Dekalb White

Product Guide
Alternative Production Systems

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Introduction

Use of alternative production systems is expanding across the world. The conditions in alternative production systems differ from the traditional cage housing systems and require a different management approach.

To make sure the ISA customers get the maximum performance out of our layers, ISA has developed a guide with recommendations that will help to get the best results in alternative production systems. This guide gives the key points for each period of the bird's life cycle, from hatching until depletion, to keep it healthy and highly productive in alternative production system.

In recent years ISA has developed pure line breeds which take account of all breeding goals,from productivity and parent stock performance, to commercial stock performance and shell quality. Furthermore, ISA has also been working on welfare, behaviour, robustness and liveability, both within our internal R&D programmes as well as in collaborative programs with universities and research institutes.

In order to improve commercial stock performance from crosses between non related lines, ISA R&D department studies have been conducted on pure line birds which are bred in a safe environment, and with crossline progeny which are tested in field conditions and under various production systems. This is a crucial part of bringing great hybrid power to the progeny, destined for alternative production systems.

We recognise that the genetic potential created by ISA breeding programmes cannot be realised without the experience and know-how of the stockperson managing the flocks. This guide highlights management factors, which can help to achieve maximum profit from egg layers from the ISA breeding department.

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Definition of the different systems

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

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

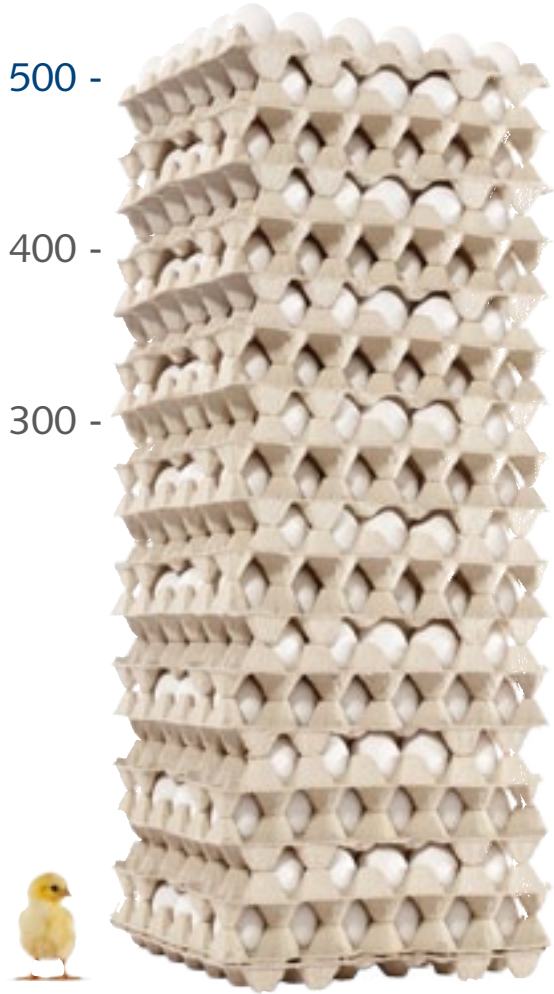
- A barn (deep litter) system is a house where birds have access to a litter area, and are able to practice natural behaviour like dust bathing and scratching. A barn house also provides nest boxes and can have a slatted area where water and feed are presented.
- An aviary house (multi tier) is like a barn house, but 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 where the birds have access to an outside range area.

ISA Breeding

With roots dating back to the beginning of the 20th century, ISA has emerged as the world's leading breeder of brown and white laying hens, which thrive in both traditional and alternative production systems and in different climatic conditions.

Our mission is to contribute to profitable and sustainable egg production by improving the economic life of laying hens. This involves breeding hens that with each generation lay more eggs for a longer period of time, without compromising on egg quality, animal health & welfare. We own the largest gene pool of pedigreed pure lines in the world and collaborate closely with renowned academic and research institutes in numerous research projects in order to achieve our mission. The progress we are witnessing every year in our breeding program and in production results obtained by egg producers, gives us great confidence that our breeding objective of 500 first quality eggs by 2020 is well within reach.

Aside from breeding, we produce and supply parent stock to around 300 distributors around the world with whom we have built a strong business relationship over the years. Our hens are available on the market under the brand names Isa, Babcock, Shaver, Hisex, Bovans and Dekalb. ISA is part of multi-species breeding company Hendrix Genetics.



Breeding for 500 first quality Eggs !

