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PROGRESS

# Feeding the Modern Broiler Chicken for Sustainable Production

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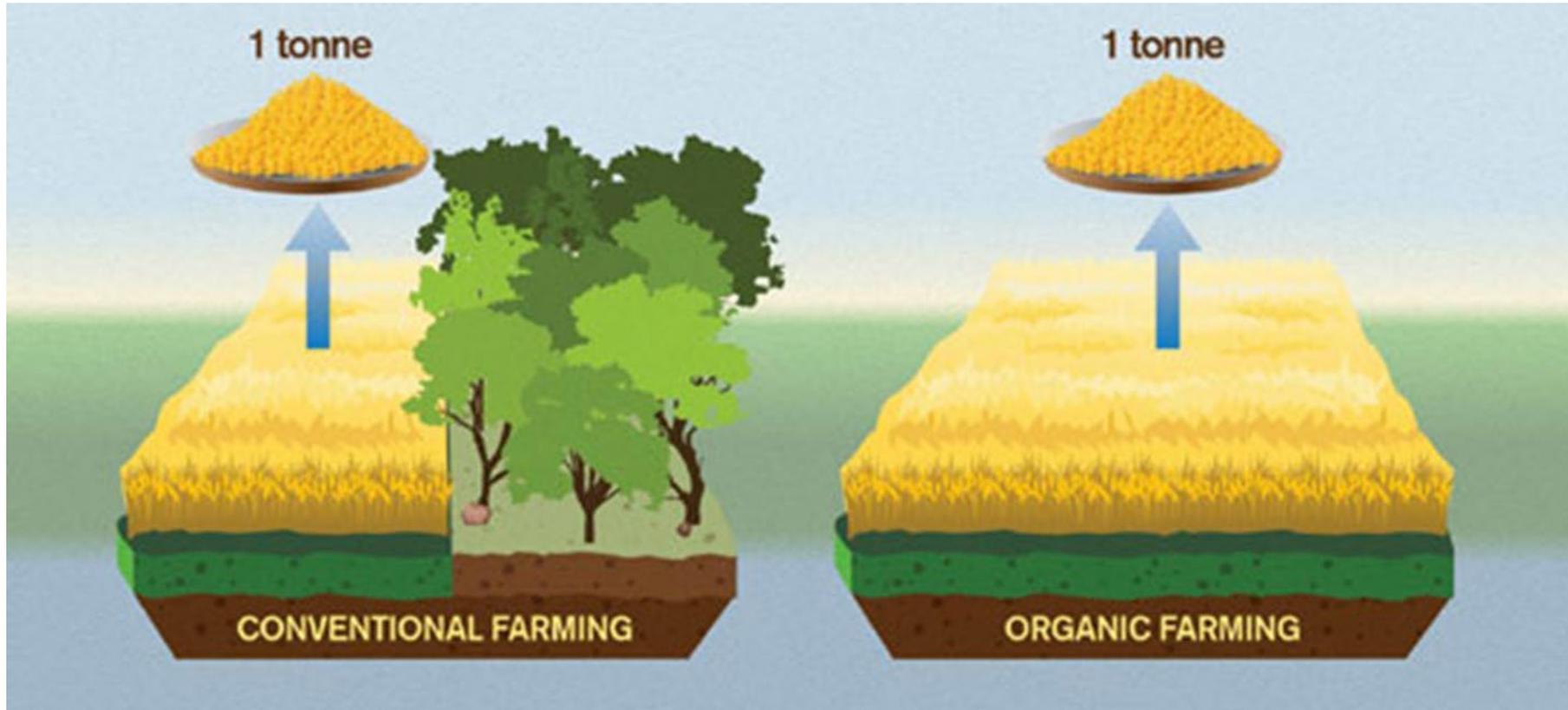
South Africa

# Customer demands exert pressure on producers

- Huge increase in demand for broiler products by 2050
- High protein & energy environmental demands
- Challenge: to meet demand sustainably
- Consumer preferences are changing
- Mention 'sustainable' - think 'organic'.



