Valine and isoleucine requirements in piglets

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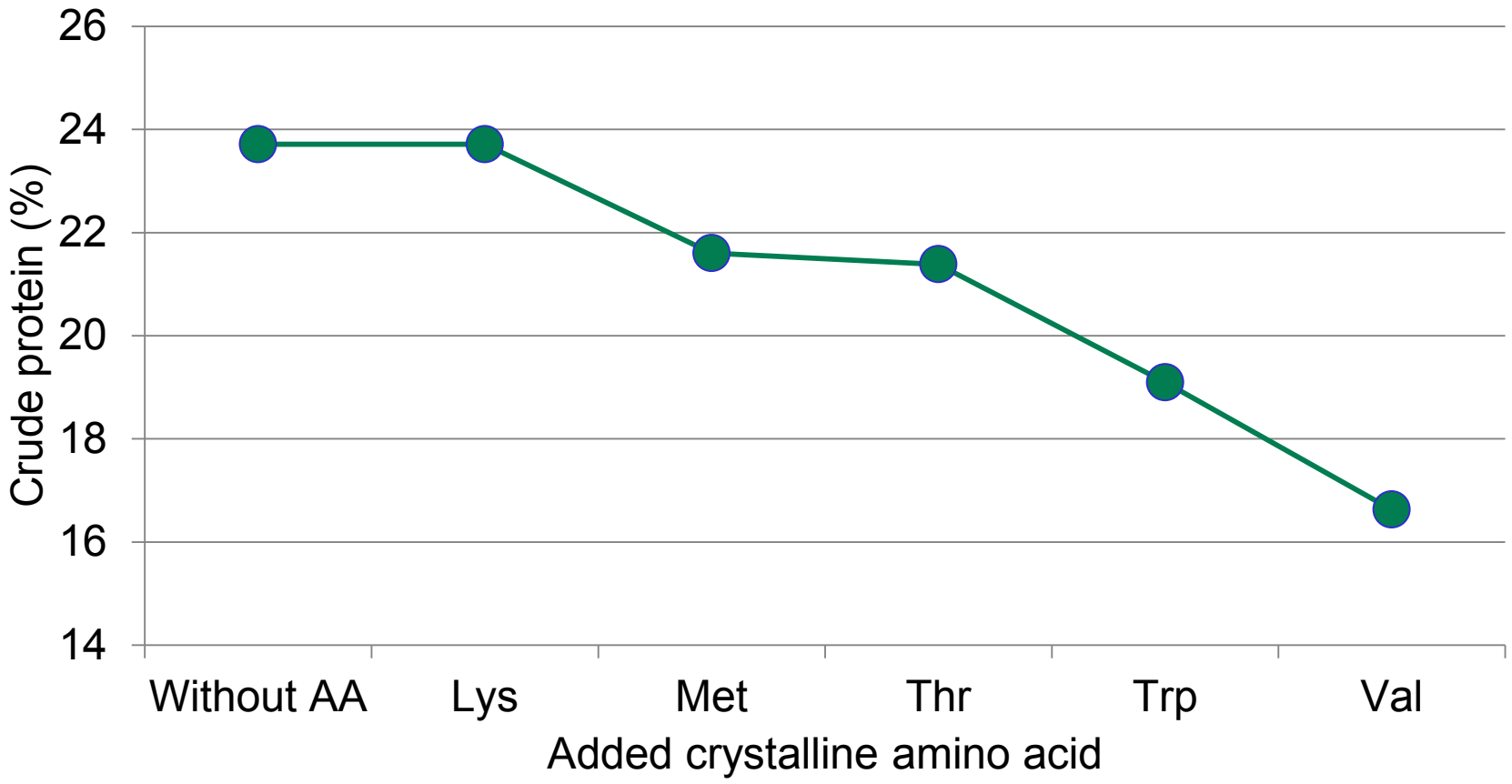

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Context

- To control nitrogen excretion:
  - control the CP content of the diet
  - use crystalline amino acids
  - improve the amino acid balance
- More amino acids become co-limiting (Lys, Met, Thr, Trp, and ….)

Crystalline amino acids allow reducing the CP content in diets



Diets formulated on a “least-CP” basis with 1.15% SID Lys

Ideal amino acid profiles

	INRA (1993)	NRC (1998)	BSAS (2003)
Lys*	100	100	100
Met*	30	27	30
Met+Cys	60	55	59
Thr*	65	60	65
Trp*	18	18	19
Val*	68	68	70
Ile	60	54	58
Leu	100	102	100
Phe	-	60	57
Phe+Tyr	95	93	100
His	32	32	34

