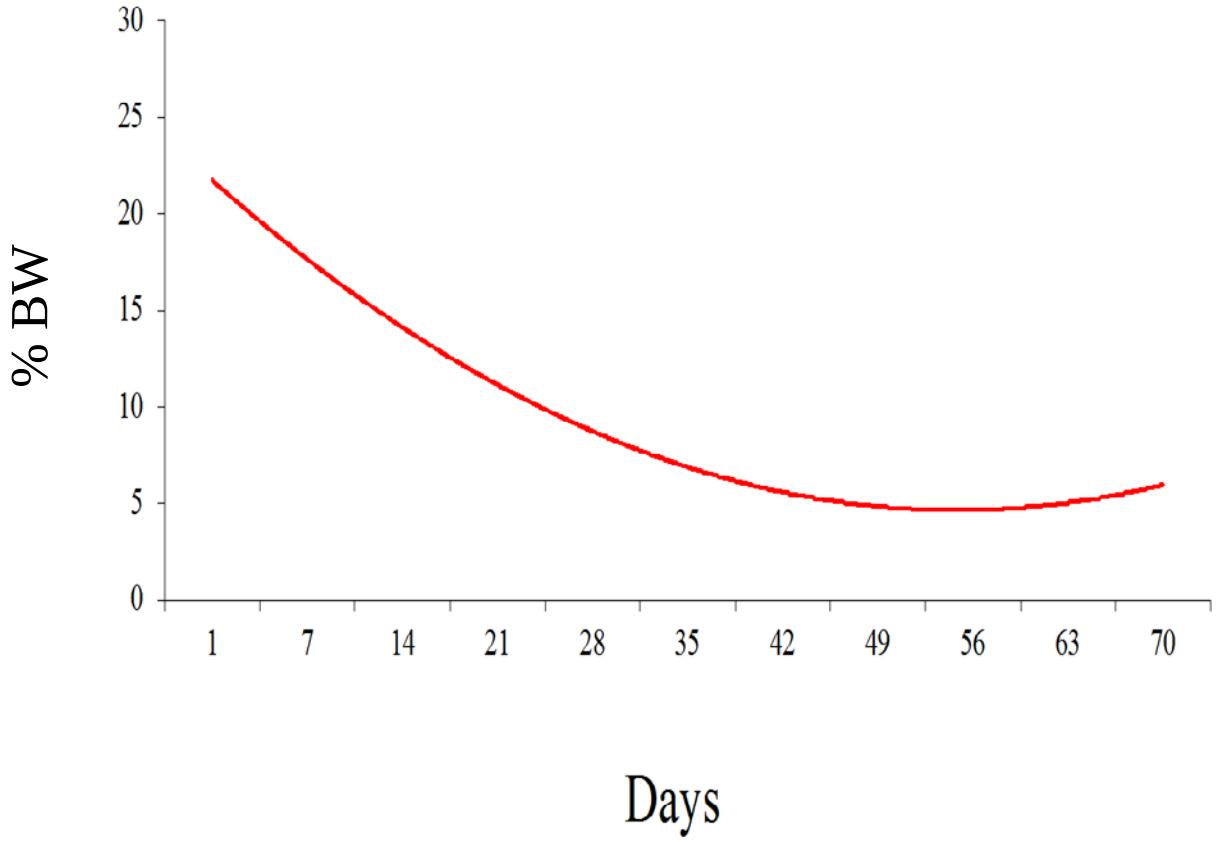
Economic responses to dietary amino acid allowances for broilers

