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From crude protein to precision protein: a way to reduce the dietary protein content for piglets

Jaap van Milgen, Mathieu Gloaguen, Roberto Barea,
Ludovic Brossard and Nathalie Le Floc'h



AGRO
CAMPUS
OUEST

ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

INRA

Outline

- Introduction
- Expressing amino acid requirements and interpreting the response to the amino acid supply
- Responses to the supply of Ile and Val (meta-analyses)
- How far can we go with precision protein?
- Conclusions

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- **Introduction**
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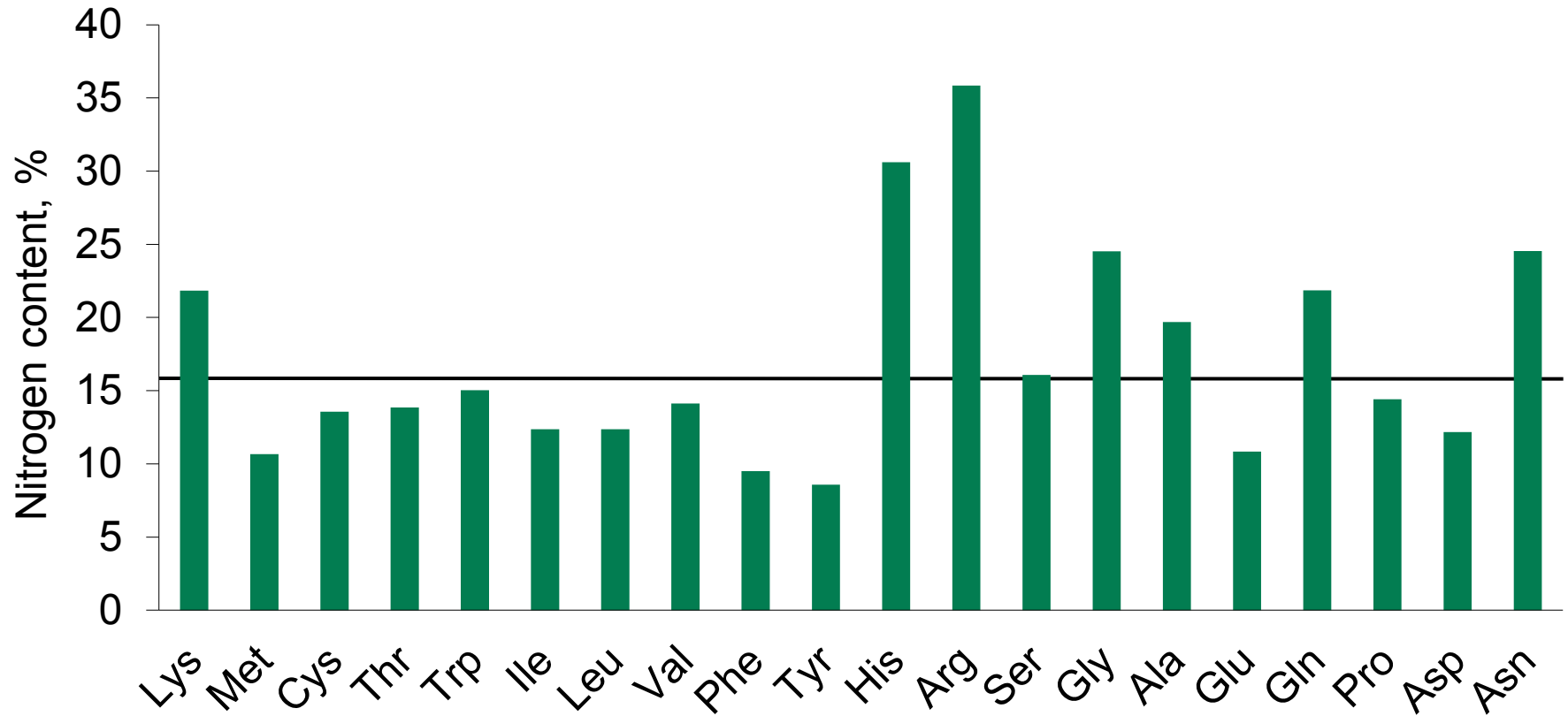
Previous presentations at Indukern symposia

- Jaap van Milgen (2009):
 - Response to the Val and Ile supply
- Mathieu Gloaguen (2011):
 - Interactions among branched-chain amino acids
- Mathieu Gloaguen (2012):
 - Response to the Ile, Leu, and His supply

Introduction

- Reducing the CP content in the diet:
 - Reduces the risk of digestive problems
 - Increases the efficiency of N utilization
 - Reduces N excretion
- With the use of L-Lys, DL-Met, L-Thr, L-Trp, and L-Val, more amino acids potentially become colimiting
- Little is known about the “requirements” of secondary amino acids

