PARENTSTOCK

Pocket Guide

2013

The Pocket Guide

This Pocket Guide was produced to compliment the Ross® Parent Stock Management Handbook. It should be used for quick and practical reference. Each section contains cross-references to the relevant section of the Parent Stock Management Handbook.

This Pocket Guide is not intended to provide definitive information on every aspect of parent stock management, but draws attention to important features which, if overlooked, may depress flock performance.

Performance

This Pocket Guide summarizes best practice management for parent stock that receive first light stimulation after 147 days/21 weeks of age and achieve 5% production at 25 weeks of age. However, poultry production is a global activity and across the world, differing management strategies may need to be adapted for local conditions.

The information within this Pocket Guide cannot wholly protect against performance variations which may occur for a wide variety of reasons. The management techniques covered are considered to be the most appropriate to achieve good performance, consistent with maintaining the health and welfare of the bird.

For further information on the management of Ross parent stock, please contact your local Technical Service Manager or the Technical Service Department.

www.aviagen.com

Contents

Key Management Timetable

Age (days)	Action
Before chick delivery	Preheat the house. Temperature and relative humidity (RH) should be stabilized for at least 24 hours, prior to the chicks being delivered. All housing and equipment should be cleaned and disinfected and efficacy of the biosecurity operations verified prior to chick placement.
On chick arrival	Achieve optimum environmental conditions. Establish a minimum ventilation rate. Monitor chick behavior to ensure that temperature is satisfactory. Bulk weigh a sample of chicks.
0-7	Develop appetite from good brooding practice. Provide good quality feed and maintain optimum temperatures. Ensure adequate drinker and feeder space. Use crop fill assessment as an indication of appetite development. Monitor bird behavior.
7-14	Achieve target body weights. Obtain body-weight sample. Where possible, provide a constant (8-hour) daylength by 10 days of age.
14-21	Start recording individual body weights and calculate uniformity (CV%) between 14 and 21 days/2 and 3 weeks of age.

Age (days)	Action
28	Grade males and females at 28 days/4 weeks. After grading, revise body-weight profiles to achieve target body weights by 63 days/9 weeks.
28-63	Adjust daily feed allocation for the male and female populations to achieve any revised body-weight targets, and maintain uniformity. Monitor and record body weight weekly.
63	Check graded population weights and combine populations that are of similar weight and feed intake. If populations are not following the target profile, a new target body-weight line should be drawn. Movement of birds between populations should stop.
63-105	Adjust daily feed allocation for the male and female populations to achieve the target or any revised body-weight targets, and maintain uniformity. Monitor and record body weight weekly.
105	Re-examine body weights in relation to target. Revise profiles as necessary. Remove any sexing errors as they are identified.
105-161	Achieve correct weekly body-weight gains by ensuring the appropriate feed amounts are given. All populations should achieve similar body weights by light stimulation. Monitor and record body weight weekly.
126-147	Remove remaining sexing errors.
140	Calculate and record the uniformity (CV%) of the flock to determine the lighting program.

Age (days)	Action
147-161	First light increase given (not before 147 days of age). Monitor and record body weight weekly.
147-168	Mating-up - the exact time of this will depend on the relative maturity of both males and females. Monitor and record body weight weekly.
168-175	Introduce the breeder feed from 5% hen-day production at the latest.
161-196	From first egg, increase feed amounts according to the rate of daily egg production, daily egg weight, and body weight. Monitor and record body weight weekly.
210-depletion	Manage males by observing bird condition. Remove non-working males to maintain appropriate mating ratios. Monitor and record body weight.
245-depletion	Feed reduction should be started approximately 35 days/5 weeks after peak production is achieved. Feed intake should be reviewed weekly and any reductions in feed should be based on egg production, daily egg weight, egg mass, and body weight.

BIRD HANDLING

It is important that all birds are handled in a calm and correct way at all times. All people handling birds (for catching, weighing, physical assessment, crop fill assessment, or vaccination) should be experienced and appropriately trained so that they can handle the birds with the care that is appropriate for the purpose, age, and sex of the bird.

Section 1

Rearing (0-105 days/0-15 weeks)

Objective

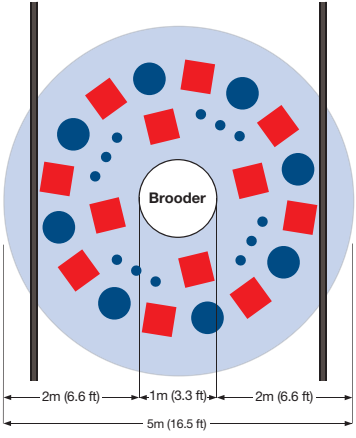
To meet the requirements of male and female parent stock during each stage of rearing, and to prepare them for sexual maturity.

Management Requirements for Males and Females During Rear

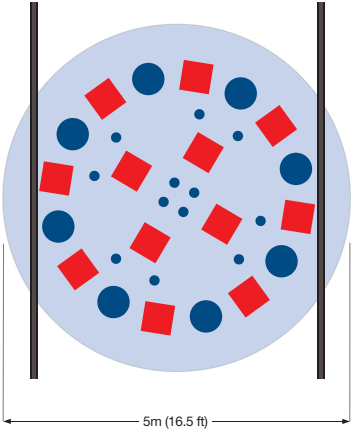
Farm Preparation for Chick Arrival

- Houses should be cleaned and disinfected prior to chick arrival.
- Be prepared - know what is coming and when.
- Plan placements so that chicks from different aged donor flocks can be brooded separately.
- Chick holding and transport environment should be monitored closely to prevent the chicks from becoming chilled or over-heated.
- Plan areas for grading.
- Ensure that the correct conditions are achieved at least 24 hours before chick arrival.
- At placement, the environmental conditions required are:
  - An air temperature of 30°C/86°F (measured at chick height in the area where feed and water are positioned).
  - A floor temperature of 28-30°C (82-86°F).
  - A RH of 60-70%.
- Litter material should be spread at a depth of:
  - 8-10 cm (3-4 in) for track feeding.
  - 4 cm (1.5 in) for floor feeding or where litter disposal is an issue.
- Chicks should not have to travel more than 1 m (3.3 ft) for access to water.
- Chicks should have unobstructed access to both feed and water.

Examples of a typical spot brooding layout (1,000 chicks) on top and a typical whole-house brooding layout (1,000 chicks) on bottom.



Spot Brooding



Whole-house Brooding

- Check all drinker heights are correct.
- Water temperature should be at 15-20°C (59-68°F).
- Bleed water lines just prior to chick arrival to ensure water is as fresh as possible.

Brooding Management

- Frequently monitor house temperature and RH, adjust where necessary.
- Replenish feed and water regularly during the first 3 days.
- Provide maximum daily feed allocation in small amounts given frequently (i.e. 5-6 times per day) and remove supplementary drinkers completely by 3-4 days of age.
- Expand brooding rings (if used), gradually from 3 days of age and remove brooding rings completely by 5-7 days.
- Open-sourced drinkers should be cleaned out regularly.
- Position supplementary feeders and drinkers near to the main feeding and drinking systems.
- Check feed, water temperature, and RH 1-2 hours after placement and adjust where necessary.

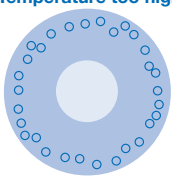
MANAGEMENT FUNDAMENTAL

Monitor chick behavior.

Spot Brooding Behavior

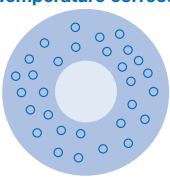
The following diagram illustrates bird distribution under brooders. The brooder is illustrated by the light blue circle in the center of each diagram.

Temperature too high



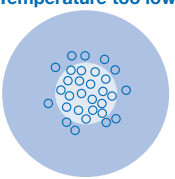
Chicks make no noise.
Chicks pant, head and wings droop.
Chicks away from brooder.

Temperature correct



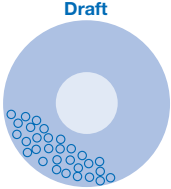
Chicks evenly spread.
Noise level signifies contentment.

Temperature too low



Chicks crowd to brooder.
Chicks noisy, distress-calling.

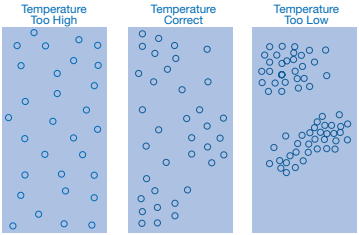
Draft



This distribution requires investigation.
Influenced by draft,uneven light distribution,external noises.

Whole-house Brooding Behavior

The diagram below illustrates typical behavior of chicks in whole-house brooding.



Temperature and Humidity

The following table shows the dry bulb temperatures required to achieve equivalent temperatures at varying RH. Dry bulb temperatures at the ideal RH are colored red.

	Dry Bulb Temperature at RH%* °C (°F)				
Age (days)	**40**	**50**	**60**	**70**	**80**
Day-old	36.0 (96.8)	33.2 (91.8)	30.8 (84.4)	29.2 (84.6)	27.0 (80.6)
3	33.7 (92.7)	31.2 (88.2)	28.9 (84.0)	27.3 (81.1)	26.0 (78.8)
6	32.5 (90.5)	29.9 (85.8)	27.7 (81.9)	26.0 (78.8)	24.0 (75.2)
9	31.3 (88.3)	28.6 (83.5)	26.7 (80.1)	25.0 (77.0)	23.0 (73.4)
12	30.2 (86.4)	27.8 (82.0)	25.7 (78.3)	24.0 (75.2)	23.0 (73.4)
15	29.0 (84.2)	26.8 (80.2)	24.8 (76.6)	23.0 (73.4)	22.0 (71.6)
18	27.7 (81.9)	25.5 (77.9)	23.6 (74.5)	21.9 (71.4)	21.0 (69.8)
21	26.9 (80.4)	24.7 (76.5)	22.7 (72.9)	21.3 (70.3)	20.0 (68.0)
24	25.7 (78.3)	23.5 (74.3)	21.7 (71.1	20.2 (68.4)	19.0 (66.2)
27	24.8 (76.6)	22.7 (72.9)	20.7 (69.3)	19.3 (66.7)	18.0 (64.4)

**Temperature calculations based on a formula from Dr. Malcolm Mitchell (Scottish Agricultural College).*

- Adjust temperature settings accordingly if RH increases above 70% or falls below 60%.
- Monitor temperature and humidity regularly. Check automatic equipment with manual measurements at chick level.

Lighting

The following table shows the recommended lighting program for rearing birds 0-147 days/0-21 weeks of age.

Age (days)	Daylengths* (hours)	Light Intensity†
1	23	80-100 lux (8-10 foot candles) in brooding area. 10-20 lux (1-2 foot candles) in the house.
2	23	
3	19	
4	16	
5	14	
6	12	30-60 lux (3-6 foot candles) in the brooding area. 10-20 lux (1-2 foot candles) in the house.
7	11	
8	10	
9	9	
10-146	8	10-20 lux (1-2 foot candles).

