

In practice:

- They can be used any time throughout lay, including the early stages if it is economically useful to get a higher egg weight.
- When starting to use one of these programs, we advise keeping the same total hours of light per day for several weeks.
- According to evolution of the feed consumption, a progressive increase of each dark period is possible. This reduction of total light duration doesn't affect the production but reduce activity (improve liveability) and save feed.
- These programs assist in reducing red mite by encouraging preening and delousing.

The practical implementation: progressively according to age and consumption

Choice of cycle* **Age**	**2 hours**	**3 hours**	**4 hours**	**6 hours**
From 5% of lay Length of light	1h15 L+ 0h45 N *15 hours*	2h L + 1h N *16 hours*	2h30 L + 1h30 N *15 hours*	3h45 L + 2h15 N *15 hours*

- The reduction of light duration must be done progressively according to the water and feed consumption observed. It is possible to reduce total light duration to 9 hours in a progressive way.
- If feed consumption decreases too much and lasts several days after a change of pattern, then go back to the previous lighting program (increase light).

Light intensity management and relation with liveability

Light intensity during the rearing period

Light intensity is important during the first days of the rearing period in order to encourage the activity of the chicks to discover their environment and to find very quickly the water and the feed.

Therefore, this light intensity can be reduced progressively. The ideal light intensity will be determined in practice by the following needs:

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

In dark house, (Houses where the light penetration from outside doesn't exceed 0.5 lux.)

- The light intensity required is very low. The ideal light intensity is the minimum needed to get a good inspection of the flock. An intensity of 5 to 10 lux is sufficient.

In semi dark house or naturally lit houses,

- Houses where the light penetration from outside exceeds 0.5 lux), the light intensity should be adapted to the degree of darkness of the house to avoid any interference with the light stimulation.
- Artificial light intensity should be, if possible, 12 times the light intensity coming from outside. If the difference is not big enough, birds will consider the day length as the natural day length and not the artificial day length if the artificial duration of light is shorter than the natural day length.

Influence of intensity experienced during the rearing period,

- Naturally lit houses, free range and organic production systems, barn system of production asking for part of natural light
- When the production period is in naturally lit houses, an intensity of 40 lux is needed to avoid too much of an increase in intensity on transfer to the laying house, which can lead to nervousness and pecking.

Light intensity in production

The light intensity required is low. No significant differences have been found in the different trials with today's breeds. But as stated for rearing period, we encourage increase in light intensity for a few days from transfer time in order to help the bird to discover its new environment and to find easily water and feed systems.

Thereafter, the light intensity could be reduced step by step to a minimum of 0.5 lux at the feeder level in the dimmest areas of the laying house if during the rearing stage light intensity doesn't exceed 10 lux.

There is a strong relation between bird activity, stocking and feather loss during production.

Light intensity and liveability

Recent investigations have demonstrated a strong relationship between light intensity, physical activity and feather loss. High light intensity results in increased mortality as a result of vent pecking, which is increased with feather loss.

High intensity tends to increase the nervousness of the birds and pecking (Hughes 1972 and Savory 1995). The activity of the bird is also influenced by the source of light. The increase in the number of tiers in recent cage installations, together with the change from incandescent bulbs to fluorescent tubes or to fluorescent bulbs, has resulted in an important increase in light intensity to birds in close proximity to the light source.

High lights intensity results also in a higher feed conversion ratio. When light intensity is reduced by 50%, the feed saving will be about 1.6g.

Mortality and activity

- In battery cages, we sometimes find considerable differences in light intensity at different levels. The birds close to the light source demonstrate a more important activity leading to more risks of pecking and mortality.
- Control of the mortality per tier could lead to different level of mortality as the following

	Years	1996	1997
	Bottom tier	1.1	0.9
8 250 birds	Middle tier	1.6	2.3
Per tier	Top tier	6.1	6.2

Mortality and light source

- In battery, the activity has been measured in one experiment led by Boshouwers showing that activity is much more important by using fluorescent light and is strongly correlated to the light intensity. Birds are sensitive to fluorescent light, which they see as scintillating rapidly.

	Movements	Light intensity		
	per hour	1 lux	10 lux	100 lux
Boshouwers	higher F	1363	2317	3271
	activity I	1292	1929	2566
	average F	197	343	499
	activity I	189	283	377

F = Fluorescent Lighting I= Incandescent Lighting

Practical advises

- As shown herewith, the light intensity required is low.

