Hy-Line® BROWN

Alternative Systems

Management Guide

Hy-Line®

Use of the Management Guide

The genetic potential of Hy-Line Brown Commercial can only be realised if good poultry husbandry practices and management are used. This management guide outlines successful flock management programmes for Hy-Line Variety Brown Commercial based on field experience compiled by Hy-Line International and using an extensive commercial layer flock database of Hy-Line flocks from all parts of the world. Hy-Line International Management Guides are periodically updated as new performance data and/or nutrition information become available.

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Introduction

Alternative systems have been developed to satisfy the increasing customer demand for eggs produced outside of conventional cages. This type of production requires different management to optimise production and bird welfare. Alternative production systems fall into three broad categories:

Barn Systems—Floor systems with a litter area which covers part or all of the facility. Birds are allowed to freely move within the facility. An elevated slat area with nests, feeders, perches, and waterers is provided. Automatic colony nest boxes are utilised for egg collection.

Barn systems allow birds free movement. Floors can be slatted, littered or a combination of both.

Barn systems can be a 2/3 slats and 1/3 litter combination.

Aviary Systems—Multi-tier structures over a litter floor where nests, feeders, waterers, perches, and welfare enrichments are provided. Aviary systems are typically designed to have feeders on some levels, and nests and water on other levels. Manure belt disposal systems are provided on elevated levels. The litter floor area should be greater than 30% of the usable space in the aviary, including slat floors but excluding the nests and perches. The top level is typically for birds to rest/sleep. Aviaries increase the living space within a facility, allowing for greater efficiency of production.

Aviary systems utilise the vertical space within a facility to allow better use of the facility and to provide environmental enrichments to increase bird welfare.

Aviary systems typically have littered scratch areas between rows of multi-level living areas with feeders, waterers, perches, and nests.

Free Range Systems—Barn or aviary systems where birds have access to the outside range or pasture. Birds have outside pasture areas with perimeter fencing, or summer porches or verandas which are enclosed with fencing and a roof. Some free range systems allow constant access to pasture/range areas and utilise mobile housing units with feed and water, which are periodically moved to keep the pasture fresh.

Free range systems provide the birds access to outdoor paddocks during the day. The birds return to the facility for feed and water and sleeping at night.

Free range systems provide many welfare benefits, including the expression of foraging behaviour.

Summary of Performance Standards

REARING PERIOD (TO 17 WEEKS):	
Liveability	98%
Feed Consumed	6069 g
Body Weight at 17 Weeks	1460 g
LAYING PERIOD (TO 90 WEEKS):	
Percent Peak	94.8–96.6%
Hen-Day Eggs to 60 Weeks Hen-Day Eggs to 72 Weeks Hen-Day Eggs to 90 Weeks	257.5–269.0 328.9–343.4 425.5–445.2
Hen-Housed Eggs to 60 Weeks Hen-Housed Eggs to 72 Weeks Hen-Housed Eggs to 90 Weeks	254.1–265.5 323.3–337.7 415.0–434.2
Liveability to 60 Weeks Liveability to 80 Weeks Liveability to 90 Weeks	97.4% 95.1% 93.5%
Days to 50% Production (from hatch)	144
Egg Weight at 26 Weeks Egg Weight at 32 Weeks Egg Weight at 72 Weeks	58.4–61.8 61.1–63.5 63.9–66.5
Total Egg Mass per Hen-Housed (18–90 weeks)	27.0 kg
Body Weight at 32 Weeks Body Weight at 72 Weeks	1.88–1.99 kg 1.93–2.04 kg
Freedom From Egg Inclusions	Excellent
Shell Strength	Excellent
Shell Colour Score at 38 Weeks Shell Colour Score at 56 Weeks Shell Colour Score at 72 Weeks Shell Colour Score at 90 Weeks	87 85 81 79
Haugh Units at 38 Weeks Haugh Units at 56 Weeks Haugh Units at 72 Weeks Haugh Units at 90 Weeks	90.0 84.0 81.0 79.7
Average Daily Feed Consumption (18–90 weeks)	117.9 g/day per bird
Feed Conversion Rate, kg Feed/kg Eggs (20–60 weeks) Feed Conversion Rate, kg Feed/kg Eggs (20–72 weeks) Feed Conversion Rate, kg Feed/kg Eggs (20–90 weeks)	1.93–2.24 1.96–2.27 2.03–2.36
Feed Utilisation, kg Egg/kg Feed (20–60 weeks) Feed Utilisation, kg Egg/kg Feed (20–72 weeks) Feed Utilisation, kg Egg/kg Feed (20–90 weeks)	0.45–0.52 0.44–0.51 0.42–0.49
Feed Consumption per 10 Eggs (20–60 weeks) Feed Consumption per 10 Eggs (20–72 weeks) Feed Consumption per 10 Eggs (20–90 weeks)	1.23–1.37 kg 1.26–1.40 kg 1.31–1.47 kg
Feed Consumption per Dozen Eggs (20–60 weeks) Feed Consumption per Dozen Eggs (20–72 weeks) Feed Consumption per Dozen Eggs (20–90 weeks)	1.48–1.65 kg 1.51–1.68 kg 1.58–1.76 kg
Skin Colour	Yellow
Condition of Droppings	Dry

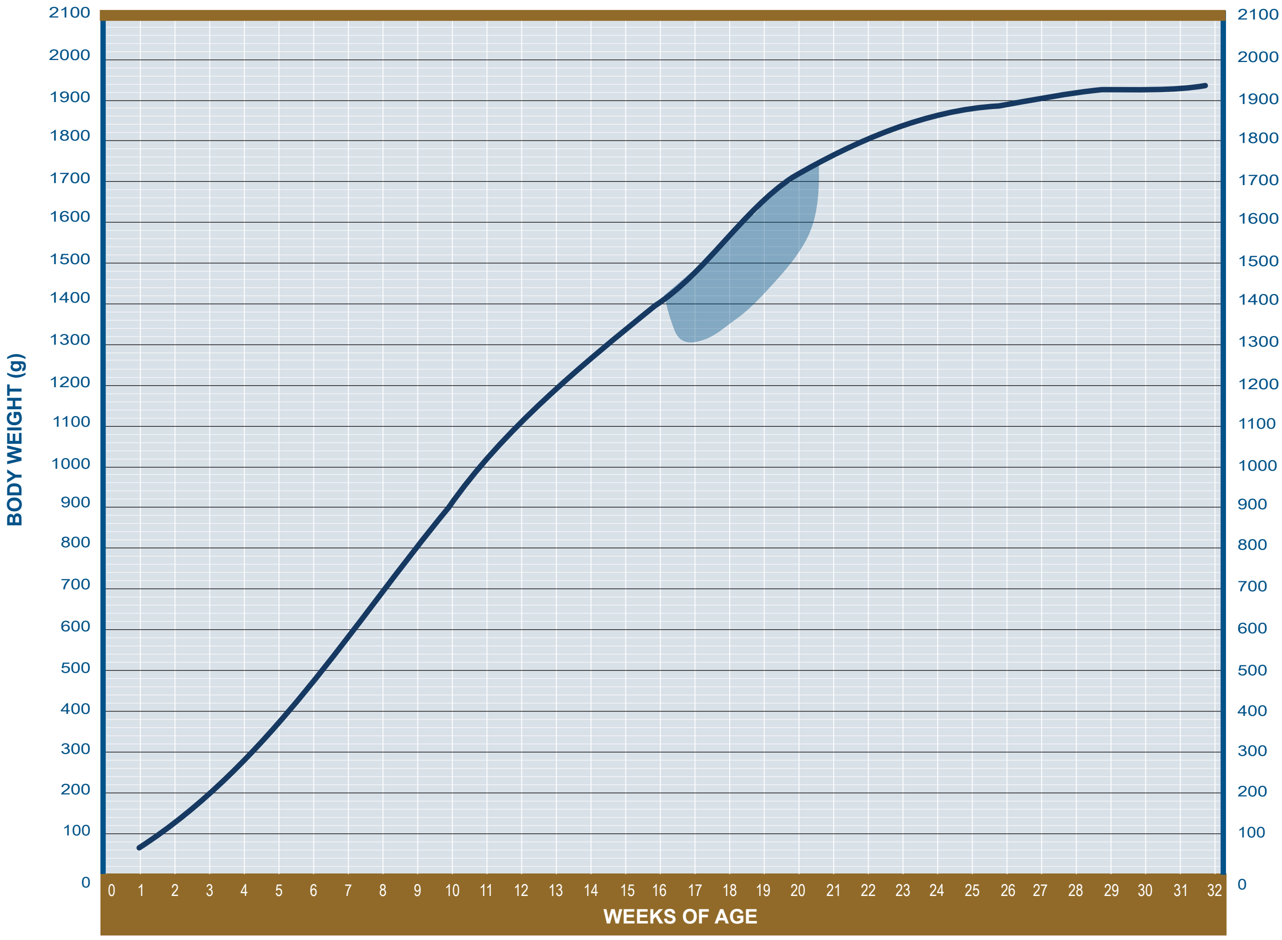
Performance Summary data is based on results obtained from customers around the world. Please send your results to info@hyline.com. An easy to use record-keeping programme, Hy-Line International EggCel, can be found in Technical Resources at hyline.com.

Performance Tables and Space Recommendations

Rearing Period Performance Table

AGE (weeks)	MORTALITY Cumulative (%)	BODY WEIGHT (g)	WATER INTAKE (ml/bird/day)	FEED INTAKE (g/bird/day)	CUMULATIVE FEED INTAKE (g/bird to date)	UNIFORMITY %
1	0.40	60 – 70	18 – 28	12 – 14	84 – 98	65–70%
2	0.55	120 – 130	25 – 42	17 – 21	201 – 244	
3	0.65	180 – 200	30 – 50	20 – 25	343 – 418	
4	0.75	260 – 290	37 – 60	25 – 30	515 – 627	
5	**0.85**	**350 – 380**	**43 – 73**	**29 – 36**	**717 – 883**	
6	0.95	460 – 480	52 – 89	35 – 44	960 – 1193	
7	1.05	550 – 590	62 – 98	41 – 49	1249 – 1537	
8	1.15	660 – 710	71 – 112	47 – 56	1580 – 1929	
9	1.25	770 – 820	78 – 122	52 – 61	1943 – 2355	
10	**1.35**	**870 – 930**	**84 – 129**	**56 – 64**	**2334 – 2806**	70–75%
11	1.45	980 – 1040	90 – 137	60 – 69	2754 – 3287	
12	1.55	1070 – 1130	93 – 144	62 – 72	3189 – 3791	
13	1.63	1150 – 1220	96 – 148	64 – 74	3637 – 4308	
14	1.70	1220 – 1290	99 – 154	66 – 77	4099 – 4845	80%
15	**1.78**	**1290 – 1360**	**102 – 158**	**68 – 79**	**4575 – 5399**	
16	1.85	1360 – 1430	105 – 164	70 – 82	5066 – 5973	85%
17	2.00	1420 – 1500	108 – 170	72 – 85	5570 – 6568	

Growth Curve



Blue shaded area represents potential body weight loss during transfer.

Production Period Performance Table

AGE (weeks)	% HEN-DAY Current	HEN-DAY EGGS Cumulative	HEN-HOUSED EGGS Cumulative	MORT-ALITY Cumulative (%)	BODY WEIGHT (kg)	WATER INTAKE (ml/bird/day)	FEED INTAKE (g/bird/day)	HH EGG MASS Cumulative (kg)	AVG. EGG WEIGHT (g/egg)
18	1.1–7.7	0.1–0.5	0.1 –0.5	0.05	1.49 – 1.61	110–176	73–88	0.0	45.4–49.9
19	8.2–27.1	0.7–2.4	0.7 –2.4	0.08	1.59 – 1.70	128–188	85–94	0.1	48.3–51.7
20	**30.8–57.3**	**2.8–6.4**	**2.8 –6.4**	**0.13**	**1.65 – 1.77**	**135–198**	**90–99**	**0.2**	**50.7–53.7**
21	61.4–80.5	7.1–12.1	7.1 –12.1	0.20	1.70 – 1.81	146–206	97–103	0.5	52.6–55.8
22	82.4–90.6	12.9–18.4	12.8 –18.4	0.27	1.75 – 1.85	150–214	100–107	0.8	54.2–57.8
23	90.6–94.1	19.2–25.0	19.2 –25.0	0.34	1.78 – 1.88	156–222	104–111	1.2	55.6–59.0
24	93.2–95.5	25.7–31.7	25.7 –31.6	0.40	1.81 – 1.91	164–228	109–114	1.6	56.7–60.1
25	**94.2–96.2**	**32.3–38.4**	**32.2 –38.3**	**0.46**	**1.82 – 1.93**	**168–238**	**112–119**	**2.0**	**57.6–61.1**
26	94.6–96.4	39.0–45.2	38.8 –45.0	0.50	1.83 – 1.94	171–242	114–121	2.4	58.4–61.8
27	94.8–96.6	45.6–51.9	45.4 –51.8	0.55	1.85 – 1.95	173–244	115–122	2.8	59.1–62.2
28	94.8–96.6	52.2–58.7	52.0 –58.5	0.61	1.86 – 1.97	174–246	116–123	3.2	59.6–62.4
29	94.8–96.6	58.9–65.5	58.6 –65.2	0.66	1.87 – 1.98	176–248	117–124	3.6	60.1–62.7
30	**94.8–96.5**	**65.5–72.2**	**65.2 –71.9**	**0.71**	**1.87 – 1.98**	**176–250**	**117–125**	**4.0**	**60.5–63.0**
31	94.7–96.5	72.1–79.0	71.8 –78.6	0.76	1.87 – 1.98	176–250	117–125	4.4	60.9–63.3
32	94.7–96.5	78.8–85.7	78.4 –85.3	0.80	1.88 – 1.99	176–250	117–125	4.9	61.1–63.5
33	94.6–96.3	85.4–92.5	84.9 –92.0	0.86	1.88 – 1.99	176–250	117–125	5.3	61.4–63.8
34	94.4–96.1	92.0–99.2	91.5 –98.7	0.92	1.89 – 2.00	176–250	117–125	5.7	61.6–64.0
35	**94.2–96.0**	**98.6–105.9**	**98.0 –105.3**	**0.97**	**1.89 – 2.00**	**176–250**	**117–125**	**6.1**	**61.8–64.2**
36	94.0–95.8	105.2–112.6	104.5 –111.9	1.02	1.89 – 2.00	174–248	116–124	6.5	62.0–64.4
37	93.7–95.7	111.7–119.3	111.0 –118.6	1.08	1.89 – 2.00	174–248	116–124	6.9	62.1–64.6
38	93.5–95.5	118.3–126.0	117.5 –125.2	1.12	1.89 – 2.01	174–248	116–124	7.3	62.3–64.7
39	93.3–95.3	124.8–132.7	123.9 –131.8	1.18	1.90 – 2.01	174–248	116–124	7.8	62.4–64.9
40	**93.1–95.0**	**131.3–139.3**	**130.4 –138.3**	**1.24**	**1.90 – 2.01**	**174–248**	**116–124**	**8.2**	**62.5–65.0**
41	92.8–94.9	137.8–146.0	136.8 –144.9	1.30	1.90 – 2.02	174–248	116–124	8.6	62.6–65.1
42	92.5–94.6	144.3–152.6	143.2 –151.4	1.35	1.91 – 2.02	174–248	116–124	9.0	62.7–65.1
43	92.1–94.4	150.8–159.2	149.5 –157.9	1.41	1.91 – 2.02	174–248	116–124	9.4	62.8–65.2
44	91.8–94.1	157.2–165.8	155.9 –164.4	1.47	1.91 – 2.02	174–248	116–124	9.8	62.9–65.2
45	**91.5–93.8**	**163.6–172.3**	**162.2 –170.9**	**1.52**	**1.92 – 2.03**	**174–248**	**116–124**	**10.2**	**62.9–65.3**
46	91.2–93.5	170.0–178.9	168.4 –177.3	1.59	1.92 – 2.03	174–248	116–124	10.6	63.0–65.3
47	90.9–93.3	176.3–185.4	174.7 –183.8	1.64	1.92 – 2.03	174–248	116–124	11.0	63.1–65.4
48	90.7–93.1	182.7–191.9	181.0 –190.2	1.70	1.92 – 2.03	174–248	116–124	11.5	63.1–65.4
49	90.4–92.8	189.0–198.4	187.2 –196.5	1.76	1.92 – 2.03	174–248	116–124	11.9	63.2–65.5
50	**90.0–92.7**	**195.3–204.9**	**193.4 –202.9**	**1.83**	**1.92 – 2.03**	**174–248**	**116–124**	**12.3**	**63.2–65.5**
51	89.8–92.4	201.6–211.4	199.5 –209.3	1.89	1.92 – 2.03	174–248	116–124	12.7	63.3–65.6
52	89.6–92.2	207.9–217.8	205.7 –215.6	1.95	1.92 – 2.03	174–248	116–124	13.1	63.3–65.6
53	89.4–91.9	214.1–224.3	211.8 –221.9	2.01	1.92 – 2.03	174–248	116–124	13.5	63.4–65.7
54	89.3–91.7	220.4–230.7	217.9 –228.2	2.09	1.92 – 2.03	174–248	116–124	13.9	63.4–65.7
55	**88.9–91.5**	**226.6–237.1**	**224.0 –234.4**	**2.16**	**1.93 – 2.04**	**174–248**	**116–124**	**14.3**	**63.4–65.8**
56	88.7–91.4	232.8–243.5	230.1 –240.7	2.24	1.93 – 2.04	174–248	116–124	14.7	63.5–65.8
57	88.4–91.2	239.0–249.9	236.1 –246.9	2.33	1.93 – 2.04	174–248	116–124	15.1	63.5–65.9
58	88.2–91.0	245.2–256.3	242.2 –253.2	2.40	1.93 – 2.04	174–248	116–124	15.5	63.5–65.9
59	87.9–90.8	251.3–262.6	248.2 –259.4	2.49	1.93 – 2.04	174–248	116–124	15.9	63.6–66.0
60	**87.6–90.5**	**257.5–269.0**	**254.1 –265.5**	**2.57**	**1.93 – 2.04**	**174–248**	**116–124**	**16.3**	**63.6–66.0**

AGE (weeks)	% HEN-DAY Current	HEN-DAY EGGS Cumulative	HEN-HOUSED EGGS Cumulative	MORTALITY Cumulative (%)	BODY WEIGHT (kg)	WATER INTAKE (ml/bird/day)	FEED INTAKE (g/bird/day)	HH EGG MASS Cumulative (kg)	AVG. EGG WEIGHT (g/egg)
61	87.3–90.2	263.6–275.3	260.1 –271.7	2.65	1.93–2.04	174–248	116–124	16.6	63.6–66.1
62	87.0–90.0	269.7–281.6	266.0 –277.8	2.77	1.93–2.04	174–248	116–124	17.0	63.7–66.1
63	86.7–89.8	275.7–287.9	271.9 –283.9	2.85	1.93–2.04	174–248	116–124	17.4	63.7–66.2
64	86.4–89.6	281.8–294.1	277.8 –290.0	2.92	1.93–2.04	174–248	116–124	17.8	63.7–66.2
65	**86.1–89.3**	**287.8–300.4**	**283.6 –296.1**	**2.97**	**1.93–2.04**	**174–248**	**116–124**	**18.2**	**63.8–66.3**
66	85.6–89.0	293.8–306.6	289.4 –302.1	3.08	1.93–2.04	174–248	116–124	18.6	63.8–66.3
67	85.1–88.6	299.7–312.8	295.2 –308.1	3.14	1.93–2.04	174–248	116–124	19.0	63.8–66.4
68	84.5–88.3	305.7–319.0	300.9 –314.1	3.20	1.93–2.04	174–248	116–124	19.4	63.8–66.4
69	83.8–88.0	311.5–325.2	306.6 –320.1	3.30	1.93–2.04	174–248	116–124	19.7	63.8–66.4
70	**83.2–87.6**	**317.4–331.3**	**312.2 –326.0**	**3.43**	**1.93–2.04**	**174–248**	**116–124**	**20.1**	**63.9–66.5**
71	82.7–87.0	323.1–337.4	317.8 –331.9	3.58	1.93–2.04	174–248	116–124	20.5	63.9–66.5
72	82.0–86.4	328.9–343.4	323.3 –337.7	3.73	1.93–2.04	174–248	116–124	20.8	63.9–66.6
73	81.4–85.8	334.6–349.4	328.8 –343.5	3.88	1.93–2.04	174–248	116–124	21.2	63.9–66.6
74	80.7–85.2	340.2–355.4	334.2 –349.2	4.03	1.93–2.04	174–248	116–124	21.6	63.9–66.7
75	**80.1–84.6**	**345.8–361.3**	**339.6 –354.9**	**4.18**	**1.93–2.04**	**174–248**	**116–124**	**21.9**	**64.0–66.7**
76	79.5–84.0	351.4–367.2	344.9 –360.5	4.33	1.93–2.04	174–248	116–124	22.3	64.0–66.8
77	78.9–83.4	356.9–373.1	350.2 –366.1	4.48	1.93–2.04	174–248	116–124	22.7	64.0–66.8
78	78.3–82.8	362.4–378.8	355.4 –371.6	4.63	1.93–2.04	174–248	116–124	23.0	64.0–66.9
79	77.7–82.2	367.8–384.6	360.6 –377.1	4.78	1.93–2.04	174–248	116–124	23.4	64.0–66.9
80	**77.1–81.6**	**373.2–390.3**	**365.7 –382.5**	**4.93**	**1.93–2.04**	**174–248**	**116–124**	**23.7**	**64.0–67.0**
81	76.6–81.0	378.6–396.0	370.8 –387.9	5.08	1.93–2.04	174–248	116–124	24.0	64.0–67.0
82	76.1–80.4	383.9–401.6	375.8 –393.2	5.23	1.93–2.04	174–248	116–124	24.4	64.1–67.1
83	75.6–79.8	389.2–407.2	380.9 –398.5	5.38	1.93–2.04	174–248	116–124	24.7	64.1–67.1
84	75.2–79.2	394.5–412.7	385.8 –403.7	5.53	1.93–2.04	174–248	116–124	25.1	64.1–67.2
85	**74.8–78.6**	**399.7–418.2**	**390.8 –408.9**	**5.68**	**1.93–2.04**	**174–248**	**116–124**	**25.4**	**64.1–67.2**
86	74.4–78.0	404.9–423.7	395.7 –414.1	5.83	1.93–2.04	174–248	116–124	25.7	64.1–67.3
87	74.0–77.4	410.1–429.1	400.5 –419.2	5.98	1.93–2.04	174–248	116–124	26.1	64.1–67.3
88	73.6–76.8	415.2–434.5	405.4 –424.2	6.13	1.93–2.04	174–248	116–124	26.4	64.1–67.4
89	73.3–76.3	420.4–439.8	410.2 –429.2	6.28	1.93–2.04	174–248	116–124	26.7	64.1–67.4
90	**73.0–75.8**	**425.5–445.2**	**415.0 –434.2**	**6.45**	**1.93–2.04**	**174–248**	**116–124**	**27.0**	**64.1–67.5**
91	72.7–75.3	430.6–450.4	419.7 –439.1	6.65	1.94–2.05	174–248	116–124	27.3	64.2–67.5
92	72.4–74.9	435.6–455.7	424.4 –444.0	6.85	1.94–2.05	174–248	116–124	27.7	64.2–67.6
93	72.1–74.5	440.7–460.9	429.1 –448.8	7.10	1.94–2.05	174–248	116–124	28.0	64.2–67.6
94	71.8–74.1	445.7–466.1	433.8 –453.6	7.30	1.94–2.05	174–248	116–124	28.3	64.2–67.7
95	**71.5–73.7**	**450.7–471.2**	**438.4 –458.4**	**7.50**	**1.94–2.05**	**174–248**	**116–124**	**28.6**	**64.2–67.7**
96	71.2–73.3	455.7–476.4	443.0 –463.2	7.60	1.94–2.05	174–248	116–124	28.9	64.2–67.8
97	70.9–72.9	460.7–481.5	447.6 –467.9	7.80	1.94–2.05	174–248	116–124	29.2	64.2–67.8
98	70.6–72.5	465.6–486.5	452.1 –472.5	8.00	1.94–2.05	174–248	116–124	29.5	64.2–67.9
99	70.3–72.1	470.5–491.6	456.7 –477.2	8.20	1.94–2.05	174–248	116–124	29.8	64.2–67.9
100	**70.0–71.7**	**475.4–496.6**	**461.2 –481.8**	**8.40**	**1.94–2.05**	**174–248**	**116–124**	**30.1**	**64.2–68.0**

Rearing Period Space Recommendations

(check local regulations concerning space requirements)

- Useable space is calculated as litter floor and raised slat areas, not including nest space or perch space.
- If the veranda (winter porch) floor space is considered as useable space when calculating stocking density, then the birds must be able to always access this area.
- Rearing density depends on age of transfer to the laying facility. Use the approximation at right.

