Feeding Modern Layer Genotypes Practically

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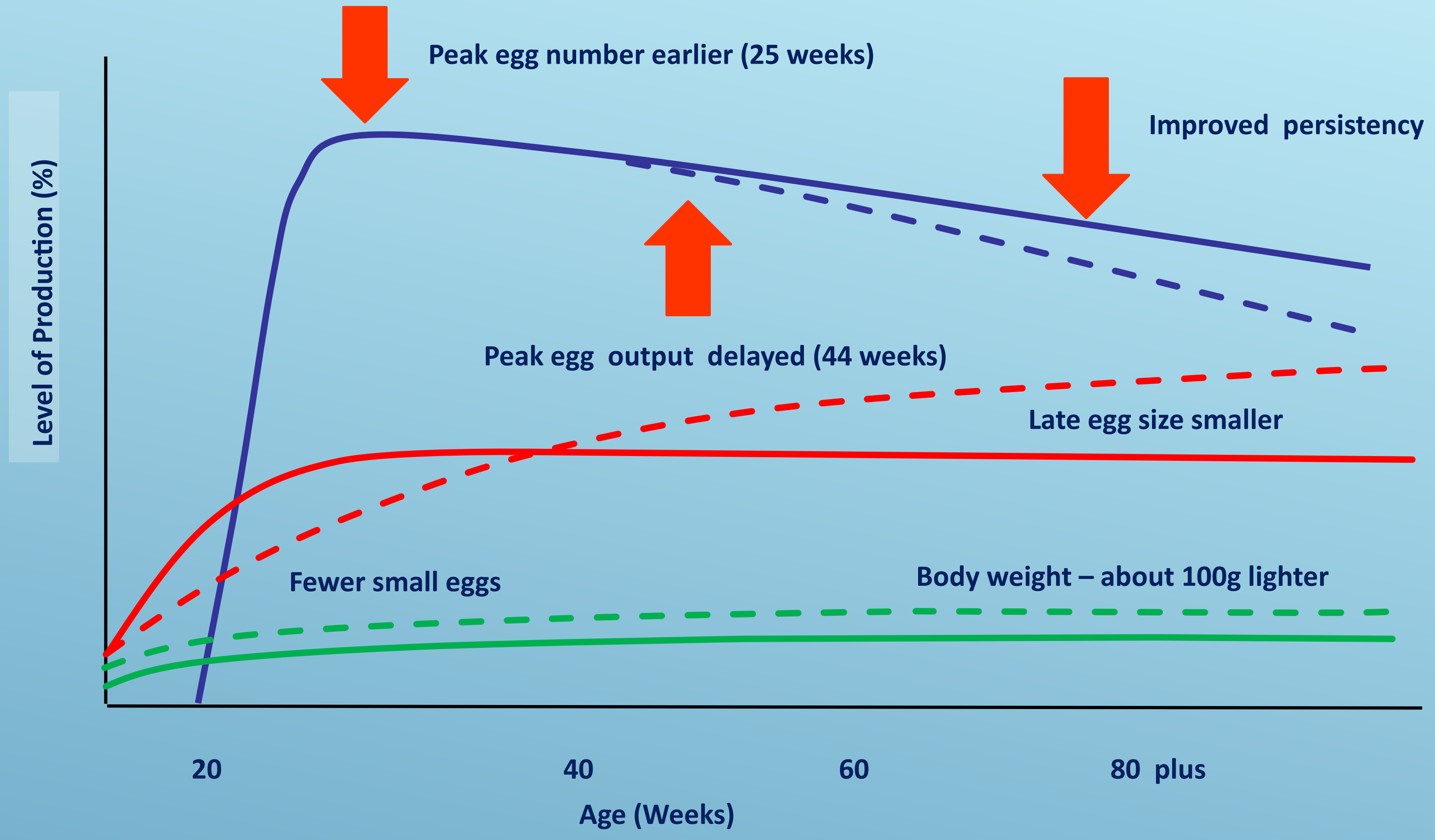
The Laying Hen

- Lay represents new physiological status.
- Meet requirements - growth, oviduct, maintenance & lay.
- Ability to consume feed – may be compromised.
- Birds averse to new diets (high limestone).
- 4 days before first egg – intake drops 20% (Anderson, 2017).
- What happens during rear really matters.

Changes in the Modern Layer



Note: Dashed lines represent older genotypes

Modern Layer Nutrition.

- Modern birds:
  - Are lighter and lay smaller eggs.
  - Lay longer clutches (more eggs).
  - Bird - still only lays an egg a day!
  - However – now expect 500 eggs by 100 weeks of age.
  - Housing systems are evolving.
  - Eating patterns may well change.

Overview of Experiments

- Conducted three trials using individual hens.
- Individual – more accurate from a biological perspective.
- But - do not experience the pressure of a colony.
- Data is not always transferable to commercial situations.
- However – an excellent way of gaining perspective.
- Experiments congruent – as illustrated by feed intake model.

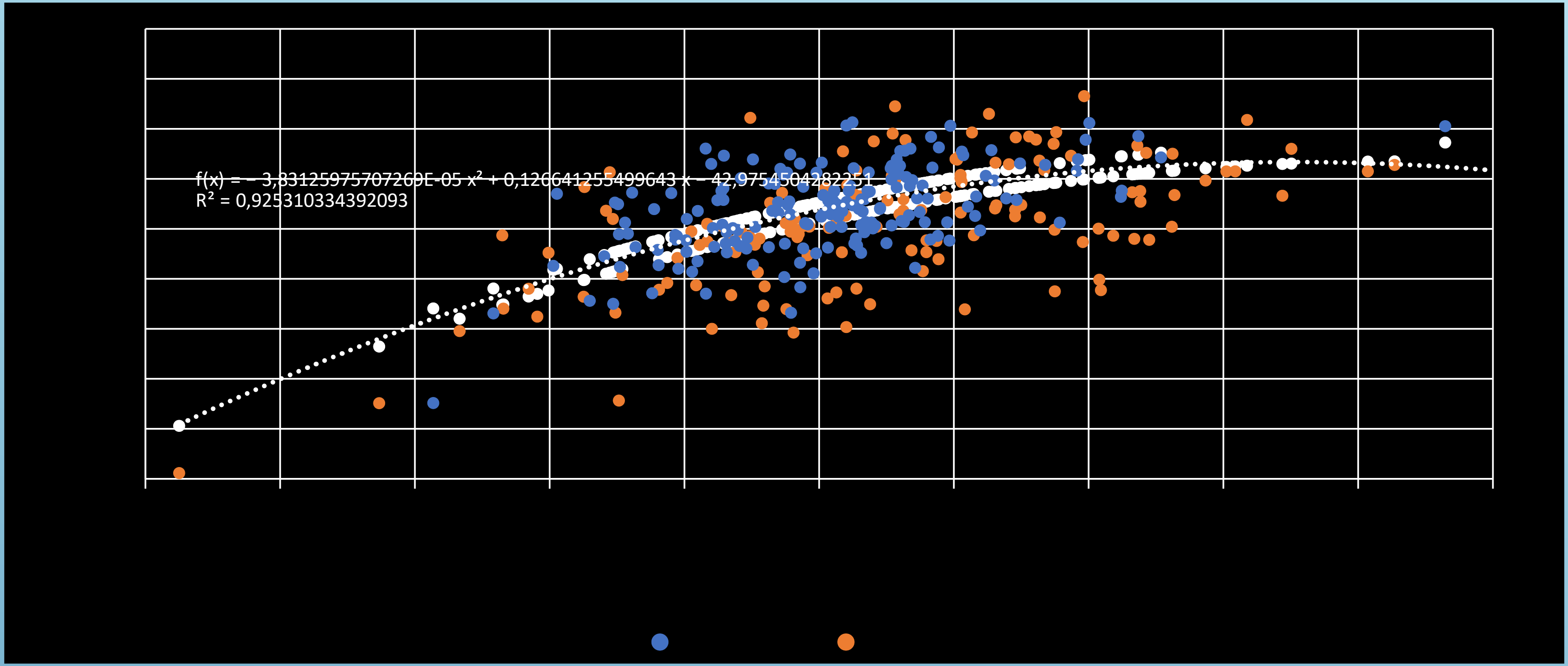
Summary of Trials

	Hisex Brown	Hy-Line Brown	Hy-Line Silver Brown
	36-40 weeks	27 to 30 weeks	87 to 90 weeks
Year trial conducted	1985	2017	2018
ME levels (MJ/kg)	10,11,12,13	11, 11.75, 12.5	11, 11.75, 12.5
SID Lysine (g/kg)	5,6,7,8	6,7,8,9	6,7,8,9
Number of hens at 100%	18	111	5
Number of hens stopped lay	2	3	6

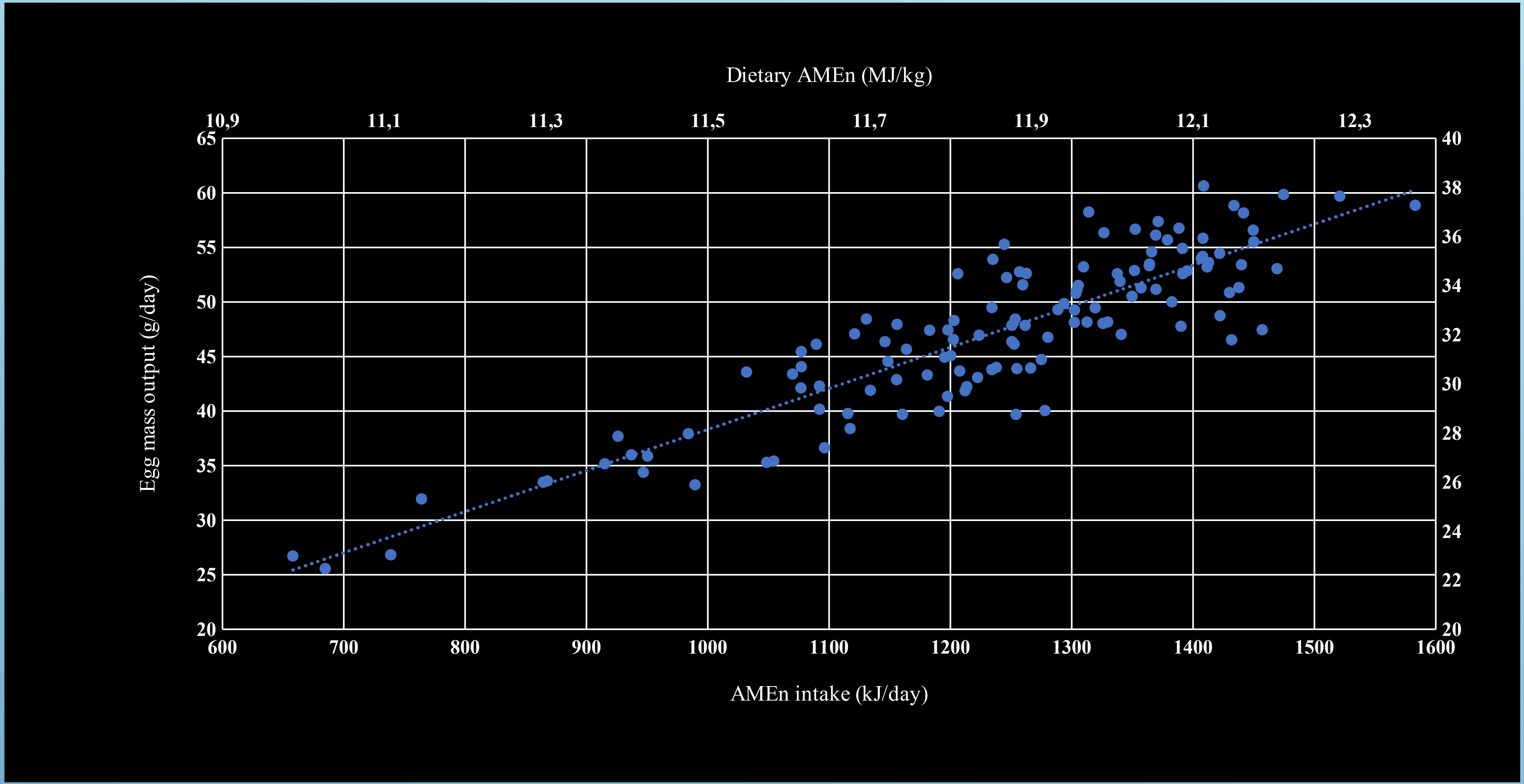
Summary of Trials

	Hisex Brown	Hy-Line Brown	Hy-Line Silver Brown
	36-40 weeks	27 to 30 weeks	87 to 90 weeks
Final body weight (g)	2068	1874	1974
Change in body weight (g/d)	1.12	0.21	-0.082
Feed Intake (g)	117.5	113.3	104.1
Hen day production (%)	89.18	97.42	79.52
Egg weight (g/egg)	62.3	57.9	60.5
Egg output (g/d)	55.5	56.4	47.9
FCR (g feed/g egg day)	2.12	2.01	2.56