Effect of light intensity of performance.

	Intensity at the level of feed trough	Egg number 20/76 wks.	Egg mass (g/d)	Feed cons. (g/d)	BW gain (g) 20/72 wks.	Mortality %
Tuckler 1993	0.5 lux	311	52.2	123	470	5.3
	2 lux	314	52.3	122	460	5.6
	15 lux	310	52.2	122	430	6.4

- It is most important to have the most uniform distribution of light as possible. The distribution of many bulbs arranged in quincunx form in the new large laying units with several tiers.
- Existing arrangements can be improved by using shades or adhesive tape on the bulbs to reduce the intensity for those birds situated in front of the bulbs. Red or warm light seems to be useful for reducing activity, feather loss and pecking.

Before any modifications are made, it is extremely important to measure the light intensity at various points. The reduction of light intensity, we have to be certain that the least well-illuminated area has a light intensity of 0.5 to 1 lux. This control of light intensity will help to improve the feed conversion ratio. This energy use increases by 1 Kcal/hour/bird when the intensity goes from 1 to 10 lux and also from 10 to 100 lux. This is equal to a little more than 5 g of feed between 1 and 10 lux and nearly 11 g of feed between 1 and 100 lux (Boshouwers 1993).

Oviposition times and shell quality

Shell quality depends on the amount of calcium present in the digestive tract during formation. Taking into account the timing of egg laying and thus the timing of shell formation, allows us to adapt feeding times to satisfy the calcium needs of the bird.

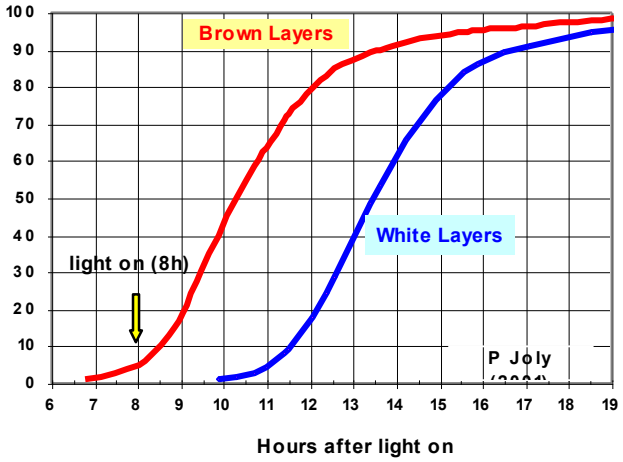
A reminder on egg formation

- **Ovulation:** Ovulation occurs in the 5 to 10 minutes that follow the expulsion of the previous egg.
- **Entry in the Uterus:** After the secretion of the albumen and the shell membrane, the egg enters the uterus about 5 hours after ovulation.
- **Hydration of the Albumen**: This phase lasts about 6 hours.
- **Calcium Deposition – 2 Phases**:
  - ***1st Phase.*** During the first 5 hours following entry into the uterus, calcium crystals begin to form.
  - ***2nd Phase***. Begins about 10 hours after ovulation and lasts for about 12 hours. ***During this time 90% of the calcium is deposited on the shell at a rhythm of 180 to 200 mg of calcium per hour.*** (see graph below).
- **Pigmentation:** For brown eggs layers, deposits of pigments (ooporphyrins) occur at the end of shell formation and at the beginning of formation hours.
- **Cuticle formation:** Cuticle is deposited in the following 2 hours.

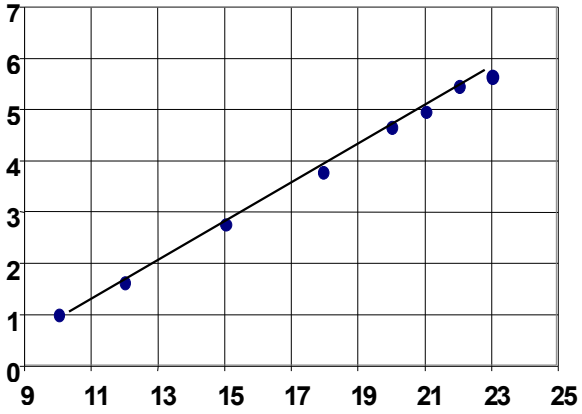
Laying Times or Oviposition times

Laying times are determined by the “lights out” time. Many experiments have shown that they vary very little from one flock to another. The graph given below shows the evolution of time of lay as a function of time elapsed after “lights out”.

