ROBUST RESULTS

Bovans White
Commercial Product Guide

North American Version

The Story of the **Bovans White**

By the 1950s traditional Dutch poultry breederswere facing increased competition from larger American companies. So in 1954 four family owned layer breeding farms formed a new breeding company called Bovans Organisatie N.V. (Bovans Poultry Breeders). These hard working, farming families were the Bongers, Van Duijnhoven, Van Lankveld and Van der Linden (one Bo and three Vans = Bovans).

The founders of Bovans were Harry van Duijnhoven and his wife Nora. The Bovans breeding center was at Harry van Duijnhoven's farm at Stevensbeek and their Bovans layers reflected the robust and hardworking ethics of the four families.

The original Bovans logo, which is still in use, was designed by Harry van Duijnhoven's brother.

Bovans Poultry Breeders soon developed into a strong and successful breeder, selling its birds in Europe, the America's, Africa and the Middle East.

THE BOVANS WHITE TODAY

The Bovans White is an exceptionally balanced layer, combining high peak performance, feed efficiency and livability.

Robust and easy to manage the Bovans White enables egg producers to achieve their desired egg weight level, for table eggs or processing.

A productive layer with a flat egg weight curve, a very strong shell and excellent laying persistency, the Bovans White is suitable for longer laying cycles, and is adaptable to differing environments and management systems.

Flat egg weight curve

Superior egg production

Robust and easy to manage

Exceptionally balanced bird

Strong bottom line results

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The performance data contained in this document was obtained from results and experience from our own research flocks and flocks of our customers. In no way does the data contained in this document constitute a warranty or guarantee of the same performance under different conditions of nutrition, density or physical or biological environment.

In particular (but without limitation of the foregoing) we do not grant any warranties regarding the fitness for purpose, performance, use, nature or quality of the flocks. ISA makes no representation as to the accuracy or completeness of the information contained in this document.

INTRODUCTION

This guide highlights feeding, management and environmental factors, which can help achieve maximum profit from this genetically superior white egg layer. These, combined with sound stock sense, are the prime ingredients required for good performance. It is recommended that the guide be read completely prior to setting up a management program to ensure co ordination of all phases of the life of the flock. This is important, particularly where growing and laying phases are separate operations. Improper treatment in the growing period can limit the pullet's potential.

Table 1 - Bovans White

COMMERCIAL PERFORMANCE OBJECTIVES 18-90 WEEKS

Body weight at 18 weeks:	1302-1369 g	2.87 – 3.02 lb.
Body weight at 30 weeks:	1611 g	3.55 lb.
Body weight at 90 weeks:	1710 g	3.77 lb.
Hen housed production		
at 60 weeks:	258 eggs	
at 72 weeks:	328 eggs	
at 90 weeks:	426 eggs	
Age at 50% rate of lay:	143 days	
Peak production:	96 %	
Production rate:		
at 60 weeks:	89 %	
at 72 weeks:	85 %	
at 90 weeks:	79 %	
Total egg mass		
at 60 weeks:	15.50 kg	34.2 lb.
at 72 weeks:	19.97 kg	44.0 lb.
at 90 weeks:	26.37 kg	58.1 lb.
Average egg weight:	62.0 g	49.2 lb./case
Feed Conversion* (ratio by weight)	2.03 kg/kg	3.32 lb./dozen
Average feed consumption during lay per day	108 g	23.7 lbs./100
Shell Strength	4200 g/cm2	
Haugh Units	83	
Liveability (18 – 90 weeks)	94 %	

* Data concerning feed conversion is based on controlled environmental temperature and phase feed under this guide's recommendation (Tables 2-4).

SUGGESTED RATIONS

The choice of diet will be determined by factors such as price, type of ingredients and climate. The Bovans White is capable of good performance on a wide range of different feeds, as long as they are balanced properly. Suggested ration specifications are shown in Tables 2, 3 and 4.

Table 2

RECOMMENDED PULLET FEEDING PROGRAM

Nutrients	Starter 1 – 8 weeks	Grower I 9 – 12 weeks	Grower II 13 – 16 or 17 weeks
Crude Protein (%)	20.5 – 21.0	18.0 – 18.5	17.0 – 17.5
ME (kcal/kg)	2850 – 2950	2750 – 2850	2700 – 2800
(kcal/lb)	1295 – 1340	1250 – 1295	1225 – 1270
Linoleic Acid (%)	1.30	1.00	1.00
Amino Acids (%)			
Methionine	0.49	0.43	0.38
Methionine + Cystine	0.85	0.73	0.65
Lysine	1.10	1.00	0.90
Tryptophan	0.23	0.21	0.18
Threonine	0.75	0.70	0.60
Arginine	1.20	1.10	1.00
Minerals (%)			
Calcium	1.1	1.1	1.2
Available Phosphorus	0.45 – 0.50	0.45 – 0.50	0.42 – 0.47
Sodium	0.18	0.18	0.18
Chloride (max.)	0.25	0.25	0.25

Notes:

Starter diet could be fed in a crumble form to improve feed intake (when achieving proper body weights is challenging)

Feed Chick starter and grower rations containing a coccidiostat from day-old to 8-12 weeks of age when rearing flocks on litter floors without the use of a coccidiosis vaccine.

Table 3

RECOMMENDED VITAMIN TRACE MINERAL LEVELS ADDED PER TONNE OF COMPLETE FEED

Nutrients		Starter	Grower	Layer
Vitamin A	(IU)	12,000,000	9,000,000	11,000,000
Vitamin D3	(ICU)	2,500,000	2,500,000	3,000,000
Vitamin E	(IU)	30,000	20,000	20,000
Vitamin K3	(g)	3	3	3
Thiamine	(g)	2.5	2.5	2.2
Riboflavin	(g)	7	5	6.5
Pantothenic Acid	(g)	12	9	10
Niacin	(g)	40	30	40
Pyridoxine	(g)	5	3.5	4.5
Biotin	(g)	0.2	0.2	0.2
Folic Acid	(g)	1	1	1
Vitamin B12	(g)	0.03	0.02	0.02
Choline	(g)	1,000	800	1,000
Iron	(g)	80	80	80
Copper	(g)	10	10	10
Manganese	(g)	85	85	85
Zinc	(g)	80	80	80
Iodine	(g)	1	1	1
Selenium	(g)	0.3	0.3	0.3

Note:
Antioxidants should be added at levels recommended by the manufacturer. Antioxidants are especially important in hot climates and where fats are added to the ration.

Table 4

BOVANS WHITE FEEDING RECOMMENDATIONS LAYING PERIOD

Nutrients Age Range	Layer I 16/17 – 38 weeks	Layer II * 39 – 51 weeks	Layer III ** 52 – 64 weeks	Layer IV *** 65 – 77 weeks	Layer V **** 78 – end
Feed Cons. Range	21-22.5 lbs/100 95-102 g/bird	21.4-22.9 lbs/100 97-104 g/bird	22-23 lbs/100 100-105 g/bird	22-23 lbs/100 100-105 g/bird	22-23 lbs/100 100-105 g/bird
Crude Protein (%)	18.0 – 18.5	17.5 – 18.0	16.5 – 17.0	15.5 – 16.0	15.0 – 15.5
ME (kcal/kg)	2860 – 2900	2850 – 2880	2840 – 2860	2820 – 2840	2820 – 2840
(kcal/lb)	1300 – 1320	1295 – 1310	1290 – 1300	1280 – 1290	1280 – 1290
Linoleic Acid (%)	1.90	1.60	1.40	1.30	1.30
Amino Acids (%)					
Methionine	0.50	0.46	0.42	0.39	0.36
Methionine + Cystine	0.82	0.77	0.72	0.68	0.62
Lysine	0.98	0.94	0.90	0.86	0.82
Tryptophan	0.22	0.19	0.18	0.17	0.16
Threonine	0.70	0.66	0.63	0.61	0.57
Arginine	0.96	0.92	0.88	0.84	0.80
Minerals (%)					
Calcium	4.1 – 4.2	4.2 – 4.3	4.3 – 4.4	4.4 – 4.5	4.6 – 4.7
Available Phosphorus	0.45 - 0.48	0.43 – 0.46	0.40- 0.43	0.37 - 0.40	0.34 - 0.37
Sodium	0.18	0.18	0.18	0.18	0.18
Chloride (max.)	0.25	0.25	0.25	0.25	0.25

* Changes from Layer I to Layer II should be made based on daily egg mass. After peak mass has been achieved (about 39 weeks of age), change from Layer I to Layer II.

** Changes from Layer II to Layer III should be made around 52 weeks, when egg mass is about 57.1 grams.

*** Changes from Layer III to Layer IV should be made around 65 weeks, when egg mass is about 55.7 grams.

**** Changes from Layer IV to Layer V should be made around 78 weeks, when egg mass is about 54.1 grams.

Changes should be subtle, if possible mixing both formulas for a week between each phase.

Note:

Daily egg mass output can be calculated by multiplying the actual hen-day rate of egg production by the average egg weight in grams (e.g. a flock laying 93% with an average egg weight of 60 grams has a daily egg mass output of 55.8 grams per bird).

THE BROODING PERIOD

(First day to 6th week)

The objective is for uninterrupted growth in order to achieve the correct body weight and frame development from day old through sexual maturity and during the egg production period.

The bird's ability to resist disease, to respond to vaccines, to reach the correct mature body size and, eventually, to perform to its genetic potential, depends greatly on what happens during these first 6 weeks. Lighting and vaccination programs, as well as body weight, all start during the brooding period. These, and other management aspects, are dealt with in the appropriate chapters.

Table 5

RECOMMENDED SPACE ALLOWANCE FROM DAY OLD TO 6 WEEKS FOR OPTIMUM PERFORMANCE

	Cages	Litter	Litter & Slats
Floor	160 cm 2 (24.8 sq.in.) / bird	18 birds/m2 (0.6 sq. ft./bird)	
Feeder Trough Pans	5.0 cm (2") / bird -	5.0 cm (2") / bird 4/100 birds	
Drinker Trough	2.5 cm (1") / bird	2.5 cm (1") / bird	
Birds/Round Bell Drinker	-	90	
Cups or Nipples	maximum 10 birds/cup or nipple a minimum of 2 cups or nipples per cage	maximum 10 birds/cup or nipple	

Notes:

1. With all types of equipment, do not exceed the manufacturer's recommendations for minimum floor, feeder and drinker space.
2. These recommendations reflect general practice. In some countries, legislation dictates greater minimum space allowances. Comply with the law.
3. In some countries, floor, feeder and drinker allowances are less than required for optimum performance. Under these conditions, lower performance is expected and accepted. Bovans birds perform competitively under all circumstances.
4. In hot weather conditions, allow 25% more space than figures above.

Planning & preparation

"All in, all out" is recommended.

CLEANING

Remove all traces of manure, litter, dust, feathers, feed and any other residues from previous flocks. If stored or spread, keep manure at least 300 m (1,000ft) downwind from poultry houses. Take steps to eliminate rodents, wild birds, insects and other pests. Carry out all repairs. Flush and sanitize waterlines and tanks. Empty and clean bulk feed bins and store rooms.

The house and equipment, after cleaning and disinfecting, must be left dry, to air for at least 10 days before the new flock arrives.

ISOLATION

If buildings are less than 45 m (150 ft) apart, place young stock upwind from older birds. The attendant should not go near older flocks. If this is unavoidable, visit the younger flock first and change footwear, cap and overalls before tending the older birds. Hands should be washed too, using plenty of soap and water.

Place a 10 cm (4") deep bath of disinfectant solution at each house door. All who enter must first dip their footwear. Clean the bath and replenish the disinfectant at least once daily. Keep the footbath sheltered from sun and rain. Unless their presence is essential, allow no visitors in, or close to, the poultry house.

Water

Water intake restriction, whether accidental or deliberate, will reduce feed intake and growth rate. Water is also essential for body temperature regulation.

Before chicks arrive, have clean, fresh water ready. In a cool climate, it should be at room temperature, but even in hot regions, never warmer than 35°C (95°F).

Provide plenty of easily accessible, well-illuminated drinkers. For a fast start, especially when new arrivals have been heat stressed or dehydrated, give water, but no feed for the first two hours.

To limit wastage, begin raising drinkers as soon as possible. Nipples should be within "stretching" reach overhead. Cups and troughs should have their rims at mid neck height. Water depth must be sufficient to allow immersion of the whole beak, but for baby chicks, never so deep as to risk drowning.

Approximate water consumption levels for pullets and layers are in Appendix 6.

Feed

Feed conversion efficiency will never be better than during these first few weeks of life. Take full advantage of this. Go for maximum intake and thus maximum growth in the "Brooding Period".

Use a good quality diet (see Tables 2-4). Crumbles are better than mash at this stage. Provide plenty of feeder space. Place the first feed on clean paper or new fibre egg trays, but as soon as possible, have the chicks eat from regular feed troughs.

Keep feeders full at the beginning but, within a week, reduce feed depth to minimize wastage. Chicks must still be able to eat without restriction.

By the end of the second week, the rims of both manual and automatic troughs should be at the level of the bird's back.

DANGER SIGNS

Watch for, listen, and react to the chick's complaints. Their welfare is your profit. They can help you avoid mistakes.

Some indications are:

Loud chirping - hunger, cold, fear

Huddling together - cold, draughts

Prostrate, listless - too hot

Cage brooding

TEMPERATURE

Preheat the house for 24 hours before chicks arrive, maintaining 30-32°C (86-90°F) at cage level. Check temperatures at several different locations in the house.

To maintain health, growth and comfort of the flock, reduce temperature by about 3°C (5°F) per week. Aim for 22°C (72°F) at 21 days, but temper all adjustments to the behaviour and the real needs of the birds. When stressed, sick, or reacting to a vaccine, a flock's needs for warmth may increase temporarily, even beyond the age of 6 weeks.

Excessively high temperatures reduce feed intake. Any apparent advantage of lower consumption is more than wiped out by slower development and the lost opportunity to maximize growth while feed efficiency is at its peak.

Caged birds cannot escape to more comfortable areas. They rely on the attendant to get their environmental conditions right the first time.

HUMIDITY

For optimum feather growth, health and feed conversion, maintain a relative humidity in the house of not less than 50%. If necessary, the cage house walkways and walls can be hosed down with a fine spray 3 or 4 times daily. Avoid getting water on the feed.

PAPER

Several layers of newsprint, or similar absorbent, non slip paper over the wire floors will allow chicks immediate full use of the available space. It may also conserve heat and stop draughts.

Spread the paper under all drinkers to give quick, easy access to water. Peel back one layer at a time, as it becomes soiled. Remove paper altogether by 10 days.

Not all cage designs need paper on the floor. Besides the high labour requirement it entails, paper may interfere with ventilation. Follow the recommendations of the cage manufacturer.

Floor brooding

TEMPERATURE

Preheat for 24 hours before chick arrival and maintain a room temperature of 24°C (75°F).

Brooder temperatures, before chick arrival, should start at 32°C (90°F), 5 cm (2") above the litter at the edge of the canopy. Aim to reduce this by 3°C (5°F) each week to a room temperature of 22°C (72°F) at 21 days.

Do not rely only on automatic controls or thermostats. Be guided by chick behaviour and see that their real needs are met.

CHICK GUARDS

Use circular screens 38-46 cm (15-18") high to confine chicks to the heated area. In cold seasons, the circle can be 1 m (about 3'3") from the edge of the heater canopy. In hot seasons, leave 2 m (6'6") or more space.

Cardboard or similar flexible, draught proof material can be used, but when night temperatures stay above 30°C (86°F), small mesh wire netting makes a better substitute.

Space all feeders and drinkers within the circle, but never under the direct heat of the brooder.

Gradually enlarge the circle, at least every second day, adding equipment as necessary and spacing it evenly. By 6-10 days, remove the chick guards altogether.

LITTER

Litter should be able to absorb and release moisture quickly. It should be non abrasive and non toxic.

Use 8 cm (3") of litter spread evenly over the floor.

Concrete floors are recommended. Level the litter carefully in the brooder area. Do not cover it. Mould grows quickly even in new litter when paper or other materials exclude air.

Chick box lids, or similar containers, make good first time feeders and help to exclude litter from feeder troughs. Place drinkers on small boards for the same reason, but always ensure that the chicks have easy access to water.

Most manure will accumulate where the chicks rest. From the first week, turn this litter over to prevent caking. Let it become evenly "humid" rather than wet in spots. Promptly remove badly caked or soaking wet litter.

BEAK TREATMENT

Where windowed or open sided houses are used, or where intensive systems of management are employed and when high-energy diets are fed, beak treatment is recommended for the control of cannibalism and to improve feed conversion.

For the least interruption in growth, beaks should be precision trimmed by infrared beak treatment at hatch or at 6-9 days of age, not later. Trimmed carefully, they will not need touching again, but for assurance, inspect all at 10-12 weeks of age, when touch up is still feasible. Beak treatment after 10 days of age creates an unnecessary stress at a critical age, when a reduction in growth rate is least desired. As an alternative to beak treatment at this time, to burn the tip of the beak and subsequently do a precision treatment at 10-12 weeks has proven to be satisfactory, with least interference in growth and precise shape and size of beak.

AT HATCH

Use standard beak treatment protocol for the infrared beak treatment at hatch (i.e. 27/23c interface plate, glass radius mirror, treatment level 47 – chicks from PS flock younger than 30 weeks of age; 25/23 with treatment level 50 – chicks from PS flock 30 weeks and older).

Infrared beak treated chicks should have very easy access to the water upon arrival to the brooding facility. Watering system could impact livability, weight and chicks uniformity. Usage of 360 degree nipples is strongly recommended.