** Constant 8-hour daylengths should be reached by 10 days of age. However, if problems have regularly occurred with early body-weight gain, the reduction to a constant daylength may be more gradual so that 8 hours is not reached until 21 days.*

† Average intensity within a house or pen measured at bird-head height. Light intensity should be measured in at least 9 or 10 places and include the corners, under lamps and between lamps. During the dark period (interpreted as night) a light intensity of ≤ 0.4 lux (0.04 foot candles) should be achieved. Ideally, variation in light intensity within the house should not exceed 10% of the mean.

- If reared in open-sided housing, broiler breeders should be allowed to experience whatever changes occur in the natural daylength.
- Ensure males and females are synchronized in terms of sexual maturity by rearing them on the same lighting program.

Chick Start Assessment

MANAGEMENT FUNDAMENTAL

Crop fill should be assessed and monitored during the first 48 hours, but achieving the correct crop fill in the first 24 hours is the most critical.

PROCEDURE

Crop Fill

1. Collect 30-40 chicks at 3-4 different places in the house (or surround where spot brooding is used).
2. Gently feel the crop of each chick.
   - » Full, soft and rounded - chicks have found feed and water
   - » Full but hard with original feed texture felt - chicks have feed but little/no water.

The chick on the left has a full, rounded crop while the chick on the right has an empty crop indicating it has not found feed or water.

The following table shows target crop fill assessment guidelines.

Time of Crop Fill Check After Placement	Target Crop Fill (% of Chicks with Full Crops)
2 hours	75
8 hours	>80
12 hours	>85
24 hours	>95
48 hours	100

MANAGEMENT FUNDAMENTAL

If target levels of crop fill are not being achieved then something is preventing the chicks from feeding and drinking, and action must be taken to resolve this.

Equipment and Facilities

The following table shows the recommended stocking densities during rear (from 14 days onward).

Rearing 14-105 days/2-15 weeks	
Males Birds/m^2 (ft^2/bird)	Females Birds/m^2 (ft^2/bird)
3-4 (2.7-3.6)	4-7 (1.5-2.7)

- If stocking density is increased, then ventilation, feeders, and drinkers must also be increased appropriately.
- If the environment and/or housing conditions experienced by the birds are not optimal the stocking density will need to be reduced.
- Follow the local legislation.
- When calculating floor space make sure necessary reductions are made for any equipment in the bird area.

The following table shows feeder and drinker space from 0-105 days/15 weeks.

	Feeding Space			
	Male		Female	
Age (days)	Track Feeder cm (in)	Pan Feeder cm (in)	Track Feeder cm (in)	Pan Feeder cm (in)
0-35 days	5 (2)	5 (2)	5 (2)	4 (2)
36-70 days	10 (4)	9 (3.5)	10 (4)	8 (3)
71-105 days	15 (6)	11 (4)	15 (6)	10 (4)

- Ensure there is enough feeding space for the number of birds in the house.
- Spacing between feeders should allow the birds easy access.
- The distance between feeders should be a 1 m (3.3 ft), for easy access.

Uniform distribution of females around a track feeder when adequate feeder space is given.

Uniform distribution of males around a pan feeder when adequate feeding space is given.

Feeding Management

PROCEDURE

Transition from Floor to Automated Track Feeding

1. Gradually increase the amount of feed in the automated system from 8 days of age onward. Continue to hand feed any remaining feed and complete transition to automated system by 10-11 days of age.
2. If more than one feed track is used, operate them in opposite directions.
3. Feed distribution time must be 3 minutes or less to each population.
4. Use supplementary feeders (feed hoppers/satellite bins) where necessary to reduce feed distribution time.
5. Feeder height must be adjusted appropriately for bird age and growth.

- Where floor feeding is used:
  - Pen population size should be 1000-1500 birds (depending on pen shape/spinner size).
  - Pellet size should be 2.5 mm (3/32 in) diameter and 3-4 mm (1/8 in) in length.
  - Good physical feed form is essential.

PROCEDURE

Transition from Floor to Automated Spin Feeder

1. Feed crumb in feed trays until approximately 14 days of age.
2. Mix crumb and pellet feed on floor/feeder trays for at least 2 days.
3. Feed 100% pellet and start to use mechanical/spin feeders from 16 days onward.

- Avoid storing feed for more than 7 days.

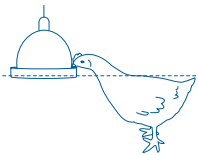
Drinker Management

The recommended drinking space requirements during rear (post brooding) are given below.

Type of Drinker	Drinker Space
Bell drinkers	1.5 cm (0.6 in)
Nipples	8-12 birds/nipple
Cups	20-30 birds/cup

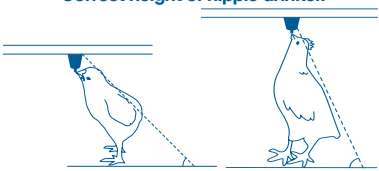
- Birds should have continual access to fresh, clean, drinkable water.
- The measurement of water consumption by metering is an essential daily management practice.
- Check and adjust drinker height daily.

Correct height of bell drinker.



From 18 days old the base of the drinker should be level with the bird's back.

Correct height of nipple drinker.



The back of the chick should be at 35-45° to the floor.

For older birds, drinker should be raised to form an angle of 75-85° with the floor.

- At 21°C (69.8°F) water intake ratio is 1.6-1.8:1 (water:feed).
- Test the water supply regularly for bacteriological and mineral contaminants and take any necessary corrective action.
- Where bacterial loads are high, treatment with chlorination to give 3-5 ppm of free chlorine may be required to reduce bacterial load of drinking systems.

Introduction of Perches

Perches should be installed from 28 days onward allowing 3 cm (1.2 in) per bird (sufficient for 20% of the birds to roost).

Monitoring Birds in Rear

Sample Weighing

- Growth and development in a flock are assessed and managed by weighing representative samples of birds and comparing them with target weight for age.
- Sample weighing should start at day-old and continue at least weekly.
- Individual bird weights should be taken from 14-21 days of age for calculation of CV%.
- Weigh birds at the same time each week using the same set of scales.
- Scale accuracy should be checked regularly.
- If sample weighing produces data inconsistent with previous weights or expected gains, weigh a second sample immediately to confirm.

PROCEDURE

Bulk Weighing Chicks at Placement

1. "Zero" scales used for weighing.
2. Weigh an empty chick box with the lid on and record the weight.
3. Count and record the number of chicks in each box.
4. Weigh the box with chicks and lid to obtain the total weight.
5. Subtract the box weight from the total weight.
6. Divide the remaining weight by the number of chicks in the box.
7. Plot average weights on a weight chart.

PROCEDURE

Bulk Weighing Chicks at 7 and 14 Days

1. Place an empty bulk weighing container onto the scales and set them to "zero".
2. Place 10-20 birds into the container and record the weight.
3. Empty the chicks from the container back into the main pen population and repeat this step until all birds caught have been weighed.
4. Add all bulk weights together and divide the total weight by the total number of chicks weighed in the pen. Plot this average weight on a weighing chart.

PROCEDURE

Individual Weighing After 14 Days

1. Suspend the scales in a secure place in the weighing pen, and ensure that they are set to "zero" with a shackle for holding birds firmly attached.
2. Using a catching pen, sample at least 2%, or 50 birds per population, whichever is greater. Male sample size should be increased to 10% after mating-up.
3. Birds should be sampled from 3 points within the house, away from doors and walls.
4. Calmly and correctly handle each bird, place it on the shackles, wait until it is still, and record the weight from the scale.
5. Release the bird back into the main pen population and repeat the process until ALL BIRDS CAUGHT have been weighed.

Assessment of Bird Condition

- Handle a representative sample of both males and females weekly during weighing from placement to determine overall flock condition.
- It is also good practice to catch and physically assess individual birds while doing a house 'walk-through'.
- Assessment of bird physical condition in rear is based primarily on body-weight monitoring and skeletal size (frame size and shank length).
- Monitoring shank length at feeding can give an indication of the uniformity of the flock.
- High variability in shank length is an indication of an uneven flock which should be monitored and investigated further.
- Be aware of the degree of fleshing, general health, alertness, and activity.

Grading to Manage Uniformity

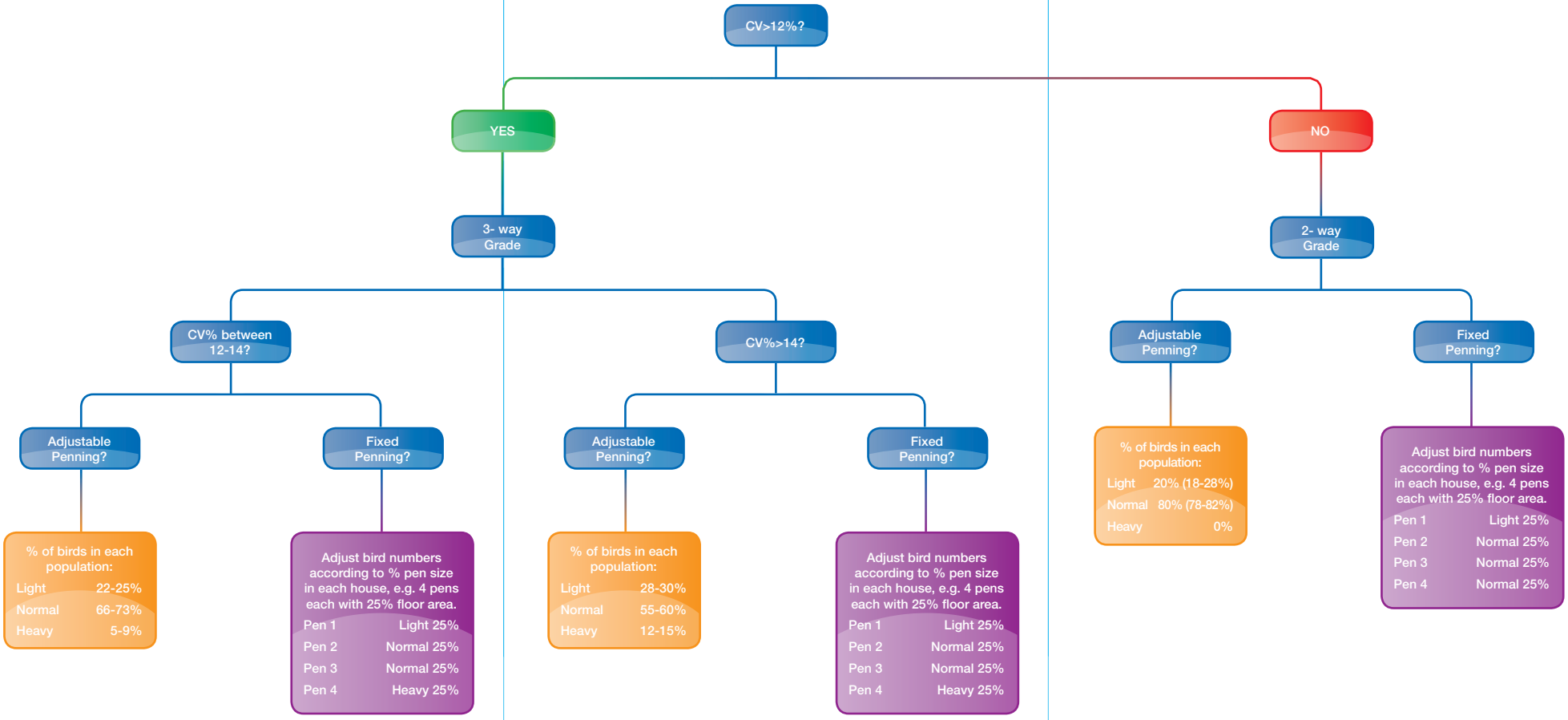
Grading Procedures

The actual grading procedure will largely depend on the farm/house design and management practices (e.g. flexibility of pen arrangements and feeding systems), and the uniformity of the flock at 28 days.

