Nutrition of the Hy-Line bird

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Presentation overview

Part 1
- Importance of data recording
- Pullet growth and development
- General layer nutrition
- Egg size
- Hot weather

Part 2
- Practical approaches to formulating for the Hy-Line bird
Information tools

- **Management guides available online**
  - [www.hyline.com](http://www.hyline.com) or from your local distributor
  - Eggcel production recording program available

- **Redbook management guide**

- **Eggcel performance recording**
## EggCel

### SBROWN

- **Farm Name:** SA EXAMPLE
- **House or Flock ID:** 1
- **Hatch Date:** February 6, 2014
- **Hens Housed:** 50,000
- **Variety:** SBROWN

#### Mortality

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#### Production

- **Body Weight (Kg):**
  - **Body Weight Actual:**
  - **Body Weight Std.**
  - **Egg Weight Actual**

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1. To help you ..
2. To help Hy-Line help you ..
The importance of the rearing phase

- Significant performance potential is determined by rear!
- Getting off to a great start
  - Brooding
  - Feed and Water
- Meet or exceed (<10%) the growth rates in rear
- Follow the curve ‘in parallel’
- Minimise vaccination impact on weight gain ‘stall’
  - Increase diet density
  - Extra vitamins/electrolytes
- Do not restrict feed – change the diet!
- Achieve bodyweight on as high intake as possible to encourage intake.
  - Adjust feed density
- Diet strategies
  - 3 diets (Starter/Grower/Developer) vs 5 diets
  - Starter 1 (3 weeks) - establish better growth early
  - Pre-Lay – sets the bird up for laying period & conditions them to higher calcium
- Change feed by body weight not age
- Control coccidiosis and gut health

**CROP FILL – ARE THE CHICKS EATING?**

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The phases of growth

6-13 weeks weights must be on target
Getting it right in rearing

- Bones, muscles, and feathers ("frame")

- Tall, lean hen
- Short, round hen

Body weight (g) vs. Age, weeks
Uniformity is key

- Weight pullets weekly
- Calculate CV% from 3-4 weeks individual bird weights
What determines feed intake

- Nutrient requirement
  - Size / Breed of bird
  - Environmental temperature
  - Daily egg mass output

- Nutrient density
  - Energy content of the feed
  - Calcium appetite
  - Protein/lysine response

- Housing conditions
  - Feeder space per hen
  - Stocking density
  - Depth of feed in trough
  - Beak trimming
  - Availability and composition of water

- Health status flock
Feeding times

- Running feed tracks little and often encourages intake
- Avoid feeding during peak laying time
  - Feed before and after
- Late feed (1-2 hours before lights out) leaves food (and calcium) in the gut during dark period
  - Especially important for birds laying early in the morning
  - Use correct limestone particle size
- Train birds in rear to consume more feed in the afternoon
- Aim to supply more calcium from feed & less calcium from bone
  - Also lowers phosphorous excretion and requirement through less medullary bone turnover
  - Improve persistency of shell quality
Feeding behaviour

Circadian pattern of feed intake and feeding behaviour in laying hens

(Martinec et al., 1999)

Ovulation -> albumen addition (4 hours) -> ‘pumping’ (5 hours) -> 14-16 hours calcification
1.9 kg bird @ 20°C @ 90% production or a 62 g egg on 11.7 MJ diet = 127.4 g /d ME = 1.49 MJ (356 kcal)/d

134.9 g/d (+ 6%) 1.578 MJ (376.9 kcal/d) 15°C

128 g/d (+ 0.5%) 1.5 MJ (357.8 kcal)/d 63 g

125.3 g/d (- 2.7%) 1.491 MJ (356 kcal)/d

126.1 g/d (-1.1%) 1.475 MJ (352.3 kcal)/d

87% production

Modern birds seem less able to adjust for dietary energy...
Better at compensating for decreases than increases;
More risk of over consumption than under consumption

Leeson & Summers 2005
Energy

Target = Matrix?


Different systems exist for calculation of energy

- Europe: WPSA, CVB, Schorthorst, INRA
- European energy is generally lower than US energy (i.e. Europe generally will over formulate requirement against a US energy target by 3-5%). CVB (layer AME) is the exception.
- Guides set a range to accommodate this.