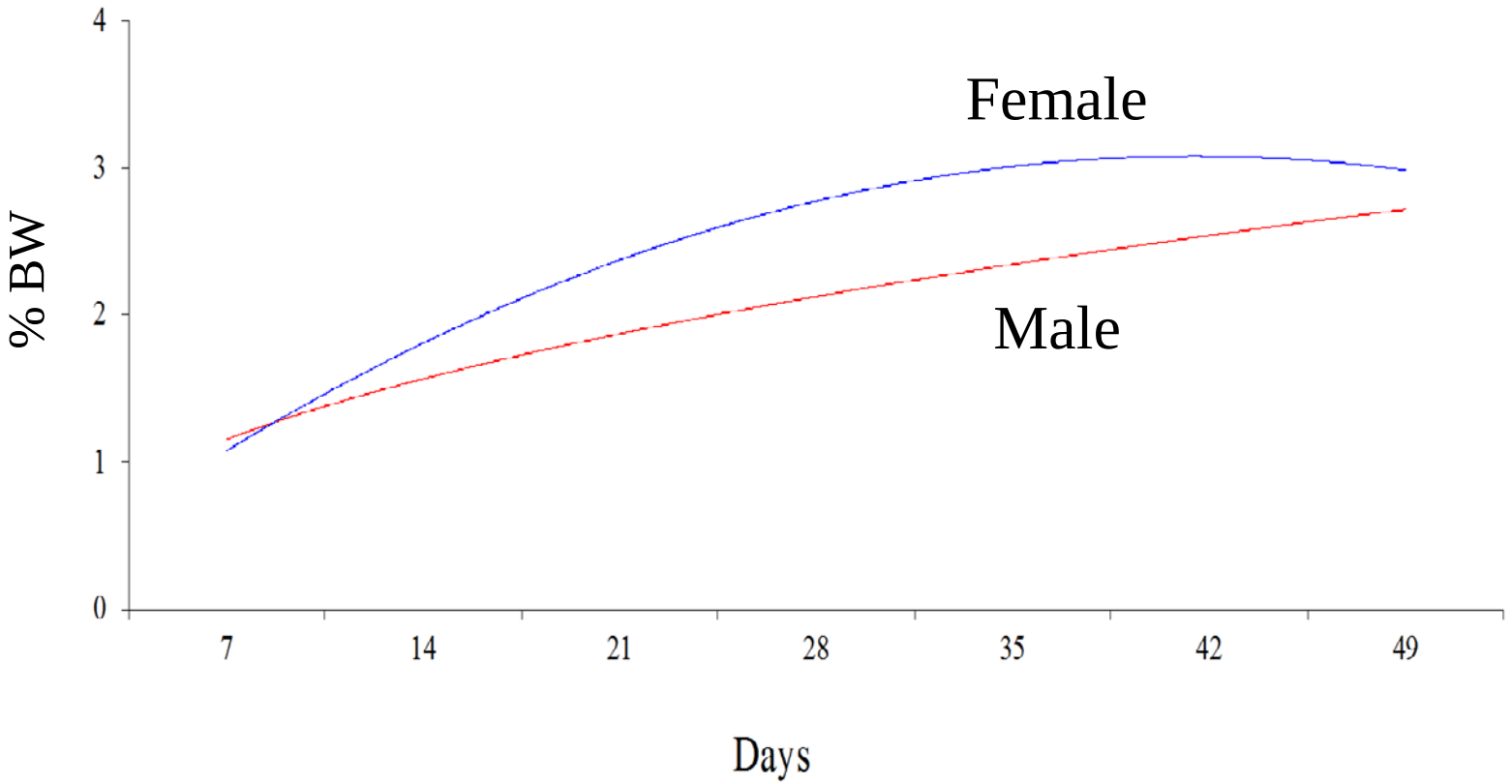
Sergio L. Vieira, Ph.D

UFRGS, Porto Alegre, Brazil

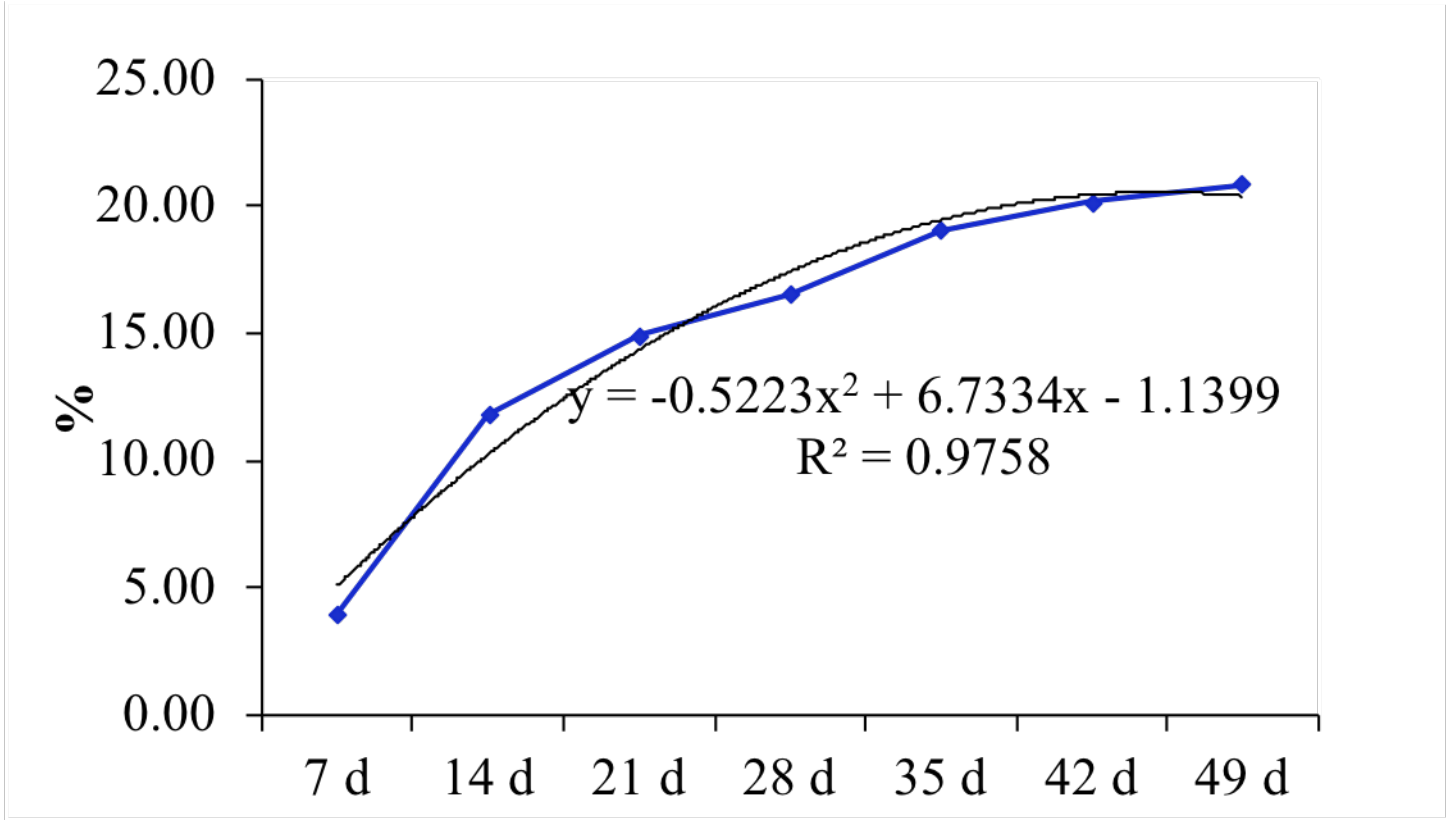
GI Tract, % Body Weight



Feathers, % Body Weight

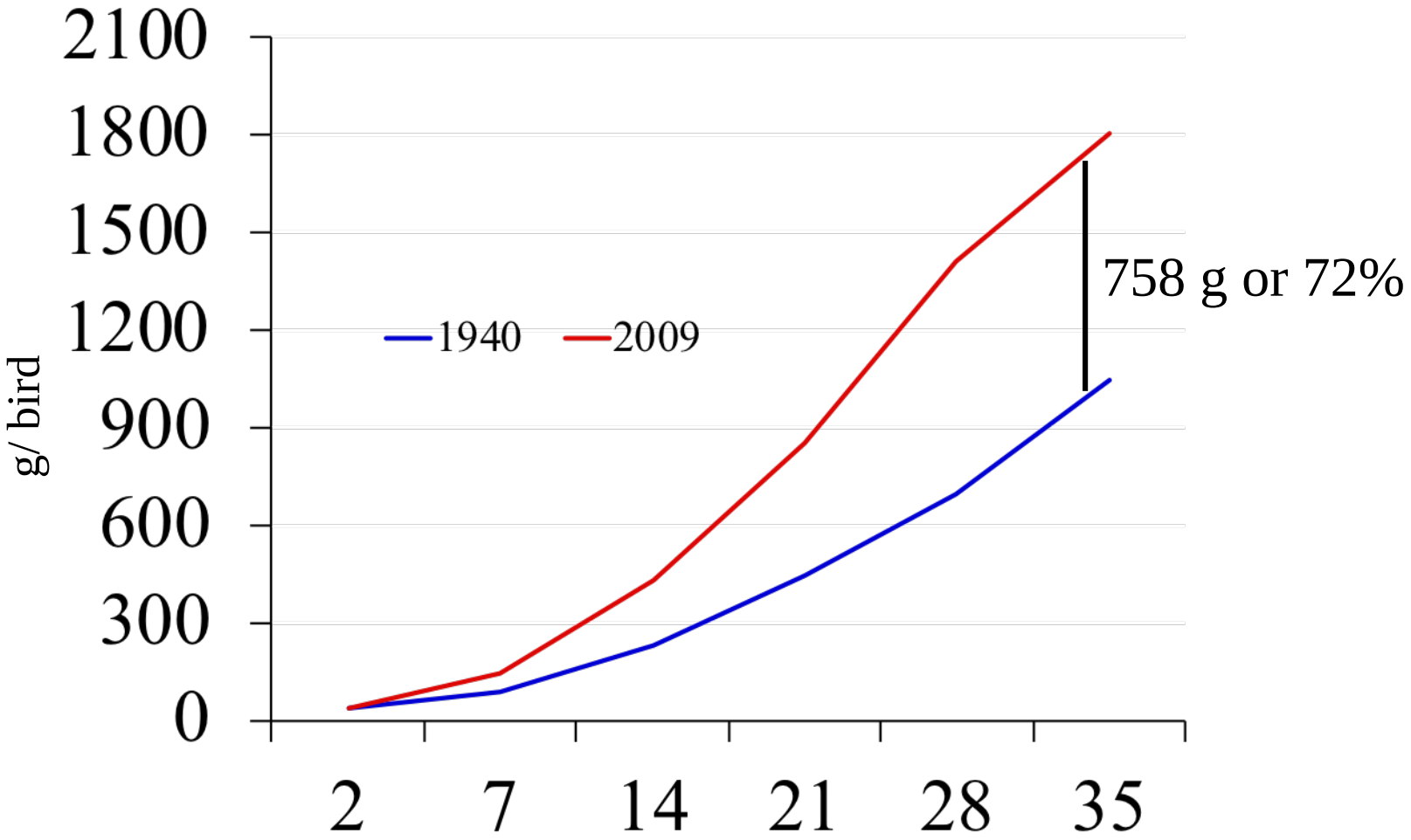


Breast Meat Yield, % Body Weight



Vieira et al., 2016

Broiler: 1940 *vs.* 2009



Schmidt et al., 2009

Broiler : 1940 *vs.* 2009

	Weight	Breast		Heart		Intestines		Liver	
	g/d	g/d	+ 14 d*	mg/ d	g/g	cm/d	cm/ ave**	mg/d	mg/g
1940	30.8	1,6	1,09	240	7	1,8	123	800	24
2009	53.1	6,1	1,25	316	5	2,5	141	1300	24
2009/ 1940	1.8	3.8	1.14	1.3	0.7	1.4	1.1	1.6	1