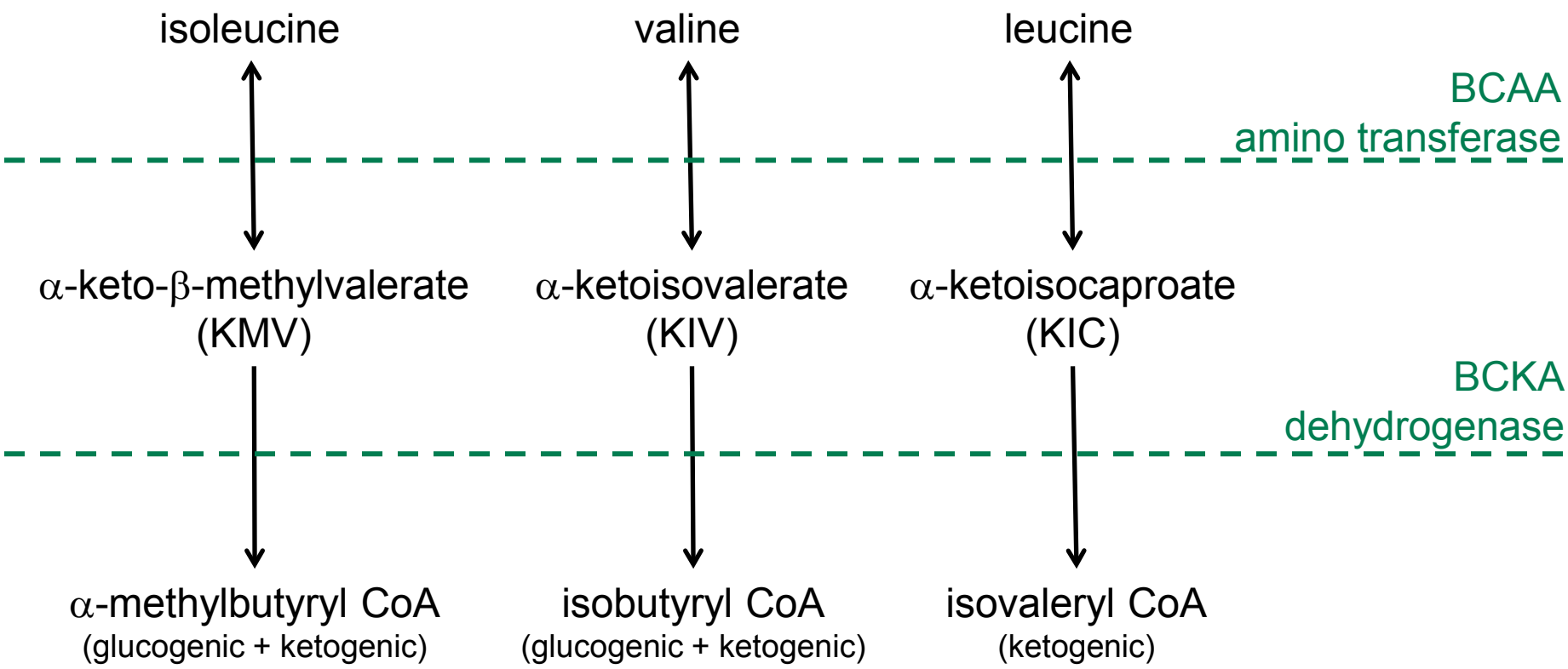
General objective

Acquire knowledge on the branched-chain amino acid (BCAA) requirements in piglets:

little information is available for valine, a little more for isoleucine

there may be interactions between the BCAA (Val, Ile, and Leu)

Metabolism of branched-chain amino acids



Experimental design



6 wk of age
~12 kg

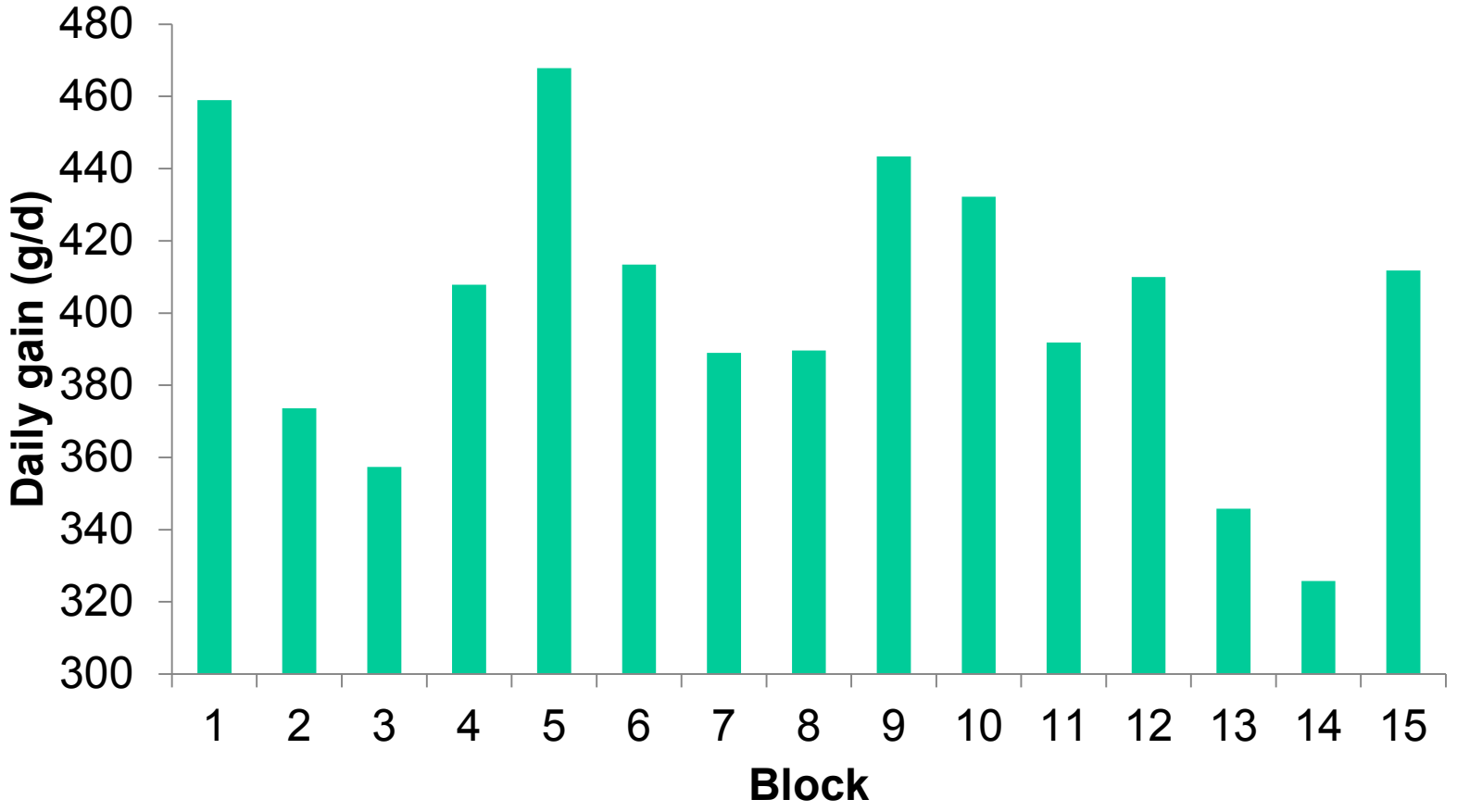
- Piétrain x (Large White x Landrace)
- Blocks of barrows and females
- 15-16 piglets per treatment
- Individually housed



9 wk of age
~24 kg

21 days

Why do we use a randomized block design?