AT 6-9 DAYS

- Use the "baby chick" adapter on the machine.
- Select the guide hole that will allow the guillotine blade to make its cut 1-2 mm (3/64"-6/64") distal from the nostril. In most cases, this would be the 4.4 mm (11/64") diameter hole.
- The blade must be sharp, straight and heated to a cherry red color (600°C or 1112°F). Blades must be replaced after every three hours of use. Do not clean it with metal scrapers.
- Insert the beak squarely into the guide hole. The thumb should be pressed lightly against the back of the chick's head, the forefinger at its throat to hold back the tongue.
- Depress the blade firmly and steadily to achieve a clean cut. Keep the blade down for a count of 2,5 seconds and keep the beak firmly against the blade.
- An automatic cam on the machine can take the guesswork out of that part of the operation and through controlling the blade movement, achieve better, more uniform results.
- Do not cauterize for longer than 2,5 seconds.
- If the cut continues to bleed, stop the machine and re-sharpen or, preferably, replace the blade. Do not increase the blade temperature above that recommended.
- One common cause of permanent beak damage is excessive cauterization.

If the job is done with precision, it will last the flock's lifetime. If done in haste, or without due care, re-beak treatment may be needed within a few weeks and, at that time, may seriously interrupt growth rate.

At the age of 6-10 days, a skilled operator should beak trim at the rate of 500-600 birds per hour, not faster.

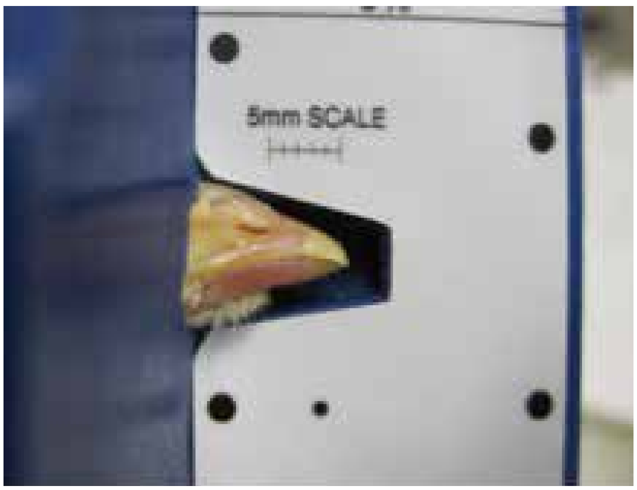
AT 10-12 WEEKS

- Inspect 100% of the pullets' beaks and select individuals that need a touch-up (birds with beak regrowth, of either upper or lower beak, or with sharp edges or "prongs", that may cause injury during eventual peck behavior). Depending on the precision of the first treatment, it may be even necessary to tough-up the whole flock, which is commonly done.
- Do not use any "baby chick" adapter, but only the beak-support bar (for older birds) on a manually operated beak-treatment machine.

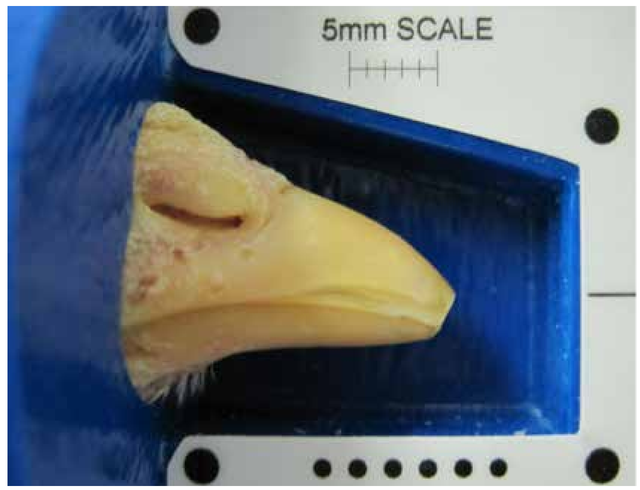
- The blade must be at a higher temperature: 700°C - (1245°F)
- Cut and cauterize the upper and lower beak separately, to achieve ideal shape and size desired for upper and lower beak. A single block cut will give less than optimum results for control of regrowth
- Cut the upper beak 5 mm from the nostrils, with the pullet's head on an angle 10° to 15° below horizontal. Cauterize the upper beak for 2.5-3.0 seconds, slightly turning the pullet head to the sides, but still pressing the cut edge against the centre of the blade, thus allowing a thorough rounding of the corners of the beak.
- Cut the lower beak at the same length or 1-2 mm longer than the upper beak, but never shorter. Cauterize it rounding the corners.
- To ensure a rapid recovery from the inevitable stress caused by beak treatment, increase the depth of feed in feeders during the day of beak treatment and subsequent week.
- Provide water soluble Vitamin K and Vitamin C for two days prior to treatment and three days after.
- Mid-night feeding for a week has provided satisfactory results in body weight recovery after beak treatment.

EXAMPLES OF PROPER INFRARED BEAK TREATED BIRDS:

Infrared beak-treated chick at day of age



Infrared beak-treated hen at 17 weeks of age



Photos: courtesy of Nova–Tech Engineering, LLC

INSOLUBLE GRIT

Insoluble grit should be given from the first day where birds have access to litter. It is an aid to feed digestion and also helps birds cope with any fibrous materials that they may ingest such as feathers, litter, etc.

(Specifications on Table 6)

VENTILATION

There are 5 main objectives for ventilation:

- to provide fresh air
- to remove stale air
- to control temperature
- to control humidity
- to remove dust

Each of these five must be satisfied if the flock is to perform to its best ability in feed conversion, livability, growth and egg production. (Specifications on Table 7)

Table 6

Insoluble grit

Age	Grit Size	Litter Housing	Cages & Wire Floor
1 - 21 days	Baby Chick (1.0-1.5 mm diameter)	1 handful/200 birds/week	1 handful/200 birds/week
22 - 70 days	Grower (2.0-2.5 mm diameter)	500 g (1 lb.) / 100 birds/week	500 g (1 lb.) / 100 birds/month
71 days to end of lay	Layer (3.0-4.0 mm diameter)	500 g (1 lb.) / 100 birds/week	500 g (1 lb.) / 100 birds/month

Note:
Amounts are approximate. Surplus grit in an automatic feeding system may cause damage.

Table 7

Ventilation rates

Type of House	Fan Design Specifications at 2.0 mm (0.08 in) Static Pressure			
	Maximum Air Requirement/Bird		Minimum Air Requirement/Bird	
	m3/hr	C.F.M.*	m3/hr	C.F.M.*
Brooder House (0-6 wks)	3.5	2.1	0.5	0.3
Grower House (7-17 wks)	7.7	4.6	1.0	0.6
Layer House (17 wks-end of lay)	11.0	6.5	1.0	0.6

THE GROWING PERIOD

REARING SPACE REQUIREMENTS

The requirements for feeder, drinker and floor space are shown in Table 8. These are minimum requirements and should be increased during periods of hot weather and where ventilation or feed quality is marginal.

MONITORING DEVELOPMENT

Important records to keep during the growing period include:

- body weight
- feed intake
- water intake
- hours of light
- temperature
- vaccination
- mortality

Other important information to record includes:

- type of feed (protein and energy values)
- any change of attendant
- equipment failures
- disease outbreaks
- beak treatment

Complete records, analyzed correctly, will provide the opportunity to make good management decisions to improve the profitability of current and future flocks.

Every time the records are updated, compare the actual information with the objective for that age. Any deviation from the expected target indicates that some form of management change is necessary to bring the flock back to the correct line of performance.

To develop a large framed, strong, lean pullet for optimum laying results, it is necessary to grow the pullet to the correct weight for age. To achieve and maintain target body weights, monitor growth by individually weighing a representative sample of the flock.

Table 8

Rearing space requirements 6-18 weeks

	Cages	Litter	Litter & Slats
Floor	350 cm2 (54 sq.in.) / bird	10 birds/m2 (1.07 sq.ft./bird)	
Feeder Trough Pans	7.5 cm (3") / bird -	7.5 cm (3") / bird 4/100 birds	
Drinker Trough	5.0 cm (2") / bird	5.0 cm (2") / bird	
Birds/Round Bell Drinker	-	90	
Cups or Nipples	maximum 10 birds/cup or nipple a minimum of 2 cups or nipples per cage	maximum 10 birds/cup or nipple	

Notes:

1. With all types of equipment, do not exceed the manufacturer's recommendations for minimum floor, feeder and drinker space.
2. These recommendations reflect general practice. In some countries, legislation dictates greater minimum space allowances. Comply with the law.
3. In some countries, floor, feeder and drinker allowances are less than required for optimum performance. Under these conditions, lower performance is expected and accepted. Bovans birds perform competitively under all circumstances.

Weighing

Start weighing at 4 weeks of age.

In a cage house, select the cages containing the birds to be weighed from various locations and different levels in the house. Include some on both the delivery and the return sides of the automatic feeder. Always weigh every bird in the cage and mark the selected locations so that the same birds are weighed each time. In a litter house, use a lightweight screen to block off two areas in each pen and weigh every bird enclosed.

Growth rate control

Compare the bird's average body weight with the standard (Table 9). If on target at 28, 35 and 42 days, it will probably be safe to plan the change from starter to grower ration for the 50-57 day period. If body weights are not reaching the standard, postpone the feed change and/or take other measures to speed growth. In any case, it is normally not recommended to continue with chick starter feed beyond the 10th week.

Some ways to stimulate feed intake and growth rate

a) If the age and health of the flock permit, reduce room temperatures (gradually) by 1 or 2°C (2 or 4°F).
b) Increase light intensity over drinkers and feeders.
c) Increase the number of drinkers per pen, or per cage.
d) Increase the frequency of feeding, or feeder line operation.
e) Increase depth of feed in the trough.
f) Add feeders, or decrease bird numbers per pen, or per cage.
g) Increase the energy level of the diet (adding fat).
h) Increase the protein level in the chick starter.
i) Verify the amino acid balance and vitamin/mineral levels in the diet.
j) In rearing, delay the step-down lighting program or step down to a longer day length (but not more than 12 hours).
k) An additional 1-hour of light in the middle of the dark period ("mid-night feeding") has also been shown to increase feed consumption.

Underweight flocks should be checked to determine the reason. Poor growth can be the result of a disease outbreak, low energy or low protein feed, heat stress, overcrowding and other environmental factors. Take prompt action to correct deficiencies and to stimulate feed intake.

Consult your feed supplier or nutritionist for further advice.

Table 9

Body weights & approximate feed consumption for Bovans White pullets

Age		Body Weight minimum - maximum		Feed intake per bird per day minimum - maximum		Feed intake per bird cumulative minimum - maximum	
Weeks	Days	(g)	(Lbs.)	g/bird	Lbs./100 birds	g/bird	Lbs./100
1	0 - 7	62 - 65	0.14 - 0.14	6 - 8	1.3 - 1.7	40 - 54	8.9 - 12.0
2	8 - 14	126 - 132	0.28 - 0.29	13 - 15	2.8 - 3.2	128 - 156	28.3 – 34.5
3	15 - 21	193 - 203	0.43 - 0.45	19 - 21	4.1 - 4.6	260 - 302	57.3 – 66.6
4	22 - 28	264 - 278	0.58 - 0.61	25 - 27	5.4 – 5.9	432 - 488	95.2 – 107.6
5	29 - 35	338 - 356	0.75 - 0.78	30 - 32	6.6 – 7.0	641 - 711	141.2 – 156.6
6	36 - 42	415 - 436	0.91 - 0.96	35 - 37	7.6 – 8.1	883 - 967	194.6 – 213.1
7	43 - 49	493 - 518	1.09 - 1.14	39 - 41	8.6 - 9.0	1155 - 1253	254.6 – 276.2
8	50 - 56	572 - 602	1.26 - 1.33	43 - 45	9.4 – 9.9	1455 - 1567	320.7 – 345.4
9	57 - 63	652 - 686	1.44 - 1.51	46 - 48	10.2 - 10.7	1780 - 1906	392.4 – 420.2
10	64 - 70	733 - 770	1.62 - 1.70	50 - 52	11.0 - 11.4	2128 - 2268	469.2 – 500.0
11	71 - 77	812 - 854	1.79 - 1.88	53 - 55	11.6 – 12.1	2498 - 2652	550.7 – 584.6
12	78 - 84	891 - 937	1.96 - 2.07	56 - 58	12.3 - 12.7	2888 - 3056	636.7 – 673.7
13	85 - 91	968 - 1018	2.13 - 2.24	59 - 61	12.9 – 13.3	3298 - 3480	727.0 - 767.1
14	92 - 98	1042 - 1096	2.30 - 2.42	61 - 63	13.5 – 14.0	3727 - 3923	821.6 – 864.8
15	99 - 105	1114 - 1171	2.46 - 2.58	64 - 66	14.2 – 14.6	4176 - 4386	920.7 – 967.0
16	106 - 112	1181 - 1242	2.60 - 2.74	67 - 69	14.8 – 15.3	4646 - 4870	1024.3 - 1073.7
17	113 - 119	1244 - 1308	2.74 - 2.88	70 - 72	15.5 – 16.0	5139 - 5377	1133.0 – 1185.4
18	120 - 126	1302 - 1369	2.87 – 3.02	76 - 78	16.7 - 17.2	5670 - 5922	1250.0 – 1305.6

Uniformity

Commercial poultrymen apply their management techniques to the complete flock as a single unit because it is impractical to manage each bird as an individual. It is for this reason that flock uniformity is so important in obtaining optimum performance and the greatest profitability.

The lighting program, diet changes and vaccinations are applied to the whole flock. If it is uniform in weight and maturity, the flock will derive maximum benefit from these treatments. The better the uniformity in a laying flock, the higher the peak. Better persistency of egg production, livability and uniformity of egg size can also be expected.

Wherever flock uniformity is less than desired, take action to improve it. Poor uniformity may be caused by disease, poor ventilation, lack of, or poor distribution of equipment, or any other management fault.

A good level of uniformity is when 80% of the birds are within plus or minus 10% of the flock's average weight.

Weigh scales

The "uniformity" of a flock may work out at 75% if weights are taken on a scale with 5-gram (0.2-oz) increments. If these weights are simultaneously measured on a scale with 20 gram (0.7 oz) increments, uniformity would appear better, in this case about 80%. With still larger increments, 50 grams or about 1/10 lb., the uniformity would appear to be as high as 85%.

Do not compare separate "uniformity" calculations unless the scales measure in the same increments.

At ISA, we recommend using a 5-kg or 11-lb. dial faced scale graduated in either 20 gram or 1/10-lb. increments.

FEED IN THE GROWING PERIOD

Suggested ration specifications are provided in Tables 2, 3 and 4. These should be full fed. Where temperatures exceed 30°C (86°F), feed intake may be depressed and body weights fail to reach target. Under these circumstances, a change in diet formulation may be necessary. Consult your nutritionist for such changes. Starter ration should be fed from week 1 to week 8; Grower 1 ration from 9 to 12 and Grower 2 ration from week 13 to 16 or 17.

Moving to the laying house

During and following the move from the growing facilities to the laying house, the birds are subject to many varied stresses. Make every effort to keep these factors to an absolute minimum.

Losses of between 5-10% in body weight can be common at this time. Every effort should be made following transfer to regain this weight and attain target weights. Failure to maintain growth in the early production period can result in low peak egg production, inadequate egg size and/or post peak dips in production.

Complete the move by 112 days (16 weeks) of age. This will allow the birds to settle down and become familiar with their new surroundings before production starts. The main vaccination program must be completed before the flock is moved. For the first 2-5 days in the new quarters, keep light intensity high until you are sure all the birds have located feed and water.

LIGHTING MANAGEMENT

The lighting program, together with the recommended feeding and management programs contained in this guide, are designed to achieve the performance standards of Appendices 3 and 4. The Bovans White has shown great adaptability in egg size distribution to meet various market requirements.

The purpose of controlling daylength during the rearing and laying periods is:

- to adjust maturity and onset of production for the correct age and stage of development
- to achieve the best rate of egg production
- to achieve required egg size
- to achieve adequate body weight
- feed and water.

Introduction

- An increasing photoperiod stimulates the bird to mature. A decreasing photoperiod retards maturity and will affect egg production.
- Daylength control in the rearing and laying periods is an important management tool in the achievement of economic performance, both in egg number and egg weight.
- The lighting program starts immediately day old chicks arrive.
- For suggested lighting programs, see pages 16 - 20.

Table 10

Lighting program for controlled environment housing

Age	Day Length (hours)
Day 1 – 7	23
Day 8 – 14	21
Day 15 – 21	19
Day 22 – 28	17
Day 29 – 35	15
Day 36 – 42	13
Day 43 – 112	11
Week 17 (113 days)	12
Week 18	13
Week 19	13:30
Week 20	14
Week 21	14:30
Week 22	15
Week 23	15
Week 24	15
Week 25	15

Table 11

Lighting program for open sided houses at the equator

Age	Day Length (hours)
Day 1 – 7	23
Day 8 – 14	20
Day 15 – 21	18
Day 22 – 28	16
Day 29 – 119	12
Week 18 (120 days)	13
Week 19	13:30
Week 20	14
Week 21	14:30
Week 22	15
Week 23	15:30
Week 24	16
Week 25	16
Week 26	16
Week 27	16
Week 28	16

Notes:

- Pullets must reach 17 weeks standard body weight before light stimulation begins (min.1244 g or 2.74 Lbs.).
- If pullets grown with higher than recommended stocking density it is possible to use longer Step down program, to ensure proper weight gain.
- If layer house is not 100% light proof (no light traps at fan openings) it is possible to go up to 16 hours of light during lay.