Week of Transfer	Birds/m^2 of Useable Space
15	15
16	14
17	13
18	12

	MULTI-TIER	FLOOR
Floor space	< 20 kg live weight per m^2 of useable space at 16 weeks when transferred to the laying facility. Adjust stocking density if birds are transferred at other ages.	< 20 kg live weight per m^2 floor space at end of rearing period
Feeder space	2.5 cm/bird with access on both sides; 5 cm/bird with side access; 2.0 cm/bird with circular feeders	2.5 cm/bird with access on both sides; 5 cm/bird with side access; 2.0 cm/bird with circular feeders
Drinking systems, cups or nipples	12.5 birds per nipple drinker; 20 birds per cup	12.5 birds per nipple drinker; 20 birds per cup; 125 birds per bell drinker
Perch space	10–15 cm/bird	10–15 cm/bird

Production Period Space Recommendations

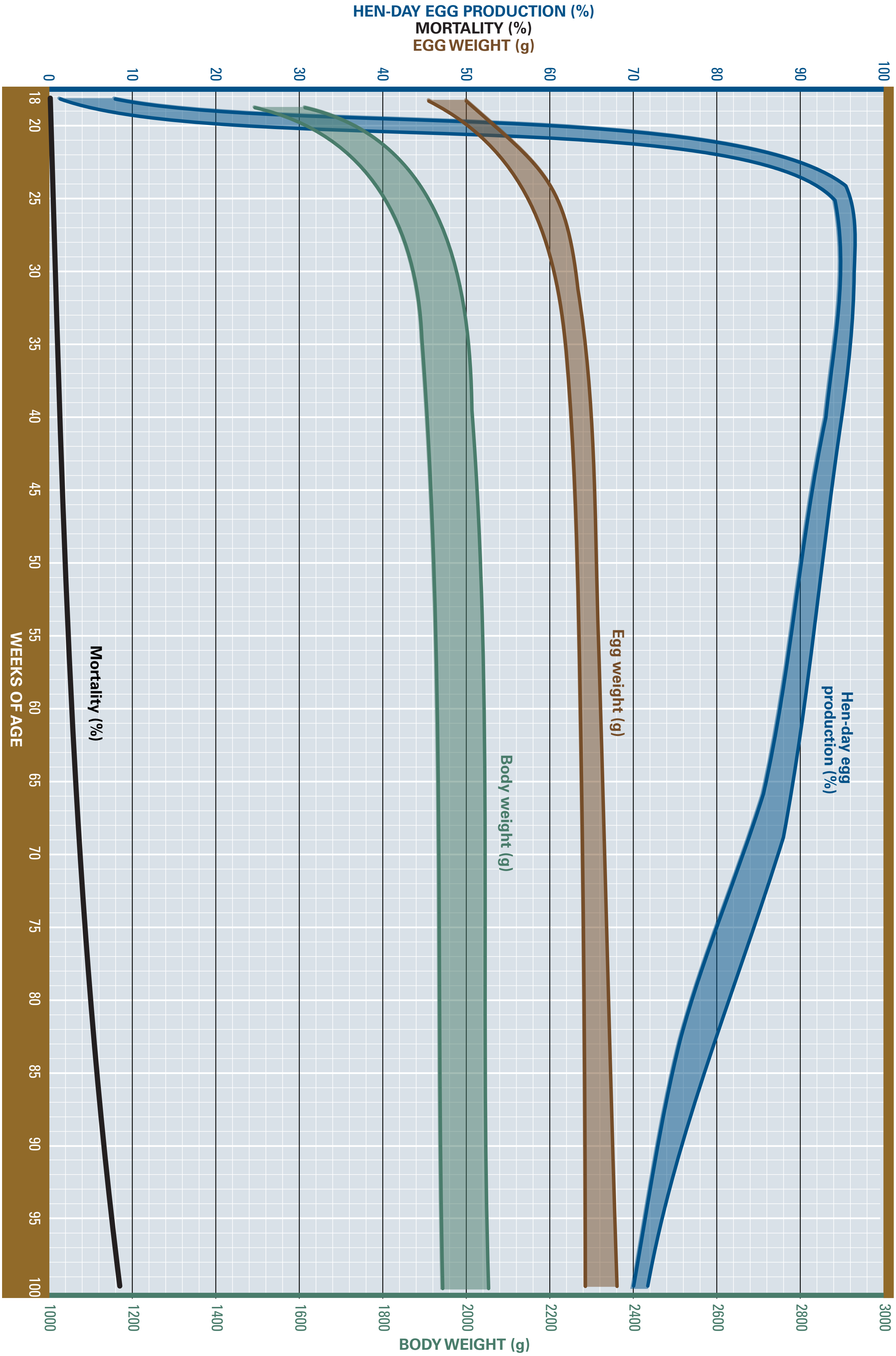
(check local regulations concerning space requirements)

Floor	7–9 birds/m^2 of useable space. Higher stocking densities can be used in aviary systems. Consult equipment manufacturers.
Feeders	5cm/bird (with access on both sides); 10 cm/bird (with access on one side); 4 cm/bird with circular feeders
Drinkers	Nipples/cups: 1 per 10 birds; circular drinkers: 1 cm/bird; linear drinker: 2.5 cm per bird
Perches	10–15 cm/bird
Nests	5 birds/nest or 120 birds per m^2 in colony nests

Stocking Density in Aviary Systems

- Stocking density from 6 to 9 birds/m^2 of useable floor space (excluding nests and perches).
- In aviary systems, the vertical living space of the facility is increased, allowing for higher bird density by utilising this additional surface area. Consult with equipment manufacturers for appropriate stocking densities.
- If the porch (veranda) area is being considered as useable space for calculating bird density, then birds must have constant access to these areas.
- Overcrowded birds struggle to access feed and water. In higher stocking densities, follow the feeder and drinker space guidelines carefully.
- To avoid bird injuries, the vertical height of an aviary system from which birds directly descend to the floor, should not exceed 2 m, measured from floor to bottom of the manure belt of the highest level.
- Aviary systems typically have the upper level as a resting/sleeping area. Use a sequential lighting programme to encourage birds up into the system at night. See Lighting for Aviary Flocks on p. 38.
- Ramps help facilitate bird movement between levels in an aviary system. Use ramps to facilitate bird movement between the floor and the system or between tiers within the system. Generally, if there is a change in elevation greater than 90 cm, a ramp will be needed to encourage birds to move and to prevent injuries.

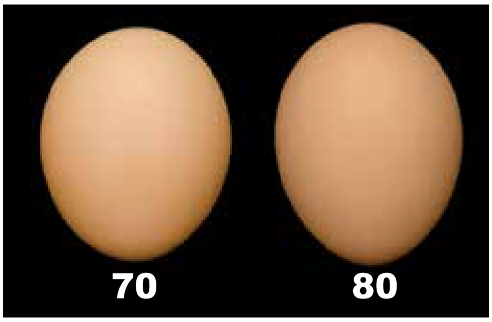
Performance Graph

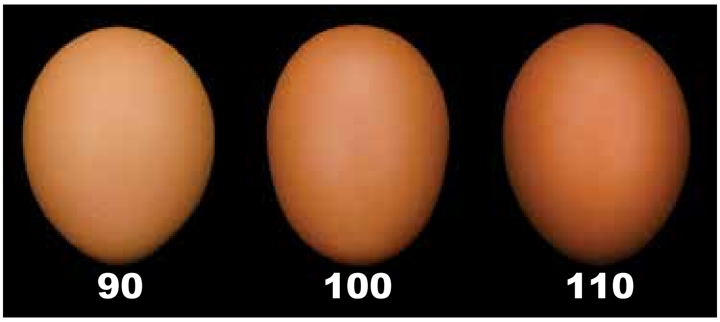


Egg Quality

AGE (weeks)	HAUGH UNITS	BREAKING STRENGTH	SHELL COLOUR
20	**97.8**	**4605**	**89**
22	97.0	4590	89
24	96.0	4580	89
26	95.1	4570	88
28	94.2	4560	88
30	**93.3**	**4540**	**88**
32	92.2	4515	88
34	91.5	4490	88
36	90.6	4450	87
38	90.0	4425	87
40	**89.3**	**4405**	**87**
42	88.5	4375	87
44	87.8	4355	87
46	87.1	4320	87
48	86.4	4305	87
50	**85.6**	**4280**	**86**
52	85.0	4250	86
54	84.6	4225	86
56	84.0	4190	85
58	83.1	4170	85
60	**82.6**	**4150**	**85**
62	82.2	4130	84
64	81.9	4110	83
66	81.6	4095	83
68	81.5	4085	82
70	**81.1**	**4075**	**81**
72	81.0	4065	81
74	80.8	4055	80
76	80.5	4040	80
78	80.2	4020	80
80	**80.1**	**3995**	**80**
82	80.0	3985	79
84	79.9	3975	79
86	79.8	3965	79
88	79.7	3960	79
90	**79.7**	**3955**	**79**

Shell Colour Scores





Egg shell colour is a genetically determined trait but environmental factors may reduce the intensity of the pigment. Certain diseases which infect the shell gland, such as infectious bronchitis and Egg Drop Syndrome, are known to reduce shell colour. Stress can result in the egg being held longer in the shell gland, resulting in white calcium carbonate deposition on the egg shell surface. Shell colour normally declines gradually with age.

For more information on egg quality, see The Science of Egg Quality at hyline.com.

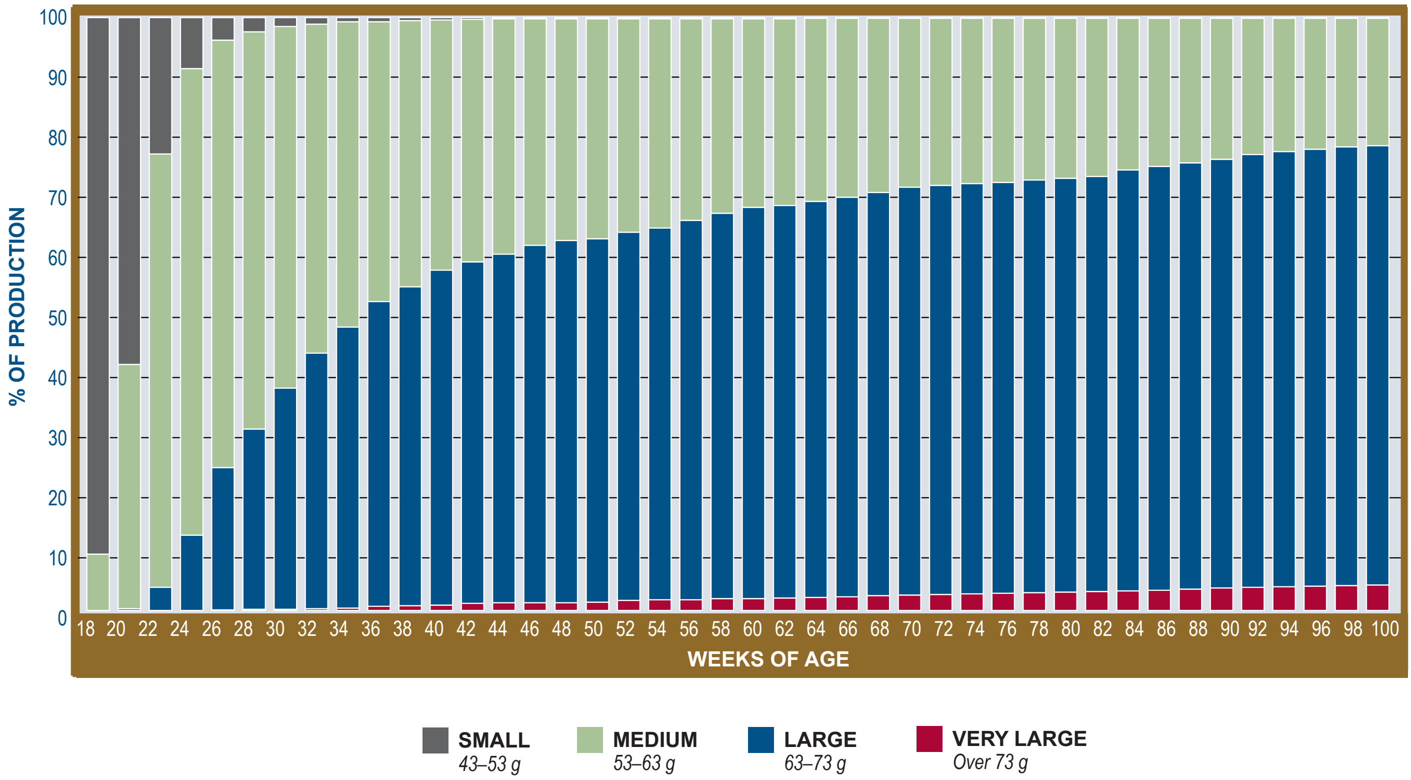
Egg Size Distribution

E.U. Standards–Weekly*

AGE (weeks)	AVERAGE EGG WEIGHT (g)	WEEKLY % SMALL 43–53 g	WEEKLY % MEDIUM 53–63 g	WEEKLY % LARGE 63–73 g	WEEKLY % VERY LARGE Over 73 g
18	47.7	90.5	9.5	0.0	0.0
20	**52.2**	**58.5**	**41.2**	**0.3**	**0.0**
22	56.0	23.0	73.1	3.9	0.0
24	58.4	8.6	78.7	12.7	0.0
26	60.1	3.8	72.1	24.0	0.1
28	61.0	2.4	67.0	30.4	0.2
30	**61.8**	**1.5**	**61.0**	**37.3**	**0.2**
32	62.3	1.1	55.5	43.1	0.3
34	62.8	0.7	51.5	47.4	0.4
36	63.2	0.7	47.2	51.4	0.7
38	63.5	0.5	44.9	53.8	0.8
40	**63.8**	**0.4**	**42.2**	**56.5**	**0.9**
42	63.9	0.3	40.9	57.6	1.2
44	64.0	0.2	39.7	58.8	1.3
46	64.1	0.2	38.2	60.3	1.3
48	64.3	0.2	37.4	61.1	1.3
50	**64.4**	**0.2**	**37.1**	**61.3**	**1.4**
52	64.5	0.2	36.0	62.1	1.7
54	64.5	0.2	35.3	62.7	1.8
56	64.6	0.2	34.0	64.0	1.8
58	64.7	0.2	32.8	65.0	2.0
60	**64.8**	**0.2**	**31.8**	**66.0**	**2.0**
62	64.9	0.2	31.5	66.2	2.1
64	65.0	0.1	30.9	66.8	2.2
66	65.0	0.1	30.2	67.4	2.3
68	65.1	0.1	29.4	68.0	2.5
70	**65.2**	**0.1**	**28.5**	**68.8**	**2.6**
72	65.3	0.1	28.2	69.0	2.7
74	65.3	0.1	27.9	69.2	2.8
76	65.4	0.1	27.7	69.3	2.9
78	65.5	0.1	27.3	69.6	3.0
80	**65.5**	**0.1**	**27.0**	**69.8**	**3.1**
82	65.6	0.1	26.7	70.0	3.2
84	65.6	0.1	25.6	71.0	3.3
86	65.7	0.1	25.0	71.5	3.4
88	65.8	0.1	24.4	71.9	3.6
90	**65.8**	**0.1**	**23.8**	**72.3**	**3.8**
92	65.9	0.1	23.0	73.0	3.9
94	65.9	0.1	22.5	73.4	4.0
96	66.0	0.1	22.1	73.7	4.1
98	66.1	0.1	21.7	74.0	4.2
100	**66.1**	**0.1**	**21.5**	**74.1**	**4.3**

** Distribution of egg sizes based on weekly (not cumulative) average egg weights.*

E.U. Standards–Weekly*



** Distribution of egg sizes based on weekly (not cumulative) average egg weights.*

Chick Management

Hy-Line Brown chicks adapt well to both floor and aviary system brooding environments. Hatchery services/treatments are performed as requested by the customer. For more information, see Growing Management of Commercial Pullets at hyline.com.

One Day Before Chick Delivery

- Pre-heat the brooding facility prior to chick delivery: 24 hours in normal or warm climates, 48 hours in cool climates and 72 hours in cold climates. The facility should be at proper brooding temperature for several hours before the arrival of the chicks.
- Establish proper facility temperature of 33–36°C and 60% humidity (measured at chick level).
- Bright light (30–50 lux) during 0–7 days helps chicks quickly find feed and water and adapt to the new environment.
- Floor temperature should be 32°C at the time of chick placement.
- Check water system and adjust to the correct height for chicks. The first day nipple lines can be placed low to encourage rapid discovery by chicks. On day 2 they should be adjusted to the correct height to maintain the best water access and litter conditions.
- Sanitise and flush water lines.
- Check to make sure equipment is working properly and is adjusted to the correct height.
- Check the lighting system and confirm correct light intensity.

Day of Chick Delivery

- Check that facility temperatures are appropriate for brooding chicks.
- When using nipple drinkers, adjust the water pressure to ensure there is a droplet of water visible on the nipple.
- Place supplementary feed onto papers or trays.
- Fill feeders to their highest feed level, allowing easy access for the chicks.
- Lights should be adjusted to provide a minimum light intensity of 30 lux for the first week.

Transportation from Hatchery to the Farm

- Use a truck designed for transportation of chicks.
- Truck should be environmentally controlled, maintaining 26–29°C at 70% relative humidity (measured inside chick box), with a minimum air flow of 0.7 m^3 per minute.
- Provide space between stacks of chick boxes for air flow.

Chick Placement

- Brood chicks in groups of similar aged breeder flocks when possible.
- Unload chick boxes quickly and gently place the chicks in the brooding area.
- As chicks are placed, trigger water cups or nipples to encourage drinking.

Brooding Recommendations

The brooding period (0–14 days) of the pullet's life is critical. The digestive and immune systems develop during this time. Good management during this period assures that the pullet gets off to a good start toward reaching her genetic potential.

RING AND PARTIAL FACILITY BROODING SYSTEMS

Water

- Drinking water should be tested for quality and cleanliness from source and end of the water line.
- Flush water lines prior to chick arrival.
- Maintain water temperature of 20–25°C during brooding period.
- Do not give cold water to chicks. Be careful when flushing water lines for chicks. Allow water time to warm up in the facility so chicks are comfortable drinking.
- Flush water lines at night to limit chicks' exposure to cold drinking water.
- Clean supplemental chick drinkers daily to avoid build-up of organic matter that could encourage bacterial growth.
- Use a ratio of 80 chicks/circular drinker (25 cm diameter).
- Use a ratio of one nipple/cup per 12 birds for the first three weeks.
- Chicks should not need to move more than 1 metre to find feed or water.
- Use vitamins and electrolytes in chicks' drinking water (avoid sugar-based products to prevent growth of microorganisms).

Paper

- Cover entire floor of brooder ring with paper. In partial facility brooding, feed off paper that is placed close to the permanent feeders.
- Place crumb starter feed on paper for 0–3 days. For beak-treated chicks, feed on paper for 0–7 days.
- If using a vaccine for coccidia, feed on paper for 14 days. After 14 days, either keep 1/4 of the paper or add a fibre tray to allow for coccidiosis vaccine cycling until 28 days of age.
- Remove paper between 7–14 days to avoid the build-up of manure.

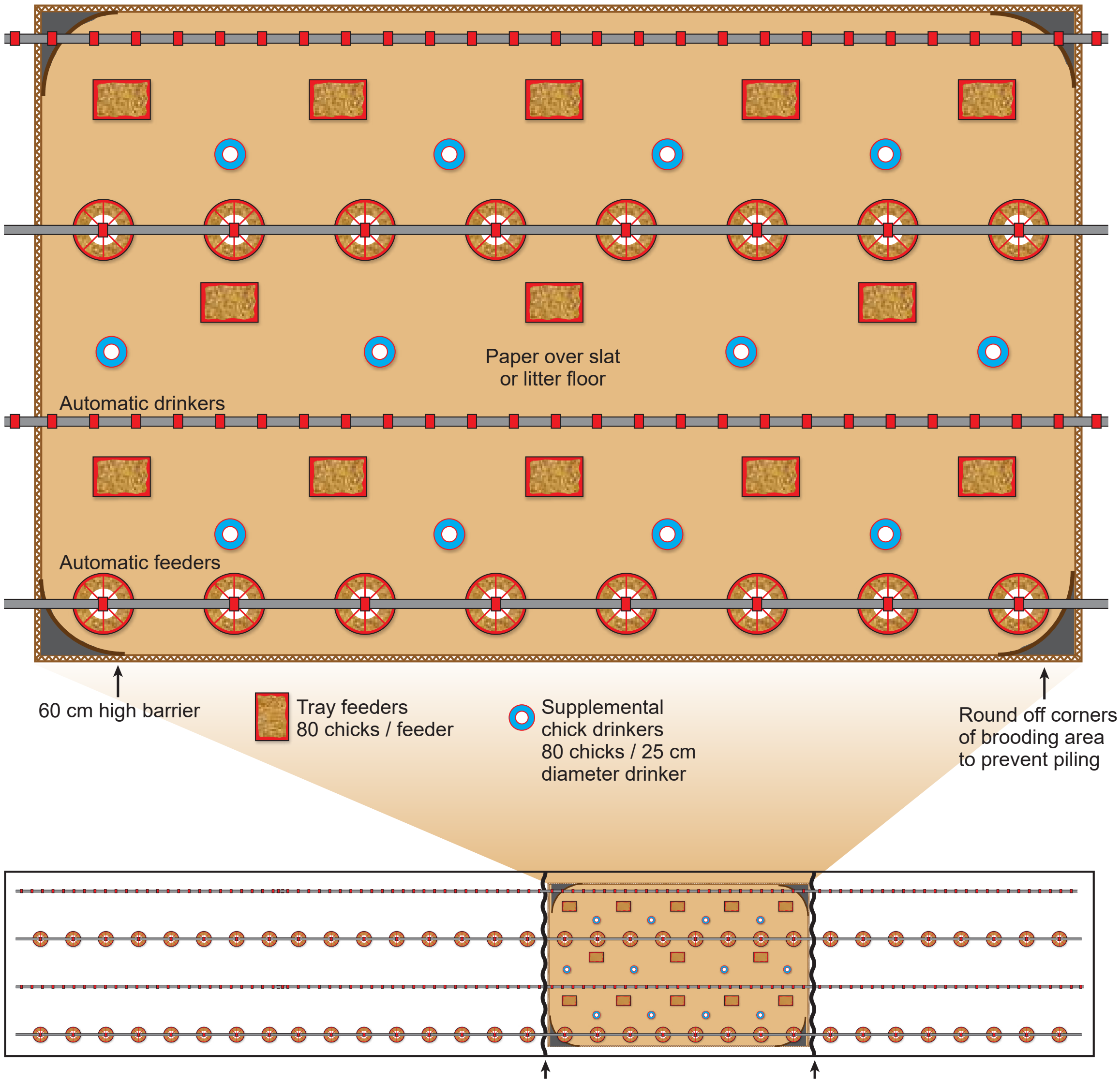
Lights

- Bright light (30–50 lux) during 0–7 days helps chicks find feed and water and adapt to the facility environment. Ensure that the light (measured at the level of the water nipple) is uniform in the brooding area. Avoid shadows and dark areas.
- An intermittent lighting programme for chicks is strongly preferred. If not using an intermittent lighting programme, use 20 hours of light and 4 hours of dark for 0–7 days.
- Do not use 24 hours of light. Birds require a dark period to grow properly.
- After the first week, reduce light intensity and begin slow step-down lighting programme (see Light Programme for Light Controlled Housing on p. 39).

Tray Feeders

- Use a ratio of 80 chicks/tray feeder. Clean egg trays and box tops can also be used.
- Use good quality crumb starter feed consisting of uniform 1–2 mm particles.

Partial Facility (Floor) Brooding



Partial Facility (Floor) Brooding

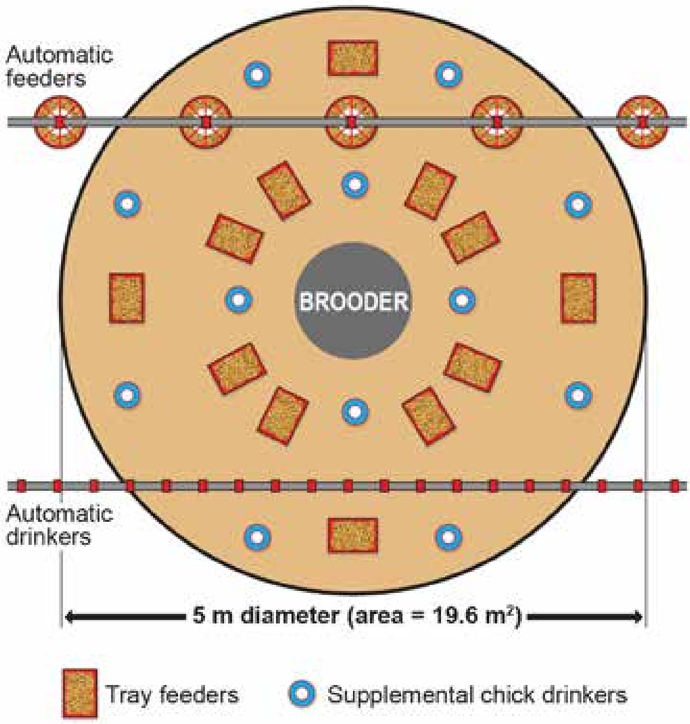
- A section of the facility is partitioned and used for brooding.
- When using brooding stoves instead of whole facility heating, minimum facility air temperature during floor brooding is 30°C.
- Eliminate all drafts from the brooding facility.
- Spread litter after concrete floors have warmed.
- Gradually remove supplemental drinkers and tray feeders beginning at 3 days.

Brooder Rings

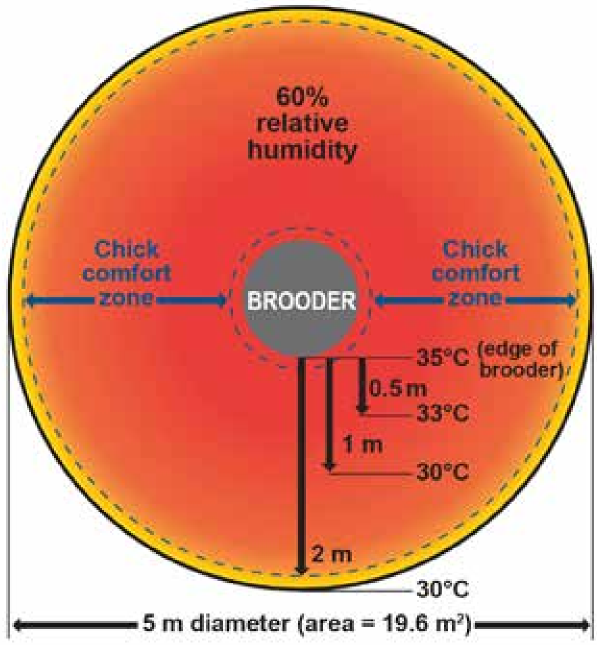
- Enlarge brooder rings at 3 days to increase group size.
- Continue enlarging brooder rings until all rings are removed by 14 days.
- Slowly remove supplemental drinkers and tray feeders beginning at 3 days.