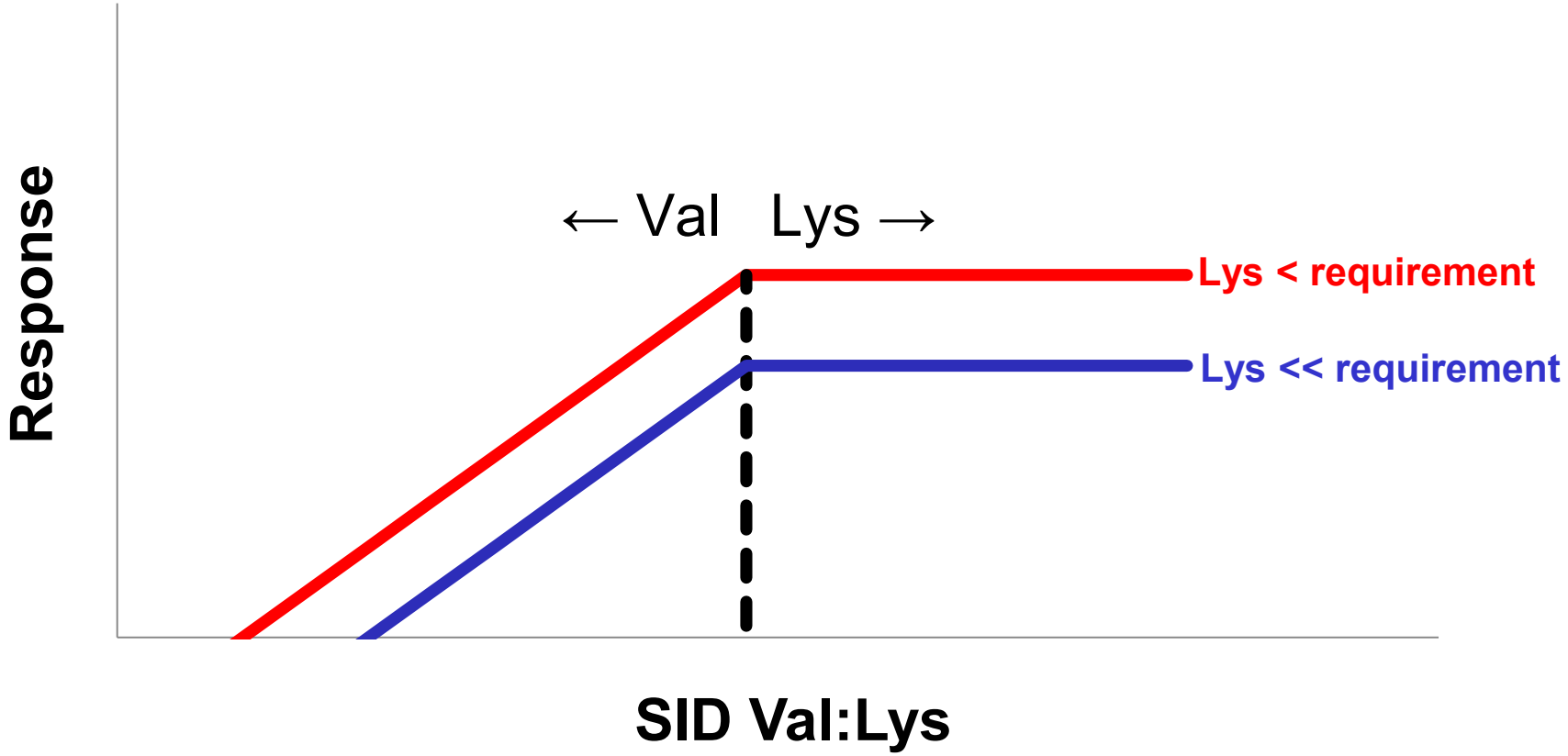
Diets and feeding

- Most diets based on a cereal mixture (60% corn, 20% wheat, 20% barley) and soybean meal
- L-Lys, DL-Met, L-Thr and L-Trp used if necessary
- Feeding level:
  - ~95% of ad libitum (exp. 1 and 2)
  - ad libitum (other experiments)