Egg Output and Energy Intake

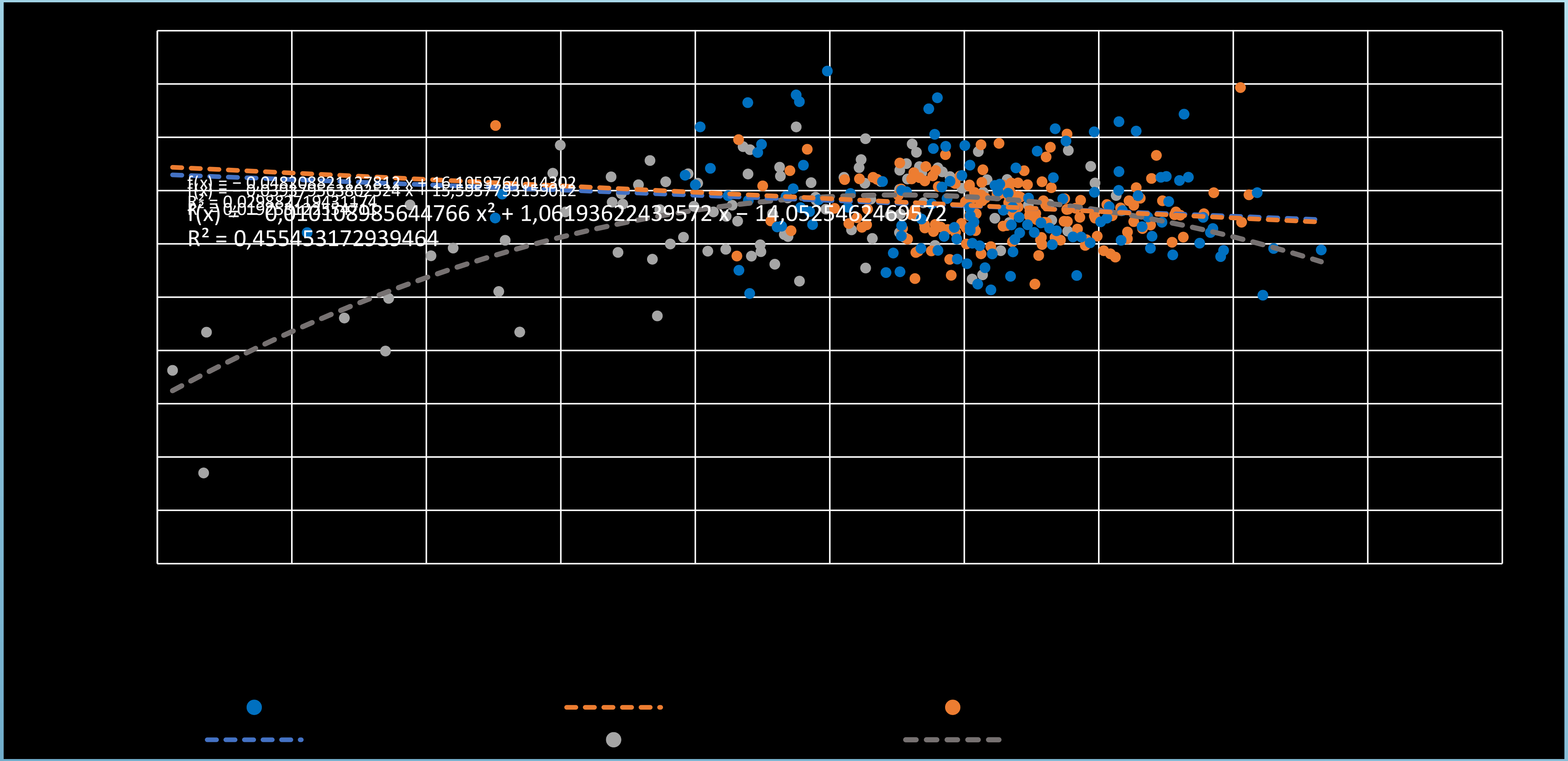


Dietary Energy Level, Intake and Egg Output



Orange – dietary energy level ($r^2 = 0.02$; $p = 0.06$)
Blue – ME intake ($r^2 = 0.78$; $p < 0.01$)

Energy Usage and Egg Output



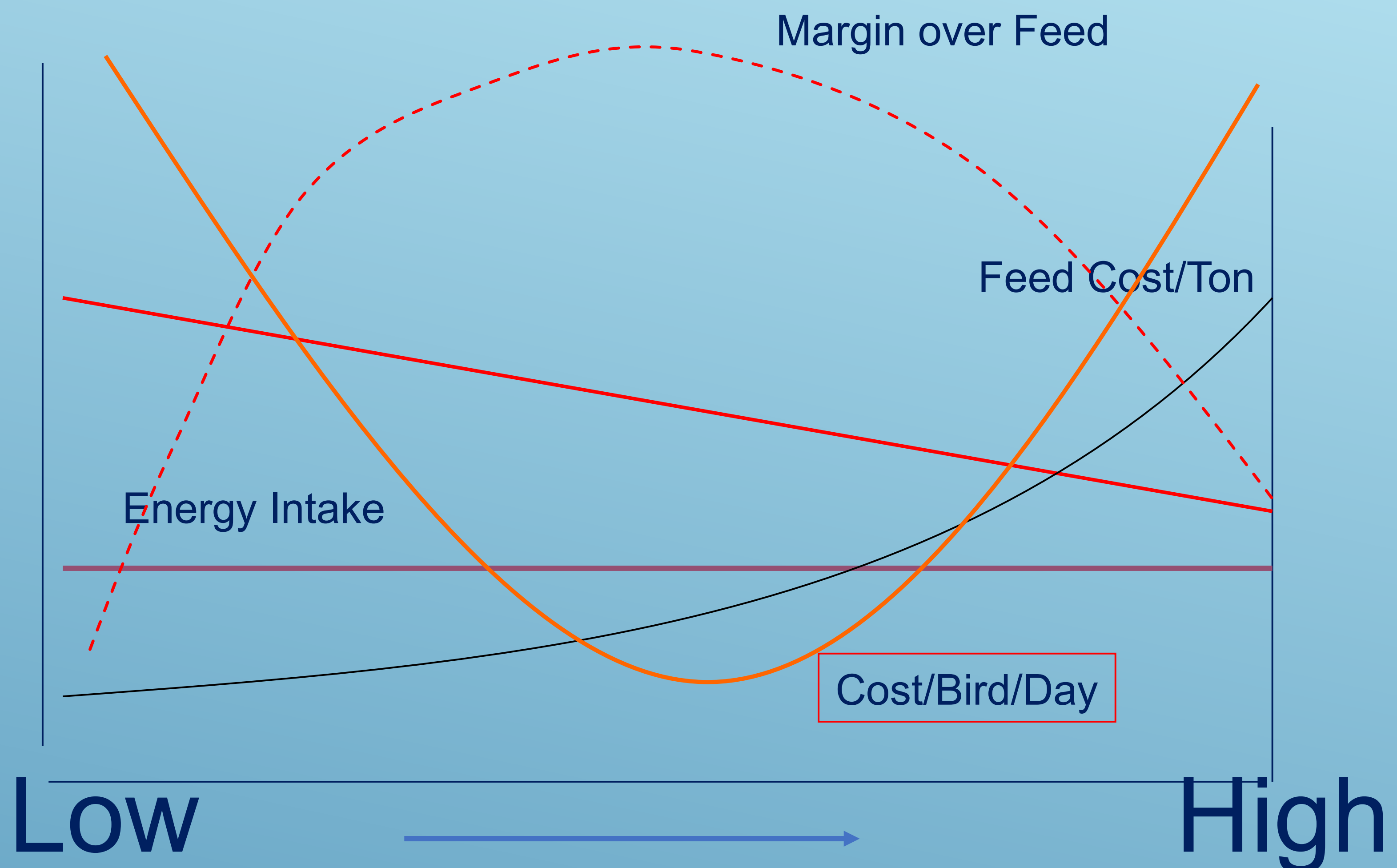
Energy

- Energy utilisation – unchanged with improved genotype.
- Birds adjust feed intake to meet requirements.
- Nutritionist decides on the ME level.
- Based on:
  - Cost & availability of ingredients.
  - Commercial considerations
- Housing system – (colony size and stocking density) influences energy requirement.

Energy

- Requirement for maintenance & production.
- Increases with size and reduced feathering.
- Predict ME intake - reasonable accuracy.
- Hens perform > 10 to <13 MJ/ME kg.
- Consume enough to meet ME requirement.