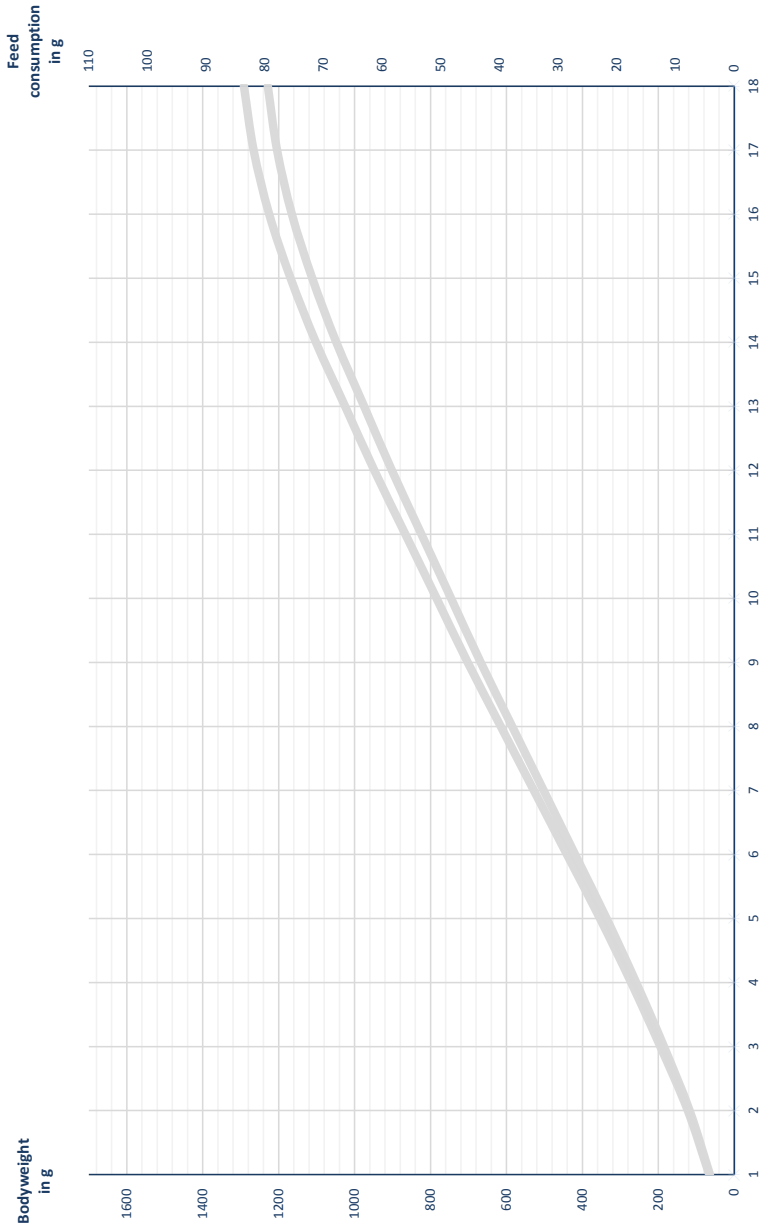
Contents

Rearing table

Weeks	Age in days	Feed intake per bird per day (g)		Feed intake per bird cum. (g)		Body weight (g)	
		minimum	maximum	minimum	maximum	minimum	maximum
1	0-7	6	8	42	56	64	66
2	8-14	12	14	126	154	118	122
3	15-21	20	22	266	308	185	195
4	22-28	29	31	469	525	258	272
5	29-35	36	38	721	791	336	354
6	36-42	40	42	1001	1085	419	441
7	43-49	43	45	1302	1400	502	528
8	50-56	45	47	1617	1729	585	615
9	57-63	47	49	1946	2072	668	702
10	64-70	49	51	2289	2429	746	784
11	71-77	51	53	2646	2800	824	866
12	78-84	53	55	3017	3185	902	948
13	85-91	55	57	3402	3584	975	1025
14	92-98	57	59	3801	3997	1048	1102
15	99-105	60	62	4221	4431	1112	1169
16	106-112	64	66	4669	4893	1165	1225
17	113-119	70	72	5159	5397	1204	1266
18	120-126	77	79	5698	5950	1229	1292

The information supplied in this guide is based on many actual flock results obtained under good environment and managing conditions. It is presented as a service to our customers and should be used as a guide only. It does not constitute a guarantee or warranty of performance in any way.

Rearing graph



Notes

Production summary

Laying period	18-90 weeks	
Liveability	92.5	%
Age at 50% production	142	days
Peak percentage	96	%
Average egg weight	63.1	g
Egg number hen housed	411	
Egg mass hen housed	25.9	kg
Average feed intake	115	g/day
Feed conversion	2.24	kg/kg
Body weight	1720	g
Shell strength	4100	g
Haugh untis	86	

Production table 1

PER HEN DAY					
Age in weeks	% Lay	Egg weight (g)	Egg mass per day (g)	Feed intake per day (g)	Feed conversion per week
18				86	
19	6.0	40.1	2.4	90	37.41
20	43.0	43.2	18.6	96	5.17
21	66.0	45.9	30.3	105	3.47
22	82.0	49.4	40.5	109	2.69
23	88.0	52.2	45.9	112	2.44
24	91.4	53.9	49.3	114	2.31
25	93.0	55.2	51.3	115	2.24
26	94.5	56.5	53.4	116	2.17
27	95.3	57.4	54.7	117	2.14
28	96.0	58.2	55.9	118	2.11
29	96.0	58.9	56.5	118	2.09
30	96.0	59.5	57.1	118	2.07
31	95.8	60.0	57.5	118	2.05
32	95.6	60.5	57.8	118	2.04
33	95.4	60.9	58.1	118	2.03
34	95.2	61.3	58.4	118	2.02
35	94.9	61.7	58.6	118	2.02
36	94.6	62.0	58.7	118	2.01
37	94.3	62.3	58.7	118	2.01
38	94.0	62.5	58.8	119	2.03
39	93.7	62.7	58.7	119	2.03
40	93.4	62.9	58.7	119	2.03
41	93.1	63.1	58.7	119	2.03
42	92.8	63.3	58.7	119	2.03
43	92.5	63.5	58.7	119	2.03
44	92.2	63.7	58.7	119	2.03
45	91.9	63.8	58.6	119	2.03
46	91.5	63.9	58.5	120	2.05
47	91.1	64.0	58.3	120	2.06
48	90.7	64.0	58.0	120	2.07
49	90.3	64.1	57.9	120	2.07
50	89.9	64.2	57.7	120	2.08
51	89.5	64.3	57.5	120	2.09
52	89.1	64.4	57.4	120	2.09

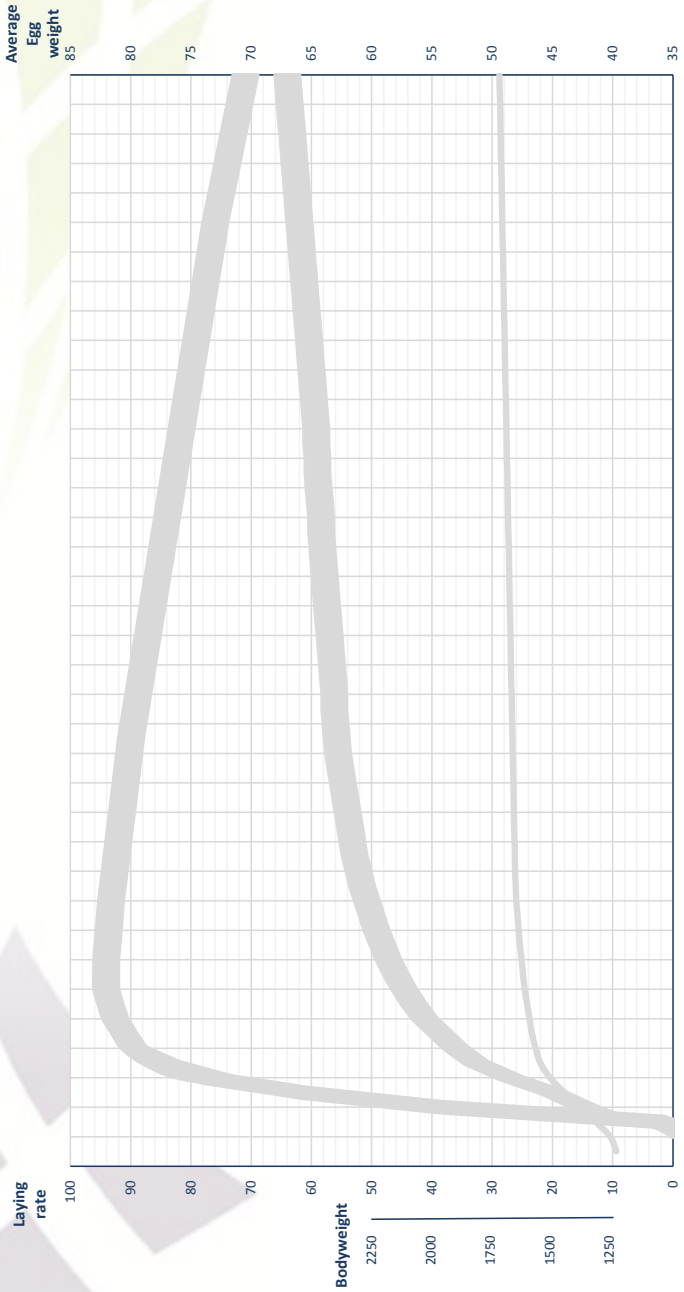
PER HEN HOUSED						
Age in weeks	Eggs per bird cum.	Egg mass cum.	Feed intake cum. (kg)	Feed conversion cum.	% Liveability	Body weight (g)
18			0.6		99.9	1260
19			1.2	73.19	99.8	1320
20	3	0.1	1.9	12.97	99.8	1380
21	8	0.4	2.6	7.36	99.7	1460
22	14	0.6	3.4	5.30	99.6	1510
23	20	1.0	4.2	4.35	99.6	1550
24	26	1.3	5.0	3.81	99.5	1570
25	33	1.7	5.8	3.47	99.4	1585
26	39	2.0	6.6	3.24	99.3	1595
27	46	2.4	7.4	3.06	99.2	1605
28	53	2.8	8.2	2.93	99.2	1615
29	59	3.2	9.0	2.83	99.1	1622
30	66	3.6	9.8	2.74	99.0	1628
31	73	4.0	10.7	2.67	98.9	1635
32	79	4.4	11.5	2.62	98.8	1640
33	86	4.8	12.3	2.57	98.8	1645
34	92	5.2	13.1	2.53	98.7	1650
35	99	5.6	13.9	2.49	98.6	1652
36	105	6.0	14.7	2.46	98.5	1655
37	112	6.4	15.5	2.43	98.4	1656
38	118	6.8	16.4	2.40	98.3	1657
39	125	7.2	17.2	2.38	98.2	1659
40	131	7.6	18.0	2.36	98.1	1660
41	138	8.0	18.8	2.35	98.1	1661
42	144	8.4	19.6	2.33	98.0	1662
43	150	8.8	20.5	2.32	97.9	1663
44	157	9.2	21.3	2.30	97.8	1665
45	163	9.6	22.1	2.29	97.7	1666
46	169	10.0	22.9	2.28	97.6	1667
47	175	10.4	23.7	2.28	97.5	1668
48	182	10.8	24.5	2.27	97.4	1669
49	188	11.2	25.4	2.26	97.3	1671
50	194	11.6	26.2	2.25	97.2	1672
51	200	12.0	27.0	2.25	97.1	1673
52	206	12.4	27.8	2.24	97.0	1674