The table below shows grading cut off points.

Flock Uniformity CV%	Percentage in Each Population after Grading			
	2 or 3-way grade	Light (%)	Normal (%)	Heavy (%)
10 or greater	2-way grade	20	~ 80 (78-82)	0
12 or greater	3-way grade	22-25	~ 70 (66-73)	5-9
14 or greater	3-way grade	28-30	~ 58 (55-60)	12-15

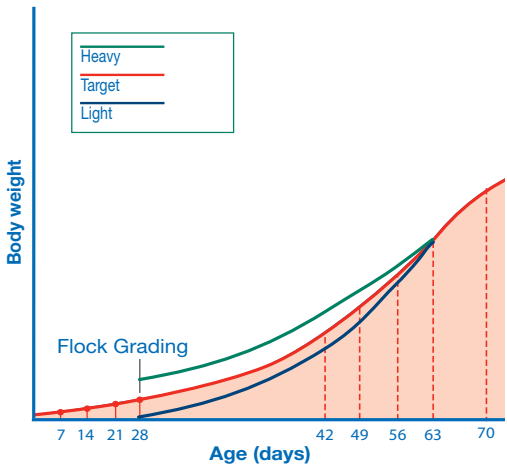
- Grade males and females at 28 days/4 weeks.
- From each pen/population a random sample of birds should be caught in a catching pen and weighed.
- All birds caught in the catching pen must be weighed to avoid selective weighing, but as a minimum, the weights of 2% of the pen/population or 50 birds, whichever is greater, need to be recorded.
- Birds are split into graded populations depending on CV% and weight.
- Grading cut off points for light, normal and heavy birds within a population can be determined by using the table above.
- After grading, the light population may not need to receive an immediate increase in feed. Body weight will increase due to the reduced competition from the larger birds and so an initial increase in feed is not required.
- Each graded population should be re-weighed and counted to confirm the average body weight and uniformity, so projected target body weights and feeding rates can be determined.
- Each graded population is best served by its own dedicated feeding system. Where this cannot be provided, supplementary feeding must allow even distribution of feed and adequate feeding space per bird.
- Ensure that stocking density, drinking and feeding space are consistent with the recommended guidelines after grading.
- A successful grading will reduce the CV% to below 8 in all of the graded populations.


CV>12%?
YES
NO
3- way Grade
2- way Grade
CV% between 12-14?
CV%>14?
Adjustable Penning?
Fixed Penning?
Adjustable Penning?
Fixed Penning?
Adjustable Penning?
Fixed Penning?
% of birds in each population:
Light 22-25%
Normal 66-73%
Heavy 5-9%
Adjust bird numbers according to % pen size in each house, e.g. 4 pens each with 25% floor area.
Pen 1 Light 25%
Pen 2 Normal 25%
Pen 3 Normal 25%
Pen 4 Heavy 25%
% of birds in each population:
Light 28-30%
Normal 55-60%
Heavy 12-15%
Adjust bird numbers according to % pen size in each house, e.g. 4 pens each with 25% floor area.
Pen 1 Light 25%
Pen 2 Normal 25%
Pen 3 Normal 25%
Pen 4 Heavy 25%
% of birds in each population:
Light 20% (18-28%)
Normal 80% (78-82%)
Heavy 0%
Adjust bird numbers according to % pen size in each house, e.g. 4 pens each with 25% floor area.
Pen 1 Light 25%
Pen 2 Normal 25%
Pen 3 Normal 25%
Pen 4 Normal 25%

Flock Management after Grading (Post 28 Days)

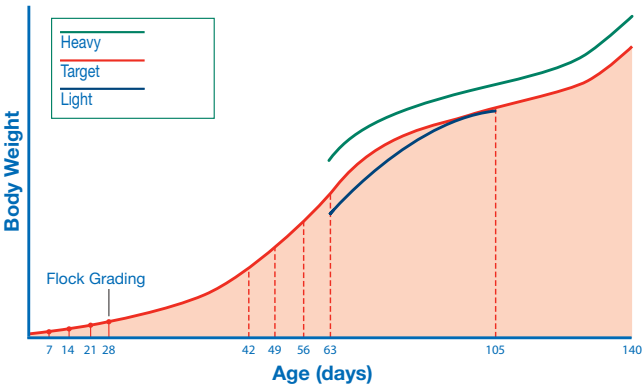
- After grading, the flock must be managed (body weight monitored weekly and feed allocations adjusted accordingly) so that graded populations achieve target weight in a uniform and coordinated manner within the period that skeletal development occurs (i.e. 63 days/9 weeks of age).

Re-drawing of future body-weight targets up to 63 days of age.



- At 63 days/9 weeks of age, the weight of the population in relation to targets should be re-assessed.

Re-drawing of future body weight targets when average body weight is below, on target, and above target at 63 days/9 weeks of age.



- Do not attempt to bring birds that are overweight at 63 days back to target, this will delay sexual maturity and reduce peak production.

MANAGEMENT FUNDAMENTAL

If population sizes in lay are likely to be larger than they were in rear, it is even more important that managment after grading ensures birds achieve a common weight by the age of transfer.

- It is especially important that management after grading results in the birds converging to a common target body weight by the expected age of transfer.
- Continue weekly body-weight monitoring.
- Care should be taken before mixing any pens to ensure body weight and feed consumption per bird are similar between pens.

Alleviation of Body Weight Problems

If the average body weight differs from target by +/-100 g (0.22 lb) or more, re-weigh a sample of birds. If the weights are correct, consider the following:

Underweight prior to 105 days, consider the following in current flocks:

- Initiate the next feed increase earlier and consider increasing the feed amount if necessary, until body weight is brought gradually back to target.

Overweight prior to 105 days:

- Do not reduce feed lower than the current feeding level.
- Reduce the next feed increment, e.g. 2 g (0.07 oz) per bird instead of 4 g (0.14 oz) per bird.
- Delay the next feed increase.
- Check to see if the energy level of the diet is higher than expected.

Records

Record keeping, and data analysis and interpretation, are an essential aid to effective management. Record keeping should be used in conjunction with target performance parameters. Records required to be kept are as follows:

Rearing
Breed
Source flock
Hatch date
Number of birds housed (male and female)
Floor area and stocking density
Feeder space per bird
Drinker space per bird
Feed/bird – daily, weekly and cumulative
Mortality and culls – daily, weekly and cumulative
Body weights, CV% and age of recording (male and female) – daily/weekly
External and internal temperatures - minimum and maximum and operating (internal only)
Water consumption – daily
Water:feed ratio
Sexing errors

Section 2

Management into Lay (15 Weeks to Peak Production)

Objective

To minimize variation in the onset of sexual maturity of the flock and to prepare the flock for the physiological demands of reproduction.

To bring the female into lay by stimulating and supporting egg production using feed and light. To promote and support female reproductive performance throughout the laying cycle.

From 105 Days (15 Weeks) to Light Stimulation

Management Considerations

Recommended stocking densities from 15 weeks of age.

	Stocking Density Birds/m² (ft²/bird)	Stocking Density Birds/m² (ft²/bird)
	15-20 weeks	20 weeks to depletion
Male	3-4 (2.7-3.6)	3.5-5.5 (2.0-3.1)
Female	4-7 (1.5-2.7)	

Recommended feeder and drinker space from 15 weeks of age.

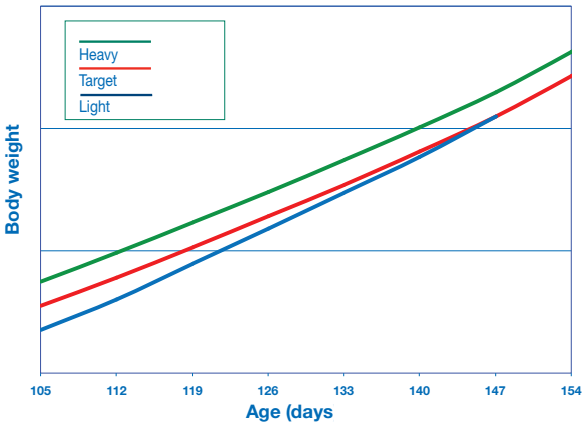
		Feeder		Drinker		
	Age	Track cm (in)	Pan cm (in)	Bell cm (in)	Nipple	Cups
Male	15-20 weeks	15 (6)	11 (4)	1.5 (0.6)	8-12 birds per nipple	20-30 birds per cup
	20 weeks to depletion	20 (8)	13 (5)	2.5 (1.0)	6-10 birds per nipple	15-20 birds per cup
Female	15-20 weeks	15 (6)	10 (4)	1.5 (0.6)	8-12 birds per nipple	20-30 birds per cup
	20 weeks to depletion	15 (6)	10 (4)	2.5 (1.0)	6-10 birds per nipple	15-20 birds per cup

Target Weight

Regular monitoring and recording of body weight and uniformity are essential management tools during this period.

- Re-draw target body weight if the flock is 100 g (0.22 lb) or more above target weight (overweight) or 100 g (0.22 lb) or more below target weight (underweight) at 15 weeks.
- Grow birds that are underweight to regain target by light stimulation, for overweight birds, set a new target.

Re-drawing of body-weight profiles if females are under or over target weight at 15 weeks/105 days of age.



Transfer

Day-old to Depletion

Where there is a change in feeding system between rear and lay, manage this transfer carefully by ensuring that birds can easily find and get access to the new feeders.

Rear and Move Facilities

- For light proof laying facilities transfer should not occur later than 146 days/21 weeks of age.
- For open-sided laying facilities transfer may need to be later than 21 weeks depending on the season.
- Transfer should never be completed before 126 days/18 weeks of age or after 161 days/23 weeks of age, regardless of laying facility type.
- Transfer males at least 24 hours before the females to allow the males to find feeders and drinkers. Increase feed allocation by approximately 50% on the day before and the day of transfer to help compensate for any moving stress.
- Do not feed birds on the morning they are due to be moved, but ensure birds have immediate access to feed once transfer is complete.
- Return feed levels to normal on the first or possibly the second day after transfer.
- Assess crop fill after transfer to ensure all birds have found feed and water. Check 50 males and 50 females 30 minutes and 24 hours after their first feed.

Mating-up

- Mating-up should start from 147 days/21 weeks of age.
- Ensure both males and females are sexually mature at mating-up.
- Mating-up should be delayed by 7-14 days if sexual maturity is delayed, or when moving from dark-out rear to open-sided lay facilities.
- A mature male/female will have a well-developed comb and wattles that are red in color.