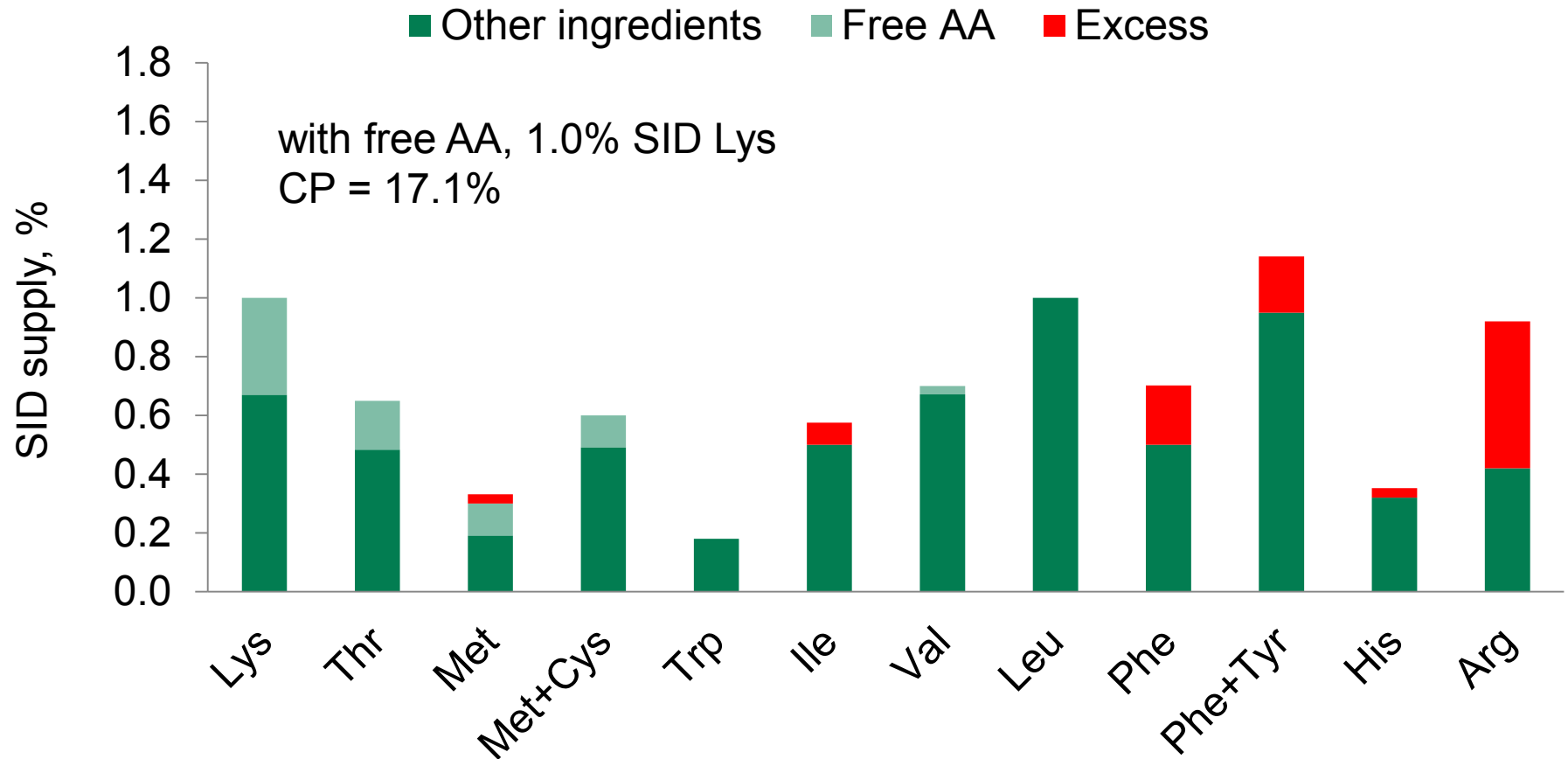
The CP content of amino acids is rather “crude”