Table 12

Lighting program for open sided houses - northern hemisphere

HATCHES FROM APRIL TO SEPTEMBER

Age	Day Length (hours)
Day 1 – 7	22
Day 8 – 14	20
Day 15 – 21	18
Day 22 – 28	16
Day 29 – 112	Constant day length, equivalent to longest natural day in this period
Week 17 (113 days)	+1 h
Week 18	+30 min
Week 19	weekly increases of 30 minutes until reaching a total of 16 hours
Week 20	
Week 21	
Week 22	
Week 23	
Week 24	
Week 25	
Week 26	
Week 27	

HATCHES FROM OCTOBER TO MARCH

Age	Day Length (hours)
Day 1 – 7	22
Day 8 – 14	21
Day 15 – 21	20
Day 22 – 28	19
Day 29 – 35	18
Day 36 – 42	17
Day 43 – 119	Constant day length, equivalent to longest natural day in this period
Week 18 (120 days)	+1 h
Week 19	+30 min
Week 20	weekly increases of 30 minutes until reaching a total of 16 hours
Week 21	
Week 22	
Week 23	
Week 24	
Week 25	
Week 26	

Note:

Flocks hatched from April to September will tend to be later into production than flocks hatched from October to March. Therefore, we recommend:

- Hatches from April to September:
- Quicker step-down program in rearing and an earlier stimulus of one extra hour at week 17.
- Constant Light between 5 and 16 weeks. Total day length never shorter than longest natural day in the period.
- Hatches from October to March:
- Longer Step down program in rearing, to ensure proper weight gain.
- Constant Light between 7 and 17 weeks. Total day length never shorter than longest natural day in the period.

Table 12

Lighting program for open sided houses - southern hemisphere

HATCHES FROM OCTOBER TO MARCH

Age	Day Length (hours)
Day 1 - 7	22
Day 8 - 14	20
Day 15 - 21	18
Day 22 - 28	16
Day 29 - 112	Constant day length, equivalent to longest natural day in this period
Week 17 (113 days)	+1 h
Week 18	+30 min
Week 19	weekly increases of 30 minutes until reaching a total of 16 hours
Week 20	
Week 21	
Week 22	
Week 23	
Week 24	
Week 25	
Week 26	
Week 27	

HATCHES FROM APRIL TO SEPTEMBER

Age	Day Length (hours)
Day 1 – 7	22
Day 8 – 14	21
Day 15 – 21	20
Day 22 – 28	19
Day 29 – 35	18
Day 36 – 42	17
Day 43 – 119	Constant day length, equivalent to longest natural day in this period
Week 18 (120 days)	+1 h
Week 19	+30 min
Week 20	weekly increases of 30 minutes until reaching a total of 16 hours
Week 21	
Week 22	
Week 23	
Week 24	
Week 25	
Week 26	

Note:

Flocks hatched from October to March will tend to be later into production than flocks hatched from April to September. Therefore, we recommend:

- Hatches from October to March:
- Quicker step-down program in rearing and an earlier stimulus of one extra hour at week 17.
- Constant Light between 5 and 16 weeks. Total day length never shorter than longest natural day in the period.
- Hatches from April to September:
- Longer Step down program in rearing, to ensure proper weight gain.
- Constant Light between 7 and 17 weeks. Total day length never shorter than longest natural day in the period.

The basics of daylength adjustment

REARING

In rearing, use a "Step down" or a "Constant" lighting pattern, or a combination of the two. A step down program tends to retard maturity and increase lifetime average egg size, more so if applied beyond 42 days of age. However, in the early weeks, when chicks are growing rapidly, longer days stimulate higher feed intake and maximum bone growth at the least cost. In fact, the light program is flexible. A decision not to reduce day length as quickly as planned may be taken if growth is insufficient. However, this may delay sexual maturity and affect egg size.

CONTROLLED ENVIRONMENT HOUSING

See Table 10

OPEN SIDED HOUSING

Birds should be reared on a day length equal to the longest natural photoperiod that they will encounter during the period of 6-18 weeks of age. An example is provided in Table 11 for the situation encountered at the equator with a constant day length of 12 hours. For recommendations that are more suited to your particular conditions, please consult your local Bovans representative.

START OF LAY

Never increase day length until the rearing period is over and then time it carefully to match the needs of the flock in terms of body weight and physical maturity. If body size and development have been retarded, the day length increase should be postponed a few days. The timing of photostimulation should be based on body weight. A precocious, well-grown flock could be stimulated safely earlier than the Guide suggests, depending on your particular egg size requirements. Light stimulation at 16 weeks of age can only be safely employed if birds are on target weight for 17 weeks of age. Obviously, any deficiency in body weight will reduce average egg weight.

In fully blacked out, light proofed houses, where daylight cannot enter, a year round day length of 15 hours is recommended once egg production has peaked (see Table 10). Sixteen hours will also support maximum production in open sided houses, wherever the longest day of the year is 14 hours or less.

Whenever the longest natural day is more than 15 hours and the house not 100% light proof, day length throughout lay must at least equal the longest natural day. This ensures that the flock will never experience shortening days after mid summer, a factor that could induce neck moult, or a significant drop in egg production.

ON OFF TIMES & TIME CLOCKS

Light "On" and "Off" times are usually arranged to suit working hours. A popular system is for lights to come on one hour before attendants arrive. "Off" time in the evening allows for a routine inspection of the flock after the lights are out. The regular, repeated pattern of lights on, lights off is the stimulation for a flock's egg production response. If the pattern is interrupted or irregular, the full benefit of lighting may be lost. As a result, egg production will suffer, especially in older flocks (over 40 weeks). Reliable, fully automatic, accurate and properly maintained electric time clocks are strongly recommended.

Table 14

Suggested light intensities

Age	Light Intensities	
(days)	Lux	Foot Candles
0 - 3	20 - 30	2.0 - 3.0
4 - 10	20	2.0
11 - 112	15 - 20	1.5 – 2.0
113 - end of lay	5 - 10	0.50 - 1.0

Light intensity

Once accustomed to a particular level of light intensity, a flock will react to any noticeable change. More brightness will increase activity, may stimulate feed intake and will increase the chance of cannibalism. Under bright lights, birds in strange surroundings find water and feed more quickly than with dim lights.

Decreasing brightness will make a flock calmer, although the bird's initial response to a sudden large reduction in light intensity may be to cease activity and sleep. This happens even when the light level is theoretically adequate. Minimum light intensity is usually put at 10 lux (1.0-foot candle), but may, under some circumstances, be as low as 5.0 lux (0.5-foot candle).

DIMMERS

Dimmers on the light circuits give some advantages. Day to day management may require more or less light at short notice for such jobs as vaccinating, catching, beak treatment and routine inspections. None the less, to avoid possible interruptions in eating or laying habits, long term changes in light intensity should be made slowly. Small daily adjustments over a 7 day period can achieve a change without any negative reaction from the flock.

THE PRE-LAY AND LAYING PERIODS

Laying house requirements

Adult optimum space requirements are presented in Table 15. In hot areas, allow 20% more space per bird, particularly when ventilation is marginal.

Table 15

Adult space requirements

	Cages	Litter	Litter & Slats
Floor	450 cm2 (69.8sq.in.) / bird	6 birds/m2 1.8 sq.ft./bird	8 birds/m2 1.3 sq.ft./bird
Feeder Trough Pans	10 cm (4") / bird -	7.5 cm (3") / bird 4/100 birds	
Drinker Trough	10 cm (4") / bird	5.0 cm (2") / bird	
Birds/Round Bell Drinker	-	90	
Cups or Nipples	maximum 10 birds/cup or nipple a minimum of 2 cups or nipples per cage	maximum 10 birds/cup or nipple	

Notes:

1. With all types of equipment, do not exceed the manufacturer's recommendations for minimum floor, feeder and drinker space.
2. These recommendations reflect general practice. In some countries, legislation dictates greater minimum space allowances. Comply with the law.
3. In some countries, floor, feeder and drinker allowances are less than required for optimum performance. Under these conditions, lower performance is expected and accepted. BOVANS birds perform competitively under all circumstances.

Feeding during pre laying period

Bovans White layers should be full fed for maximum production. During the 2-3 weeks prior to first egg, the liver and reproductive systems increase in size in preparation for egg production. At this time, calcium reserves are built up.

Layer I ration should be given to the birds as soon as the first secondary signs of sexual maturity appear (combs, wattles). Ideally, at least one week before expected first egg.

In order to avoid feeding a costly layer ration when the birds are still not laying, some programs utilize a pre-lay ration to replace the 17-18% crude protein grower. A pre lay ration is similar to a laying ration, except for 2.0-2.5% total calcium. Furthermore, the linoleic acid content of a pre lay ration does not need to be over 1.0%. Just as with the layer, the pre-lay Energy level must be higher than that of the grower ration. Pre lay ration can only be fed until first egg is reached, and never after. Failure to feed laying hens with a complete Layer ration may result in less than optimum shell quality later in production. To obtain the best results, pullets should be housed no later than 16 weeks of age, or one week prior to light stimulation.

Feeding at onset of production

At first egg, birds must be already on a layer ration (Table 4). Recommended vitamin and trace mineral levels are found in Table 3.

In certain circumstances, the flock might not reach 100 g/bird (22 lb/100) daily feed intake before peak production. In such cases, a high nutrient density layer ration may be required to ensure the birds receive the required nutrients for sustained production and early egg size increase. It is also recommended to stimulate feed intake, through suggestions on page 15.

Protein

Satisfying the crude protein requirement is no assurance that the bird will attain its genetic potential. The daily intake of essential amino acids in the proper proportions is essential if maximum performance is to be obtained. Specific amino acid daily intake recommendations are shown in Appendix 2.

Table 16

Body Weight In The Adult Period

Age in weeks	Grams	Pounds
19	1388	3.06
20	1435	3.16
21	1473	3.25
22	1503	3.31
23	1519	3.35
24	1535	3.39
25	1550	3.42
26	1564	3.45
27	1577	3.48
28	1589	3.5
29	1601	3.53
30	1611	3.55
40	1677	3.7
50	1699	3.74
65	1702	3.75
75	1705	3.76
90	1710	3.77

Energy

Energy intake of the hen is often more limiting than protein or amino acid intake. This is especially true during warm periods (25°C (77°F) and above), and also at the onset of production when feed intake is low. The energy level, as well as density of all other nutrients in the ration, should be adjusted in accordance with actual intake of feed. Appendix 2 can be used to determine correct nutrient densities based on actual feed consumption.

Body weight, egg size and production increase

During the 10 weeks after the flock reaches 5% daily egg production, weekly egg weights and body weights should be taken (see Appendix 3 and Table 16). The aim is for weekly increases in body weight and egg weight. Body weight should increase by 300 grams (0.66 lb.) and egg weight by 14.5 grams (11.5 lb. per 30 dozen case) during this 10-week period. If the flock fails to increase body weight in any one week, egg weight may also soon fail to increase. Loss in egg numbers could follow if effective remedial action is not taken promptly.

Low gain in egg and body weight is usually indicative of sub-optimal nutrient intake. Stimulate feed intake as necessary (see "Some Ways to Stimulate Feed Intake", page 15) and consult a nutritionist for ration changes. Disease conditions can adversely influence nutrient absorption. Check with a veterinarian or poultry pathologist when necessary.

Adjusted density feeding

Market conditions vary throughout the world. Premiums are paid for eggs of a certain size in some markets, while in others they are sold by weight. The "ideal size" from an economic point of view varies with market area.

Egg weight tends to increase throughout the life of a flock. This trend can be modified by regulating nutrient intake, as well as modifications in lighting and other management techniques.

Several formulae for the laying period are given in Table 4. Energy densities between 2820 kcal/kg or 1280 kcal/lb. and 2900 kcal/kg or 1320 kcal/lb. are suitable. The change from one ration to another should be based not only on percent production, but also on egg mass output. Page 8 illustrates how this output is calculated. Do not shift from Layer I to II before daily egg mass starts declining (usually at about 58.2 g). The change from Layer II to III should not be made before daily egg mass is down to 57.1 g. Change from Layer III to IV before daily egg mass goes below 55.7 g. Change from Layer IV to V before daily egg mass goes below 54.1 g.

The formulae suggested differ in the level of protein and other nutrients. The protein must provide all required amino acids in the proper balance. Make sure that the recommended amino acid levels are met.

Decide which formula should be used, based on the actual feed intake and on daily protein requirements (see Appendix 2).

Protein and amino acid requirements are greatest from the onset of production up to peak egg mass. This is the period when body weight, egg weight and egg production are all increasing.

While production is over 85%, feed 19-20 g of protein/bird/day.

The Adjusted Density Feeding Program is designed to provide adequate levels of all nutrients early in the laying cycle to encourage good early egg size.

Post peak protein and energy

After the peaks in both egg numbers and daily egg mass have been reached, daily nutrient requirements are lower. The protein/energy level in the ration can be adjusted to reflect this lower requirement.

Do not decrease daily protein intake in any one week by more than 0.5 g/bird/day and energy by 50 kcal/kg (23 kcal/lb). Intervals between subsequent reductions must be at least 3-4 weeks.

Post peak body weights

From 36 weeks of age to the end of lay, body weight should remain relatively constant with only a slight gain (Table 16). Investigate any decrease in body weight. The cause, if not corrected, may lead to reduced egg production.

Egg size

Egg size may be manipulated by adjusting nutrient intake or the lighting program. If satisfactory egg size is not obtained, check your critical amino acid levels, particularly that of methionine. If this is not adequate, correct it by either increasing protein intake, and/or adding a feed grade form of methionine. The level of linoleic acid should also be checked to make sure that it is over 1.9% in Layer 1 Ration.

Small egg size can be caused by low energy intake, as well as low protein intake which, in turn, may be caused by extremes in temperature, excessive feed control and/or inadequate feeder space.

Egg size may be increased by switching to a 3 hour on and 3 hour off lighting program. A small loss in egg numbers may be experienced at this time, but egg size is increased and shell quality and colour are also improved. Returning to a regular lighting program will return egg size to normal. This program should only be used in light tight housing.

It must be noted that limiting protein/energy in an attempt to reduce egg size may adversely affect egg numbers. Changing the protein/energy level to control egg size must be done carefully and slowly.

Temperature and ventilation

For optimum bird health and performance, laying house temperatures should be between 21-24.5°C (70-76°F). This is the range within which normal metabolic heat production is balanced by heat loss. However, in temperate climates, laying houses are often kept at 24-28°C (75-82°F) for maximum feed efficiency.

Calcium

Calcium is one of the most critical nutrients for laying hens. Calcium absorption is more efficient when it is provided both as ground limestone and granular limestone or marine shells.

From the commencement of lay to 40 weeks of age, it is recommended that two thirds of the total calcium be provided as ground limestone powder and one third in a granular form.

After 40 weeks of age, the amount of granular calcium should be increased so that it represents two thirds of the calcium, while the powder is one third.

The efficiency of calcium absorption may become progressively lower after 40 weeks of age. In addition, the increase in egg size raises the amount of calcium required for a strong shell, thus a higher daily intake is necessary.

Recommended daily calcium allowances are shown in Appendix 2. Appendix 2 can be used to determine the calcium level required in the feed to meet the recommended calcium allowance.

Phosphorus

Phosphorus requirements vary slightly during the laying period from about 0.45% of Available Phosphorus early in the production cycle to 0.37% at the end. Do not feed over 0.5 g of Available Phosphorus per bird per day. Excess phosphorus has been shown to be detrimental to egg shell quality.

PULLET AND HEN HEALTH

Bird health results from the interface between adequate biosecurity, sanitation, animal welfare, poultry husbandry, proper housing and equipment usage, nutrition, immunization, and general disease prevention, control and monitoring. This section is intended to serve as a general guide for maintaining healthy flocks. Pullets and hens reared and maintained on the floor may have slightly different requirements to maintain bird health depending on many items. Details on actual procedures should be provided by a poultry health professional. This section is intended to be used only as a reference for pullet and hen health. The end user is responsible for the use or misuse of this information and Hendrix Genetics do not accept liability for the results of the use of this reference information.