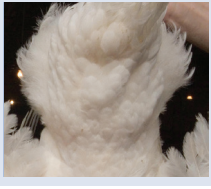
Example of a sexually mature male (on the left) and an immature male (on the right).

Example of a sexually mature female (on the left) and an immature female (on the right).

Sexing Errors

It is good practice to remove sexing errors whenever they are identified during the life of the flock. Ideally, all sexing errors should be removed before mating-up.

Criteria for identifying males and females for the resolution of sexing errors.

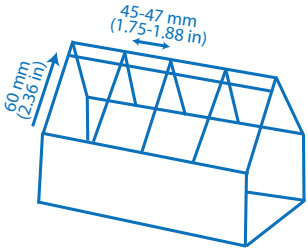
Male		Female
	***Comb and Wattles*** **105 days/15 weeks** *More developed and redder in males.*	
	***Hock Joints*** **140 days/20 weeks** *Thicker and broader in males. Narrower and smoother in females.*	
	***Feathering Around the Neck*** **140 days/20 weeks** *Long-fringed, spear-shaped feathers in males. Denser, paddle-shaped feathers in females.*	
	***Body Shape*** **140 days/20 weeks** *Males longer and narrower. Females more compact and broader around pelvis.*	

Separate-sex Feeding Equipment

After mating-up, feed males and females from separate feeding systems.

- Female feeding systems should have grills fitted to prevent male access.
- Male feeders must be raised to a height that will allow only males to access them.

Female Grill Feeder



- Observe feeding behavior daily to ensure both sexes are feeding separately, male feeders are at the correct height, and feeding space and feed distribution are adequate.
- Make daily checks for damage, displacement or irregularity of gaps in the female feeder system.

Lighting

Daylength increases from rearing to laying.

Age		Daylength (hours) for flocks with different CV% at 140 days/20 weeks		Light Intensity
Days	Weeks	Laying Daylengths (Hours)		
		CV 10% or less	CV 10% or greater	
10-146		8	8	
147	21	11	8	30-60 lux (3-6 foot candles)
154	22	12	12	
161	23	13	13	
168	24	13	13	
175 - depletion	25 - depletion	13	13	

Daylength may be increased abruptly in a single increment without adversely affecting total egg production (although peak may be higher and persistency slightly poorer) provided the body weights are on target and the flock is uniform (CV ≤ 10%).

- The maximum response to the pre-lay increase in daylength is only obtained by achieving the correct body-weight profile during rear, good flock uniformity, and the appropriate nutritional input.
- During lay, there is no advantage in exceeding 13 to 14 hours of light per day at any stage (where light proofing is good, there is no need to go beyond 13 hours).
- Where birds are kept in open-sided housing during lay, and the longest natural daylength exceeds 14 hours, the combined artificial and natural lighting should be extended beyond 14 hours to equal the longest natural daylength.

Management of Females Post Light Stimulation Until 5% Production

Management Considerations

- Achieve target body weight by concentrating on correct weekly incremental feed increases and resultant bird gains.
- Follow the recommended lighting program.
- Monitor flock uniformity, body weight, and feed clean-up time, and respond quickly to any issues.
- Provide ad libitum access to clean, good quality water.
- Change from grower to breeder layer feed at 5% production at the latest.
- Open nest boxes just before anticipated arrival of first egg.
- Where automatic nest systems are used, run the egg gathering belt several times each day so that birds become accustomed to the sound and vibration.

Pin Bone Spacing

PROCEDURE

Monitoring Pin Bone Spacing

1. Monitor pin bone spacing regularly from 105-112 days/15-16 weeks of age up to point of lay.
2. Monitor every time the house is 'walked' but as a minimum, once per week during weighing.
3. Ideally the same person should measure pin bone spacing from week to week to ensure accurate and consistent measurement and allow for differences in hand size.
4. Select females randomly during the monitoring process and handle with care.
5. Hold the female in one hand and measure spacing by placing your fingers between the pin (pelvic) bones, measuring the distance between them (see picture to the right).
6. As a general rule, birds are at the point of lay when the distance between the pin bones is about 3 fingers (approximately 5-6 cm or 2-2.5 in).

Expected changes in pin bone spacing with age.

Age	Pin Bone Spacing
84-91 days	Closed
119 days	One finger
21 days before first egg	1½ fingers
10 days before first egg	2-2½ fingers
Point of lay	3 fingers

If pin bone spacing does not develop as expected, i.e. is below 1.5 fingers at first light stimulation, or if there is a big variation in pin bone spacing between individuals, then delay light stimulation by approximately 1 week.

Floor Eggs

To help manage and reduce floor egg levels, the following management points may be used:

- Introduce perches from 28 days/4 weeks.
- Incorporate a suitable alighting/perching rail in nest box design.
- Have uniform distribution of light greater than 60 lux (5.6 foot candles); avoiding the presence of dark and shaded areas next to walls, corners, and in the areas next to steps and slat fronts.
- Run egg gathering belts several times each day from transfer where automated systems are used.
- Walk around the house as frequently as possible (at least 6 and up to 12 times per day) picking up any floor eggs.
- Set feeder and drinker heights appropriately so that they are not obstacles to nest access.
- Put 20% at floor level to start when using manual nests. Thereafter, gradually raise them (over a period of 3-4 weeks) to the normal height.
- Allow 3.5-4 hens per nest hole for manual nests.
- Allow 40 hens per linear meter (12 birds per linear foot) for mechanical (communal type) nests.
- Set feeding times to avoid the peak of egg laying activity. Feeding time should be either within 30 minutes of "lights on", or 5-6 hours after "lights on" to prevent birds from feeding when the most eggs are likely to be laid.

MANAGEMENT FUNDAMENTAL

Attention to detail avoids floor eggs.

Management of Females from 5% Hen-day Production Until Peak Egg Production

Management Considerations

The table below shows the frequency of observation of important production parameters used to determine whether or not feed allocation is correct.

Parameter	Frequency
Egg production	Daily
Increase in egg production	Daily
Egg weight	Daily
Body weight	Daily
Body-weight gain	Daily
Feed clean-up time	Daily
House temperature (min. and max.)	Daily
Body condition and fleshing	Weekly (and on walk-through)

- Monitoring body weight, egg weight, and egg production is key.
- Monitor and record both absolute and trend data.

Feed Increases from 5% Production to Peak

- Define program of feed increases based on feed amount prior to production, dietary energy level, ambient temperature, and expected flock productivity.
- Feed increases given should be proportional to actual rates of production.
- To prevent excessive weight gain, small but frequent increases should be used.
- The first feed increase should be given at 5% production if flock CV is less than 10%.
- If flock CV is greater than 10%, the first feed increase should be delayed until 10% production is reached.
- In high producing flocks, feed increases beyond recommendations may be required.
- If egg weights and/or body weights are judged to be markedly below expected targets, feed increases should be advanced.

Feed Clean-up Trends

A guide to feed clean-up times is given in the table below.

Feed Clean-up Time at Peak Production (hours)	Feed Texture
3-4	Mash
2-3	Crumble
1-2	Pellet

- Monitor feed clean-up times and trends in feed clean-up times.
- Respond to any changes in feed clean-up trends.

Egg Weight

PROCEDURE

Weighing Eggs

1. Record daily egg weight from 10% hen-day production onwards.
2. Bulk weigh a sample of 120-150 eggs daily.
3. Collect the eggs directly from the second nest collection.
4. Remove any double-yolked, small and abnormal eggs (e.g. soft shelled).
5. Calculate average daily egg weight by dividing the bulk egg weight (weight of eggs minus weight of tray or trays) by the number of eggs weighed.
6. Plot the daily weight against the target.
7. If the flock is being underfed, egg size will not increase over a 3-4 day period and egg weight will deviate from the target.
   - » If peak feed amount has not been reached then the next planned feed increase should be brought forward.
   - » If peak feed has been reached then an additional increase in peak feed amount will be required (3 to 5 g [0.1 to 0.2 oz]) per bird.

MANAGEMENT FUNDAMENTAL

It is normal for average egg weight to fluctuate on a daily basis due to sampling variation and environmental influences.

Management of Males Post Light Stimulation Until Peak Egg Production

To maintain fertility throughout lay, substandard and non-working males can be progressively removed from the flock as it ages.

A guide to typical mating ratios as a flock ages.

Age		Number of Good Quality Males Per 100 Females
Days	Weeks	
154 - 168	22 - 24	9.50 - 10.00
168 - 210	24 - 30	9.00 - 10.00
210 - 245	30 - 35	8.50 - 9.75
245 - 280	35 - 40	8.00 - 9.50
280 - 350	40 - 50	7.50 - 9.25
350 to depletion	50 to depletion	7.00 - 9.00

Males retained for mating should have the following characteristics:

- Uniform in body weight.
- Free from physical abnormalities (alert and active).
- Strong, straight legs and toes.
- Well feathered.
- Good upright stance.
- Good muscle tone and body condition (fleshing).
- Comb and wattles should be red in color.
- Vent should be moist and show signs of mating activity.

Review mating ratios weekly. Whenever over-mating occurs, surplus males must be removed as quickly as possible.

Section 3

Management in Lay (Peak to Depletion)

Objective

To maximize the number of fertile hatching eggs produced per female, by ensuring persistency of egg production post peak.

Management of Males After Peak Production Through to Depletion

Assessing Body Condition (breast shape or fleshing)

PROCEDURE

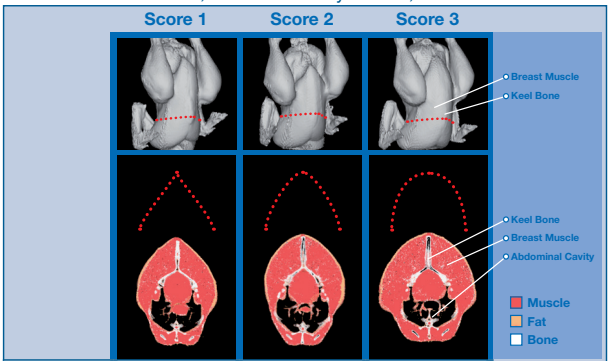
Assessing Body Condition (fleshing)

- While holding the bird by both legs, run hand over the keel bone.
- Assess the prominance of the keel bone, and the amount, shape, and firmness of the breast bone, on either side of the keel bone.
- The breast should be firm and rounded to the touch.

Body Condition Scoring System

CT scanner images illustrating the fleshing scoring system for assessing bird condition.

Score 1 = under-fleshed, **Score 2** = ideally fleshed, **Score 3** = over-fleshed



	Score 1	Score 2	Score 3
Breast shape	V Shape	Narrow U Shape	Wide U Shape
Keel Bone	Prominent and easily felt.	Less prominent and smooth to touch.	Not obvious and often indented (dimple can be seen) at extreme.
Breast muscle	Little breast muscle (volume and depth), will feel concave (rather than convex) in shape. Poor muscle tone.	Good breast muscle covering that will feel convex or rounded in shape. Firm muscle tone.	Excessive breast muscle covering with high volume and depth. Firm muscle tone.

- Assess body condition (fleshing) at least weekly during weighing.
- Assess all birds being weighed and score their condition.
- Record condition scores and calculate the flock average. Monitor the trend over time.
- Determine appropriate management and feeding strategies using body condition in conjunction with body weight and uniformity.
- The same person should ideally score the birds each week.