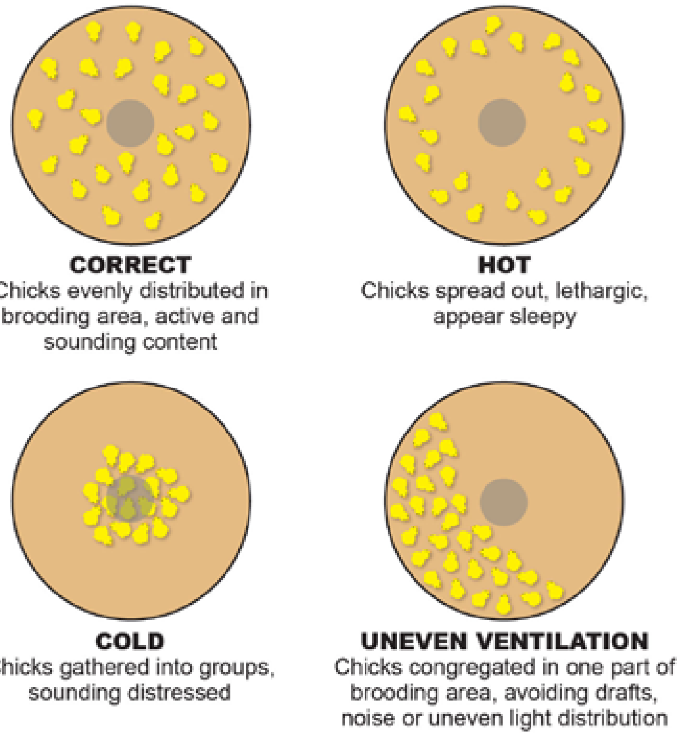
Aviary Systems

- Chicks raised within the aviary system during brooding are on chick paper, which must remain in place for sufficient time to prevent the legs of young chicks getting caught in mesh floor.
- If utilising a coccidiosis vaccine, paper must remain on the floor from 0–14 days to enable recycling of oocysts and successful vaccination.
- Introduce chicks to the entire aviary system as soon as possible. Optimal time to introduce chicks to the whole system is by 15 days of age. Some producers have waited until 4–6 weeks to release the chicks, due to system type or management practices.



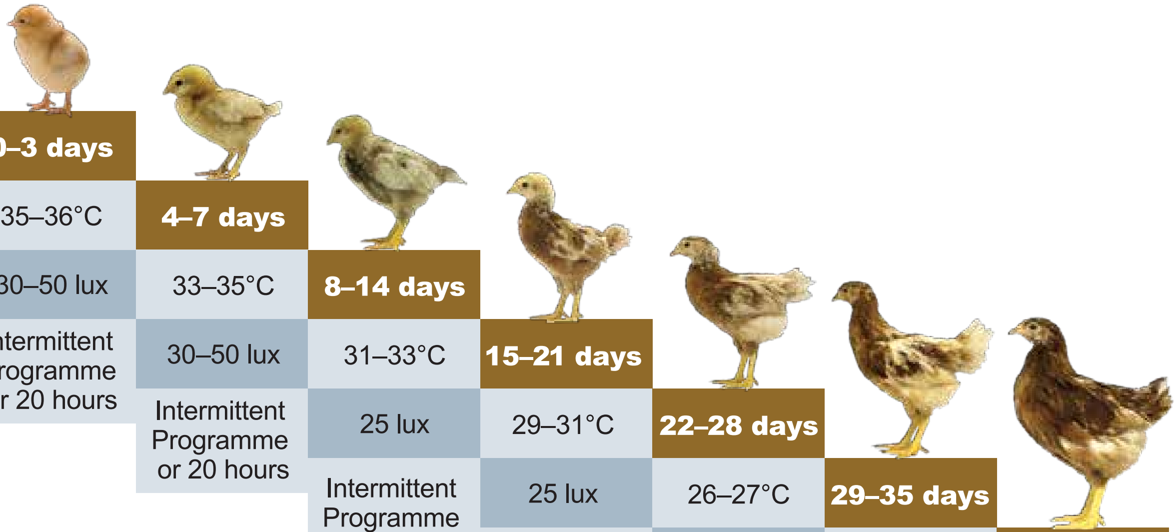
Use ramps to assist birds onto higher levels of the aviary. Flocks that learn at an early age to use the entire system perform best. Photo courtesy Big Dutchman.





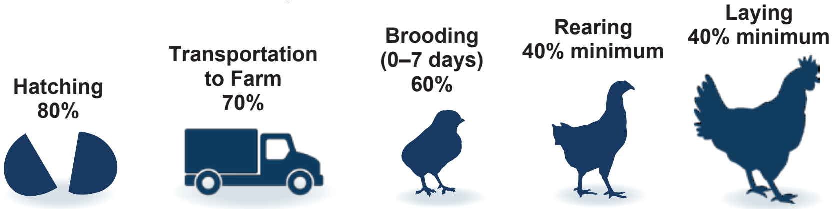
Brooding Temperature and Relative Humidity

- Find optimum balance of temperature, humidity, and ventilation rate for chick comfort.
- Chicks are unable to fully control body temperature during the first week of life and depend on proper environmental temperature.
- Adjust brooder temperatures according to relative humidity. Lower temperatures should be used with higher humidity. For every 5 percentage points above 60% relative humidity, reduce brooding temperature 1°C.
- Provide temperature zones within the brooding ring accessible to the chicks. This allows birds to seek a comfort zone.
- After the first week, reduce temperature weekly 2–3°C until reaching 21°C.



AGE	0–3 days	4–7 days	8–14 days	15–21 days	22–28 days	29–35 days	36–42 days
AIR TEMP. (FLOOR)	35–36°C	33–35°C	31–33°C	29–31°C	26–27°C	23–25°C	21°C
LIGHT INTENSITY	30–50 lux	30–50 lux	25 lux	25 lux	25 lux	10–15 lux	10–15 lux
LIGHT HOURS	Intermittent Programme or 20 hours	Intermittent Programme or 20 hours	Intermittent Programme or 19 hours	17.5 hours	16 hours	14.5 hours	13 hours

Relative Humidity



Low humidity

- Reduces bird comfort
- Increases dehydration
- May result in pasty vents in chicks
- May increase agitation and possibility of pecking
- Adversely affects feather cover
- Increases dust

Excessive humidity

- Increases ammonia
- Causes poor litter and air quality

Crop Fill – Are the Chicks Eating?

Hours after chick placement	Chicks with feed in crop
6	75%
12	85%
24	100%

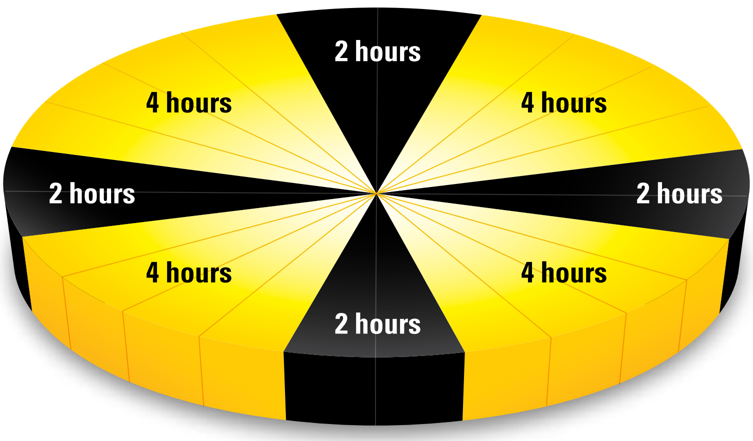
Chick with starter feed in crop

Chick without starter feed in crop

Cloacal Temperature

- Target body temperature for chicks is 39.4–40.5°C.
- Measured using a digital infant ear thermometer by gentle insertion at the chick's vent.
- Cloacal temperature correlates well with the core body temperature.
- Cloacal temperature is an indicator of chick comfort and adequacy of the brooding environment.
- Chilling or overheating chicks during the brooding period can result in poor growth and increased susceptibility to disease.

An infant ear thermometer being used to measure the chick's body temperature via the vent.



Rope lights can provide uniform lighting to brooding sections in aviary systems.

Intermittent Lighting Programme for Chicks

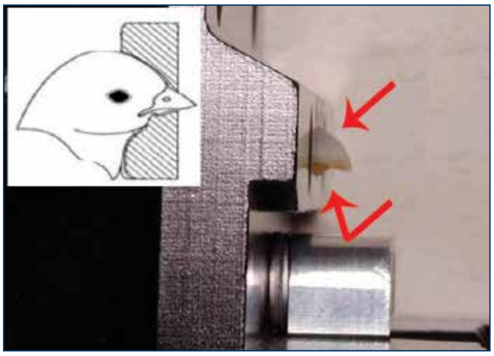
- Preferred lighting technique.
- Use from 0–7 days (can be used up to 14 days of age).
- Intermittent dark periods provide rest periods for chicks.
- Synchronises chicks' activities and feedings.
- Establishes more natural behaviour of rest and activity.
- May improve 7-day liveability and pullet body weight.
- Some dark periods may be shortened or removed to accommodate work schedules.

Infrared Beak Treatment (IRBT)

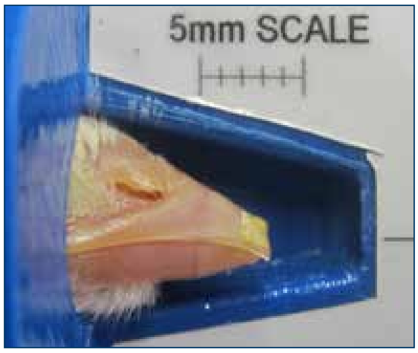
(Check local regulations concerning use of beak treatment)

- Infrared beak treatment has been proven a successful, non-invasive method of controlling the growth of the beak in egg type chickens.
- One (properly applied) IRBT should be sufficient.
- Hatchery beak treatment reduces feed wastage and leaves the beak less damaging to other birds.
- Hatchery beak treatment is more efficient and uniform than on-farm practices.
- The beak remains intact until 10–21 days of age, when the treated beak tip will soften and wear off gradually.
- Infrared treatment is adjustable to manage differences in breeder flock age, chick size, climate, and variety of birds.
- For more information, see [Infrared Beak Treatment](#) at hyline.com.

Loading chick



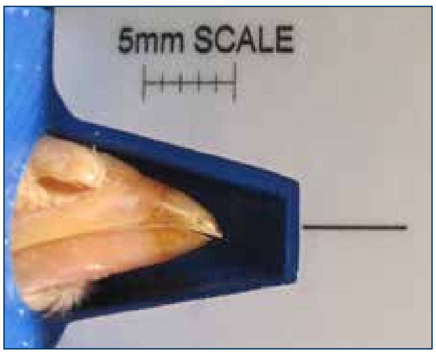
Infrared beak treatment can be modified according to local conditions.



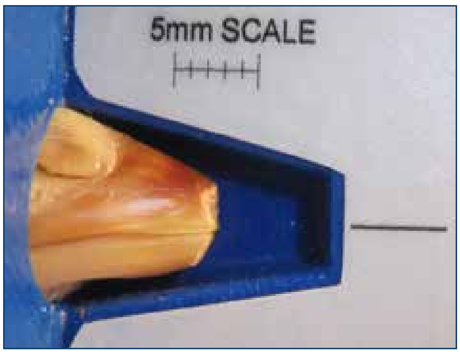
One day post-treatment

Precautions when performing IRBT:

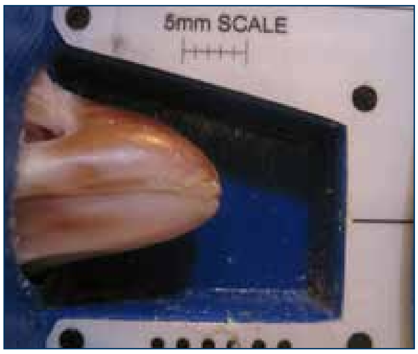
- Water intake is the most important factor for success with IRBT chicks. Chicks require immediate and easy access to water.
- If using nipple drinkers, use only 360° activated nipples for IRBT chicks, as well as supplemental chick drinkers.
- Nipple drinkers with splash cups provide additional support for IRBT chicks.
- Keep feed at the highest level in the feeder for several days after beak treatment.
- Feed on paper for 0–7 days.
- Provide extra light (30–50 lux) on nipple drinkers after beak treatment.



Seven days post-treatment

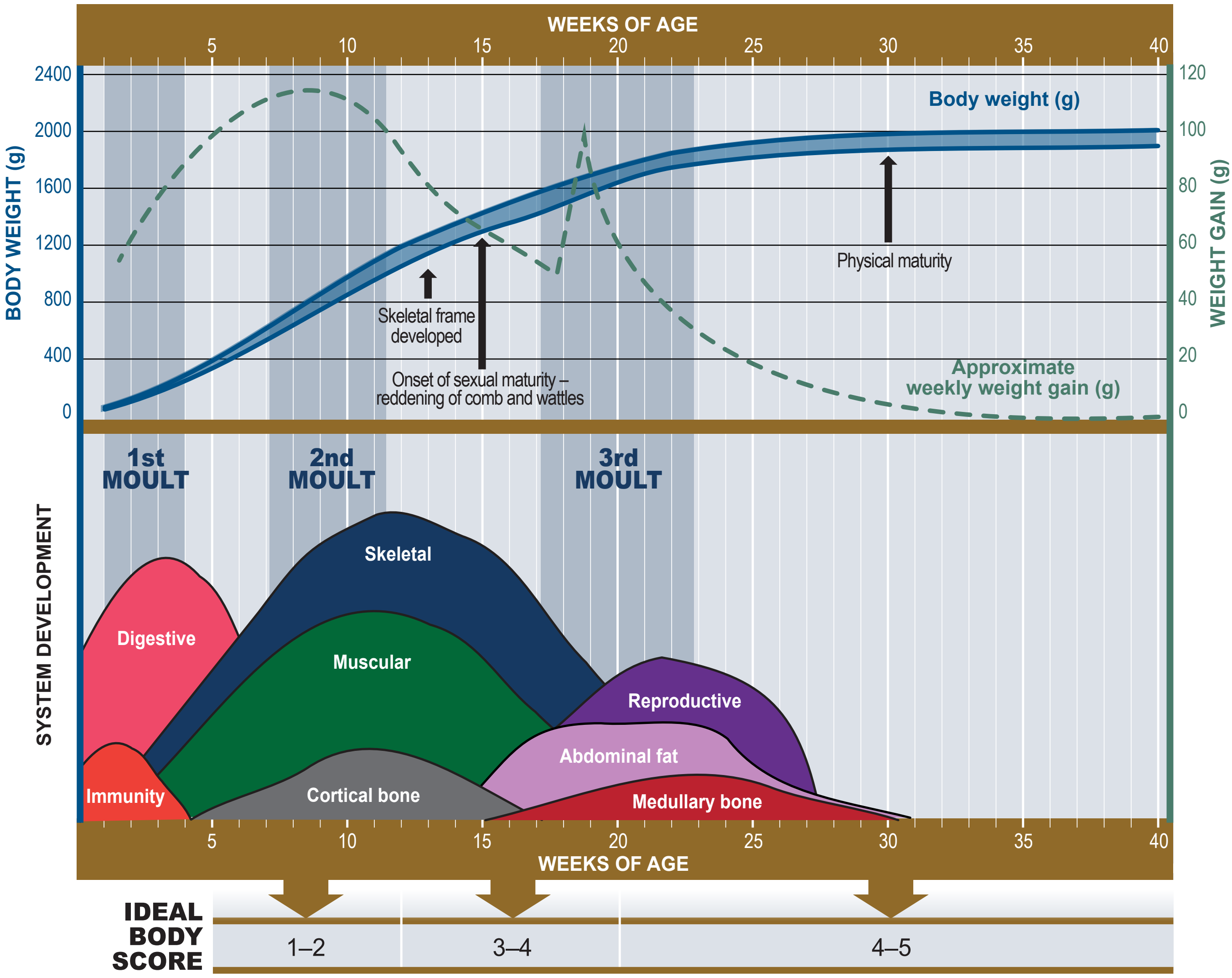


Four weeks post-treatment

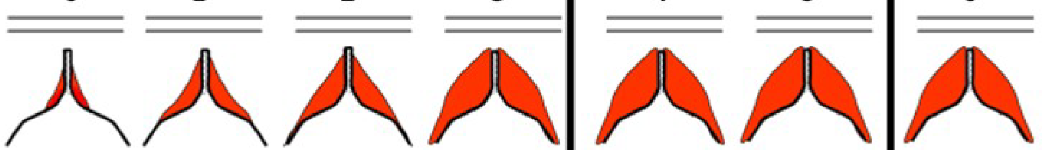


Properly trimmed beak

Development of the Organ Systems in Pullets



Body Score Chart



	0	1	2	3	4	5	6
Sternum (Keel)							
Abdominal Fat Pad	Nothing	Nothing	Nothing	Nothing	< 0.7 cm	> 0.7 cm	Hard fat abdominal fat pad
Observations	Emaciated birds	Low level of muscle in pyramid shape	Moderate level of muscle in pyramid shape	Good level of muscle in pyramid shape	Low fat pad. Muscle in pyramid shape	Increase in the abdominal fat pad	High abdominal fat pad

Monitoring Flock Body Weights and Uniformity

- Body weights should be monitored weekly up to 30 weeks of age and thereafter every five weeks.
- Weigh birds individually using a scale with increments no larger than 20 g.
- A minimum of 100 birds should be weighed. In order to get the best representative sample, all birds caught in the pen should be weighed even if the number is more than 100.
- Always weigh birds on the same day of the week and at the same time of day.
- Weighing birds weekly will help to identify when a flock deviates from the body weight standard in either weight or uniformity. If the body weight or the uniformity is not appropriate there are several actions that can be taken to correct the problem such as implementing midnight feedings, grading the birds into weight categories, stimulating the birds to eat more often, or changing the diet. Birds with poor body weight or uniformity could struggle to achieve good peak production, strong persistency, or have other production-related issues. It is essential to find these issues early and take corrective action.
- It is critical to weigh birds prior to a scheduled feed change. If a flock is below target for body weight, it should remain on a high nutrient density diet until the target weight is reached.
- Factors that can adversely affect body weight include chick and pullet quality, environment, inadequate nutrition, water quality and intake, overcrowding, and disease.

Uniformity

- The uniformity of body weights within a flock is an indicator of flock development.
- Prior to point of lay, flocks should have a minimum uniformity of 85%.
- Uniformity of body weights makes accurate feeding and management of the flock easier.
- Body weight gains and uniformity may be negatively affected by bird handling, vaccination, transfer, and disease outbreak.
- Multiple hatch dates complicate lighting, feeding, and vaccination programmes.

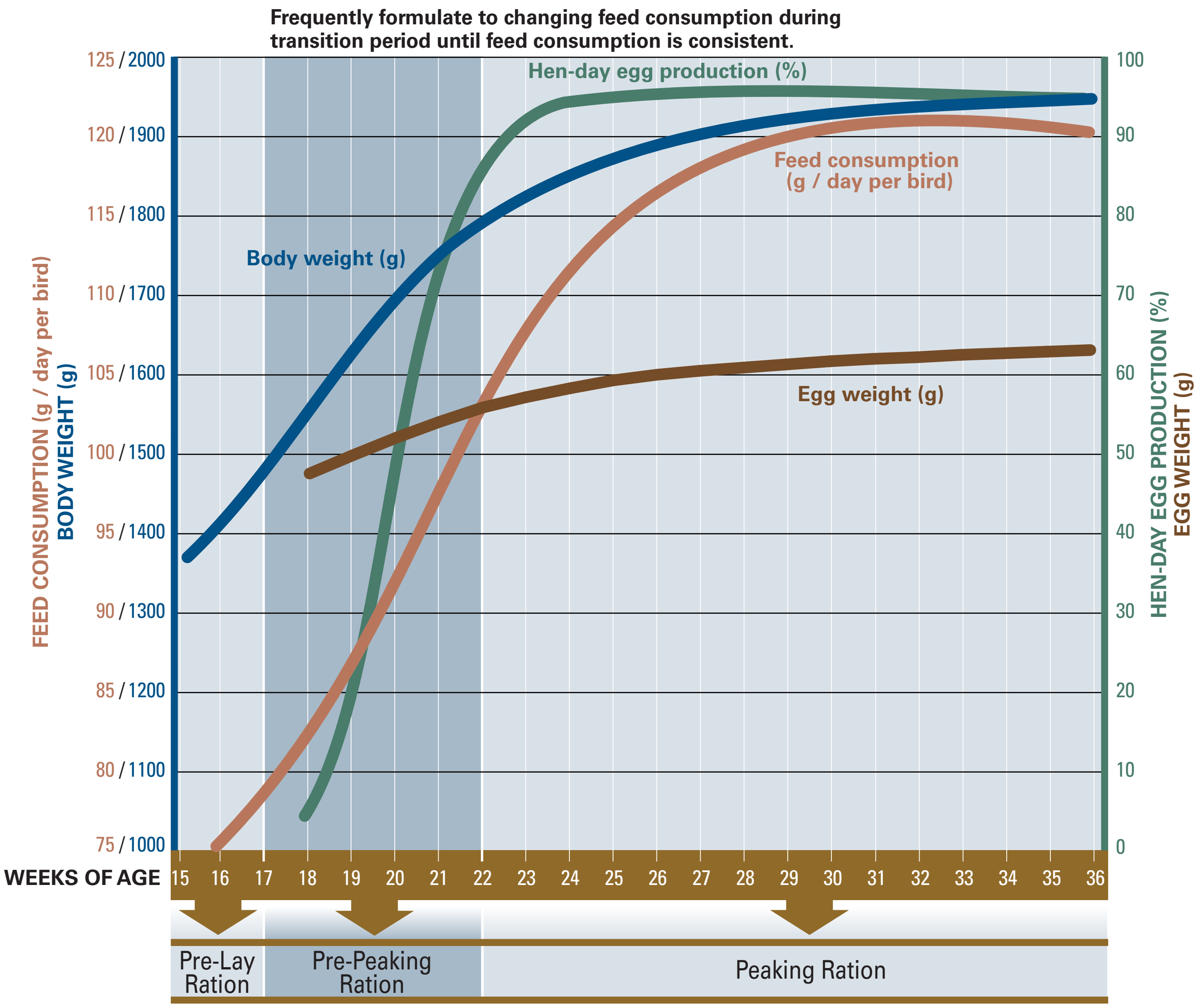
CV%	Uniformity (+/- 10% of average)
5	95.4
6	90.4
7	84.7
8	78.8
9	73.3
10	68.3
11	63.7
12	58.2
13	55.8
14	52.0
15	49.5
16	46.8

Approximate relationship between CV% and uniformity.

Weigh birds separately after 3 weeks using a digital scale that calculates uniformity.

Three-week-old pullets from the same flock with very different development show the importance of monitoring flock body weight uniformity.

Transition Period from Rear to Peak Egg Production



Transition Period

- Avoid excessive weight gain during the transition period.
- Body weight gain from 18–25 weeks should not exceed 20%. If you have a 1.59 kg bird at 18 weeks, the goal should be to stay under 1.91 kg by 25 weeks, otherwise there is a risk of fatty liver.
- During the transition period, nutrient requirements increase dramatically and diets should be adjusted to accommodate this phase. See Pre-Peak Diet in Nutrition section.
- The following occurs during the transition period:
  - Rapidly increasing egg production
  - Increasing egg size
  - Increasing body weight
- In some flocks, feed consumption may increase slowly during this transition. This can occur:
  - In underweight flocks
  - In flocks lacking uniformity
  - During high environmental temperatures
- Poor uniformity prolongs the transition period and may result in delayed onset of egg production, low production peaks, and poor persistency of egg production.
- It is essential to monitor feed intake carefully during transition and adjust dietary nutrient concentration according to actual feed intakes.

Conditioning the Pullet for Egg Production

Pullet conditioning are those management programmes used to prepare the pullets for the smooth, low-stress transfer to the laying facility and for the commencement of egg production.

Management Tips for Effective Pullet Conditioning

Facility			
Factor	**Practice**	**Result**	**Tips**
Drinker and feeder systems; elevated water tables	Drinker and feeder type should be matched in the rearing and production facility.	Smoother, low stress transition from rearing to production. After transfer the pullets can better navigate the aviary environment.	The configuration of drinking and feeder lines should be similar in rear and production facilities.
Floor type and litter type	Floor type should be matched in the rearing and production facilities (e.g. slats in rear, slats in the production facility).	Smoother, low stress transition from rearing to production. Avoids misplaced foraging behaviour and reduces feather pecking and aggression.	If litter is used, then the litter type (i.e. wood shavings, straw, rice hulls etc.) should be the same in both rearing and production facilities.
Perches	Provide perches in rear. Habituates jumping behaviour in pullets.	Improves nesting behaviour and reduces floor eggs. Reduces feather pecking and aggression.	Use the same type of perches and configure in the same locations within the rearing and production facilities.
Lighting Programme			
Factor	**Practice**	**Result**	**Tips**
Light intensity	Two weeks prior to transfer increase the light intensity in the rearing facility. This increase prepares the pullets for transfer to the laying facility.	Prepares pullets for transfer to the laying facility and for light stimulation after transfer.	By transfer, the number of light hours and light intensity should be matched with the lights in the production facility.
Time of light stimulation	Provide light stimulation when the pullet flock reaches their target average body weight with >85% uniformity.	Improves flock uniformity. Uniform flocks respond more evenly to light stimulation and higher consumption of Pre-Peak and Peaking diets.	Underweight pullet flocks or with <80% uniformity should delay light stimulation. If the pullet flock has a large spread in hatch ages and/or poor bodyweight uniformity, then light stimulation is based on the oldest hatch date or heaviest birds.
Bird Behaviour			
Factor	**Practice**	**Result**	**Tips**
Accustom the pullets to noise, colour, and human presence	Playing music, walking in the flock frequently, and changing the colour of the workers clothes can help acclimate the birds.	Desensitises the birds to these stimuli resulting in less fear responses and behaviour problems.	Provide toys and shiny objects in the pullet environment. Make noise while walking in pullet flocks.
Nest training in rear	Nest training should begin during the rearing period with frequent walks through the flocks.	Better nesting behaviour and less floor eggs. Birds access upper tier nests.	Provide perches in the pullet flocks to improve young layers accessing elevated nests.

Nutrition			
Factor	**Practice**	**Result**	**Tips**
Feeding schedule	Match the feeding schedules used in rear and the production period.	Smoother, low stress transition from rearing to production. Improves feed consumption in young laying flocks.	
Feed presentation and feed particle size	Feed presentation (i.e. mash or pellet) should be the same in rearing and production diets.	Improves feed consumption in young layer flocks.	Manage feeders to avoid accumulation of fine feed particles.
Large particle calcium	Introduce large particle calcium beginning in the Pre-Lay diet.	Builds medullary bone in pullet flocks. Early introduction of larger calcium particles will ease the transition to consuming Pre-peak and Peaking diets.	
Higher fibre in pullet feed	Beginning in the Developer diet increase the amount of fibre.	Improves digestive tract development. Increases feed intake at the commencement of egg production.	Higher fibre diets increase feeding time and reduce feather pecking behaviour.