Biosecurity

The concept of biosecurity may be complex and difficult to generalize or adapt to every possible circumstance. However, the important notion and objective of biosecurity is to prevent infectious disease from affecting otherwise healthy flocks; to prevent disease spreading from already infected flocks or contaminated premises; and to ensure adequate flock performance through disease prevention and control. Among the many strategies used to prevent infectious disease, some of the most effective ones include: a) limit access of unnecessary visitors and preventing access to contaminated vehicles and equipment; b) prescribe a quarantine period of at least 72 hours for any visitors prior to visiting the farm; c) maintain a record of all visitors; d) avoid visits to multiple farms in the same day; e) shower in and out of any poultry facility; f) even when showering is not possible, it is imperative to wear clean clothes or coveralls, footwear, hairnets and to cover facial hair with personal protective equipment or clothes (ppe) that should not leave the farm being visited; f) establish, maintain and monitor adequate programs for rodent and insect control and prevent direct or indirect contact with wild birds and other animals; and g) practice biosecure entry procedures to every barn or chicken house. A good practice is the "Danish entry system", which consists of entering a vestibule in the barn where there are "clean" and "dirty" areas separated by a physical barrier at the knee level. Personnel entering the dirty area should already be wearing clean and sanitized biosecure boot covers. The physical barrier dividing the clean and dirty zones should not be crossed without a complete change of footwear. The footwear to be used in the clean area and inside the chicken barn should never leave the clean area and barn and it should be fitted such that it never touches the dirty area. It is a good idea to have a bench around the dividing barrier so that personnel can sit down, remove one shoe or boot at a time and fit the "clean area" boot without touching the dirty area. Once one clean boot is fitted, it can go on the ground while the second foot is fitted with a clean area boot. In addition, it is important to consider all major risks in terms of biosecurity such as moving birds into and from the farm; sales, maintenance, equipment and construction personnel; manure removal personnel, pullet transfer and vaccination crews; beak conditioning crews; welfare and food safety auditing personnel; and vehicles and equipment among other personnel and fomites. Service personnel should not visit any flocks after having been in contact with flocks with known, suspect or obvious signs of disease caused by agents such as MG, MS, ILT, NDV, AIV or IBV. Certainly, other disease agents must be considered as well. Oftentimes a simple drop of water and/or feed consumption, or even a drop in egg production or egg weight could be the very first sign of disease in the poultry house. In those circumstances it is best to limit visits to any other farms until absence of infectious disease can be confirmed. Poultry houses must be thoroughly cleaned and disinfected prior to placing or housing pullets or hens. All chicken houses must be bird-proof and care must be followed not to track wild bird droppings into the chicken house. For this purpose, footbaths with a clean disinfectant and/or a careful change of footwear just prior to entering the premises can help to minimize the risk of infection with unwanted disease agents. Avoid having bodies of water close to or around the farm since this may attract wild birds that may carry deadly diseases such as avian influenza. Do not use open water reservoirs as a source of drinking water. If there is no other choice, always sanitize the water by acidification and chlorination, but verify that the water pH is not lower than 6.0 and that chlorine at the drinker level is not higher than 3 ppm. Do not share equipment with other farmers without thoroughly cleaning and disinfecting it and simply do not share it if at all possible. Finally, be aware of the fact that one of the most effective ways to spread infectious diseases is through contaminated manure trucks and equipment; mortality and rendering trucks and equipment; spent fowl collection vehicles, equipment and personnel; and pullet crews and vaccination crews.

Welfare and poultry husbandry

Overall bird health and welfare are relatively easy to maintain by simply applying good husbandry practices. The health and productivity of chickens is closely related to their welfare, which in turn depends on the use of adequate biosecurity and husbandry practices. In many areas, official regulations dictate specific requirements related to animal welfare and it is important to ensure compliance with regulatory agencies. Local or national poultry associations and Government institutions are usually a good source of welfare guidelines that are relevant for each geographical area. Although it may seem counterintuitive, keep in mind that maintaining birds on the floor (cage-free, free-run or cage-free with access to pasture) in a variety of housing systems may not necessarily result in better livability compared to maintaining the birds in enriched or community cages because birds on the floor are subject to possible trauma, intestinal diseases and even predation if they have access to the outdoors.

Disease prevention by immunization

An individual becomes "immune", "immunized" or resistant to a specific disease after inoculation of a specific vaccine, or after exposure to a disease agent in the field. Vaccination programs should be designed to "immunize" flocks against diseases of economic importance; and against disease agents that could potentially compromise food safety. The entire disease control program relies on sound and well-designed vaccination programs and adequate biosecurity, husbandry and nutrition. At the same time, vaccinations should be administered at times or ages when their detrimental impact should be minimal, and at times or ages when the best possible benefit can be obtained from them.

Most vaccination programs are intended to immunize chickens against diseases that affect the immune system; cause tumors in chickens; affect the respiratory, urinary or reproductive tracts; affect the nervous system; induce disease in the intestinal tract; cause skin infections; or represent a food safety concern. Fortunately there are biosecurity procedures and vaccines and vaccination methods available to protect chickens against most of these groups of conditions or diseases.

Prior to using any vaccines, ensure that their use is legal locally and that it will not disqualify specialty flocks because of the type of preservatives contained in the vaccines. Always verify the contents of the vaccine vial and vaccine diluent, and keep a record of the type of vaccine being used, the manufacturing company, serial number, expiration date and number of doses per vial and per diluent container (bag or bottle) according to the label.

Types of vaccines

There are many types of vaccines available for commercial poultry. It is important to become familiar with the basic characteristics related to their potential for protection, safety, ease of administration, relative cost, reactivity, compatibility with other vaccines, etc. Following is a list of some of the most important types of vaccines and disease prevention products:

- Live attenuated virus vaccines
- Recombinant virus vaccines
- Live attenuated bacterial vaccines
- Inactivated (killed) bacterial vaccines (also called bacterins)
- Gene-modified and gene-deletion mutant live attenuated bacterial vaccines
- Autogenous inactivated bacterial vaccines or bacterins
- Autogenous inactivated viral vaccines
- Live coccidiosis vaccines
- Live Mycoplasma vaccines
- Inactivated Mycoplasma vaccines (bacterins)
- Recombinant Mycoplasma vaccines
- Competitive exclusion products, probiotics and prebiotics

Vaccination methods

It is important to know the characteristics of each vaccine and to use each product according to the manufacturer's recommendations. Vaccines are designed and approved for individual or mass application methods and are intended to be given at specific age ranges. Some should be administered only as booster and not as a primer.

Individual vaccination methods include:

- Ocular (eye drop)
- Beak dipping or intranasal
- Subcutaneous injection
- Intramuscular injection
- Transcutaneous injection (wing web)
- Vent brush application

Mass vaccination methods include:

- In ovo injection
- Drinking water vaccination
- Spray vaccination

Ocular (eye drop), beak dipping and intranasal vaccination

Eye drop vaccination is commonly used to protect chickens against some respiratory viruses, Mycoplasma and occasionally against infectious bursal disease. Ocular vaccination is most suitable for delivery of live vaccines against respiratory diseases or agents such as (but not exclusively) Newcastle disease, infectious bronchitis, infectious laryngotracheitis, avian metapneumovirus and Mycoplasma gallisepticum (MG). Eye drop vaccination is likely the most effective and safest method for respiratory viruses. Direct contact of the vaccine with the mucosa of the eye will result in stimulation of the Harderian gland and a strong local immune response. Despite being highly effective, eye drop vaccination is labor intensive and time consuming and thus it is usually limited to application of vaccines that must be administered via the ocular route and by no other method, such as some (but not all) live MG vaccines and live attenuated vaccines against ILT or Newcastle disease. Intranasal and beak dipping application of vaccines has the same objectives as with the ocular route but the tissues preferentially stimulated reside in the nasal cavity, the paranasal sinuses and the oropharynx and larynx. Intranasal application is popular in some countries but beak dipping is rarely used. The vaccine is administered by depositing a drop (usually 30 ul or 0.03 ml) of reconstituted vaccine directly on the eye or into the nostrils. The advantage of eye drop application is that if applied properly, every bird receives a similar dose of vaccine and is thus likely to be immunized (protected) against the disease, as opposed to mass application methods, which unavoidably result in suboptimal coverage since not every bird receives an equally immunizing dose and some may even be missed altogether. Because eye drop vaccination requires individual handling of birds, biosecurity is most important and the vaccination crews must follow strict biosecurity procedures not to bring infectious diseases to the flock being vaccinated. For the beak dipping method to be successful, both nostrils must be immersed in the vaccine. This method is suitable only for chicks up to 7 days of age and is used for immunization against NDV or IBDV. It is used in areas or farms where an even vaccine uptake is not possible using the drinking water or spray methods, or with the objective of minimizing vaccine reactions. Care should be exercised not to accidentally inoculate fowl pox vaccines by eye drop because this will cause severe local inflammation, loss of the affected eye and even death, or at least a severe delay in pullet development.

Subcutaneous and intramuscular injection

Injection via the intramuscular and subcutaneous routes is reserved primarily for inactivated vaccines and bacterins in the case of growing pullets, but it can also be used for some live vaccines such as Marek's disease vaccines given to pullets at hatch. The vaccination equipment should be sterile and the needles used should be of the proper caliber and length for the age of the bird and also for the type of product being injected. The needles should be replaced with sterile needles at least every 500 injections to prevent injections with bent or blunt needles, and to avoid transmission of some diseases from infected to non-infected chickens. Most inactivated (killed) vaccines are administered at approximately 12-14 weeks of age but in many cases layer operations may be forced to apply killed vaccine injections at younger or later ages. Should it be necessary to vaccinate younger chickens with inactivated products it should be kept in mind that bird handling and administration of inactivated vaccines or bacterins between 6 and 11 weeks of age might delay or alter the development of the pullets. Inactivated viral vaccines are usually available in aluminum hydroxide, or in a water-in-oil (WO) or water-in-oil-in-water (WOW) emulsion; the latter is typically less reactive. Such products can be injected via the intramuscular or subcutaneous routes, provided the injection is done in the proper site and without depositing any of the vaccine product in the abdominal cavity or directly into the internal organs. Inactivated products containing killed Mycoplasmas and/or killed bacteria such as Salmonella, Pasteurella, E. coli or Avibacterium (the causative agent of infectious coryza) may be quite reactive and every effort should be made to minimize the local vaccine reactions that can be derived from the injections. For subcutaneous injections, it is especially important to avoid the thymus by injecting the vaccine in the middle line (avoiding the sides of the neck), and by not injecting the vaccine too close to the head or to the base of the neck. Injections done too close to the head or too low towards the base of the neck tend to induce unnecessary swelling. For intramuscular injections (in the breast muscle), every effort should be made to avoid injecting the product into the cavity. Vaccinations in the thigh may contribute to reduce adverse reactions but care must be exercised to minimize injuries resulting in lameness.

Transcutaneous injection (wing web)

Transcutaneous (wing web) application is used almost exclusively to vaccinate chickens against fowl poxvirus (POX), avian encephalomyelitis (AE), and for live fowl cholera vaccines. For convenience, manufacturers of vaccines have added other agents to the AE vaccines such as chicken infectious anemia virus (CAV) for breeder hens and avian encephalomyelitis virus (AE) to POX vaccines and thus it is possible to vaccinate pullets simultaneously against AE, POX and CAV in a single wing web injection. CAV is only necessary in layer breeders or grandparents but AE and POX are routinely used in commercial layers. In addition, there are recombinant vaccines containing fowl poxvirus as a vector that carries genes that express proteins from ILTV or MG. Such products can also be administered by wing web application.

Vent brush vaccination

Vent brush vaccination was developed decades ago to protect chickens against ILTV using vaccine strains that were extremely reactive and caused vaccine-induced ILT (VLT). The procedure involves dipping a rough brush into the reconstituted ILTV vaccine vial and brushing harshly the mucosa of the vent. This procedure is still used with relative success in a few countries for administration of live attenuated vaccines against ILTV.

In ovo injection

In ovo vaccination is a mass-application procedure that is reserved for vaccination of embryos in the hatchery and is typically done at 17 to 19 days of incubation. The procedure was designed for immunization against Marek's disease virus (MDV). With the advent of recombinant vaccines, in ovo vaccination can now be used to protect chickens against diseases such as Marek's disease, fowl poxvirus, infectious laryngotracheitis, infectious bursal disease (Gumboro) and Newcastle disease. In addition, some coccidiosis vaccines are now registered and approved for in ovo administration. However, commercial layers are typically vaccinated at hatch for the first time and not in ovo.

Drinking water (oral) vaccination

Vaccination via the drinking water is a suitable method to vaccinate pullets against hardy viruses such as infectious bursal disease virus (IBDV) and CIAV, but it can also be used to vaccinate chickens against diseases such as Newcastle disease, infectious bronchitis, infectious laryngotracheitis (only for chicken embryo origin vaccines), colibacillosis, salmonellosis and other diseases. Along with spray vaccination and in ovo vaccination, administration of live vaccines via the drinking water is considered a mass-application method. Although practical, mass application methods usually result in less-than-optimal vaccine coverage and thus protection might be suboptimal compared to individual vaccination methods. Vaccination via the drinking water should be used in birds that are at least one week old or older because water consumption in younger pullets might be too irregular for every pullet to get an even dose of vaccine. Oral vaccination can be done by directly adding the vaccine into the water reservoirs supplying water to the barn to be vaccinated; it can also be accomplished by using "medicators", "dosifiers" or "medication tanks" that can be connected to the main water pipelines feeding the drinkers.

The method relies on the preparation of a stock solution of vaccine that is to be placed in a container (a clean bucket) from which the medicator draws small quantities of vaccine to be mixed automatically with fresh incoming water in the water pipelines. For example, 1 ounce of stock solution of vaccine (approx. 28.5 ml) is drawn by the medicator and mixed with every 1 gallon (approx. 3.78 liters) of fresh water to be consumed. This method requires that the birds to be vaccinated be thirsty so that water consumption results in relatively rapid vaccine consumption (within approximately 60 minutes or less). Thus, access to water by the birds should be interrupted for approximately 2-4 hours or longer (depending on the barn temperature, barn humidity, age of the birds, etc.) prior to vaccination. Because the stock solution is drawn in a pulse manner, and because it must be mixed with incoming water automatically before it is delivered it is not possible to achieve an even vaccination in all birds. Using this method in the early morning hours as the lights are turned on ensures rapid vaccine consumption since the pullets or hens tend to be thirsty after several hours of darkness during the night.

Vaccination through a medicator

Vaccination through a medicator is one of the methods of vaccination with live virus vaccines which is least recommended, albeit it is a suitable method for administration of drugs, vitamins, etc. Coccidiosis vaccination using a medicator should be avoided because the Eimeria oocysts will tend to settle and the actual dose of oocysts per bird will vary greatly, giving very poor results. The best vaccination age for coccidiosis is at hatch but several provisions must be followed after vaccination for proper vaccinal oocyst cycling.

Water vaccination can also be accomplished using a water pump to "inject" or "force" the vaccine into the water lines, which is a popular and very effective method of mass application using the drinking water for delivery of live vaccines. Water pump vaccination requires a closed water system (nipple drinker lines) and can be used successfully for delivery of vaccines against diseases or disease agents such as IBDV, CIAV, NDV, IBV or ILTV. As with other methods involving water delivery, this one requires that the birds be thirsty prior to delivering the vaccine to them. Wherever possible, the drinker lines are raised high enough so as to prevent drinking by the pullets in the 2-3 hours prior to vaccination. For pullets or hens in cages where the drinker lines are fixed or can be removed away from the reach of birds, one must take advantage of the hours of darkness when birds do not drink water and vaccinate immediately as the lights are turned on while the birds are thirsty.

Water vaccination

Water vaccination requires flushing the drinker lines with fresh water a day ahead of vaccination to minimize unwanted residues. Commercial products can be used to clean the drinker lines thoroughly prior to vaccination. Even after the use of commercial products, it is recommended to flush the lines with clean fresh water before vaccinating the flock in order to avoid chemical residues that may inactivate vaccine viruses. This is particularly important in operations that have hard water, or in operations that have used antibacterial drugs or other products that may have formed a film or precipitates in the drinker lines. Prior to vaccination, it is important to allow the birds to become thirsty by interrupting their access to water. Check the drinkers or nipple drinkers to ensure they are clean and operational and shut down all water sanitizing systems (interrupt the use of added chlorine to the water). The amount of time required for the birds to become thirsty will depend on their age, environmental temperature, environmental relative humidity, feed formulation, etc. The goal should be for all pullets to consume the vaccine in a matter of 60 minutes or less, but not in less than 30 minutes.

If the birds consume the vaccine in less time, it would mean they were too thirsty and it is possible that only or mostly the dominant birds will consume an immunizing dose. On the other hand, if it takes the birds more than one hour to fully consume the vaccine this would be an indication that the water was not removed long enough prior to vaccination and therefore vaccine strength (virus titer) may be compromised after sitting indefinitely in the water lines.

A few essential steps for water vaccination are listed as follows:

- Clean and flush the water lines.
- Turn off the water sanitation system.
- Ensure proper functioning of the drinker system.
- Interrupt access to drinking water so that the pullets consume the vaccine in less than one hour.
- Verify that the vaccine to be administered has been stored according to the manufacturer's recommendations; that is still viable (before expiration); and maintain a record of the type of vaccine, serial (lot) number, number of doses per vial and number of vials used, as well as the expiration date and who actually reconstituted the vaccine and administered it to the flock.
- Reconstitute the vaccine in an aseptic manner and verify that the number of vials used matches the number of doses to be given. The amount of vaccine to be consumed in volume should be equivalent to approximately 1/7 the total water consumed the previous day.
- Use a commercially produced vaccine stabilizer or powdered skim milk to help protect the vaccine viruses. Follow closely the recommendations of the manufacturer of the vaccine stabilizer and the vaccine itself. If skimmed milk is used, approximately 2.5 g of well-dissolved skim milk per liter of water plus vaccine is enough to protect the vaccine from any residual chemicals or minerals in the drinking water. Keep the reconstituted vaccine cool and away from exposure to the sun light. The water used for vaccination should not be too acidic or too basic. The ideal pH for vaccine delivery should be between 5.5 and 7.2 but slight deviations should be harmless provided a suitable vaccine stabilizer is used. The water temperature should not exceed 26C if the vaccination is to be done via the drinking water.
- Deliver the vaccine into the drinkers and drinker lines. To ensure a complete fill out of the drinker lines (pipes) add

a visual aid such as commercial-grade vaccine dye and let the vaccine be flushed to the end of the water lines until blue dye is seen at the end of the lines. At this time close the end of the water lines and allow the birds to drink. If the vaccine is delivered into open water systems, it is important to walk slowly through the house to stimulate water consumption and to help distribute the birds in the house until the vaccine is consumed completely. If the premise is an open-sided house avoid the vaccine to be exposed directly to sunlight.