- The target fleshing score should be a 2, although this may vary between individual flocks around a 2 score.
- This is not a primary assessment, but a complimentary system aimed at aiding management decisions.

MANAGEMENT FUNDAMENTAL

Regular assessments of male and female physical condition (fleshing) should be made throughout the life of the flock.

Alertness and Activity

Males should be alert, active and spread evenly throughout the house.

Good distribution of males within a flock.

Legs and Feet

- Good foot and leg health is essential for males.
- Legs – straight with no bent toes.
- Footpads – free from physical damage.
- Remove any male with poor feet and leg condition from the flock.

Good leg health in males.

Head

- Comb, wattles and eye area should be uniform, intense red color.
- Well conditioned males will redden-up from the face towards the eye.
- Poorly conditioned males will lose color from the eye outwards.
- Males with low face color may have a low mating activity and should be considered for removal.

A healthy, active male showing a red face and comb (on the left), and a male in poorer condition, showing paleness around the eye (on the right).

Feathering

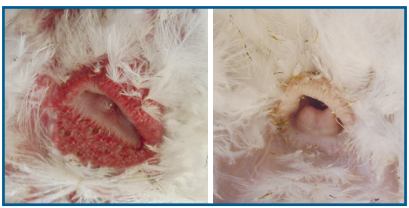
- Partial feather loss should be seen in good working males, especially around the shoulders, thighs, breast and tail.
- Well feathered males generally have low mating activity and should be considered for removal.

An active male showing some feather wear (on the left), and an inactive male showing no feather wear (on the right).

Vent (cloaca) Condition

Monitor male vent condition during weekly weighing.

Variation in vent color used to indicate degree of mating activity in males. The vent on the left is from a working male while the vent on the right is from a non-working male. Feather wear and moistness should also be used as an indicator of mating activity.



Management of Males after Peak

- Ensure sufficient sample of males are weighed (10% in lay).
- Never decrease male feed allocation.
- Feed increases should account for body weight, fleshing, and physical condition, to maintain growth and persistency of fertility.
- Maintain litter quality to promote good footpad health.
- Follow a planned male reduction program.

Management of Females After Peak Production Through to Depletion

General Guidelines for Post-peak Feed Reduction

- Follow a feed reduction program that allows the birds to gain weight at a rate of 15 to 20 grams per week (0.5 to 0.7 oz).
- Failure to control body weight from peak production will reduce production persistency and effect egg size.
- Make weekly feed adjustments based on trends in egg weight and body weight.
- Flocks producing at levels above production targets may require more feed. Feed reductions should be of smaller amounts and more gradual.
- If a flock peaks poorly, the feed withdrawal should be more rapid to avoid birds becoming fat.

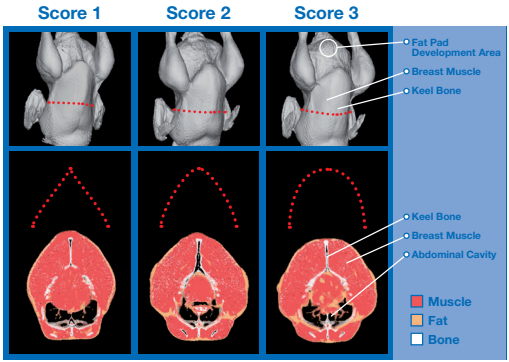
The following characteristics should be measured, recorded, and graphed onto a chart:

- Daily (or weekly) body weight and body-weight change relative to target.
- Daily egg weight and egg-weight change relative to target.
- Daily changes in feed clean-up time.

Monitoring Body Condition in Females

In general, a uniform flock of females achieving the target body-weight profile in lay should also achieve an acceptable body condition.

- Handle females frequently (at least weekly) to assess body condition/ fleshing.
- Use the same scoring system for females as males.
- Average flock score in lay should be maintained between 2.0 and 2.5.
- In lay, the occurrence of Score 1 females (under-fleshed) must be minimized.



Abdominal fat pad

- Assess fat pad routinely (at least weekly) from the start of lay.
- As a guide, maximum fat pad volume should be no more than the size of an average person's cupped hand or a large egg (roughly 8-10 cm [3-4 in]).

Assessing abdominal fat pad in a female broiler breeder.

MANAGEMENT FUNDAMENTAL

Using a combination of physical assessments (body weight, fleshing, fat pad, and pin bone spacing) provides a reliable indication of overall female condition.

Records

Record keeping, and data analysis and interpretation, are an essential aid to effective management. Record keeping should be used in conjunction with target performance parameters. Records required to be kept are as follows:

Laying
Breed
Source flock
Hatch date/date of housing
Number of birds housed (male and female)
Floor area and stocking density
Mating ratio
Eggs produced - daily, weekly, and cumulative per bird
Hatching egg number - daily, weekly, and cumulative
Floor eggs – daily, weekly, and cumulative
Feed - daily and cumulative
Clean-up time
Body weights (male and female) – daily and weekly
Average egg weight - daily and weekly
Egg mass - daily and weekly
Mortality and culls - daily, weekly, and cumulative
Hatchability
Fertility
External and internal temperatures - minimum and maximum and operating (internal only)
Water consumption – daily
Water:feed ratio
Humidity
Hours of light

Treatments and Significant Events
Lighting program
Feed deliveries
Vaccination - date, dosage and batch number
Medications - date, dosage and veterinary prescription
Disease - type, date and number of birds affected
Veterinary consultations - date and recommendations
Cleaning and disinfection – materials and methods
Bacterial counts after cleaning out (TVC)
Incidents - equipment malfunction etc.

Section 4

Care of Hatching Eggs on Farm

Objective

To keep the embryo and egg contents in the best possible condition for good hatchability and chick quality.

Egg Quality

Examples of good quality hatching eggs.

Good quality nest eggs

Examples of eggs with an increased risk of lower hatchability or contamination.

Slight soiling | Clean floor egg | Pale shell

Examples of eggs that should be rejected.

Fecal soiling | Yolk on shell | Blood on shell

Best Practice for Care of Hatching Eggs

Egg Collection

- Keep the insides of the nests and any collection belts free of litter and droppings.
- Collect eggs a minimum of 4 times per day.
- Collect floor eggs separately and as often as possible, and keep separate from nest eggs.

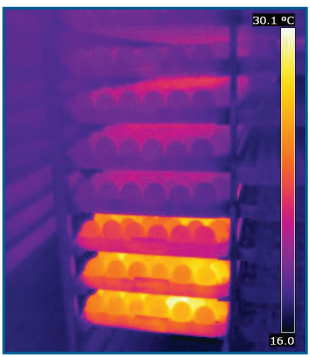
Egg Packing and Selection

PROCEDURE

Egg Packing and Selection

1. Select and pack eggs immediately after each collection.
2. Reject eggs that are cracked or damaged, misshapen eggs, double-yolk eggs, soft shelled eggs, and any eggs that are more than 25% covered with dirt or droppings.
3. Record numbers rejected in each category and monitor them.
4. Place packed trays in egg store immediately. Pack trolleys from bottom up.
5. Do not remove trolleys from the egg store when loading eggs.
6. If boxing, eggs should be cooled to egg store temperature first.
7. Do not wrap eggs or trolleys in plastic until they have cooled to egg store temperature.

Hatching eggs **incorrectly** stored in a trolley. The thermal image to the right shows freshly collected, warm eggs being placed below already cool eggs collected earlier. This is **not** good practice.



Egg Disinfection

The use of formaldehyde fumigation is the preferred method for disinfecting eggs, but appropriate safety precautions must be taken.

PROCEDURE

Egg Disinfection

1. Fumigate eggs with formaldehyde at least once before they leave the farm.
2. Make sure that the eggs are well separated on plastic egg or setter trays – cardboard tends to absorb the gas.
3. Ensure the fumigation room is well sealed during fumigation and allow at least 20 minutes for the gas to circulate after it has been generated.
4. Either heat 10 g (0.4 oz) paraformaldehyde prills or mix 43 ml formalin (37.5%) and 21 g (0.7 oz) potassium permanganate per m^3 of fumigation room.
5. Ensure room temperature is a minimum of 24°C (75.2°F) and humidity a minimum of 65% RH.
6. Run a circulating fan during fumigation to help circulate the fumigant gas between the eggs.
7. Make sure that all the gas is completely exhausted from the room before workers re-enter to move the eggs. This should be re-checked periodically using an appropriate meter. Workers should not be exposed to formaldehyde gas and all local health and safety regulations on the use of formaldehyde should be followed.
8. Eggs should not be fumigated if they have condensation on them.

Cleaning Soiled Eggs

Provided surface dirt is not extensive, it can be removed by gently flicking off the dirt with a finger nail, or for soft droppings, by gently wiping off with a clean paper towel. The washing of eggs is not good practice, but in some cases may be unavoidable:

- Spray eggs with a warm disinfection solution and avoid immersing eggs.
- Wash water should be 41°C (106°F).
- The process should be recorded and monitored.
- Make sure that the disinfectant concentration does not fall below the recommended minimum effective concentration level.
- Allow eggs to dry before they are cooled in egg store.
- Washed eggs need to be fumigated, but this should not be done until they are dry.

Egg Storage

The relationship between length of egg storage and temperature of egg store.

Storage Period (days)	Temperature of Storage* °C (°F)
1-3	20-23 (68-73)
4-7	15-18 (59-64)
< 7	12-15 (54-59)
> 13	12 (54)

** Humidity between 75 and 80%.*

- Keep temperature constant once eggs are cooled.
- Adjust storage temperature as average egg storage duration changes. On farm storage should be adjusted for the oldest eggs.
- Keep the farm store 2°C (4°F) warmer than the hatchery store with truck temperature intermediate of the two. This will help to avoid condensation.

MANAGEMENT FUNDAMENTAL

Cooled eggs should not be moved into a warm humid environment to avoid condensation forming on egg surface.

Humidity

- Egg store humidity should be between 75 and 80% RH.
- Make sure that the water in the humidifier is clean and that spray nozzles are maintained properly so that they produce a fine mist of water and not large droplets.

Problems with Rots and Bangers

If the hatchery is observing an excessive number of rots and bangers, check the following:

- The number and severity of dirty eggs being produced. Make sure nests and collection belts are checked regularly and cleaned immediately if problems occur.
- Floor eggs are not washed and then mixed with nest eggs.
- The eggs are not collected and packed into dirty trays.
- The shell quality is normal for the age of the flock.
- Egg washing and disinfectant media are 41°C (106°F).
- Washed eggs are not mixed with clean eggs.
- Wet eggs are not being placed in the egg store.
- If the humidifier has a reservoir, replace it with one that operates off the main water supply.

Dew Point or Condensation Table

When eggs are moved from a cold environment into warmer, more humid conditions, they may sweat. The following table gives the shell temperature that will result in condensation when moving eggs into a wide variety of temperatures and humidities. To avoid condensation the egg shell temperature needs to be higher than that given in the table.

Eggs may sweat when they are transported from a cold egg store on the farm to a warm hatchery or from a cold egg store in the hatchery for pre-warming or incubation.