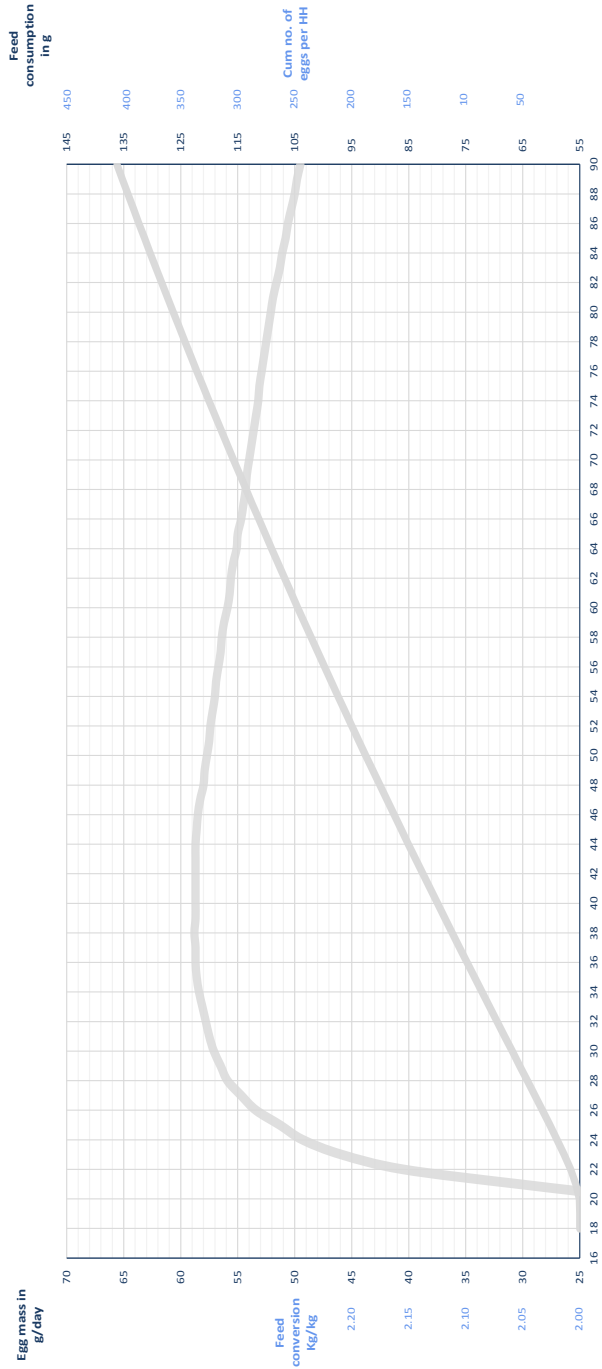
Production table 2

PER HEN DAY					
Age in weeks	% Lay	Egg weight (g)	Egg mass per day (g)	Feed intake per day (g)	Feed conversion per week
53	88.7	64.5	57.2	120	2.10
54	88.3	64.6	57.0	120	2.10
55	87.9	64.7	56.9	120	2.11
56	87.5	64.8	56.7	120	2.12
57	87.1	64.9	56.5	120	2.12
58	86.7	65.0	56.4	120	2.13
59	86.3	65.1	56.2	120	2.14
60	85.9	65.1	55.9	120	2.15
61	85.5	65.2	55.7	120	2.15
62	85.1	65.3	55.6	120	2.16
63	84.7	65.4	55.4	120	2.17
64	84.3	65.4	55.1	120	2.18
65	83.9	65.5	55.0	120	2.18
66	83.5	65.5	54.7	120	2.19
67	83.1	65.6	54.5	120	2.20
68	82.7	65.7	54.3	120	2.21
69	82.3	65.8	54.2	120	2.22
70	81.9	65.9	54.0	120	2.22
71	81.5	66.0	53.8	120	2.23
72	81.1	66.1	53.6	120	2.24
73	80.7	66.2	53.4	120	2.25
74	80.3	66.3	53.2	120	2.25
75	79.9	66.4	53.1	120	2.26
76	79.5	66.5	52.9	120	2.27
77	79.1	66.6	52.7	120	2.28
78	78.7	66.7	52.5	120	2.29
79	78.3	66.8	52.3	120	2.29
80	77.9	66.9	52.1	120	2.30
81	77.4	67.0	51.9	120	2.31
82	76.9	67.1	51.6	120	2.33
83	76.4	67.2	51.3	120	2.34
84	75.9	67.3	51.1	120	2.35
85	75.4	67.4	50.8	120	2.36
86	74.9	67.5	50.6	120	2.37
87	74.4	67.6	50.3	120	2.39
88	73.9	67.7	50.0	120	2.40
89	73.4	67.8	49.8	120	2.41
90	72.9	67.9	49.5	120	2.42