Energy Level in Layer Diets

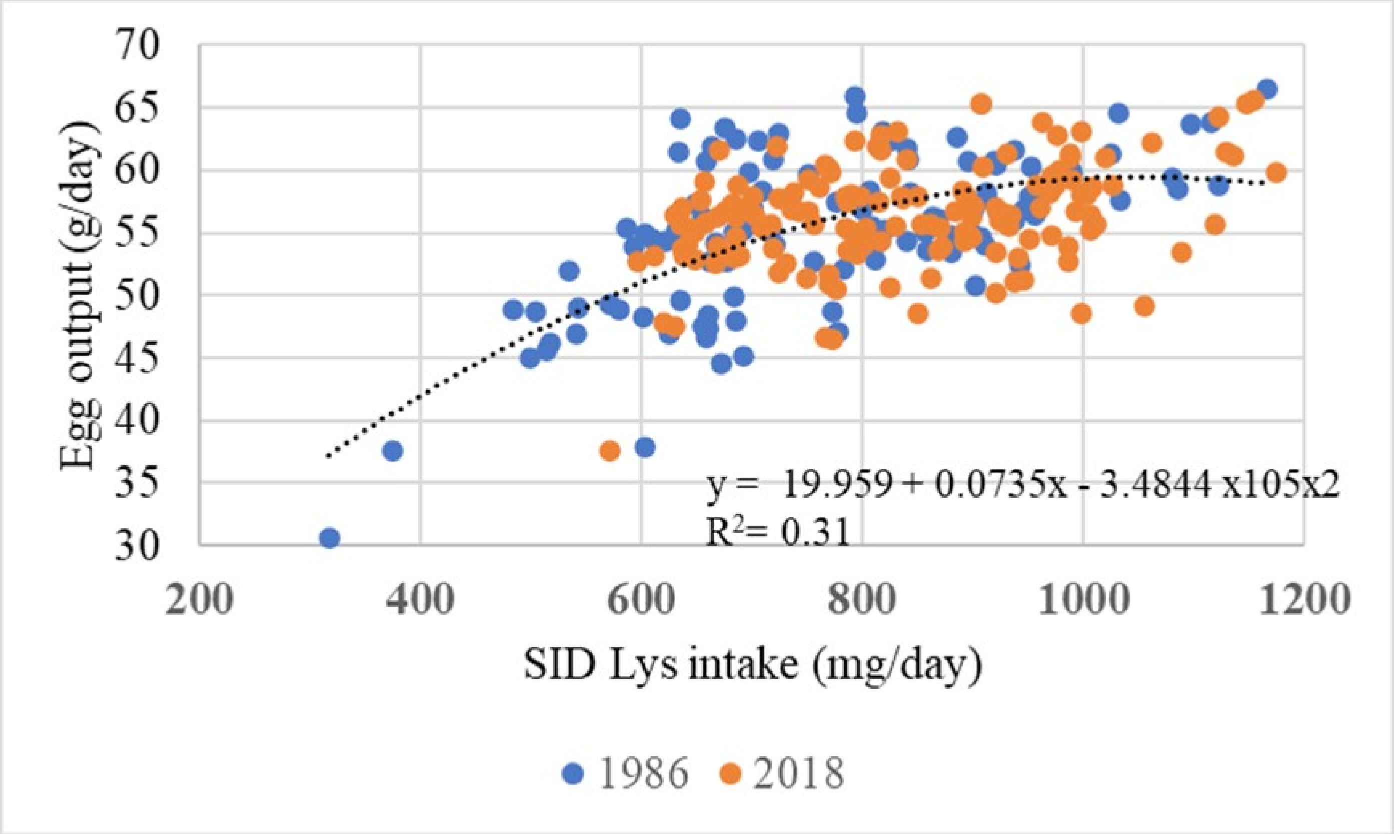


Protein and Amino Acids

Crude Protein and Amino Acids

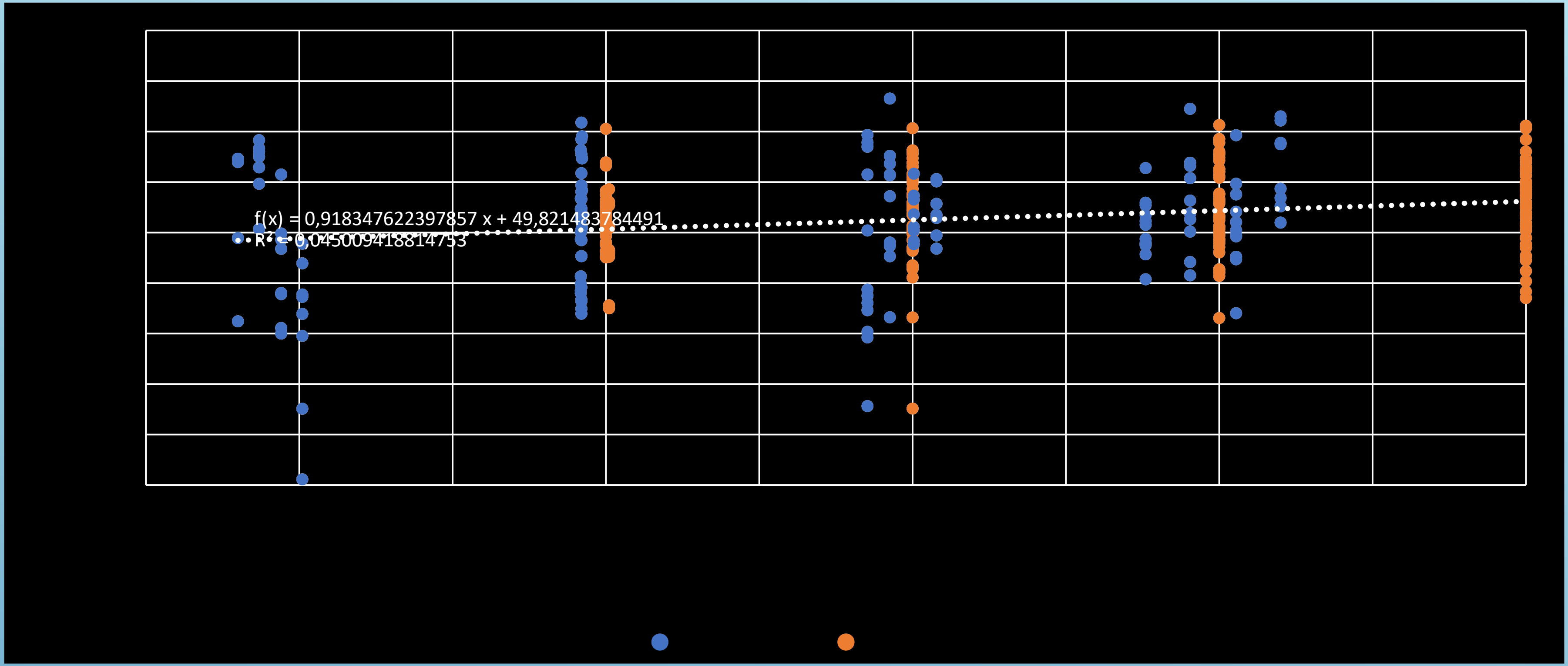
- If essential AA's are adequate, CP is irrelevant.
- Lysine and TSAA of particular concern.
- Birds respond to incremental doses of AA typically.

Egg output in response to lysine intake

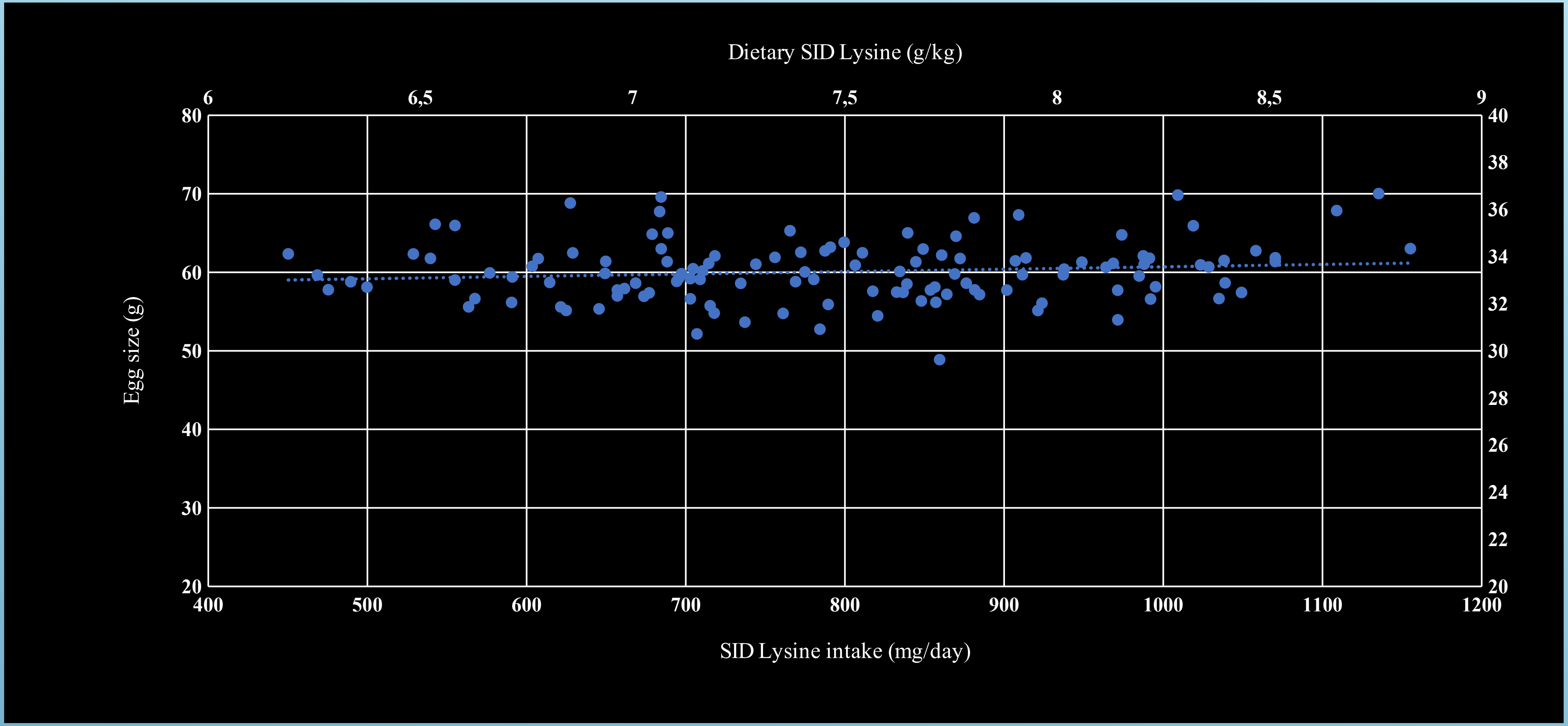


Hisex Brown excluded
Hy-Line Brown 27 to 30 weeks of age (2018)
Hy-Line Silver Brown 87 to 90 weeks of age (2019)
390 individual birds – 28 different diets