Transfer to the Laying Facility			
Factor	**Practice**	**Result**	**Tips**
Age of transfer	Transfer flocks on time to prevent overcrowding in the rearing facility.	Late transfer may restrict feed, water, and living space and could result in loss of pullet body condition.	Transfer flocks by 16 weeks to allow time to acclimatise to the new laying environment.

Vaccination Programme			
Factor	**Practice**	**Result**	**Tips**
Pullet vaccination programme	Avoid a stressful vaccination just before the transfer.	May result in loss of pullet body condition.	Design vaccination programme to minimise the number of times birds are handled.

Heat Stress Tolerance			
Factor	**Practice**	**Result**	**Tips**
Heat stress tolerance	Exposure of pullets to high environmental temperatures.	Results in production of heat shock proteins which can mitigate future heat stress.	

Management of Free-Range Flocks

Pophole Management

- Refer to local regulations for pophole management. Wherever acceptable follow the guidelines below.
- Popholes should be evenly distributed along the outside of the facility and in sufficient numbers to prevent traffic jams as birds move in and out of the facility. Preferably have popholes on two sides of the facility.
- One pophole should be used per 600 birds, with each pophole measuring 200 cm long and 45 cm high. Minimum pophole size is 50 cm long and 45 cm high depending on flock size.
- Close popholes during inclement weather, if permitted by local regulation.
- Begin opening popholes to give laying hens access to the outside after they are consistently using the nests.
- On days with strong wind, only open the popholes on the side of the facility opposite the wind to prevent stirring of dust in the facility, if permitted by local regulation.
- Introducing birds to pasture too quickly can disturb their eating behaviour and reduce their nutrient intake. It is best to introduce the birds to pasture gradually by increasing the amount of time the popholes are open. Transition this process over a week, starting in the afternoon and slowly adding hours onto the beginning.
- Close popholes gradually as birds are returning to the facility from outside. Popholes should close at dusk or when artificial lights are to be turned off.

Popholes are opened to give birds access to pasture as soon as possible after transfer.

Good maintenance of the area around popholes keeps the area dry and dirt out of the facility.

- Once the flock is given access to pasture, routinely open popholes to avoid bird stress. If birds must be retained inside due to inclement weather or disease threat, please follow these 8 tips.
- Slats/mesh, a concrete apron, or large stones should be placed outside of pophole openings to prevent muddy areas.

Pasture Management

- The stocking density in pasture systems will be based on local regulations, soil type, and diet. Typically, 2000–2500 layers per hectare of well-drained pasture is acceptable.
- Pullets should have at least 1 m^2 of outside space per bird (check local regulations regarding pasture space requirements).
- In some countries, the stocking density is determined by manure nutrient (phosphorus and nitrogen) management plans. Use of synthetic amino acids to reduce dietary nitrogen load and low phosphorus diets can allow higher stocking densities.
- Ensure the pasture has good drainage—no puddles for birds to access dirty water.
- Stocking density on well-drained pasture can be higher than on poorly drained clay soil.
- The pasture surrounding the laying facility can be divided into paddocks, which the birds use for periods of 6–8 weeks before rotating to a new paddock. Rotation of paddocks provides time to regrow grass in bird-worn areas. Resting paddocks may also reduce the parasite load in the soil. If a rotational pasture system is used, stocking density can often be higher.
- Birds tend to use pasture areas near the facility more than areas away from the facility. Take the time to spread birds over all usable pasture areas.
- Pastures can be maintained in good condition by the judicious use of chain harrows. Harrowing breaks up the soil, restores soil structure, and improves drainage. Harrowing the soil may also decrease parasite eggs in the area.

- Use more clover with grass in bird-worn areas around popholes and areas near the facility. Clover is more durable than grasses when faced with trampling by birds.
- Placing shelters in the pasture area encourages birds to move further from the facility and utilise more of the pasture area. Shelters also provide shade and protection from rain and wind. Shelters should provide 8 m^2 of cover per 1000 birds.
- Pasture shelters, when used as the only housing, should be able to shelter all the birds at one time, and provide feed and water.
- Trees, shrubs, and shelters in the pasture area provide cover for birds to feel safe as they move away from the facility. Chickens are naturally fearful of exposed areas.
- Between flocks, revegetate/seed the pastures with emphasis on heavily used areas near the facility and around popholes.
- Bird pastures can be dual purposed as orchards, woodlands, and for livestock grazing, although consideration should be given to biosecurity and disease risk when introducing other animals into the pasture.
- Pasture enrichments like fallen trees for perching and covered sand boxes for dust bathing can be considered.
- Some plants are poisonous to birds (i.e. hemlock, monkshood, privet, yew, nightshade, horseradish) and the pasture should be checked for dangerous species. Other plants may give an off-flavour to the eggs and should be removed from paddocks.

Birds should be evenly distributed on the provided pasture.

Pastures should be well drained, not allowing standing water after a rain.

Exposure to Pasture: *(check local regulations for free range flocks)*

- Hens that will have exposure to pasture during the lay period should be exposed to pasture during the pullet period.
- Birds in rear can be exposed to pasture when they are fully feathered.
- Birds can be encouraged to explore pasture by opening access doors after the peak laying time and walking the facility to drive birds onto the pasture.
- Gradually introduce birds to pasture after they are effectively using the nest boxes. During the nest training period, hens can be let outside after the peak egg laying period.

Predators

Free range layers are attractive to predators. There are several types of predators—from mammals (badgers, dogs, foxes, coyotes) to large reptiles (iguanas, snakes) and raptors (hawks, owls). Predators can cause injury and death. Predators will often kill or injure large numbers of birds—far more than they are able to consume. Predator attacks on the birds cause panic and hysteria in the flock. This can lead to piling (smothering) and trigger outbreaks of feather pecking.

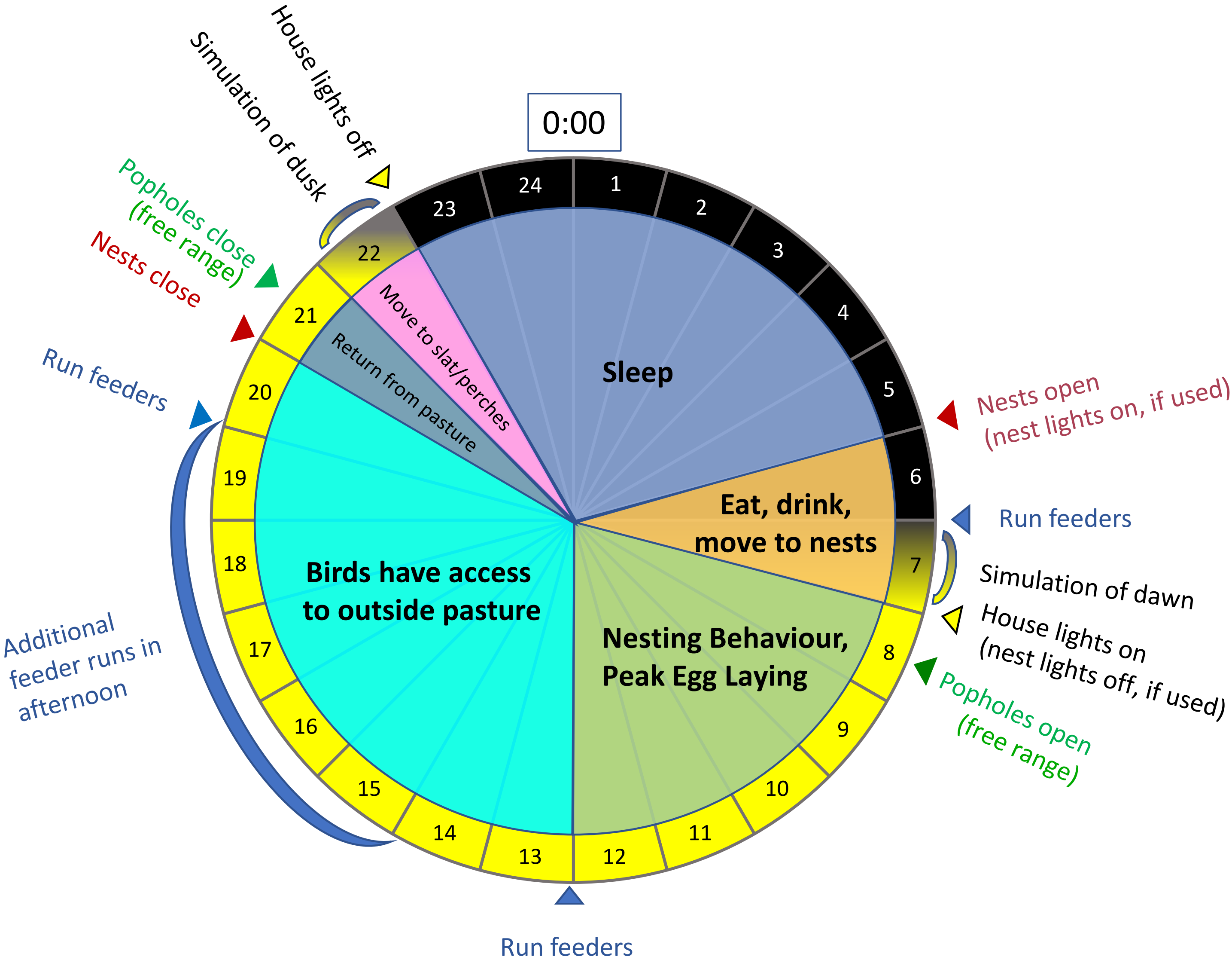
Tips for Dealing with Predators:

- Permanent fencing should be at least 1.8 m in height, with a 0.30 m overhang to the outside to prevent predators from climbing over. The fence mesh should be small enough to exclude predators.
- Bury fencing 0.25 m into the ground to prevent predators from digging under the fence.
- Overhead netting can be used to prevent attacks by wild bird predators and contact with other wild birds that might transmit disease.
- Keep pastures mowed to prevent predators from approaching the birds unaware.
- Old CDs or other reflective materials can be hung in paddocks to deter predatory birds.
- Use live traps outside the fence when predators are seen.
- Alpacas or llamas in the pasture can help deter predators, particularly foxes.

Electric Deterrent Fencing to Exclude Predators

- Flexible electrified fencing will generally provide satisfactory levels of protection against most predators.
- Two electric wires should be used on the fence: one in the middle of the fence and the other just off the ground.
- Electric deterrent wires should be 0.25 m above the ground and 0.6 m away from the permanent fence. A non-charged grounding wire placed between the ground and the electrified deterrent wire will help direct predators into the electrified wire.
- Check connections between the sections of fence and the transformer.
- The fencing and power unit must be well maintained in order to continue to work effectively.
- Grass underneath the fence must be kept cut or sprayed with herbicide to prevent shorting of the electrical system, and regular checks should be made on the connections between sections of fence and the transformer.

Management Wheel



Environment of the Bird: Water

Drinking Systems

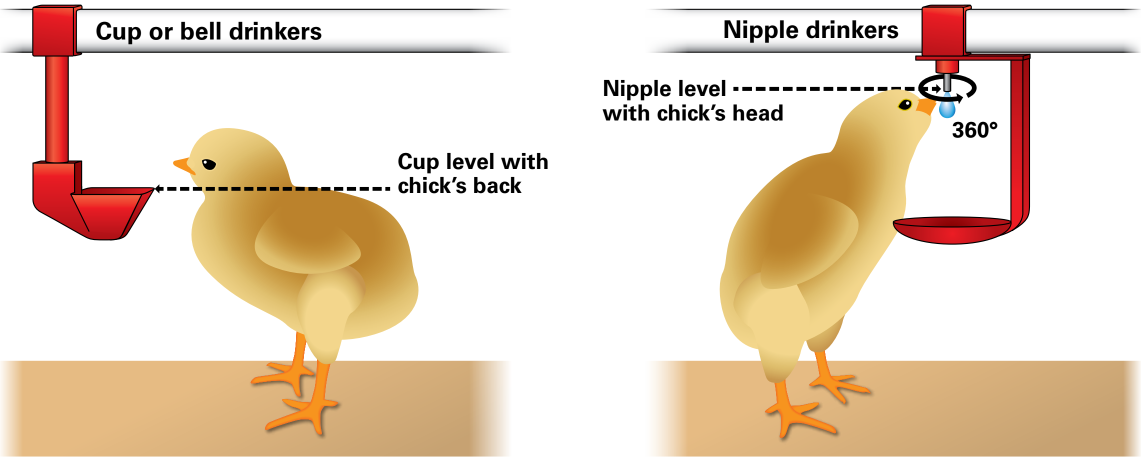
- The type of drinkers used during rearing should be the same as in the production facility. Use the same nipple type in rearing and production facility (vertical vs. 360° activated nipples). In general, 360° activated nipples are recommended, especially for IRBT flocks.
- Ensure that palatable water is available to the birds at all times. Water should be kept fresh and clean by flushing water lines weekly during rearing and production periods. Flush water lines during the night, before lights come on in the morning.
- Record daily flock water consumption. A drop in water consumption is often the first sign of a serious problem in the flock.
- Regular water treatment with a bird-safe sanitiser is recommended.
- In aviary systems, the water lines should be in front of nests. Avoid using water lines above nest level.

Cup or bell drinkers

- Cup drinkers should be manually filled during 0–3 days to train chicks to drink.
- Open drinkers (bell, supplemental chick drinkers, trough) are easily contaminated and should be cleaned daily.

Nipple drinkers

- Nipple drinking systems are preferred because they are a closed system and more sanitary.
- Adjust nipple water system pressure to create a hanging drop to help chicks find water for 0–3 days and in layer facility at transfer for 7 days. Seeing a hanging drop after the first 7 days is an indication that the water pressure is too low and should be adjusted to the appropriate level for the age of the flock.
- Splash cups are useful during brooding period and in hot climates.
- 360° activated nipples make drinking easy for chicks.
- Use only 360° activated nipples for IRBT chicks, as well as supplemental chick drinkers.
- Nipple drinkers should deliver a minimum 60 ml per minute / nipple in adult layers, although this may change based on the water line manufacturer.
- Production facilities should be at 18–25°C and 40–60% humidity.



Water Quality

- Good quality water must be available to birds at all times.
- Water and feed consumption are directly related—when birds drink less, they consume less feed and production quickly declines.
- As a general rule, healthy birds will consume 1.5–2.0 times more water than feed. This ratio will increase in high ambient temperatures.
- Test water quality at least once per year. The water source will determine the regularity of water testing.
- Drinking water should be tested periodically for quality and cleanliness by taking two samples: one from the water source prior to entering the poultry facility and a second sample from the end of the water line. Testing water from the source is a measure of bacterial load coming into the farm and should be managed by addressing the water source directly. Testing at the end of the line and comparing to the water source value is a measure of how effective the line cleaning has been and the current status of the water birds are drinking.

- When collecting a well water sample, let the water run for 2 minutes prior to collecting the sample. Water samples should be kept below 10°C and submitted to the lab in less than 24 hours.
- Surface water requires more frequent testing, as it is more affected by season and rainfall patterns.
- Closed wells taking water from aquifers or deep artesian basins will be more consistent in water quality but are generally higher in dissolved mineral content.
- The presence of coliform bacteria is an indicator that the water source has been contaminated with animal or human waste.
- Some water sources contain high levels of dissolved minerals such as calcium, sodium and magnesium. When this occurs, amounts of these minerals in water have to be considered when formulating feed.
- Preferable drinking water temperature for chicks is 20–25°C and for layers is 15–20°C.
- Ideal water pH is 5–7 to promote good water sanitation, increase feed consumption, and improve upper gastrointestinal health.
- Less than optimum water quality can have a significant impact on intestinal health which will lead to poor utilisation of nutrients in feed.

ITEM	MAXIMUM CONCENTRATION (ppm or mg/L)*	
Nitrate NO_3^- [1]	25	Older birds will tolerate higher levels up to 20 ppm. Stressed or disease challenged birds may be more sensitive to effects of Nitrate.
Nitrate Nitrogen (NO_3-N) [1]	6	
Nitrite NO_2^- [1]	4	Nitrite is considerably more toxic than Nitrate, especially for young birds, where 1 ppm Nitrite may be considered toxic.
Nitrite Nitrogen (NO_2-N) [1]	1	
Total dissolved solids [2]	1000	Levels up to 3000 ppm may not affect performance but could increase manure moisture.
Chloride (Cl^-) [1]	250	Levels as low as 14 mg may be problematic if sodium is higher than 50 ppm.
Sulphate (SO_4^-) [1]	250	Higher levels may be laxative.
Iron (Fe) [1]	<0.3	Higher levels result in bad odour and taste.
Magnesium (Mg) [1]	125	Higher levels may be laxative. Levels above 50 ppm may be problematic if sulphate levels are high.
Potassium (K) [2]	20	Higher levels may be acceptable depending on sodium level, alkalinity, and pH.
Sodium (Na) [1,2]	50	Higher concentration is acceptable but concentrations above 50 ppm should be avoided if high levels of chloride, sulphate, or potassium exist.
Manganese (Mn) [3]	0.05	Higher levels may be laxative.
Arsenic (As) [2]	0.5	
Fluoride (F^-) [2]	2	
Aluminium (Al) [2]	5	
Boron (B) [2]	5	
Cadmium (Cd) [2]	0.02	
Cobalt (Co) [2]	1	
Copper (Cu) [1]	0.6	Higher levels result in bitter taste.
Lead (Pb) [1]	0.02	Higher levels are toxic.
Mercury (Hg) [2]	0.003	Higher levels are toxic.
Zinc (Zn) [1]	1.5	Higher levels are toxic.
pH [1]	6.3–7.5	Birds may adapt to lower pH. Below pH 5 may reduce water intake and corrode metal fittings. Above pH 8 may reduce intake and reduce effectiveness of water sanitation.
Total bacteria counts [3]	1000 CFU/ml	This is likely to indicate dirty water.
Total Coliform bacteria [3]	50 CFU/ml	
Faecal Coliform bacteria [3]	0 CFU/ml	
Oxygen Reduction Potential (ORP) [3]	650–750 mEq	The ORP range at which 2–4 ppm of free chlorine will effectively sanitise water at a favourable pH range of 5–7.

* Limits may be lower as interactions exist between magnesium and sulphate; and between sodium, potassium, chloride, and sulphate.

[1] Carter & Sneed, 1996. Drinking Water Quality for Poultry, Poultry Science and Technology Guide, North Carolina State University Poultry Extension Service. Guide no. 42

[2] Marx and Jaikaran, 2007. Water Analysis Interpretation. Agri-Facts, Alberta Ag-Info Centre. Refer to http://www.agric.gov.ab.ca/app84/rwqit for online Water Analysis Tool

[3] Watkins, 2008. Water: Identifying and Correcting Challenges. Avian Advice 10(3): 10–15 University of Arkansas Cooperative Extension Service, Fayetteville

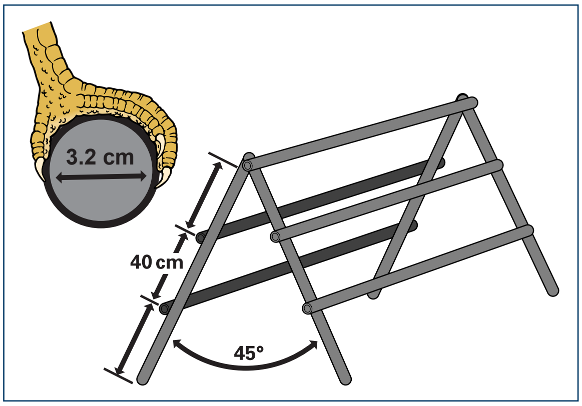
Environment of the Bird: Temperature

Physiology of Thermoregulation

- Thermoregulation is the ability to control the body temperature. This function takes approximately 10 days after hatching to achieve in the developing pullet.
- There are two mechanisms for thermoregulation: behavioural thermoregulation and neural thermoregulation.
  - » Behavioural thermoregulation occurs in cold temperatures when the chicks will attempt to decrease surface area for heat loss by "hunching" or "huddling." Chicks will often crowd in groups to further reduce temperature loss. This ability is readily available to chicks when they hatch.
  - » Neural thermoregulation is accomplished through temperature sensing in the nervous system and characterised by "shivering." Neural thermoregulation may take up to four weeks to develop post hatch to the point where the chick can maintain body temperatures without supplemental heat.
- An important part of the chick thermoregulation process is the growth of feathers which they use to trap air, and thus heat, against the body.
- Thermal stress occurs when the birds are subjected to temperatures above or below their thermoneutral (comfortable) zone. In laying hens, the thermoneutral zone is considered generally to be between 18–25°C. At temperatures outside the thermoneutral zone, the bird has to expend energy to maintain normal body temperature and metabolic activities. This diverts energy and other nutrients away from growth and egg production, resulting in performance loss.
- Young chicks have difficulty regulating their body temperature until they are fully feathered. Cold or heat stress can lead to a suppression of the immune system and these flocks become very susceptible to disease. It is common to see pasting vents, poor feed intake, and increased mortality when young flocks are subjected to prolonged chilling, overheating, or several days of large temperature swings (> 4°C). Whenever possible, maintain flocks in a thermoneutral zone appropriate for their age.
- Periods of high environmental temperatures, often accompanied by high relative humidity, are common in the summer months. Heat stress can profoundly affect the productivity of a flock. At environmental temperatures above 33°C, high mortality and large production losses are readily evident, but at less extreme temperatures, heat stress is often overlooked as a cause for poor growth or subtle losses in egg production and shell quality.
- Flocks raised in cold temperatures will struggle more as adult birds to adjust to hot weather.
- For information on management of layers in heat stress conditions, see Understanding Heat Stress in Layers.

Environment of the Bird: Perches

- Perches are essential for rearing birds that will go into an aviary system.
- Perches enrich the birds' environment and allow expression of normal behaviours.
- Perches encourage jumping habits, which develops leg and breast muscles, increases bone strength, and increases calcium content of bone. Birds able to jump will have better nesting behaviour and be more mobile in multi-tier aviary systems.
- Perches reduce social stress by providing safe resting sites.
- Perches increase living space in the facility.
- Perches allow birds to roost at night.
- Use of perches may reduce piling behaviour in flocks.



A-frame perch design


Water line perch


Perch over feeder

Perch Design

- Floor-reared birds should have access to perches and slats no later than 10 days of age.
- Perch height should not exceed 1 m to avoid injuries.
- Provide 10–15 cm perch space per bird (check local regulations concerning perch space).
- Separate perch rails by at least 30 cm to prevent cannibalistic pecking of birds on adjacent rails.
- Place perches on slats to maintain good litter conditions and control floor eggs.
- Avoid slippery perches.
- Perches should support the bottom of the foot and be comfortable for the bird.
- If possible, use the same perch style in rear and lay facilities.
- Do not use perches above water lines during rear if using an electric deterrent over the water line during production.
- Perches should be easy to clean and disinfect between flocks.
- Seal cracks, crevices, and open ends of pipes to reduce hiding areas for red mites (*Dermanyssus gallinae*).
- Perches are ideally placed over feed lines and on the top level in aviaries.


Perch in aviary system


Elevated platform


Perch on slats

Environment of the Bird: Air

- Production facility should be at 18–25°C and 40–60% humidity.
- The general rule for determining required fan capacity—4 m^3 of air movement/kilogram of body weight per hour.
- Ventilation is essential to:
  - » Provide each bird with adequate supply of oxygen
  - » Remove moisture from facility
  - » Remove carbon dioxide produced by birds
  - » Remove dust particles
  - » Dilute aerosolised pathogenic organisms
- Positive pressure facilities where exhaust air is exiting through vents and popholes prevents cold damp air from entering the facility in winter and causing wet litter.

Air Movement (m^3 / hour per 1000 birds)

AMBIENT TEMP. (°C)	WEEKS OF AGE					
	1	3	6	12	18	19+
32	360	540	1250	3000	7140	9340–12000
21	180	270	630	1500	3050	5100–6800
10	130	180	420	800	2240	3060–4250
0	75	136	289	540	1500	1020–1700
-12	75	110	210	400	600	700–1050
-23	75	110	210	400	600	700–850

Acknowledgment: Dr. Hongwei Xin, Professor

- In tunnel ventilated facilities, if birds are confined inside the facility due to hot or cold weather, ensure that the stocking densities are appropriate for bird confinement.
- Allowable levels of noxious gases at floor level in the facility are based on local regulations; however, the minimum standards are:
  - » Ammonia (NH_3): < 25 ppm
  - » Carbon dioxide (CO_2): < 5000 ppm
  - » Carbon monoxide (CO): < 50 ppm (measured over 8 hours)

Environment of the Bird: Litter

Litter is used in a poultry facility to dilute manure, absorb moisture, and provide bird welfare such as the opportunity to dust bathe. A number of substrates are used as litter in poultry facilities. Birds can express foraging and scratching behaviours on litter. The ideal litter should be absorbent, non-caking, non-toxic, and resist mould growth. It should have high carbon levels to make it easily compostable. Use 5 cm of litter in laying facilities. The key aspect of litter management is moisture control. The ideal litter moisture level is 25–30%. Litter moisture above 30% can result in excessive ammonia in the facility and allow the growth of pathogenic microorganisms. If not managed and maintained, drinker lines, foggers, and evaporative cooling pads can cause wet litter problems.

Litter selection is a balance of animal welfare, costs, and egg sanitation. Each litter substrate has benefits and weakness to its use. It is important to expose the flock to litter during the pullet period. Birds exposed to litter at an early age (first 2 weeks of life) have less incidence of pecking behaviour.

Keys to Maintaining Dry Litter

- Use a good litter material with high moisture absorbency.
- Maintain sufficient minimum ventilation rate in the facility.
- Maintain leak-free water systems, replace leaking nipples, and maintain proper water level in bell drinkers.
- Maintain proper drinker height and water pressure to prevent water spillage.
- Ensure good drainage of rain water away from the facility.
- Remove caked litter frequently and replace with clean dry litter.
- Occasionally rake the litter to keep it friable and prevent caking. Encourage the birds to break up litter by placing small amounts of whole grain on top of the litter.
- Remove extra litter to prevent floor eggs and maintain good air quality (less dust).