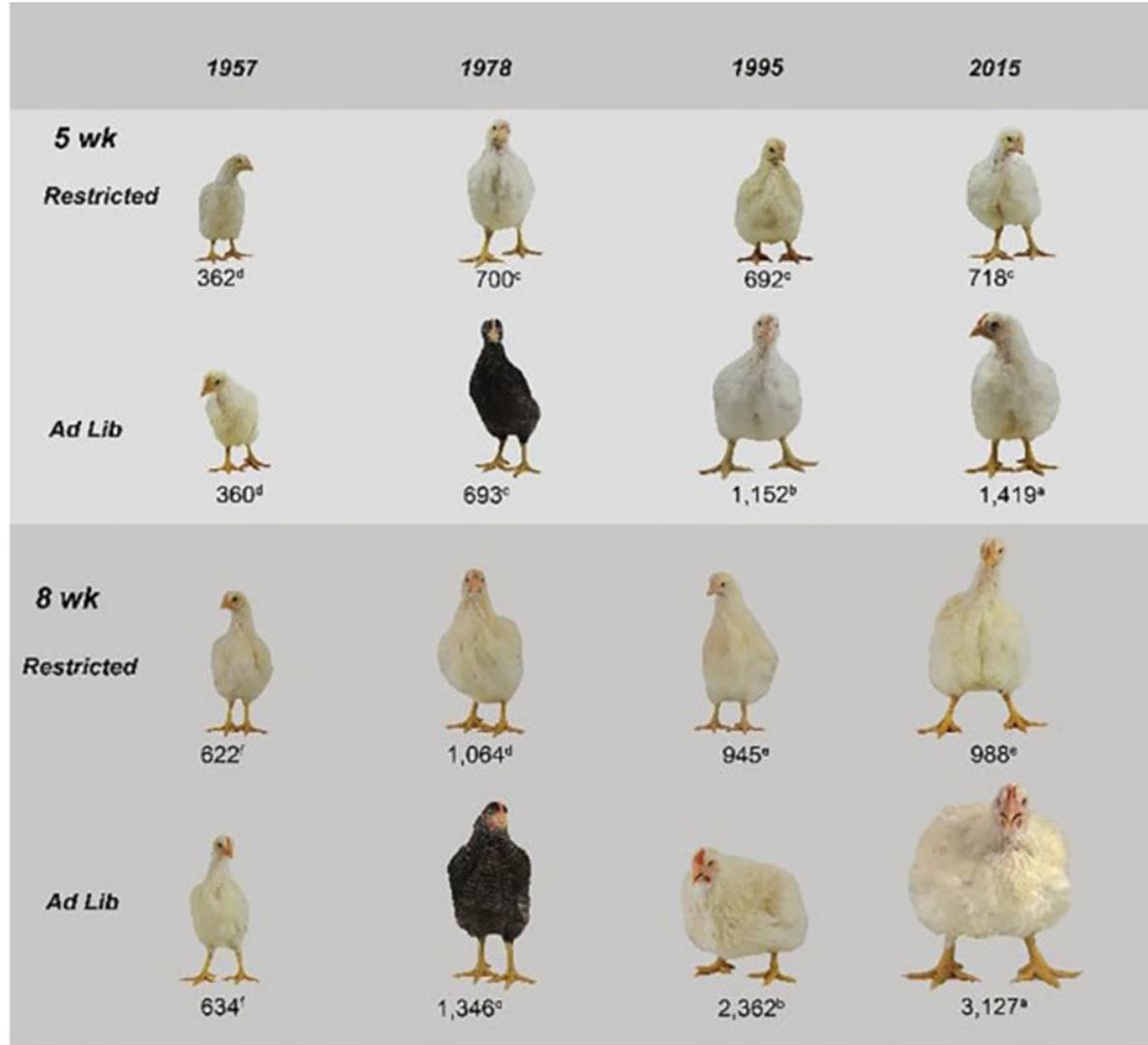
# Organic chickens – eat organic crops



# Poultry – Life Cycle Assessment

Impacts and resources used per ton.	Broiler (per edible ton produced)		
	Housed	Free range	Organic
Primary energy used (GJ)	16	16.7	18.5
Global Warming potential (t CO <sub>2</sub> e)	2.6	3.0	3.9
Eutrophication potential (kg PO <sub>4</sub> equivalent)	20	25	43
Acidification potential (kg SO <sub>2</sub> equivalent)	37	46	63
Pesticides Used (dose Ha)	3	3.7	0.3
Land occupation (Ha)	0.61	0.76	1.4