Egg Output and Dietary Lysine Level

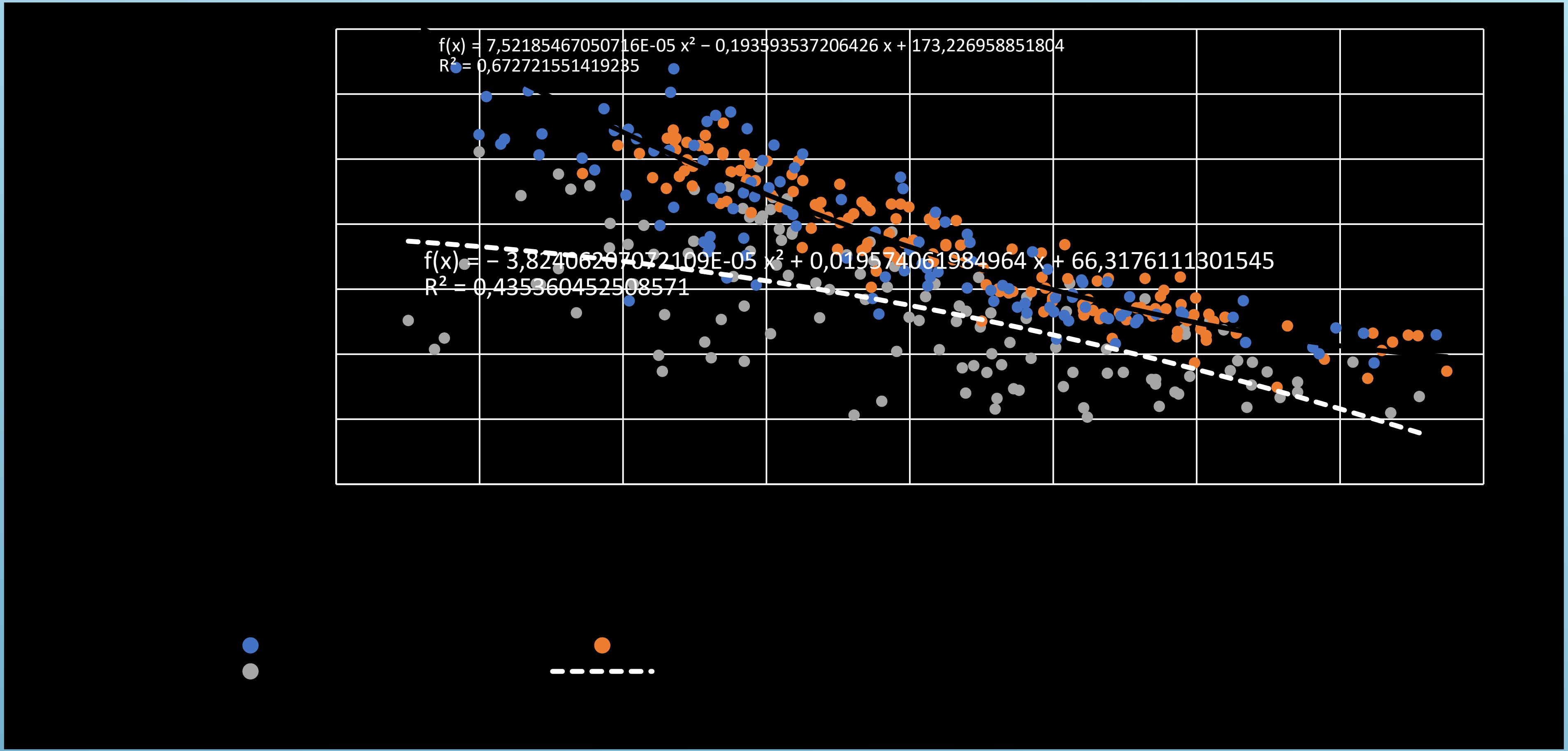


Dietary Lysine Level, Intake and Egg Size



Orange – dietary lysine level ($r^2 = 0.024; p = 0.59$)
Blue – lysine intake ($r^2 = 0.017; p = 0.14$)

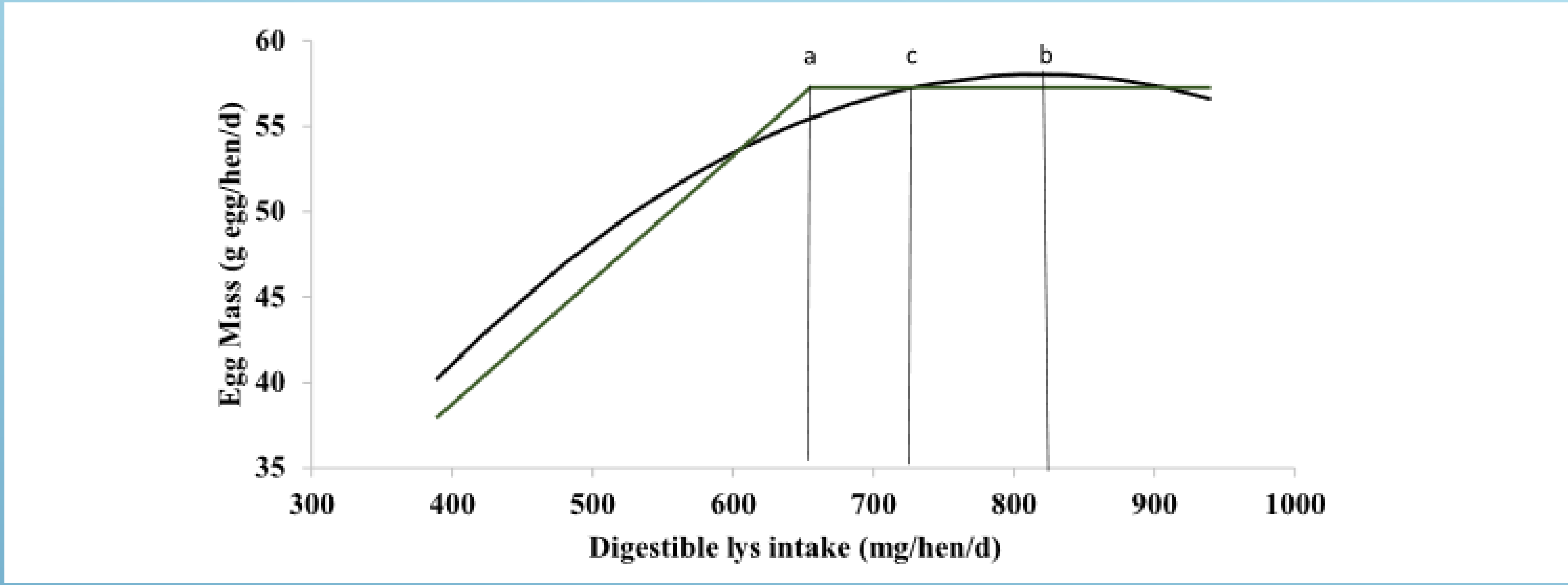
Efficiency of Lysine Use



Optimum Amino Acid Dose

- Mostly determined for Lysine.
- Then apply ideal protein profile.
- Translate into a feed specification.
- Published values – vary hugely.

Fit a Statistical Model to the Data



Spangler et al., 2019

Optimum Amino Acid Dose

Source	Year	Av Lysine
NRC	1994	740
Leeson	2003	680
Lemme	2009	810
Adisseo	2013	838
Brazilian	2017	710-840
CVB	2018	784
Spangler	2019	765
Kumar	2019	770-840
Elliot	2020	800
Maceline	2021	750

Broken Line Model for all 3 trials

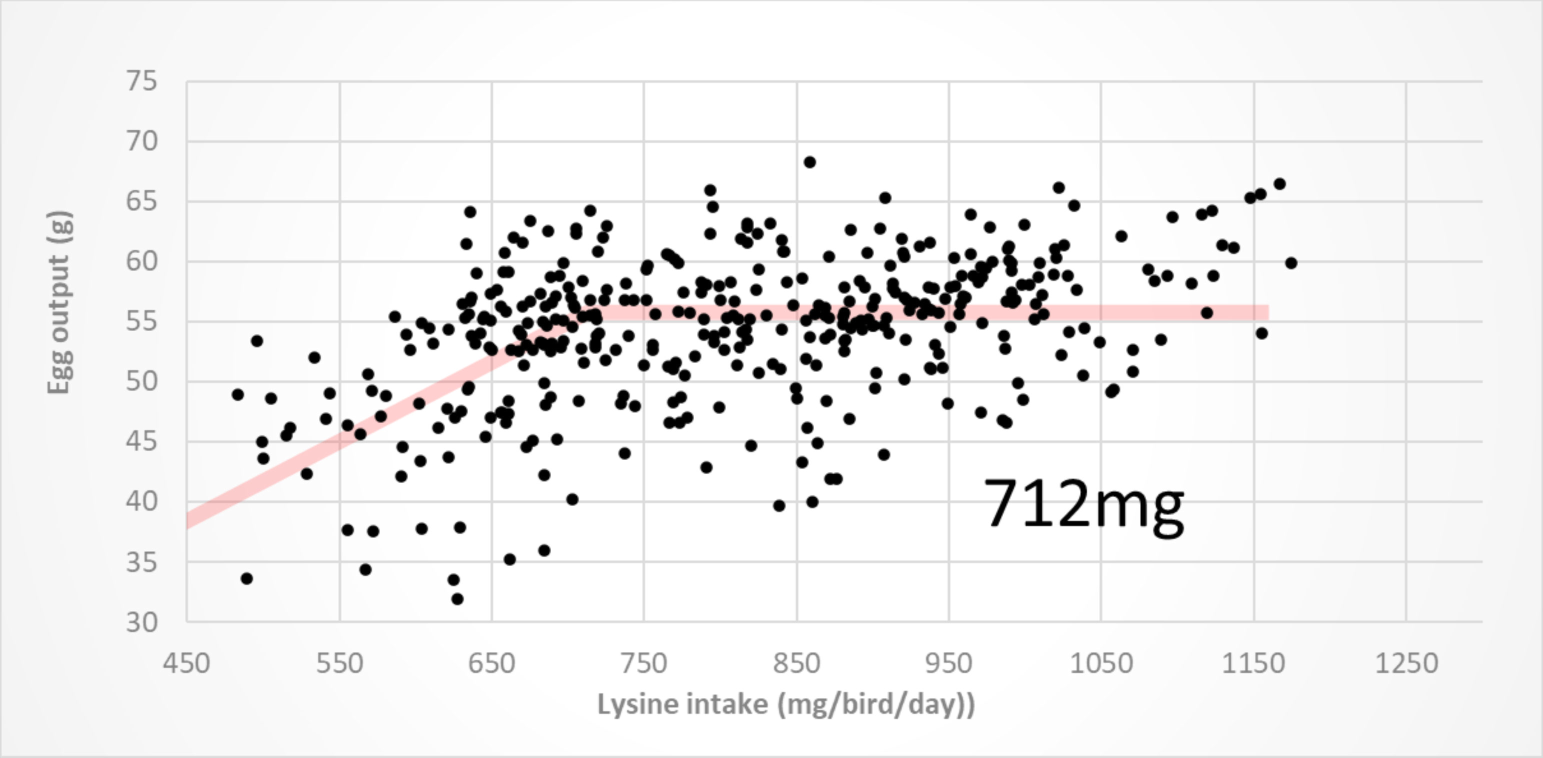


Figure produced by S Macelline, University of Sydney

Quadratic Model for all three trials

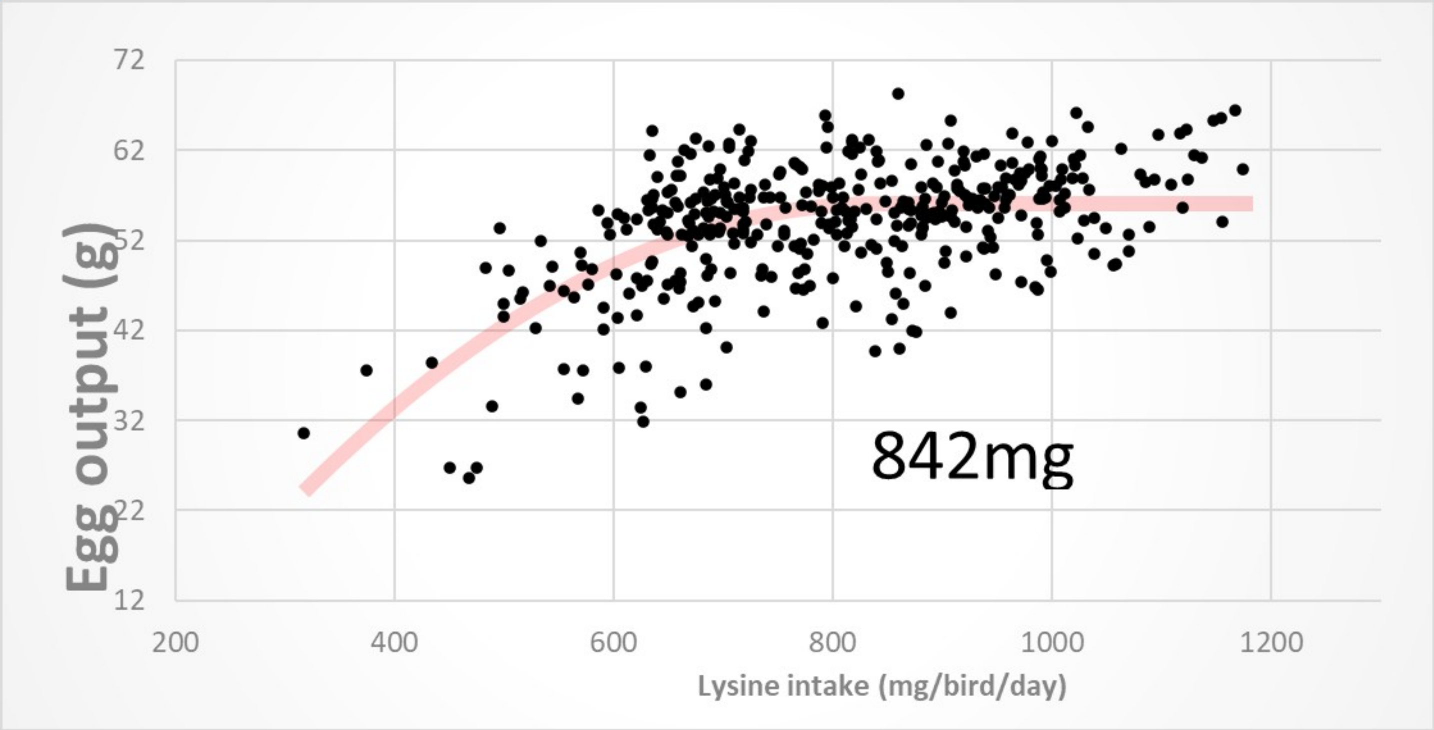


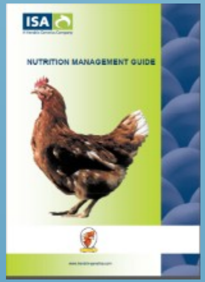
Figure produced by S Macelline, University of Sydney