PER HEN HOUSED						
Age in weeks	Eggs per bird cum.	Egg mass cum.	Feed intake cum. (kg)	Feed conversion cum.	% Liveability	Body weight (g)
53	212	12.8	28.6	2.24	96.9	1675
54	218	13.2	29.4	2.24	96.8	1677
55	224	13.5	30.2	2.23	96.7	1678
56	230	13.9	31.1	2.23	96.6	1679
57	236	14.3	31.9	2.23	96.5	1680
58	242	14.7	32.7	2.22	96.4	1681
59	247	15.1	33.5	2.22	96.3	1683
60	253	15.4	34.3	2.22	96.1	1684
61	259	15.8	35.1	2.22	96.0	1685
62	265	16.2	35.9	2.22	95.9	1686
63	270	16.6	36.7	2.22	95.8	1687
64	276	16.9	37.5	2.21	95.7	1689
65	282	17.3	38.3	2.21	95.6	1690
66	287	17.7	39.1	2.21	95.5	1691
67	293	18.0	39.9	2.21	95.4	1692
68	298	18.4	40.7	2.21	95.2	1693
69	304	18.8	41.5	2.21	95.1	1695
70	309	19.1	42.3	2.21	95.0	1696
71	315	19.5	43.1	2.21	94.9	1697
72	320	19.8	43.9	2.21	94.8	1698
73	325	20.2	44.7	2.21	94.6	1699
74	331	20.5	45.5	2.22	94.5	1701
75	336	20.9	46.3	2.22	94.4	1702
76	341	21.2	47.1	2.22	94.3	1703
77	346	21.6	47.9	2.22	94.2	1704
78	351	21.9	48.7	2.22	94.0	1705
79	357	22.3	49.4	2.22	93.9	1707
80	362	22.6	50.2	2.22	93.8	1708
81	367	23.0	51.0	2.22	93.7	1709
82	372	23.3	51.8	2.22	93.5	1710
83	377	23.6	52.6	2.23	93.4	1711
84	382	24.0	53.4	2.23	93.3	1713
85	387	24.3	54.2	2.23	93.1	1714
86	392	24.6	54.9	2.23	93.0	1715
87	396	24.9	55.7	2.23	92.9	1716
88	401	25.3	56.5	2.24	92.8	1717
89	406	25.6	57.3	2.24	92.6	1719
90	411	25.9	58.1	2.24	92.5	1720

Production graphs



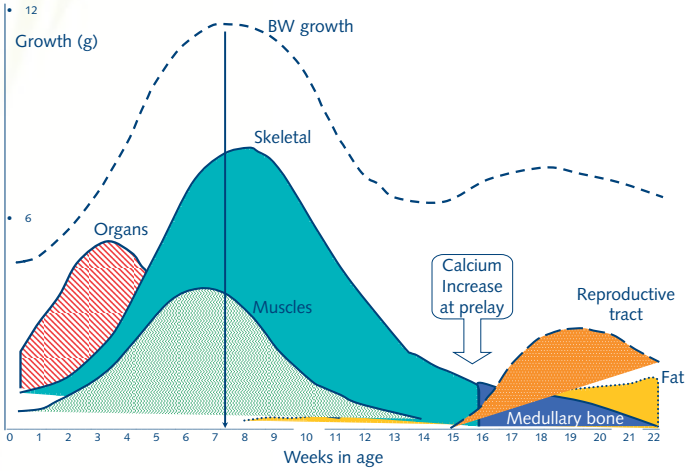


Rearing period

Good rearing is needed to reach the best genetic potential as it directly affects the flock's performance.

A good growing period which keeps the chicks in their "comfort zone" will enhance viability and production levels during the laying period. The same type of production housing system should be used for rearing. The birds are easily acquainted with the production house and its equipment after transfer, and overcome this stressful period smoothly. Ideally the house should be empty for at least 14 days after all the traces of the previous flock have been cleaned out. It should be disinfected and dry.

Figure 1: Bodyweight development



Litter consists of wood shavings or chopped straw of good quality. Litter should be dried and friable and be approx. 30°C at the time chicks are placed on to the floor.

Perch surface per bird is 5 cm. The first accessible level must be at 20 cm height and must be introduced before 4 weeks.

Partitions can decrease competition between birds for feeding and drinking and can have a positive effect on behaviour.

Feeders should be easily accessible. They should distribute the feed rapidly and enable the birds to finish it to encourage feed intake capacity. Feed intake must be measured.

Drinking systems should be disinfected and washed before the flocks arrival. They should be easily accessible and provide water of good quality. Nipples must be suitable for day old chicks. Providing supplementary drinkers during the first days of life promotes water consumption. Drinkers should be cleaned daily during the first 2 weeks then once per week.

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

During the first two days tepid (20-25°C) water should be used. Water consumption must be measured. For infrared beak treated birds, we recommend using a 360° nipple or providing open water for the first week.

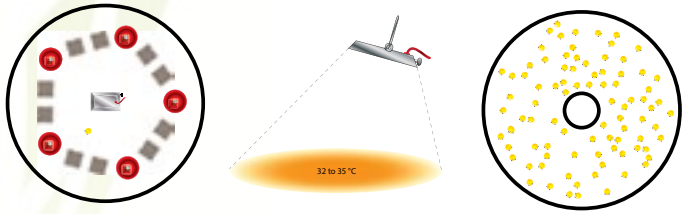
Feed and water monitoring systems are recommended.

Ventilation requirement is 0,7 m3/kg bw and the maximum ventilation requirement is 3,6 m3/kg bw.

Lighting systems must be independent, dimmable and programmable. They should be placed on strategic places: above perches, slatted area and above the floor. Light intensity should be uniform (see table 3&4, see page 20).

Closed heating systems without open fire are more appropriate to reach the required temperature (see table 1). Two gas brooders or two radiant heaters of 1450kcal/1000birds is recommended.

Figure 2 & 3: Recommended layout for 500 chicks & Radiant heater position and ground temperature.



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

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).

Body weight at 5/6 weeks is the most important determinant of pullet quality. It is extremely important to follow ISA body weight recommendations during the life of the birds.

Uniformity of the flock should be very good to facilitate management and stimulation.

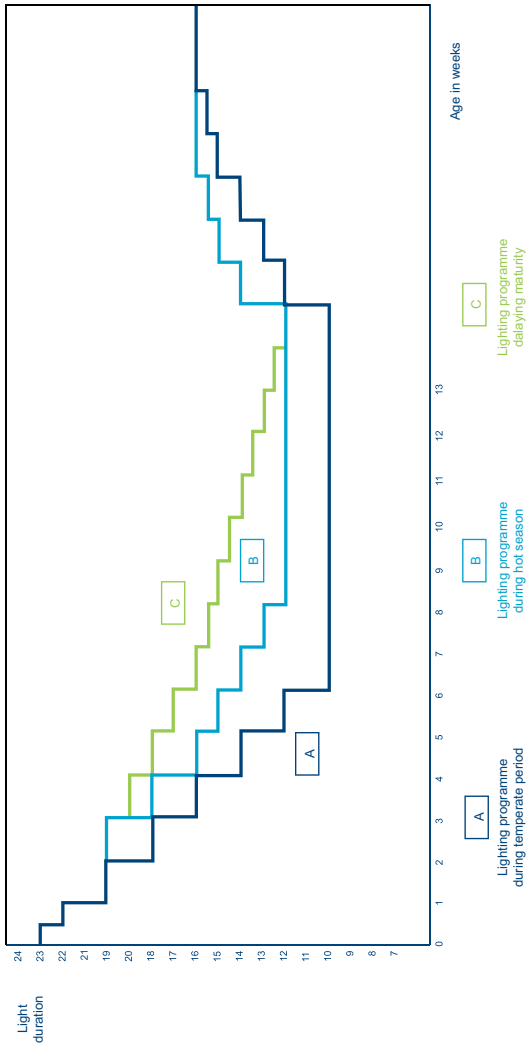
Table 2: equiment requirement for rearing

Stocking density (maximum)		12-14 birds / m^2
Minimum ventilation rate		0.7 m^3 / 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 after 5 weeks

Because of the sensitivity of birds to day length, lighting programmess are used to encourage growth and control the birds' sexual maturity. Never increase day length between 6 weeks of age and the start of light stimulation. Timing of light stimulation should always be based on body weight, not on age.