Difficult to make comparisons across systems

Importance of insoluble fibre

Can observe better than expected performance on low energy/high insoluble fibre diets - Improved digestion?

Understanding the value of (NSP) enzymes in layers

Non additive effect of enzymes

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<sup>1</sup>Feedstuffs 2008 Reference issue and buyers guide. Feedstuffs, September 10, 2008. Minnetonka, Minnesota, USA.
<sup>3</sup>Centraal Veevoederbureau (CVB). 2008. CVB Table booklet feeding of poultry. CVB-series no. 45. (values of ME for laying hens, "ME<sub>la</sub>,” are shown).
<sup>6</sup>MTT Agrifood Research Finland – uses the WPSA 1986 system.
Protein

- Preferable to formulate to Standardised Ileal Digestible Amino acids
- Needs accurate raw material knowledge and matrix maintenance
- Allows crude protein limits to be reduced
  - Reduces excess nitrogen
- Optimises cost
- Utilizes synthetic amino acids
- Must follow Ideal Protein Concept and balance for all amino acids
Ideal Protein concept

- Protein requirement is determined by amino acids not crude protein
  - Crude protein levels in the guide are only indicative when diets are formulated to the correct level of amino acid
- Quality not Quantity
  - Requirement is expressed as ratio to lysine (first limiting) of the limiting essential amino acids out of 22 total amino acids
  - Production potential is determined by the amino acid that is at or below its optimum ratio.

- Ideal balance not ‘fixed in stone’
  - Influenced by measurement parameter; growth, age, egg yield, immune system demand…. so requirements are a composite of these.
  - Most commonly flexed for methionine/M+C to control egg size
Ideal Protein concept

What is the ideal ratio?
- Generally 6 amino acids are limiting depending on the diet composition
- Individually, all amino acids give a dose response to production, egg size and egg mass

Application to the diet
- Understand effects
- Understand the dose response
- Understand the market
- Appreciate the economics

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Egg size

- Different markets demand different weights
- Breed line selection
- Genetic programs ‘flattening the curve’
- Pullet weight & uniformity
- Bodyweight at stimulation
  - 45g = 0.5g egg size in early lay
- Egg Mass = egg size x egg number

- Key nutrient drivers in Egg size
  - Protein - Amino acids – Methionine
    - Methionine ‘sparing’ nutrients (Methyl donors)
  - Energy
    - Oil & linoleic acid
Egg size: Methionine (chemistry)

- Folic acid/betaine/choline/B12 ‘spare’ methionine for production by increasing reconversion
- Cysteine cannot convert to methionine, methionine can convert to cysteine
  - Both methionine & methionine + cysteine limits important
  - Methionine limit must me met first
- More methionine = more production
- Methionine ‘alternatives’ = apply correct methionine equivalence values

Growth & egg mass → Protein synthesis → DNA Methylation → Methionine → Homocysteine

Vitamin B6 → Cysteine

Folic acid → Vitamin B12 → Choline/Betaine
Egg size: Methionine (practice)

- Reducing amino acid supply reduces egg number and egg size = less egg mass
- Take care controlling egg size when egg number or egg mass output is important or impact both
- Consider relationships with other amino acids
  - Maintain ideal ratio versus modified ratio (i.e. reduced methionine:lysine ratio = smaller eggs/less impact on production)
  - Avoid excess or deficiency
  - Avoid formulating to crude protein
- Digestible amino acid system
  - More accurate reflection of amino acid supply
  - Important when changing raw materials
  - Check matrix against analysis

Standard
63.3g @ 433mg/d

18 mg/g egg

7.5-8 mg/g egg
Egg size: Energy

- **1 g egg size**
  - 1.8 kcal/d or 0.08 MJ/d (<1% of energy intake on 2800 kcal/11.7MJ diet)
  - Equivalent to 0.5°C increase in temperature
    - Reducing temperature to control egg size = more energy demand = more intake or methionine if no correction on diet = vicious circle