- If there are automatic (mechanical) feeders in the barn, activate the feeders to stimulate feed consumption, which might prompt the birds to drink the vaccine more rapidly.
- Once the vaccine has been consumed (when the vaccine dye is no longer visible in the drinking water), check the oral cavity and tongues of at least 100 birds throughout the barn to verify that they have consumed the vaccine and that the vaccine dye is easily seen in their oral cavity and tongue. If enough dye was used, it should be easy to observe a blue coloring of the tongue, head feathers and occasionally the crop, which may be visible through the skin. Vaccine coverage of at least 97% should be a realistic and acceptable goal.

Spray vaccination

Spray vaccination is used primarily for immunization against respiratory viruses such as Newcastle disease virus (NDV) and infectious bronchitis virus (IBV). At least one of the commercially available MG vaccines is labeled for spray administration, albeit the best results with these vaccines are attained when given by eye drop. It should be noted that spray vaccination should involve the less invasive forms or strains of viruses, such as the B1B1 strain of Newcastle, or H120 of infectious bronchitis, albeit other vaccine strains may be suitable for spray vaccinations (always check with the vaccine supplier). In general, the more invasive the virus, the better the protection against disease but the harsher the vaccine reactions, especially in flocks infected with MG or even some strains of MS. Coccidiosis vaccines are sometimes sprayed on the feed of layer breeders or cage-free layer pullets in some areas, but more recently spray application of coccidiosis vaccines has become a popular practice in commercial hatcheries, with substantially better results than with field vaccinations. Some live Mycoplasma gallisepticum vaccines (but not all) can be sprayed directly on chickens in the field, although the best method for live MG vaccine application is by eye drop. Each type of equipment intended for spray vaccinations may be different and the operator must be thoroughly familiar with each piece of equipment and its spray patterns, pressure and particle size. For example, pressurized sprayers are excellent to deliver vaccine to the respiratory tract but because of the small particle size that they produce the vaccine will tend to remain suspended in the air or it may be sucked towards the house fans if they are not turned off prior to vaccinating the birds. During the hot weather season, the minimum ventilation fans may be run during vaccination but care must be observed not to allow the sprayed vaccine to be sucked out of the house via the exhaust fans and at the same time the reduction of ventilation rates during vaccination must not threaten the welfare and health of the birds. With some types of sprayers the equipment must be located not more than 50 cm over those birds to be vaccinated. This method is therefore not practical for mass application over chickens on the ground. Rather, sprayers intended for horticultural use or pesticide application in the horticultural industry have proved very popular and effective for application of live respiratory vaccines in the field if pullets are grown on the floor, but keep in mind that if the equipment scares the birds away from the vaccinator, the vaccine coverage may be poor. The particle size will range between 100 and 300 um, which is suitable for most respiratory viruses but some sprayers produce rather a mist that consists of very fine droplets. Mist vaccination induces very good immune responses but may cause significant vaccine reactions that could potentially result in respiratory complex. In general, spray vaccination is used for protection against respiratory viruses and Mycoplasma in pullets; and for protection against respiratory viruses in caged hens in production. Water vaccinations are better suited for cage-free pullets and hens. A few essential considerations for spray vaccination are listed as follows:

- Record the type of vaccine used, the expiration date, vaccine strains contained, number of doses in the vials, amount of diluent used, serial number for the vaccine and vaccine stabilizer, manufacturer, age of the birds being vaccinated, etc.
- Prior to choosing spray vaccination to immunize chickens against respiratory viral diseases, consider all possible options. Be aware that spray vaccination against Newcastle disease and Infectious Bronchitis generally provides better protection than water vaccination, but vaccine reactions can be harsh, particularly in Mycoplasma-positive chickens;

and/or in dusty environments; and/or wherever air quality is suboptimal. Spray vaccination against Infectious Laryngotracheitis should be avoided and must never be done in chickens in production. Vaccinate only healthy chickens.

- For adult flocks, verify the flock antibody titers prior to vaccination. If IBV or NDV antibody titers are low, vaccine reactions may be harsh and egg production and eggshell quality may be detrimentally affected. Avoid using spray vaccination for MG-positive hens.
- Ensure that the vaccination equipment has been thoroughly cleaned, disinfected and rinsed to remove all traces of vaccine and disinfectant.
- Drive the birds (if reared on the floor) to an area of the barn where they can be vaccinated without them flying or moving freely away from the vaccination equipment. If birds are flighty or too nervous, do not vaccinate by spray and choose the water vaccination method instead.
- Calculate the total number of doses and the total volume of diluent (distilled deionized water) required to vaccinate all chickens. The water used should not be chlorinated and should have a pH of 5.5 to 7.2 (ideally 6.8 to 7.2). Using a commercial vaccine stabilizer helps to minimize water pH and chlorine problems.
- Turn off the lights, space brooders and ventilation system (only briefly while leaving on minimal ventilation and ensuring the birds do not overheat or suffocate). The flock should be relatively calm at the moment of spraying the vaccine on them.
- Reconstitute the vaccine aseptically and in the shade, and only immediately prior to vaccinating the flock.
- Use appropriate personal protective equipment (PPE), including protective mask and goggles.
- Adjust the spray nozzle to a proper droplet size. Coarse sprays (>80-120 microns) are recommended for priming vaccinations and also for invasive vaccines. Fine sprays (50-60 microns) are recommended for boost vaccinations in older chickens, but only after they have been primed with similar viruses and after they have developed a robust antibody response after previous vaccinations against the same virus (es). MG-infected chickens tend to react too severely to spray vaccinations, particularly if the droplet size is too small and thus they should be vaccinated via the drinking water instead or by eye drop and using mild vaccine strains.
- Use distilled water or clean water without chlorine to dilute the vaccine (the amount should be adjusted to every situation). If a pressurized spray apparatus is used, it should be kept in mind that this type of equipment delivers droplets with a large diameter range, and consequently only part of the vaccine will be inhaled. Hence, it is necessary to spray the vaccine at a distance not larger than 50 cm from the chickens. This type of equipment typically requires a relatively large volume per chicken house (15-20 liters). For situations where a controlled-droplet application apparatus is used, the droplet size is considerably more uniform (~50-150 microns). Although the droplet size is more uniform with this type of equipment, some of the droplets are too small and may remain in suspension for quite some time after the vaccine is sprayed. This may represent a problem because a vaccine that stays in suspension a long time may decrease in virus titer before it is inhaled and much of the vaccine ends up on house and equipment surfaces but not in or on the chickens. In addition, if much of the vaccine remains in suspension (in the form of a mist), re-activating the ventilation system will draw the vaccine out of the house through the exhaust fans.
- Spray-vaccinate only healthy birds. Avoid spraying birds that are infected with MG.
- Adjust the nozzle to obtain the desired droplet size.
- Wear a mask and goggles for personal protection when spray-vaccinating.
- Make sure the sprayer to be used is clean and has no residual disinfectant or alcohol-based products. The vaccine containers of the spray apparatus should be rinsed with distilled water prior to and after every use.
- Use only one dose per bird or less and ensure that all vaccines being given are compatible with each other.
- Always comply with local regulations and make sure that the vaccine preservatives are allowed for use in organic egg production or antibiotic-free (ABF) production according to local regulations.
- Reconstitute the vaccine only immediately prior to use.
- Close up the house including curtains and doors and shut the ventilation system (while allowing minimum ventilation and ensuring the birds do not overheat or suffocate) and dim the lights while the birds are being vaccinated and if possible, during the 20-30 minutes after vaccination (provided the air quality and temperature

allow for a temporary shut down without compromising the flock integrity). If the flock is in a high temperature area, vaccinate birds at night or early in the morning and restore ventilation immediately. Make sure the ventilation system is not running at the time the vaccine is being applied or that it runs at a minimum power.

- Spray the birds evenly and thoroughly at least twice and ensure that all calculated doses are used evenly. The heads and upper body of the sprayed birds should appear wet after vaccination.
- Make a point about not leaving the farm without making sure the ventilation system and the lights have been reengaged. Ventilation should be restored approximately 20 minutes after the initiation of the vaccination process, but this may vary according to the time of the year and the prevailing environmental temperature and relative humidity.
- Rinse, clean, disinfect and rinse again the vaccination equipment before leaving the farm.
- Destroy all residual vaccine and vaccine vials by incineration. Follow local regulations regarding adequate disposal of vaccines, vaccine vials and biological materials.

Parasite control

The most common internal parasites in laying hens include coccidia, Histomonas ("black head"), Capillaria worms, round (Ascaridia) worms, cecal (Heterakis) worms and various tape worms. External parasites frequently seen in layer operations include the Northern fowl mite (Ornythonyssus). The red mite or roost mite (Dermanyssus) and poultry lice are less frequent but can be frequently seen in some areas. The Northern fowl mite completes its entire life cycle on the birds, whereas the red mite feeds on the birds only at night. As a whole, mites are external parasites that must be controlled to avoid drops in egg production, dermatitis around the vent, restless birds, increased mortality and farm employee discomfort. Some mites are known to carry other disease agents and can induce anemia if the infestation is severe and thus must be controlled. Of these, the only type of parasite that can be prevented by vaccination is Eimeria (coccidia). Tape and round worms as well as external parasites should be controlled by using a combination of cleaning, disinfection, biosecurity and preventative or therapeutic treatments that must comply with local regulations for their use and in accordance to the type of bird (conventional production, organic, ABF, etc.).

Vaccination against coccidiosis

Pullets reared in battery cages do not ordinarily experience significant internal parasitic diseases. However, if they have access to droppings in the hen house because of the type of equipment and manure removal systems and/or because of poor fly control, outbreaks of coccidiosis could potentially occur. Pullets reared on the floor (cage-free, free-run, chickens on pasture or in aviary systems) are commonly exposed to coccidia parasites at a relatively young age. Regardless of the type of operation, it is important to ensure immunity against coccidiosis, which can be accomplished by using one of two common methods. Where legal, pullets reared on the floor may be treated with anticoccidial drugs for up to 8-12 weeks of age to allow for a gradual acquisition of immunity. Commonly used drugs for this purpose include (not exclusively) amprolium and salinomycin. However, other anticoccidial drugs have been used successfully. Perhaps the best approach to control coccidiosis in pullets reared on the floor is vaccination. Pullets can be vaccinated by spray at the hatchery with one of the various commercially available vaccines. It is important to use a commercial product that will contain at least E. acervulina, E. maxima, E. tenella, E. necatrix and E. brunetti. Coccidiosis vaccines for broiler chickens do not contain E. necatrix, an essential component of coccidiosis vaccines for long-lived birds. Ideally, the volume of vaccine per 100 chicks should be at least 21 ml or up to 25 ml to ensure proper coverage and vaccine consumption through preening. Gel-based coccidiosis vaccines may require a different total volume per 100 chicks. When coccidiosis vaccines are used, it is critical not to medicate the flock with any drug that coccidia would be sensitive to in order to allow at least two to three complete coccidial cycles, which normally occurs at approximately 14-16 days of age, depending on various factors including litter moisture, bird density, environmental temperature, etc. It is also important to allow vaccinated birds to remain in the brood chamber for the duration of at least 2 complete coccidial cycles before allowing them to occupy the entire barn. If vaccinated pullets are given the entire barn prior to the second cycle being completed, many of them will not be properly immunized and might develop coccidiosis at a later age, with the significant consequences of increased mortality, delayed growth, poor uniformity and the need for treating the flock. This means that if pullets are maintained on 100% plastic or wooden slats or wire floor from day of age, the floor should be covered with paper and kept covered with paper until at least 16 days of age to allow for proper coccidial oocyst cycling and consumption, and to allow for at least 2-3 coccidial cycles. Specialty flocks may not be treated with drugs of any kind and thus it is critical to ensure proper coccidiosis control with the use of vaccines.

Histomoniasis and round worms

Histomonas meleagridis (HM) is the causative agent of histomoniasis or histomonosis ("black head") and affects almost exclusively pullets reared on the floor, particularly in premises with dirt floors or in flocks with access to the outdoors. The condition, which can be devastating, has made a come back after the ban of many anti-parasitic drugs and upon rearing pullets on the floor (cage-free). Histomoniasis is difficult to control since there are no effective drugs that can be used legally in many areas of the world. Because the microscopic parasite depends to some extent on the life cycle of cecal worms and earthworms (round worms or nematodes), one of the strategies for control involves the control of worms. Early administration of drugs against round worms might contribute to maintain HM under control. The layer industry uses most commonly piperazine and anti-worm compounds in the family of the benzimidazole drugs such as levamizole, albendazole or fenbendazole in the drinking water; or feed-grade hygromycin (12 grams per ton of feed); or, where legal, antiparasitic drugs in the family of the ivermectins. Controlling worms reduces the challenge posed by HM. Where legal, HM infection may be treated with drugs such as nitarsone, but even this drug is only partially effective and has been withdrawn from the market in many countries. Control of HM involves not only treating birds against worms, but also proper cleaning and disinfection, adequate husbandry, biosecurity, proper coccidosis control, particularly of E. tenella, and avoiding rearing birds on dirt floor.

Mites

The best form of prevention for mite infestation is biosecurity. Infested flocks should never be visited before visiting mite-free flocks. Mites can easily be mechanically carried from farm to farm on birds, in clothes, footwear, on people, equipment, egg flats and egg boxes, etc. Such parasites usually thrive in sexually mature flocks and thus most treatments become necessary while the infested flocks are in production. Effective control requires direct application of "acaricide" products. A variety of products can be used for mite control, including pyrethroids, ivermectin, organophosphates, carbamates, mineral-based products, vegetable oils, citrus concentrated extracts and other products. Some of such products can be administered by dry (dust) spray, or as a wet spray. Careful observation of precautions with each of these drugs should be practiced. Prior to using any of these products it is critical to determine whether they are locally approved for use in hens in production, and also whether the personnel applying the products require personal protective equipment.

Some products are poorly effective if applied dry but quite effective when applied wet directly on the birds, which requires considerable more time than the application of dry products. Treating birds against mites is frequently expensive and it may be necessary to treat an infested flock more than once. After the affected flock is removed, thorough cleaning and disinfection and chemical treatment of the premises and equipment is necessary. Heating the affected barn to as high a temperature as possible for several days may help reduce viability of the parasites. Breeder houses and cage-free houses can be treated with sulphur prior to housing hens. The barns are cleaned, disinfected, treated for rodents and insects, and then (where legal) sulphur is carefully applied (using personal protective equipment) to the ground prior to furnishing the barn with wood shavings, rice hulls or other suitable bedding material. The skin of birds or humans should not be allowed to come in direct contact with sulphur to avoid chemical dermatitis. The best approach is to exercise adequate biosecurity and never to transit from infested flocks to clean flocks, or to share equipment and egg flats or boxes between infested and clean premises.

Controlling groups of diseases by vaccination

Infectious diseases can be grouped by the organ system they affect. Thus, infectious diseases can affect the respiratory, digestive, nervous, urinary, reproductive and immune systems among others. Other diseases tend to affect the integument (skin or cutaneous tissues) and yet some others are considered a concern for food safety.

Respiratory diseases

Respiratory diseases of major concern in commercial layers include Newcastle disease, infectious bronchitis, infectious laryngotracheitis, avian influenza, avian metapneumovirus infection (swollen head syndrome), avian mycoplasmosis (MG and MS), infectious coryza, avian pasteurellosis (fowl cholera) and Gallibacterium anatis (formerly Pasteurella haemolytica) infection. All such diseases or disease agents can be prevented or controlled by using a combination of biosecurity and vaccination. In general, vaccination against respiratory viruses is done with live vaccines followed by killed (inactivated) vaccines. Live attenuated avian influenza vaccines are not legally available anywhere, but recombinant vaccines and killed vaccines are (in some areas or countries). Bacterial diseases (infectious coryza, fowl cholera and Gallibacterium infection) are typically prevented by means of inactivated (killed) vaccines or bacterins, which are given once or twice during the rearing period. Bacterins are usually administered by intramuscular or subcutaneous injection at approximately 10-14 weeks of age or earlier. Live vaccines against viral respiratory diseases may be administered by spray or in the drinking water once or multiple times while the flocks are in production.

Peritonitis in layers

Peritonitis in layers is frequently caused by E. coli strains that are unrelated to E. coli strains affecting cattle or humans. However, they can induce severe economic losses if there is no adequate control. Colibacillosis associated with peritonitis in layers is not strictly a respiratory condition, but E. coli can penetrate via the respiratory tract (descending infection). E. coli can also penetrate via an ascending route (via the reproductive tract), or possibly from the intestinal tract, a mechanism that has not yet been confirmed. Peritonitis in layers should be controlled by a variety of approaches, including maintaining proper husbandry practices, adequate ventilation, and vaccination against E. coli among other strategies. Vaccination against E. coli in layers is a very effective method of control and is commonly done by using live vaccines by spray or in the drinking water twice during rearing, once at hatch and once a few weeks later. Live E. coli vaccines can also be given safely in flocks in production or soon before onset of production if they were not vaccinated during rearing. It should be kept in mind that E. coli is not the sole pathogen inducing peritonitis in layers. Another common pathogen causing peritonitis, salpingitis and polyserositis is Gallibacterium anatis (formerly Pasteurella haemolytica), for which inactivated vaccines (bacterins) may be available in some countries but not in the U.S.

Diseases of the digestive system

Diseases of the digestive system that are preventable by vaccination include the parasitic disease coccidiosis. Coccidiosis vaccines are typically administered at the hatchery in ovo or by spray, or by spray on the feed during the first week of life.

Diseases affecting the nervous system

Diseases affecting the nervous system such as avian encephalomyelitis (AE) require effective vaccination for prevention. Flocks may be vaccinated via the drinking water or by transcutaneous injection in the wing web, usually along with POX vaccination at approximately 10-12 weeks of age. AE vaccines should not be given for the first time before 10 weeks of age or too soon before the flock initiates egg production because they can induce disease or drops in egg production. AE vaccines that are combined with fowl pox can only be given safely by wing web application.