Types of Litter Material

	Advantages	Disadvantages	Notes
Sand or Gravel (<8 mm) 	Reduces bacterial growth in the facility compared to organic litter substrates; Lower surface temperature; Allows for dust bathing behaviour	Destructive to machinery. Sand recycling system may need to be purchased. Difficult to remove from the facility and clean	More attention to floor temperature is needed
Wood Shavings 	A common litter material with good moisture absorbency that is compostable	Shavings from hardwood may splinter, injuring the bird (sawdust as litter is less absorbent than wood shavings and tends to cake when wet)	Wood shavings should be made from softwood trees; May increase feather pecking; Limited in availability and expensive in some areas.
Straw 	Absorbs more moisture than wood shavings	Incidence of caking is higher in straw compared to wood shavings or bark. This can cause foot pad lesions; Use of straw may increase incidence of feather pecking; Poor quality straw may increase exposure to moulds such as aspergillus	Straw from barley, Bermuda grass, flax, oat, wheat, or rye can be used; Wheat straw is the most common; Straw should be chopped to 2.5 cm or less
Bark Mulch/Wood Chips 	Good moisture holding capacity	Particles more than 2.5 cm in size lead to excessive caking; Excessive moisture can lead to mould problems	Very similar to wood shavings
Rice Hulls 	Does not hold water well, most liquids quickly sink to the bottom	Less moisture holding capacity	

Nest Training

Preventing Floor Eggs in Aviary/Barn Systems

- Rear pullets in compatible aviary or barn systems that best match the production system.
- Train pullets to jump early by giving access to the aviary system by 15 days of age. In floor (barn) operations, provide perches or elevated slats.
- Light should be evenly distributed within the facility, avoiding areas of shadows. Use bulbs with good light dispersion to eliminate dark spots under feeders and in corners.
- Lighting in the facility should keep the entrance to the nests well lit, but keep the inside of nests dark.
- Eliminate corners where hens like to lay eggs. The use of electric deterrent wires is effective if allowed by the local production code.
- For more information, see Understanding Nesting Behaviour at hyline.com.

Nest Training

- In aviary systems, walk the birds in the evening to prevent birds from sleeping on the floor.
- Manually place floor birds in the system until they are trained to sleep in the system.
- If aviary has capacity to lock birds in at night, this should be done during the transition period to teach birds to lay in the nests (if allowed under local code of practice). Do not open aviary doors until birds are consistently laying in the nest.
- In barn systems having automatic colony nests, open nest boxes an hour before first light (either natural or according to the lighting programme–whichever is first).
- Lift a few curtains to encourage nest exploration from the first day after transfer.
- Frequently walk through the barn in the morning for the first 8 weeks after birds are moved to the production barn. While walking, move birds away from resting areas, out of corners, and toward nests. If you notice that walking is drawing the birds out of the nests, reevaluate this practice.
- During the first week of production, leave a few eggs in the nest to encourage hens to use nests.
- Do not give birds access to the outside range until they are consistently using the nests to lay eggs (if allowed under local code of practice).
- Collect floor eggs frequently. Floor egg collection must be done more frequently at the beginning of lay. Birds will lay eggs on the floor if other eggs are present.
- Be sure all floor eggs are removed before lights go out at night.

Open nest boxes and pull open a few curtains on nests after transfer for birds to explore and become accustomed to nests. Slats can be inclined to the nest opening to make access easier.

Nests should have a staging area at the entrance to allow hens to examine the nests with easy access and sufficient space for movement.

Ramps make elevation changes easier and reduce crowding in front of the nests. Use ramps when the elevation change is greater than 90 cm.

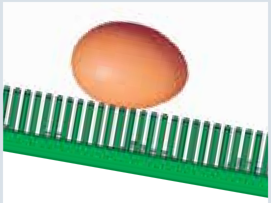
It is important to train newly housed birds to roost in the aviary system, not on the litter.

Nests

- Ensure there is sufficient nest space (6 birds per nest or 120 birds per m^2 in colony nests) and that hens are using all the nests. Partition the facility if it appears only a few nests are being used.
- Have a ramp or perching area at the entrance of the nest to allow for easy access by the birds.
- Any obstruction to accessing the nest should be removed. Feed lines should not be directly in front of nests.
- In aviary systems with nest boxes within the system, position the water lines in front of nests and in lower levels but so as not to create a barrier for movement into the nest.
- Swinging drinker lines can discourage birds from going towards the nests so ensure drinkers are secured accordingly.
- Do not place the water lines on levels above the nest boxes.
- Nests should be dark (< 0.5 lux), secluded, warm, and free of draughts.
- If the nests do have lighting, turn nest lights on 1–1.5 hours before barn lights are turned on to encourage nest investigation. Turn nest lights off 1 hour after barn lights come on. Rope lights work well in this application.
- Discontinue nest light usage after 26 weeks of age.
- If the birds are overcrowding in corner nest boxes, adding false walls or partitions (perpendicular to nests and spaced every 5–7 m) may reduce this behaviour.
- Close nests at night. Do not allow birds to sleep in nests.
- Replace worn nest floor mats.

Drinker lines should not obstruct access to the nest.

A good nest floor mat:



- Provides comfort for nesting female
- Cushions egg to prevent damage
- Keeps egg clean
- Separates dirt and feathers from egg surfaces
- Allows egg to roll easily to egg belt

Nest partitions placed perpendicular to the nests and spaced every 5–7 metres reduces overcrowding in nests.

Facility Management

- Use < 5 cm litter depth. Litter deeper than 5 cm may result in brooding behaviour in hens. Remove excess litter if needed.
- Flocks housed in all-slat production facilities should also be grown on slat or wire floors.
- Solid perches above water and feed lines are preferred.
- Schedule feed lines to run when the first light comes on and again 4 to 5 hours later (around mid-day) after most of the eggs have been laid. Do not disturb the hens during the peak egg laying time.
- Programme the lights to encourage birds to sleep on the slatted area or within the aviary system
- Ensure good ventilation throughout the facility. Cooler temperatures make the flock more active while warmer temperatures make them more sedentary.

Behavioural Issues

Feather Pecking

Good feather cover is an important welfare trait in layer flocks. Feather cover protects the skin from injury and direct sunlight. Good feather cover provides insulation from the cold and improves feed efficiency. Older flocks with good feather cover are more marketable and have greater value.

Birds have a social hierarchy called the pecking order. Some pecking is normal behaviour to establish a stable social structure. In their natural environment birds spend a significant portion of the day foraging for food. Environments that limit foraging behaviour result in feather pecking. In extreme cases, cannibalism of other birds can occur. Currently, feather pecking is managed by reducing light intensity and beak trimming, which attenuate, but do not address the cause of the behaviour.

Factors Affecting the Incidence of Feather Pecking	
Nutritional Deficiencies	• Low protein and amino acid imbalance, particularly methionine and arginine • Low mineral levels, ie. calcium, sodium
Diet Characteristics	• Low fibre, fine textured or pelleted feed, and restricted feeding practices reduce the bird's feeding time • Sudden changes in feed ingredients or feed particle size • Pecking around the preen gland (near the tail) may indicate low salt in the diet or, in pullets 3–6 weeks of age, might be an indication of infectious bursal disease
Environmental Stressors	• Loud noises • Heat stress • Litter substrates, such as fine-particle wood shavings or sawdust • Large flock sizes have a less stable social structure • High stocking density, leading to overcrowding of the bird's floor, feeder, water, and nest space • Mite infestation, even in moderate numbers
Flock Characteristics	• Poor beak trimming • Poor uniformity

Tips for Preventing Excessive Feather Pecking Behaviour

- Prevention measures taken during the rearing and early production periods are more effective than in older flocks already exhibiting excessive feather pecking behaviour.
- Match rearing and production facility environments as closely as possible. Provide sufficient perch space in both. In order to prevent vent pecking avoid perches which present the vent at bird eye-level.
- Provide the recommended levels of light intensity in the facility. In flocks exhibiting excessive feather pecking behaviour, reduce light intensity to calm the flock.
- Ensure that nests are dark (< 0.5 lux).
- Check the diet adequacy, paying particular attention to energy, protein, sulphur-containing amino acids, salt, and calcium.
- Reduce bird density if possible. Reduce bird group size with the use of partitions.
- Minimise heat stress during the summer months. For more information, see Understanding Heat Stress in Layers.

- Provide pecking blocks or objects to help blunt the beak in addition to occupying the bird's time.
- Enrich the facility environment by adding bales of lucerne (alfalfa) on the floor to encourage foraging, or add attractions like hanging string or rope, plastic bottles or other toys to occupy birds' attention.
- Encourage more foraging behaviour in barn systems by adding small amounts of grain into the litter in the afternoon.
- Quickly remove injured and dead birds from the flock.
- Remove any birds displaying aggressive pecking and cannibalistic behaviour.
- Keep facilities in good repair, eliminating loose wires, sharp edges and areas where birds can be caught.
- The use of nipple drinkers may reduce feather pecking.
- For more information, see Feather Scoring at hyline.com.

Hen with poor feather cover.

Piling

Birds may pile without a discernible cause, resulting in suffocations. Identifying time periods when birds tend to gather or pile can provide important clues to identify the reason for piling. Walking in the flock during these times may prevent piling and smothering.

Potential causes of piling:

- Panic in the flock caused by a flight response to a predator or heavy rodent populations.
- Hot and poorly ventilated areas within the facility environment.
- Sunlight shining directly into the facility creating bright spots on the floor.
- The search for a nesting area.
- High light intensity or sudden changes in the lighting programme.
- Flickering of the lights for any reason, such as a generator test.
- Human or other activity that attracts the birds to gather in one location.

Management steps to prevent piling:

- Round off corners to prevent birds from congregating there.
- Place pallets or similar objects in known piling areas to help disperse the birds.
- Install partitions to reduce piling in some nest boxes.
- Playing music in the facility may keep birds calm and less reactive to sounds. This is good practice to begin from the rearing phase.
- An afternoon feeding before lights go out will spread the birds out in the facility.

Good Lighting Practices

- Verandas (winter porches) should be equipped with lights.
- Keep light bulbs and covers clean to prevent loss of light intensity.
- Prevent dark areas in the facility which can be created by too much distance between lights or burned-out light bulbs.
- Shiny or white surfaces reflect light and contribute to more uniform light distribution.
- Take local conditions into account which may require adaptations to lighting programmes.
- Light hours of rearing and production facilities should be matched at transfer.
- Light stimulation period should extend into the peaking period (achieve 16 hours of light by approximately 25 weeks).
- Light intensity should gradually increase for the 2 weeks before flock is transferred to the laying facility (but not prior to 15 weeks of age). Final rearing facility light intensity should match the production facility light intensity.
- Free range flocks should use lighting programmes designed for open housing. It is important that lights are on when birds are returning from pasture. Birds will not return to a dark facility.

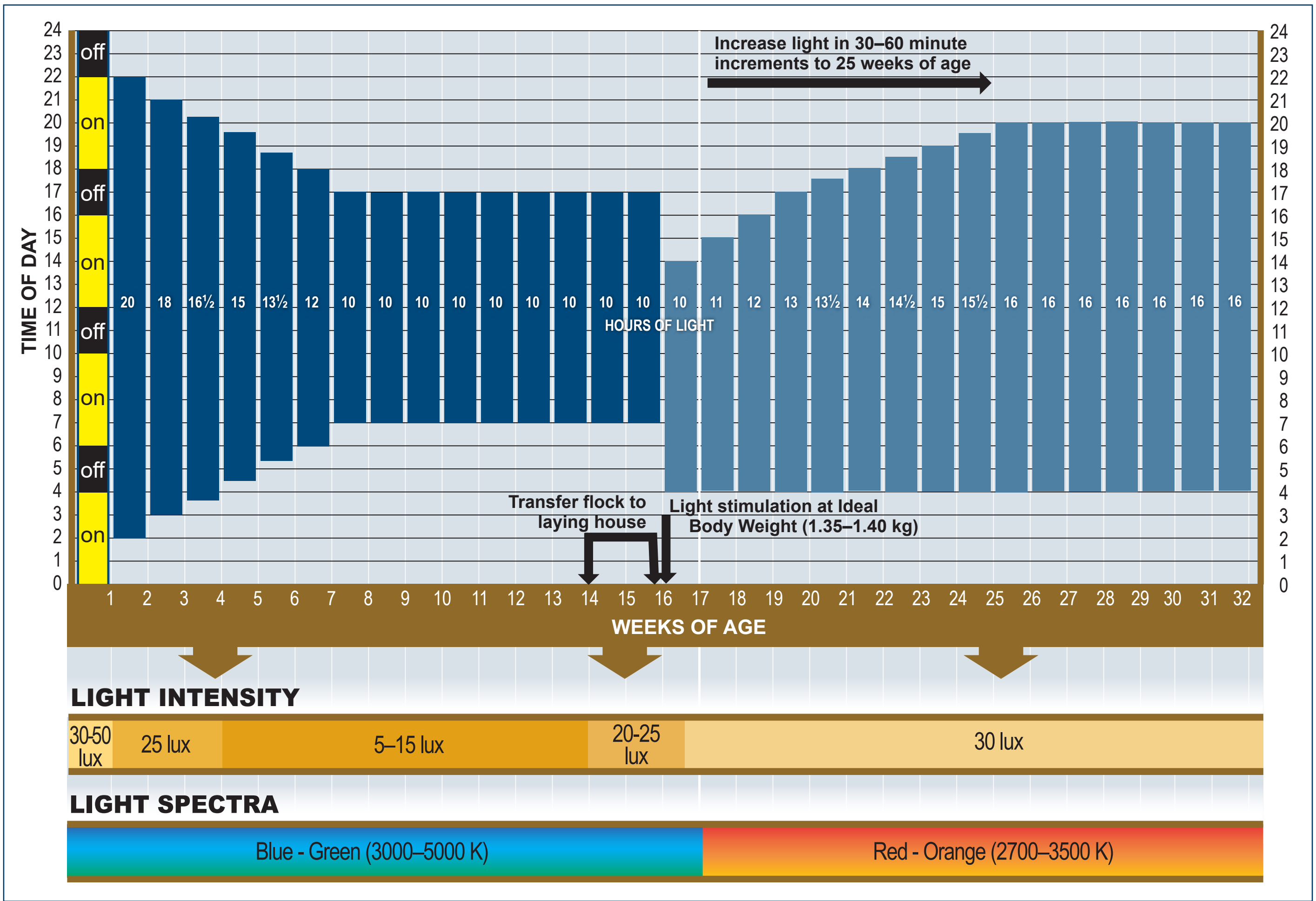
Lighting for Aviary Flocks

Simulating Sunrise and Sunset

- Simulation of sunrise and sunset using sequential lighting is used to move birds within the aviary system. Sunrise lighting moves birds down and out of the aviary system for nesting. Sunset lighting moves birds into the system prior to lights off to encourage birds to roost in the system at night.
- 30 minutes before the scheduled time for facility lights to turn off, turn off the lights at the floor level. 15 minutes later, turn lights off at the second level and finally the top level. This simulation of sunset within the facility brings the birds up into the system to sleep on the upper roosting level.
- In the morning, this lighting sequence is reversed to bring birds down from the upper level to nests, feed, and water.
- Rope lighting within the system works well for this application.

Light Programme for Light-Controlled Housing

- Use a slow step-down lighting programme for 0–8 weeks to increase the feed intake during the rearing period and to optimise pullet flock growth and uniformity. A slower step-down period can be used to achieve increased pullet weights and potentially increased egg weights.
- An intermittent lighting programme for chicks is preferred. If not using an intermittent lighting programme from 0–7 days, use 20 hours of light from 0–7 days.
- "Lights on" time can be varied between facilities in laying flocks to facilitate egg collection on multiple flock complexes.
- If the laying flock has a large spread in hatch ages and/or poor uniformity, light stimulate the flock based on the oldest hatch date or heaviest birds.
- Use cool lights (3000–5000 K) in the rearing facility to ensure sufficient blue-green light spectrum. Use warm lights (2700–3500 K) in the production period to ensure sufficient red spectrum.
- For more information on poultry lighting, see Understanding Poultry Lighting at hyline.com.



Customised Lighting Programmes for Open-Sided Housing

Houses with natural light influence can be difficult to manage depending on the season the chicks were hatched and the latitude of the farm. The Hy-Line International Lighting Programme can be used to help determine the sunrise and sunset of the flock and create a base programme. However, this programme may need to be customised to suite the exact location and management of the farm.

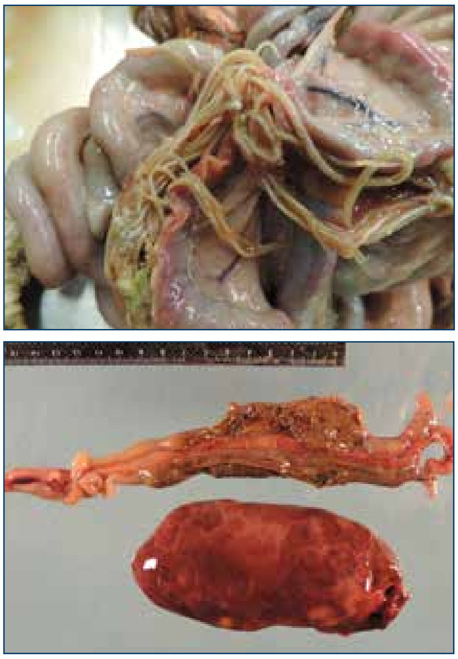
Internal Parasites

Internal parasites can be a significant problem for free-range flocks by causing damage to the bird's intestinal tract and reducing the absorption of feed nutrients.

Signs of internal parasites:

- Loss of shell strength, yolk, colour, and egg size.
- Poor body weight gain leading to unevenness or stunted birds. Affected birds may be dull with pale combs.
- Increased cannibalism through vent pecking due to straining.
- Death in very heavy infestations.
- Internal parasites can make birds more susceptible to disease or worsen an existing disease condition.
- Worm populations can increase rapidly in the flock. Consult with a veterinarian for an appropriate parasite control programme. (Check local regulations regarding treatment and prevention options.)

There are several worms that may cause problems in free range birds:



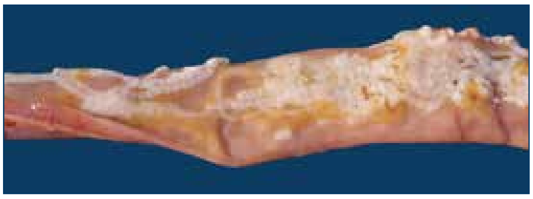
Top: ascarids (roundworms). Bottom: heterakis (caecal worms). Photos courtesy Dr. Yuko Sato, Iowa State University.

Roundworms (ascarids)

- ***Ascaridia galli* (roundworms)**
  - » These are the largest and most common. They are white, up to 5 cm long, and can be visible in droppings in heavy infestations.
  - » The roundworm life cycle is 21 days. Repeated treatments 21 days apart are needed to eliminate a heavy infestation.
  - » Ascarid eggs may be eaten by insects. The infestation spreads when the insects are then eaten by free range birds.
- ***Capillaria* Spp. (hairworms or threadworms)**
  - » These are much smaller (hair-like) and are barely visible with the naked eye but can cause significant damage even in only moderate infestations.
  - » *Capillaria* worms can infest the crop, esophagus, and intestine.
  - » Eggs become infective in 4–6 weeks in faeces.
  - » Some species of *Capillaria* use the earthworm as an intermediate host to complete its life cycle.
- ***Hetarakis gallinarum* (caecal worms)**
  - » *Hetarakis* worms spend most of their time in the ceca, located at the lower end of the intestine. They cause no obvious harm in themselves, but can carry another parasite called *Histomonas meleagridis*, the cause of Blackhead.
  - » Effective control of caecal worms provides good protection against Blackhead. *Heterakis* eggs can survive three years in pastures.
  - » Birds become infected by picking up worm eggs from litter, soil, and faeces.
  - » The worm eggs need warm, moist conditions to develop outside the bird, which is why problems are frequently worse in the spring and summer, especially following a wet spring.
- **Cestodes (tapeworms)**
  - » Flat, ribbon-shaped, segmented intestinal worms that anchor their heads (scolex) into the wall of the bird's small intestine with hook-like mouthparts. Despite this, most tapeworms do not cause physical damage to the intestinal wall.
  - » Tapeworms compete for available nutrients in the intestinal tract of birds, damaging their health and hampering growth.
  - » *Davainea proglottina* is a species of tapeworm which can cause damage to the intestinal tract. If the worms migrate to the head and sinuses, the birds may present with neurological signs such as torticollis.
  - » Birds become infected with tapeworm by eating intermediate hosts, which include arthropods and other invertebrates. Controlling these intermediate hosts and good pasture management will help reduce the infectious pressure. See Fly Management at hyline.com.
  - » Drug treatments are available, but most are used off label, thus requiring the advice of a veterinarian.

Control of internal parasites:

- Worm infestation in the flock is identified by microscopic examination of faeces to look for parasite eggs.
- Rotation of pasture can be helpful in controlling internal parasites and keeping vegetation short to expose worm eggs to sunlight.
- Internal parasite infestations should be routinely monitored by necropsy of cull birds and microscopic examination of faeces for worm egg counts.
- Effective control is aimed at breaking the cycle of infection.
- Strategic use of feed or water administered deworming treatments will control worms in the flock, when used in conjunction with limiting stock density on land, rotation of paddocks, and providing good drainage. Start treatments in the rearing phase and continue through the laying period.
- Removal of heavily contaminated soil around popholes and other areas of heavy bird traffic can reduce exposure to worm eggs.



Heavy infestation of tapeworms within the intestine. Tapeworms compete with the bird for available nutrients.

Protozoa

Coccidia infection may lead to intestinal damage and, in severe infestations, death. More commonly, poor control of sub-clinical infection reduces feed conversion or leaves pullets with chronic, irreversible gut damage. Pullet flocks may be uneven or underweight at housing and not perform to their full potential in lay.

Control of coccidia includes the following measures (check local regulations):

- Use ionophores or other chemicals in a step-down dosing programme to protect the bird from coccidiosis and allow stimulation of immunity in pullets.
- Cocci vaccines require cycling by contact to manure to achieve full immunity. Discuss this with the vaccine manufacturer.
- Live vaccine use is preferred to anti-coccidial drug treatments. Vaccines are administered in the hatchery as a spray or spray gel, or at chick placement in the rearing facility.
- Control of flies and beetles which are vectors of coccidia spread.
- Cleaning and disinfection of facilities reduces challenge pressure. The oocytes are resistant to disinfection and can persist in the environment.
- In aviary systems, limit bird access to manure belts.
- Dry, well drained pasture areas prevent the sporulation of oocytes. The oocytes sporulate and become infectious when conditions are hot and humid.
- In barn and aviary facilities, good litter management is key to controlling coccidia in the flock.

Coccidia infection.

External Parasites

Red Mite (*Dermanyssus gallinae*)

Red mite is an external parasite in laying flocks in all systems of management. Red mites are nocturnal blood feeders that hide during the day in dark, secluded areas in the facility. Red mites multiply rapidly in warm summer months. Even light infestations create irritation, leading to poor performance and feed intake.

Red mite (Dermanyssus gallinae).

Signs of red mite infestation in the flock:

- Flocks that are nervous with increased feather and vent pecking behaviour.
- Feed intake may be depressed.
- Reduction in egg production by up to 5%.
- Birds become anaemic due to blood loss. These birds will be evident in the flock by their pale combs. If severely affected, mortality may increase.
- Loss of shell or yolk colour.
- Soiling of eggshells with mite faeces, which may lead to downgrading of eggs.
- Increase in floor eggs as birds will be reluctant to use infested nests.
- Egg collectors may experience skin irritation from red mites.

Red mites come out from hiding locations at night to take a blood meal from birds.

Controlling red mite:

- Breaking the cycle of re-infection when the facility is empty is the most effective approach.
- Treat the facility between flocks, immediately after the birds are removed from the facility while the red mites are still active.
- Use approved and effective products that have been properly applied into all crevices on equipment, walls, slats, and nest boxes.
- Use a fan nozzle to produce a flat spray for good coverage of surfaces and crevices.
- Do not mix pesticides with disinfectants unless recommended by the manufacturer.
- Red mites can live off the bird without feeding for up to 6 months. Facilities typically require multiple treatments to eliminate infestation. Filling cracks or holes in the facility and equipment will limit potential red mite areas.
- Apply treatments at night when red mites are active.
- Rotate pesticide products to avoid mites developing resistance.
- Monitor the facility and birds and provide prompt treatment when red mites are observed.
- Schedule treatments to break the red mite life cycle which is 10 days. A three-treatment programme (on days 0, 10, and 20) is effective.

Red mite/northern fowl mite treatments (check local regulations regarding mite treatment):

- **Pyrethroids**—A manmade chemical that causes paralysis and death in insects. As this is a common treatment, resistant varieties of mites exist throughout the world.
- **Organophosphates, carbamates**—Interferes with acetylcholine transmission in insects which causes death of the mite. Normally ingested by the parasite, there are types ingested by the birds that are passed to the mite when birds are bitten.
- **Fluralaner**—Acts as a potent inhibitor of the mite's nervous system by acting antagonistically on ligand-gated chloride channels (GABA-receptor and glutamate-receptor).
- **Vegetable oil**—Apply directly to the chicken to treat mites (impractical solution for large operations).
- **Mineral-based products** (both liquid and sand dusts)—Can be applied to the floor and walls of the facility to prevent the spread of mites.
- **Diatomaceous earth products**—These kill mites by absorbing the lipids from the exoskeleton and causing dehydration. Unlike pesticides, there is no development of resistance with these products.

Northern Fowl Mite (*Ornithonyssus sylviarum*)

Northern fowl mite is another common ectoparasite of chickens. These mites feed on blood and skin cells of the chicken and can cause significant losses of productivity and health with heavy infestations. Northern fowl mite is usually found on the downy feathers that surround the cloaca (vent). They live on the bird for their entire life, but can survive off the bird for up to three weeks. Mites can be found on eggs, egg belts, and on poultry workers when infestations are severe. There can be increased susceptibility of some individual birds to infestations while other birds are unaffected. Infested birds can be identified by finding characteristic dark areas on the feathers around the vent made up of mites, dead mites, dried blood, and skin cells.

Northern fowl mites can be found on the feathers surrounding the vent area (top), as well as on eggs and egg belts (bottom). Photos courtesy Dr. Bradley Mullens, University of California, Riverside.

Signs of northern fowl mite infestation in the flock:

- Flocks that are nervous with increased feather and vent pecking behaviour.
- Feed intake may be depressed.
- Reduction in egg production by up to 5%.
- Birds become anaemic due to blood loss. These birds will be evident in the flock by their pale combs. If severely affected, mortality may increase.
- Loss of shell or yolk colour.
- Increase soiling of eggshells with mite faeces which may lead to downgrading of eggs.
- Increase in floor eggs as birds will be reluctant to use infested nests.
- Egg collectors may experience skin irritation from northern fowl mites.