# Broiler genotypes improved

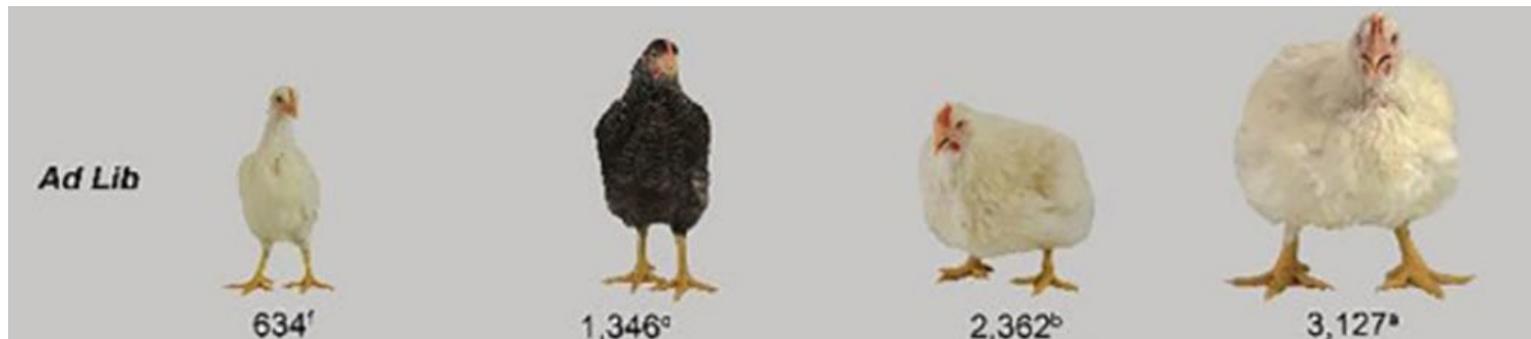


# Nutrient demand is related to genotype

- **In broad terms birds:**

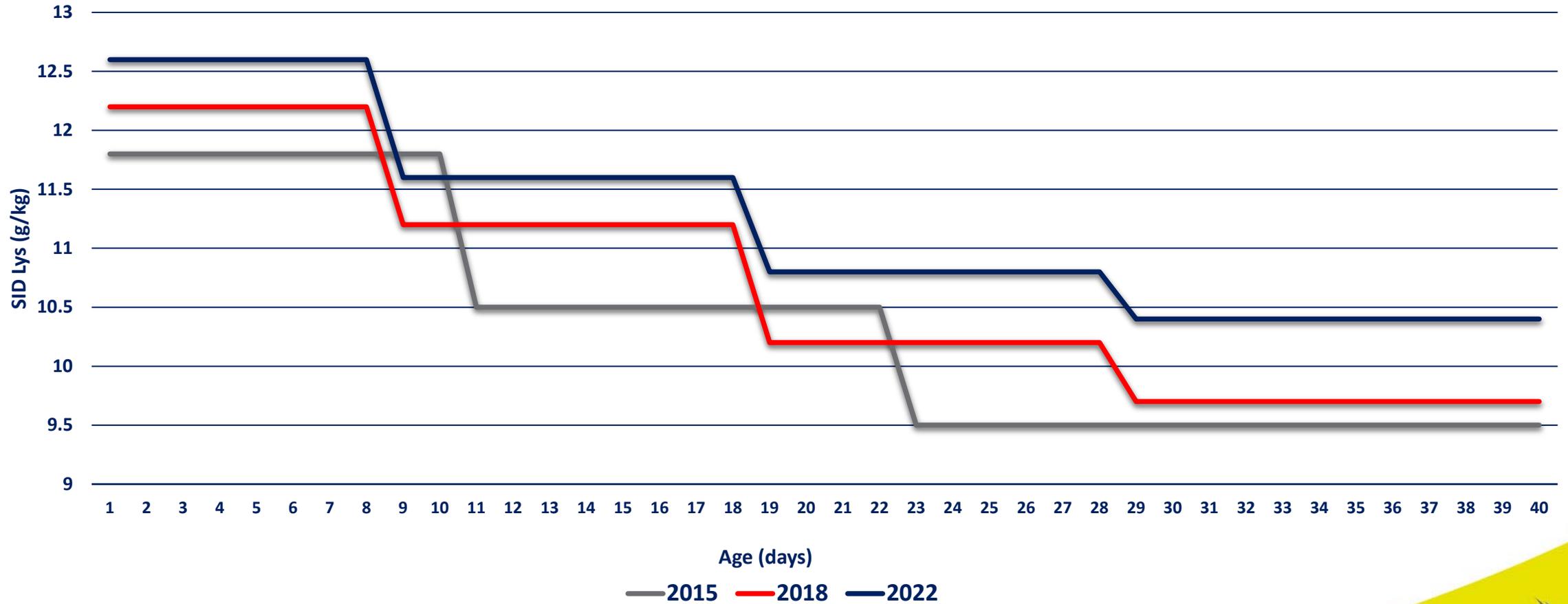
- Gut: reduced relative to mass of bird.
- Digestive efficiency unchanged. (Lopez et al, 2005; Tallentire et al., 2016)
- Less energy (faster growth, reduced maintenance).
- Require more protein (faster relative growth, breasts).
- Increased innate immunity (inflammation) - nutrient hungry (Cheema et al., 2003).

- **Primary breeder recommendations reflect this.**



# New Genotypes have higher requirements

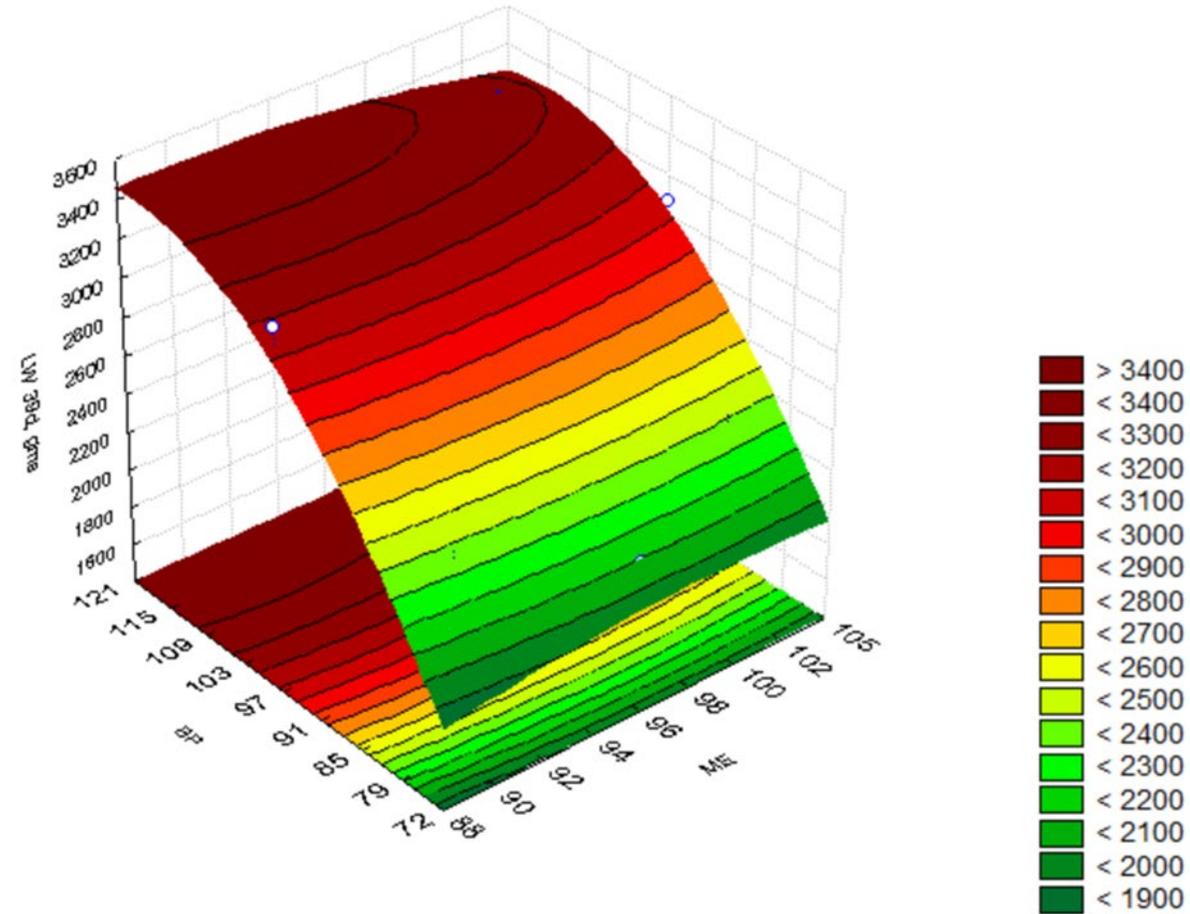
(Cobb, 2015, 2018, 2022)