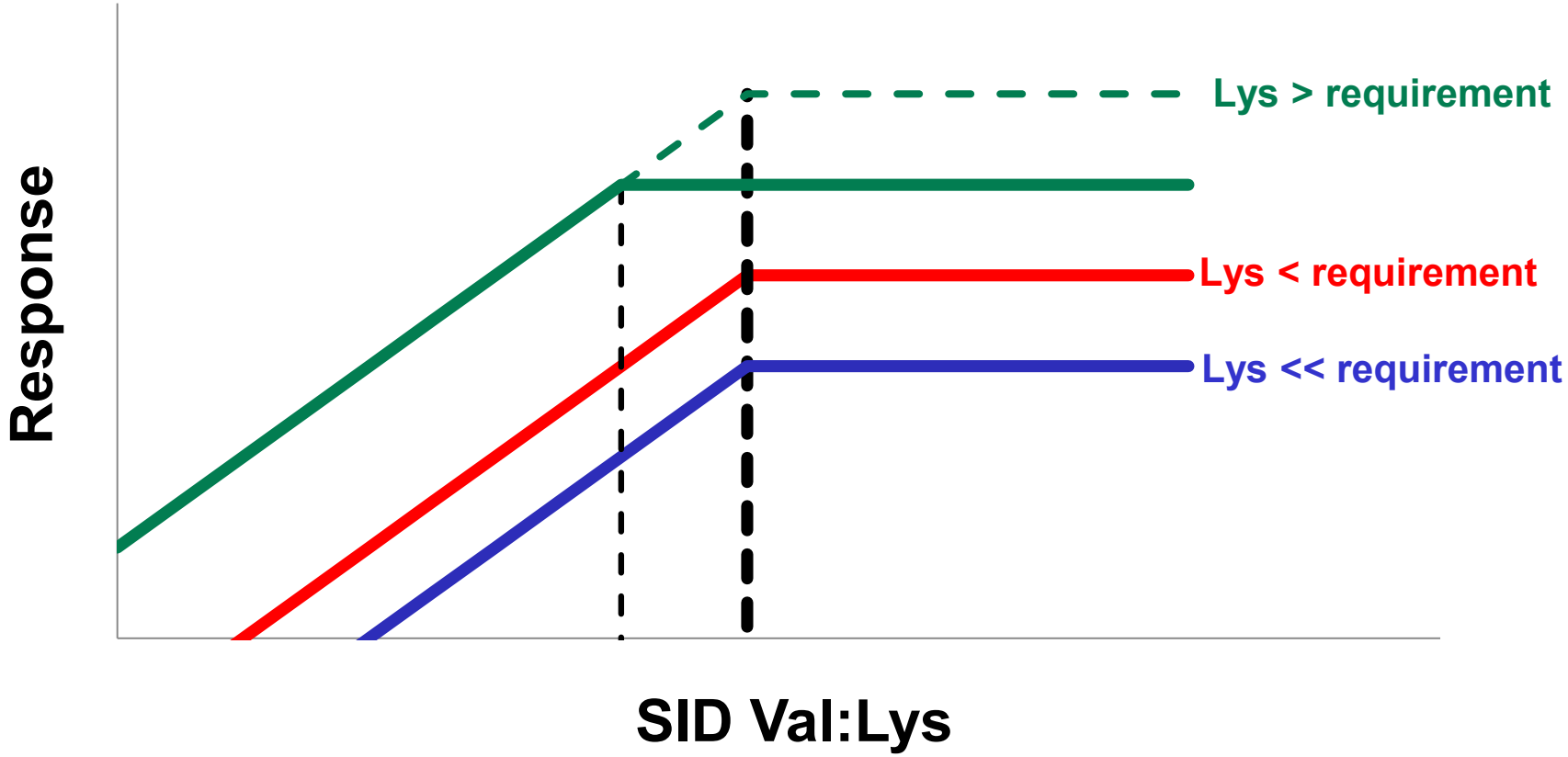
Preliminary studies

Experiment	Objective
1	Determination of a SID lysine level limiting performance
2	Response to L-Val and L-Ile supplementation

Why should Lys be second-limiting?



Why should Lys be second-limiting?



Determination of a SID Lys level limiting performance (exp. 1)

Crude protein, % SID Lys, %	17.3 1.00	18.3 1.20	21.1 1.20	RSD	*P*
Feed intake, g/d	820	818	803	27	0.18
Daily gain, g/d	486[a]	530[b]	513[b]	36	<0.01
Gain:Feed	0.59[a]	0.65[b]	0.64[b]	0.03	<0.01

Response to L-Val and L-Ile supplementation (exp. 2)

SID Val:Lys, % SID Ile:Lys, %	57 50	57 60	70 50	70 60	RSD	Probability Val	 Ile	 Val×Ile
Feed intake, g/d	689	695	814	808	55	<0.01	0.99	0.63
Daily gain, g/d	401	393	501	484	41	<0.01	0.25	0.65
Gain:Feed	0.58	0.57	0.62	0.60	0.03	<0.01	0.11	1.00