If eggs are sweating they should not be fumigated or put into a cold egg store until they are dry.

Temperature at Which Eggs are to be Moved °C (°F)	Relative Humidity (%RH)					
	40	50	60	70	80	90
15 (59)					11	13
20 (68)			12	14	16	18
Pre-warming 23 (74)		12	15	17	19	21
25 (77)	10	13	16	19	21	23
30 (86)	14	18	21	24	26	28
35 (95)	18	21	25	28	31	33
Incubator	21	25	28	31	34	36
40 (104)	23	27	30	33	36	38

Section 5

Ventilation

Objective

To ensure that good welfare and reproductive performance are achieved by maintaining birds under appropriate, and where possible, optimal environmental conditions.

Ventilation

Open-sided/Natural Ventilation

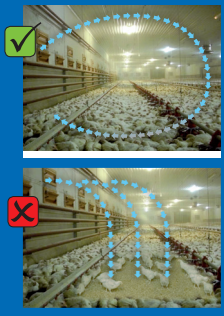
Natural ventilation requires continuous 24 hour management if the house environment is to be satisfactorily controlled.

- Vary curtain height to achieve optimum airflow.
- Curtains should be fastened to the sidewalls at the bottom and be opened from the top down to minimize drafts and wind flowing directly onto birds.
- Open curtains on both sides of the house to provide cross-ventilation.
- In light wind or wind that changes direction frequently curtains on each side should be opened the same amount.
- If the wind is coming consistently from one side of the building, the curtain on the prevailing side should be opened less than the downwind side to minimize drafts.
- Recirculation fans should be used to supplement and enhance temperature control within the house.
- In hot weather conditions, several steps can be taken to minimize the impact of high temperatures:
  - Reduce stocking densities.
  - Ensure adequate roof insulation is in place, use water sprayed on the house roof to cool the roof. (Use with caution as this may raise RH levels).
  - Use circulation fans.
  - Use tunnel ventilation with evaporative cooling pads.

Negative Pressure Ventilation Systems (Controlled Environment Housing)

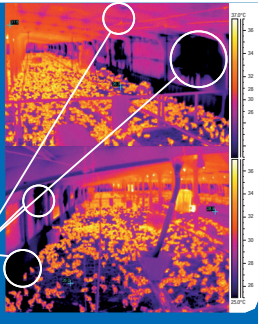
Achieve good airflow and volume

- **If incoming air flow speed and volume is too low:**
  - Cold air will drop directly on to the birds/litter
  - Litter will become wet and birds may get chilled



Ensure house is tightly sealed

- Ventilation only works effectively if the house is adequately sealed.
- This ensures the speed at which air enters the house is controlled.
- Avoid air leaks.



Uniform air inlet openings

- Open air inlets must be evenly distributed through the house and be opened equally.
- This will create uniform:
  - Volume of air flow
  - Speed of air flow
  - Direction of air flow
  - Distribution of air flow
- At lower ventilation rates close some inlets to force the same volume of air through fewer inlets.

Monitor and evaluate regularly

- Monitor house pressure & air speed:
  - Pressure should be 30-40 Pa (0.12-0.16 inches of water column) depending on house width
  - Air speed around 4 m/sec (800 ft/min) measured at air inlet
- Use smoke tests to confirm if air flow direction and inlet settins are correct.
- Monitor bird behavior and litter quality.
- Complete regular evaluation of:
  - Air quality
  - RH
  - Signs of condensation
  - Dust levels

PROCEDURE

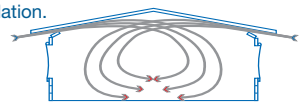
Evaluating Negative Pressure of Controlled Environment Housing

1. Close all doors and inlets in the house.
2. Switch on one 122 cm (48 in)/127 cm (50 in) fan, or two 91 cm (36 in) fans.
3. The pressure within the house should not measure less than 0.15 inches of water column (37.5 Pa).

Minimum Ventilation

- It is essential to provide some ventilation to the house regardless of the outside conditions.
- Minimum ventilation is used for young chicks, nighttime, or winter ventilation.
- Extraction fans (usually 91 cm [36 in] in size) operating on a cycle timer (on/off) draw air into the house through sidewall or ceiling air inlets.
- It is recommended that a 5 minute cycle timer is used.
- Air inlets should be opened at least 5 cm (2 in) for the airflow into the house to be effective.
- Accurate ventilation settings for the house can be determined by carrying out smoke tests. Alternatively, strips of cassette tape can be hung from the ceiling every 1-1.5 m (3-5 ft) in front of an air inlet up to the apex of the house.

Correct airflow during minimum ventilation.



Approximate minimum ventilation rates per bird.

Age	Cubic Meter per Hour (CMH/bird)	Cubic Feet per Minute (CFM/bird)
1-8 weeks	0.16	0.10
9-15 weeks	0.42	0.25
16 – 35 weeks	0.59	0.35
36 weeks - depletion	0.76	0.45

MANAGEMENT FUNDAMENTAL

Monitor airflow and bird behavior to determine if settings are correct.

PROCEDURE

Calculating Minimum Ventilation Rates

1. Determine the appropriate minimum recommended ventilation rate. The exact rates will vary with temperature and for each individual poultry house, and with company of fan manufacture (fan type).
2. Calculate the total ventilation rate required for the house:

   Total minimum ventilation =
   (minimum ventilation rate per bird) x
   (number of birds in the house)

3. Calculate the percentage time the fans are required to run:

   $$\text{Percentage of time} = \frac{\text{(total ventilation needed)}}{\text{(total capacity of fans used)}}$$

4. Multiply the percentage time the fans are required to run by the total fan timer cycle to give the amount of time that the fans are required to be on in each cycle.

Transitional Ventilation

- Transitional ventilation is used when the house temperature is above the desired (or set point) temperature, but it is not yet warm enough, or the birds are still not old enough, to use tunnel ventilation.
- A general guideline for transitional ventilation is to open enough air inlets so that approximately 40-50% of the tunnel fan capacity is being used.

Tunnel Ventilation

Tunnel ventilation is used to keep the birds feeling cool. The switch from transitional ventilation to tunnel ventilation should occur when the birds need the cooling effect of wind chill. Younger birds that are not fully feathered will feel a greater wind chill than older birds and so are more prone to chilling.

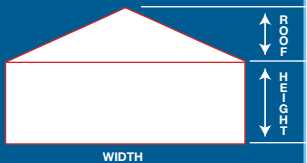
PROCEDURE

Tunnel Ventilation Calculations

1. Determine the fan capacity required for a given air speed.

   Required fan capacity =
   (design air speed) x (cross section area)

   Where:

   - Design air speed (min).
     - » 2.03 meters per second (m/s) or 400 feet per minute (fpm) for rearing.
     - » 2.54 meters per second (m/s) or 500 feet per minute (fpm) for production.
   - Cross section area = (0.5 x Width x Roof) + (Width x Height).

2. Determine the number of fans required:

   $$\text{Number of fans} = \frac{\text{(required fan capacity)}}{\text{(fan operating capacity)}}$$

   Where:

   - Fan operating capacity is the capacity at the assumed operating pressure.
   - As a guideline for tunnel ventilation with cooling pads, use the fan capacity at an operating pressure of 37.5 Pa (0.15 inches water column).

Evaporative Cooling Systems

- Evaporative cooling systems are commonly used when temperatures exceed 27°C (81°F). Effectiveness of evaporative cooling systems depends on the RH levels.
- Evaporative cooling adds moisture to the air and increases RH. It is important to operate the system based on RH, as well as dry bulb temperature, to ensure bird welfare.

MANAGEMENT FUNDAMENTAL

If in-house RH levels reach more than 70-80%, turn off the evaporative cooling system.

Spray Cooling (fogger)

- High pressure (water) spray systems should operate at 400-600 psi (28-41 bar), and produce a very fine mist with a droplet size of 10-15 microns.
- Low pressure fogging systems operate at 100-200 psi (7-14 bar), and produce a droplet size greater than 30 microns.
- Fogging lines must be placed near air inlets in order to maximize the speed of evaporation, and additional lines should be placed throughout the house.

Pad Cooling

- In pad cooling systems, cool air is drawn through a water soaked filter (cooling pad) by the tunnel ventilation fans.

$$\text{Cooling pad area} = \frac{\text{(tunnel fan capacity)}}{\text{(pad air speed)}}$$

- Cooling pad area is the total area required. Half of this area is usually installed on each outside wall of the inlet end of the house.
- Tunnel fan capacity is the actual total operating capacity.
- Expected pad air speeds:
  - » For 100 mm (4 in) thick pad, use 1.27 m/s (250 fpm).
  - » For 150 mm (6 in) thick pad, use 1.91 m/s (375 fpm).

Section 6

Nutrition

Objective

To maximize welfare, reproductive potential (of both males and females), and chick quality by supplying a range of balanced diets that meet the requirements of broiler parent stock at all stages of their development and production.

Nutrition

- Birds respond to daily intakes of nutrients, therefore feeding programs (and feed levels) must relate to dietary nutrient content; especially energy and the nutritional requirements of the bird at a given age.
- Diets need to be regularly sampled and the samples analyzed to ensure that the diet is as it should be.

Feeding Programs

Starter Feed

Starter feed should be fed as a sieved crumb from 0-28 days of age. If body weights at 28 days are consistently below target then feeding the Starter diet for an extra 1-2 weeks may help.

Growing Period

It is important to carefully manage the change in diet from Starter to Grower, ensuring that there is no loss in body-weight gain.

The Grower feed should be fed from approximately 28 days through 5% production. Feed should be distributed quickly and evenly throughout the house.

The Laying Stage

During this stage, a breeder feed should be fed from 5% production through depletion.

Laying hens require 4-5 g (14-18 oz Ca per 100 birds) of calcium per hen per day to maintain calcium balance. In practice, this is achieved by feeding the recommended breeder ration calcium levels no later than 5% egg production. To maintain optimal shell quality, consider supplementing 1.0 g (0.03 oz Ca per bird per day) of calcium in the form of a large particle-sized limestone (diameter 3.2 mm [1/8 in]) or oyster shell.

Consequences for the laying flock of not meeting the nutrient specifications.

	Effect of Undersupply	**Effect of Oversupply**
Crude protein	Depends on amino acid levels, but generally decreased egg size and number. Poor chick quality from young flocks.	Increased egg size and lower hatchability. Increased metabolic stress during hot weather conditions.
Energy	Body weight, egg size, and egg number will decrease unless feed quantity is adjusted.	Excess leads to increased double yolks, oversized eggs, and obesity. Late fertility/ hatchability suffers.
Lysine, methionine & cystine	Decrease egg size and number.	
Linoleic acid	Decreased egg size.	
Calcium	Poor shell quality.	Reduced availability of nutrients.
Available phosphorous	May impair egg production and hatchability. Reduced bone ash in chicks.	Poor shell quality.

If a separate male diet is used it should be introduced when birds are moved to the laying house or at light stimulation.

Temperature Effect on Energy Requirements

As operating temperature differs from 20°C (68°F), energy intakes should be adjusted *pro rata* as follows:

- Increased by 0.126 MJ (30 kcal) per bird per day if temperature is decreased by 5°C from 20° to 15°C (68° to 59°F).
- Reduced by 0.105 MJ (25 kcal) per bird per day if temperature is increased by 5°C from 20° to 25°C (68° to 77°F).