# Protein and energy in the diet influence performance

	Body Weight (g)	Feed Intake (g/d)	FCR	SID Lys Intake (mg/d)	AME Intake (kj/d)	Carcass in % of BW	Breast in % of BW
<b>TME<sub>n</sub> (MJ/kg)</b>							
<b>2875</b>	2375 <sup>ab</sup>	177.3 <sup>a</sup>	1.69 <sup>a</sup>	-	1979	64.98 <sup>b</sup>	18.31 <sup>a</sup>
<b>3000</b>	2393 <sup>a</sup>	170.7 <sup>b</sup>	1.61 <sup>b</sup>	-	2010	66.10 <sup>a</sup>	18.20 <sup>a</sup>
<b>3125</b>	2355 <sup>ab</sup>	162.7 <sup>c</sup>	1.57 <sup>c</sup>	-	2167	65.63 <sup>a</sup>	17.88 <sup>ab</sup>
<b>3250</b>	2323 <sup>b</sup>	157.0 <sup>d</sup>	1.54 <sup>d</sup>	-	1990	65.47 <sup>ab</sup>	17.49 <sup>b</sup>
<b>SID Lysine (g/kg)</b>							
<b>8.5</b>	2205 <sup>b</sup>	162.2 <sup>b</sup>	1.71 <sup>a</sup>	1378	-	64.56 <sup>c</sup>	16.39 <sup>c</sup>
<b>10</b>	2420 <sup>a</sup>	170.0 <sup>a</sup>	1.57 <sup>b</sup>	1700	-	65.64 <sup>b</sup>	18.43 <sup>b</sup>
<b>11.5</b>	2459 <sup>a</sup>	168.0 <sup>a</sup>	1.52 <sup>c</sup>	1932	-	66.45 <sup>a</sup>	19.09 <sup>a</sup>