SID Lys: 1.0%
Other essential amino acids: ≥ ideal protein

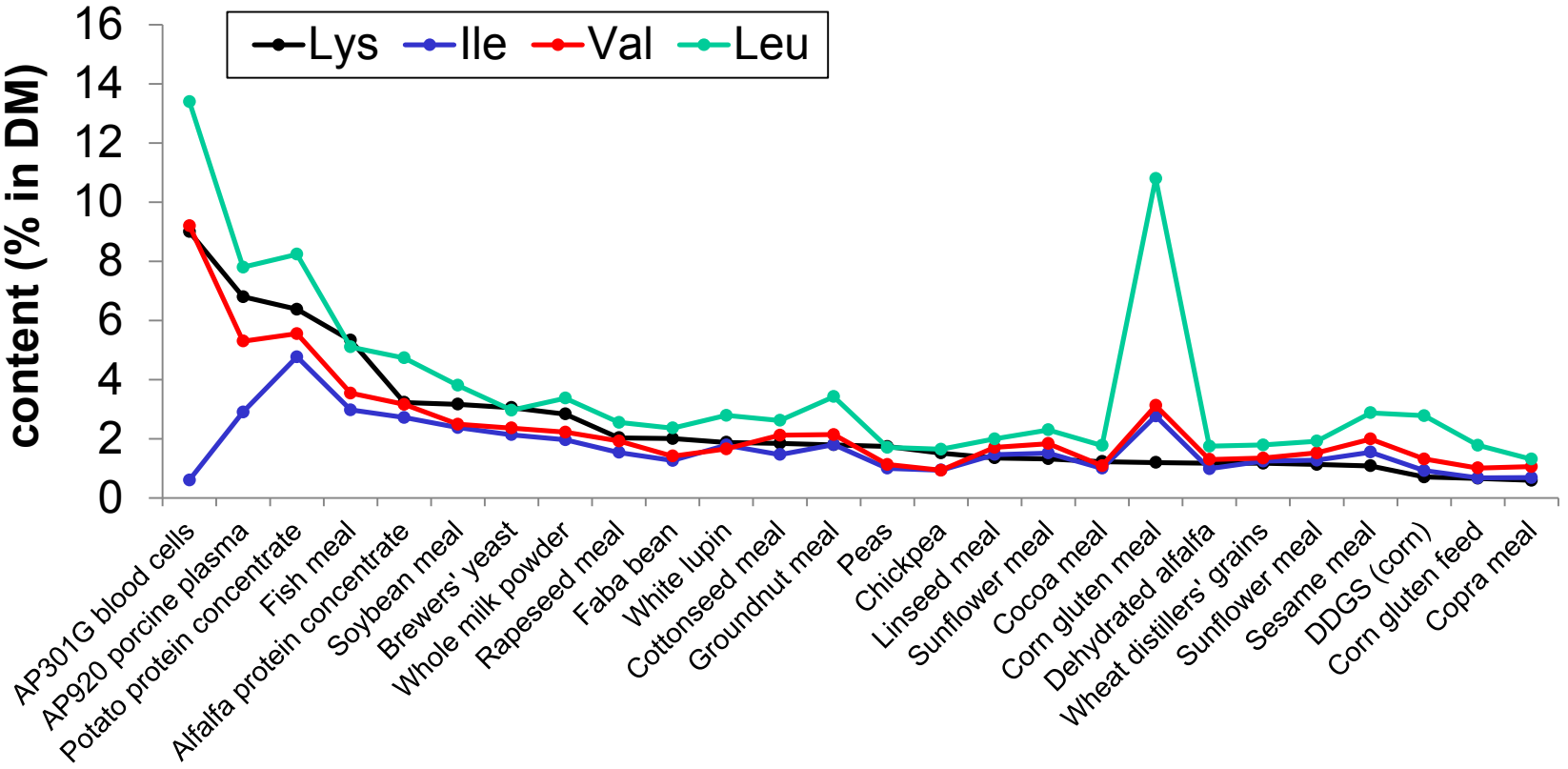
Isoleucine response/requirement studies

Experiment	Objective
3	Interaction between Ile and Lys
4	Interaction between Ile and other BCAA

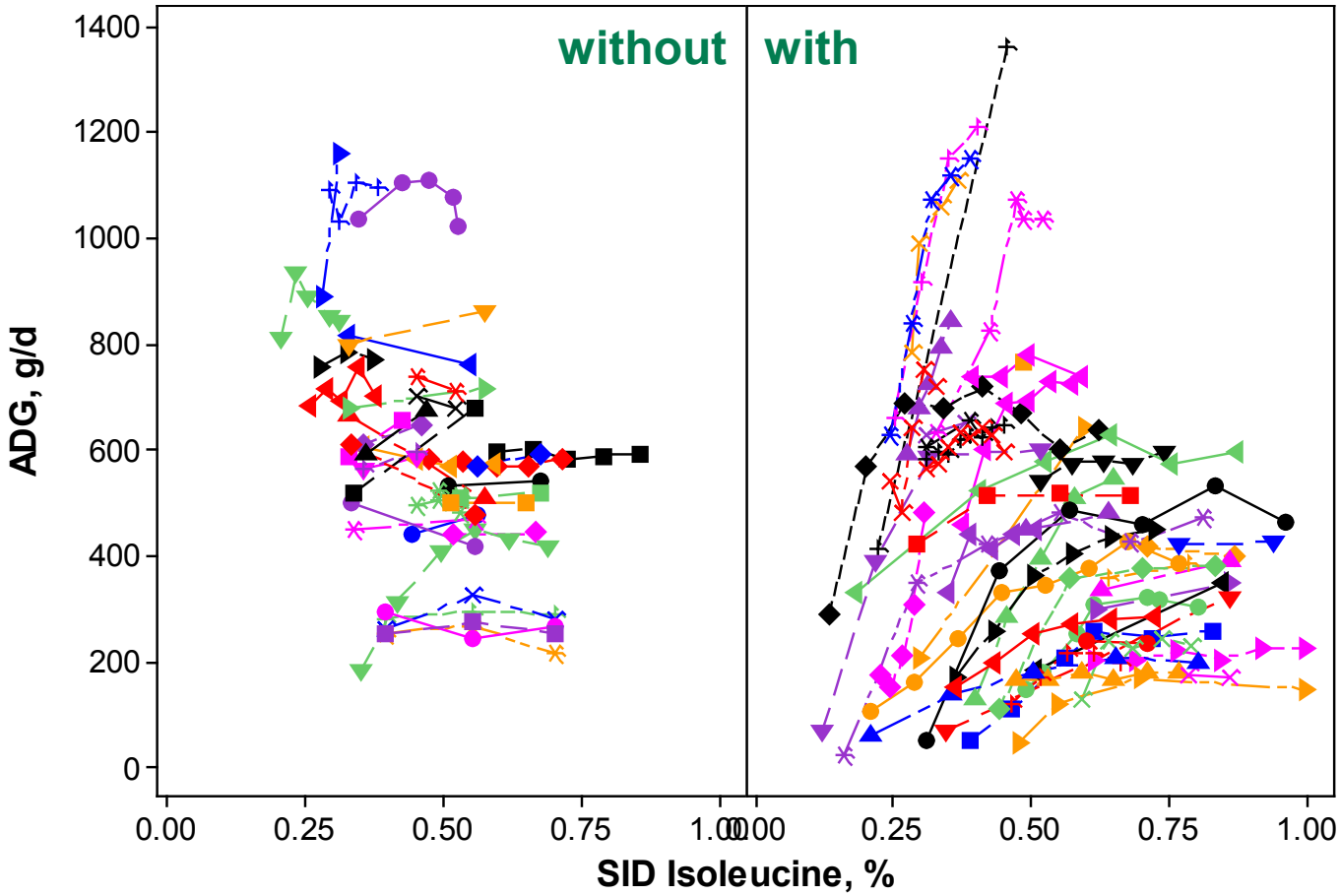
Interaction between Ile and Lys (exp. 3)

SID Lys, %	1.00	1.00	1.15	1.15		Probability		
SID Ile:Lys, %	48	60	48	60	RSD	Ile	Lys	Ile×Lys
Feed intake, g/d	800	819	815	827	123	0.61	0.70	0.91
Daily gain, g/d	443	478	501	499	76	0.39	0.04	0.33
Gain:Feed	0.56	0.58	0.62	0.60	0.05	0.85	<0.01	0.09

Amino acid content in feed ingredients



Reported responses to Ile supplementation: with *vs* without blood cells



Interactions between Ile and excess BCAA (exp. 4)