When temperatures are above 25°C (77°F) the relationship is not as straight forward. Feed composition, feed amount, and environmental management should be controlled to reduce heat stress.

Feed Management

- Ideally, feed should not remain on the farm for more than a week.
- Feed bins should always remain covered and be in good condition to prevent water entry. Any feed spills should be cleaned up promptly.
- Use a standard weight to check the accuracy of the feed scales daily before use.
- A visual assessment of every feed delivery should be made. The feed should be assessed on its physical quality, color, appearance, and smell. For mash, check that there is good distribution of raw materials throughout the feed.
- Levels of fines should not exceed 10% for pellets/crumbs or 25% for mash. The level of fines within a feed can be measured using a feed shaker sieve.

Trouble Shooting - Vitamin Deficiency

Possible Cause	Problem							
	Egg Production	Fertility	Hatchability	Resistance to Disease	Feathering	Bone Deformities	Leg Weakness	Thin Shell Eggs
Vitamin A	X		X	X	X		X	
Vitamin D3	X		X			X		X
Vitamin E	X	X	X	X				
Vitamin B12	X		X					
Riboflavin			X	X			X	
Niacin					X	X		
Pantothenic Acid			X	X	X			
Choline	X					X		
Vitamin K								
Folic Acid	X		X		X	X		
Thiamin B1								
Pyridoxine B6	X		X					
Biotin	X	X	X		X	X	X	

Section 7

Health and Biosecurity

Objective

To achieve hygienic conditions within the poultry house, and to minimize the adverse effects of disease.

To attain optimum performance and bird welfare, and to provide assurance on food safety issues.

Health and Biosecurity

Preventing Diseases Transmitted by Humans

- Minimize the number of visitors and prevent unauthorized access to the farm.
- All people entering the farm should follow a biosecurity procedure.
- Maintain a record of visitors.
- Workers and visitors should wash and sanitize boots and hands when entering and leaving the poultry house.
- Clean and disinfect tools used in the poultry house.
- It is recommended to only visit one farm per day.

Preventing Diseases Transmitted by Animals

- Place farm on an "all in/all out" placement cycle.
- A minimum downtime of 3 weeks will reduce contamination on the farm.
- Keep all vegetation cut 15 m (50 ft) away from the buildings to provide an entry barrier for rodents and wild animals.
- Do not leave equipment, building materials or litter lying around.
- Clean up feed spills as soon as they occur.
- Store litter material in bags or inside a storage building or bin.
- Keep wild birds out of all buildings and maintain an effective rodent control program.
- Use an integrated pest management program.

Site Cleaning

MANAGEMENT FUNDAMENTAL

Site cleaning must cover both the interior and exterior of the house, all equipment, external house areas, and the feeding and drinking systems.

PROCEDURE

Site Cleaning

1. Plan.
2. Control insects:
   - once the flock has been removed, while the house is still warm, spray litter, equipment and surfaces with an insecticide.
   - spraying with an approved insecticide may also be done 2 weeks before depletion.
   - a second treatment of insecticide should also occur prior to fumigation.
3. Remove dust.
4. Pre-spray with a detergent solution throughout the inside of the house.
5. Remove all equipment.
6. Remove and dispose of litter.
7. Wash using a pressure washer with foam detergent, and rinse with hot water.

PROCEDURE

Cleaning Water Systems

1. Drain pipes and header tanks.
2. Flush lines with clean water.
3. Scrub header tanks to remove scale and biofilm deposit and drain to the exterior of the house.
4. Refill the tank with fresh water and add an approved water sanitizer.
5. Run the sanitizer solution through the drinker lines from the header tank, ensuring that there are no air locks.
6. Make up header tank to normal operating level with additional sanitizer and solution at appropriate strength. Replace lid and allow disinfectant to remain for a minimum of 4 hours.
7. Drain and rinse with fresh water.
8. Refill with fresh water prior to chick arrival.

- If physical cleaning is not always possible, cleaning of water lines between flocks may be done using high levels (140 ppm) of chlorine or peroxygen compounds.
- Ensure water lines are flushed completely before birds are allowed to drink.
- Test water quality routinely for bacterial and mineral contamination and take necessary corrective action based on the test results.
- Take samples from source, storage tank, and drinker points.

PROCEDURE

Cleaning Feeding Systems

1. Empty, wash, and disinfect all feeding equipment.
2. Empty bulk bins and connecting pipes, and brush out where possible.
3. Clean out and seal all openings.
4. Fumigate wherever possible.

Disinfection

- Disinfection should not take place until the whole building (including the external area) is thoroughly cleaned and all repairs are completed.
- Disinfectants are ineffective in the presence of dirt and organic matter.
- Manufacturers' instructions must be followed at all times.
- Disinfectant should be applied using either a pressure-washer or backpack sprayer.
- Heating houses to high temperatures after sealing can enhance disinfection.
- If using a selective coccidial treatment, this should only be used by suitably trained staff and should be applied to all clean internal surfaces.

Health Management

- Good management and biosecurity will prevent many poultry diseases.
- Monitor feed and water intake for the first signs of a disease challenge.
- Respond promptly to any signs of a disease challenge by completing post-mortem examinations and contacting an Aviagen veterinarian.
- Vaccination alone cannot prevent flocks from overwhelming disease challenges and poor management.
- Vaccination is most effective when disease challenges are minimized through well designed biosecurity and management programs.
- Base vaccination programs on local disease challenges and availability of vaccine.
- Monitor and control worm burden.
- Salmonella infection via feed is a threat to bird health. Heat treatment and monitoring of raw materials will minimize the risk of contamination.
- Only use antibiotics to treat disease with veterinary supervision.
- Keep records and monitor flock health.

Every attempt has been made to ensure the accuracy and relevance of the information presented. However, Aviagen® accepts no liability for the consequences of using the information for the management of chickens.

For further information please contact your local Technical Service Manager.

www.aviagen.com

Age Wks	Ross Male		Ross 308 Female	
	Weight g	Feed Amt g/bird/day	Weight g	Feed Amt g/bird/day
0		ad lib		ad lib
1	150	35	115	26
2	320	42	215	32
3	525	48	335	36
4	755	52	450	40
5	945	56	560	43
6	1130	60	660	45
7	1280	63	760	47
8	1420	66	860	49
9	1545	69	960	50
10	1670	72	1060	52
11	1795	75	1160	54
12	1920	78	1260	57
13	2045	81	1360	59
14	2170	84	1460	62
15	2295	88	1560	66
16	2420	92	1670	71
17	2560	96	1790	76
18	2715	101	1915	83
19	2875	106	2050	90
20	3035	111	2195	98
21	3195	115	2345	104
22	3355	120	2500	113
23	3515	123	2660	122
24	3675	127	2820	131
25	3825	129	2975	138
26	3960	131	3120	148
27	4035	132	3245	158
28	4090	134	3340	168
29	4120	135	3395	168
30	4150	136	3435	168
31	4180	136	3465	168
32	4210	137	3490	168

Age Wks	Ross Male		Ross 308 Female	
	Weight g	Feed Amt g/bird/day	Weight g	Feed Amt g/bird/day
33	4240	138	3510	168
34	4270	138	3530	168
35	4300	139	3550	168
36	4330	140	3570	167
37	4360	140	3590	166
38	4390	141	3610	166
39	4420	141	3630	165
40	4450	142	3650	165
41	4480	142	3670	164
42	4510	143	3690	163
43	4540	143	3710	163
44	4570	144	3730	162
45	4600	144	3750	162
46	4630	144	3770	161
47	4660	145	3790	160
48	4690	145	3810	160
49	4720	146	3830	159
50	4750	146	3850	159
51	4780	147	3870	158
52	4810	147	3890	157
53	4840	148	3910	157
54	4870	148	3930	156
55	4900	149	3950	156
56	4930	149	3970	155
57	4960	149	3990	155
58	4990	150	4010	154
59	5020	150	4030	153
60	5050	151	4050	153
61	5080	151	4070	152
62	5110	152	4090	152
63	5140	152	4110	151
64	5170	153	4130	150

ROSS 308®

Age Wks	Ross Male		Ross 308 Female	
	Weight lb	Feed Amt lb/100/day	Weight lb	Feed Amt lb/100/day
0		ad lib		ad lib
1	0.33	7.6	0.25	5.6
2	0.71	9.3	0.47	7.0
3	1.16	10.5	0.74	8.0
4	1.66	11.6	0.99	8.8
5	2.08	12.4	1.23	9.4
6	2.49	13.2	1.46	9.9
7	2.82	13.9	1.68	10.3
8	3.13	14.6	1.90	10.7
9	3.41	15.2	2.12	11.1
10	3.68	15.9	2.34	11.5
11	3.96	16.5	2.56	12.0
12	4.23	17.2	2.78	12.5
13	4.51	17.9	3.00	13.0
14	4.78	18.6	3.22	13.7
15	5.06	19.4	3.44	14.5
16	5.34	20.2	3.68	15.6
17	5.64	21.2	3.95	16.8
18	5.99	22.2	4.22	18.3
19	6.34	23.3	4.52	19.9
20	6.69	24.4	4.84	21.5
21	7.04	25.4	5.17	22.8
22	7.40	26.4	5.51	24.9
23	7.75	27.2	5.86	26.9
24	8.10	27.9	6.22	29.0
25	8.43	28.4	6.56	30.5
26	8.73	28.9	6.88	32.7
27	8.90	29.2	7.15	34.8
28	9.02	29.5	7.36	36.9
29	9.08	29.7	7.48	36.9
30	9.15	29.9	7.57	36.9
31	9.22	30.1	7.64	36.9
32	9.28	30.2	7.69	36.9
33	9.35	30.4	7.74	36.9
34	9.41	30.5	7.78	36.9
35	9.48	30.6	7.83	36.9
36	9.55	30.8	7.87	36.8
37	9.61	30.9	7.91	36.7
38	9.68	31.0	7.96	36.5
39	9.74	31.1	8.00	36.4
40	9.81	31.2	8.05	36.3
41	9.88	31.3	8.09	36.1
42	9.94	31.4	8.13	36.0
43	10.01	31.5	8.18	35.9
44	10.08	31.6	8.22	35.8
45	10.14	31.7	8.27	35.6
46	10.21	31.8	8.31	35.5
47	10.27	31.9	8.36	35.4
48	10.34	32.0	8.40	35.2
49	10.41	32.1	8.44	35.1
50	10.47	32.3	8.49	35.0
51	10.54	32.4	8.53	34.8
52	10.60	32.5	8.58	34.7
53	10.67	32.6	8.62	34.6
54	10.74	32.7	8.66	34.5
55	10.80	32.8	8.71	34.3
56	10.87	32.9	8.75	34.2
57	10.93	33.0	8.80	34.1
58	11.00	33.1	8.84	33.9
59	11.07	33.2	8.88	33.8
60	11.13	33.3	8.93	33.7
61	11.20	33.4	8.97	33.6
62	11.27	33.4	9.02	33.4
63	11.33	33.5	9.06	33.3
64	11.40	33.7	9.10	33.2