# Three dimensional: protein vs. energy

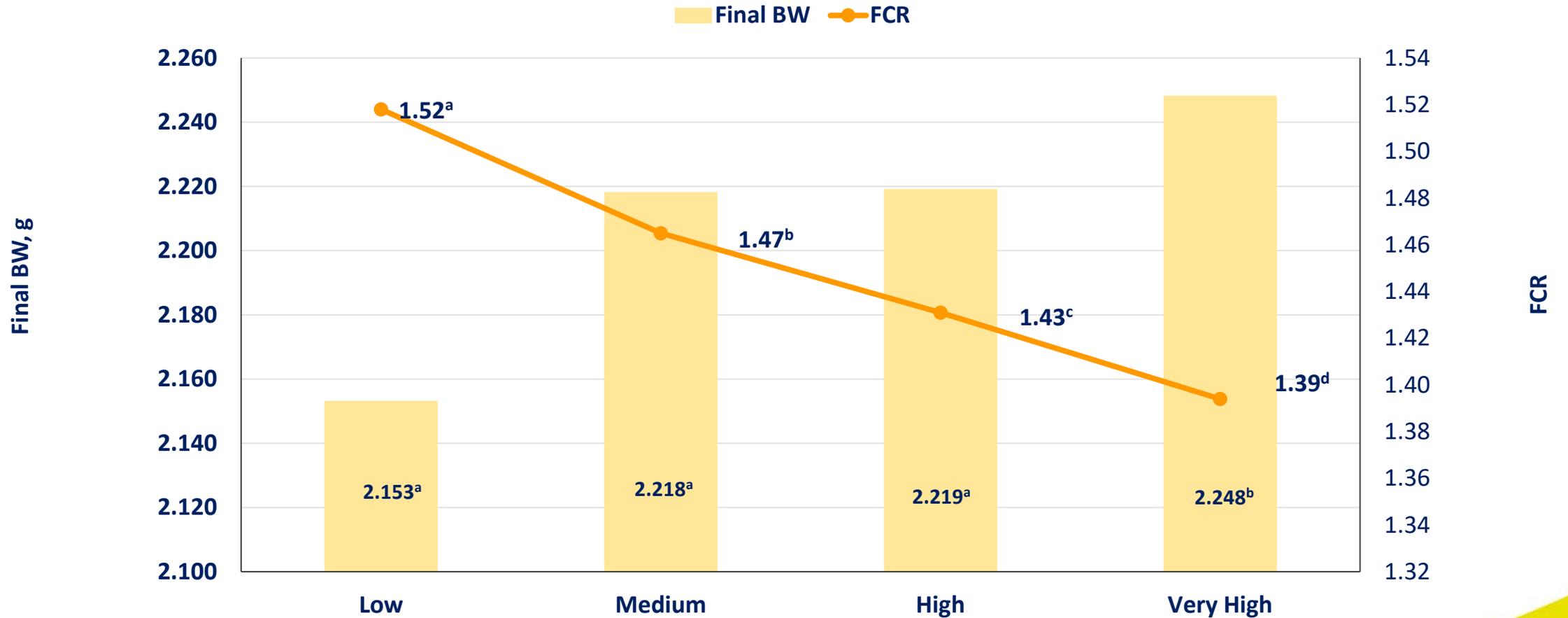


# Cobb 500 response to AA to 35 d

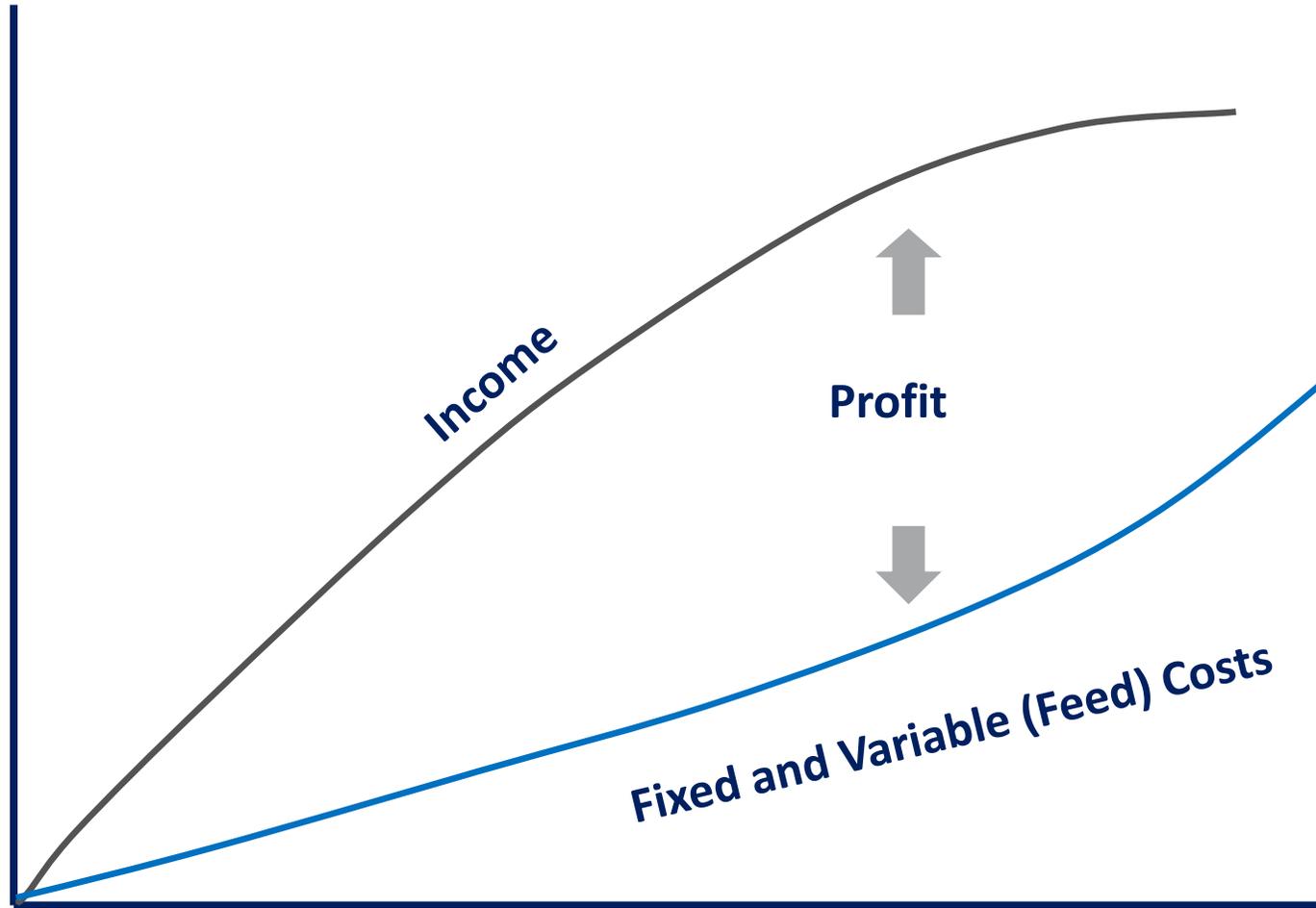
Phases (days fed)	AA density (Dig. Lys g/kg)				ME kcal/kg	Cobb Recommendations (2018)	
	Low	Med <sup>1</sup>	High	Very High		Dig Lys (g/kg)	ME (Kcal/kg)
	91%	100%	109%	119%			
<b>Starter (0 – 11)</b>	10.8	11.8	12.8	13.9	3025	12.2	2975
<b>Grower (12 – 28)</b>	9.5	10.5	11.5	12.6	3075	11.2	3025
<b>Finisher (29 – 35)</b>	8.7	9.5	10.3	11.2	3125	10.2	3100