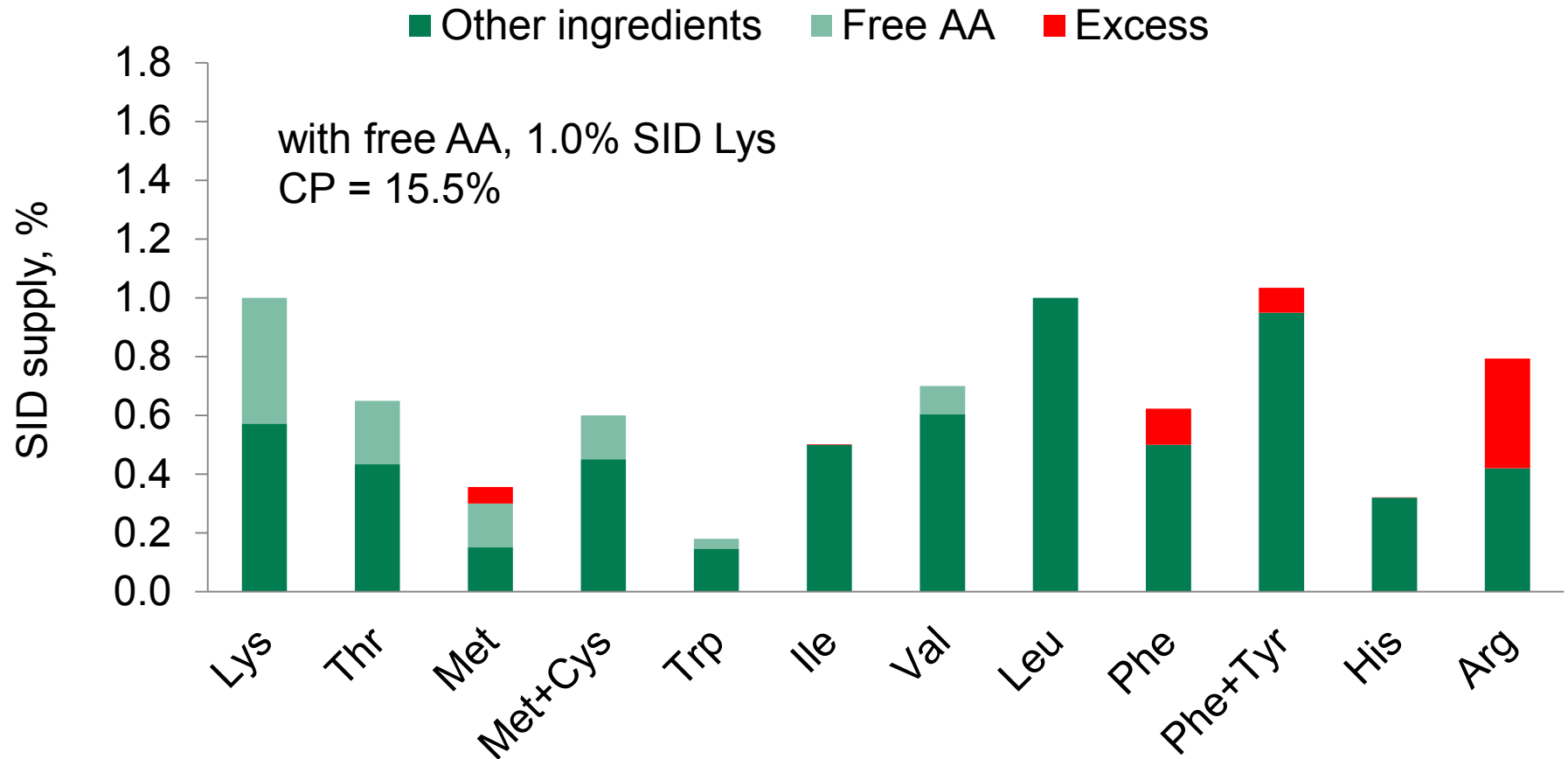
Using free AA allows improving the AA profile