Controlling northern fowl mite (check local regulations regarding mite treatment):

- Life cycle is 4–5 days, so outbreaks can occur rapidly.
- Pesticide treatments do not kill eggs, so repeat treatments are needed for good control.
- Sulphur treatment of the environment or feed has been reported to have a good effect on controlling northern fowl mites.
- The pesticide must penetrate the feathers to be effective. Sprays should be delivered at 125 PSI and be directed to the vent area. Dust baths utilising powder containing insecticide can be used in alternative systems.
- Individual birds can be dipped into room temperature pesticide solutions.
- A small stock oral dosing gun can be used to apply pesticide through the feathers directly onto the skin of the bird.

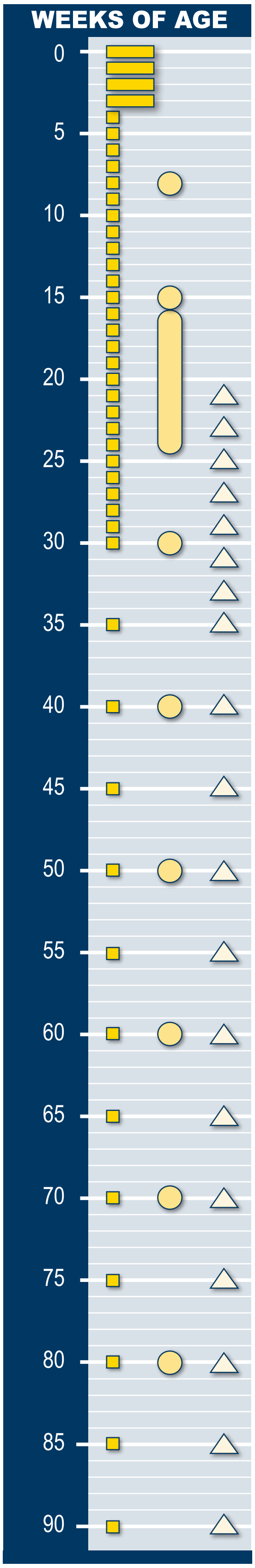
Bacterial Infections

- **Spotty Liver**
  - » Bacterial disease occurring mostly in free range flocks caused by *Campylobacter hepaticus*.
  - » Sudden onset of mortality (up to 10%) and a reduction of egg production (up to 30%) occurs in laying flocks during the peak period of egg production.
  - » Mortality occurs suddenly in healthy appearing birds without signs of illness.
  - » Necropsy of the mortalities show liver lesions. Multi-focal pale foci 1–2 mm in diameter are present throughout the liver.
  - » The presence of environmental stressors (heat stress, poor pasture conditions) are important in disease outbreaks caused by *C. hepaticus*.
  - » Antibiotic therapy (tetracyclines) can cause a reduction of mortality and improve egg production but reoccurrence of the disease after treatment is common.

Spotty liver disease occurs in free range laying flocks after exposure to stress such as poor pasture conditions.

- ***Brachyspira*** **(spirochaetes)**
  - » *Brachyspira pilosicoli* is an intestinal spirochaete associated with inflammation of the large intestine in a broad range of mammals and birds.
  - » It has been associated with typhilitis (inflamed ceca), diarrhea (yellow and frothy), reduced egg production, and egg shell soiling in chickens.
  - » Other related organisms can be present without causing adverse effects (*Brachyspira innocens*) or varying severity of adverse effects (*Brachyspira intermedia* and occasionally *Brachyspira hyodysenteriae*, the cause of swine dysentery).
  - » An abundance of frothy yellowish faeces is often considered to be an indication of *Brachyspira* infection.
  - » As with other intestinal infections, correct nutrition, good water hygiene, and avoidance of pooled water in the facility or on pasture are important control measures.
  - » Laboratory diagnosis of infection is based on culture or PCR of pooled faecal samples. Microscopic examination of pooled faecal samples is another method of identification.
  - » Affected flocks can be given antibiotic treatment (check local regulations concerning antibiotic use).
- ***Mycoplasma gallisepticum***
  - » See MG Control in Commercial Layers at hyline.com.
- ***Mycoplasma synoviae***
  - » See *Mycoplasma Synoviae* at hyline.com.
- **Focal Duodenal Necrosis (FDN)**
  - » See An Overview of Focal Duodenal Necrosis at hyline.com.
- **Colibacillosis**
  - » See Colibacillosis in Layers: An Overview at hyline.com.

Flock Monitoring



Ages of Body Weight Measurements

0–3 weeks

- Bulk weigh 10 batches of 10 chicks.

4–29 weeks

- Weigh 100 birds individually every week.
- Calculate uniformity.

30–90 weeks

- Weigh 100 birds individually every 5 weeks.
- Calculate uniformity.

When handling birds for body weights, assess:

- Keel bone—straightness and firmness (see Understanding the Role of the Skeleton in Egg Production at hyline.com)
- Body score (see Body Score Chart on p. 20)
- Body fat
- External parasites
- Clinical symptoms of disease

Ages of Sera Collection

- Collect 10–20 sera samples per flock for titer determination.
- For more information, see Proper Collection and Handling of Diagnostic Samples at hyline.com.

8 weeks

- Assess early vaccination technique and disease exposure.

15 weeks

- Collect sera before transfer to lay facility to assess possible change in disease exposure.
- It is common to not send to laboratory and freeze for future analysis in event of disease outbreak on lay farm.

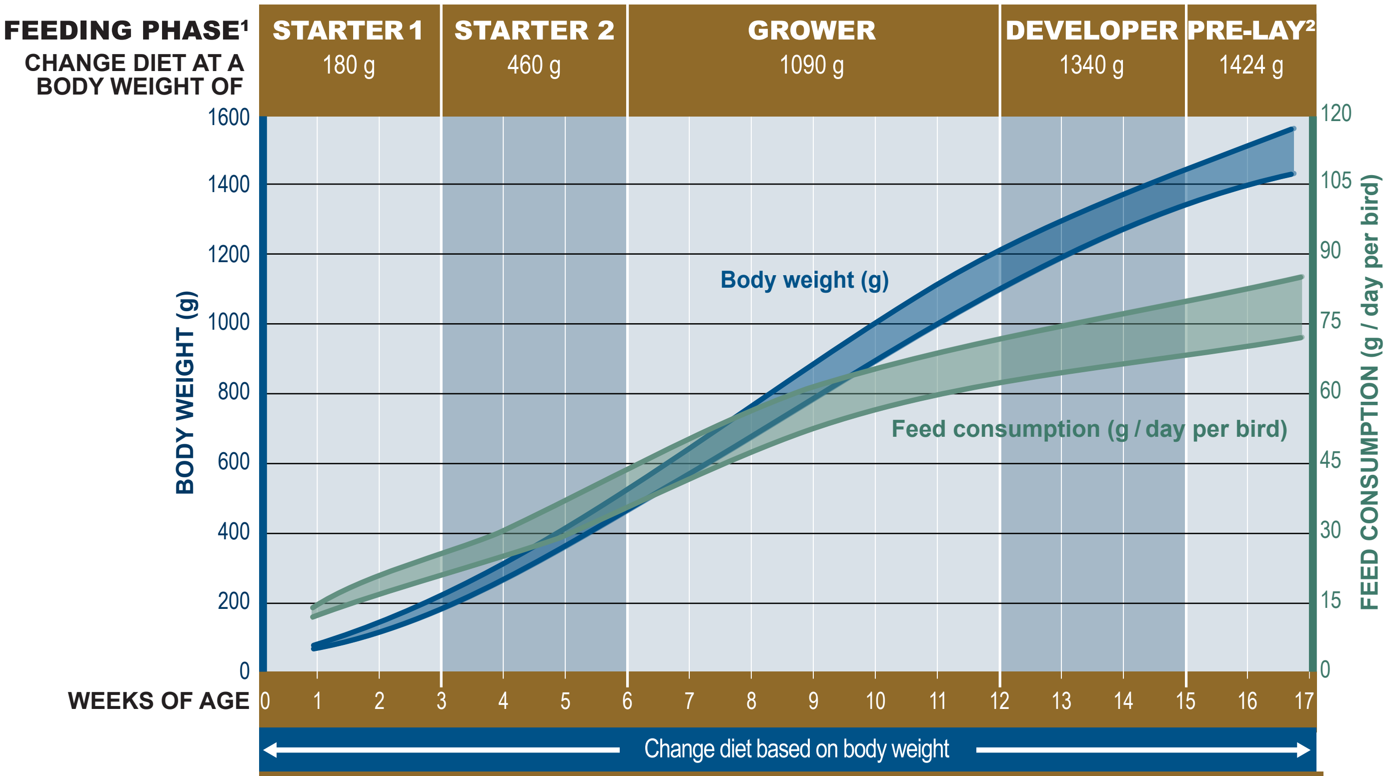
16–24 weeks

- Collect sera at least 4 weeks after final inactivated vaccination to measure post-vaccination antibody response.
- It is useful to assess disease challenge and response to inactivated vaccinations after transfer to lay farm.

Ages to Monitor Egg Weights

Weigh 100 eggs from randomly selected nests. Monitor egg weights on a specific day of the week within the same 3-hour time frame. Monitor worm egg counts in pooled faecal samples every month.

Rearing Period Nutritional Recommendations



NUTRITION	RECOMMENDED NUTRIENT CONCENTRATION				
Metabolisable energy[3], kcal/kg	2900–3100	2850–3050	2800–3000	2700–3000	2750–3000
Metabolisable energy[3], MJ/kg	12.13–12.97	11.92–12.76	11.72–12.55	11.30–12.55	11.51–12.55
	Standardised Ileal Digestible Amino Acids / Total Amino Acids[4]				
Lysine, %	**1.07** / 1.17	**0.92** / 1.00	**0.82** / 0.89	**0.60** / 0.66	**0.72** / 0.78
Methionine, %	**0.48** / 0.52	**0.42** / 0.45	**0.39** / 0.43	**0.28** / 0.30	**0.35** / 0.38
Methionine+Cystine,%	**0.82** / 0.91	**0.72** / 0.81	**0.66** / 0.74	**0.50** / 0.57	**0.62** / 0.70
Threonine, %	**0.69** / 0.82	**0.60** / 0.70	**0.55** / 0.64	**0.41** / 0.49	**0.50** / 0.58
Tryptophan, %	**0.19** / 0.22	**0.17** / 0.20	**0.17** / 0.20	**0.13** / 0.16	**0.16** / 0.20
Arginine, %	**1.11** / 1.20	**0.96** / 1.03	**0.85** / 0.91	**0.63** / 0.68	**0.75** / 0.81
Isoleucine, %	**0.75** / 0.80	**0.66** / 0.71	**0.61** / 0.66	**0.45** / 0.48	**0.56** / 0.61
Valine, %	**0.77** / 0.84	**0.68** / 0.75	**0.64** / 0.70	**0.48** / 0.53	**0.61** / 0.67
Crude protein[5], %	20.00	18.00	17.00	15.50	16.50
Calcium[6], %	1.05	1.00	0.95	0.90	2.50
Phosphorus (available)[7], %	0.45	0.44	0.43	0.38	0.42
Phosphorus (digestible), %	0.41	0.40	0.39	0.34	0.38
Sodium, %	0.18	0.18	0.18	0.18	0.18
Chloride, %	0.18	0.18	0.18	0.18	0.18
Linoleic acid (C18:2 n-6), %	1.20	1.20	1.20	1.20	1.20
Choline, mg/kg	2,000	1,800	1,800	1,500	1,800

[1] Body weights are approximate. Ages shown are a guide only. Please note that at time of transfer, there will be some loss in body weight (normally 10–12%) due to reduced water intake.

[2] Do not feed Pre-Lay Diet earlier than 15 weeks of age. Do not feed Pre-Lay later than first egg as it contains insufficient calcium to support egg production.

[3] Recommended energy range is based on raw material energy values shown in feed ingredient table at back of this guide. It is important that target concentrations of dietary energy are adjusted according to energy system applied to raw material matrix.

[4] Recommendation for Total Amino Acids is only appropriate to corn and soybean meal diet. Where diets utilise other ingredients, recommendations for Standardised Ileal Digestible Amino Acids must be followed.

[5] Diets should always be formulated to provide required intake of amino acid. Concentration of crude protein in diet will vary with raw material used. Crude protein value provided is an estimated typical value only.

[6] Calcium should be supplied as fine calcium carbonate (mean particle size less than 2 mm). Coarse limestone (2–4 mm) can be introduced in Pre-Lay Diet at up to 50% of total limestone.

[7] Where other phosphorus systems are used, diets should contain recommended minimum level of available phosphorus.

Phase Feeding in Rear

Starter

- Starter feed is preferably in the form of a crumb with a particle size distribution between 1 to 3 mm and minimal levels of fine material (particles less than 1 mm) to support feed intake.
- Starters are formulated using ingredients which are both highly palatable and digestible for the chick with particular emphasis on protein contributors.
- If necessary, a second stage starter (Starter 2) diet can be used as an intermediate diet between the first stage starter (Starter 1) and Grower diet to further support development.
- Oil levels can be increased to 2.0% in starter diets when given as a mash to control dust and increase feed palatability

Grower

- Typically given during the period of rapid growth in pullet body size between 6 and 12 weeks of age.
- Sufficient levels of protein, essential amino acids, and minerals are required for muscle growth and skeletal development during this period.
- Attention should be given to ensure that the nutrient density of the Grower diet is sufficient to compensate for any stress event which may compromise feed intake.

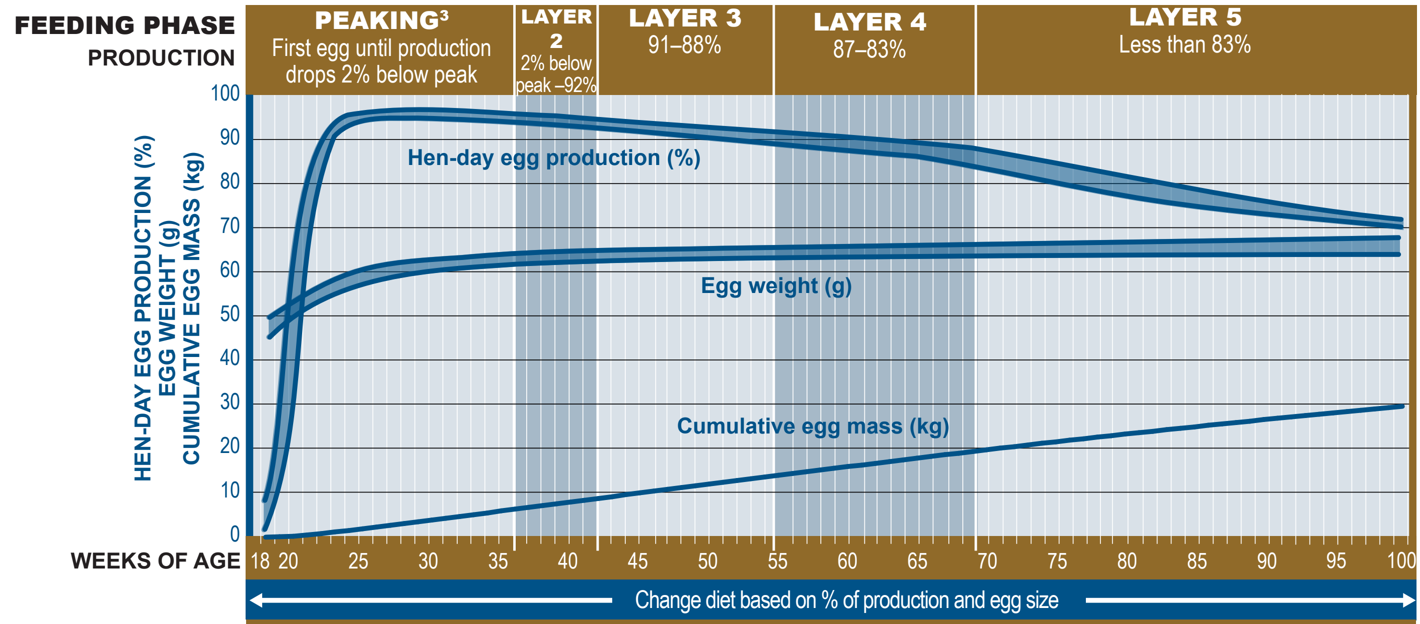
Developer

- Typically introduced at 12 weeks of age providing that body weight objectives have been achieved.
- The Developer diet should be fed up to the Pre-Lay period and be sufficiently low in density to encourage feed intake and increase enteric capacity.
- Fibre levels in the Developer diets are often higher than the Grower diet.
- The Developer diet can have a wide range of nutritional levels since it can be used either to increase or to control body weight gain.
- Avoid excessive levels of choline (> 150 ppm per bird per day) in the Developer phase to facilitate fat accumulation for the onset of lay.

Pre-Lay

- The Pre-Lay diet contains increased calcium and phosphorus levels relative to the Developer diet to increase medullary bone reserves in pullets preparing for egg production. Medullary bone contains minerals that are quickly mobilised for eggshell formation and vital for development of the first egg.
- Plan to feed for maximum of 10–14 days before point of lay.
- Pre-Lay diets can be started when most pullets show reddening of combs.
- Introduce large particle calcium sources, such as limestone, into the Pre-Lay diet in order to familiarise birds to large particles. Ideally, at least 50% of the limestone in the Pre-Lay diet should be coarse.
- When feeding, the Pre-Lay diet can be synchronised with light stimulation.
- Discontinue feeding the Pre-Lay diet with the commencement of egg production.

Production Period Nutritional Recommendations for Economical Performance[1,2]



NUTRITION	RECOMMENDED DAILY NUTRIENT INTAKE				
Metabolisable energy[4], kcal/bird/day	315 – 330	310 – 325	305 – 320	300 – 315	300 – 315
Metabolisable energy[4], MJ/bird/day	1.32 – 1.38	1.30 – 1.36	1.28 – 1.34	1.26 – 1.32	1.26 – 1.32
	Standardised Ileal Digestible Amino Acids / Total Amino Acids[5]				
Lysine, mg/day	**830** / 909	**810** / 887	**780** / 854	**745** / 816	**700** / 766
Methionine , mg/day	**415** / 446	**405** / 435	**390** / 419	**373** / 401	**350** / 376
M+C, mg/day	**747** / 842	**729** / 822	**702** / 792	**671** / 756	**623** / 703
Threonine, mg/day	**581** / 684	**567** / 667	**546** / 642	**522** / 614	**490** / 576
Tryptophan, mg/day	**178** / 213	**174** / 200	**168** / 200	**160** / 191	**151** / 180
Arginine, mg/day	**863** / 928	**842** / 872	**811** / 872	**775** / 833	**728** / 783
Isoleucine, mg/day	**664** / 714	**648** / 671	**624** / 671	**596** / 641	**560** / 602
Valine, mg/day	**730** / 806	**713** / 786	**686** / 757	**656** / 723	**616** / 679
Crude protein[6], g/day	17.80	17.60	16.70	16.30	15.50
Sodium, mg/day	180	170	170	170	170
Chloride, mg/day	180	170	170	170	170
Linoleic acid (C18:2 n-6), g/day	1.60	1.50	1.40	1.40	1.40
Choline, mg/day	180	180	180	180	180

CALCIUM AND PHOSPHORUS

	Calcium[7,8] g/day	Phosphorus (available)[7,9] mg/day	Phosphorus (digestible) mg/day	Calcium Particle Size (fine : coarse)
Weeks 18–33	4.00	432	389	40% : 60%
Weeks 34–48	4.20	405	366	35% : 65%
Weeks 49–62	4.40	373	337	30% : 70%
Weeks 63–76	4.60	347	314	25% : 75%
Weeks 77+	4.70	324	291	25% : 75%

IDEAL PROTEIN REFERENCE

	PEAKING	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Lysine	100%	100%	100%	100%	100%
Methionine	50%	50%	50%	50%	50%
M+C	90%	90%	90%	90%	89%
Threonine	70%	70%	70%	70%	70%
Tryptophan	22%	22%	22%	22%	22%
Arginine	104%	104%	104%	104%	104%
Isoleucine	80%	80%	80%	80%	80%
Valine	88%	88%	88%	88%	88%

Production Period Dietary Nutrient Concentrations for Economical Performance[1,2]

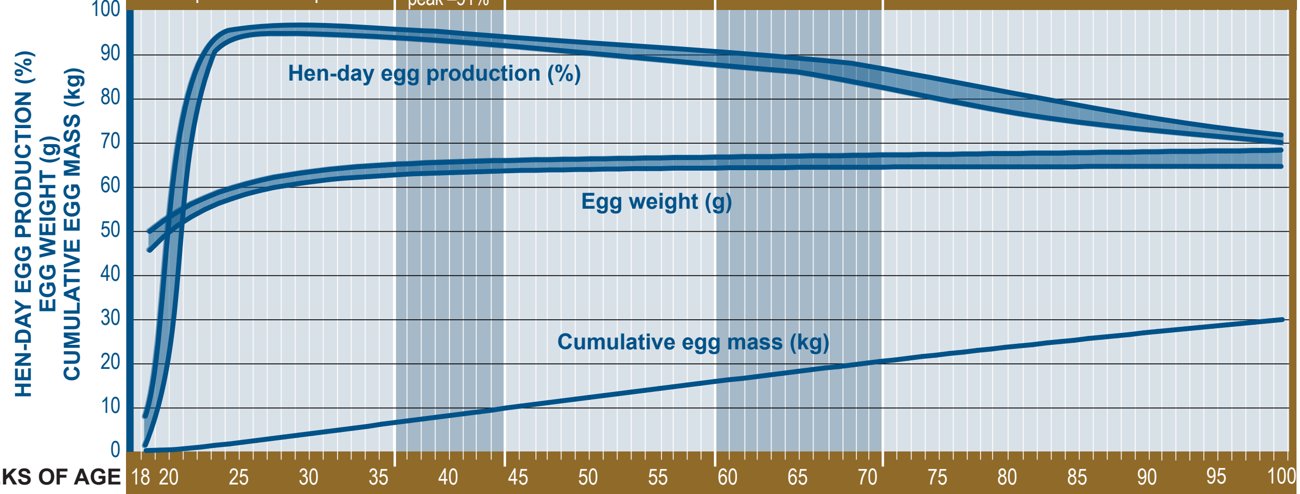
FEEDING PHASE PRODUCTION	PEAKING[3] First egg until production drops 2% below peak					LAYER 2 2% below peak to 92%					LAYER 3 91–88%					LAYER 4 87–82%					LAYER 5 Less than 83%				
NUTRITION	**RECOMMENDED CONCENTRATION**																								
ME[4], kcal/bird/day	315–330					310–325					305–320					300–315					300–315				
ME[4], MJ/bird/day	1.32–1.38					1.30–1.36					1.28–1.34					1.26–1.32					1.26–1.32				
	FEED CONSUMPTION (*Typical Feed Consumption)																								
g/day/bird	90	95	**100***	105	110	105	110	**115***	120	125	105	111	**117***	123	129	105	111	**117***	123	129	105	111	**117***	123	129
	Standardised Ileal Digestible Amino Acids																								
Lysine, %	0.92	0.87	**0.83**	0.79	0.75	0.77	0.74	**0.70**	0.68	0.65	0.74	0.70	**0.67**	0.63	0.60	0.71	0.67	**0.64**	0.61	0.58	0.67	0.63	**0.60**	0.57	0.54
Methionine, %	0.46	0.44	**0.42**	0.40	0.38	0.39	0.37	**0.35**	0.34	0.32	0.37	0.35	**0.33**	0.32	0.30	0.36	0.34	**0.32**	0.30	0.29	0.33	0.32	**0.30**	0.28	0.27
M+C, %	0.83	0.79	**0.75**	0.71	0.68	0.69	0.66	**0.63**	0.61	0.58	0.67	0.63	**0.60**	0.57	0.54	0.64	0.60	**0.57**	0.55	0.52	0.60	0.57	**0.54**	0.51	0.49
Threonine, %	0.65	0.61	**0.58**	0.55	0.53	0.54	0.52	**0.49**	0.47	0.45	0.52	0.49	**0.47**	0.44	0.42	0.50	0.47	**0.45**	0.42	0.40	0.47	0.44	**0.42**	0.40	0.38
Tryptophan, %	0.20	0.19	**0.18**	0.17	0.16	0.17	0.16	**0.15**	0.15	0.14	0.16	0.15	**0.14**	0.14	0.13	0.15	0.14	**0.14**	0.13	0.12	0.14	0.14	**0.13**	0.12	0.12
Arginine, %	0.96	0.91	**0.86**	0.82	0.78	0.80	0.77	**0.73**	0.70	0.67	0.77	0.73	**0.69**	0.66	0.63	0.74	0.70	**0.66**	0.63	0.60	0.69	0.66	**0.62**	0.59	0.56
Isoleucine, %	0.74	0.70	**0.66**	0.63	0.60	0.62	0.59	**0.56**	0.54	0.52	0.59	0.56	**0.53**	0.51	0.48	0.57	0.54	**0.51**	0.48	0.46	0.53	0.50	**0.48**	0.46	0.43
Valine, %	0.81	0.77	**0.73**	0.70	0.66	0.68	0.65	**0.62**	0.59	0.57	0.65	0.62	**0.59**	0.56	0.53	0.62	0.59	**0.56**	0.53	0.51	0.59	0.55	**0.53**	0.50	0.48
	Total Amino Acids[5]																								
Lysine, %	1.01	0.96	**0.91**	0.87	0.83	0.84	0.81	**0.77**	0.74	0.71	0.81	0.77	**0.73**	0.69	0.66	0.78	0.74	**0.70**	0.66	0.63	0.73	0.69	**0.65**	0.62	0.59
Methionine, %	0.50	0.47	**0.45**	0.42	0.41	0.41	0.40	**0.38**	0.36	0.35	0.40	0.38	**0.36**	0.34	0.32	0.38	0.36	**0.34**	0.33	0.31	0.36	0.34	**0.32**	0.31	0.29
M+C, %	0.94	0.89	**0.84**	0.80	0.77	0.78	0.75	**0.71**	0.69	0.66	0.75	0.71	**0.68**	0.64	0.61	0.72	0.68	**0.65**	0.61	0.59	0.68	0.64	**0.61**	0.58	0.55
Threonine, %	0.76	0.72	**0.68**	0.65	0.62	0.64	0.61	**0.58**	0.56	0.53	0.61	0.58	**0.55**	0.52	0.50	0.58	0.55	**0.52**	0.50	0.48	0.55	0.52	**0.49**	0.47	0.45
Tryptophan, %	0.24	0.22	**0.21**	0.20	0.19	0.20	0.19	**0.18**	0.17	0.17	0.19	0.18	**0.17**	0.16	0.16	0.18	0.17	**0.16**	0.16	0.15	0.17	0.16	**0.15**	0.15	0.14
Arginine, %	1.03	0.98	**0.93**	0.88	0.84	0.86	0.82	**0.79**	0.76	0.72	0.83	0.79	**0.75**	0.71	0.68	0.79	0.75	**0.71**	0.68	0.65	0.75	0.71	**0.67**	0.64	0.61
Isoleucine, %	0.79	0.75	**0.71**	0.68	0.65	0.66	0.63	**0.61**	0.58	0.56	0.64	0.60	**0.57**	0.55	0.52	0.61	0.58	**0.55**	0.52	0.50	0.57	0.54	**0.51**	0.49	0.47
Valine, %	0.90	0.85	**0.81**	0.77	0.73	0.75	0.71	**0.68**	0.66	0.63	0.72	0.68	**0.65**	0.62	0.59	0.69	0.65	**0.62**	0.59	0.56	0.65	0.61	**0.58**	0.55	0.53
Cr. protein[6], %	19.78	18.74	**17.80**	16.95	16.18	16.76	16.00	**15.30**	14.67	14.08	15.90	15.05	**14.27**	13.58	12.95	15.52	14.68	**13.93**	13.25	12.64	14.76	13.96	**13.25**	12.60	12.02
Sodium, %	0.20	0.19	**0.18**	0.17	0.16	0.16	0.15	**0.15**	0.14	0.14	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13
Chloride, %	0.20	0.19	**0.18**	0.17	0.16	0.16	0.15	**0.15**	0.14	0.14	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13
Linoleic acid (C18:2 n-6), %	1.78	1.68	**1.60**	1.52	1.45	1.43	1.36	**1.30**	1.25	1.20	1.33	1.26	**1.20**	1.14	1.09	1.33	1.26	**1.20**	1.14	1.09	1.33	1.26	**1.20**	1.14	1.09
Choline, mg/kg	2000	1895	**1800**	1714	1636	1714	1636	**1565**	1500	1440	1714	1622	**1538**	1463	1395	1714	1622	**1538**	1463	1395	1714	1622	**1538**	1463	1395