*Allometric growth

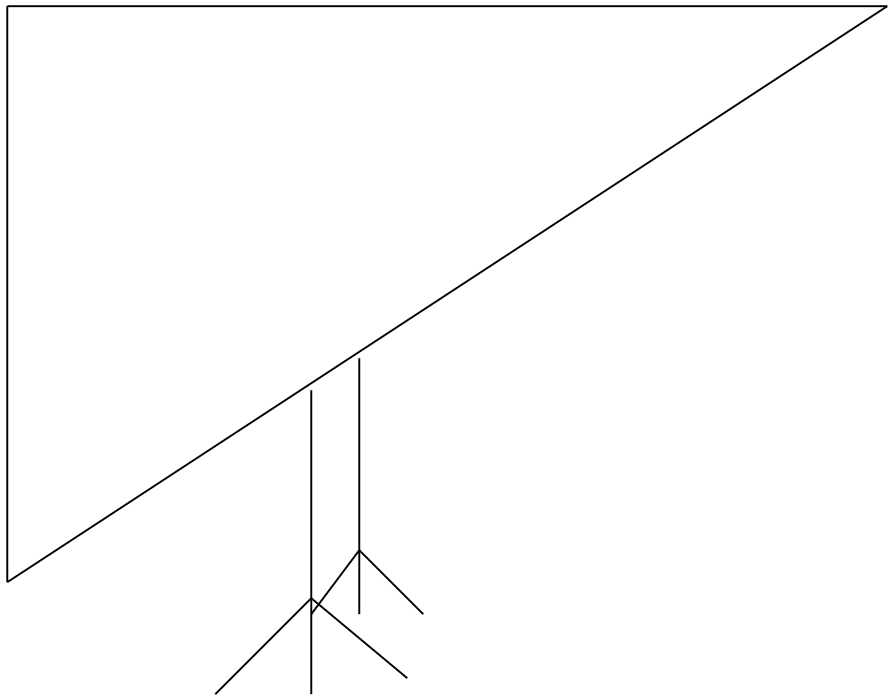
**Similar body weight

Schmidt et al., 2009

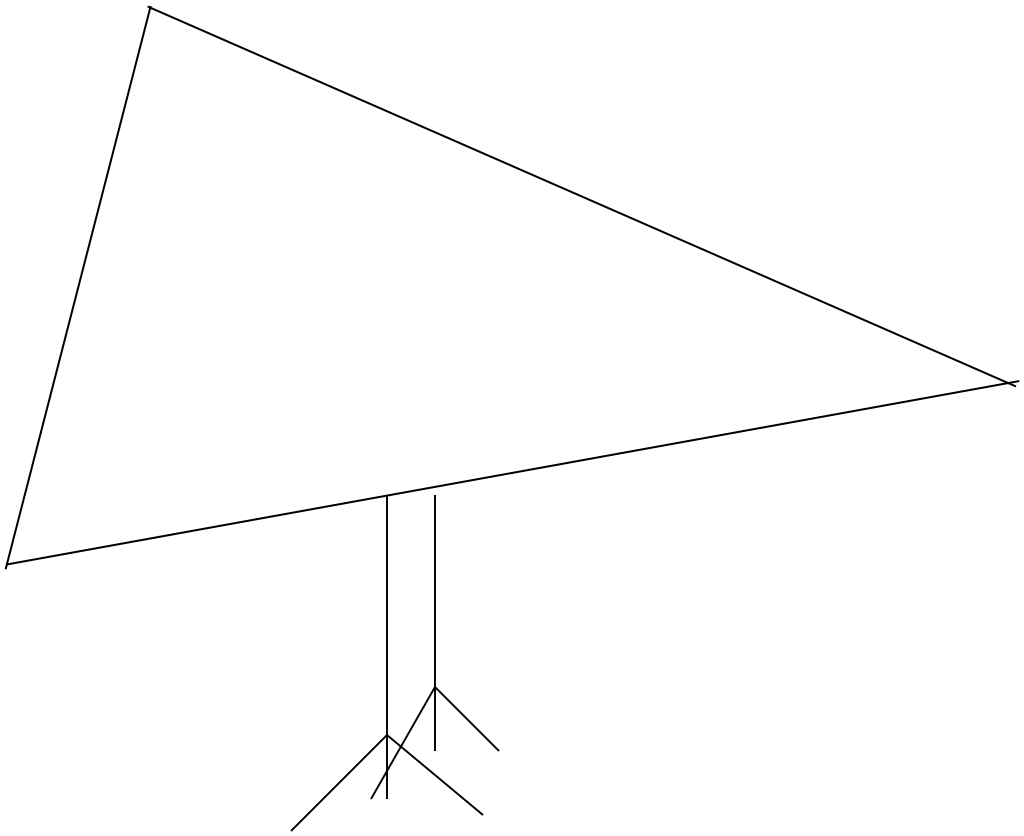
Present Broiler

- Grows faster
- Better FCR
- Breast muscles grow for longer period
- Heart is proportionally smaller
- Greater intestinal surface
- Lysine is a higher proportion of the body

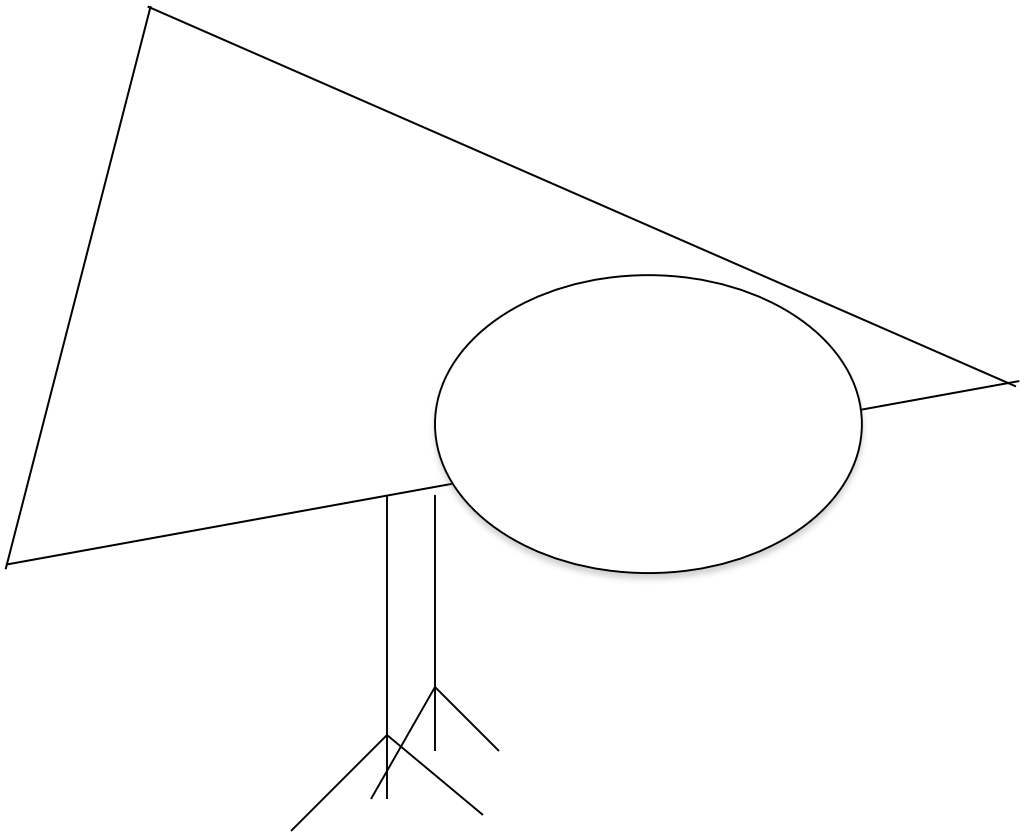
Chicken



Broiler



Modern Broiler



Protein Retention

- From all the ingested protein a smaller fraction is actually retained ≅ 40 %
- Protein retention is affected by many variables, specially by its “Amino acid balance”