Using free AA allows improving the AA profile



Using free AA allows improving the AA profile



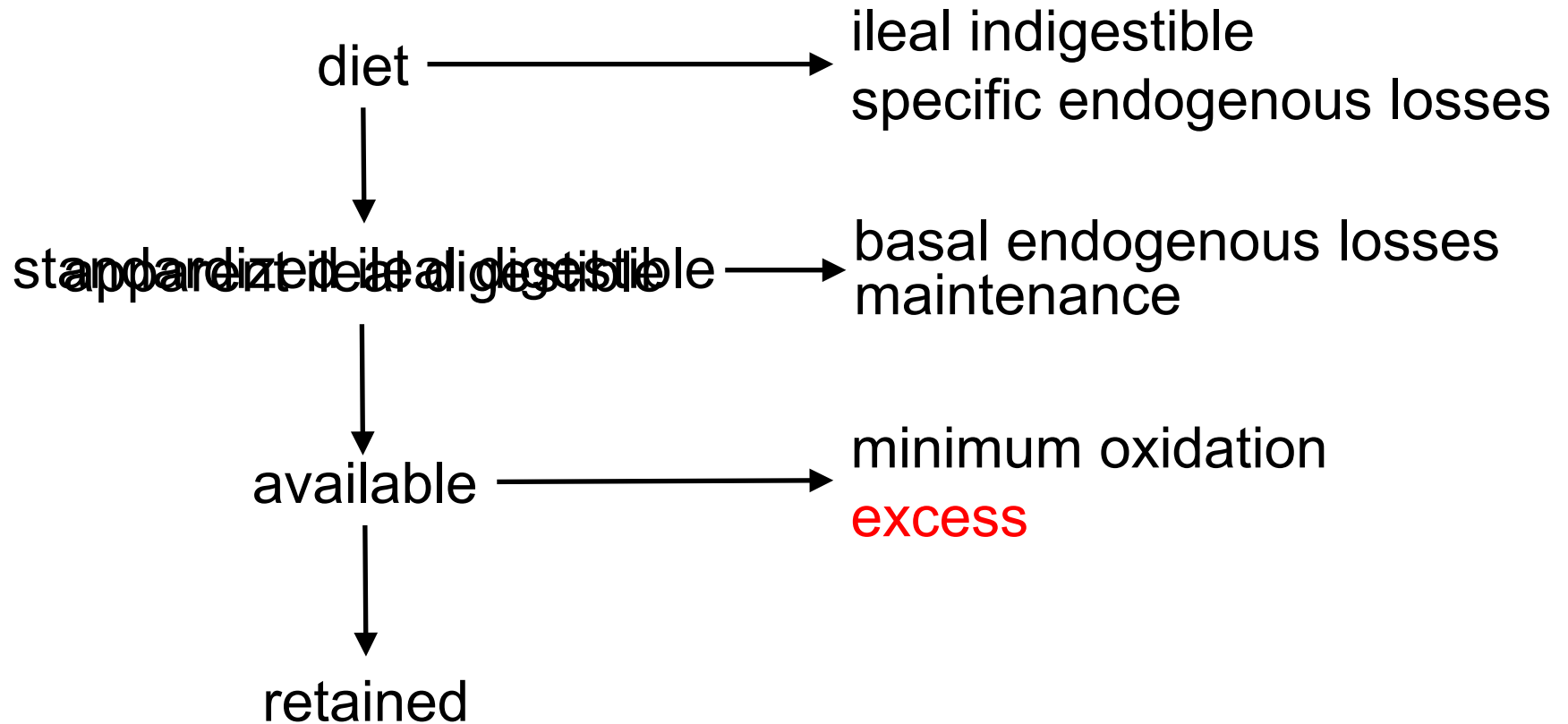
Outline

- Introduction
- **Expressing amino acid requirements and interpreting the response to the amino acid supply**
- Responses to the supply of Ile and Val (meta-analyses)
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Expressing amino acid requirements and interpreting the response to the amino acid supply

- Expressing AA requirements (AID, SID, % of Lys)
- Experimental considerations
- Estimating “the” requirement vs the response