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



When pullets are reared in dark houses, use a slow step down lighting programme in order to maximise growth during the first weeks and keep a constant light duration adapted to growth performance or the sexual maturity expected.

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			
Increasing daylengths: From 49 days to light stimulation	10	11	12	13	14

When pullets are reared in open system houses, control of sexual maturity is difficult to achieve. Darken the poultry house and use a lighting program 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.

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 normally carried out to prevent feather pecking and cannibalism.

Different methods for beak trimming can be applied. Following cauterization by hot blade or infra-red treatment it is recommended to increase the water level in the drinkers and lower 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 one day old is still sensitive, it is advisable to use side activated nipples (360°) or nipple drinkers with cups and the use of supplementary starting mini drinkers in the rearing farm for the first few days.

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

Feeding in rearing

- 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.

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
Metabollsable 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

(1): To avoid falls in food consumption, 50% of the calcium should be supplied in granular form (diameter= 2 to 4 mm) Remark:For temperature above 24° other nutritionnal recommendation are available in our complete alternative management guide.

Litter management

The top priority is to keep the litter dry. Well managed ventilation and good gut health are key points.

Litter should be friable and 'moveable'. The birds help to maintain this condition by scratching and dust bathing. Scratching may be encouraged by providing a small daily 'scratch feed' of whole grain.

Water pressure in drinker supply lines should meet suppliers specification to avoid leakage.

Where nipple drinkers are provided, they should be suspended so that the birds have to reach up to drink.

Litter depth should be 5 to 10 cm depending on the type of floor.

Additional litter should be added, on top of the existing litter, in order that moisture content is kept low.

Wet patches resulting from water spillage should be promptly removed.

During cold and/or wet weather, it is important to work the litter regularly with a fork.

Transfer to laying house

This is a stressful period for the birds due to handling and transport involved in movement from rearing to laying facilities, and the change from a rearing to a laying environment. This should be done at 4 weeks (ideally) and certainly no later than two weeks before egg production starts. This will give the bird enough time to adapt to the situation in the new environment.

Preparation – rearing farm

Birds must always conform to the breed bodyweight.

Light intensity and rearing temperature should be adjusted, over a period of 2 to 4 weeks, and must be equal to the level in the laying house. Two weeks prior to transfer, 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.

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

Preparation – laying farm

An appropriate terminal hygiene program must be implemented to avoid cross disease transmission.

Maintenance and repairs to complete before the arrival of stock:

- Flush the water system and provide fresh water the day before arrival of new stock.
- Where nipple lines are used, ensure the height is slightly below the back of the birds (for the first 7 days), then raise 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 and preheated in cold season.

Transfer

An ideal time for transfer is during the early morning. If the stock are unloaded by the time their day would have started on the rearing farm, disturbance to their routine of drinking and eating is minimised.

Transport vehicles and equipment must be clean and disinfected.

The flock should be transferred within the same day.

The whole procedure should be fast with the loading of the birds, transport and unloading all conforming to local regulations. Additionally every effort should be made before and after transfer to maintain water and feed intake according to the normal routine of the flock.

Precautions should be taken to minimize undue exposure to wind and rain/sun during transfer procedure.

After housing

The period of the first 48 hours after housing is a critical period; close supervision and observations are required to ensure the normal behavior of the entire flock.

The following points should be noted:

Water consumption – normal drinking habits, within 6 hours after arrival.

Temperature: ideally 15°c, 18°c is the maximal temperature. 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 (3 to 7 days), prior and during lights off.

Nest boxes must be closed until you see the first egg. Open them 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 to keep birds on the system for a few days if they were not reared on a partly slatted house (according to local regulations).

Table 6: minimum mesurements and record keeping

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

Laying period

Building and equipment for production

Housing Equipment

It is important the birds are reared in the same system as they will experience in production.

Table 7: standard stocking densities and environnement.

Stocking density		7 birds / m^2*
Min. ventilation rate		0.7 m^3 / 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 $1m^2$ of collective nest
Perches		10 cms of perch / hen (distance 40 cms 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, either plastic, wooden or metallic should be adapted to the building design. They should be on a level which provides easy access for the birds and which also accommodates manure throughout the whole production cycle. When higher than 90 cm, use the perch rails to help the birds' access them, as drinkers, feeders and nests are placed here.

Feed and Water

We recommend a feeding system that distributes feed rapidly and enables the birds to finish all the distributed feed each day. It helps the correct feeding technique with a rapid increase of feed intake at start of lay, no fine particles accumulation and feed intake control. Rapid floor mounted chain feeders seem to be the best option. If pan or tube feeders are used they should be adapted properly to this technique.

It is best to use the same type of drinkers in rearing and production (for example nipples to nipples).

The feeders and drinkers should be easily accessible and recognised by the birds, their height adapted to the size of the birds. If slatted areas are used in the house, place the slats in front of the nests. The drinker line attracts the birds to the nest boxes.

The standards for drinking and feeding space given in the table of stocking densities and environment must be followed from transfer until depletion.

Remember: If the hen 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

Use one comfortable individual nest for 5 – 6 birds or 1 m² of collective nest for 120 birds. The individual nest should be strawed. Any nests must be clean and well maintained. A dim light (0.3-0.5 lux) placed in the nests or over the slats switched on 1.5 h before lights on could be used to avoid floor eggs.

Perches

Perches improve the welfare of the birds. They also help to increase the usable surface per bird and decrease floor density, train the birds to jump in the system and allow an escape to aggressed birds.

Minimum perch length per bird is 10cm. The first accessible level must be at 20cm height.

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

Partitioning the house into different pens helps the bird distribution and makes the flock management easier.

Fencing – Outside:

Perimeter fencing is a requirement to protect birds from different predators and to aid security and bio security.

A fencing example could be a wire type mesh construction, 2m high 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 could be approx 30cm underground to act as an anti-tunneling barrier. Alternatively commercially available safety electric fencing can be used.

For range management, a more practical and lighter material like electrified netting can be used.

Heating

If possible keep the laying house temperatures between 18-22°C, though the hens can withstand lower or higher temperatures during winter and summer. Keep in mind that at lower temperatures a hen increases feed intake and at higher temperature decreases the feed intake. A temperature change of 1°C will translate to approximately 1.4g change in feed intake.

To avoid temperature stress in wintertime, it is advisable to preheat the production houses before transfer of point of lay pullets, up to 18°C.

Make sure you always follow minimum ventilation requirements to avoid damage by high CO2 and NH3 levels. Lower temperature is less harmful than high CO2 and NH3 levels.

Ventilation

A major priority of ventilation is the provision of fresh air. If the air in the poultry house is stuffy – humid – smells or laden with dust, then the rate of air change is too low!

The minimum rate of air change, in order to supply the birds' respiratory needs is 0.7 m³ / hour / kg live weight. Good working ventilation removes the excessive moisture – maintains a good litter quality, removes the dust, maintains a sufficient oxygen supply and removes noxious gases from a chicken house.

Ventilation system

A free range house can be ventilated mechanically, naturally, or by a combination of both systems. Fundamental to any system is the provision of finely adjustable air inlets, usually at eaves level on both sides of the house, and outlets in the apex of the roof. Some houses are be cross ventilated, with inlets one side of the building and the extractor fans on the other side. If the climatic conditions suit a low ventilation rate.