Age and Breast Muscle Synthesis

	7	14	28	42
Synthesis, mg/d	702	1.193	2.521	5.086
Degradation, mg/d	226	569	1.338	3.914
Deposition, mg/d	476	624	1.183	1.172
Efficiency, %	68	52	47	23

Kang et al. 1985

Breast Synthesis

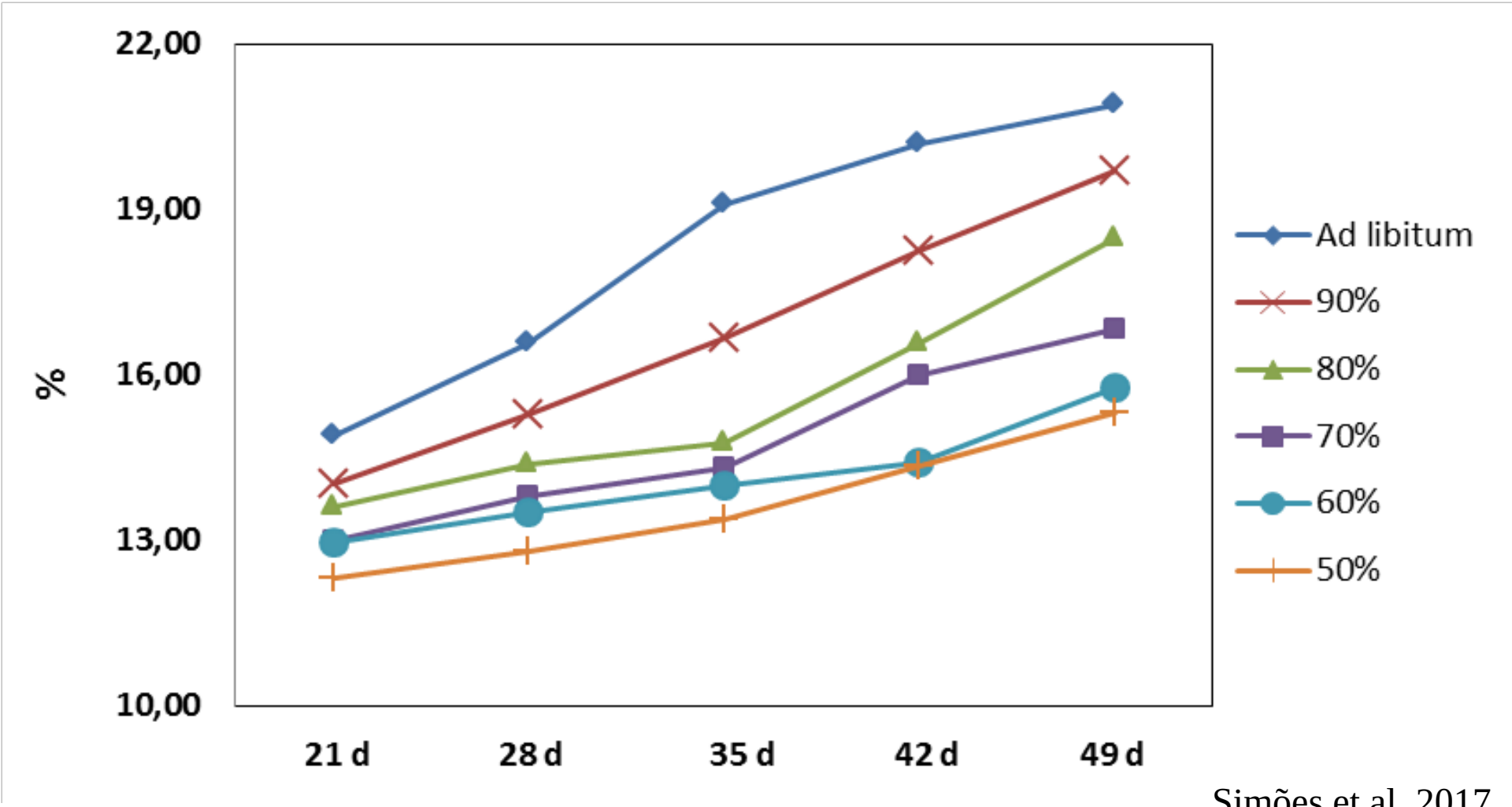
CP, %	Lys, %	Synthesis, mg/d	Degradation, mg/d	Growth, mg/d	Efficiency
21	0.86	485 b	190 b	291 b	1,66
	1.22	534 b	159 b	322 a	1,65
	1.34	634 a	278 a	309 a	2,05
	1.46	612 ab	286 a	299 ab	2,04
25	0.86	649 b	307	290 c	2,23
	1.22	663 ab	313	301 bc	2,20
	1.34	699 ab	325	322 a	2,17
	1.46	727 a	371	313 ab	2,32

Urdaneta-Rincon e Leeson, 2004

Can Growth be Manipulated?

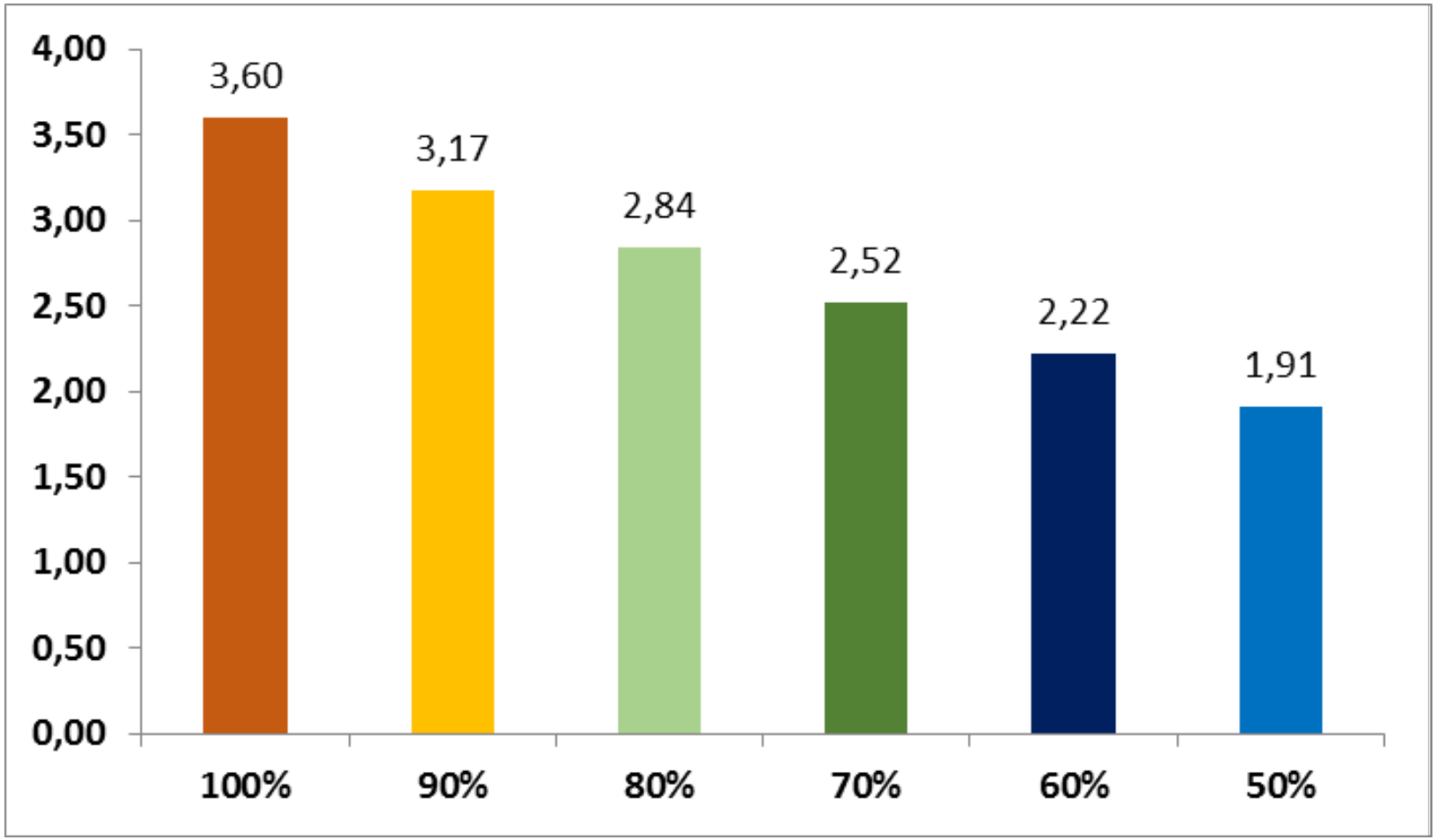
- Yields
  - Consumption of protein and energy
    - Proportion of cuts
    - Body composition
- Maintenance cost
  - Maintain what has been built
  - Inflammation