Age Wks	Ross Male		Ross 708 Female	
	Weight g	Feed Amt g/bird/day	Weight g	Feed Amt g/bird/day
0		ad lib		ad lib
1	150	35	110	26
2	320	42	215	31
3	525	48	310	35
4	755	52	400	37
5	945	56	490	39
6	1130	60	580	41
7	1280	63	670	42
8	1420	66	760	43
9	1545	69	850	44
10	1670	72	940	46
11	1795	75	1030	47
12	1920	78	1120	49
13	2045	81	1210	51
14	2170	84	1300	54
15	2295	88	1390	58
16	2420	92	1480	62
17	2560	96	1585	67
18	2715	101	1700	73
19	2875	106	1825	80
20	3035	111	1960	86
21	3195	115	2100	93
22	3355	120	2245	99
23	3515	123	2395	107
24	3675	127	2545	117
25	3825	129	2690	126
26	3960	131	2825	139
27	4035	132	2955	151
28	4090	134	3055	159
29	4120	135	3145	159
30	4150	136	3230	159
31	4180	136	3285	159
32	4210	137	3300	159

Age Wks	Ross Male		Ross 708 Female	
	Weight g	Feed Amt g/bird/day	Weight g	Feed Amt g/bird/day
33	4240	138	3370	159
34	4270	138	3400	159
35	4300	139	3430	159
36	4330	140	3450	159
37	4360	140	2470	158
38	4390	141	3485	158
39	4420	141	3500	157
40	4450	142	3515	157
41	4480	142	3530	156
42	4510	143	3545	156
43	4540	143	3560	155
44	4570	144	3575	155
45	4600	144	3590	154
46	4630	144	3605	154
47	4660	145	3620	153
48	4690	145	3635	153
49	4720	146	3650	152
50	4750	146	3665	152
51	4780	147	3680	151
52	4810	147	3695	151
53	4840	148	3710	150
54	4870	148	3725	150
55	4900	149	3740	149
56	4930	149	3755	149
57	4960	149	3770	148
58	4990	150	3785	148
59	5020	150	3800	147
60	5050	151	3815	147
61	5080	151	3830	146
62	5110	152	3845	145
63	5140	152	3860	145
64	5170	153	3875	144

Age Wks	Ross Male		Ross 708 Female	
	Weight lb	Feed Amt lb/100/day	Weight lb	Feed Amt lb/100/day
0		ad lib		ad lib
1	0.33	7.6	0.23	5.7
2	0.71	9.3	0.47	6.8
3	1.16	10.5	0.68	7.6
4	1.66	11.6	0.88	8.2
5	2.08	12.4	1.08	8.6
6	2.49	13.2	1.28	8.9
7	2.82	13.9	1.48	9.2
8	3.13	14.6	1.68	9.5
9	3.41	15.2	1.87	9.8
10	3.68	15.9	2.07	10.1
11	3.96	16.5	2.27	10.4
12	4.23	17.2	2.47	10.8
13	4.51	17.9	2.67	11.3
14	4.78	18.6	2.87	11.9
15	5.06	19.4	3.06	12.7
16	5.34	20.2	3.30	13.7
17	5.64	21.2	3.49	14.8
18	5.99	22.2	3.75	16.1
19	6.34	23.3	4.02	17.6
20	6.69	24.4	4.32	19.1
21	7.04	25.4	4.63	20.5
22	7.40	26.4	4.95	21.9
23	7.75	27.2	5.28	23.6
24	8.10	27.9	5.61	25.7
25	8.43	28.4	5.93	27.8
26	8.73	28.9	6.23	30.7
27	8.90	29.2	6.51	33.2
28	9.02	29.5	6.74	35.1
29	9.08	29.7	6.93	35.1
30	9.15	29.9	7.12	35.1
31	9.22	30.1	7.24	35.1
32	9.28	30.2	7.34	35.1
33	9.35	30.4	7.43	35.1
34	9.41	30.5	7.50	35.1
35	9.48	30.6	7.56	35.1
36	9.55	30.8	7.61	35.0
37	9.61	30.9	7.65	34.9
38	9.68	31.0	7.68	34.8
39	9.74	31.1	7.72	34.7
40	9.81	31.2	7.75	34.6
41	9.88	31.3	7.78	34.4
42	9.94	31.4	7.82	34.3
43	10.01	31.5	7.85	34.2
44	10.08	31.6	7.88	34.1
45	10.14	31.7	7.91	34.0
46	10.21	31.8	7.95	33.9
47	10.27	31.9	7.98	33.8
48	10.34	32.0	8.01	33.7
49	10.41	32.1	8.05	33.5
50	10.47	32.3	8.08	33.4
51	10.54	32.4	8.11	33.3
52	10.60	32.5	8.15	33.2
53	10.67	32.6	8.18	33.1
54	10.74	32.7	8.21	33.0
55	10.80	32.8	8.25	32.9
56	10.87	32.9	8.28	32.8
57	10.93	33.0	8.31	32.6
58	11.00	33.1	8.34	32.5
59	11.07	33.2	8.38	32.4
60	11.13	33.3	8.41	32.3
61	11.20	33.4	8.44	32.2
62	11.27	33.4	8.48	32.1
63	11.33	33.5	8.51	32.0
64	11.40	33.7	8.54	31.9

ROSS 308®

Age Weeks	Hen Week %	Eggs/Bird/ Cum.	Hatch All Eggs %	Cum. Chicks Hen Housed	Egg Weight g (oz/doz)
25	5.4	0.38			50.4 (21.3)
26	22.3	1.93	75.6	0.85	52.3 (22.1)
27	52.5	5.58	78.9	3.39	53.9 (22.8)
28	74.2	10.73	81.7	7.24	55.5 (23.5)
29	83.0	16.48	84.0	11.80	56.8 (24.0)
30	86.1	22.43	85.9	16.71	58.0 (24.5)
31	86.9	28.43	87.4	21.80	59.0 (25.0)
32	86.4	34.38	88.4	26.94	59.8 (25.3)
33	85.4	40.25	89.0	32.05	60.4 (25.6)
34	84.4	46.04	89.5	37.11	61.0 (25.8)
35	83.4	51.75	89.7	42.10	61.6 (26.1)
36	82.4	57.38	89.9	47.03	62.1 (26.3)
37	81.4	62.93	89.9	51.90	62.5 (26.5)
38	80.3	68.40	89.8	56.67	62.9 (26.6)
39	79.3	73.79	89.7	61.37	63.3 (26.8)
40	78.3	79.09	89.5	65.98	63.7 (27.0)
41	77.2	84.31	89.1	70.50	64.0 (27.1)
42	76.2	89.45	88.7	74.92	64.4 (27.3)
43	75.1	94.51	88.3	79.26	64.7 (27.4)
44	74.1	99.49	88.0	83.51	65.1 (27.6)
45	73.0	104.39	87.5	87.66	65.4 (27.7)
46	72.0	109.21	87.0	91.72	65.8 (27.8)
47	70.9	113.95	86.4	95.69	66.1 (28.0)
48	69.8	118.60	85.9	99.55	66.5 (28.1)
49	68.8	123.17	85.2	103.32	66.8 (28.3)
50	67.7	127.66	84.6	106.99	67.2 (28.4)
51	66.6	132.07	84.0	110.57	67.5 (28.6)
52	65.5	136.40	83.2	114.05	67.9 (28.7)
53	64.4	140.65	82.4	117.43	68.2 (28.9)
54	63.3	144.82	81.7	120.72	68.5 (29.0)
55	62.2	148.91	80.9	123.91	68.8 (29.1)
56	61.1	152.91	80.0	127.00	69.1 (29.2)
57	60.0	156.83	79.0	129.98	69.4 (29.4)
58	58.9	160.67	78.1	132.87	69.6 (29.5)
59	57.8	164.43	77.2	135.66	69.8 (29.5)
60	56.6	168.11	76.2	138.36	70.0 (29.6)
61	55.5	171.71	75.2	140.97	70.1 (29.7)
62	54.4	175.23	74.1	143.47	70.2 (29.7)
63	53.2	178.67	73.0	145.89	70.3 (29.8)
64	52.1	182.02	71.7	148.19	70.4 (29.8)

ROSS 708®

Age Weeks	Hen Week %	Eggs/Bird/ Cum.	Hatch All Eggs %	Cum. Chicks Hen Housed	Egg Weight g (oz/doz)
25	5.4	0.38			49.4 (20.9)
26	18.9	1.70	77.4	0.71	51.2 (21.7)
27	49.2	5.12	79.5	3.13	52.8 (22.3)
28	70.9	10.04	81.2	6.87	54.6 (23.1)
29	79.7	15.56	82.7	11.31	55.7 (23.6)
30	82.7	21.28	83.9	16.11	57.0 (24.1)
31	83.6	27.05	84.9	21.06	58.1 (24.6)
32	83.0	32.77	85.6	26.07	58.9 (24.9)
33	82.0	38.41	86.3	31.04	59.7 (25.3)
34	81.0	43.97	86.8	35.96	60.4 (25.6)
35	80.0	49.45	87.2	40.81	60.9 (25.8)
36	79.0	54.85	87.5	45.61	61.4 (26.0)
37	78.0	60.17	87.8	50.33	61.9 (26.2)
38	77.0	65.41	88.0	54.97	62.3 (26.4)
39	76.0	70.57	88.2	59.54	62.7 (26.5)
40	74.8	75.64	88.3	64.02	63.0 (26.7)
41	73.8	80.63	88.4	68.41	63.4 (26.8)
42	72.8	85.54	88.5	72.72	63.7 (27.0)
43	71.7	90.37	88.6	76.94	64.1 (27.1)
44	70.7	95.12	88.6	81.07	64.4 (27.3)
45	69.6	99.79	88.6	85.11	64.8 (27.4)
46	68.6	104.38	88.6	89.06	65.1 (27.6)
47	67.5	108.89	88.5	92.91	65.4 (27.7)
48	66.3	113.31	88.5	96.66	65.8 (27.8)
49	65.3	117.65	88.4	100.30	66.1 (28.0)
50	64.2	121.91	88.3	103.86	66.5 (28.1)
51	63.1	126.09	88.2	107.33	66.8 (28.3)
52	62.0	130.19	88.1	110.70	67.2 (28.4)
53	61.0	134.21	87.9	113.97	67.5 (28.6)
54	59.9	138.15	87.8	117.14	67.8 (28.7)
55	58.8	142.01	87.6	120.22	68.1 (28.8)
56	57.5	145.78	87.5	123.19	68.4 (28.9)
57	56.4	149.47	87.3	126.06	68.7 (29.1)
58	55.3	153.08	87.1	128.83	68.9 (29.2)
59	54.2	156.61	86.9	131.51	69.1 (29.2)
60	53.1	160.06	86.7	134.09	69.3 (29.3)
61	52.0	163.43	86.5	136.58	69.4 (29.4)
62	50.9	166.72	86.2	138.97	69.5 (29.4)
63	49.7	169.93	86.0	141.26	69.6 (29.5)
64	48.4	173.05	85.8	143.44	69.7 (29.5)