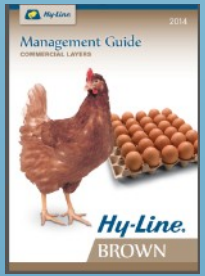
Ideal Amino Acid Profile

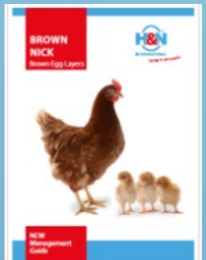
Source	CVB -2006	Lemme -2009	Brazilain (2017)	Elliot (2020)	Macelline (2021)
Av Lysine Requirement (mg/d)	700	810	710-840	800	750
Lys	100	100	100	100	100
Met	50	50	49	44	36
TSAA	93	91	90	82	86
Thr	66	70	79	71	67
Trp	19	21	23	19	21
Arg	-	104	100	107	101
Ile	79	80	76	75	73
Val	101	88	95		89

Primary Breeders

	Hendrix (2020)	Hy-Line (2022)	Lohmann (2019)	H&N Brown (2022)	H&N White (2022)
Feed Recommendation	28 to 50 weeks	90% prod	From 50% prod to 40 weeks	58 – 60 g/egg day	58 – 60 g/egg day
Crude Protein (g/d)	18.2	16.75	18.1	18.3	17.1
Avl Lysine (mg day)	810 (100)	830 (100)	810 (100)	830 (100)	800 (100)
Avl TSAA (mg/day)	693 (86)	730 (92)	660 (82)	747 (90)	720 (90)







H&N Lysine Requirements

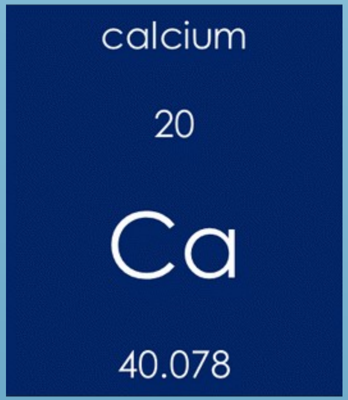
Egg output (g/day)	H&N Brown (2020	H&N White (2020)
Target: 58 – 60 g	830	800
Target: 55 – 57 g	800	770
Target: 52 – 55 g	770	740
Target: < 52 g	750	720

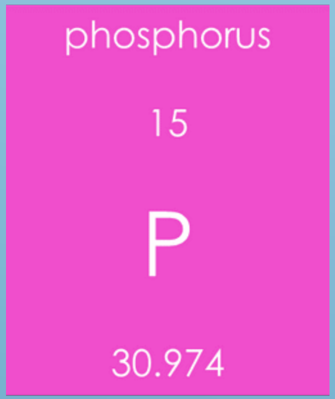
Interpretation the data

- Impossible to know who is correct.
- Modern hens is smaller and lays smaller egg.
- Lifetime performance may have increased.
- But - hens still lay an egg a day.
- Absolute protein requirements may have declined.
- Should always apply economic analyses.

Calcium and Phosphorus

- Essential in all phases of poultry production.
- A cycle exists!
- Skeletal integrity and shell quality are linked.
- Hens maintain shell quality at expense of bone.



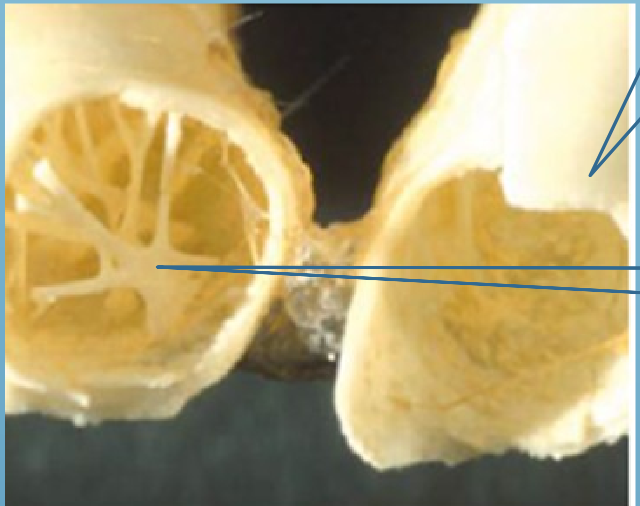


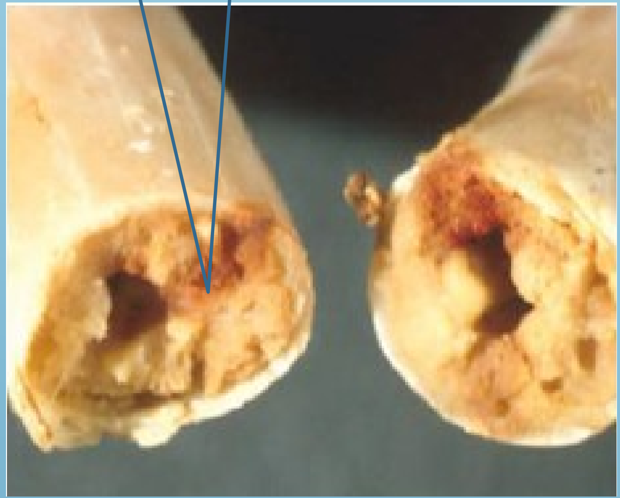
Calcium and Phosphorus

- Usually dealt with together.
- Share a metalloprotein transport mechanism.
- Modulated by Vit D
- > 90% of Ca and P in skeleton.
- Crystalline hydroxyapatite ($(Ca_{10}(PO_4)_6(OH)_2)$)

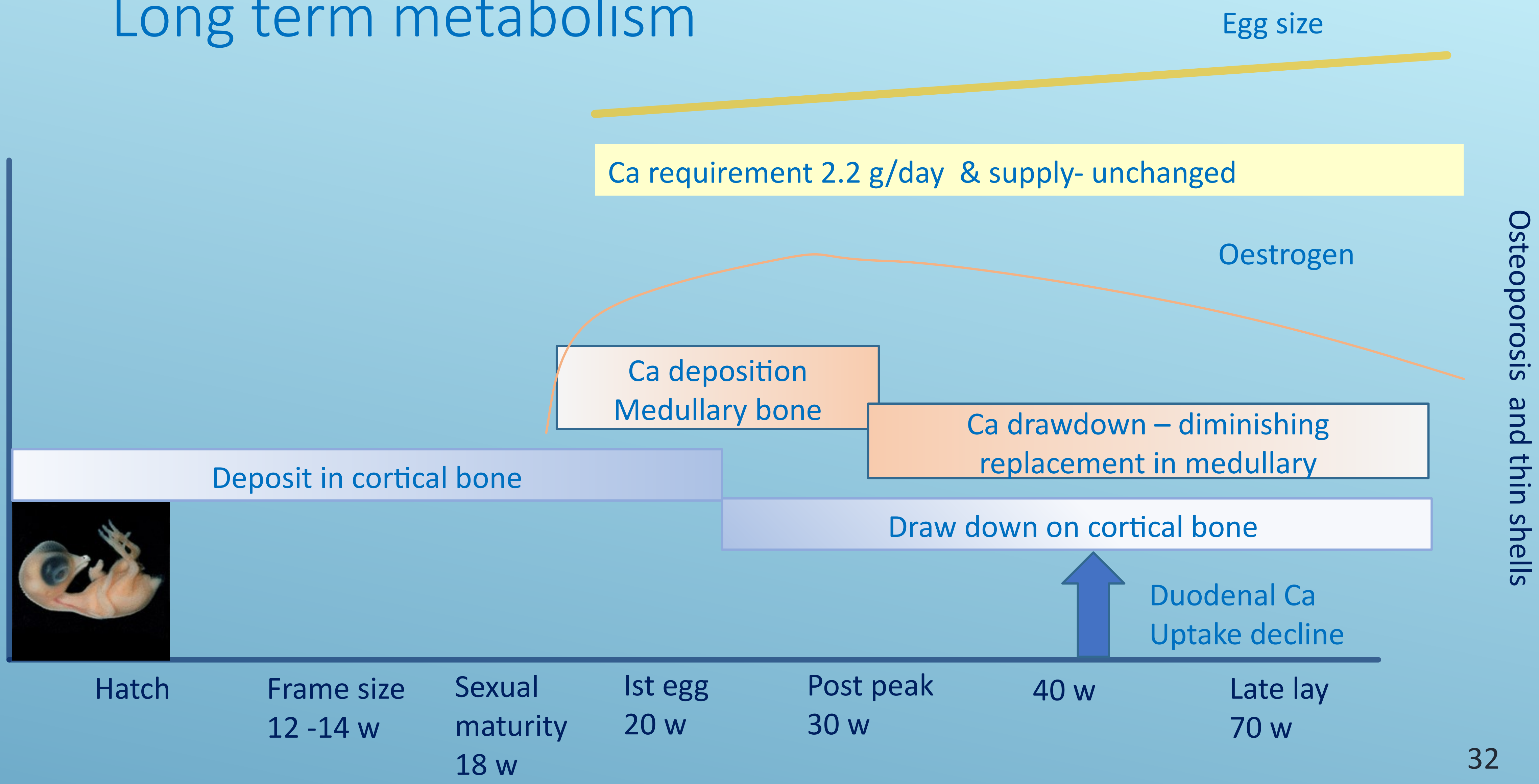
Bone

- Cortical, trabecular - strength-providing structural tissues
- Medullary bone - a labile store of Ca to support of eggshell formation.
- Medullary large surface - well vascularized.
- Metabolised 10 – 15 times faster than cortical bone