Progress of egg laying during the day as a function of time elapsed after "lights out" for brown and white layers



Change in the weight of the shell (g) as a function of time elapsed after last egg



Hours after oviposition

Nys (1986)

Shell Formation

For a light duration of 16 hours:

- ***for brown layers:*** around 40 % of birds have finished their calcium deposit at light on and on average birds begin shell formation 4 hours before lights out
- ***for white layers:*** around 50 % of birds have finished their calcium deposit 3h30 after light on and in average birds begin shell formation just before lights out

Calcification of the shell is mainly realised during the night. A high percentage of brown birds stop calcification at lights on or just after while white layers finished their shell after lights on.

A reminder of Shell Formation

During shell formation the bird first uses the calcium contained in the digestive tract, it is dissolved by abundant secretion of Hydrochloric acid. When the quantity of calcium is insufficient, the bone reserves are used (the calcium is deposited and the phosphorus eliminated by the kidneys). It has been demonstrated many times that birds which are forced to use their bone reserves, produce eggs of poorer shell quality.

Shell quality depends on the quantity of calcium remaining in the gizzard at lights on for brown and the ability for white birds to access to soluble form of calcium after lights on.

How to improve shell quality

All methods that help to increase the quantity of calcium stocked in the gizzard have a positive effect on shell quality (strength and colour) and help to ingest a soluble form of calcium after lights on. Accordingly, we advise as from transfer:

For Brown Layers:

- *encourage maximum food intake during the last 6 hours of the day (distribute 6 - 7 hours before lights out).*
- *arrange to have feeders empty in the middle of the day to encourage food intake in the afternoon.*
- *distribute feed during the night in the light period of 1-2 hours, 4 hours after "lights out" if midnight light is used or at lights on.*
- *ensure that the calcium content of the feed has at least 70% in particles of 2 to 4 mm to encourage retention in the gizzard and storage for the night period.*
- *provide 30% of the calcium in easily soluble powder form for quick availability at lights on.*

For White Layers:

- *encourage maximum food intake during the last 4 hours of the day (distribute 4 hrs before lights out).*
- *arrange to have feeders empty in the middle of the day to encourage food intake in the afternoon.*
- *ensure that the calcium content of the feed has 50% in particles of 2 to 4 mm to encourage retention in the gizzard and storage for the night period.*
- *provide 50% of the calcium in easily soluble powder form for quick availability at lights on.*

Important Remark:

During hot season or in summer, heat stress delays the oviposition time mainly when birds are in panting situation. Panting provokes a loss of carbon dioxide and bicarbonate in blood plasma. As a consequence, oviposition times are delayed. Maximum of feed has to be given during midnight lighting and early in the morning to maintain production and shell quality.

Adjusting egg weight to meet market requirements

Egg producers want to produce eggs of a size which matches market demand and in the end satisfies the needs of their customers and optimises margins.

The principal factors affecting egg weight are:

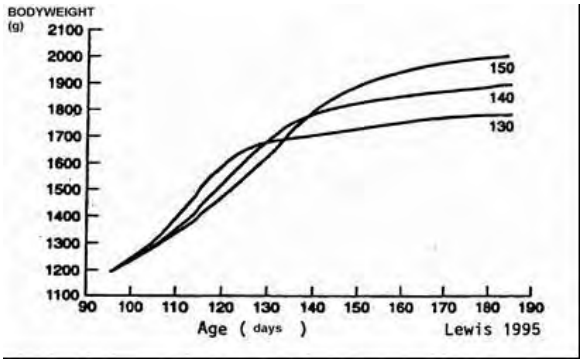
- genetic aspects
- bodyweight at sexual maturity (so at the time of the first egg is laid)
- feed consumption and growth from first egg till achieving of adult bodyweight
- nutritional factors

Genetic aspects

Egg weight is one of the major criteria of the breeding program. First at all, the heritability of the criteria is correct. So, each breed has its own profile. In addition, for some strains, a real effort has been done to reach marketable egg weights rapidly from start of lay while avoiding an increase in egg weight at the end of lay Nevertheless, management techniques and nutritional characteristics of the diet can both change egg weight. Each strain has a potential of range of egg weights, which can vary by about 3 to 4 g, which is very important.