As hatched Cobb MV X Cobb 500  
 Medium density – Cobb (2015) recommendation

# Cobb response to AA to 35 d



# Economic sustainability



# Energy and profit

Dietary Energy Level <sup>1</sup>	2875	3000	3125	3250
Body Weight	2375	2393	2355	2323
Feed Cost (\$/ton)	512.65	523.11	542.06	559.02
FCR	1.69	1.61	1.57	1.54
Feed/bird (kg)	4.01	3.85	3.70	3.58
Calories/bird (kj)	1153	1155	1156	1163
Feed Cost/bird (\$)	2.06	2.02	2.00	2.00
Margin over Feed (\$/bird) <sup>2</sup>	3.20	3.33	3.19	3.07
Margin over Feed (\$/bird) <sup>3</sup>	1.03	1.15	1.09	1.04
Margin over Feed (\$/bird) <sup>4</sup>	0.23	0.38	0.35	0.33

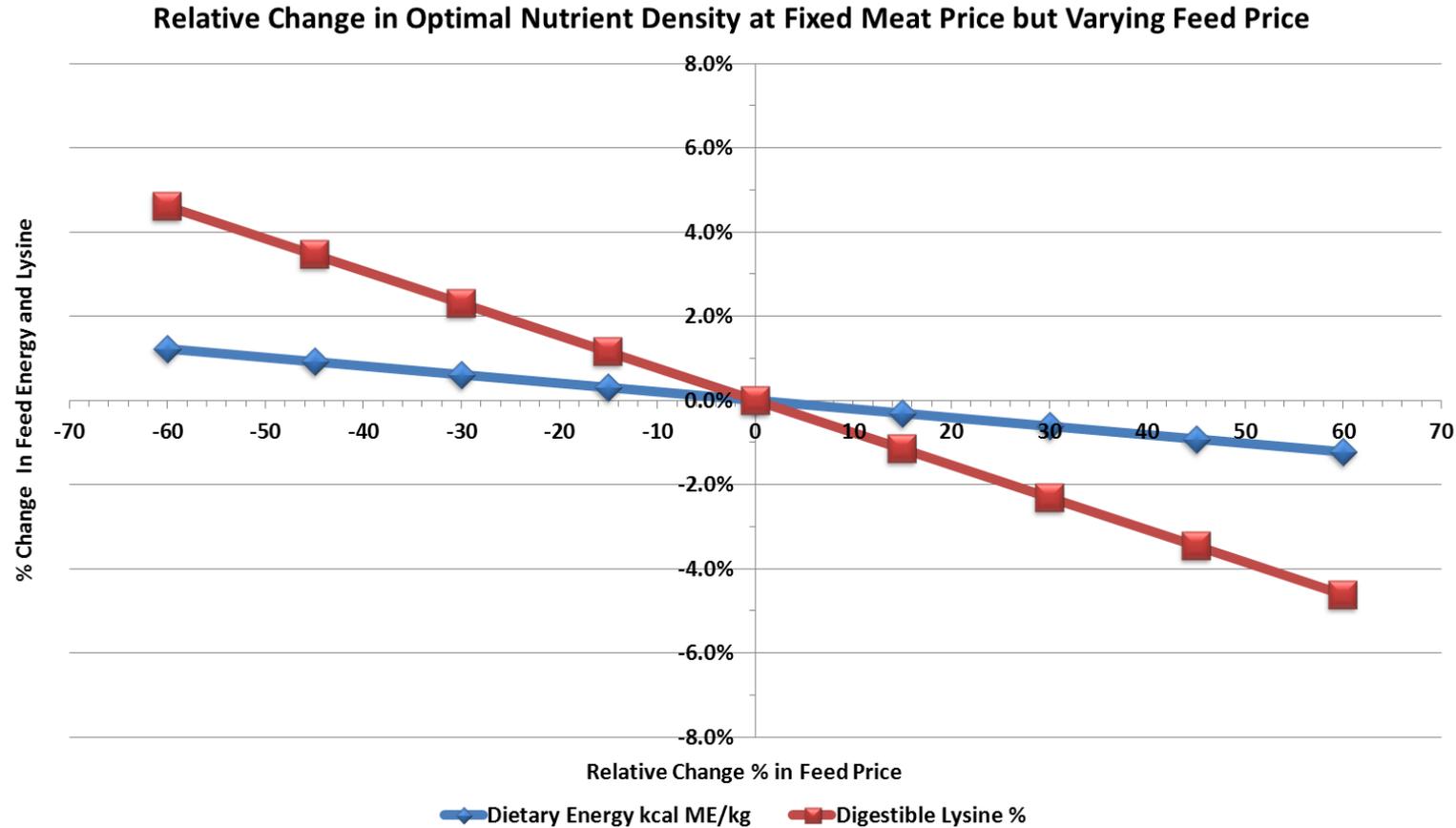
- Notes: 1. All diets at 310 g/kg SID Lys  
 2. Breast Meat at \$7.00. Remainder at \$2.00  
 3. All meat at \$ 2.00  
 4. Increase feed cost by \$ 200/ton

# Protein and profit

<b>Dietary Lysine Level (g/kg)<sup>1</sup></b>	<b>8.5</b>	<b>10.0</b>	<b>11.5</b>
<b>Body Weight</b>	2205	2420	2459
<b>Feed Cost (\$/ton)</b>	517.06	553.57	571.37
<b>FCR</b>	1.71	1.57	1.52
<b>Feed/bird (kg)</b>	3.77	3.80	3.74
<b>Feed Cost/bird (\$)</b>	2.01	2.16	2.20
<b>Margin over Feed (\$/bird)<sup>2</sup></b>	2.70	3.30	3.48
<b>Margin over Feed (\$/bird)<sup>3</sup></b>	0.90	1.07	1.13
<b>Margin over Feed (\$/bird)<sup>4</sup></b>	0.14	0.31	0.38