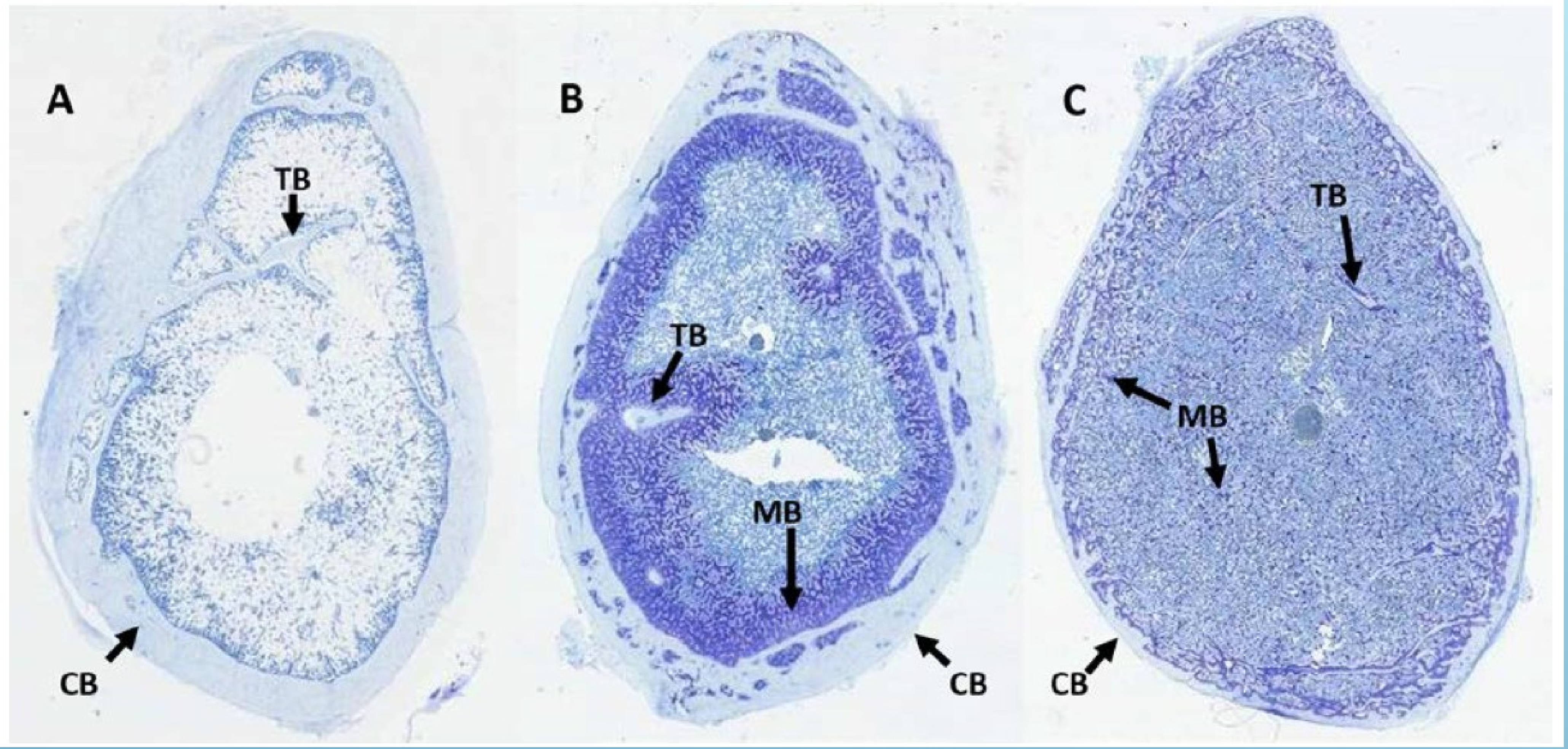


Long term metabolism



Layer bones

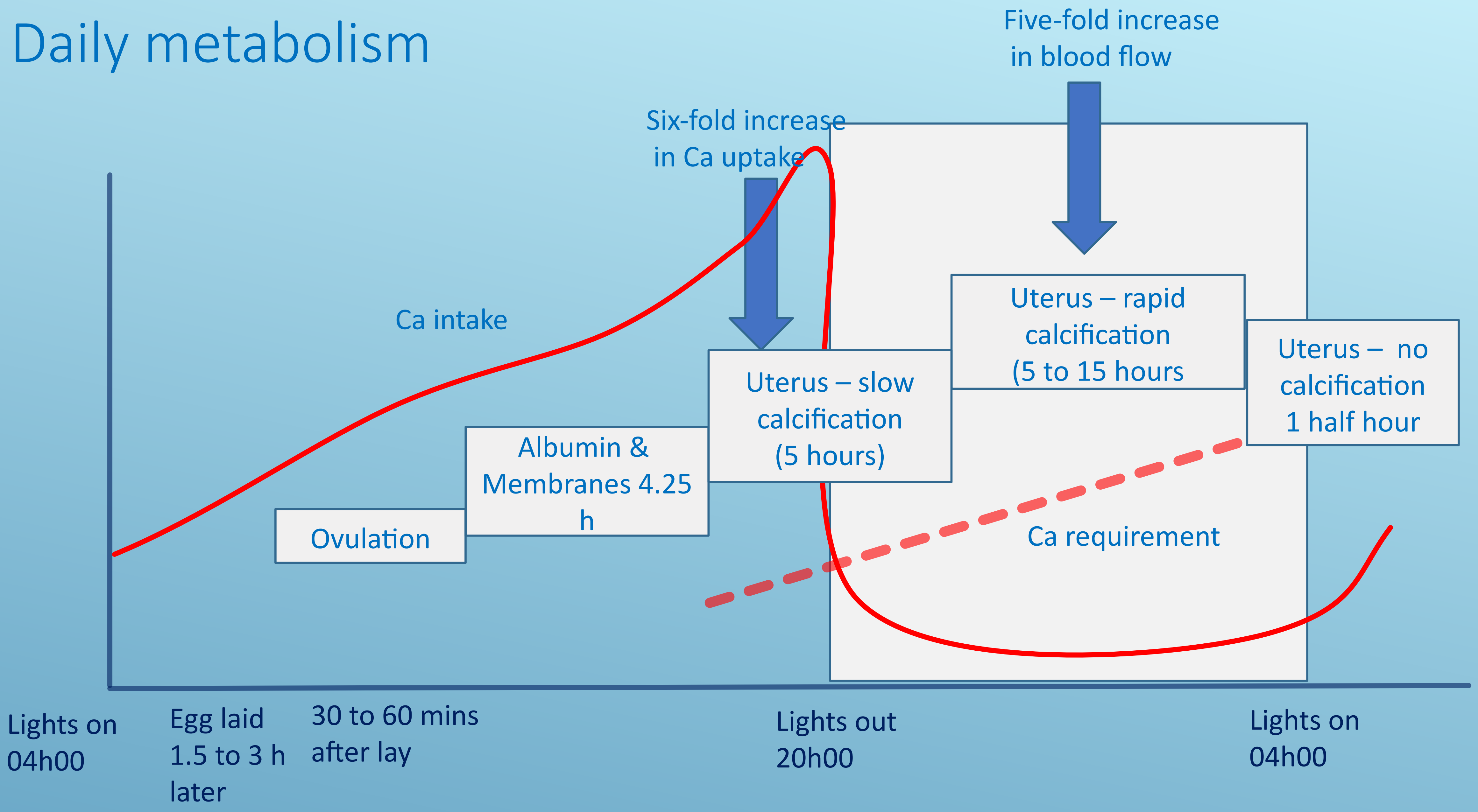
(Korver, 2020)



Pullet 16 weeks | After 1st egg | Hen 67 weeks

CB = cortical bone; TB= trabecular bone; MB = Medullary bone

Daily metabolism



What Happens on a **Daily** Basis.

Hen require 4 g Ca/day

2/3 of Ca - from feed

1/3 of Ca – skeletal
(at night)

Ca must be replenished (during daylight)

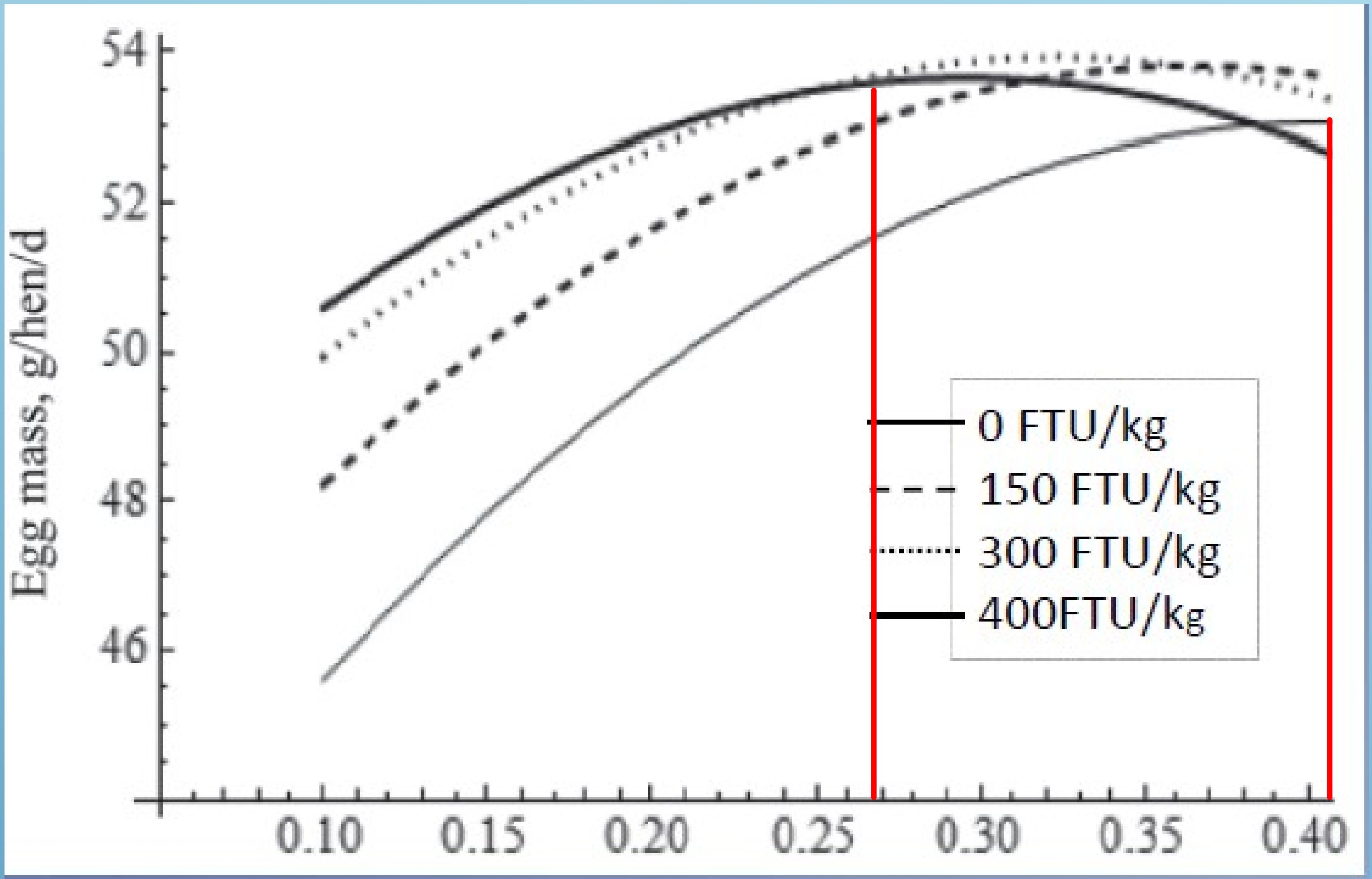
Egg contains 2.2 g Ca
Utilised with 50 - 60% efficiency

Calcium and Phosphorus – some numbers

- Hen has about 20 g of Ca in her body (1% of body mass)
- 4 – 5 g in medullary bone at point of lay.
- Each egg takes 5.5 g of $CaCO_3$
- This 2.2 to 2.3 g of Ca.
- By 80 weeks - will have deposited 2.1 kg of shell.
- Lifetime - hens up to 50 times more in shells than present in her own skeleton.