Table 8: Air quality levels

Trait	Recommended level
Ammonia (NH^3)	20 ppm max
Carbon dioxide (CO^2)	2500 ppm max

Air Circulation

When the rate of air change is low, it is best to keep a good air circulation in the house. It helps a better distribution of the fresh, as well as the warmer air, throughout the whole house It also allows a better moisture removal from litter and improves the birds' comfort in case of hot weather. Be careful of direct draughts on birds. The use of an axial fan can be a good method of effective air circulation.

Frequently problems associated with poor ventilation

Table 9: Air quality recommendations

Too little ventilation	Too much	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 & external egg quality	Nervousness	Nervousness
Poor production		Poor production
	Crowding	Crowding
Litter quality		Litter quality

Litter is also considered to be one of the wellbeing factors for birds, allowing them to scratch, dust bathe and be more relaxed.

Slatted areas covering an enclosure, to which the birds are denied access,should be used 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 the litter management is to maintain a dry, friable and odourless material, 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. Materials like sand or gravel, wood shavings, wheat spelt or rye chopped straw, bark mulch or coarse wood chips can be used as litter. Sawdust is not suitable as once moistened it compacts, becomes immovable and does not release moisture to the atmosphere.

Neither material should be contaminated and should not be moved on site from flock to flock. It should be uncontaminated when spread in the poultry house. Straw should be chemically treated so that it is free of moulds, aspergillus species in particular.

If the system allows it, frequently remove accumulated litter/manure. This prevents floor eggs and improves the 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 advise the creation of three zones, one as a scratching area, one as a 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 to avoid dark areas where bird could 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 could be used with brown birds to attract them into the nest before the general light on.

Lighting systems using bulbs with too low frequency will result in flickering light which will stress birds. Warm color 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 - body weight development & uniformity

From transfer to around 30 weeks of age the birds need to achieve at least 300g of bodyweight gain. Growth after 30/35 is mostly due to fat deposition, and its excess will be negative for lay and feed conversion.

A lack of bodyweight gain after transfer makes hen less robust against environmental variations (disease, heat, etc…).

Flock uniformity has to be maintained in order to avoid extremes of bodyweight leading to poor laying performance.

Pre-lay key targets

Increase layer bone mineralisation

The pre lay period is characterised by an increase of the calcium concentration of the feed.

The first objective is to reinforce the mineralisation of medullary bone and calcium storage before the beginning of the lay.

The second objective is to prevent demineralisation of early layers in the flock. The calcium concentration of a grower feed would not be sufficient to compensate the calcium exported for the eggshell of these birds.

In summary, a higher calcium level on pre lay diets 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

Pre lay diet constitutes a step, in terms of feed composition, between rearing and laying feed. The abrupt increase of both fine as well as coarse calcium carbonate particles has a strong influence on feed palatability and presentation. There is an increased risk of low feed consumption after transfer if pre lay feed is not used. We strongly recommend the use of a pre lay diet to accustom bird to layer feed.

Growth continuation, lightest bird catching up and maintaining uniformity

The birds continue to grow during the pre-lay phase, for the lightest ones it is the last chance to catch up and the earliest can start to lay. Both groups require a high nutritional feed to assist correct growth and production. Without using an adapted feed, uniformity of the flock could decrease.

Working with the birds after transfer

Put the birds close to drinkers and feeders at transfer.

Keep the flock on a slatted area for a few days, it helps the birds to get used to slats, find drinkers and feeders but also 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. Switch off the lights gradually starting from floor ending at a top tier of aviary.

Place the birds found on litter just before dusk on to the slatted area during the first week.

Collect the floor eggs several times per day at start of lay, until the level becomes acceptable.

Automatic nests must be open at least 2 hours before lights on. After all the eggs are laid close the nests (to be adapted according to the flocks laying behaviour). It helps to keep the nests clean and to remove all birds from them.

Continue to check the growth by measuring bodyweight.

Monitor feed and water intake.

Watch out for birds that do not find the drinking/feeding points. Look for these on top level of aviary system, on the scratching area or perches. Move them to drinkers and feeders.

Training caged reared birds

Rear the birds on floor or in an aviary when these are destined to be housed on floor or aviary systems during production. If birds reared in cages are transferred to a production house with a floor or aviary system there is a high risk of problems. The birds might not find their way to drinkers and feeders, are not accustomed to jump and mount on slats and into the system. More weakened birds and higher mortality may occur after transfer, the flock may have a low peak, with many eggs laid on floor.

If you are forced to transfer the cage reared birds to floor or aviary systems for production ,here are some tips to help you and the birds to cope.

1. 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 kept there (with a temporary fence) for some time (7-10 days) without a risk of overcrowding.
3. Place all the drinking and feeding equipment on slatted areas.
4. Use as many different ladders and steps as possible so that the birds are not forced to jump to high to get back to slats.
5. Start to release the birds from the slatted area to litter gradually, after you are sure they all have found water and feed.
6. Inspect the flock more frequently and help the “lost” individuals to find water and feed.
7. When released, encourage the flock to get back to slats or aviary system in the evening.
8. This type of transfer needs much more physical work from skilled workers.
9. Special attention is needed for coccidiosis prevention or treatment.

Stocking density

Respect for this parameter in lay is as important as it is in the rearing period. Flocks with enough feeding and drinking space will fulfil their genetic potential much more successfully.

Follow the local regulations for stocking density. However, it should not exceed 7 birds per usable m^2 on litter, 9 birds per usable m^2 on slats. However, the aviary system enables an increase of stocking density up to 18 or even more birds per m^2 of the floor of the house.

In any of these cases the birds must have enough easily accessible drinking and feeding space. Overcrowded flocks risk low feed and water intake, they could show pecking, cannibalism, suffocation, mortality, culls and finally a compromised performance.

Drinking and feeding

Ensure at least 1 nipple per 10 birds or 1 bell drinker for 100 birds in temperate climates and1 bell drinker for 80 birds in hot climates. We consider 10 cm of linear chain space should be assured per bird and that 1 pan is sufficient for 25 birds (if their mutual distance allows the access from all sides). The height of the feeders and drinkers should be adjusted for an easy access for all the birds and so that they do not impede the movement of birds, nor encourages floor laying under them.

Measuring daily feed- and water intake

The daily monitoring of water and feed intake is very useful. 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; they tend to leave the fine part of the feed. Consequently, the feed needs to be uniformed, with a maximum of 10% coarse particles above 3.2mm and 15% maximum of fines particles below 0.5mm. Too high proportion of coarse particles will lead to feed sorting, uneven bodyweight and laying performance, too high proportion of fine particles will decrease feed consumption.

Birds also do not like variation in feed presentation. Similarly to fine particles, variation in feed presentation decreases feed consumption.

Addition of 1% oil to mash layer feed, is recommended to improve feed presentation. Oil sticks the finest particles together and makes them easily 'eatable'.

In case when the feed intake is very low or the feed presentation is poor, crumbs could be used, they are easy to take by beak and each particle is nutritionally balanced. Crumbs increase water intake and wet droppings and a change from crumbs to mash, can decrease feed consumption.