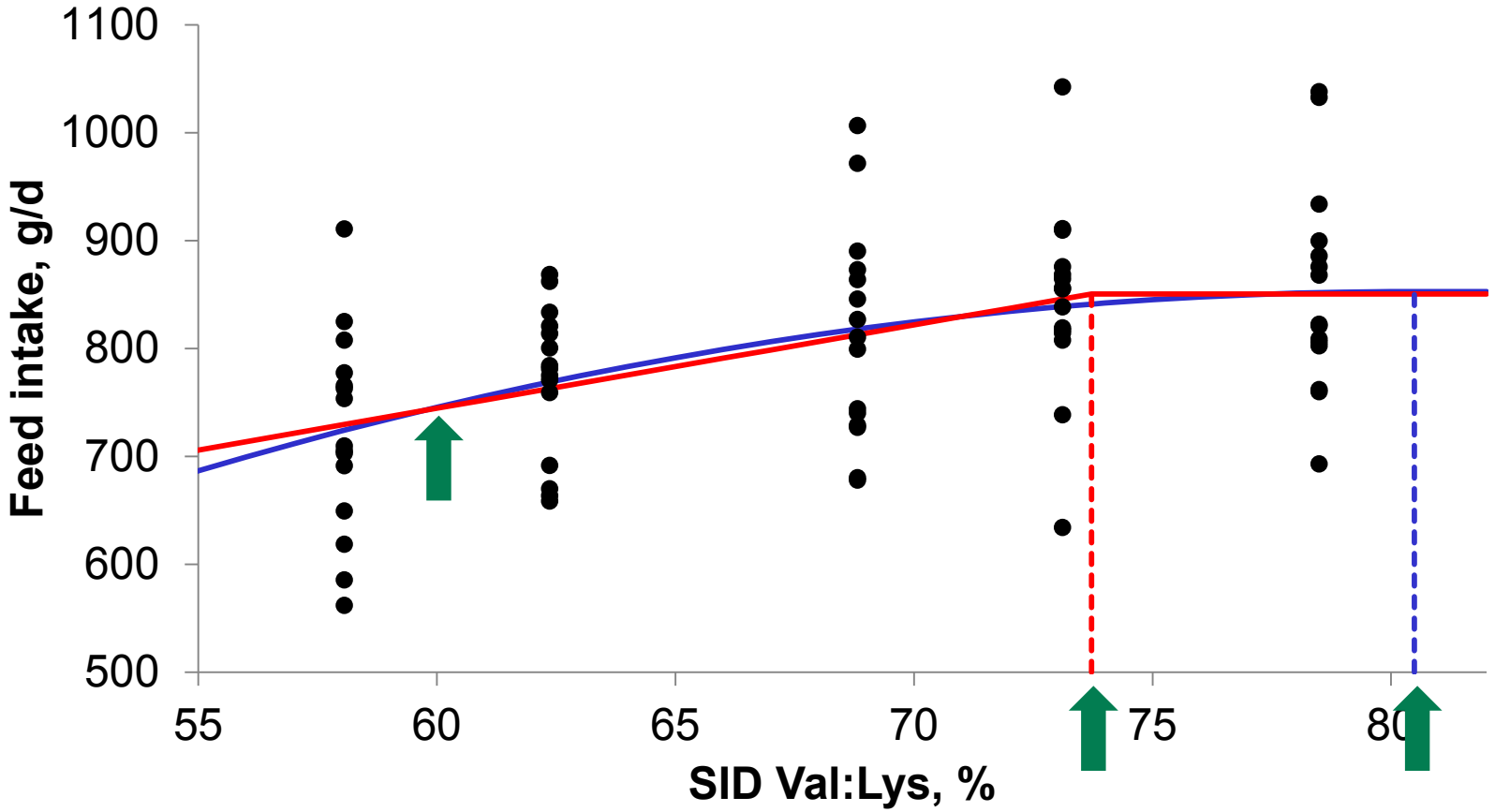
Protein source	Corn gluten meal		Spray-dried blood cells			Probability		
SID Ile:Lys, %	50	65	50	65	RSD	source	Ile	source×Ile
SID Val:Lys, %	70	70	105	105				
SID Leu:Lys, %	180	180	168	168				
Feed intake, g/d	744	744	736	803	75	0.20	0.09	0.08
Daily gain, g/d	442	444	449	482	62	0.16	0.28	0.35
Gain:Feed	0.59	0.60	0.61	0.60	0.04	0.27	0.65	0.43

Valine response/requirement studies

Experiment	Objective
5	Response to L-Val supplementation (“control” BCAA)
6	Response to L-Val supplementation (excess Leu; corn gluten meal)
7	Interaction between Val and excess Leu