Bodyweight at sexual maturity

Bodyweight at sexual maturity depends mainly on the age at which they are given light stimulation and on the rearing period.
If one has a standard growth curve, and the age at start of lay is changed, then the bodyweight at sexual maturity is also changed.
The age at start of lay has a direct effect on the adult weight and, therefore, on the egg size throughout the whole laying period. Earlier maturing flocks will produce a greater number of eggs, but these eggs will be smaller than those from delayed flocks because the pullets are lighter.



Influence of pullet bodyweight at first egg on egg weight (g) over different periods.

	Pullet bodyweight at first egg (g)			
Period (weeks)	**1 300 – 1 500 g**	**1 500 – 1 700 g**	**1 700 – 1 900 g**	**> 1 900 g**
18 to 28 weeks	49.75	53.25	56.05	57.60
28 to 40 weeks	57.55	59.20	61.03	62.35
40 to 60 weeks	61.65	62.55	64.55	65.80

Isa Brown pullets - Lewis - 1992

Control of the sexual maturity

Research has shown that mean egg weight increases by 1 g when sexual maturity is delayed by one week. Conversely, the number of eggs will be decreased. For each change of one week in age at start of lay, there will be a change of about 4.5 eggs in number laid. By using the appropriate techniques, the age at start of lay can be modified to produce eggs of the required weight, without affecting the total egg mass produced.
Rather than giving light stimulation according to age, we advice not starting to increase day-length until pullets have reached the target weight planned. By that means, they will not be allowed to come into lay at too low bodyweight, which would be prejudicial to egg weight and overall performance.

Bodyweight at 24 weeks

Egg weight is highly dependent on bodyweight at 24 weeks. Between 5 % lay and peak production, bodyweight should increase by at least 300 g.
Our research has enabled us to determine optimum bodyweights throughout the rearing and laying periods. This plays an essential role in obtaining performance as measured by egg numbers, egg weights and feed conversion ratio.
Throughout rearing and after transfer, attention should be focused on the feeding techniques and the growth curve.

Influence of heat

Rate of lay is generally only affected at temperature above 30°C. Egg weight falls by about 0.4% per °C between 23 and 27 °C. Above 27°C, the reduction is about 0.8% per °C. Growth at start of lay is reduced above 24°C and is extremely low above 28°C. The feed conversion ratio is minimum at 28°C. These figures are only indicative, because air movement speed and relative humidity affect thermoregulation.

Lighting programs during production

The programs called “cyclical lighting programs” allow an increase in egg weight. They can only be used, when the buildings are completely light proof. The physiological repercussions of these programs are as follows:

- Egg laying occurs throughout 24 hours and the length of time in egg formation is increased.
- This allows an increase in egg weight of 2-3 % but reduce the egg number by the same proportion

Food restriction

A light food restriction can be used to control egg weight towards the end of the laying period. It can be used only when the bird achieve the standard of body weight at 28 weeks old. This technique can be used step by step by avoiding a too strong feed restriction which will lead to a deterioration of the production rate.

- The distribution of the feeding times could be concentrate step by step to reduce the food consumption
- The introduction of one or two dark periods during the day could also be applied

Nutritional aspects

Egg weight can be increase by the use of vegetable oil in the layer ration. This effect used to be attributed to the level of linoleic acid in the ration, but Whitehead (1981) has shown that the effect on egg weight can be attributed to oil and not to the level of linoleic acid. In rations, where the cereals were either wheat or a mixture of wheat and barley, he compared the addition of either corn oil, which is rich in linoleic acid, or olive oil, which is poor in linoleic acid. From this it is preferable to speak in terms of the effects of oil, rather than the effects of linoleic acid. Over a given level, the oil level in the ration has more effect than the linoleic acid level on the ratio. The addition of unsaturated fats lead to an increase in the energy intake, of the body weight of the bird, the egg weight and the egg mass produced.

Oil	Level of palmitic acid	Level of linleic acid	Egg weight
Palm	28.4	1.52	63.0
Seaweed	18.0	1.37	63.1
Lard	17.8	1.64	64.3
Grape	11.2	2.67	65.5
Linseed	10.5	1.65	65.3

Meluzzi et al, 2001

For all the amino acids, without exception, a deficiency leads to a reduction in performance, if which 60-65% is due to a lowering of rate of lay and 35-40% to a reduction in egg weight.

Water: the most critical nutrient

The water is the most critical nutrient for the poultry. A daily control of water consumption is essential. If an animal does not drink, it will not eat and can not produce.