Feed Restriction
Breast Meat Yields, %



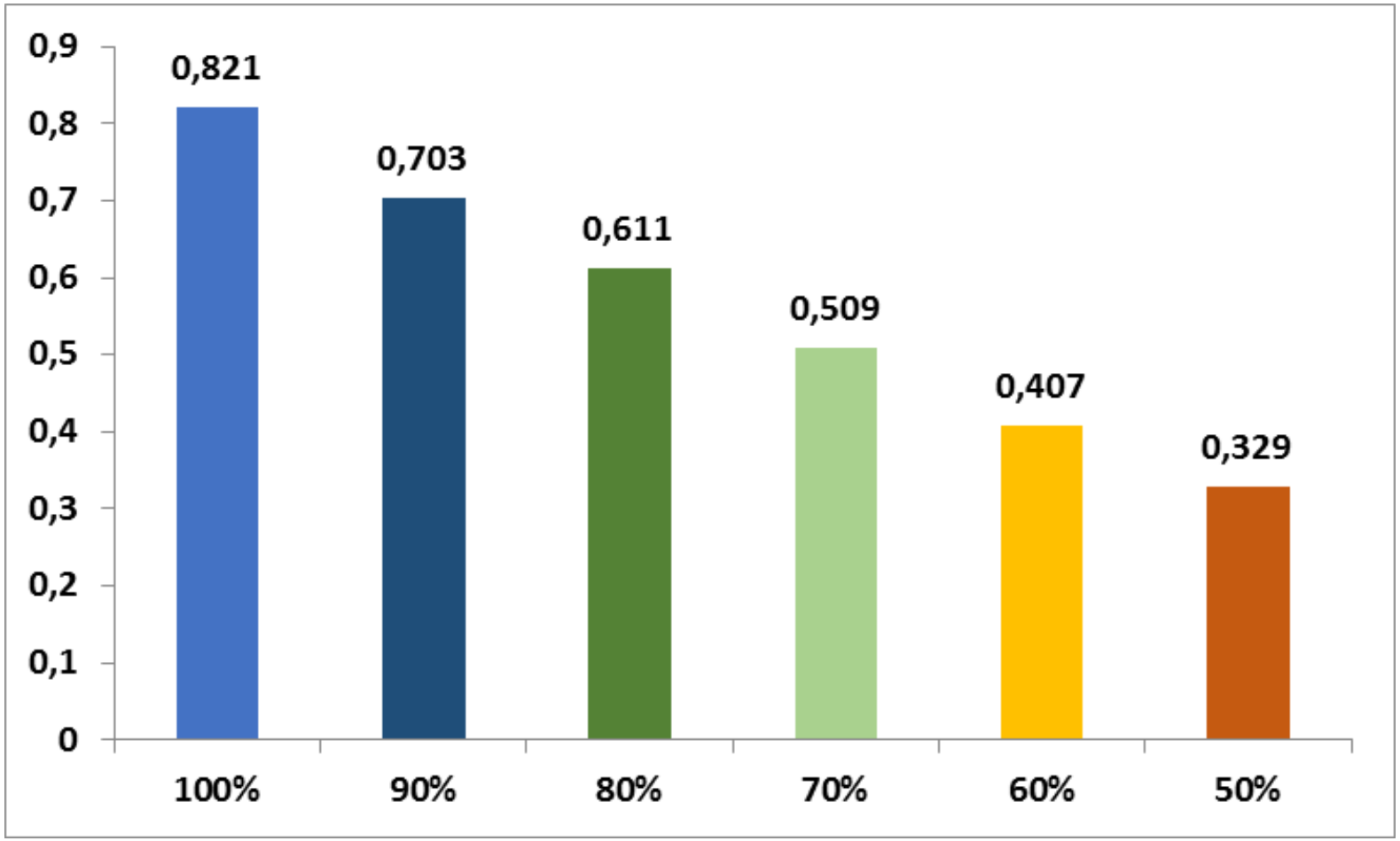
Simões et al, 2017

Cost of Feed Intake, 1 to 49 days, R$



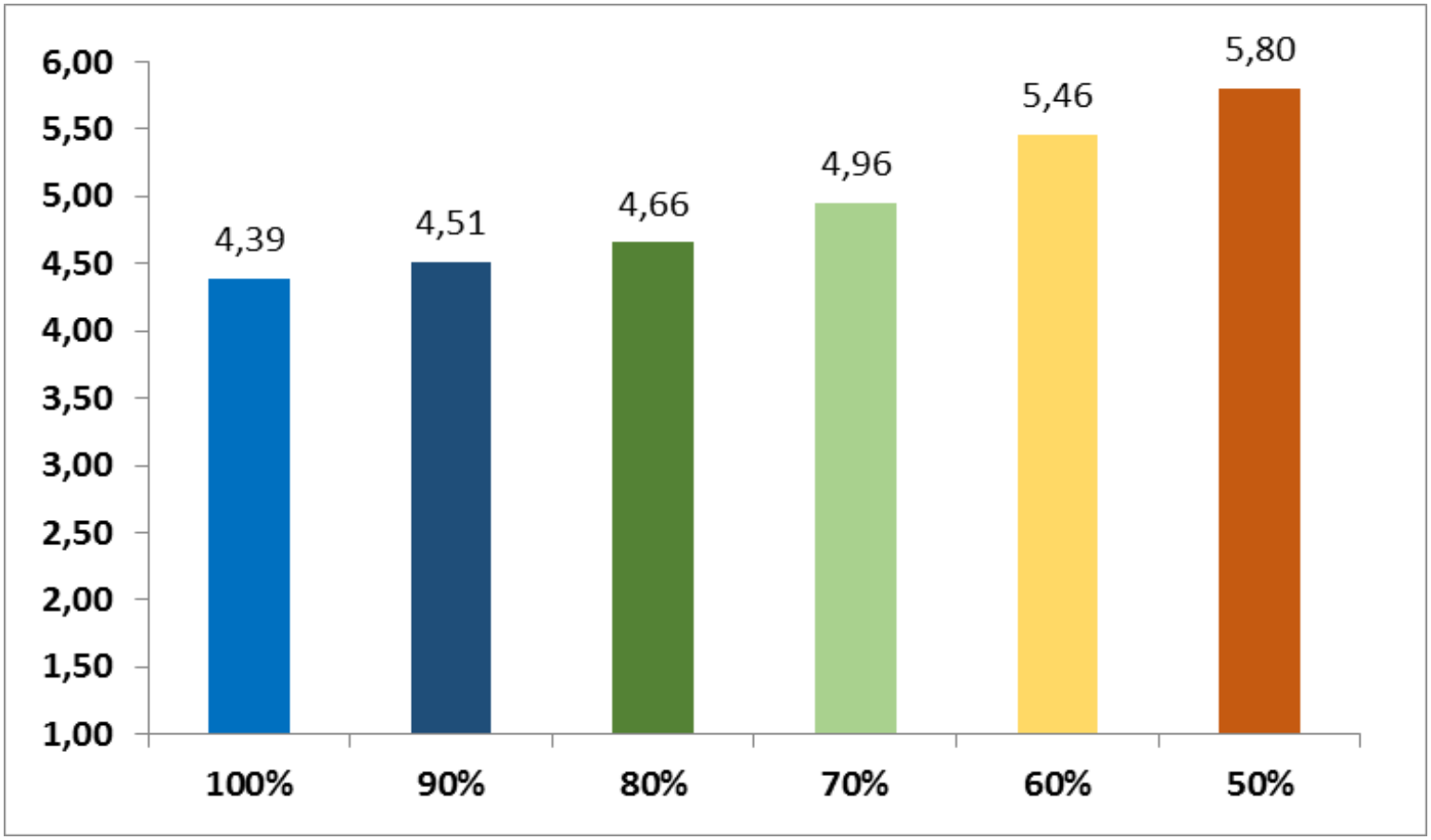
Simões et al, 2017

Breast Meat at 49 d, kg



Simões et al, 2017

Cost to Produce 1 kg of Breast Meat, R$



Simões et al, 2017

Feeding Programs to Optimize Growth

- FCR is a flexible objective