	CALCIUM AND PHOSPHORUS CHANGES BASED ON FEED INTAKE																										
	Weeks 18–33							Weeks 34–48					Weeks 49–62					Weeks 63–76					Weeks 77+				
Feed Consumption, g/day per bird	90	95	100	**106**	112	118	124	100	106	**112**	118	124	100	106	**112**	118	124	100	106	**112**	118	124	100	106	**112**	118	124
Calcium[7,8], %	4.44	4.21	4.00	**3.81**	3.64	3.48	3.33	4.20	4.00	**3.82**	3.65	3.50	4.40	4.19	**4.00**	3.83	3.67	4.60	4.38	**4.18**	4.00	3.83	4.70	4.48	**4.27**	4.09	3.92
Phosphorus (available)[7,9], %	0.48	0.46	0.43	**0.41**	0.39	0.38	0.36	0.41	0.39	**0.37**	0.35	0.34	0.37	0.36	**0.34**	0.32	0.31	0.35	0.33	**0.32**	0.30	0.29	0.32	0.31	**0.29**	0.28	0.27
Phosphorus (digestible), %	0.43	0.41	0.39	**0.37**	0.35	0.34	0.32	0.37	0.35	**0.33**	0.32	0.31	0.34	0.32	**0.31**	0.29	0.28	0.31	0.30	**0.29**	0.27	0.26	0.29	0.28	**0.26**	0.25	0.24

1 All nutrient requirements are based on the Feed Ingredient Tables.
2 Crude protein, methionine+cystine, fat, linoleic acid, and / or energy may be changed to optimise egg size.
3 Peaking nutrient levels are calculated for birds at peak egg production. Prior to achieving peak egg production, the nutrient requirements will be lower.
4 A good approximation of the influence of temperature on energy needs is that for each 0.5°C change higher or lower than 22°C, subtract or add about 2 kcal /bird /day, respectively.
5 Recommendation for Total Amino Acids is only appropriate to corn and soybean meal diet. Where diets utilise other ingredients, recommendations for Standardised Ileal Digestible Amino Acids must be followed.
6 Diets should always be formulated to provide required intake of amino acid. Concentration of crude protein in diet will vary with raw material used. Crude protein value provided is an estimated typical value only.
7 Calcium and available phosphorus requirements are determined by flock age. When production remains higher and diets are fed for longer than ages shown, it is recommended to increase to calcium and phosphorus concentrations of next feeding phase.
8 Calcium carbonate particle size recommendation varies throughout lay. Refer to Calcium Particle Size at hyline.com. Dietary calcium levels and fine to coarse ratio may need to be adjusted based on limestone solubility.
9 Where other phosphorus systems are used, diets should contain recommended minimum level of available phosphorus.

Production Period Nutritional Recommendations for Optimal Performance[1,2]

FEEDING PHASE / PRODUCTION	PEAKING[3] First egg until production drops 2% below peak	LAYER 2 2% below peak –91%	LAYER 3 90–87%	LAYER 4 86–82%	LAYER 5 Less than 82%



Change diet based on % of production and egg size

NUTRITION	RECOMMENDED DAILY NUTRIENT INTAKE				
Metabolisable energy[4], kcal/bird/day	315 – 330	310 – 325	305 – 320	300 – 315	300 – 315
Metabolisable energy[4], MJ/bird/day	1.32 – 1.38	1.30 – 1.36	1.28 – 1.34	1.26 – 1.32	1.26 – 1.32
	Standardised Ileal Digestible Amino Acids / Total Amino Acids[5]				
Lysine, mg/day	**870** / 953	**845** / 925	**820** / 898	**795** / 870	**770** / 843
Methionine , mg/day	**435** / 468	**423** / 454	**410** / 441	**398** / 427	**385** / 414
M+C, mg/day	**800** / 903	**769** / 867	**738** / 832	**716** / 807	**693** / 782
Threonine, mg/day	**609** / 716	**592** / 696	**574** / 675	**557** / 655	**539** / 634
Tryptophan, mg/day	**191** / 229	**186** / 222	**180** / 216	**175** / 209	**169** / 202
Arginine, mg/day	**905** / 973	**879** / 945	**853** / 917	**827** / 889	**801** / 861
Isoleucine, mg/day	**713** / 737	**684** / 736	**656** / 705	**636** / 684	**616** / 662
Valine, mg/day	**783** / 864	**752** / 829	**722** / 796	**700** / 772	**678** / 747
Crude protein[6], g/day	18.25	17.85	17.42	16.30	15.50
Sodium, mg/day	180	170	170	170	170
Chloride, mg/day	180	170	170	170	170
Linoleic acid (C18:2 n-6), g/day	2.00	2.00	1.60	1.50	1.40
Choline, mg/day	160	180	180	180	180

CALCIUM AND PHOSPHORUS

	Calcium[7,8] g/day	Phosphorus (available)[7,9] mg/day	Phosphorus (digestible) mg/day	Calcium Particle Size (fine : coarse)
Weeks 18–33	4.00	432	389	40% : 60%
Weeks 34–48	4.20	405	366	35% : 65%
Weeks 49–62	4.40	373	337	30% : 70%
Weeks 63–76	4.60	347	314	25% : 75%
Weeks 77+	4.70	324	291	25% : 75%

IDEAL PROTEIN REFERENCE

	PEAKING	LAYER 2	LAYER 3	LAYER 4	LAYER 5
Lysine	100%	100%	100%	100%	100%
Methionine	50%	50%	50%	50%	50%
M+C	92%	91%	90%	90%	90%
Threonine	70%	70%	70%	70%	70%
Tryptophan	22%	22%	22%	22%	22%
Arginine	104%	104%	104%	104%	104%
Isoleucine	82%	81%	80%	80%	80%
Valine	90%	89%	88%	88%	88%

Production Period Dietary Nutrient Concentrations for Optimal Performance[1,2]

FEEDING PHASE / PRODUCTION	PEAKING[3] First egg until production drops 2% below peak					LAYER 2 2% below peak to 91%					LAYER 3 90–87%					LAYER 4 86–82%					LAYER 5 Less than 82%				
NUTRITION	**RECOMMENDED CONCENTRATION**																								
ME[4], kcal/bird/day	315–330					310–325					305–320					300–315					300–315				
ME[4], MJ/bird/day	1.32–1.38					1.30–1.36					1.28–1.34					1.26–1.32					1.26–1.32				
	FEED CONSUMPTION (*Typical Feed Consumption)																								
g/day/bird	90	95	**100***	105	110	105	110	**115***	120	125	105	111	**117***	123	129	105	111	**117***	123	129	105	111	**117***	123	129
	Standardised Ileal Digestible Amino Acids																								
Lysine, %	0.97	0.92	**0.87**	0.83	0.79	0.80	0.77	**0.73**	0.70	0.68	0.78	0.74	**0.70**	0.67	0.64	0.76	0.72	**0.68**	0.65	0.62	0.73	0.69	**0.66**	0.63	0.60
Methionine, %	0.48	0.46	**0.44**	0.41	0.40	0.40	0.38	**0.37**	0.35	0.34	0.39	0.37	**0.35**	0.33	0.32	0.38	0.36	**0.34**	0.32	0.31	0.37	0.35	**0.33**	0.31	0.30
M+C, %	0.89	0.84	**0.80**	0.76	0.73	0.73	0.70	**0.67**	0.64	0.62	0.70	0.66	**0.63**	0.60	0.57	0.68	0.65	**0.61**	0.58	0.56	0.66	0.62	**0.59**	0.56	0.54
Threonine, %	0.68	0.64	**0.61**	0.58	0.55	0.56	0.54	**0.51**	0.49	0.47	0.55	0.52	**0.49**	0.47	0.44	0.53	0.50	**0.48**	0.45	0.43	0.51	0.49	**0.46**	0.44	0.42
Tryptophan, %	0.21	0.20	**0.19**	0.18	0.17	0.18	0.17	**0.16**	0.16	0.15	0.17	0.16	**0.15**	0.15	0.14	0.17	0.16	**0.15**	0.14	0.14	0.16	0.15	**0.14**	0.14	0.13
Arginine, %	1.01	0.95	**0.91**	0.86	0.82	0.84	0.80	**0.76**	0.73	0.70	0.81	0.77	**0.73**	0.69	0.66	0.79	0.75	**0.71**	0.67	0.64	0.76	0.72	**0.68**	0.65	0.62
Isoleucine, %	0.79	0.75	**0.71**	0.68	0.65	0.65	0.62	**0.59**	0.57	0.55	0.62	0.59	**0.56**	0.53	0.51	0.61	0.57	**0.54**	0.52	0.49	0.59	0.55	**0.53**	0.50	0.48
Valine, %	0.87	0.82	**0.78**	0.75	0.71	0.72	0.68	**0.65**	0.63	0.60	0.69	0.65	**0.62**	0.59	0.56	0.67	0.63	**0.60**	0.57	0.54	0.65	0.61	**0.58**	0.55	0.53
	Total Amino Acids[5]																								
Lysine, %	1.06	1.00	**0.95**	0.91	0.87	0.88	0.84	**0.80**	0.77	0.74	0.86	0.81	**0.77**	0.73	0.70	0.83	0.78	**0.74**	0.71	0.67	0.80	0.76	**0.72**	0.69	0.65
Methionine, %	0.52	0.49	**0.47**	0.45	0.43	0.43	0.41	**0.39**	0.38	0.36	0.42	0.40	**0.38**	0.36	0.34	0.41	0.38	**0.36**	0.35	0.33	0.39	0.37	**0.35**	0.34	0.32
M+C, %	1.00	0.95	**0.90**	0.86	0.82	0.83	0.79	**0.75**	0.72	0.69	0.79	0.75	**0.71**	0.68	0.64	0.77	0.73	**0.69**	0.66	0.63	0.74	0.70	**0.67**	0.64	0.61
Threonine, %	0.80	0.75	**0.72**	0.68	0.65	0.66	0.63	**0.61**	0.58	0.56	0.64	0.61	**0.58**	0.55	0.52	0.62	0.59	**0.56**	0.53	0.51	0.60	0.57	**0.54**	0.52	0.49
Tryptophan, %	0.25	0.24	**0.23**	0.22	0.21	0.21	0.20	**0.19**	0.19	0.18	0.21	0.19	**0.18**	0.18	0.17	0.20	0.19	**0.18**	0.17	0.16	0.19	0.18	**0.17**	0.16	0.16
Arginine, %	1.08	1.02	**0.97**	0.93	0.88	0.90	0.86	**0.82**	0.79	0.76	0.87	0.83	**0.78**	0.75	0.71	0.85	0.80	**0.76**	0.72	0.69	0.82	0.78	**0.74**	0.70	0.67
Isoleucine, %	0.85	0.81	**0.77**	0.73	0.70	0.70	0.67	**0.64**	0.61	0.59	0.67	0.64	**0.60**	0.57	0.55	0.65	0.62	**0.58**	0.56	0.53	0.63	0.60	**0.57**	0.54	0.51
Valine, %	0.96	0.91	**0.86**	0.82	0.79	0.79	0.75	**0.72**	0.69	0.66	0.76	0.72	**0.68**	0.65	0.62	0.74	0.70	**0.66**	0.63	0.60	0.71	0.67	**0.64**	0.61	0.58
Cr. protein[6], %	20.28	19.21	**18.25**	17.38	16.59	17.00	16.23	**15.52**	14.88	14.28	16.59	15.69	**14.89**	14.16	13.50	15.52	14.68	**13.93**	13.25	12.64	14.76	13.96	**13.25**	12.60	12.02
Sodium, %	0.20	0.19	**0.18**	0.17	0.16	0.16	0.15	**0.15**	0.14	0.14	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13
Chloride, %	0.20	0.19	**0.18**	0.17	0.16	0.16	0.15	**0.15**	0.14	0.14	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13	0.16	0.15	**0.15**	0.14	0.13
Linoleic acid (C18:2 n-6), %	2.22	2.11	**2.00**	1.90	1.82	1.90	1.82	**1.74**	1.67	1.60	1.52	1.44	**1.37**	1.30	1.24	1.43	1.35	**1.28**	1.22	1.16	1.33	1.26	**1.20**	1.14	1.09
Choline, mg/kg	1778	1684	**1600**	1524	1455	1714	1636	**1565**	1500	1440	1714	1622	**1538**	1463	1395	1714	1622	**1538**	1463	1395	1714	1622	**1538**	1463	1395

	CALCIUM AND PHOSPHORUS CHANGES BASED ON FEED INTAKE																										
	Weeks 18–33							Weeks 34–48					Weeks 49–62					Weeks 63–76					Weeks 77+				
Feed Consumption, g/day per bird	90	95	100	**106**	112	118	124	100	106	**112**	118	124	100	106	**112**	118	124	100	106	**112**	118	124	100	106	**112**	118	124
Calcium[7,8], %	4.44	4.21	4.00	**3.81**	3.64	3.48	3.33	4.20	4.00	**3.82**	3.65	3.50	4.40	4.19	**4.00**	3.83	3.67	4.60	4.38	**4.18**	4.00	3.83	4.70	4.48	**4.27**	4.09	3.92
Phosphorus (available)[7,9], %	0.48	0.46	0.43	**0.41**	0.39	0.38	0.36	0.41	0.39	**0.37**	0.35	0.34	0.37	0.36	**0.34**	0.32	0.31	0.35	0.33	**0.32**	0.30	0.29	0.32	0.31	**0.29**	0.28	0.27
Phosphorus (digestible), %	0.43	0.41	0.39	**0.37**	0.35	0.34	0.32	0.37	0.35	**0.33**	0.32	0.31	0.34	0.32	**0.31**	0.29	0.28	0.31	0.30	**0.29**	0.27	0.26	0.29	0.28	**0.26**	0.25	0.24

1 All nutrient requirements are based on the Feed Ingredient Tables.
2 Crude protein, methionine+cystine, fat, linoleic acid, and / or energy may be changed to optimise egg size.
3 Peaking nutrient levels are calculated for birds at peak egg production. Prior to achieving peak egg production, the nutrient requirements will be lower.
4 A good approximation of the influence of temperature on energy needs is that for each 0.5°C change higher or lower than 22°C, subtract or add about 2 kcal /bird /day, respectively.
5 Recommendation for Total Amino Acids is only appropriate to corn and soybean meal diet. Where diets utilise other ingredients, recommendations for Standardised Ileal Digestible Amino Acids must be followed.
6 Diets should always be formulated to provide required intake of amino acid. Concentration of crude protein in diet will vary with raw material used. Crude protein value provided is an estimated typical value only.
7 Calcium and available phosphorus requirements are determined by flock age. When production remains higher and diets are fed for longer than ages shown, it is recommended to increase to calcium and phosphorus concentrations of next feeding phase.
8 Calcium carbonate particle size recommendation varies throughout lay. Refer to Calcium Particle Size at hyline.com. Dietary calcium levels and fine to coarse ratio may need to be adjusted based on limestone solubility.
9 Where other phosphorus systems are used, diets should contain recommended minimum level of available phosphorus.

Phase Feeding in Production

Pre-Peak

- Pre-Peak diets are intended for flocks with low feed intake and are fed for a limited period from first egg to the beginning of peak production. The nutrient specification of the Pre-Peak diet should be dense enough to allow for lower feed intake and also cater to the increased nutritional needs of the bird entering egg production. Continue to feed the Pre-Peak until feed intake has developed sufficiently to allow transition to the Peak diet.
- If utilised until no more than 50–70% HD, a Pre-Peak diet with reduced energy concentration can be beneficial to stimulate feed intake. Pre-Peaking diets are useful in situations where local conditions may result in reduced feed intake, such as hot climates where feed intake may be depressed.
- Increasing the vitamins and trace mineral inclusion to 30% can be useful to cope with the lower feed intake during the Pre-Peak phase.

Peaking Ration

- Peaking rations need to be formulated according to actual flock feed consumption and egg mass output. Increase vitamin and trace mineral levels in these low intake diets if not already increased during the Pre-Peak phase.
- Begin feeding the Peaking diet at the onset of lay (1% egg production), if a Pre-Peak diet is not given.
- Birds should continue to grow during the Peak production period. Inadequate nutrient intake in this period can lead to loss of body weight (or insufficient body weight gain), soft bones, and loss of performance after Peak.
- Monitor keel bone development during the peaking period. See Understanding the Role of the Skeleton in Egg Production at hyline.com.

Phase Feeding during the Egg Production Period

- As the flock progresses through lay, the diet specification should be based on the bird's feed intake and egg mass output. In laying hens, the calcium requirement increases while the phosphorus requirement decreases with age. Maintaining good eggshell quality through adequate provision of minerals is key to successful extended cycle egg production.
- Around 32 weeks of age, the medullary bone is completely formed and filled, and the phosphorus levels can be decreased.
- Control of egg size is critical in maintaining eggshell quality in older laying flocks.

Egg Size Management

- Closely monitor egg weight of each flock and make nutritional changes as needed to ensure the target egg weight profile is achieved. If smaller eggs are desired, egg weight should be controlled at an early age.
- Along with management practices, egg weight control is achieved by controlling amino acid and energy intake and ensuring that feed intake is not too high.
- Reducing only the methionine or sulphur-containing amino acids is not the best way to control egg weight since it can lead to poor performance and reduced feather coverage.
- Monitor egg weight as frequently as possible. Start plans for controlling egg weight when average egg weight is within 2 g of target egg weight.
- For more information, see Optimising Egg Size in Commercial Layers at hyline.com.

Calcium Particle Size

- The introduction of large particle calcium should begin with the Pre-Lay diet. The digestion of large particle calcium provides the laying hen with a slow, sustained availability of calcium for eggshell formation.
- The percentage of large particle calcium is gradually increased during the production period. Toward the end of lay, the proportion of large particle limestone should be 75% of the total calcium (depending on the limestone solubility).
- The appropriate particle size depends on the solubility of limestone. Large particle size calcium sources are generally between 2–4 mm in diameter.
- Dietary calcium levels may need to be adjusted based on limestone solubility.
- Coarse limestone with higher solubility will be retained for a shorter period, so it needs to be included at a higher proportion or larger particle size.
- Limestone which is dark in colour is geologically older. Typically, these contain more impurities (usually magnesium) and are generally lower in both solubility and calcium availability.
- Oyster shell and other marine shells (with low microbiological contamination) are good sources of soluble calcium.

Top: fine calcium (0–2 mm). Bottom: coarse calcium (2–4 mm). Photos courtesy Longcliff Quarries Ltd.

PARTICLE SIZE	STARTER, GROWER, DEVELOPER	WEEKS 18–33	WEEKS 34–48	WEEKS 49–62	WEEKS 63–76	WEEKS 77+
Fine (0–2 mm)	100%	40%	35%	30%	25%	25%
Coarse (2–4 mm)	–	60%	65%	70%	75%	75%

Vitamins and Trace Minerals

As the vitamin/trace mineral premix is often found in fine feed particles, a minimum level of 1% added liquid oil/fat in diets binds small particles in feed.

ITEM [1,2,3,4]	IN 1000 KG COMPLETE DIET Rearing Period	Production Period
Vitamin A, IU	10,000,000	8,000,000
Vitamin D_3[5], IU	3,300,000	3,300,000
Vitamin E, g	25	20
Vitamin K (menadione), g	3.5	2.5
Thiamin (B_1), g	2.2	2.5
Riboflavin (B_2), g	6.6	5.5
Niacin (B_3)[6], g	40	30
Pantothenic acid (B_5), g	10	8
Pyridoxine (B_6), g	4.5	4
Biotin (B_7), mg	100	75
Folic acid (B_9), g	1	0.9
Cobalamine (B_{12}), mg	23	23
Manganese[7], g	90	90
Zinc[7], g	85	80
Iron[7], g	30	40
Copper[7], g	15	8
Iodine, g	1.5	1.2
Selenium[7], g	0.25	0.22

[1] Minimum recommendations for rearing and laying periods. Local regulations may limit dietary content of individual vitamins or minerals.

[2] Store premixes according to supplier's recommendations and observe 'use by' dates to ensure vitamin activity is maintained. Inclusion of antioxidant may improve premix stability.

[3] Vitamin and mineral recommendations vary according to activity.

[4] Where heat treatment is applied to diet, higher levels of vitamins may be required. Consult with vitamin supplier regarding stability through individual production processes.

[5] A proportion of Vitamin D_3 can be supplemented as 25-hydroxy D_3 according to supplier's recommendations and applicable limits.

[6] Higher levels of Niacin are recommended in non-cage systems.

[7] Greater bioavailability and productivity may be possible with use of chelated mineral sources.

Feeding Programmes for Alternative Systems

- Feeding birds in alternative systems is generally regarded as more challenging than feeding birds in colony systems because of the additional competition between birds for feeder space, as well as the greater fluctuations in facility temperature. Birds in alternative systems generally have higher nutrient requirements than birds in intensive systems.
- Be aware of the potential pitfalls that can occur because of inadequate nutrition, and of the measures that may be required to prevent or rectify them. Key points to remember:
  - » Make sure that feeding space is adequate and that the distribution of feeders allows good access by the birds.
  - » Ensure feed is adequately distributed around the entire feeding system quickly to avoid separation of components. A track speed of 20 m/minute will distribute feed efficiently.
  - » Seasonal changes in temperature can exert a major influence on feed intake, particularly in poorly insulated facilities. The bird's feed intake can change by as much as 30–40 g/bird/day from summer to winter. Ensure birds have good access to feed to allow for increased consumption during cold weather. Seasonal changes in the concentration of nutrients should be considered when intake falls below requirement levels. The same feeding schedule used in the rearing facility should be repeated in the laying facility to train feeding behaviour. This will encourage higher feed intake during the Pre-Peak and Peak period.

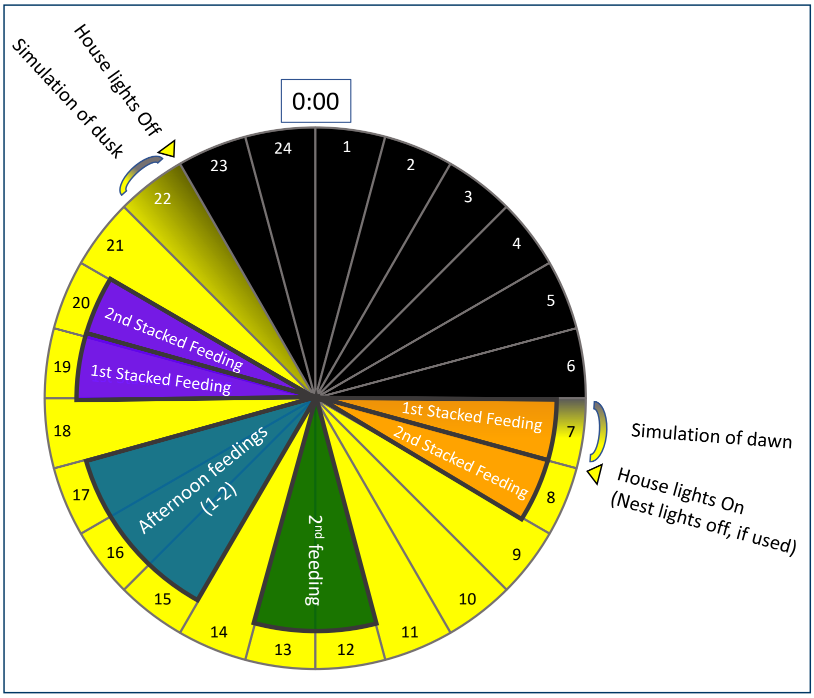
Basic Feeding Programme for Layers

Morning Feeding (First Feeding)

- First feeder run is usually scheduled with lights-on or just after.
- Fresh feed should be available as birds become active and are coming down from resting sites.
- **Stacked morning feeding programme** is an optional feeding programme that provides two morning feedings one hour apart. Stacked morning feeding provides more feeding opportunities to ensure good nutrient intake in all birds. Stacked morning feeding may reduce floor eggs by reducing crowding in the nest area. The second feed in a stacked feeding schedule attracts early laying dominant hens off the nests to the feeders. This may create more nesting opportunities for other less dominant hens.