Expressing amino acid requirements

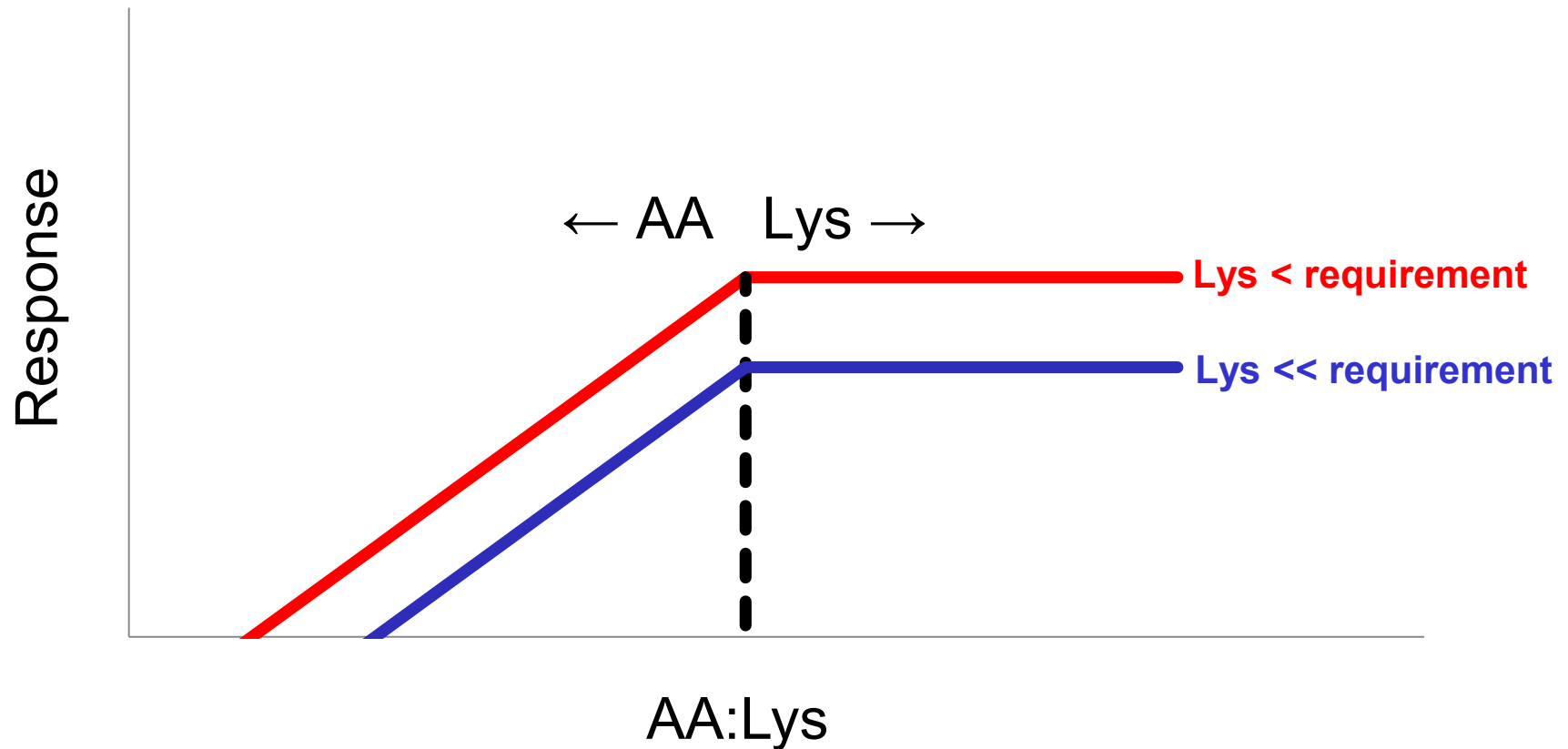


Amino acid requirements are typically greater when expressed on a SID basis

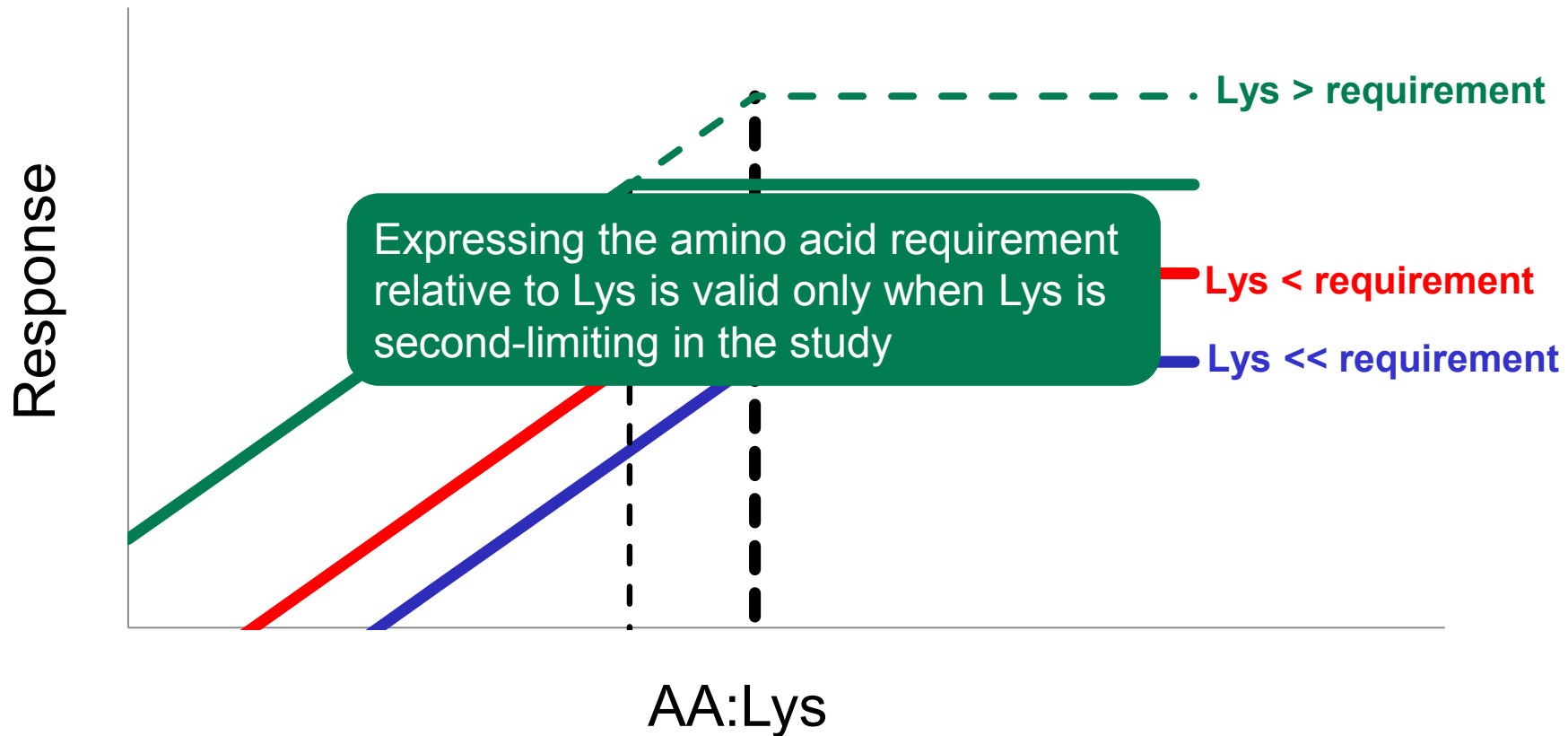
	AID*	Basal endogenous losses*	SID*
Lys	100	100	100
Met	30	28	30
Met + Cys	59	72	60
Thr	63	105	65
Trp	17	37	18
Val	68	114	70
Ile	53	82	54
Leu	98	136	99
Phe	48	87	49
Phe + Tyr	92	159	94
His	31	41	32