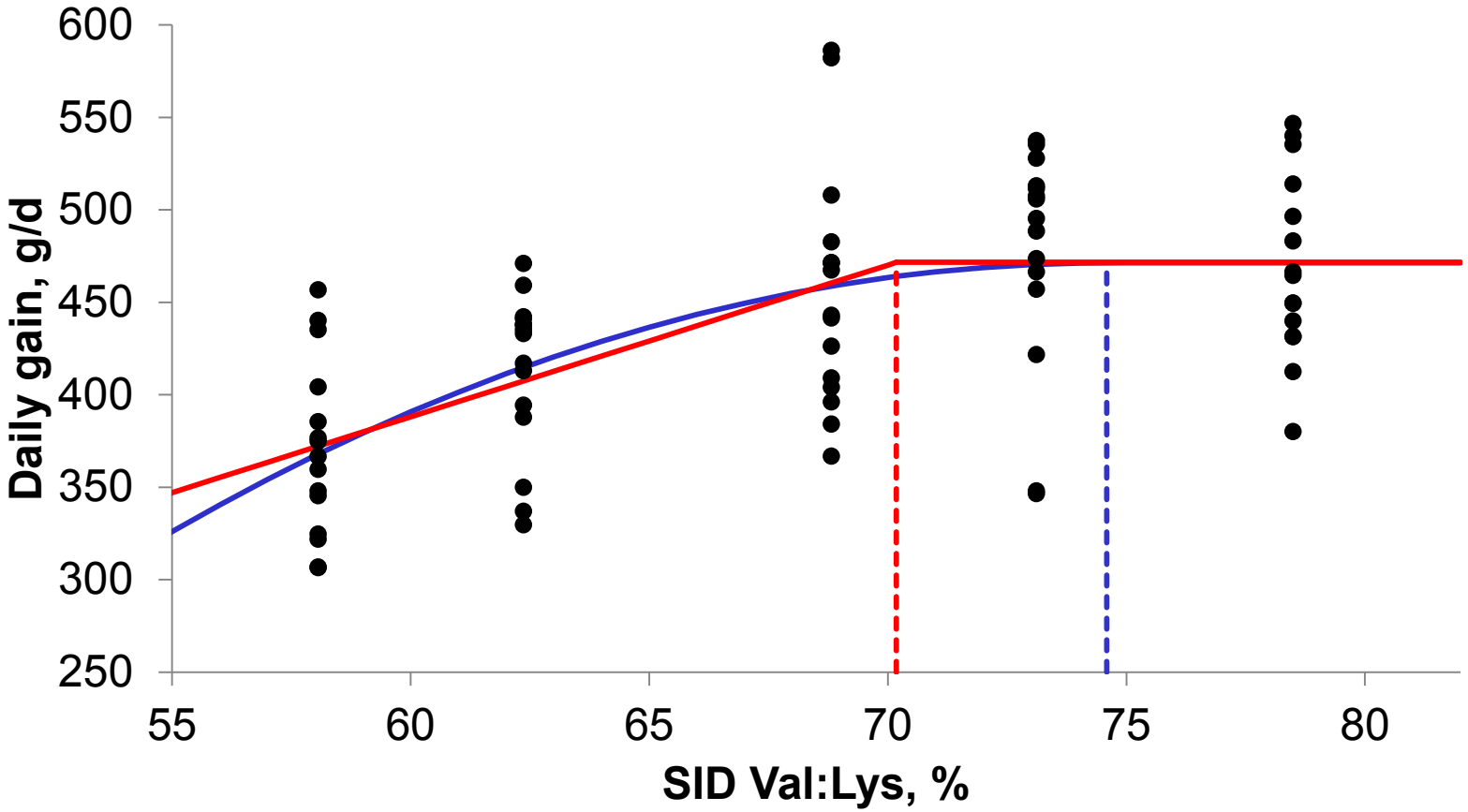
Response to Val supplementation (exp. 5)

("control" BCAA; 55% Ile:Lys; 113% Leu:Lys)