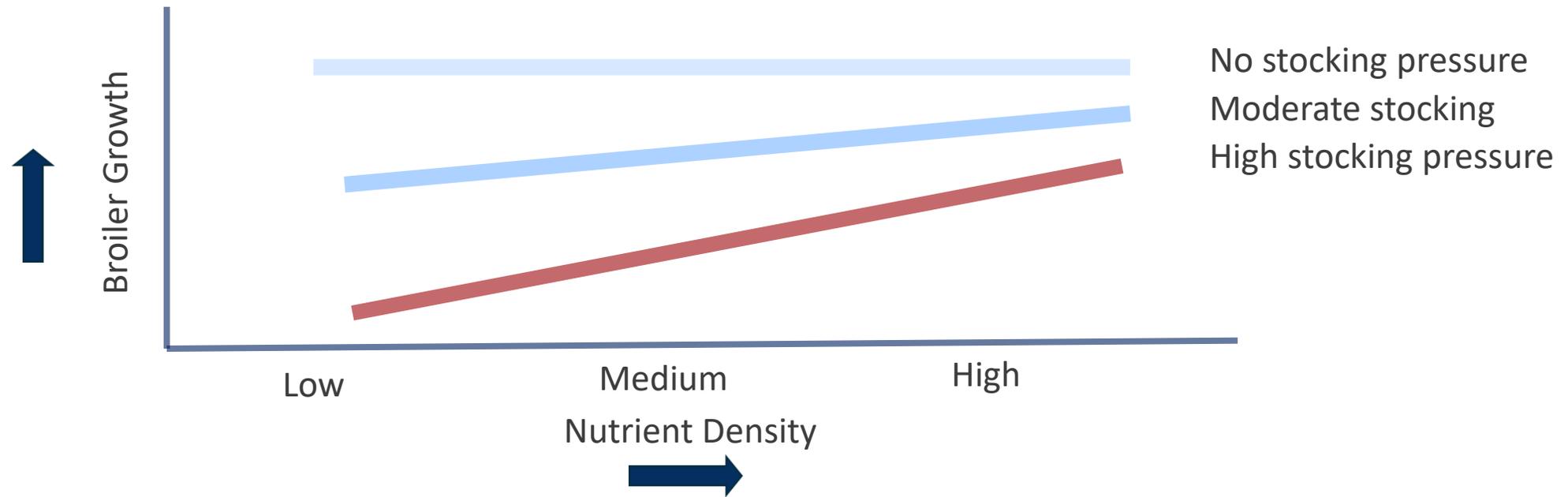
- Notes: 1. All diets at 3250 kcal/kg  
 2. Breast Meat at \$7.00 . Remainder at \$2.00  
 3. All meat at \$ 2.00  
 4. Increase feed cost by \$ 200/ton

# Feed price influences optimal nutrient density

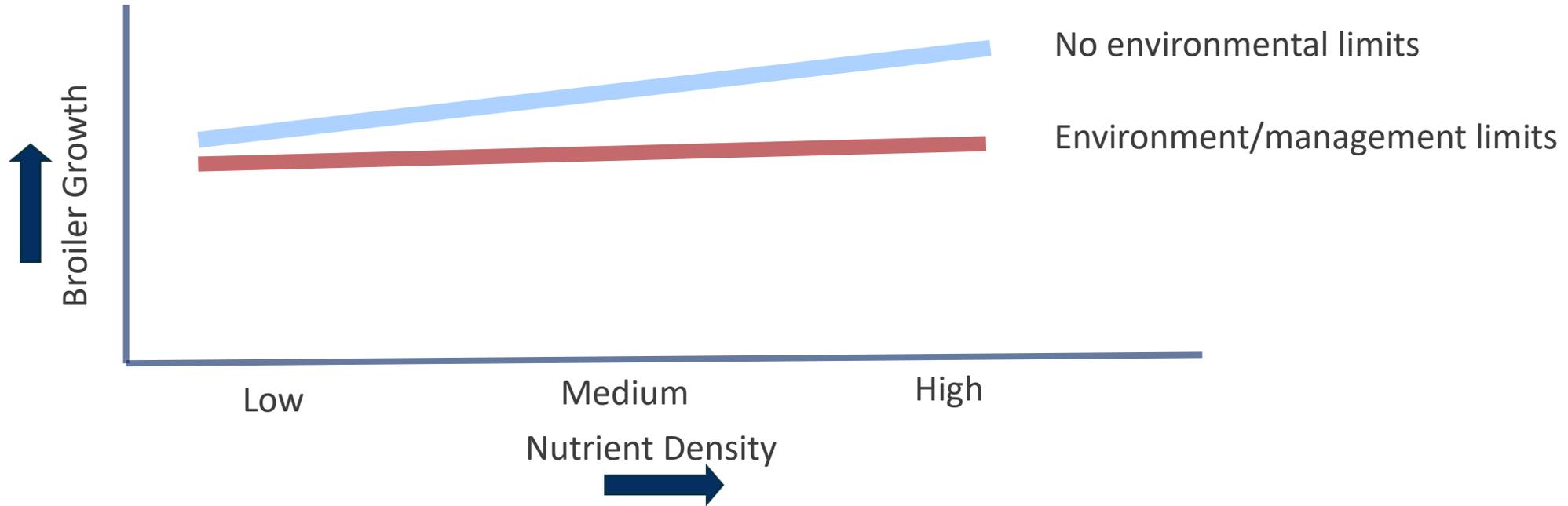


Change in lysine energy is less sensitive to ingredient price changes than amino acids