- **Modern layers may be less sensitive to dietary energy**
  - More responsive to dietary energy drops than energy increases
    (Harms et al. 2000)
  - i.e. more inclined to over consume than under consume
  - More likely to get large eggs due to oversupply of energy
  - Likely to be associated with multiple ovulations – double yolks – prolapse – peritonitis
  - Increased fat pad (15-20 mm maximum)

- **What causes energy oversupply**
  - Energy system misalignment – Matrix energy, target energy
  - US corn/soya diet on a EU energy system can be 3-5% different in effective AME
  - High oil diets

- **Too little energy = low body weight, low egg production, low egg weight**
  - Post peak dip
Egg size: Energy

- Energy undersupply example

Graph showing:
- Hen Day Actual (%)
- Hen Day Std. (%)
- Egg Weight Actual
- Egg Weight Std.

Key points:
- Post peak dip
- Low egg weight
Egg size: Oil & Linoleic acid

Dietary oil vs linoleic acid
- Balance of evidence suggests dietary oil is greater influence than linoleic (Safaa et al. 2008)

Conflicting field experience
- High oil diets give larger eggs
- High linoleic diets don’t necessarily give large eggs
- Birds do respond to reducing linoleic acid below ~1.8%

Why?
- Correct energy values on oils
- CVB calculation gives layers 15% more AME from oil than ‘adult’ calculation
- High linoleic acid oils are generally highly unsaturated and have higher AME values
- Birds over consume energy on high oil diets.

Study by Whitehead et al. (1991)
- Interaction between effect of dietary oil and hen age on egg size
  - Young hens (<46 weeks) = ↑ Yolk & Albumen
  - Older hens (>46 weeks) = ↑ Albumen only
- Fatty acid stimulating oviduct protein synthesis
- 1993: egg size is highly correlated to plasma oestradiol
- Dietary fatty acids – mediated by oestradiol – effect egg size

Omega 3 (fish oils) ↓ egg weight
- Importance of Omega3:Omega 6 ratio?
Formulating for heat stress

Energy

- Layers require a different approach to broilers as they are regulating their energy intake
- Lower energy density may help maintain higher intake
- Increasing energy could acutely drive intake down lower
- Avoid over-formulating energy into the diet
- Understand energy systems
  - US – EU systems up to 3-4% different in ME
- Energy from good quality oils/fat have a lower heat increment than energy from starch
- Increasing oil will usually result in increased fibre which may also be useful in enhancing digestion. Select insoluble fibres where possible (e.g. sunflower meal).
Formulating for heat stress

Protein

- Amino acid intake is biggest factor in reduced egg production during heat stress (Balnave, 1998, in review)
- Formulate to maintain amino acid intake
- Avoid excess non-essential protein
  - Deamination requires energy and increases heat
- Formulate to digestible amino acids in ideal ratio
- Avoid excess protein by not formulating to Crude Protein
- Provide a high quality protein not a high quantity of protein.
Formulating for heat stress

Electrolyte balance

- Shown to effect shell strength, bird health and metabolism
- Defined as \((\text{Na}^+ + \text{K}^+ - \text{Cl}^-)\)
- Optimum around 250 mEq/kg
  - Achieved by balancing sodium source from NaCl (Salt) or NaHCO\(_3\) (Sodium - Bicarbonate)
  - Sodium and Chloride minimums must be met
- HCO\(_3^-\) ions are required to buffer negative ions
- HCO\(_3^-\) ions combine with Calcium to form egg shell (CaCO\(_3\))
- Demand for HCO\(_3^-\) increases
  - Heat stress
  - Shell formation
  - Diets containing high non essential protein
  - High dietary chloride
Formulating for heat stress

Minerals
- Adjust Calcium and Phosphorous density to maintain nutrient intake targets according to intake
- Phosphorus requirement is increased in heat stress
  - Too much will also reduce shell quality

Vitamins
- B vitamins - important in energy metabolism
  - Reduce fatty liver
- Vitamin E – antioxidant
- Vitamin D – calcium and phosphorous metabolism
- Vitamin C – reduce metabolic changes associated with corticosterone (Sahin et al., 2004)
  - Corticosterone = stress hormone = ↓ immune response, growth, production
  - 100 -300 ppm depending on severity
Formulating for heat stress