Water quality

Good quality drinking water is very important for (production) animals. Talking about poultry, the birds must always have easy access to the drinking water, the water must be fresh and bright. Taste and smell seem to be of less importance to the birds but are indicators for the water quality.

In detail:

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
"lime/chulk content"	<20	>25
"oxidizable organic matter" mg/l	<50	>200
H2S	non detectable	non detectable
Coliform bacterials cfu/ml	<100	>100
Total germ count cfu/ml	<100.000	>100.000

Monitoring Water Quality

The value of any analysis depends on when, where, and how the sample has been taken, (where it enters the house or at the end of the system). One should not forget that an analysis only refers to the quality of the water at the time, when the sample was taken, and is never a guarantee of its quality at another time.

Where farms have their own water supply, it is necessary to take a sample at least twice a year (one at the end of winter, the other at the end of summer). On farms using the mains supply an annual measurement should be adequate. It is important to realise that the sodium thiosulphate, contained in the flasks supplied by the laboratories carrying out bacteriological tests on water, only neutralises chlorine or bleach. It has no action on quaternary ammonium compounds.

Cleaning the Pipe System During the Sanitary Break.

Mineral and organic deposits in drinker pipelines give favourable conditions for bacterial growth and reduce the activity of chlorine. Therefore, it is essential to decontaminate the pipelines, when the birds have gone. The best solution is to use alkaline and acid cleaners in succession. A bacteriological test on the water at the end of the circuit should be carried out systematically before the new flock arrives as a means of evaluating the quality of the decontamination process. The water pipe should be rinse before pullets arrival.

Treatment of Drinking Water

Chlorination is still the best and most economic method of treating drinking water. The chlorine can be injected by means of a dosing pump. A contact time of 15 to 30 minutes between the water and the chlorine is necessary for good disinfection. It is essential to monitor the residual active chlorine at the end of the pipe system once a week. Only the test measuring the reaction to D.P.D. (diethyl phenylene diamine) allows us to do that. The colorimetric test using orthotoluidine does in fact measure chlorine in all its forms (active and inactive). The residual level of active chlorine at the end of the system should be 0.3 - 0.4 mg/litre (0.3 - 0.4 ppm). Chlorine becomes dissociated in water into hypochlorous acids and hypochlorite ions. The percentage of these two chlorine fractions depends on the ph of the water. Hypochlorous acid 120 times more active than the hypochlorite ion. I t is, therefore, desirable that the ph of the treated water stays below 7 so that chlorine disinfection can be effective.

Cleaning the Drinkers

The water system should be cleaned regularly, but must be cleaned after in water treatments, especially after antibiotic treatment.

The water in drinkers often becomes soiled with feed residues, and possibly with infections. To prevent the development of germs in the drinkers, they should be cleaned at least once a day during the first 2 weeks, and once a week thereafter.

In a hot climate, the drinkers should be cleaned every day. The depth of water in the drinkers should be 15 mm.

Water Consumption

Water consumption depends on ambient temperature. Above 20°C, consumption increases to enable the bird to maintain body temperature (respiratory evaporation).

The actual consumption depends on temperature and humidity of the ambient air. The following table shows the relationship between water and feed consumption according to house temperature:

Temperature	Rearing	Production
15°C	1.6	1.70 (210 ml)
20°C	1.7	1.80 (205 ml)
25°C	2.3	2.10 (230 ml)
30°C	3.0	3.10 (320 ml)

In hot periods it is essential to provide cool water for the birds. In a hot climate, cool water will improve productivity. It is extremely important to protect the water tanks from the direct sun's rays.

Vaccinations techniques

Immunity

Birds possess two primary organs of primary lymphoid activity: the thymus and the Bursa of Fabricius.

- Situated in the neck region, the thymus is the organ, where the T. lymphocytes mature, and is responsible for immunity due to cell mediation immunity. It is functional from hatching, and develops with age into the secondary lymphoid organ.
- The Bursa of Fabricius is the organ, where B type lymphocytes mature, and is responsible for immunity via the humoral system. This is functional at hatching, and remains developed and active up to between 4 and 10 weeks of age, after which it regresses gradually.

Birds possess numerous secondary lymphoid structures distributed throughout the whole body:

- Peyer's patches on the intestinal mucosa
- Caecal tonsils on the ileo-caecal mucosa
- Lymphoid structures throughout the length of the respiratory network
- Harderian gland situated at the back of the third eyelid
- Small inclusions in most organs, including the nerves
- Spleen

All these immune structures are called upon, when vaccines are administered according to different routes: putting liquid into the ocular fluid (eye drops), impregnation of the palatine groove at the time of swallowing (drinking water), inhalation of droplets (spraying).