Second Feeding

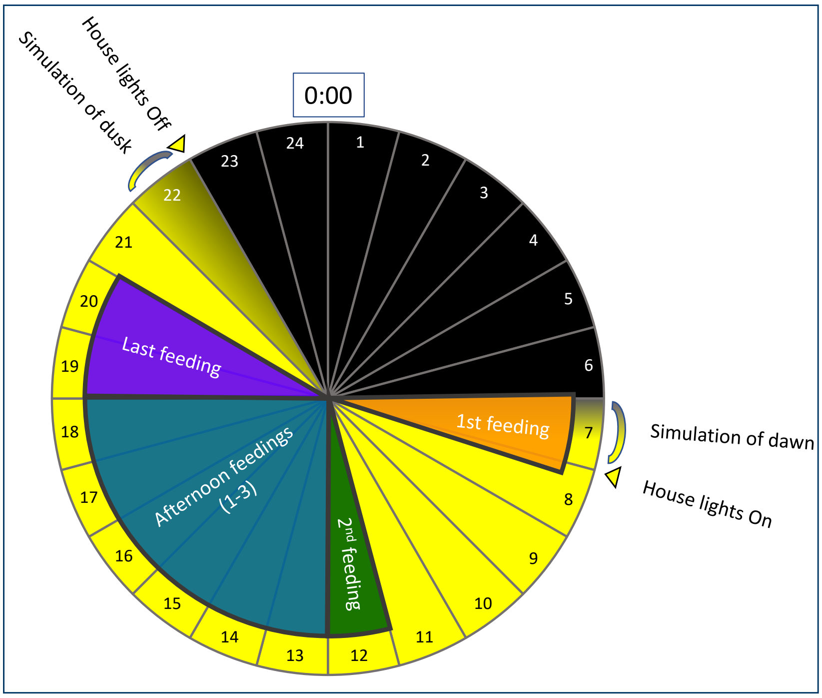
- The second feeder run should occur at the end of the peak egg laying period, usually 4–5 hours after lights on. This time can vary between flocks.
- This feeding is important after the 4–5 hour gap following the morning feeding, as feed levels tend to be low at this time.
- This feeding also attracts hens out of the nests that may be sitting on eggs, providing nesting opportunities for late laying hens.



Basic feeding programme.

Afternoon Feedings

- One to three afternoon feedings can be scheduled depending on the type of feeding system, climate, flock performance, body weight, and feed accumulation in feeders.
- During periods of heat stress, afternoon feedings can be adjusted or removed to avoid birds eating during the hottest time of the day.
- One longer time gap between two afternoon feedings can be provided to encourage birds to consume fine feed particles and clean up feeders.
- Typically, the flock will consume 60% of the daily total feed in the afternoon.
- A feeder full of coarse limestone available during the afternoon hours can be helpful to maintain a good skeleton and shell quality.



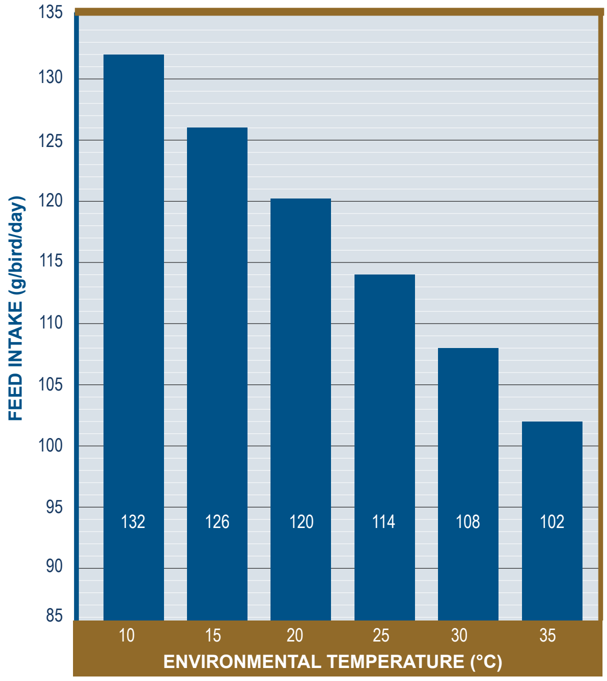
Stacked feeding programme.

Last Feeding

- The last feeding is typically 1.5–2 hours before lights off. Last feeding should coincide with the closing of nests.
- Last feeding is critical to ensure good nutrient supply for egg formation during the night.
- If large particle calcium supplementation (top dressing) is used, it is generally included in this last feeding.
- **Stacked afternoon feeding programme** (two feeder runs one hour apart) is an optional programme to encourage feed consumption before lights go off. Stacked feedings provide more feeding opportunities to more hens. This may be beneficial when eggshell quality problems exist.

Feed Consumption

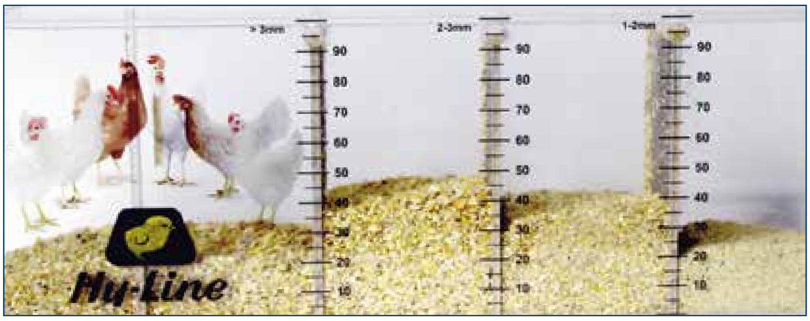
- Hens should always have access to feed.
- A phase-feeding programme should be practiced to ensure correct nutrient consumption throughout lay. The purpose of phase feeding is to match nutrient intake with requirements by the bird.
- Layer diets should be formulated according to the actual feed consumption and level of desired production (egg mass output).
- Reduce feed depth to a lower level in the middle of the day to ensure the consumption of smaller feed particles.
- Stimulate feed consumption by running feeders without adding additional feed.
- Manage feeders so that additional feedings do not create excessive fine feed particles.
- The hens' feed consumption rate is governed by several factors, including body weight (or age), egg mass output, ambient temperature, feed texture, health status, and the energy density of the diet.
- Laying hens have limited capacity to adjust their feed consumption to meet their needs for specific nutrients. It is important that performance and feed intake is monitored so that necessary adjustments to diet density can be made.
- After 10 weeks of age, brown pullets tend to be more responsive to the nutrient density of the diet from the point of feed intake—in other words, hens will consume more of a low-energy diet than a high-energy diet.
- Heat stress results in lower feed and therefore lower nutrient intake. Increasing the digestibility of the feed, in particular amino acids, and providing adequate energy in the form of lipids can result in better body weight gain, egg production, and egg weight when the effective ambient temperature is high. For more information, see Understanding Heat Stress in Layers at hyline.com.
- Fats or oils are concentrated sources of energy and can be useful in increasing the energy content and palatability of feed.
- During heat stress, do not increase the energy at the same proportion of the percentage of the feed intake drop, as this will further limit feed intake.
- Vitamins, minerals, and amino acids should be adjusted according to feed intake.
- Vegetable oils are typically high in linoleic acid, which is useful for increasing egg size up to certain limits. A blend of unsaturated vegetable oils will have the same effect.



Approximate relationship between feed intake and environmental temperature.

Feed Particle Size (Grist)

- A sieve shaker (see below) separates a feed sample into categories based on particle size.
- Use on the farm to check the feed particle size from the feed mill by testing delivery samples. Testing feed in the farm system can be done; however, bird manipulation of the feed in troughs can have misleading effects. Assess samples from the feeding system by taking samples from various points along the entire track.
- Too many fine feed particles (<1 mm) results in:
  - Decreased feed intake
  - Increased dust levels in the facility
- Too many coarse feed particles results in:
  - Birds selectively eating large particles, creating uneven nutrient intake
  - Increased risk of feed separation



Hy-Line sieve shaker.

- Separation of large particles is a particular problem with flat chain feeders.
- Feed segregation with coarser presentations is also a problem in large feed bins, where free falls are higher than 4 m (from the tip of the truck auger to the bottom of the bin).

Optimal Feed Particle Profile

PARTICLE SIZE	STARTER	GROWER	DEVELOPER	PRODUCTION
< 1 mm	1–3 mm diameter, crumb feed should contain < 10% fine feed particles	< 15%	< 15%	< 15%
1–2 mm		45–60%	25–35%	20–30%
2–3 mm		10–25%	25–40%	30–40%
> 3 mm		–	5–10%	10–15%

Best Practices

- A 3–4 hour gap in feedings at mid-day allows birds to consume fine particles.
- Add a minimum of 1% liquid oil/fat in meal diets to create a more homogenous meal.
- Use larger particle size meal or crumb to increase feed intake in hot climates.
- Use crumb starter feeds to promote feed intake and even nutrient uptake in chicks.
- Use a coarse mash feed for Grower, Developer, Pre-Lay, and Layer.

Grit

Grit is given to the flock to increase development of the crop and gizzard. Grit improves gizzard function and helps to grind up ingested forage material and increases the digestibility of nutrients in the feed.

There are two types of grit:

AGE	PARTICLE SIZE OF GRIT	AMOUNT
< 3 Weeks	0.2 mm	1 g/bird in feed
6–11 Weeks	3–5 mm	2 g in feed
11–16 Weeks	5–6 mm	4 g in feed or separate feeders
Layers	6–8 mm	7 g/week

- **Soluble grit**—Soluble grit is added to every poultry diet in the form of limestone or oyster shell. Other marine shells can be used as soluble grit as well. To ensure proper shell formation and to reduce the risk of soft bones, soluble grit should be added to the diet to achieve Hy-Line recommended calcium specification levels.
- **Insoluble grit**—Insoluble or flint grit is an indigestible stone that is either added to the diet or picked up while foraging. Pastured birds should receive grit to help them break down grasses, seeds, and insects they consume.

For more information regarding feed distribution, feeder types, and other granulometry factors, see Feed Granulometry and the Importance of Feed Particle Size in Layers at hyline.com.

Feed Ingredient Tables

INGREDIENT (as-fed basis)	DRY MATTER (%)	CRUDE PROTEIN (%)	FAT–ether extract (%)	CRUDE FIBRE	CALCIUM (%)	PHOSPHORUS total (%)	PHOSPHORUS available (%)	SODIUM (%)	CHLORIDE (%)	POTASSIUM (%)	Sulphur (%)	ME (kcal/lb)	ME (kcal/kg)	ME (MJ/kg)	LINOLEIC ACID (%)	CHOLINE (mg/kg)
Barley, grain	89.0	11.5	1.9	5.0	0.08	0.42	0.15	0.03	0.14	0.56	0.15	1250	2750	11.51	1.1	1027
Beans, broad (vicia faba)	89.0	25.7	1.4	8.2	0.14	0.54	0.20	0.08	0.04	1.20	–	1100	2420	10.13	0.9	1670
Calcium carbonate (38% Ca)	99.0	–	–	–	38.00	–	–	0.06	–	0.06	–	–	–	–	–	–
Canola meal (38%)[1]	91.0	38.0	3.8	11.1	0.68	1.20	0.40	–	–	1.29	1.00	960	2110	8.83	–	6700
Corn, yellow, grain	86.0	7.5	3.5	1.9	0.01	0.28	0.12	0.02	0.04	0.33	0.08	1530	3373	14.11	1.9	1100
Corn gluten meal (60%)	90.0	60.0	2.0	2.5	0.02	0.50	0.18	0.03	0.05	0.45	0.50	1700	3740	15.65	1.8	2200
Cottonseed meal (41%), mech. extd	91.0	41.0	3.9	12.6	0.17	0.97	0.32	0.04	0.04	1.20	0.40	955	2100	8.79	0.8	2807
Cottonseed meal (41%), direct solv.	90.0	41.0	2.1	11.3	0.16	1.00	0.32	0.04	0.04	1.16	0.30	915	2010	8.41	0.4	2706
Dicalcium phosphate (18.5% P)	99.0	–	–	–	22.00	18.50	18.50	0.08	–	0.07	–	–	–	–	–	–
DL-Methionine	99.0	58.1	–	–	–	–	–	–	–	–	–	2277	5020	21.00	–	–
Fat, animal	99.0	–	98.0	–	–	–	–	–	–	–	–	3600	7920	33.14	–	–
Fat, vegetable	99.0	–	99.0	–	–	–	–	–	–	–	–	4000	8800	36.82	40.0	–
Fish meal, anchovy, Peruvian	91.0	65.0	10.0	1.0	–	–	–	0.88	0.60	0.90	0.54	1280	2820	11.80	0.1	5100
Fish meal, white	91.0	61.0	4.0	1.0	–	–	–	0.97	0.50	1.10	0.22	1180	2600	10.88	0.1	4050
Flaxseed	92.0	22.0	34.0	6.5	–	–	–	0.08	–	1.50	–	1795	3957	16.56	54.0	3150
L-Lysine	99.0	93.4	–	–	–	–	–	–	–	–	–	1868	4120	17.24	–	–
L-Threonine	99.0	72.4	–	–	–	–	–	–	–	–	–	1619	3570	14.94	–	–
L-Tryptophan	99.0	84.0	–	–	–	–	–	–	–	–	–	2653	5850	24.48	–	–
Linseed meal flax, expeller	90.0	32.0	3.5	9.5	0.40	0.80	–	0.11	–	1.24	0.39	700	1540	6.44	0.5	672
Linseed meal flax, solvent	88.0	33.0	0.5	9.5	0.35	0.75	–	0.14	–	1.38	0.39	635	1400	5.86	0.1	1760
Meat and bone meal, 50%	93.0	50.0	8.5	2.8	9.20	4.70	4.70	0.80	0.75	1.40	0.40	1150	2530	10.59	0.5	2000
Millet, pearl grain	90.0	12.0	4.2	1.8	0.05	0.30	0.10	0.04	0.64	0.43	0.13	1470	3240	13.56	1.3	789
Mono-dicalcium phosphate (21% P)	99.0	–	–	–	16.00	21.00	–	0.05	–	0.06	–	–	–	–	–	–
Oats, grain	90.0	11.0	4.0	10.5	0.10	0.35	0.14	0.07	0.12	0.37	0.21	1160	2550	10.67	2.4	1070
Peanut meal, solvent	90.0	47.0	2.5	8.4	0.08	0.57	0.18	0.07	0.03	1.22	0.30	1217	2677	11.20	0.5	1948
Poultry byproduct meal (feed grade)	94.0	57.0	14.0	2.5	5.00	2.70	2.70	0.30	0.55	0.60	0.50	1406	3100	12.97	0.7	5980
Rice bran, unextracted	91.0	13.5	5.9	13.0	0.10	1.70	0.24	0.10	0.07	1.35	0.18	925	2040	8.54	5.2	1948
Rice, grain, rough	89.0	7.3	1.7	10.0	0.04	0.26	0.09	0.04	0.06	0.34	0.10	1335	2940	12.30	0.83	5980
Safflower seed meal, expeller	91.0	20.0	6.6	32.2	0.23	0.61	0.20	0.05	0.16	0.72	0.10	525	1160	4.85	–	800
Salt, NaCl	99.0	–	–	–	–	–	–	39.34	60.66	–	–	–	–	–	–	–
Sodium bicarbonate, $NaHCO_3$	99.0	–	–	–	–	–	–	27.38	–	–	–	–	–	–	–	–
Sorghum, milo, grain	89.0	11.0	2.8	2.0	0.04	0.29	0.10	0.03	0.09	0.34	0.09	1505	3310	13.85	1.3	678
Soybeans, full-fat, cooked	90.0	38.0	18.0	5.0	0.25	0.59	0.20	0.04	0.03	1.70	0.30	1520	3350	14.02	9.9	2420
Soybean meal, expeller	89.0	42.0	3.5	6.5	0.20	0.60	0.20	0.04	0.02	1.71	0.33	1100	2420	10.13	1.8	2673
Soybean meal, solvent	90.0	44.0	0.5	7.0	0.25	0.60	0.20	0.04	0.02	1.97	0.43	1020	2240	9.37	0.3	2743
Sunflower meal, expeller	93.0	41.0	7.6	21.0	0.43	1.00	0.25	0.20	0.01	1.00	0.10	1050	2310	9.67	6.5	–
Sunflower meal, partially dehul, solv.	92.0	34.0	0.5	13.0	0.30	1.25	0.27	0.20	0.01	1.60	0.38	1025	2260	9.46	0.2	1909
Triticale	90.0	12.5	1.5	2.59	0.05	0.30	0.10	–	0.07	–	0.20	1430	3150	13.18	0.9	460
Wheat, hard grain	88.0	13.5	1.9	3.0	0.05	0.41	0.12	0.06	0.07	0.50	0.10	1440	3170	13.26	1.00	778
Wheat, soft grain	86.0	10.8	1.7	2.8	0.05	0.30	0.11	0.06	0.07	0.40	0.10	1460	3210	13.43	1.00	778
Wheat bran	89.0	14.8	4.0	10.0	0.14	1.17	0.38	0.06	0.14	1.20	0.22	590	1300	5.44	2.10	980
Wheat middlings	89.0	15.0	3.6	8.5	0.15	1.17	0.45	0.06	0.07	0.60	0.16	950	2090	8.74	1.90	110

Nutrient recommendations are based on calculations using these energy and nutrient values (source: 2018–2019 Feedstuffs Reference Issue and field data). Values provided are "typical" based on ingredient surveys. Nutrient values should be confirmed by analysis of the materials being used in order to maintain an accurate formulation matrix.

[1] For more information, see Feeding Rapeseed Meal or Canola Meal to Hy-Line Brown and Hy-Line Silver Brown Hens at hyline.com.

INGREDIENT (as-fed basis)	CRUDE PROTEIN (%)	LYSINE (%)		METHIONINE (%)		CYSTINE (%)		THREONINE (%)		TRYPTOPHAN (%)		ARGININE (%)		ISOLEUCINE (%)		VALINE (%)	
		Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content	Total content	Digestible content
Barley, grain	11.50	0.53	0.41	0.18	0.14	0.25	0.20	0.36	0.28	0.17	0.12	0.50	0.43	0.42	0.34	0.62	0.50
Beans, broad (vicia faba)	25.70	1.52	1.29	0.25	0.18	0.14	0.09	0.98	0.77	0.24	0.16	2.20	1.91	1.00	0.73	1.22	0.88
Canola meal (38%)[1]	91.0	2.02	1.60	0.77	0.69	0.97	0.71	1.50	1.17	0.46	0.38	2.30	2.07	1.51	1.25	1.94	1.59
Corn, yellow, grain	7.50	0.24	0.19	0.18	0.16	0.18	0.15	0.29	0.24	0.07	0.06	0.40	0.36	0.29	0.26	0.42	0.37
Corn gluten meal (60%)	60.00	1.00	0.88	1.90	1.84	1.10	0.95	2.00	1.84	0.30	0.25	1.90	1.82	2.30	2.19	2.70	2.57
Cottonseed meal (41%), mech. extd	41.00	1.52	0.99	0.55	0.40	0.59	0.44	1.30	0.88	0.50	0.39	4.33	3.81	1.31	0.93	1.84	1.36
Cottonseed meal (41%), direct solv.	41.00	1.70	1.11	0.51	0.37	0.62	0.46	1.31	0.89	0.52	0.41	4.66	4.10	1.33	0.95	1.82	1.34
DL-Methionine	58.10	–	–	99.00	99.00	–	–	–	–	–	–	–	–	–	–	–	–
Fish meal, anchovy, Peruvian	65.00	4.90	4.21	1.90	1.63	0.60	0.43	2.70	2.17	0.75	0.59	3.38	2.77	3.00	2.55	3.40	2.82
Fish meal, white	61.00	4.30	3.70	1.65	1.42	0.75	0.54	2.60	2.09	0.70	0.55	4.20	3.44	3.10	2.64	3.25	2.70
Flaxseed	22.00	0.92	0.79	0.35	0.30	0.42	0.30	0.77	0.62	0.22	0.17	2.05	1.68	0.95	0.81	1.17	0.97
L-Lysine	93.40	78.80	78.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L-Threonine	72.40	–	–	–	–	–	–	98.50	98.50	–	–	–	–	–	–	–	–
L-Tryptophan	84.00	–	–	–	–	–	–	–	–	98.00	98.00	–	–	–	–	–	–
Linseed meal flax, expeller	32.00	1.10	0.99	0.47	0.37	0.56	0.44	1.10	1.00	0.47	0.43	2.60	2.39	1.70	1.49	1.50	1.29
Linseed meal flax, solvent	33.00	1.10	0.99	0.48	0.38	0.58	0.45	1.20	1.10	0.48	0.44	2.70	2.48	1.80	1.58	1.60	1.38
Meat and bone meal, 50%	50.00	2.60	2.05	0.67	0.57	0.33	0.19	1.70	1.34	0.26	0.13	3.35	2.85	1.70	1.41	2.25	1.85
Millet, pearl grain	12.00	0.35	0.32	0.28	0.25	0.24	0.20	0.44	0.37	0.20	0.18	0.55	0.49	0.52	0.46	0.70	0.62
Oats, grain	11.00	0.40	0.35	0.20	0.17	0.21	0.18	0.28	0.24	0.18	0.14	0.80	0.75	0.53	0.47	0.62	0.55
Peanut meal, solvent	47.00	1.52	1.29	0.50	0.44	0.60	0.47	1.12	0.91	0.42	0.39	4.76	4.28	1.50	1.32	1.80	1.57
Poultry byproduct meal (feed grade)	57.00	2.25	1.80	0.91	0.78	0.90	0.55	1.88	1.50	0.50	0.26	3.50	3.08	2.10	1.79	2.32	1.93
Rice bran, unextracted	13.50	0.50	0.38	0.17	0.13	0.10	0.07	0.40	0.28	0.10	0.08	0.45	0.39	0.39	0.30	0.60	0.46
Rice, grain, rough	7.30	0.24	0.19	0.14	0.13	0.08	0.07	0.27	0.22	0.12	0.11	0.59	0.54	0.33	0.27	0.46	0.39
Safflower seed meal, expeller	20.00	0.70	0.58	0.40	0.35	0.58	0.45	0.47	0.34	0.30	0.24	1.20	1.01	0.28	0.22	1.00	0.87
Sorghum, milo, grain	11.00	0.27	0.21	0.10	0.09	0.20	0.17	0.27	0.22	0.09	0.08	0.40	0.30	0.60	0.53	0.53	0.46
Soybeans, full-fat, cooked	38.00	2.40	2.16	0.54	0.49	0.55	0.45	1.69	1.43	0.52	0.46	2.80	2.60	2.18	1.94	2.02	1.78
Soybean meal, expeller	42.00	2.70	2.43	0.60	0.54	0.62	0.51	1.70	1.44	0.58	0.52	3.20	2.97	2.80	2.49	2.20	1.94
Soybean meal, solvent	44.00	2.70	2.43	0.65	0.58	0.67	0.55	1.70	1.44	0.60	0.53	3.40	3.16	2.50	2.22	2.40	2.11
Sunflower meal, expeller	41.00	2.00	1.74	1.60	1.47	0.80	0.64	1.60	1.31	0.60	0.52	4.20	3.91	2.40	2.14	2.40	2.08
Sunflower meal, partially dehul, solv.	34.00	1.42	1.19	0.64	0.60	0.55	0.43	1.48	1.26	0.35	0.30	2.80	2.32	1.39	1.25	1.64	1.41
Triticale	12.50	0.39	0.35	0.26	0.23	0.26	0.22	0.36	0.31	0.14	0.12	0.48	0.39	0.76	0.70	0.51	0.44
Wheat, hard grain	13.50	0.40	0.32	0.25	0.22	0.30	0.26	0.35	0.29	0.18	0.16	0.60	0.53	0.69	0.61	0.69	0.59
Wheat, soft grain	10.80	0.30	0.24	0.14	0.12	0.20	0.17	0.28	0.23	0.12	0.11	0.40	0.35	0.43	0.38	0.48	0.41
Wheat bran	14.80	0.60	0.43	0.20	0.15	0.30	0.22	0.48	0.35	0.30	0.24	1.07	0.88	0.60	0.47	0.70	0.54
Wheat Middlings	15.00	0.70	0.56	0.12	0.10	0.19	0.14	0.50	0.36	0.20	0.16	1.00	0.80	0.70	0.58	0.80	0.61

Amino acid digestibility is standardised ileal digestibility. Amino acid values are standardised for 88% dry matter (source: 2018–2019 Feedstuffs Reference Issue and field data). Values provided are "typical" based on ingredient surveys. Nutrient values should be confirmed by analysis of the materials being used in order to maintain an accurate formulation matrix.

[1] For more information, see Feeding Rapeseed Meal or Canola Meal to Hy-Line Brown and Hy-Line Silver Brown Hens at hyline.com.

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Diseases

An Overview of Focal Duodenal Necrosis (FDN)
MG Control in Commercial Layers
Colibacillosis in Layers: An Overview
Fowl Pox in Layers
Avian Urolithiasis (Visceral Gout)
Infectious Bursal Disease (IBD, Gumboro)
Fatty Liver Hemorrhagic Syndrome
Infectious Laryngotracheitis (ILT)
Intestinal Dilation Syndrome (IDS)
Newcastle Disease
Mycoplasma Synoviae (MS)
Low Pathogenic Avian Influenza (LPAI)

Diagnostic Samples and Breeder Flock Monitoring

Salmonella, *Mycoplasma*, and Avian Influenza Monitoring in Parent Breeder Flocks
Proper Collection and Handling of Diagnostic Samples

Management

Growing Management of Commercial Pullets
Understanding the Role of the Skeleton in Egg Production
The Science of Egg Quality
Understanding Poultry Lighting
Understanding Heat Stress in Layers
Infrared Beak Treatment
Feed Granulometry and the Importance of Feed Particle Size in Layers
Impact of Tarp Colour on Poultry Lighting
SPIDES (Short Period Incubation During Egg Storage)
Fly Management: Surveillance and Control
Optimising Egg Size in Commercial Layers
Vaccination Recommendations
Egg Drop Syndrome (EDS)
Managing Fully Beaked Flocks
Thiamin Deficiency in Pullets
Understanding Nesting Behaviour

PRODUCT UPDATES

Hy-Line Brown – Selecting for Superior Egg Quality
Feeding Rapeseed Meal or Canola Meal to Hy-Line Brown and Hy-Line Silver Brown Hens

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