Diseases affecting the urinary and reproductive tracts

Diseases affecting the urinary and reproductive tracts are represented typically by infectious bronchitis. Prevention of infectious bronchitis requires vaccination at various ages with the same or similar serotypes of virus circulating in the field. It may be necessary to vaccinate 3-4 times the pullets with live viruses during rearing and once with a killed vaccine containing at least the same or similar serotypes circulating in the field. Still, in many instances it might be necessary to vaccinate flocks in production by spray or drinking water several times in order to maintain a healthy urinary, respiratory and reproductive tract.

Diseases affecting the immune system

Diseases affecting the immune system can be numerous. Well-known diseases affecting the immune system include infectious bursal disease (IBDV, or Gumboro disease), chicken infectious anemia (CIAV), and Marek's disease (MDV), the latter being a disease that also causes tumors and mortality. IBDV can be prevented by vaccination with live attenuated vaccines, immune complex vaccines, or recombinant vaccines. Live attenuated vaccines are becoming less popular because of the need to give them multiple times in order to control IBDV effectively during the rearing period and because of the time and labor required for vaccination, even though they are quite effective and inexpensive, and they have contributed very positively to the successful control of IBDV in the field, particularly in floor rearing operations. Some immune complex live attenuated IBDV vaccines are given 3-4 times during the first 8 weeks of age, beginning with an initial application at approximately 14 days of age. It is not necessary to vaccinate commercial layers against CIAV because they are clinically susceptible to this immunosuppressive agent mostly during the first 3 weeks of life, and the layer parents should provide protection after being exposed and/or vaccinated themselves. All layer pullets must be vaccinated against MDV to prevent losses to mortality, immunosuppression and tumors. The most potent vaccines against MD in layers include vaccines that contain serotype 1 vaccines (Rispens strain, or CVI-988) and serotype 3 or HVT (herpes virus of turkey). Serotype 2 vaccines (SB-1 or 301/B1 strains) can also be added, albeit a trivalent vaccine has not been shown to have a significant advantage over bivalent vaccines (HVT+Rispens). Wherever MD is not a significant challenge, bivalent HVT+SB-1 vaccines may be sufficient to protect hens against MD in the field. Still the best combination known to date is HVT+Rispens as a MD vaccine for day-old pullets. In this case, HVT may be represented as such or as recombinant HVT vaccines (rHVT) expressing proteins from other viruses such as Newcastle disease virus (NDV), infectious laryngotracheitis virus (ILTV) or infectious bursal disease (IBDV).

Fowl adenovirus

Fowl adenovirus (FAdV) causes inclusion body hepatitis (IBH) and hydropericardium syndrome (HS) in young chickens, primarily meat type chickens. However, in some countries FAdV can be an economically significant problem affecting the livability of commercial layers reared on the floor. Inactivated IBH vaccines are available for layer chickens in some countries but not in the United States and Canada. Another important disease caused by a unrelated adenovirus (Egg Drop Syndrome 1976; or EDS76), may induce severe egg production drops and is preventable by vaccination.

Disease agents of concern for food safety

Salmonella control requires a very complex approach, part of which involves vaccination. Where legal, vaccination against Salmonella is one of the most effective means of control (albeit insufficient by itself) and is usually done with live attenuated or genetically-modified vaccines against S. typhimurium, or with live attenuated S. enteritidis (SE) vaccines followed by killed vaccines against S. enteritidis or containing other Salmonella serovars that may be residents in a particular area or operation. Live attenuated SE vaccines are available and legal only in some countries. It is recommended to use two live Salmonella vaccines (SE and/or ST) and at least one killed vaccine (but ideally two) containing SE and other serovars to reduce gut and reproductive colonization and bacterial shedding into the egg and the environment. It should be emphasized that vaccinations against Salmonella are an essential tool in the fight against Salmonella, but many other intervention and prevention strategies must be implemented in order to achieve effective Salmonella control.

Fowl typhoid caused by Salmonella gallinarum is a high impact disease that results in high mortality and severe drops in egg production. Salmonella gallinarum may be prevented by first, biosecurity; and second vaccination, where applicable.

Appendix 1

SUGGESTED DAILY NUTRIENT INTAKE FOR BOVANS WHITE COMMERCIAL PULLETS

(PER CAGED BIRD)

Age in Weeks	M.E. (kcal)	Protein (g)	Lysine (mg)	Methionine (mg)	Methionine & Cystine (mg)	Tryptophan (mg)	Threonine (mg)	Calcium (mg)	Available Phosphorus (mg)
1	24	1.7	88	39	68	18	59	84	38
2	41	3.0	154	69	119	32	104	147	66
3	59	4.3	220	98	170	46	148	210	94
4	75	5.2	247	127	221	52	172	273	122
5	90	6.2	295	152	264	62	205	326	146
6	102	7.0	333	172	294	70	231	368	165
7	116	7.8	380	196	340	80	264	420	188
8	125	8.2	409	202	344	86	284	452	202
9	132	8.9	432	202	348	99	310	494	221
10	140	9.4	460	215	365	105	320	525	235
11	148	9.8	488	228	387	111	339	557	249
12	157	10.2	515	241	409	118	353	588	263
13	165	10.6	531	254	431	121	372	649	283
14	168	11.0	537	262	445	125	378	671	293
15	176	11.2	563	275	467	131	384	704	307
16	184	11.7	590	288	489	137	402	737	322
17	202	13.0	686	350	574	154	490	2800	329
18	216	13.9	735	375	615	165	525	3000	349

Instructions for the use of Appendix 1 and 2

1. The Daily feed requirement is determined by dividing the daily energy requirement by the level of the ration, e.g. assuming a daily requirement of 300 kcal ME and a ration containing 2850 kcal ME / kg: 300 / 2850 = 0.105 kg or 105 g/bird/day
2. Add 3.5 kcal ME/bird/day for each 1°C below 21°C.
   Subtract 3.5 kcal ME/bird/day for each 1°C above 21°C.
3. Add 2 kcal ME/bird/day for each 1 g of egg mass above the figures quoted in Appendix 3.
   Subtract 2 kcal ME/bird/day for each 1 g of egg mass below the figures quoted in Appendix 3.
4. Add 6 kcal ME/bird/day for each 50 g of body weight in excess of the mean weight quoted in Table 9 and Table 16.

Appendix 2

SUGGESTED DAILY NUTRIENT INTAKE FOR BOVANS WHITE COMMERCIAL LAYERS

(PER CAGED BIRD)

Age in Weeks	M.E. (kcal)	Lysine (mg)	Methionine (mg)	Methionine & Cystine (mg)	Tryptophan (mg)	Threonine (mg)	Arginine (mg)	Calcium (g)	Available Phosphorus (mg)
19	231	784	400	656	176	560	768	3.3	368
20	246	833	425	697	187	595	816	3.5	391
21	266	902	460	754	202	644	883	3.8	423
22	275	931	475	779	209	665	912	3.9	437
23	283	960	490	804	216	686	941	4.1	451
24	286	970	495	812	218	693	950	4.1	455
25	286	970	495	812	218	693	950	4.1	455
26	286	970	495	812	218	693	950	4.1	455
27	286	970	495	812	218	693	950	4.1	455
28	286	970	495	812	218	693	950	4.1	455
29	286	970	495	812	218	693	950	4.1	455
30	286	970	495	812	218	693	950	4.1	455
31	286	970	495	812	218	693	950	4.1	455
32	286	970	495	812	218	693	950	4.1	455
33	286	970	495	812	218	693	950	4.1	455
34	286	970	495	812	218	693	950	4.1	455
35	286	970	495	812	218	693	950	4.1	455
36	286	970	495	812	218	693	950	4.1	455
37	286	970	495	812	218	693	950	4.1	455
38	286	970	495	812	218	693	950	4.1	455
39	289	949	465	778	192	667	929	4.3	444
40	289	949	465	778	192	667	929	4.3	444
41	289	949	465	778	192	667	929	4.3	444
42	289	949	465	778	192	667	929	4.3	444
43	289	949	465	778	192	667	929	4.3	444
44	289	949	465	778	192	667	929	4.3	444
45	289	949	465	778	192	667	929	4.3	444
46	289	949	465	778	192	667	929	4.3	444
47	289	949	465	778	192	667	929	4.3	444
48	289	949	465	778	192	667	929	4.3	444
49	289	949	465	778	192	667	929	4.3	444
50	289	949	465	778	192	667	929	4.3	444
51	289	949	465	778	192	667	929	4.3	444
52	294	927	433	742	185	649	906	4.5	422
53	294	927	433	742	185	649	906	4.5	422
54	294	927	433	742	185	649	906	4.5	422
55	294	927	433	742	185	649	906	4.5	422

(PER CAGED BIRD)

Age in Weeks	M.E. (kcal)	Lysine (mg)	Methionine (mg)	Methionine & Cystine (mg)	Tryptophan (mg)	Threonine (mg)	Arginine (mg)	Calcium (g)	Available Phosphorus (mg)
56	294	927	433	742	185	649	906	4.5	422
57	294	927	433	742	185	649	906	4.5	422
58	294	927	433	742	185	649	906	4.5	422
59	294	927	433	742	185	649	906	4.5	422
60	294	927	433	742	185	649	906	4.5	422
61	294	927	433	742	185	649	906	4.5	422
62	294	927	433	742	185	649	906	4.5	422
63	294	927	433	742	185	649	906	4.5	422
64	294	927	433	742	185	649	906	4.5	422
65	293	886	402	700	175	628	865	4.6	402
66	293	886	402	700	175	628	865	4.6	402
67	293	886	402	700	175	628	865	4.6	402
68	293	886	402	700	175	628	865	4.6	402
69	293	886	402	700	175	628	865	4.6	402
70	293	886	402	700	175	628	865	4.6	402
71	293	886	402	700	175	628	865	4.6	402
72	293	886	402	700	175	628	865	4.6	402
73	293	886	402	700	175	628	865	4.6	402
74	293	886	402	700	175	628	865	4.6	402
75	293	886	402	700	175	628	865	4.6	402
76	293	886	402	700	175	628	865	4.6	402
77	293	886	402	700	175	628	865	4.6	402
78	291	845	371	639	165	587	824	4.8	361
79	291	845	371	639	165	587	824	4.8	361
80	291	845	371	639	165	587	824	4.8	361
81-90	291	845	371	639	165	587	824	4.8	361

Appendix 3

BOVANS WHITE EGG PRODUCTION

Age in Weeks	% Hen Day Production	% Livability	Cumulative Eggs / Hen Housed	Average Egg Weight			Daily Egg Mass	Cumulative Egg Mass / Hen Housed		Feed Intake		Body Weight	
				g / egg	Oz./ Doz.	Lbs. / case	grams	kg	lb.	bird/ day (g)	100/day (lbs)	grams	Lbs
19	6.2	99.8	0	42.9	18.2	34.0	2.6	0.0	0.0	82	18.2	1388	3.06
20	41.5	99.8	3	46.1	19.5	36.6	19.1	0.2	0.4	89	19.6	1435	3.16
21	66.1	99.7	8	48.8	20.7	38.7	32.2	0.4	0.9	95	21.0	1473	3.25
22	81.8	99.6	14	51.0	21.6	40.5	41.7	0.7	1.5	101	22.2	1503	3.31
23	90.4	99.5	20	53.0	22.4	42.1	47.9	1.0	2.2	104	23.0	1519	3.35
24	94.1	99.4	27	54.6	23.1	43.3	51.4	1.4	3.1	105	23.2	1535	3.39
25	94.9	99.3	33	56.0	23.7	44.4	53.1	1.7	3.7	106	23.4	1550	3.42
26	95.3	99.3	40	57.1	24.2	45.3	54.4	2.1	4.6	106	23.4	1564	3.45
27	95.6	99.2	46	58.0	24.6	46.0	55.5	2.5	5.5	107	23.5	1577	3.48
28	95.9	99.1	53	58.8	24.9	46.7	56.3	2.9	6.4	107	23.6	1589	3.50
29	96.1	99.0	60	59.3	25.1	47.1	57.0	3.3	7.3	107	23.6	1601	3.53
30	96.2	98.9	66	59.8	25.3	47.5	57.5	3.7	8.2	108	23.7	1611	3.55
31	96.2	98.9	73	60.1	25.4	47.7	57.9	4.1	9.0	108	23.8	1620	3.57
32	96.2	98.8	80	60.4	25.6	47.9	58.1	4.5	9.9	108	23.8	1629	3.59
33	96.2	98.7	86	60.6	25.7	48.1	58.3	4.9	10.8	108	23.9	1637	3.61
34	96.1	98.6	93	60.8	25.7	48.3	58.4	5.3	11.7	108	23.9	1645	3.63
35	96.0	98.5	100	60.9	25.8	48.3	58.4	5.7	12.6	109	23.9	1652	3.64
36	95.8	98.4	106	61.0	25.8	48.4	58.4	6.1	13.4	109	24.0	1658	3.65
37	95.7	98.4	113	61.1	25.9	48.5	58.4	6.5	14.3	109	24.0	1663	3.67
38	95.5	98.3	119	61.1	25.9	48.5	58.3	6.9	15.2	109	24.0	1668	3.68
39	95.2	98.2	126	61.2	25.9	48.6	58.3	7.3	16.1	109	24.1	1673	3.69
40	95.0	98.1	132	61.3	25.9	48.7	58.2	7.7	17.0	109	24.1	1677	3.70
41	94.7	98.0	139	61.4	26.0	48.7	58.1	8.1	17.9	109	24.1	1681	3.71
42	94.5	98.0	145	61.5	26.0	48.8	58.1	8.5	18.7	109	24.1	1684	3.71
43	94.2	97.9	152	61.6	26.1	48.9	58.0	8.9	19.6	110	24.2	1687	3.72
44	93.9	97.8	158	61.7	26.1	49.0	57.9	9.3	20.5	110	24.2	1689	3.72
45	93.6	97.7	165	61.8	26.2	49.0	57.8	9.7	21.4	110	24.2	1692	3.73
46	93.4	97.6	171	61.9	26.2	49.1	57.7	10.1	22.3	110	24.2	1694	3.73
47	93.1	97.5	177	62.0	26.2	49.2	57.7	10.5	23.1	110	24.2	1695	3.74
48	92.8	97.5	184	62.1	26.3	49.3	57.6	10.9	24.0	110	24.2	1697	3.74
49	92.5	97.4	190	62.2	26.3	49.4	57.5	11.3	24.9	110	24.2	1698	3.74
50	92.2	97.3	196	62.3	26.4	49.4	57.4	11.6	25.6	110	24.2	1699	3.74
51	91.9	97.2	203	62.3	26.4	49.4	57.3	12.0	26.5	110	24.2	1699	3.75
52	91.6	97.1	209	62.4	26.4	49.5	57.2	12.4	27.3	110	24.2	1700	3.75
53	91.3	97.0	215	62.5	26.5	49.6	57.1	12.8	28.2	110	24.3	1701	3.75
54	91.0	97.0	221	62.6	26.5	49.7	57.0	13.2	29.1	110	24.3	1701	3.75
55	90.7	96.9	227	62.7	26.5	49.8	56.9	13.6	30.0	110	24.3	1701	3.75

Age in Weeks	% Hen Day Production	% Livability	Cumulative Eggs / Hen Housed	Average Egg Weight			Daily Egg Mass	Cumulative Egg Mass / Hen Housed		Feed Intake		Body Weight	
				g / egg	Oz./ Doz.	Lbs. / case	grams	kg	lb.	bird/ day (g)	100/day (lbs)	grams	Lbs
56	90.4	96.8	233	62.8	26.6	49.8	56.8	14.0	30.9	110	24.3	1701	3.75
57	90.1	96.7	240	62.9	26.6	49.9	56.7	14.4	31.7	110	24.3	1701	3.75
58	89.8	96.6	246	63.0	26.7	50.0	56.6	14.7	32.4	110	24.3	1701	3.75
59	89.4	96.6	252	63.1	26.7	50.1	56.4	15.1	33.3	110	24.3	1701	3.75
60	89.1	96.5	258	63.2	26.8	50.2	56.3	15.5	34.2	110	24.3	1701	3.75
61	88.7	96.4	264	63.3	26.8	50.2	56.2	15.9	35.1	110	24.3	1701	3.75
62	88.4	96.3	270	63.4	26.8	50.3	56.1	16.3	35.9	110	24.3	1702	3.75
63	88.1	96.2	276	63.5	26.9	50.4	55.9	16.6	36.6	110	24.3	1702	3.75
64	87.7	96.1	281	63.6	26.9	50.5	55.8	17.0	37.5	110	24.3	1702	3.75
65	87.4	96.1	287	63.7	27.0	50.6	55.7	17.4	38.4	110	24.3	1702	3.75
66	87.1	96.0	293	63.8	27.0	50.6	55.6	17.8	39.2	110	24.3	1703	3.75
67	86.8	95.9	299	63.9	27.0	50.7	55.5	18.1	39.9	110	24.3	1703	3.75
68	86.4	95.8	305	64.0	27.1	50.8	55.3	18.5	40.8	110	24.3	1703	3.76
69	86.1	95.7	311	64.1	27.1	50.9	55.2	18.9	41.7	110	24.3	1704	3.76
70	85.8	95.7	316	64.2	27.2	51.0	55.1	19.2	42.3	110	24.3	1704	3.76
71	85.5	95.6	322	64.3	27.2	51.0	54.9	19.6	43.2	110	24.3	1704	3.76
72	85.1	95.5	328	64.4	27.3	51.1	54.8	20.0	44.1	110	24.3	1705	3.76
73	84.8	95.4	333	64.5	27.3	51.2	54.7	20.3	44.8	110	24.3	1705	3.76
74	84.5	95.3	339	64.6	27.3	51.3	54.6	20.7	45.6	110	24.3	1705	3.76
75	84.2	95.2	345	64.7	27.4	51.3	54.4	21.1	46.5	110	24.3	1705	3.76
76	83.8	95.2	350	64.8	27.4	51.4	54.3	21.4	47.2	110	24.3	1706	3.76
77	83.5	95.1	356	64.9	27.5	51.5	54.2	21.8	48.1	110	24.3	1706	3.76
78	83.2	95.0	361	65.0	27.5	51.6	54.0	22.1	48.7	110	24.3	1706	3.76
79	82.9	94.9	367	65.1	27.6	51.7	53.9	22.5	49.6	110	24.3	1707	3.76
80	82.5	94.8	372	65.2	27.6	51.7	53.8	22.9	50.5	110	24.3	1707	3.76
81	82.2	94.8	378	65.3	27.6	51.8	53.7	23.2	51.1	110	24.3	1707	3.76
82	81.9	94.7	383	65.4	27.7	51.9	53.5	23.6	52.0	110	24.3	1708	3.76
83	81.6	94.6	389	65.5	27.7	52.0	53.4	23.9	52.7	110	24.3	1708	3.77
84	81.2	94.5	394	65.6	27.8	52.1	53.3	24.3	53.6	110	24.3	1708	3.77
85	80.9	94.4	399	65.7	27.8	52.1	53.1	24.6	54.2	110	24.3	1709	3.77
86	80.6	94.3	405	65.8	27.9	52.2	53.0	25.0	55.1	110	24.3	1709	3.77
87	80.2	94.3	410	65.9	27.9	52.3	52.8	25.3	55.8	110	24.3	1709	3.77
88	79.9	94.2	415	65.9	27.9	52.3	52.7	25.7	56.7	110	24.3	1709	3.77
89	79.6	94.1	420	66.0	27.9	52.4	52.6	26.0	57.3	110	24.3	1710	3.77
90	79.3	94.0	426	66.1	28.0	52.5	52.4	26.4	58.2	110	24.3	1710	3.77