Feed distribution

We recommend the distribution of feed equal to the amounts of feed that the hens finish each day. The feeders should be emptied daily at the beginning of the afternoon. This technique leads to decreased feed selection and to increased mineral and vitamin consumption usually found in the fine particles of feed

Feed distribution during the intensive oviposion time of a day 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 programme needs to be adapted according to observations and the feed distribution equipment.

Lighting program :

High intensity after transfer

Increase the light intensity just after transfer. This encourages hens to discover their new environnement (nipples, feeder and nest location) and stimulates feed consumption too. When feed consumption is sufficient, light intensity could be reduced.

Night flash (midnight feed)

When the local legislation allows it, a maximum of two hours of light could be given to hens 3 hours after light extinction. Birds can use this extra time to consume some more feed if needed. This technique is very useful especially during hot season.

Temperature

In comparison with rearing period, temperature could be decreased a little (1 or 2°C) to stimulate feed consumption.

Prelay diet

Prelay diet utilisation facilitates the transition from rearing to production diets that are very different especially in type and amount of calcium carbonate concentration and palatability linked to this fact.

Digestive tract development

A proper feeding technique in rearing helps to develop the digestive tract so that the birds is well prepared to eat enough during lay.

Crop

The importance of the crop as a feed storage organ is recognized especially after transfer when bird ought to increase it's feed intake from 80 to 120 g. A poorly developed crop reduces this feed intake capacity. The concept of meal feeding technique with empty feeders once a day leads to faster feed consumption and better crop development. (refer to 'Feeding mangement').

Gizzard

Pullet feed presented in coarse particles mash helps gizzard development. Coarse limestone particles in prelay feed or the use of grit in rearing also help to develop gizzard.

Insoluble grit

Grit of proper particle size was once considered essential. Now, with the mash feed, it is considered unnecessary, grit stimulates the gizzard muscle development in rearing, stimulates digestion and improves feed intake capacity.

Where the hens eat litter and feathers and have no grit, physical damage of the intestinal tract may occur. It is recommended to provide 3 g of insoluble grit per hen once a month, with a 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 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.

Table 10: Lighting program for dark laying houses.

Age and/or body weight	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

The minimum bodyweight reference is:

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

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
After	+½ hour per week in order to reach 15 to 16.30 hours at 50% production				

Note: This is a sample programme only and lighting programme should be matched to time of year, body weight and egg size requirements.

You will find an example of a lighting programme among charts. It is a sample programme only and lighting programme should be matched to time of year, body weight and egg size requirements.

Lighting programmes are only effective in light controlled environments.

Please consult your local breed representative for further advice.

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 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 is to achieve the best possible uniform light spread. Standard light bulbs with dimmer are preferred.

Floor eggs prevention

Floor eggs prevention is a key factor for flock success.

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

General Management Advice

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 preferentially lay in all darkened area.
- Limit the number of corners – place barriers.
- Lateral light should be 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.
- Ensure all birds sleep on the slatted area/system from time of placement, allow access to the litter area within a reasonable time scale – 2 weeks max.
- According to the breed used and the lighting program applied, a variable percentage of birds will lay before lights on; the probability 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.
- Installation of deflection barrier between the nest boxes enables the birds to be evenly distributed, diluting the pressure in the nest boxes. This also helps to prevent overcrowding of nest located near to partitions
- 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.
- In some situations adding one extra hour of light in the morning could solve floor eggs problems.

Important Behaviour

Just before laying, approximately 30 minutes before, birds express a specific behaviour called pre-laying behaviour which consists in 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.

Additional Influences – Floor Eggs

- Availability of perches in rear
- Feeder/Drinker availability.
- Stocking rate.
- Ventilation
- Nest availability/comfortable
- Slat position
- Incorrect installation of Electric Fence

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.

Main causes of prolapse are the following:

- Improper body weight and frame development: underweight pullets at point of lay, before 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, single or 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: carefull pecks, not resulting in feathers being pulled out and usually without interaction from the recipient bird. It 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 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. Besides, 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 **equipement 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 pecking outbreak, you need to react fast :

- Decrease light intensity*
- Paint bulbs or light covers in red
- Add salt into the water (0.5-1kg/1000l)
- 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 link and protection against dangers.

Advices to minimise the risk of smothering:

- Minimise the number of **corners** (e.g. Feeder) .
- Ensure an even **light distribution** within the house. Install light traps/deflectors.
- **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.
- It is necessary to visit the birds at the **end of the day** or when lights go off to **check birds behaviour**.
- Install **music in the houses** so the birds react less to noises.
- Make a **feed distribution one hour before lights go off.** It will evenly distribute birds through out the building.
- Ensure that available **perch space is adequate**
- **Adapt the ventilation** to obtain a uniform environment in the house and to avoid draughts
- Give **scratching material** (e.g. Grain/grit) in the afternoon to keep birds occupied

Broodiness

Broodiness can appear in certain flocks in case of stress or when they are generally underweight. Nutrients 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: staying in the nest, fluffed feathers, clucking and aggression. Therefore we advise closing nest at the end of the afternoon. Nests should not be closed until 4 hours before lights off to avoid loss of late laid eggs.

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
- The best system is to have 2 broody pens
- Treatment can be 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 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

Table 12: Broodiness and lay link duration, B Sauveur

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

Fibre for layer

Birds have a specific requirement for fibre. Deficiency in fibre can lead to feather pecking. A poor feathering observed in a flock without feathers remaining on floor could be a sign of a lack of fibre. A good supply of fibre improves feathering, decreases mortality, improves gut health and digestion.

Fibre provided to layer must be insoluble fibre and as much as possible with a coarse presentation.

Fibre could be provided through the feed by oilseed meal (sunflower / rapeseed), alfalfa (or lucerne), and oats. Cereal byproducts could provide a good amount of fibre in the feed, but their presentation is usually to fine to have 'structure effect' on the digestive tract.

Fibre could be provided directly in the building. We advised to use coarse fibre as straw, alfalfa (lucerne), wood shavings, rice/oat husk, sillage, etc... These materials must be available in the building through round feeder or directly as ball on the scratching area. Birds must have a free and ad libitum access to fibre sources. We advise to not spread directly fibre 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

Considering nutrients requirement, the main difference between cage and alternative production feed is energy requirement. To cover their higher energy requirement, birds are eating more. According to the housing system used, temperature and bird feathering, it is observed feed consumption could be increased by 3 to 20%.

In alternative production, it is essential for point of lay pullet to reach quickly their mature body weight. Energy intake is usually the limiting factor for production and growth when lay is starting. It is strongly advised to use a higher energy diet from 18 to 30/35 weeks of age. Energy levels of 2750 to 2850 Kcal/kg are adapted for start of lay diet.

After 35 weeks of age, energy concentration must be decreased to prevent fattening, improve feathering and livability (see 'Fiber for laying hen' section). According to country and raw material availability, a compromise between feed intake/FCR, bird behaviour and bird bodyweight must be found. Classical energy feed range advised after 35 weeks of age, are from 2600 to 2750Kcal/kg.

For all the other nutrients, birds requirement in alternative production are very close to these used for cage.