- Feeding is the highest cost
- Ingredients have a variable cost

Protein Sources

- Mixes of AA in variable proportions
  - Plants
  - Animals
  - Synthetic AA

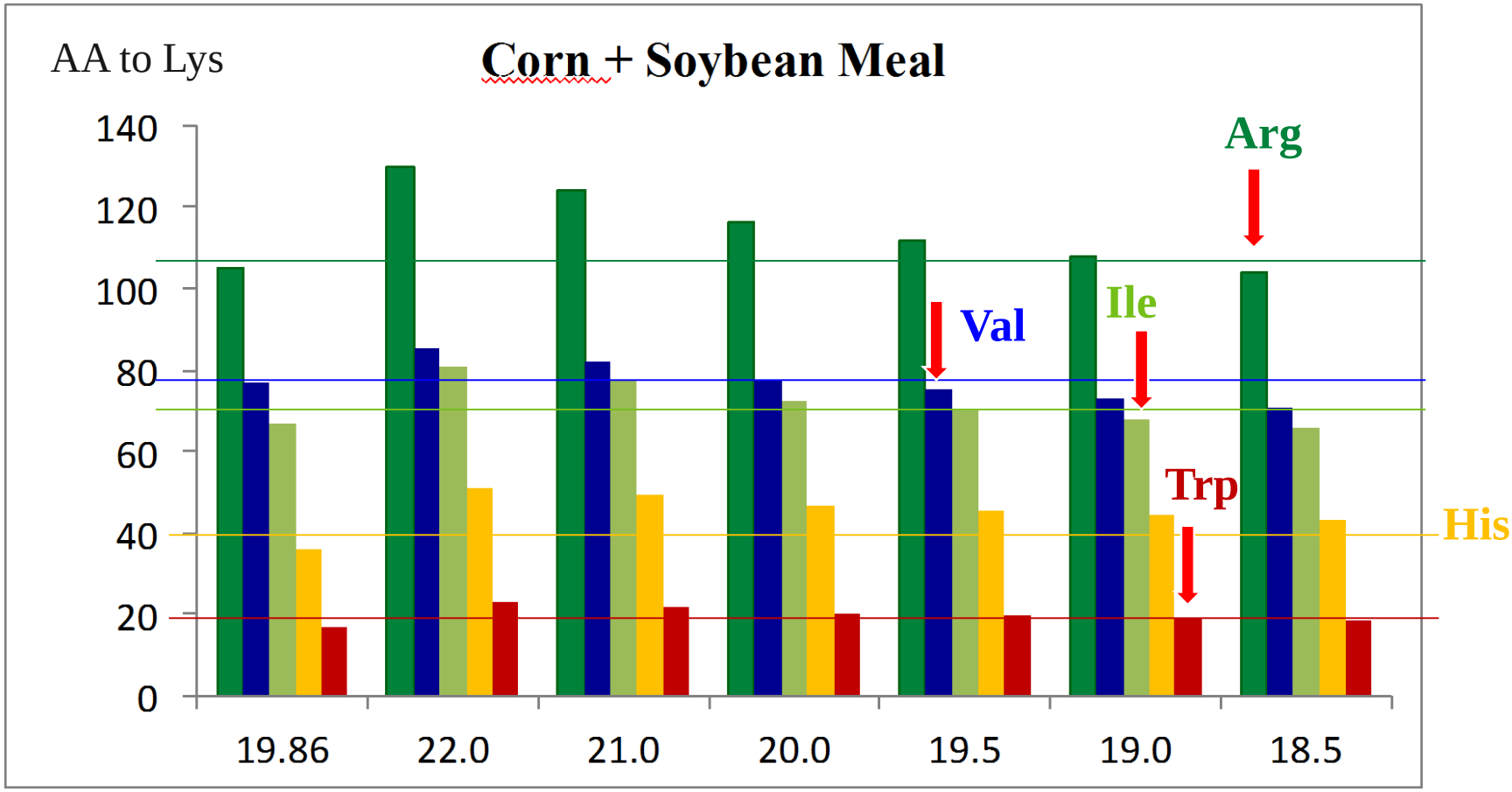
Dietary Protein

- Feed formulation
  - CP minimum and essential AA
  - Set only AA requirements
  - Ideal ratios (AA : Lys)
  - No essential AA (Total N)