* Profile used in InraPorc

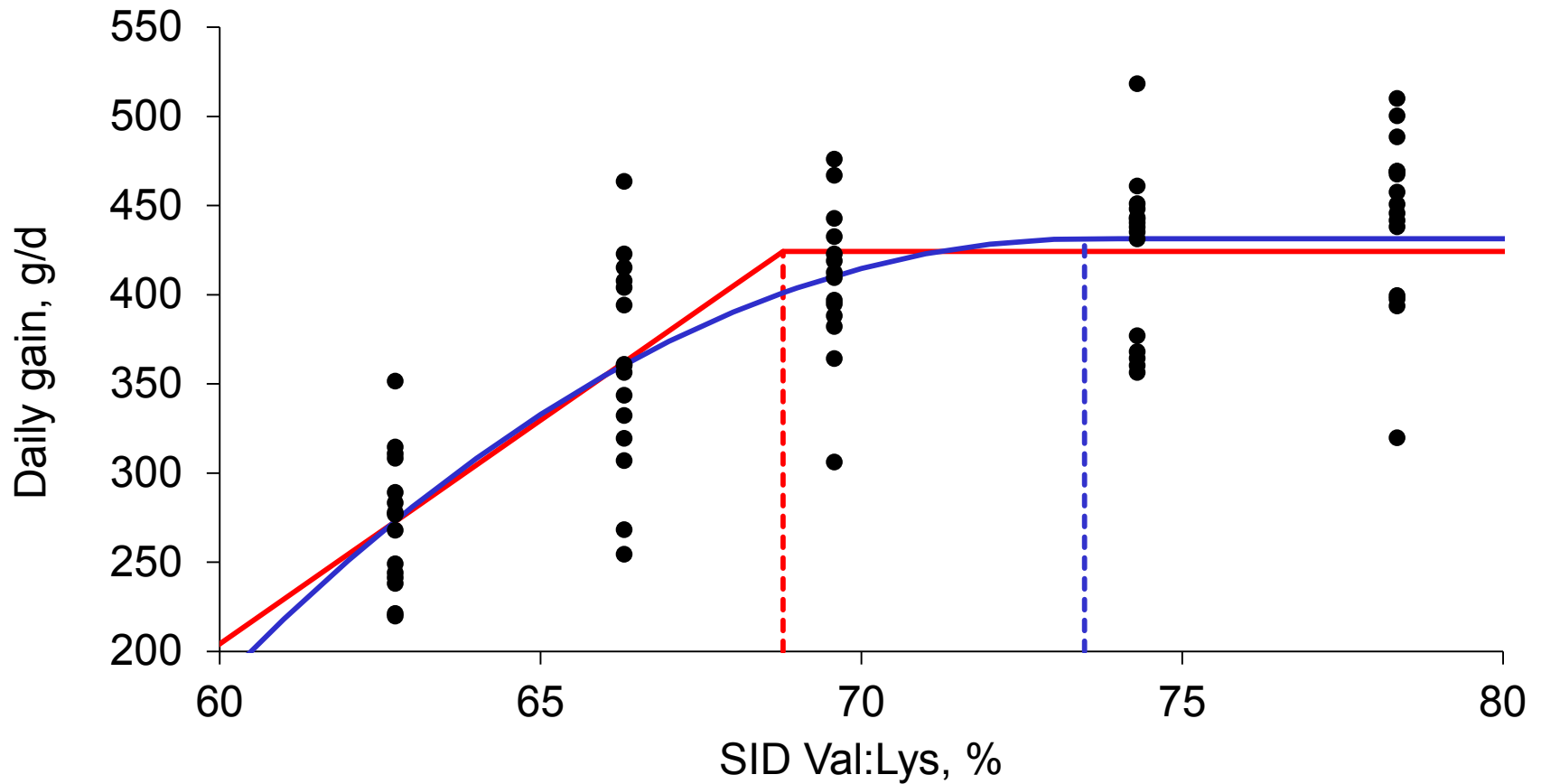
The second-limiting factor in a dose-response study should be known