Phytase, NPP and Egg Output

(Ahmadi & Rodehutscord, 2012)



Calcium Sources

Calcium supply

- Regardless of Ca -must solubilised. Then absorbed.
- Lime has different solubility
- Determined by:
- Chemical structure
- Particle size

Limestone Source & Solubility

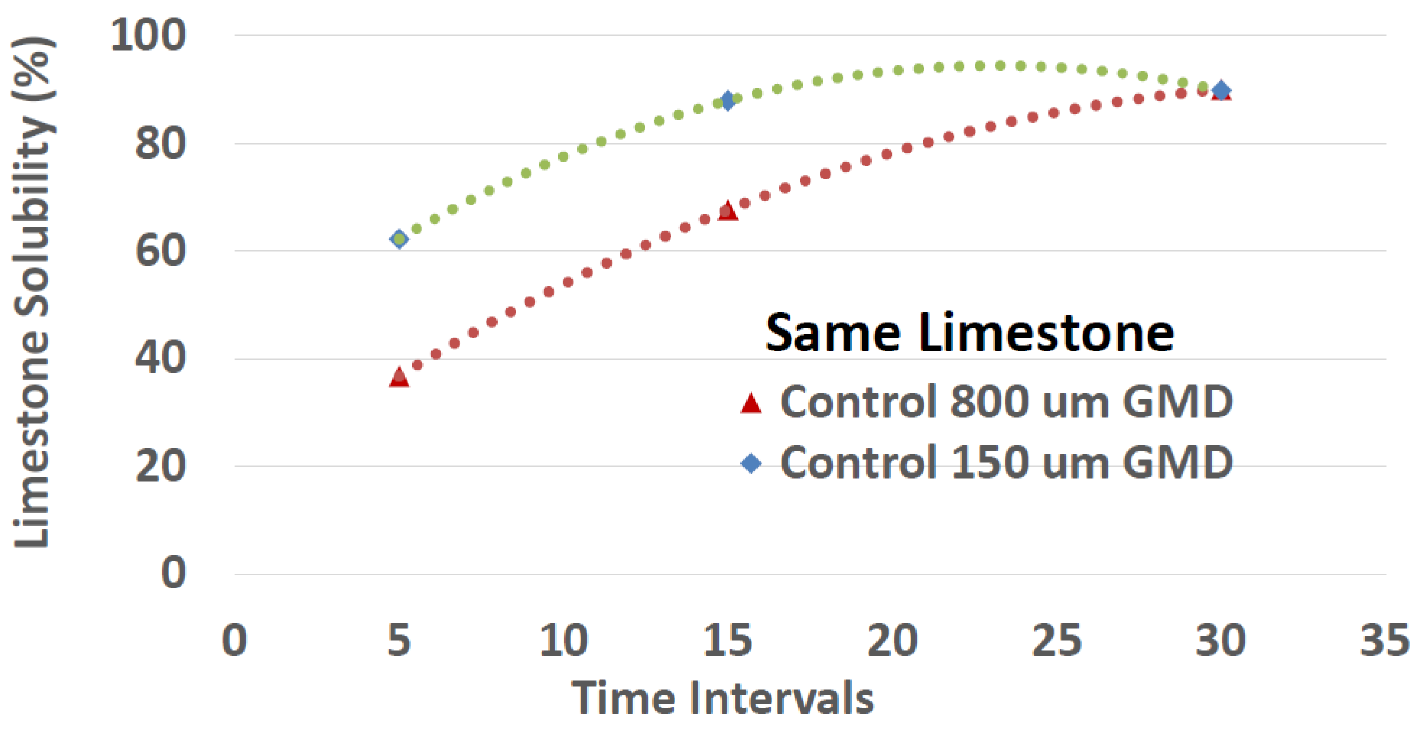
Zhang (1997)

Particle Size (mm)	Solubility (%)					
	In Vitro		*In Vivo*		Retention in Gizzard (g)	
	Low Sol	High Sol	Low Sol	High Sol	Low Sol	High Sol
3.3 – 4.7	29.8	36.3	84.8	82.5	15.4	3.4
2.0 – 2.8	45.8	54.8	79.0	84.0	11.8	4.3
1.0 – 2.0	49.3	57.7	77.8	74.4	5.5	4.7
0.5 – 0.8	63.1	67.6	76.5	69.4	0.7	1.6

Limestone, solubility and uptake

(Slides curtesy of Peter Plumstead)

When limestone has similar geology, smaller particles will solubilize faster – bigger surface area



GMD = Geometric mean diameter

DuPont limestone survey 2019

Requirements

- Require 4 to 4.5 g Ca per day.
- Less than 3.2 g – shell problems (Härtel, 1990).
- Surplus P – inhibits Ca uptake.
- Little evidence that high levels boost shell quality.
- Surplus Ca – may reduce bone and eggshell quality. (Akbari et al., 2019).
- Need to revaluate requirements in the light of phytase use (Bello 2019).
- Variable Ca levels – general malaise of flocks.

H&N Recomendations

	Before peak	Peak to 45 weeks	45 – 70 weeks	> 70 weeks
Ca (g/bird/day)	3.80	4.00	4.30	4.50
Phosphorus* (mg/bird/day)	600	540	480	430
Av. Phosphorus (mg/bird/day)	420	380	340	300
Dig. Phosphorus (mg/bird/day)	360	325	290	255

Levels can be changed based on the use and the levels of phytase

Recommendations

- We require increase Ca in dark phase.
- Avoid fine powder if possible.
- Less soluble source – always preferable.
- At “light-on” – access to powdered calcium reaches shell gland in 30 minutes.
- Many birds have finished depositing shell by then
- 60% grit and 40% powder – best results.
- Use all grit in preference to all powder.

Practical Feeding

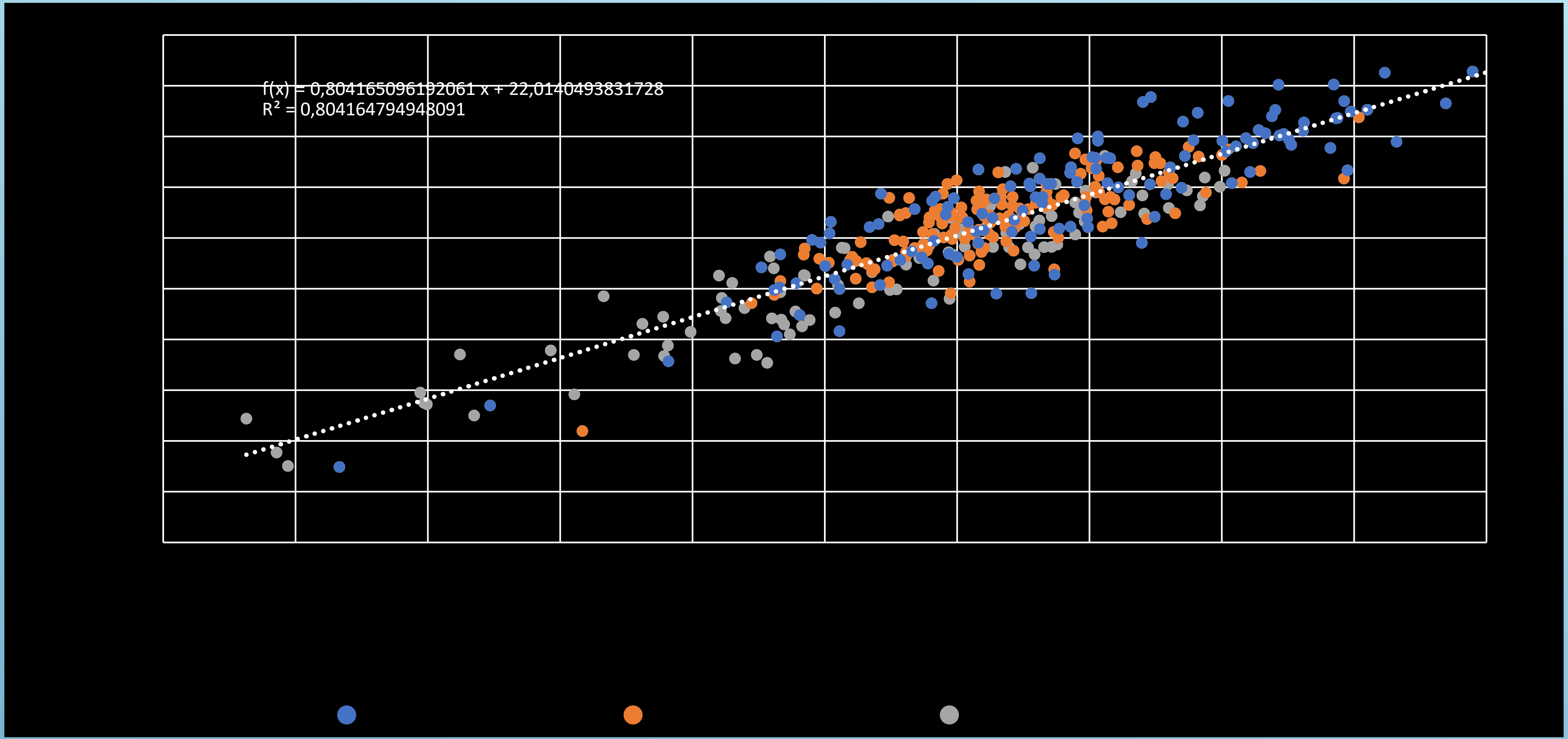
Practical Feeding

- Governed by the feed intake:
  - Must know current intake
  - Or calculate expected intake
- Ideally, nutritionist determines feed intake.
- Must match diets to intakes (age)