Additives

- Enzymes: maximize nutrient uptake/efficiency
- Betaine
  - osmolyte (protection of cells & tissue from dehydration)
- Hydroxy methionine analogue (MHA/HMBTA)
- Zinc chelate – may improve activity of carbonic anhydrase
- Copper chelate – may indirectly improve carbonic anhydrase activity by reducing Zinc:Copper antagonism
Feeding in heat stress

- **Offer feeds during cooler periods**
  - Withdraw feed and light prior to/during peak temperature (e.g. 14:00 – 18:00)
  - Use of intermittent light programs (3L:1D) help increase intake in younger hens (Belnave, 1998)

- **Bird requires more feed before dark**
  - 40:60 am/pm split (may be difficult to achieve in hot weather as heat is in second half of day)
  - Requirements for egg ‘plumping’ and shell deposition

- **Midnight feeding may help**
  - 1-2 hours maximum
  - 2-3 hours after and before lights.

- **Feed form**
  - Crumbs/pellets may increase intake under severe heat stress
  - Meals preferable because of particle structure (gizzard function and incorporation of large limestone)
  - Larger grist profile might improve intake.
  - Avoid feed separation uniformity issues.
Formulating laying diets

- Meet the Daily Nutrient Requirement of the bird
- Know your intake
- Formulate to intake
- Monitor intake on prelay post transfer to predict requirement for next diet
- Expect 3-5g/week increase from 17 -21 weeks
Why the need for a dense diet in early lay…

Intake is sustaining
- Growth
- Production (Egg Mass)
Intake “lag”

Physical Maturity
Intake plateau

Peak Production

Peak Egg Mass Output

© Hy-Line International
What can happen if nutrient intake is too low in early lay

**Energy & Amino acid**
- Post peak dips
- Low/flat peaks
- Poor egg size
- Persistency loss
- Body weight
- Analysis required to differentiate energy/amino acid deficiency

**Calcium & Phosphorous**
- Soft Bones, Crooked Keels
- Layer fatigue
- Loss of shell quality later in lay (45 weeks +)

**Investment in early lay**
- Improve peak lay
- Improve late lay
## Diet matrix

<table>
<thead>
<tr>
<th></th>
<th>Peaking</th>
<th>Post peak</th>
<th>88-85 %</th>
<th>&lt; 85%</th>
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## Diet intake matrix

### Silver Brown Commercial

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Peaking diet</th>
<th>Peak -2% -&gt;90%</th>
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</thead>
<tbody>
<tr>
<td>Intake (g/d)</td>
<td></td>
<td>93 98 103 108 113</td>
<td>100 105 110 115 120</td>
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<tr>
<td>Daily requirement</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| AME (EMP) MI/kg  | * 11.80 11.70 11.60 11.50 11.50 |                      |
| AME (EMP) Kkcal/kg | ** 2819 2795 2771 2747 2747 |                      |

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Intake (g/d)</th>
<th>Daily requirement</th>
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<tr>
<td>Dig lysine</td>
<td>850 0.91 0.87 0.83 0.79 0.75</td>
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<td>840 0.84 0.80 0.76 0.73 0.70</td>
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<tr>
<td>Dig Methionine</td>
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<tr>
<td>Dig M + C</td>
<td>714 0.77 0.73 0.69 0.66 0.63</td>
<td></td>
<td>722 0.72 0.69 0.66 0.63 0.60</td>
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<tr>
<td>Dig Threonine</td>
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<td>588 0.59 0.56 0.53 0.51 0.49</td>
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<td>Dig Tryptophan</td>
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<td>176 0.18 0.17 0.16 0.15 0.15</td>
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<tr>
<td>Dig Arginine</td>
<td>910 0.98 0.93 0.88 0.84 0.81</td>
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<td>899 0.90 0.86 0.82 0.78 0.75</td>
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<tr>
<td>Dig Isoleucine</td>
<td>672 0.72 0.69 0.65 0.62 0.59</td>
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<td>664 0.66 0.63 0.60 0.58 0.55</td>
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<td>Dig Valine</td>
<td>765 0.82 0.78 0.74 0.71 0.68</td>
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<td>756 0.76 0.72 0.69 0.66 0.63</td>
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</table>