Appendix 4

BOVANS WHITE EGG WEIGHT DISTRIBUTION (%) – CANADIAN SYSTEM

Age in Weeks	Weekly						Cumulative					
	Jumbo over 70 g	Extra Large 64-70 g	Large 56-64 g	Medium 49-56 g	Small 42-49 g	Peewee under 42 g	Jumbo over 70 g	Extra Large 64-70 g	Large 56-64 g	Medium 49-56 g	Small 42-49 g	Peewee under 42 g
19	0.0	0.0	0.0	3.9	57.0	39.1	0.0	0.0	0.0	3.9	57.0	39.1
20	0.0	0.0	0.4	20.9	65.2	13.5	0.0	0.0	0.3	18.7	64.1	16.8
21	0.0	0.0	3.1	44.3	48.4	4.2	0.0	0.0	2.0	33.6	55.0	9.5
22	0.0	0.1	11.2	57.9	29.5	1.3	0.0	0.0	5.8	43.8	44.3	6.1
23	0.0	0.5	23.4	58.8	16.8	0.5	0.0	0.2	11.4	48.5	35.6	4.3
24	0.0	1.6	36.1	52.4	9.7	0.2	0.0	0.5	17.5	49.5	29.2	3.3
25	0.1	3.6	46.2	44.1	5.8	0.1	0.0	1.1	23.2	48.4	24.6	2.6
26	0.2	6.4	53.0	36.6	3.7	0.0	0.1	2.0	28.2	46.4	21.1	2.2
27	0.5	9.4	57.0	30.5	2.6	0.0	0.1	3.1	32.3	44.2	18.4	1.9
28	0.8	12.4	58.9	26.0	1.9	0.0	0.2	4.2	35.7	41.9	16.4	1.7
29	1.2	15.1	59.6	22.6	1.5	0.0	0.3	5.4	38.3	39.7	14.7	1.5
30	1.6	17.3	59.7	20.2	1.2	0.0	0.5	6.6	40.5	37.8	13.3	1.3
31	2.0	19.1	59.4	18.4	1.0	0.0	0.6	7.8	42.2	36.0	12.2	1.2
32	2.4	20.5	59.0	17.2	0.9	0.0	0.7	8.8	43.6	34.4	11.3	1.1
33	2.6	21.6	58.7	16.3	0.8	0.0	0.9	9.8	44.8	33.0	10.5	1.0
34	2.9	22.4	58.4	15.6	0.8	0.0	1.0	10.7	45.7	31.8	9.8	1.0
35	3.1	23.0	58.1	15.1	0.7	0.0	1.2	11.5	46.6	30.7	9.2	0.9
36	3.2	23.6	57.8	14.7	0.7	0.0	1.3	12.3	47.3	29.7	8.6	0.8
37	3.4	24.0	57.6	14.3	0.7	0.0	1.4	13.0	47.9	28.8	8.2	0.8
38	3.4	24.1	57.6	14.2	0.7	0.0	1.5	13.6	48.4	28.0	7.8	0.7
39	3.6	24.6	57.3	13.9	0.6	0.0	1.6	14.2	48.9	27.2	7.4	0.7
40	3.8	25.2	57.0	13.5	0.6	0.0	1.7	14.7	49.3	26.6	7.1	0.7
41	3.9	25.7	56.7	13.1	0.6	0.0	1.8	15.2	49.6	25.9	6.8	0.6
42	4.1	26.2	56.3	12.7	0.6	0.0	1.9	15.7	49.9	25.3	6.5	0.6
43	4.3	26.7	56.0	12.4	0.5	0.0	2.0	16.2	50.2	24.8	6.2	0.6
44	4.6	27.3	55.7	12.0	0.5	0.0	2.1	16.6	50.4	24.3	6.0	0.6
45	4.8	27.8	55.3	11.7	0.5	0.0	2.3	17.1	50.6	23.8	5.8	0.5
46	5.0	28.3	54.9	11.3	0.5	0.0	2.4	17.5	50.7	23.3	5.6	0.5
47	5.2	28.8	54.5	11.0	0.4	0.0	2.5	17.9	50.9	22.9	5.4	0.5
48	5.5	29.3	54.1	10.7	0.4	0.0	2.6	18.3	51.0	22.5	5.2	0.5
49	5.7	29.8	53.7	10.4	0.4	0.0	2.7	18.7	51.1	22.1	5.1	0.5
50	6.0	30.3	53.3	10.1	0.4	0.0	2.8	19.0	51.1	21.7	4.9	0.5
51	6.3	30.8	52.8	9.8	0.4	0.0	2.9	19.4	51.2	21.3	4.8	0.4
52	6.5	31.3	52.4	9.5	0.4	0.0	3.0	19.8	51.2	21.0	4.6	0.4
53	6.8	31.7	51.9	9.2	0.3	0.0	3.1	20.1	51.3	20.6	4.5	0.4
54	7.1	32.2	51.4	8.9	0.3	0.0	3.2	20.4	51.3	20.3	4.4	0.4
55	7.4	32.7	51.0	8.7	0.3	0.0	3.3	20.8	51.3	20.0	4.3	0.4

Age in Weeks	Weekly						Cumulative					
	Jumbo over 70 g	Extra Large 64-70 g	Large 56-64 g	Medium 49-56 g	Small 42-49 g	Peewee under 42 g	Jumbo over 70 g	Extra Large 64-70 g	Large 56-64 g	Medium 49-56 g	Small 42-49 g	Peewee under 42 g
56	7.7	33.1	50.5	8.4	0.3	0.0	3.4	21.1	51.2	19.7	4.2	0.4
57	8.0	33.6	50.0	8.1	0.3	0.0	3.6	21.4	51.2	19.4	4.1	0.4
58	8.3	34.0	49.5	7.9	0.3	0.0	3.7	21.7	51.2	19.1	4.0	0.4
59	8.7	34.5	49.0	7.7	0.3	0.0	3.8	22.0	51.1	18.8	3.9	0.4
60	9.0	34.9	48.4	7.4	0.2	0.0	3.9	22.3	51.0	18.6	3.8	0.3
61	9.4	35.3	47.9	7.2	0.2	0.0	4.0	22.6	51.0	18.3	3.7	0.3
62	9.7	35.7	47.4	7.0	0.2	0.0	4.2	22.9	50.9	18.0	3.7	0.3
63	10.1	36.1	46.8	6.7	0.2	0.0	4.3	23.2	50.8	17.8	3.6	0.3
64	10.5	36.5	46.3	6.5	0.2	0.0	4.4	23.5	50.7	17.6	3.5	0.3
65	10.9	36.9	45.7	6.3	0.2	0.0	4.6	23.7	50.6	17.3	3.4	0.3
66	11.3	37.2	45.2	6.1	0.2	0.0	4.7	24.0	50.5	17.1	3.4	0.3
67	11.7	37.6	44.6	5.9	0.2	0.0	4.8	24.3	50.4	16.9	3.3	0.3
68	12.1	37.9	44.1	5.7	0.2	0.0	5.0	24.5	50.3	16.7	3.3	0.3
69	12.5	38.3	43.5	5.5	0.2	0.0	5.1	24.8	50.1	16.5	3.2	0.3
70	12.9	38.6	42.9	5.4	0.2	0.0	5.2	25.0	50.0	16.3	3.1	0.3
71	13.4	38.9	42.4	5.2	0.1	0.0	5.4	25.3	49.9	16.1	3.1	0.3
72	13.8	39.2	41.8	5.0	0.1	0.0	5.5	25.5	49.7	15.9	3.0	0.3
73	14.3	39.5	41.2	4.9	0.1	0.0	5.7	25.8	49.6	15.7	3.0	0.3
74	14.7	39.8	40.7	4.7	0.1	0.0	5.8	26.0	49.4	15.5	2.9	0.3
75	15.2	40.0	40.1	4.5	0.1	0.0	6.0	26.2	49.3	15.3	2.9	0.3
76	15.7	40.3	39.5	4.4	0.1	0.0	6.1	26.5	49.1	15.2	2.9	0.3
77	16.2	40.5	38.9	4.2	0.1	0.0	6.3	26.7	49.0	15.0	2.8	0.3
78	16.7	40.8	38.3	4.1	0.1	0.0	6.5	26.9	48.8	14.8	2.8	0.2
79	17.2	41.0	37.8	4.0	0.1	0.0	6.6	27.1	48.6	14.7	2.7	0.2
80	17.7	41.2	37.2	3.8	0.1	0.0	6.8	27.3	48.5	14.5	2.7	0.2
81	18.2	41.4	36.6	3.7	0.1	0.0	6.9	27.5	48.3	14.3	2.7	0.2
82	18.8	41.5	36.0	3.6	0.1	0.0	7.1	27.7	48.1	14.2	2.6	0.2
83	19.3	41.7	35.5	3.5	0.1	0.0	7.3	27.9	48.0	14.0	2.6	0.2
84	19.9	41.8	34.9	3.3	0.1	0.0	7.5	28.1	47.8	13.9	2.5	0.2
85	20.4	42.0	34.3	3.2	0.1	0.0	7.6	28.3	47.6	13.8	2.5	0.2
86	21.0	42.1	33.8	3.1	0.1	0.0	7.8	28.5	47.4	13.6	2.5	0.2
87	21.6	42.2	33.2	3.0	0.1	0.0	8.0	28.6	47.2	13.5	2.5	0.2
88	22.1	42.3	32.6	2.9	0.1	0.0	8.2	28.8	47.0	13.3	2.4	0.2
89	22.7	42.4	32.1	2.8	0.1	0.0	8.3	29.0	46.9	13.2	2.4	0.2
90	23.3	42.4	31.5	2.7	0.1	0.0	8.5	29.2	46.7	13.1	2.4	0.2

Appendix 5

BOVANS WHITE EGG WEIGHT DISTRIBUTION (%) – U.S.A. SYSTEM

Age in Weeks	Weekly						Cumulative					
	Jumbo over 30 Oz./Doz.	Extra Large 27-30 Oz./Doz.	Large 24-27 Oz./Doz.	Medium 21-24 Oz./Doz.	Small 18-21 Oz./Doz.	Peewee under 18 Oz./Doz.	Jumbo over 30 Oz./Doz.	Extra Large 27-30 Oz./Doz.	Large 24-27 Oz./Doz.	Medium 21-24 Oz./Doz.	Small 18-21 Oz./Doz.	Peewee under 18 Oz./Doz.
19	0.0	0.0	0.0	2.6	52.6	44.8	0.0	0.0	0.0	2.6	52.6	44.8
20	0.0	0.0	0.2	16.7	66.5	16.7	0.0	0.0	0.2	14.9	64.7	20.3
21	0.0	0.0	2.1	39.3	53.2	5.5	0.0	0.0	1.3	29.1	58.0	11.7
22	0.0	0.1	8.2	55.5	34.3	1.8	0.0	0.0	4.2	40.1	48.1	7.6
23	0.0	0.5	18.6	59.7	20.5	0.7	0.0	0.2	8.7	46.3	39.4	5.4
24	0.0	1.8	30.0	55.7	12.2	0.3	0.0	0.6	14.0	48.6	32.7	4.1
25	0.0	4.0	39.7	48.6	7.5	0.1	0.0	1.3	19.1	48.6	27.7	3.3
26	0.0	7.0	46.4	41.4	4.9	0.1	0.0	2.2	23.7	47.4	23.9	2.8
27	0.0	10.4	50.6	35.3	3.4	0.0	0.1	3.4	27.5	45.7	20.9	2.4
28	0.0	13.7	52.8	30.5	2.5	0.0	0.1	4.7	30.7	43.8	18.6	2.1
29	1.0	16.6	53.7	26.9	2.0	0.0	0.2	6.0	33.3	41.9	16.8	1.9
30	1.0	19.1	54.0	24.2	1.6	0.0	0.3	7.3	35.3	40.1	15.3	1.7
31	1.0	21.1	53.9	22.3	1.4	0.0	0.4	8.6	37.0	38.5	14.0	1.5
32	1.0	22.6	53.7	20.9	1.3	0.0	0.5	9.8	38.4	37.0	12.9	1.4
33	2.0	23.8	53.5	19.8	1.1	0.0	0.6	10.9	39.6	35.7	12.0	1.3
34	2.0	24.8	53.2	19.1	1.1	0.0	0.6	11.8	40.6	34.5	11.2	1.2
35	2.0	25.5	53.0	18.5	1.0	0.0	0.7	12.8	41.4	33.4	10.6	1.1
36	2.0	26.1	52.8	18.0	1.0	0.0	0.8	13.6	42.1	32.5	10.0	1.0
37	2.0	26.6	52.6	17.6	0.9	0.0	0.9	14.3	42.7	31.6	9.4	1.0
38	2.0	26.7	52.6	17.6	0.9	0.0	1.0	15.0	43.3	30.8	9.0	0.9
39	2.0	27.3	52.4	17.1	0.9	0.0	1.0	15.7	43.7	30.1	8.5	0.9
40	2.0	27.9	52.1	16.7	0.9	0.0	1.1	16.3	44.2	29.5	8.2	0.8
41	3.0	28.4	51.9	16.2	0.8	0.0	1.2	16.8	44.5	28.8	7.8	0.8
42	3.0	29.0	51.6	15.8	0.8	0.0	1.3	17.4	44.8	28.3	7.5	0.8
43	3.0	29.6	51.3	15.4	0.7	0.0	1.3	17.9	45.1	27.7	7.2	0.7
44	3.0	30.2	51.0	15.0	0.7	0.0	1.4	18.4	45.3	27.2	7.0	0.7
45	3.0	30.8	50.7	14.6	0.7	0.0	1.5	18.9	45.6	26.7	6.7	0.7
46	3.0	31.4	50.4	14.2	0.7	0.0	1.5	19.3	45.7	26.2	6.5	0.7
47	4.0	32.0	50.0	13.8	0.6	0.0	1.6	19.8	45.9	25.8	6.3	0.6
48	4.0	32.5	49.7	13.4	0.6	0.0	1.7	20.2	46.0	25.4	6.1	0.6
49	4.0	33.1	49.3	13.1	0.6	0.0	1.8	20.7	46.1	25.0	5.9	0.6
50	4.0	33.7	49.0	12.7	0.6	0.0	1.8	21.1	46.2	24.6	5.7	0.6
51	4.0	34.2	48.6	12.3	0.5	0.0	1.9	21.5	46.3	24.2	5.6	0.6
52	5.0	34.8	48.2	12.0	0.5	0.0	2.0	21.9	46.4	23.8	5.4	0.5
53	5.0	35.3	47.8	11.7	0.5	0.0	2.1	22.3	46.4	23.5	5.3	0.5
54	5.0	35.9	47.4	11.3	0.5	0.0	2.2	22.6	46.4	23.1	5.1	0.5
55	5.0	36.4	46.9	11.0	0.4	0.0	2.2	23.0	46.4	22.8	5.0	0.5