# Let's take a look at the real world



# Another look at the real world



# Low-protein diets



# Low-protein diets are more sustainable

## Use of low-protein diets drawing attention:

- Improves efficiency of protein utilization
- Reduces wasteful expenditure of energy
- Improves gut health
- Reduces water consumption
- Reduces litter N and moisture
- Improves the bird's environment
- They are more sustainable (all aspects)

# Low-protein diets

Crude Protein	Synth AA	Starch	Gain	FCR	Relative Pancreas	Abdomen Fat Pad	Feed Water Intake	Lys Dig
(g/kg)	(Kg/ton)	(g/kg)	(g)		(g/kg)	(g/kg)	(H <sub>2</sub> O:Feed)	
210	4.5	312	1838	1.569	2.07	8.6	2.19	0.784
195	7.9	327	1883	1.559	2.05	12.0	2.08	0.793
180	14	362	1918	1.538	1.95	12.6	1.92	0.815
165	21.5	395	1866	1.608	1.81	14.6	1.83	0.830

- Male Ross 308 14 to 35 days
- SID Lysine – all diets 10.9 g/kg
- Identical amino acid profile
- Maize-based diets

(Chrystal et al., 2020)

# Low-protein diets

- Each per cent reduction in CP - 10% reduction in litter N (according to Ballios et al., 2017).
- CP from 205.8-161.9 g/kg - AME increased by 12.75-13.06 MJ/kg  
(Chrystal et al., 2022).
- Starch levels increase – and may need to be capped (Greenhough et al., 2022)
- Breast meat yield declines
- Carcass fat increases

# Practical low-protein diets

- Difficult to make hard and fast recommendations
- The ingredients used in the diets matter
- Price and availability of synthetic AA vary
- Too much reduction - not enough amino N to support growth
- Surplus EAA becomes NEAA
- Ideal protein profile may be different in low CP diets (Selle et al., 2020)
- Start slowly – move towards your goal

- **Starter diets** – minimum 21.5 - 22% CP (Leeson, 2018; Lemmer 2019)
- **The “wall”** – about 16% CP in finisher (5 to 6% worse FCR) (Chrystal et al., 2020)
- **In all veg diets:**
  - Boost TSAA to 78% of Lys.
  - Ensure that L-Valine is used (78% of Lys). (Allemah and Toghyani, 2019)
  - Increase Thr to 67% of Lys – Gly precursor.
  - Glycine – first limiting NEAA? (Siegert et al., 2019, Hilliar et al., 2020)
- **Different feeding regimes** – different decisions (grain, animal protein)
- 2 -3 % reduction looks to be feasible

# Low-protein diets and profit

Dietary Crude Protein Level (g/kg) <sup>1</sup>	210	195	180
Weight gain	1838	1883	1918
Feed Cost (\$/ton)	663.00	652.00	664.00
FCR	1.569	1.559	1.538
Feed/bird (kg)	2.88	2.94	2.95
Feed Cost/bird (\$)	2.20	2.20	2.25
Margin over Feed (\$/bird) <sup>2</sup>	1.97	1.98	1.91
Margin over Feed (\$/bird) <sup>3</sup>	0.23	0.28	0.28
Margin over Feed (\$/bird) <sup>4</sup>	-0.35	-0.31	-0.31

- Notes: 1. All diets at 3000 kcal/kg and 10.9 g/kg SID Lys  
 2. Breast Meat at \$7.00 . Remainder at \$2.00  
 3. All meat at \$ 2.00  
 4. Increase in feed cost by \$ 200/ton

# Feed formulation and sustainability



# Sustainability and ingredients

- The INRAE (2022) feed tables & GFLI (2022) database\*
- Life Cycle Analysis (LCA).
- Six parameters are included:
  - **Climate change (carbon footprint)**
  - Phosphorus consumption.
  - Cumulative energy demand.
  - Acidification.
  - Eutrophication.
  - Land competition.



This project is supported by



# Sustainability and ingredients

## Sustainability of ingredients depends on:

- Crop yield
- Genotypes (GMO – 16% higher yields)
- Shipping distances
- Production methods (no-till, irrigated)
- Land-use changes (LUC) – deforestation or "set aside"

**Clearly – vary greatly from different sources**



# Carbon footprint of some feed ingredients

	Comment	CO <sub>2</sub> e (g/kg)
<b>Maize</b>	Sourced locally	443
<b>Wheat</b>	Ex-field	368
<b>Wheat</b>	Ex-UK – imported into Europe	525
<b>Barley</b>	Ex-field	364
<b>Soybean meal</b>	Not associated with deforestation	582
<b>Soybean meal</b>	Average deforestation	1138
<b>Sunflower 36%</b>	Local origin	324
<b>Wheat bran</b>	Local	73
<b>Soya oil</b>	Not associated with deforestation	1135
<b>Soya oil</b>	Average deforestation	4380

# Will sustainable production be paid?

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## Will sustainable feed command a premium in the future?

 By Emma Penrod | June 29, 2022     



BitsAndSplits | BigStock.com

Feed manufacturers that emphasize their product's environmental metrics, low-carbon footprint and sustainable ingredient sourcing will be able to charge more

# Take-home message



# Take-home message

- The more chicken consumed – the higher the demand for feedstuffs
- Our industry's future depends on being sustainable
- Improved performance leads to improved sustainability
- Start thinking about formulating for sustainability
- Alternative production systems – view with caution



# Take-home message

- Always look at return or profit
- Reducing feed costs - not always better profit
- Do the calculations - each situation is unique
- Practices that make money - hold true for good and bad times



**THANK YOU!**