| Crude Protein %** | 18 19.35 18.37 17.48 16.00 16.00 |                  | 17 17.00 16.19 15.45 15.50 15.50 |

| Ca %             | 4 4.30 4.08 3.88 3.70 3.54 |                  | 4.3 4.30 4.10 3.91 3.74 3.58 |
| Av Phosphorous % | 440 0.47 0.45 0.43 0.41 0.39 |                  | 400 0.40 0.38 0.36 0.35 0.33 |

| Na %             | 180 0.19 0.18 0.17 0.17 0.16 |                  | 180 0.18 0.17 0.16 0.16 0.15 |

| Cl min - max %   | 180 0.19-0.23 0.18-0.22 0.17-0.21 0.16-0.2 0.16-0.19 |                  | 180 0.18-0.22 0.17-0.21 0.16-0.2 0.16-0.2 0.15-0.19 |

Nutrients adjusted for intake
Energy – partial adjustment – **full adjustment counter productive**
Protein – **lower limit to prevent excessively low levels**
Constructing the diet...

1. Obtain feed intake from the farm
   1. If this is not available estimate from experience with Hy-Line birds elsewhere
   2. Take intake figures from the Hy-Line manual

2. Set nutrient limits according to the guide using
   1. Level of production
   2. Feed intake
Constructing the diet…

3. Run optimisation
4. Analyse result
5. Adjust constraining limits
Constructing the diet...

- Review response to constraining nutrients if available
- No magic formula for this...
- Nutritional experience/judgement
- More individual nutrient response data would be excellent!
- Response to a 5% decrease is not likely to significant at intake > 600 mg/d
- Antagonism between valine, isoleucine & leucine
  - Excessive levels can be negative
  - 8g/kg isoleucine (Peganova & Eder 2002)
6. Reduce digestible Valine limits by 3%
   • Still savings to be had
   • Sense check other limits
     ✓ D-Lysine
     ✓ D-Methionine/d-M+C
     ✓ D-Threonine
     ✓ d-Isoleucine
     ✓ Ca
     ✓ AvP
     ✓ Na

![Optimal cost: 3980.789]
Constructing the diet...

- Review diets with farm Reformulate when the intake reaches 103g/d (+5g/d)
- -1.3% drop on d-valine
- No adjustment on energy (provided bodyweight is acceptable)
Protein quality

- Protein quality is defined by amino acid balance
- Deviating from the guide
  - Unbalancing amino acids will be likely to impact performance
  - Effect will increase more ‘unbalanced’ individual amino acids are…
  - Effect will be additive if more than one amino acid is unbalanced
  - Once the ‘safe’ limits of the balance are exceeded it will be more efficient to reduce the protein density and maintain a better balance.
Constructing the phases...

- Formulating low intake/high density diets is a challenge
- Nutrient costs rise exponentially due to formula density constraint
  - Diet costs rise exponentially
  - Depends on raw materials available, quality used and cost.
- Maintain energy levels.
  - Increase only if birds are falling behind target bodyweight
  - Reduce if body weight is gaining too quickly.
  - Change energy = change intake = less predictably on diet changes
- Keep ‘standards’ levels in reference specification to avoid ‘formula’ drift
- Re-challenge expensive constraints on each formulation run/after cost, material or quality changes.
### Multiple stage 1 diets

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Intake</th>
<th>Diet</th>
<th>Cost (ZAR/T)</th>
<th>Cost/bird (ZAR/week)</th>
<th>Diet dLysine (%)</th>
<th>dLysine intake (mg/d)</th>
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**Cost/bird:** 66.93
## Single stage 1 diet

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<th>Intake</th>
<th>Diet</th>
<th>Cost (ZAR/T)</th>
<th>Cost/bird (ZAR/week)</th>
<th>Diet dLysine (%)</th>
<th>d Lysine intake (mg/d)</th>
<th>D Lysine requirement (mg/d)</th>
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Single vs multistage diets

Don’t need to be more expensive. Feed expensive diets for short periods, move to less nutrient dense lower cost diets as intake increases/stabilises.