Protein and amino acids requirements

The daily amino acids and protein requirement values could be estimated from the last review we did 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	Ideal protein based on European table 2002 Requirements in mg per g based on European table 2002			Daily Requirements based on European table 2002	
		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's diets can be carried out by introducing ISOLEUCINE and VALINE as nutritional constraints replacing protein as a constraint. If this is not possible, we give hereafter some indications for a minimum of protein for feed containing or not 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
Met + Cys	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
Met + Cys	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 THE END OF LAY					
Prot w/o MBM %	(17.4-17.9)	(16.9-17.4)	(16.4-16.9)	(15.9-16.4)	(15.4-15.9)
Prot 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
Met + Cys	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
Met + Cys	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

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 improve 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

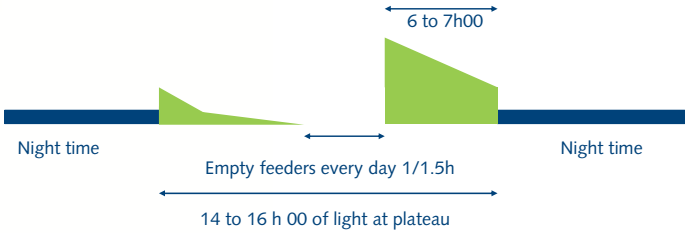
All these daily mineral recommendations must be divided by the feed consumption observed to get the ideal percentage in the feed.

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

Feeding management

The feeding management in production should follow several simple rules:

- Hens are grain eaters and have a preference for bigger feed particles. We want them to eat all the components of the formulated feed including the fine with higher concentration of amino acids, minerals and vitamins.
- Birds have to finish their ration every day so that the feeders rest empty for a while.
- Do not disturb the birds with feed distribution during their oviposition time (first 5-6 hours of the day) if floor eggs are observed
- 60% of feed must be distributed the afternoon to promote the calcium storage before the night, ensuring a good eggshell quality
- To avoid feed particles selection, a minimum of feed distribution has to be done (to be adjusted according to feeding system)
- 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.



Pasture and range management

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

Range enhancement

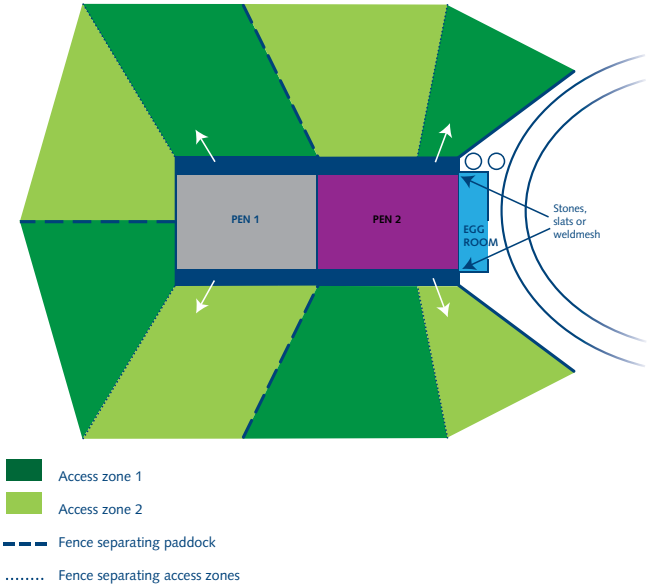
The most critical part of the range is the immediate access of the range (first 5/10 meters). It is advised to place large stones or slats immediately adjacent to the popholes or the winter garden. Trees and shelter provision on the range allows birds to utilize the range better and protect them against climatic conditions.

Pasture management:

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 and it is possible to re-seed worn areas
- When paddocks are not stocked they may be cut, hay even may be taken. It is possible to chain harrow the pasture, breaking up any mat of dead
- Owing to the break periods, the ground does not become 'fowl sick'. In particular the development of parasitic worms is kept under control.

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. But reseeding can be carried out during early autumn; this is generally preferable to spring planting for grass strength. Reseeding will normally be using hard wearing ryegrass species – these are the most durable.



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

As soon as the stock has been depopulated, 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 sanitizing 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 country regulation on waste disposal.

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 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.

Minimum measurements and record keeping

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

Table 16: minimum measurements and record keeping

	Minimal	Optimal
Feed cons.	weekly	daily (weekly records)
Bird weight	Arrival 28 Weeks of age > 28 : 1 Every 2 months	Arrival transfer to 30 weeks of age: 1 on 2 weeks >30 : 1 Per month
Mortality	weekly	daily
Water cons.	weekly < 28 weeks of age	daily
Laying rate	weekly	daily
Egg weight	weekly	daily

Special health considerations

Biosecurity and hygiene

A good health status is very important for two reasons:

Healthy animals are efficient producers. Disease costs energy.

Secondly, we produce high quality food, which must be safe for human consumption, free from pathogens and other contaminations.

Biosecurity is key to the prevention of disease in cooperation with custom-made vaccination programmes and disease eradication/ control programmes.

Vaccinations

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 neighboring farms and what type of birds are housed on the neighboring 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?
- 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?

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
H2S	non detectable	non detectable
Coliform bacteria's cfu/ml	<100	>100
Total germ count cfu/ml	<100.000	>100.000

Warranty disclaimer

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Conversion table

1 mtr.	=3.282 feet	1 foot	=0.305 mtr.
1 sq. mtr.	=10.76 sq. feet	1 sq. foot	=0.093 sq. mtr.
1 cub. mtr.	=35.316 cub. feet	1 cub. foot	=0.028317 cub. m.
1 cm.	=0.394 inches	1 inch	=2.54 cm.
1 sq. cm.	=0.155 sq. inch	1 sq. inch	=6.45 sq.cm.
1 kg.	=2.205 lbs.	1 lb.	=0.454 kg.
1 g.	=0.035 ozs.	1 oz.	=28.35 g.
1 ltr.	=0.22 gallons	1 gallon	=4.54 ltr.

1 bird per square meter	=10.76 square feet per bird
3 bird per square meter	=3.59 square feet per bird
4 bird per square meter	=2.69 square feet per bird
5 bird per square meter	=2.15 square feet per bird
7 bird per square meter	=1.54 square feet per bird
11 bird per square meter	=0.98 square feet per bird
13 bird per square meter	=0.83 square feet per bird

1 cubic meter/kilogram/hour	=16.016 cubic feet/lb./hour
1 cubic foot/lb./hour	=0.0624 cubic meter/kilogram/hour

F °	=9/5 °C+32	°C	=5/9 (°F-32)		
45 °C	=113 °F	22 °C	=72 °F	10 °C	=50 °F
40 °C	=104 °F	20 °C	=68 °F	8 °C	=46 °F
35 °C	=95 °F	18 °C	=64 °F	6 °C	=43 °F
30 °C	=86 °F	16 °C	=61 °F	4 °C	=39 °F
27 °C	=81 °F	14 °C	=57 °F	2 °C	=36 °F
24 °C	=75 °F	12 °C	=54 °F	0 °C	=32 °F

1 Joule per second = 1 Watt = Volt x Ampere

1 KJ	=1000J	Ex. large	=63.8-70.9
1 MJ	=1000KJ	Large	=56.7-63.8
1 MJ	=239 Kcal	Medium	=49.6-56.7
1 Kcal	=4.2 KJ	Small	=42.5-49.6
1 KWh	=3.6MJ - 860 Kcal		
1 BTU	=1055 J		

Notes