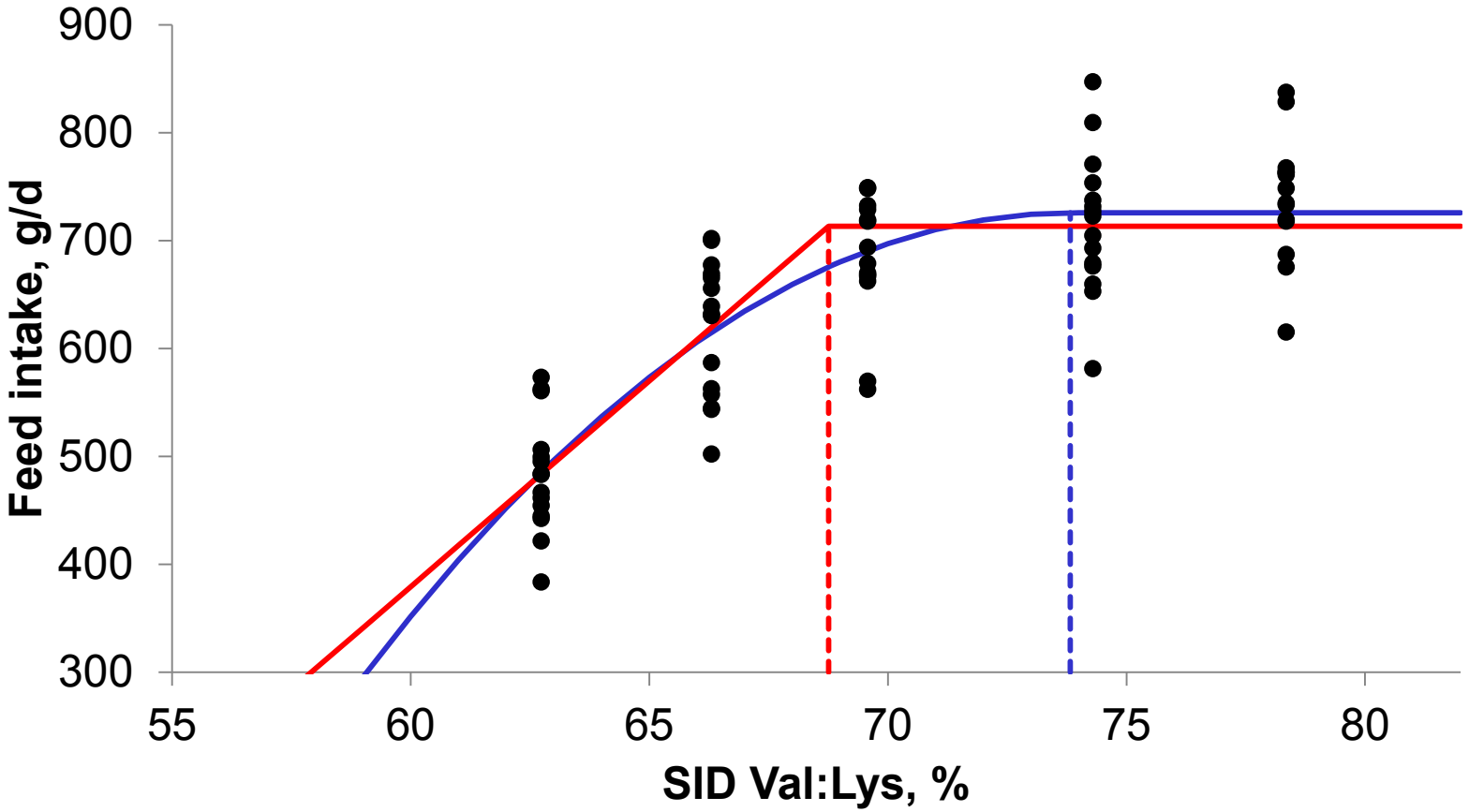
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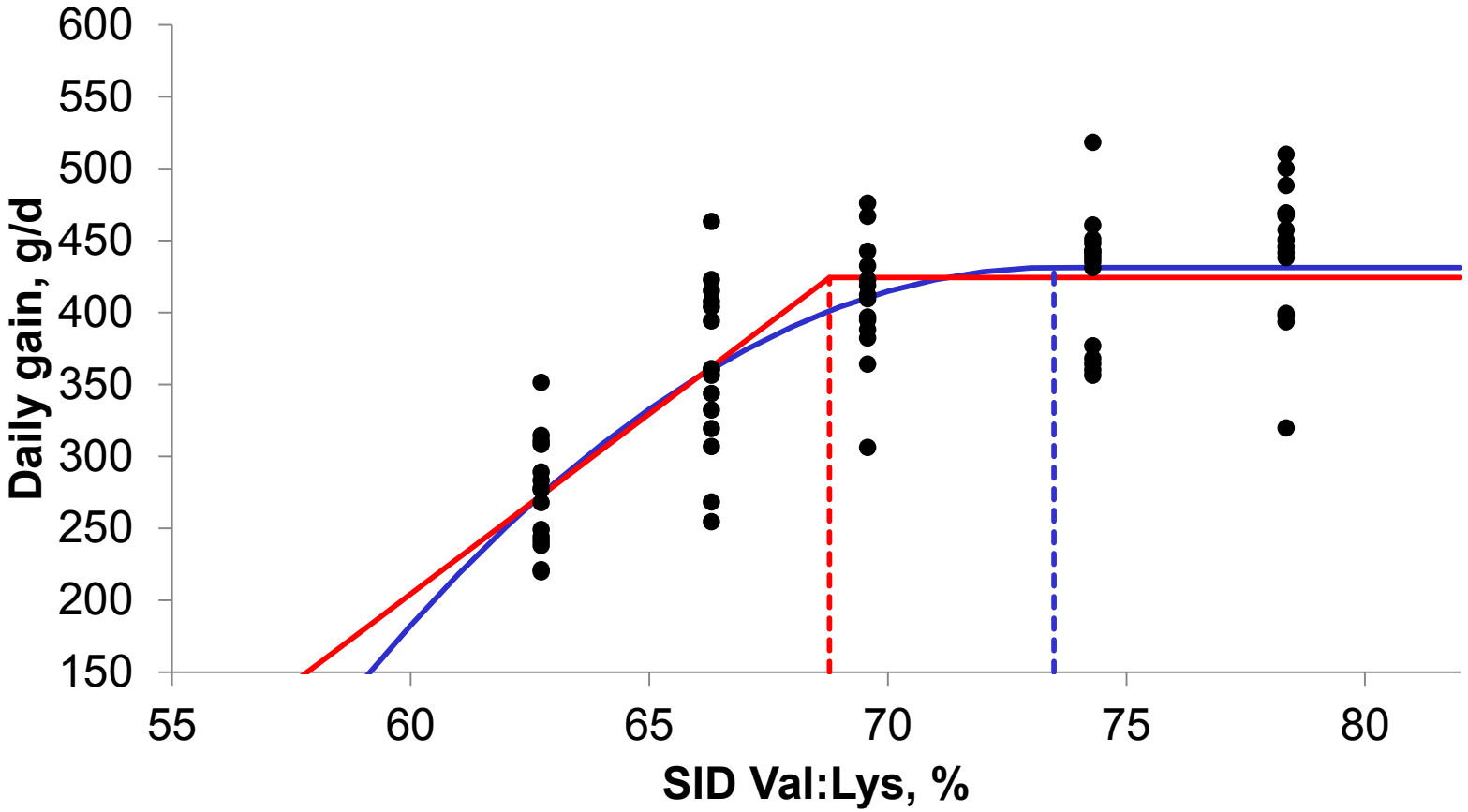
Response to Val supplementation (exp. 6)

(excess Leu; 65% Ile:Lys; 166% Leu:Lys)



Response to Val supplementation (exp. 6)

(excess Leu; 65% Ile:Lys; 166% Leu:Lys)



Response to Val supplementation (exp. 5 and 6)

	Linear-plateau			Curvilinear-plateau		
	ADFI	ADG	F:G	ADFI	ADG	F:G
"Requirement", % SID Val:Lys						
Exp. 3 (control BCAA)	73.7	70.2	67.7	80.5	74.6	71.7
Exp. 4 (excess Leu)	68.8	68.8	-	73.8	73.5	-
Response at 60% SID Val:Lys (% of the plateau value)						
Exp. 3 (control BCAA)	87.5	82.3	94.3	87.4	82.9	94.6
Exp. 4 (excess Leu)	53.2	48.1	-	48.4	42.3	-

Interactions between Val and excess Leu (exp. 7)

Protein source	Soybean meal		Corn gluten meal		RSD	Probability		
SID Val:Lys, %	60	70	60	70		source	Val	source×Val
SID Leu:Lys, %	111	111	165	165				
Feed intake, g/d	727	843	645	850	97	0.04	<0.01	0.24
Daily gain, g/d	325	465	242	420	69	<0.01	<0.01	0.28
Gain:Feed	0.45	0.55	0.38	0.51	0.07	<0.01	<0.01	0.39

preliminary results

Conclusions

Isoleucine:

The requirement may be as low 50% SID Ile:Lys (especially in diets based on cereals and SBM)

Valine:

The requirement is at least 70% SID Val:Lys in piglets

Excess leucine:

Little or no effect on Ile requirement (in our studies)

May amplify the negative effect of a Val deficiency

Thanks

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