Age in Weeks	Weekly						Cumulative					
	Jumbo over 30 Oz./Doz.	Extra Large 27-30 Oz./Doz.	Large 24-27 Oz./Doz.	Medium 21-24 Oz./Doz.	Small 18-21 Oz./Doz.	Peewee under 18 Oz./Doz.	Jumbo over 30 Oz./Doz.	Extra Large 27-30 Oz./Doz.	Large 24-27 Oz./Doz.	Medium 21-24 Oz./Doz.	Small 18-21 Oz./Doz.	Peewee under 18 Oz./Doz.
56	5.0	37.0	46.5	10.7	0.4	0.0	2.3	23.4	46.4	22.5	4.9	0.5
57	6.0	37.5	46.1	10.4	0.4	0.0	2.4	23.7	46.4	22.2	4.8	0.5
58	6.0	38.0	45.6	10.1	0.4	0.0	2.5	24.1	46.4	21.9	4.7	0.5
59	6.0	38.5	45.1	9.8	0.4	0.0	2.6	24.4	46.4	21.6	4.6	0.4
60	6.0	39.0	44.7	9.5	0.4	0.0	2.7	24.8	46.3	21.3	4.5	0.4
61	7.0	39.5	44.2	9.2	0.3	0.0	2.8	25.1	46.3	21.0	4.4	0.4
62	7.0	40.0	43.7	8.9	0.3	0.0	2.9	25.4	46.2	20.8	4.3	0.4
63	7.0	40.5	43.2	8.7	0.3	0.0	3.0	25.8	46.2	20.5	4.2	0.4
64	8.0	40.9	42.7	8.4	0.3	0.0	3.0	26.1	46.1	20.3	4.1	0.4
65	8.0	41.4	42.2	8.2	0.3	0.0	3.1	26.4	46.0	20.0	4.0	0.4
66	8.0	41.8	41.7	7.9	0.3	0.0	3.3	26.7	45.9	19.8	4.0	0.4
67	9.0	42.3	41.2	7.7	0.3	0.0	3.4	27.0	45.8	19.5	3.9	0.4
68	9.0	42.7	40.7	7.4	0.2	0.0	3.5	27.3	45.7	19.3	3.8	0.4
69	9.0	43.1	40.2	7.2	0.2	0.0	3.6	27.6	45.6	19.1	3.8	0.4
70	10.0	43.5	39.7	7.0	0.2	0.0	3.7	27.9	45.5	18.9	3.7	0.4
71	10.0	43.9	39.2	6.8	0.2	0.0	3.8	28.2	45.4	18.6	3.6	0.3
72	10.0	44.3	38.7	6.6	0.2	0.0	3.9	28.5	45.3	18.4	3.6	0.3
73	11.0	44.6	38.1	6.4	0.2	0.0	4.0	28.7	45.2	18.2	3.5	0.3
74	11.0	45.0	37.6	6.2	0.2	0.0	4.1	29.0	45.1	18.0	3.5	0.3
75	11.0	45.3	37.1	6.0	0.2	0.0	4.3	29.3	44.9	17.8	3.4	0.3
76	12.0	45.6	36.5	5.8	0.2	0.0	4.4	29.5	44.8	17.6	3.4	0.3
77	12.0	45.9	36.0	5.6	0.2	0.0	4.5	29.8	44.7	17.4	3.3	0.3
78	13.0	46.2	35.5	5.4	0.2	0.0	4.6	30.0	44.5	17.3	3.3	0.3
79	13.0	46.5	35.0	5.2	0.1	0.0	4.8	30.3	44.4	17.1	3.2	0.3
80	14.0	46.8	34.4	5.1	0.1	0.0	4.9	30.5	44.2	16.9	3.2	0.3
81	14.0	47.0	33.9	4.9	0.1	0.0	5.0	30.8	44.1	16.7	3.1	0.3
82	14.0	47.3	33.4	4.7	0.1	0.0	5.2	31.0	43.9	16.6	3.1	0.3
83	15.0	47.5	32.8	4.6	0.1	0.0	5.3	31.2	43.8	16.4	3.0	0.3
84	15.0	47.7	32.3	4.4	0.1	0.0	5.4	31.5	43.6	16.2	3.0	0.3
85	16.0	47.9	31.8	4.3	0.1	0.0	5.6	31.7	43.5	16.1	3.0	0.3
86	16.0	48.1	31.2	4.2	0.1	0.0	5.7	31.9	43.3	15.9	2.9	0.3
87	17.0	48.3	30.7	4.0	0.1	0.0	5.9	32.1	43.1	15.8	2.9	0.3
88	17.0	48.4	30.2	3.9	0.1	0.0	6.0	32.3	43.0	15.6	2.8	0.3
89	18.0	48.5	29.7	3.8	0.1	0.0	6.1	32.5	42.8	15.5	2.8	0.3
90	18.0	48.7	29.2	3.6	0.1	0.0	6.3	32.7	42.6	15.3	2.8	0.3

Appendix 6

BOVANS WHITE WATER CONSUMPTION LEVELS FOR PULLETS AND LAYERS

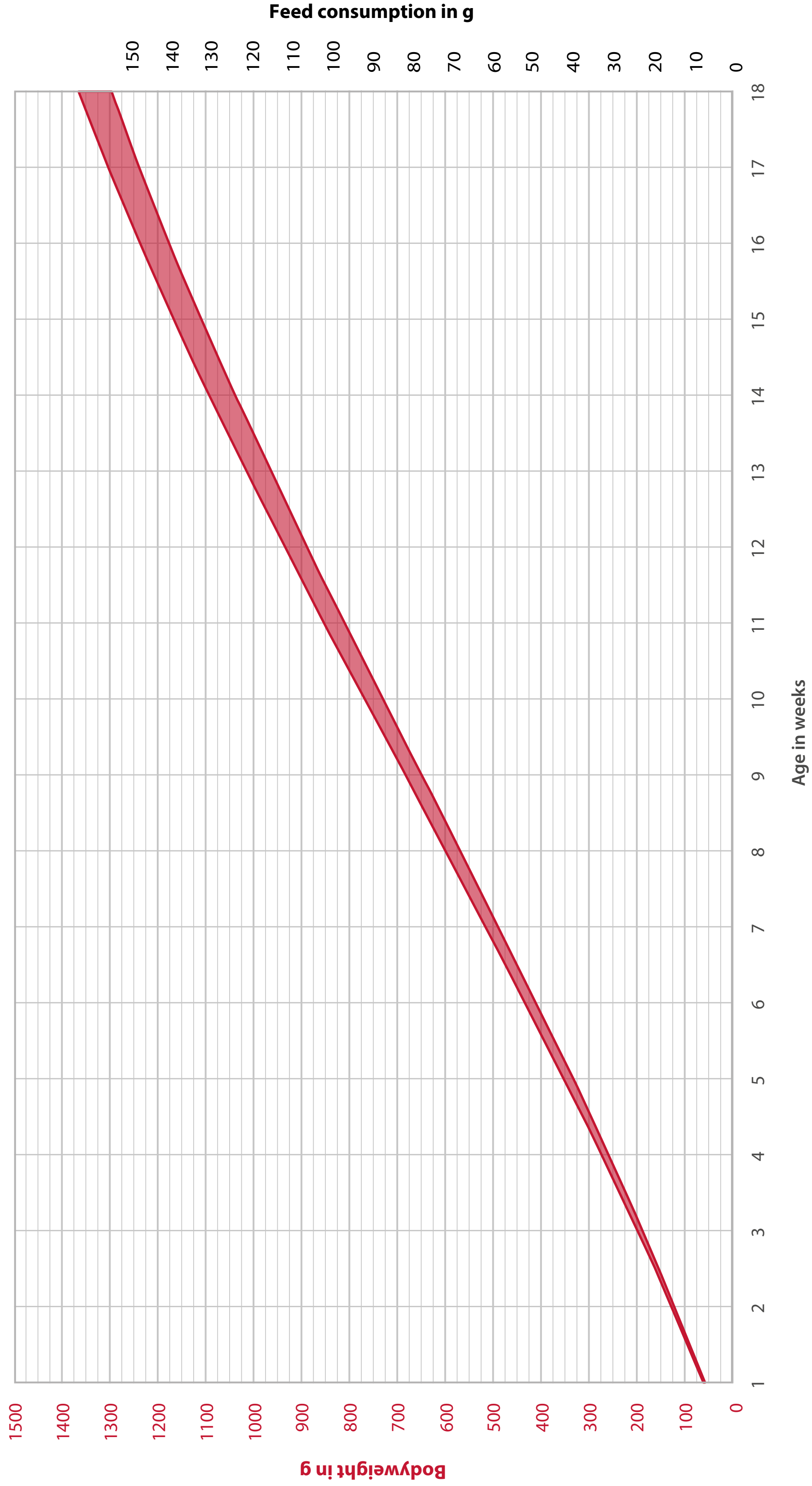
Water consumption per 100 Birds per Day				
Age in weeks	Liters		Gallons (US)	
	min	max	min	max
1	1.00	1.35	0.26	0.36
2	2.18	2.53	0.58	0.67
3	3.25	3.60	0.86	0.95
4	4.26	4.60	1.12	1.21
5	5.16	5.50	1.36	1.45
6	5.99	6.33	1.58	1.67
7	6.73	7.08	1.78	1.87
8	7.40	7.75	1.95	2.05
9	8.03	8.37	2.12	2.21
10	8.62	8.96	2.27	2.37
11	9.13	9.48	2.41	2.50
12	9.64	9.98	2.54	2.64
13	10.12	10.47	2.67	2.76
14	10.60	10.95	2.80	2.89
15	11.11	11.45	2.93	3.02
16	11.63	11.97	3.07	3.16
17	12.18	12.53	3.22	3.31
18	13.11	13.46	3.46	3.55
19-25	15.01	19.40	3.96	5.12
26-38	19.40	19.95	5.12	5.27
39-60	19.95	20.13	5.27	5.31
61-end	20.13	20.13	5.31	5.31

Notes:

1. Table gives water consumption levels for house temperatures in the range 21.1-24.4°C (70-76°F)
2. If house temperature increases above 77 degrees Fahrenheit or 25 degrees Celsius during lay cycle, water consumption increases significantly. Ratio between feed and water consumption could be in the range of 2.5 or higher.
3. Water consumption level in this table is an indicative value, that could be affected by house temperature, water temperature and humidity.
4. Important to have water meters installed in the poultry house and monitor daily water consumption. Evolution of water consumption is indicative of the flock wellbeing. Sudden change in water consumption could be a cause for alarm.

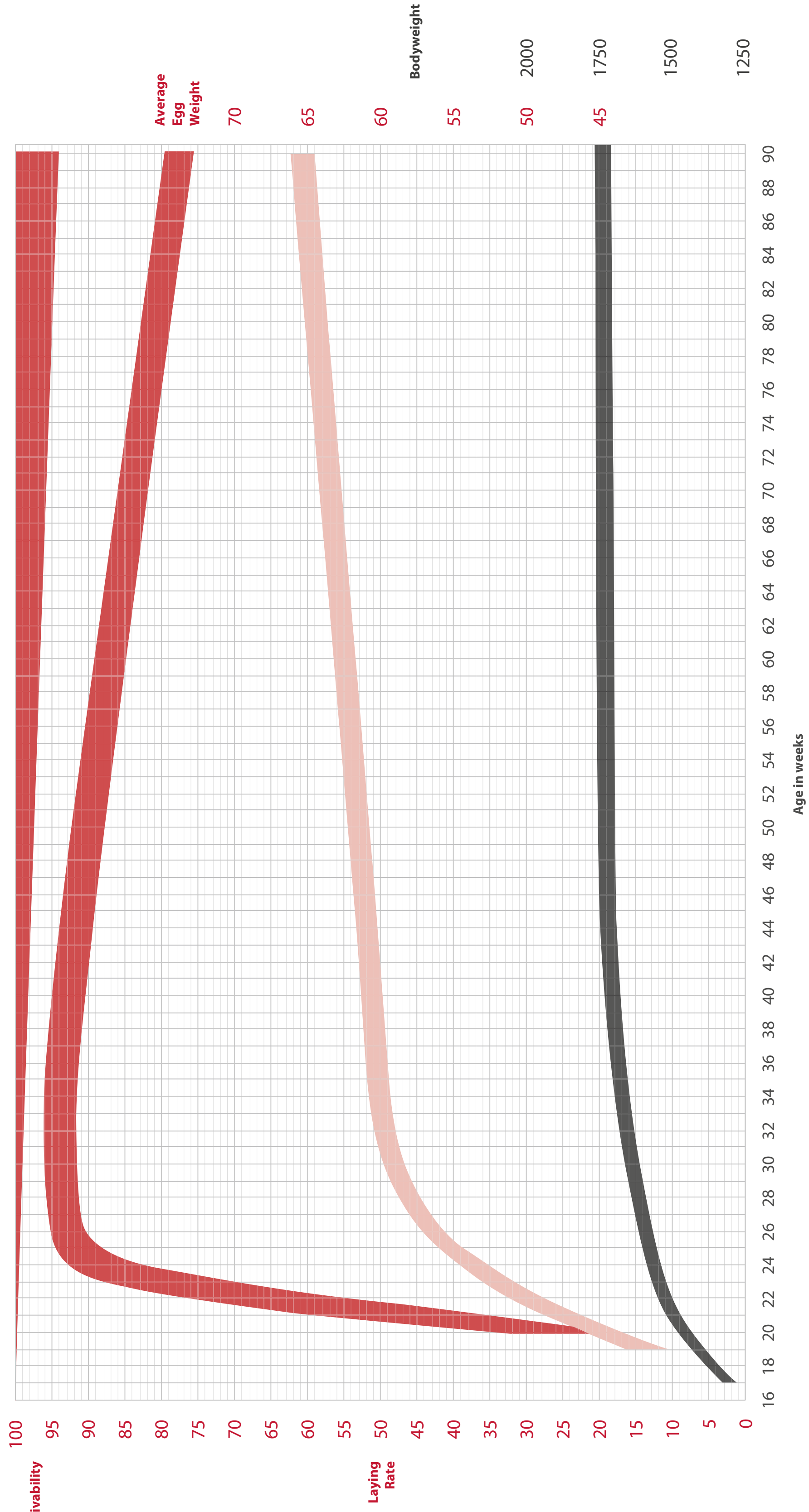
Bovans White

BODY WEIGHT REARING GRAPH



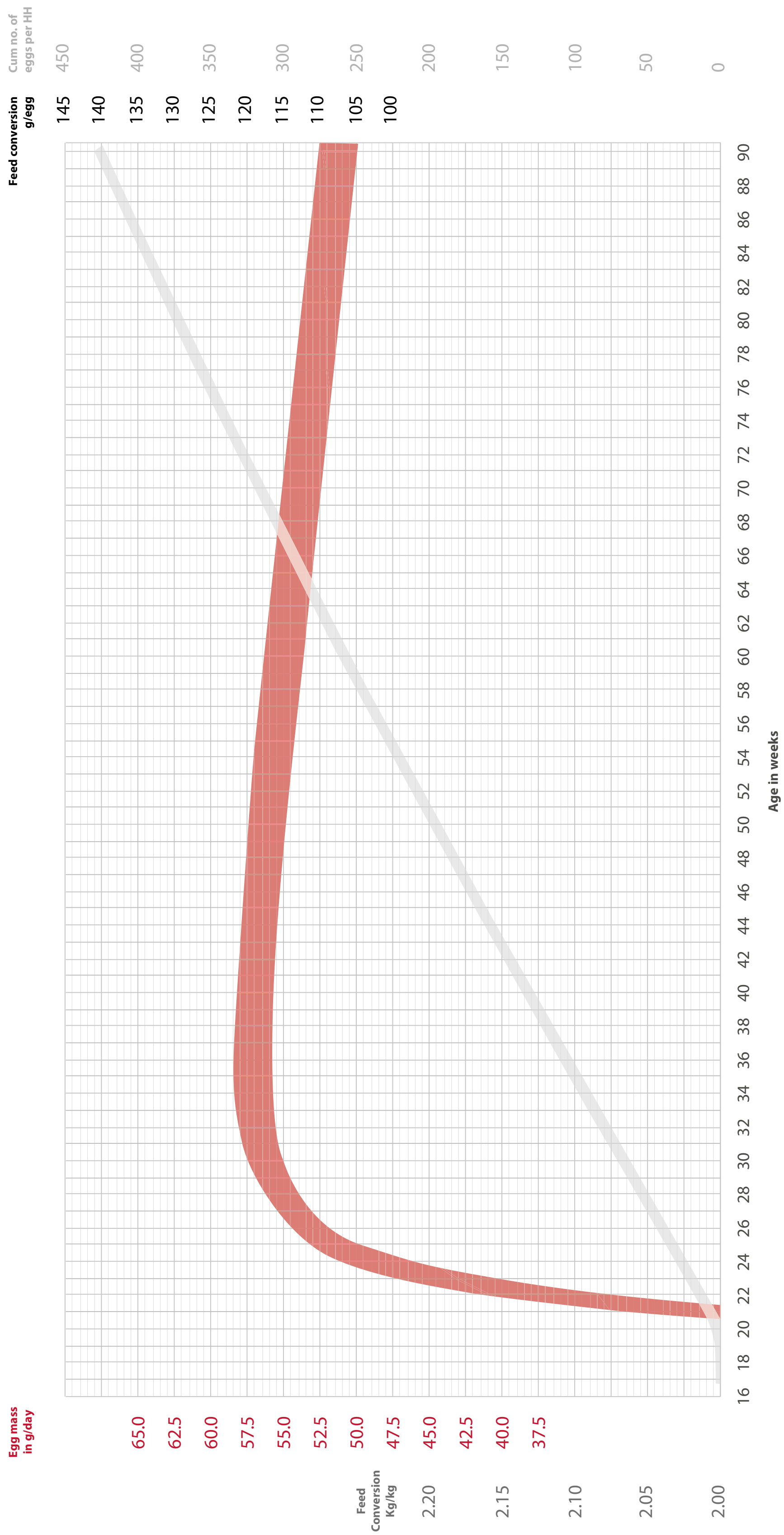
Bovans White

PRODUCTION RECORDING GRAPH



Bovans White

EGG MASS & EGGS PER HEN-HOUSE GRAPH



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