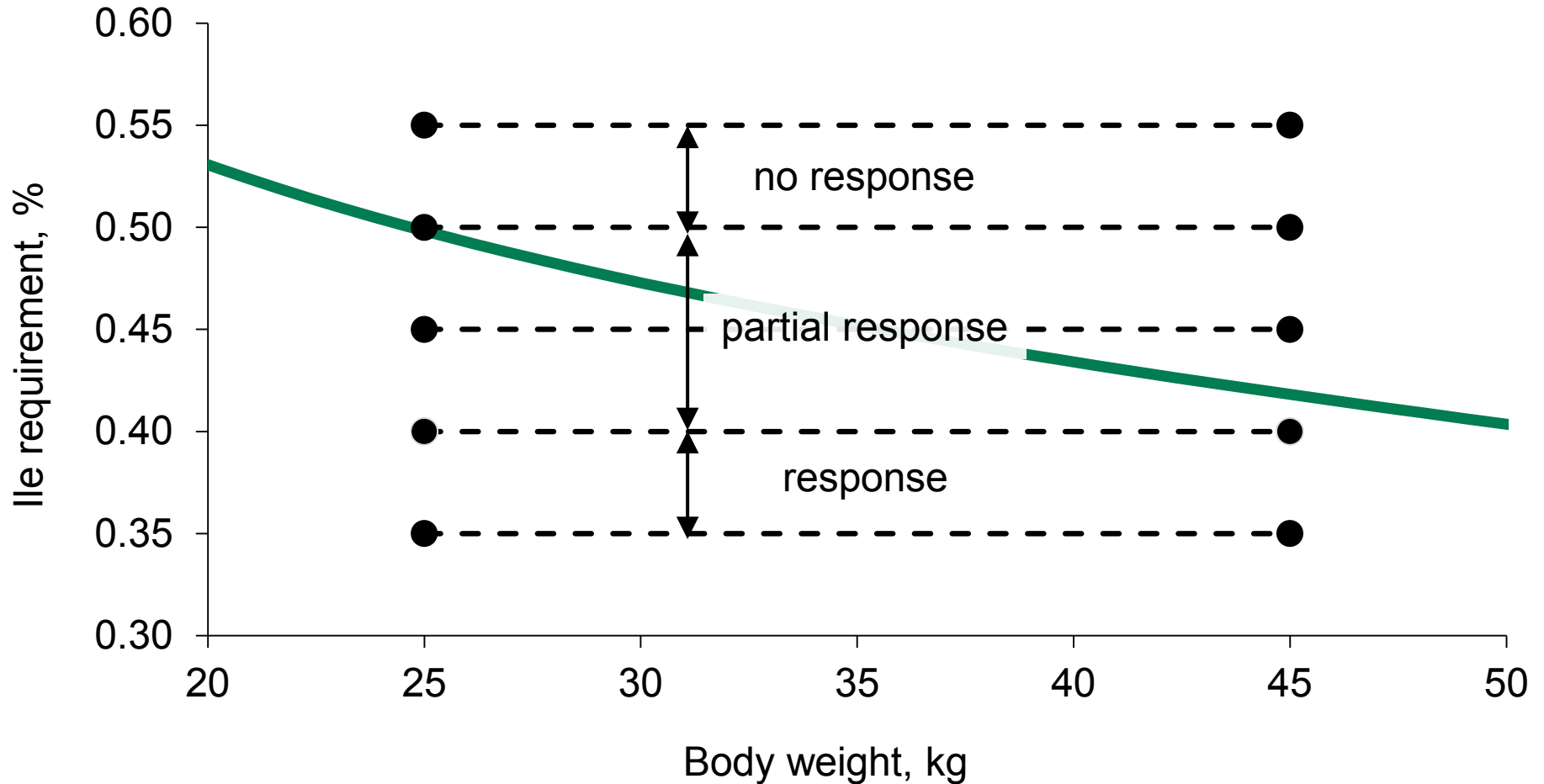
The second-limiting factor in a dose-response study should be known