Individual vaccination	**Mass vaccination**
- Oculo-nasal instillation (Eye drops) - Beak dipping - Skin puncture and scarification Intramuscular and sub-cutaneous injections	- Through the drinking water - By spraying

Oculo-nasal instillation (eye drops)

Allows a local and a general immunity, due to the presence of the Harderian gland behind the third eyelid

- Always keep the bottle vertical to avoid contact with mucous membranes
- Generally 1000 droplets per 30 ml
- Coloured ocular diluents makes it easier to see that the vaccine is administrated properly
- Generally used for Infectious Laryngotracheitis often given at the same time as injection of oil vaccines

Beak dipping

This implies dipping the beak up to the nostrils in such a way that the vaccinal solution gets into the nasal canals.

- Only to be used with chicks of less than 1 week old
- 150 to 200 ml per 1000 chicks
- Still used in many countries against Newcastle disease and Gumboro during the first week because of the need to achieve 100 % vaccination and reduce the possibility of adverse respiratory reactions
- Usually used when vaccination by drinking water is not possible (irregular water consumption before 5 days of age) and when a vaccination by spraying would run the risk of causing harmful respiratory reactions.

Skin puncture and scarification (scratch)

Only used for the administration of live fowl pox vaccination
Puncturing the wing web with the help of a double-channelled needle is generally preferred to scarification of the skin on the thigh, using a vaccination stylus.

Intramuscular and sub-cutaneous injections

- Equipment should be sterile (this is important as seroma formation may become an issue)
- Needle should be the appropriate length for the age of bird
- Change needle frequently (at least every 500 injections) This is a minimum frequency as more regular changes of the needle assist with the welfare of the birds (blunting needles) and from a disease spreading perspective – Avian leucosis.
- Take the bottles out of the fridge several hours before use to improve fluidity (inactivated oil based vaccines)
- Birds'neck (bacterial vaccines in oil based adjuvants) or Breast muscle (especially for oil based inactivated vaccines)

Through drinking water

Ideally should only be used in birds of more than one week old (in order to get uniform water consumption/take up).

- Take care to regularly de-scale and clean the pipe system using water under pressure in a contra-flow direction and then adding organic acids to the drinking water four consecutive days.
- Before vaccination, check if the drinker and nipple are clean and working well. There should be no disinfection in the lines as this will inactivate vaccination. Ensure all water sanitising systems have been turned off and the water in the system is clean water only.
- Allow the birds to become thirsty, 30 mins to 1 h 30 mins or longer (depending on climate and thirst) before distributing the vaccine solution.
- Completely empty the whole water system. Make sure that all water present is drained out, especially in the bottom of the tank and in the lowest points of the piping system.
- Always have an area available to make up the vaccine in a hygienic way – disposable gloves should also be available
- Forecast the quantity of water required, enough to be consumed in about 2 hours. Quantity is about 1/7 of the quantity consumed the previous day.
- Dissolve 2.5 g of skimmed powder per litre of water (avoid lumps forming).
- Next, dissolve in a small quantity of commercial mineral water (or distilled water) the number of doses corresponding at least to the number of birds to be vaccinated according to their age. Mix this vaccine solution thoroughly (using a plastic stirrer) to the milky water prepared previously. A colour marker may be used to identify the vaccine solution. Keep the vaccine solution cool, and away from direct sun exposure.
- Check that all the drinkers and nipples are filled with the milky water. In specific case of nipples, open the water pipe at the other end to flush the air trapped and to insure that the vaccine solution reach the other end.
- Walk slowly through the building and make sure that all the birds are drinking the vaccine solution.
- Finally, open the stopcock and return to normal watering.
- All the equipment used for the preparation of the vaccine solution should be clean without trace of disinfectant.
- Water quality aspects:
    - Should conform to the standards for human consumption without excess minerals.
    - pH should be slightly acidic for preference between 5.5 and 6.5.
    - preferably between 5.5 and 6.5.
    - Where city water or equipment with traces of chlorine are being used, add 2.5 g of skimmed milk powder to neutralise the chlorine.

To vaccinate correctly a flock, you need to have at least 90 % of the birds to have properly absorbed a full dose of vaccine in its fully live state.