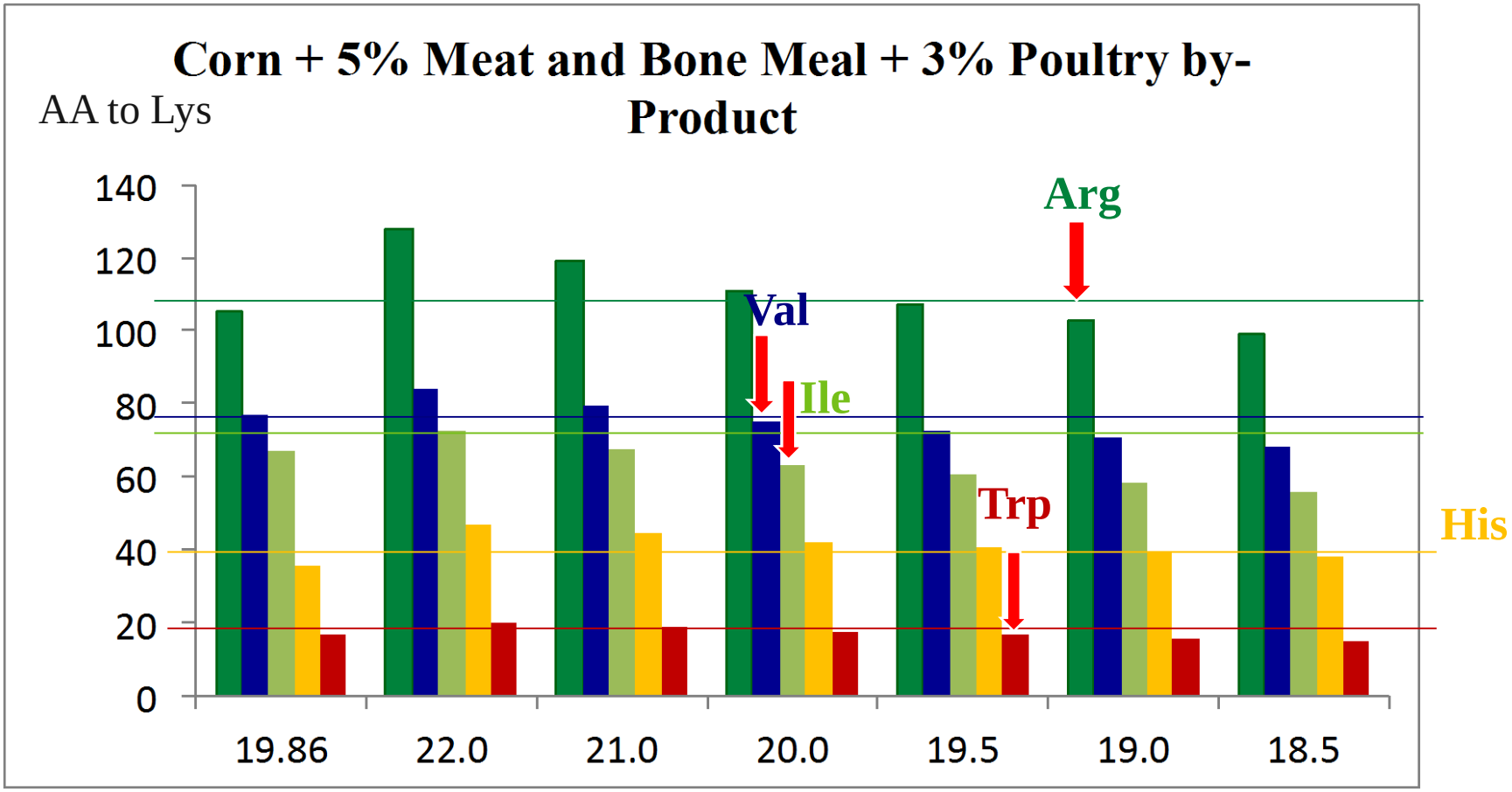
CP Minimum

- In a feed formulation without CP restricted depends on the first limiting AA
- Limiting AA is ingredient dependent
  - Methionine – TSAA – 1st
  - Lysine – 2nd
  - Threonine – 3rd
  - 4th, 5th ?
    - Ingredients !

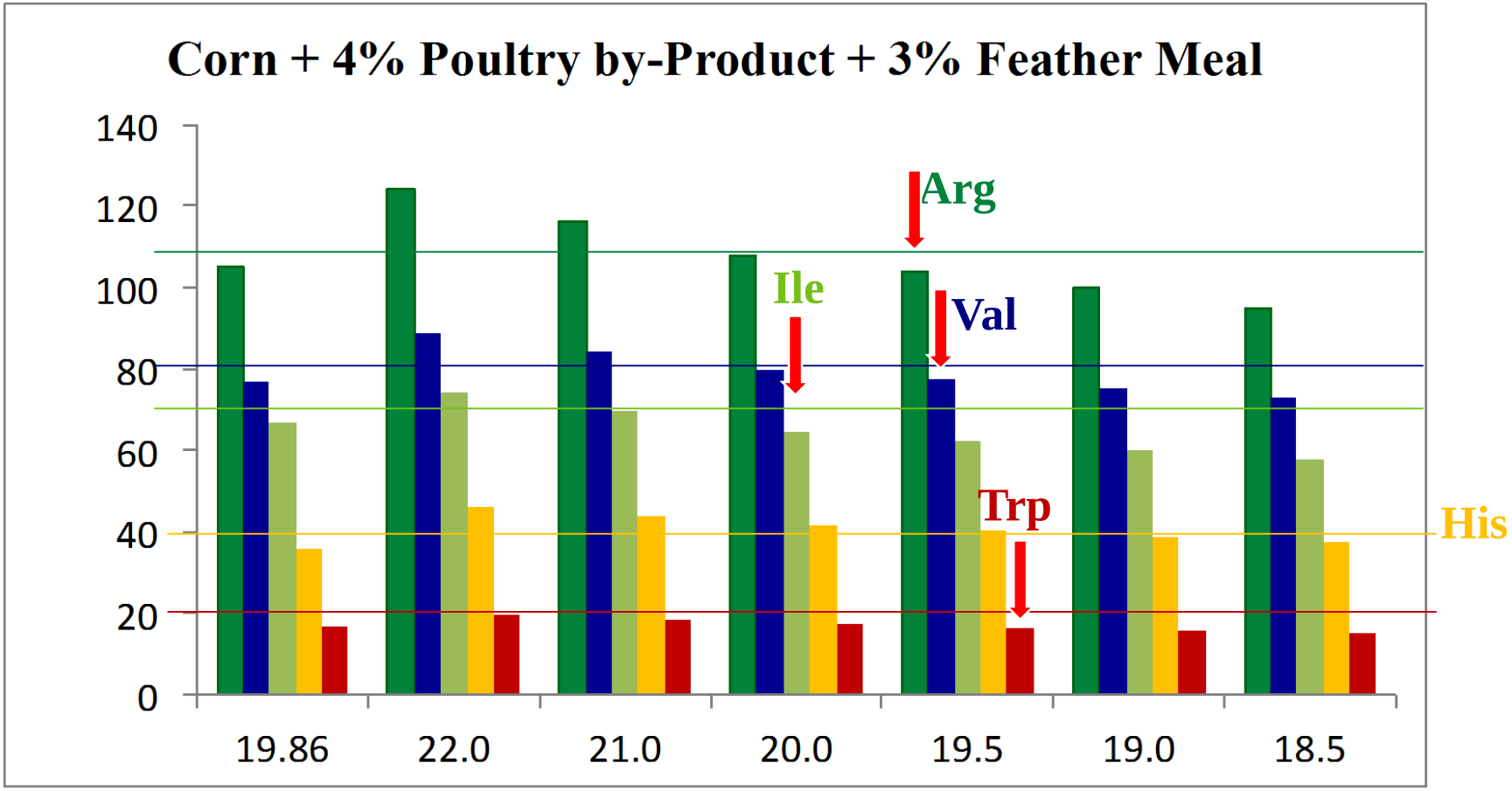
AA Limiting Order



AA Limiting Order



AA Limiting Order



Diet Simulation

- Grower diet
  - 1.13 Dig Lys, 0.73 TSAA : Lys, 0.65 Thr : Lys
- All Vegetable vs. With Animal Protein
- CP Fixed vs. Without CP Restricted
- Total CP
- L-Val added