Number of stages and period required are site specific depending on flock:
- Pullet rearing
- Environment
- Health
- Production

In this example to 40 weeks:
- Multi diet strategy cost ZAR 66.93
- Single diet strategy cost ZAR 67.59

Range on intake vs requirement:
- Multistage = 97 – 102%
- Single stage = 85 – 108%

Value return:
- Higher peaks
- Longer peak persistency
- Better egg weight profile (larger in early lay, controlled post peak)
- Avoiding “moving through” diets too quickly from 30 weeks to control egg size/body weight due to over feeding.
- Late lay persistency
- Better bird condition (efficiency and production)
- Sustained shell quality beyond 45 weeks
- Potential for longer laying cycle

-1% saving
The “value” of lower intake

- Feed is 60-70% total costs
- 50-60% of production revenue pays for feed
  - 2-3% of production revenue pays for chick!
- Diet cost more but the bird uses less of it.
- 108g diet material cost = ZAR 3859
- 113g diet material cost = ZAR 3776
- Cost difference = 2.2%. (113g diet costs ZAR 1.32/bird more for 10 weeks)
- Nutrient intake difference (fixed energy) = 4.5%
- 10 weeks = 350g more feed on 113g diet.
- Consider fixed costs ZAR 400 to cover milling, margin and transport
  + 350g/bird for 10 weeks adds a further ZAR 0.14/bird
- 100,000 birds for 10 weeks
  - Material cost difference = ZAR 132,000
  - Milling & delivery (+350T) = ZAR 14,000 ZAR
  - Total = ZAR 146,000
But..the single diet would not be fed to 40 weeks?

- Most likely it would be ‘changed down’ earlier due to increasing egg size as a result of ‘over supply’ of protein (methionine)
- Probably at ~35 weeks
  - Post production peak but before peak egg mass production
- Fighting egg size = compromising egg number
- This will hit production
- Reduce peak persistency
- Reduce flock potential
- Loss of revenue
Compare intake to requirement....

Change was too quick at 40 weeks – good performance
Review intake against requirement

- Calculate the daily nutrient intake
- Compare it to target
- Analyse the data
  - Low egg weight at start
  - Egg size increase 45 weeks +
  - Declining shell quality towards the end of lay
Analyse what happens on the diet changes

Performance Table

Egg weight & production restricted @ peak
Change downs too quick
Excessively low density diets

- Increased feed usage
- Increased ‘fixed costs’ i.e. transport and haulage costs
- Bird may not satisfy daily nutrient requirement
  - Lost performance potential
- If nutrient requirement is met with higher intake:
  - Reduced nutrient efficiency
  - Higher feed conversion
  - Poorer nutrient conversion
  - Increased cost & lower return
  - Higher environmental impact…?
- Only justified if nutrient unit cost exceeds the productivity return

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Excessively high density diets

- Daily nutrient needs met on lower levels of feed intake
  - Requires rebalancing of other nutrients to correct intake levels

- Likely to cause overweight birds
  - Heavier egg weight
  - Fatty Liver
  - Prolapse/Peritonitis

- Inefficiency
  - Higher nutrient costs
  - Excessive nutrient supply

- Higher environmental impact…?
Optimum density diets: the aim

- Found by feeding to production
- On target bodyweight (+/- 50g)
- Egg weight on target (+/- 1g to standard)
- Production on or above target
- Genetic advances mean birds will persist for longer
- Don’t feed to age – feed to production!

- Optimised value return
- Minimized environmental impact
Feeding to Production

- Communication, Communication, Communication
- Stockman – Feed producer – Nutritionist
- Guide is a guide not the law….
- Flock requirements vary by flock
  - Rearing
  - Environment
  - Health
  - Condition
- Feed back from farm to nutritionist is essential
- React
  - Changes in production %
  - Changes in feed intake
  - Changes in egg weight
- Aim to change diets according to what the bird is telling you….!
Thank You

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