Practical Feeding

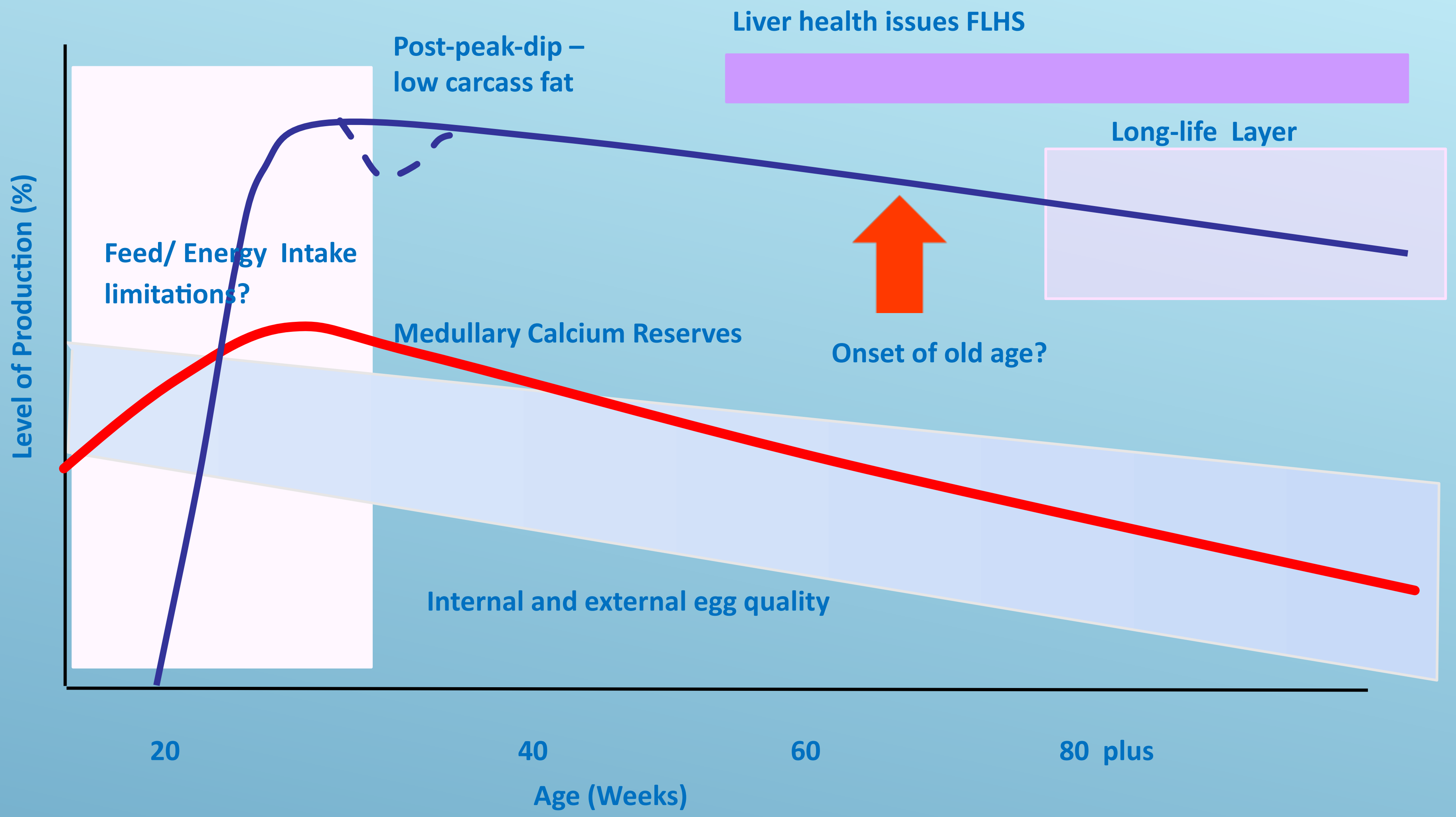
- 4 main drivers of intake
  - Size of the bird (age).
  - Egg output.
  - Season.
  - The diet itself (Protein and Energy).
- In theory - farm specific

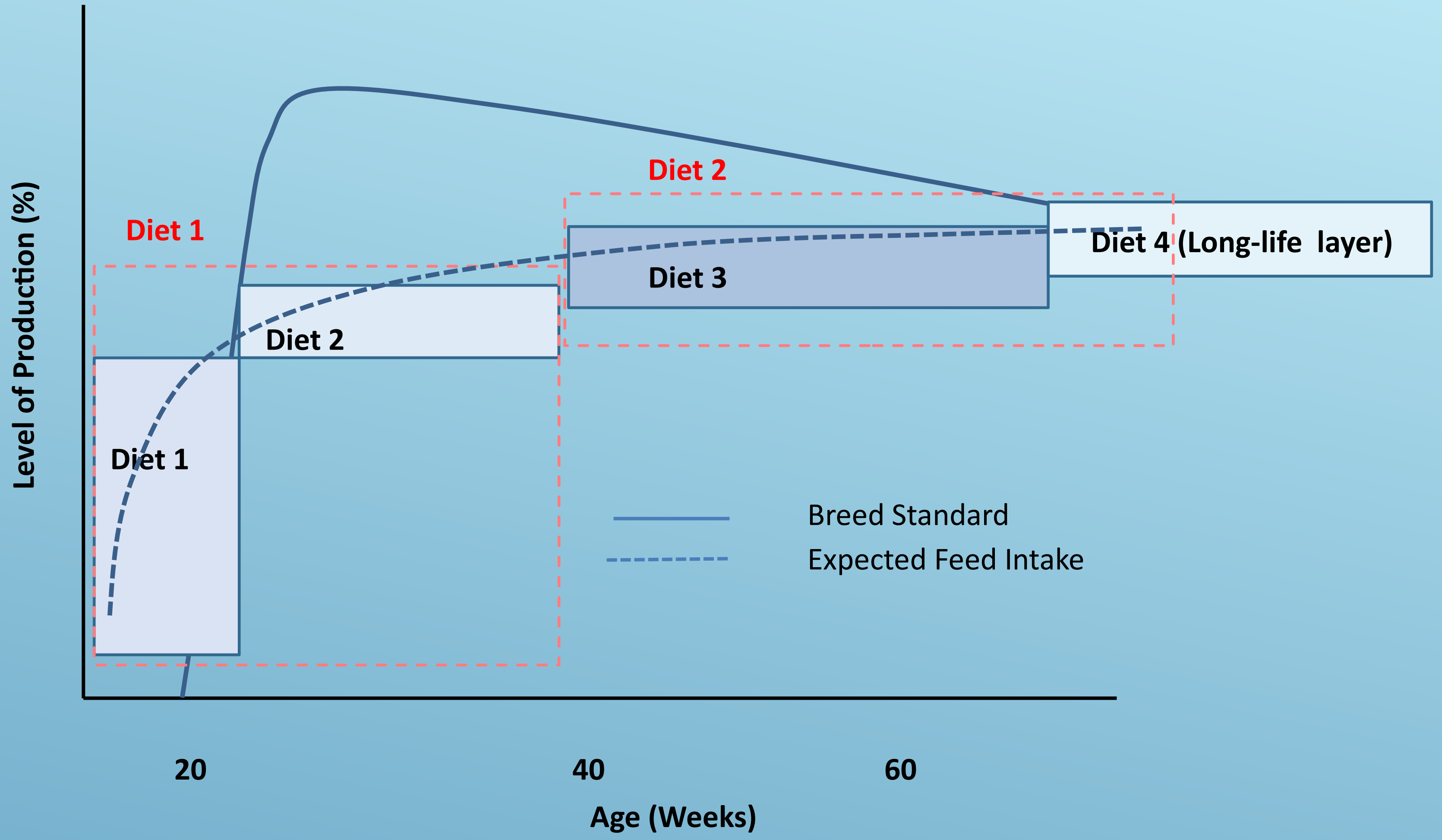
Feed Intake Model



Feed intake (g/day) = 80.042 + Body weight (kg) x 22.402 + Egg output (g/d) x 1.314 - SID Lys (g/kg) x 1.042 - Energy (MJ/kg) x 6.462 (R^2 = 0.802)

Practical Implications of Genetic Improvement




Level of Production (%)
Diet 1
Diet 2
Diet 1
Diet 2
Diet 3
Diet 4 (Long-life layer)
Breed Standard
Expected Feed Intake
20
40
60
Age (Weeks)

Practical Feeding: Pre-peak

- Point of lay management critical.
- Management strategies:
  - Crumbled diet
  - Feed depth
  - Run lines often
  - Consume more in afternoon.
  - Midnight feeding.

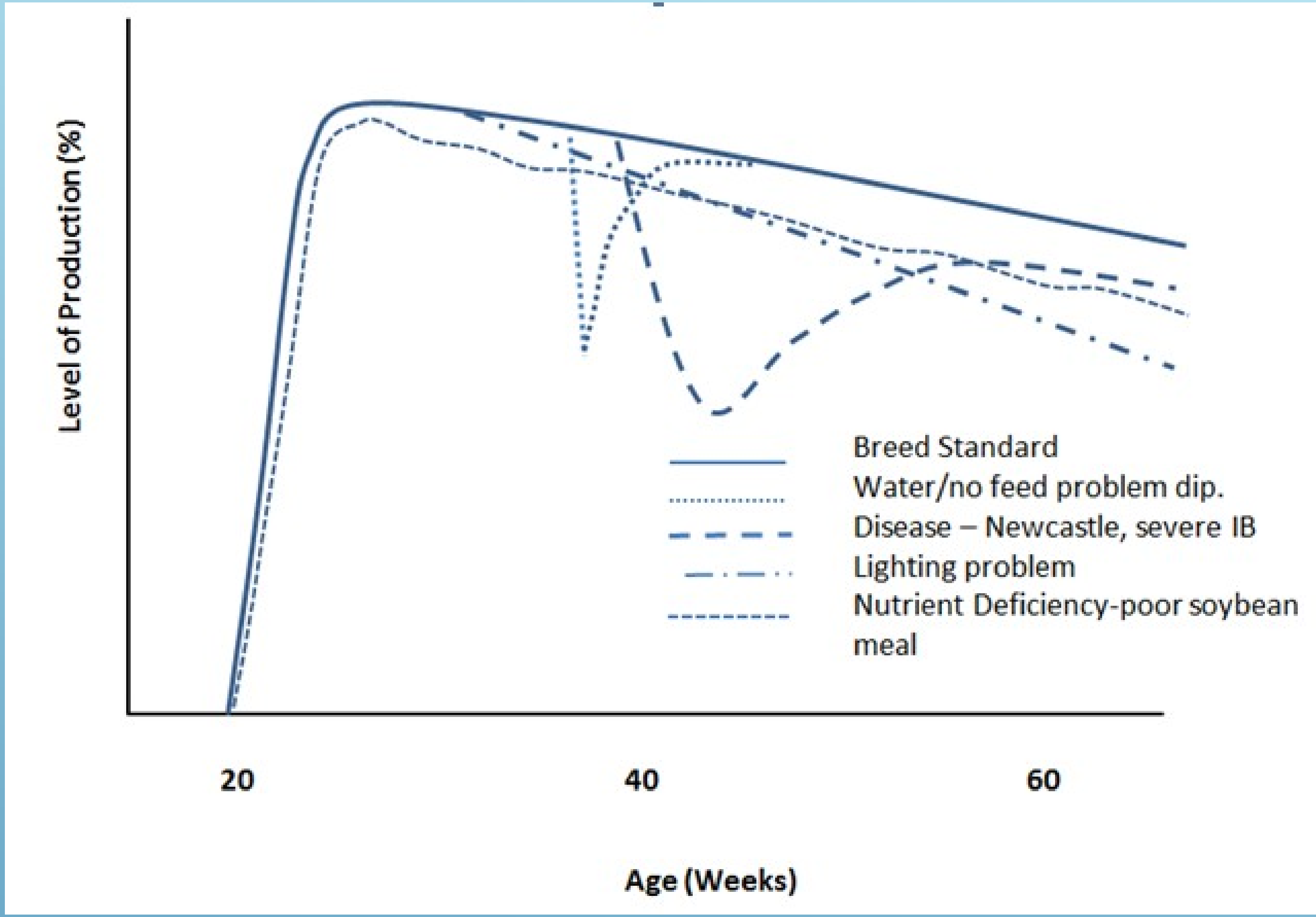
Practical Feeding: Post-peak

- Feed intake dependant.
- Have capacity to consume enough feed.
- Determining AA requirement - difficult.
- Experience – Avail Lys intake of 720 mg/day is adequate.
- Beware of large eggs in late lay.

Late Lay

- By 90 weeks: bird will produce 25.7 kg egg - 8.6 kg is yolk and 3.3 kg is eggshell.
- 55 weeks and older
  - Oviduct must remain viable.
  - Oestrogen & progesterone: hypothalamus.
  - Less efficient with age.
  - Egg quality deteriorates.
  - Selection will improve this.

Laying Problems



Ending Off

- Few advances in layer nutrition.
- Nutrient requirements may have declined.
- But – feeding patterns have changed.
- No single – “ideal” specification.
- Know how your hens respond to your diets

Don’t worry – even if you don’t know what to do, the hen does.

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