Corn	55.0	62.4	56.7	64.1	58.4	65.8
SBM	36.3	27.3	34.7	25.8	33.2	24.2
Feather meal	-	2.0	-	2.0	-	2.0
Meat meal	-	4.0	-	4.0	-	4.0
CP	21.0		20.5		20.0	
Val dig	0.90	0.88	0.87	0.86	0.85	0.83
Ile dig	0.83	0.77	0.80	0.74	0.78	0.72
Leu dig	1.65	1.57	1.62	1.54	1.58	1.50
Arg dig	1.34	1.26	1.29	1.22	1.25	1.18
Trp dig	0.24	0.20	0.23	0.20	0.22	0.19
His dig	0.52	0.47	0.51	0.46	0.49	0.45
Phe+Tyr dig	1.67	1.54	1.62	1.49	1.58	1.44
Gly+Ser dig	1.77	1.99	1.72	1.94	1.67	1.89
Ala total	1.04	0.91	1.02	0.89	1.00	0.87
Asp total	2.15	1.73	2.08	1.66	2.01	1.59
Glu total	3.83	3.20	3.73	3.10	3.63	3.00
N Total	2.71	2.59	2.64	2.61	2.58	2.55

Corn	55.0	62.4	53.30	60.71	51.61	59.01
SBM	36.3	27.3	37.79	28.83	39.29	30.37
Meat meal	-	2.0		2.0		2.0
Feather meal	-	4.0		4.0		4.0
CP	21.0		21.5		22.0	
Val dig	0.90	0.88	0.92	0.91	0.94	0.93
Ile dig	0.83	0.77	0.85	0.79	0.88	0.82
Leu dig	1.65	1.57	1.69	1.50	1.72	1.64
Arg dig	1.34	1.26	1.38	1.31	1.42	1.35
Trp dig	0.24	0.20	0.25	0.21	0.25	0.22
His dig	0.52	0.47	0.54	0.49	0.55	0.50
Phe+Tyr dig	1.67	1.54	1.72	1.58	1.77	1.63
Gly+Ser dig	1.77	1.99	1.82	2.04	1.87	2.09
Ala total	1.04	0.91	1.06	0.93	1.08	0.95
Asp total	2.15	1.73	2.22	1.80	2.28	1.87
Glu total	3.83	3.20	3.93	3.30	4.03	3.40
N Total	2.71	2.59	2.77	2.65	2.84	2.72

AA Density

- Broilers respond to increased AA density
- Physiological limits for growth
- Feed cost vs. broiler marketing value

Broiler Grillers and AA Density

	1 - 7 d		8 - 18 d		19 - 29 d	
Trt.	ME	dig Lys	ME	dig Lys	ME	dig Lys
1	3.004	1,152	3.054	1,098	3.152	0,963
2	3.004	1,280	3.054	1,220	3.152	1,070
3	3.004	1,408	3.054	1,342	3.152	1,177
4	3.050	1,152	3.100	1,098	3.200	0,963
5	3.050	1,280	3.100	1,220	3.200	1,070
6	3.050	1,408	3.100	1,342	3.200	1,177
7	3.096	1,152	3.147	1,098	3.248	0,963
8	3.096	1,280	3.147	1,220	3.248	1,070
9	3.096	1,408	3.147	1,342	3.248	1,177

Broiler Grillers and AA Density

	BW, g	FC	Intake, g
AA Density			
High	1.502 a	1.455 a	2.185 c
Moderate	1.491 ab	1.503 b	2.245 b
Low	1.478 b	1.553 c	2.295 a
EM			
High	1.502 a	1.479 a	2.221 b
Moderate	1.487 ab	1.508 b	2.243 ab
Low	1.484 b	1.524 c	2.261 a

Ingredient Cost, U$/Ton
Extremes in 2012 and 2013

	High	Moderate	Low
Corn	250	200	150
SBM	550	450	350
Carcass	1.600	1.300	1.000

Economic Sensitivity

	AADensity					
	Low	Moderate	High	Low	Moderate	High
	Corn High			Corn Low		
Feed cost	0,677	0,670	0,672	0,555	0,565	0,581
Total cost	1,554	1,536	1,540	1,432	1,431	1,450
Crude margin	-0,054	-0,036	-0,040	0,068	0,069	0,050
	Soy High			Soy Low		
Feed cost	0,701	0,715	0,737	0,559	0,552	0,553
Total cost	1,579	1,582	1,606	1,437	1,419	1,421
Crude margin	-0,079	-0,082	-0,106	0,063	0,081	0,079
	Carcass High			Carcass Low		
Feed cost	0,616	0,617	0,627	0,616	0,617	0,627
Total cost	1,493	1,484	1,495	1,493	1,484	1,495
Crude margin	0,307	0,316	0,305	-0,293	-0,284	-0,295

L-Valine and Reduced CP: 1 – 7 d

	Prg 1	Prg 2	Prg 3	Prg 4
CP	22,4	24,9	23,5	22,6
Lys dig.		1,32		
Met + Cys dig		0,95		
Thr dig.		0,86		
Val dig.	0,90	1,02 (77)	1,02 (77)	1,02 (77)
Ile dig.	0,83	0,95	0,89 (67)	0,89 (67)
L-Val	-	-	0,067	0,115
L-Ile	-	-	-	0,048
U$/kg	0,341	0,368	0,352	0,341

L-Valine and Reduced CP: 8 – 21 d

	Prg 1	Prg 2	Prg 3	Prg 4
CP	21,1	22,9	21,8	21,0
Lys dig.		1,22		
Met + Cys dig		0,88		
Thr dig.		0,79		
Val dig.	0,86	0,94 (77)	0,94 (77)	0,94 (77)
Ile dig.	0,79	0,87	0,82 (67)	0,82 (67)
L-Val	-	-	0,055	0,096
L-Ile	-	-	-	0,042
U$/kg	0,338	0,356	0,344	0,334

L-Valine and Reduced CP: 22 – 35 d

	Prg 1	Prg 2	Prg 3	Prg 4
CP	19,8	21,3	20,4	19,7
Lys dig.		1,13		
Met + Cys dig		0,81		
Thr dig.		0,74		
Val dig.	0,80	0,87 (77)	0,87 (77)	0,87 (77)
Ile dig.	0,73	0,80	0,76 (67)	0,76 (67)
L-Val	-	-	0,045	0,082
L-Ile	-	-	-	0,037
U$/kg	0,336	0,352	0,342	0,333

L-Valine and Reduced CP: 36 – 42 d

	Prg 1	Prg 2	Prg 3	Prg 4
CP	18,4	20,0	19,3	18,7
Lys dig.		1,06		
Met + Cys dig		0,76		
Thr dig.		0,69		
Val dig.	0,74	0,82 (77)	0,82 (77)	0,82 (77)
Ile dig.	0,67	0,75	0,71 (67)	0,71 (67)
L-Val	-	-	0,037	0,069
L-Ile	-	-	-	0,033
U$/kg	0,323	0,341	0,332	0,325

Responses: 1 to 21 d

	BW, g	FC	U$/kg	Intake, g
Prg 1	890 ^{b}	1.390 ^{c}	0.419	1,237 ^{b}
Prg 2	910 ^{a}	1.346 ^{a}	0.439	1,225 ^{b}
Prg 3	904 ^{a}	1.369 ^{b}	0.427	1,238 ^{ab}
Prg 4	913 ^{a}	1.378 ^{bc}	0.418	1,258 ^{a}

Responses: 22 to 42 d

	BW, g	FC	U$/kg	Intake, g
Prg 1	2,213 ^{b}	1.729 ^{b}	1.261	3.827 ^{ab}
Prg 2	2,232 ^{ab}	1.705 ^{a}	1.319	3.807 ^{b}
Prg 3	2,223 ^{ab}	1.715 ^{ab}	1.285	3.813 ^{b}
Prg 4	2,247 ^{a}	1.721 ^{ab}	1.273	3.869 ^{a}

Concluding Remarks

- Efficiency of meat production changes with age and AA density
- Feed ingredients impact AA balances
- AA supplementation reduces CP
- Proteases increase AA availability