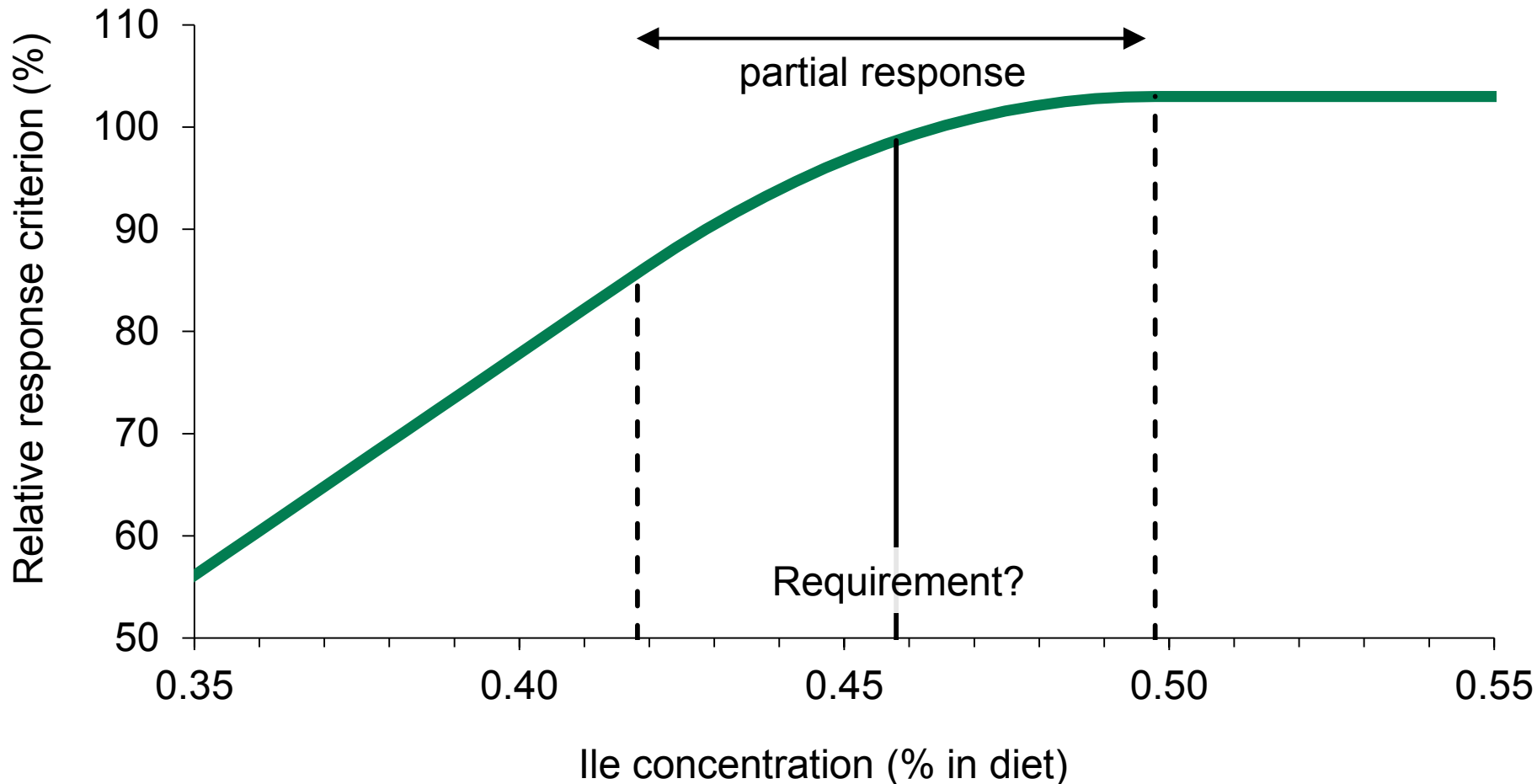
Estimating “the” requirement vs the response



The amino acid requirement typically declines during the experiment



The amino acid requirement typically declines during the experiment



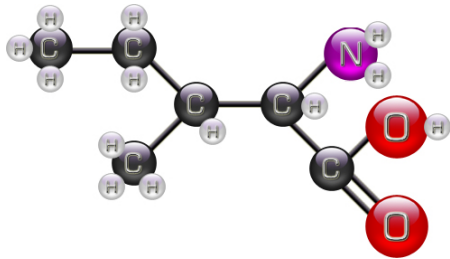
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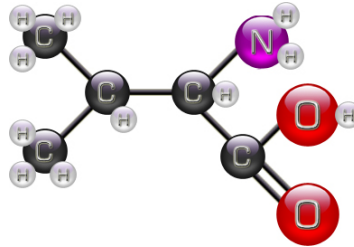
Ideal profile of branched-chain amino acids

	INRA (1993)	NRC (1998)	BSAS (2003)
Lys	100	100	100
Val	70	68	70
Ile	60	54	58
Leu	100	102	100

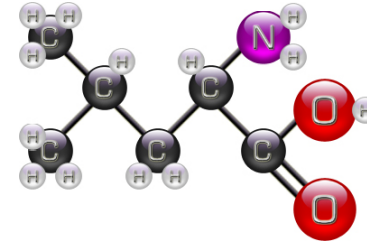
Metabolism of branched-chain amino acids



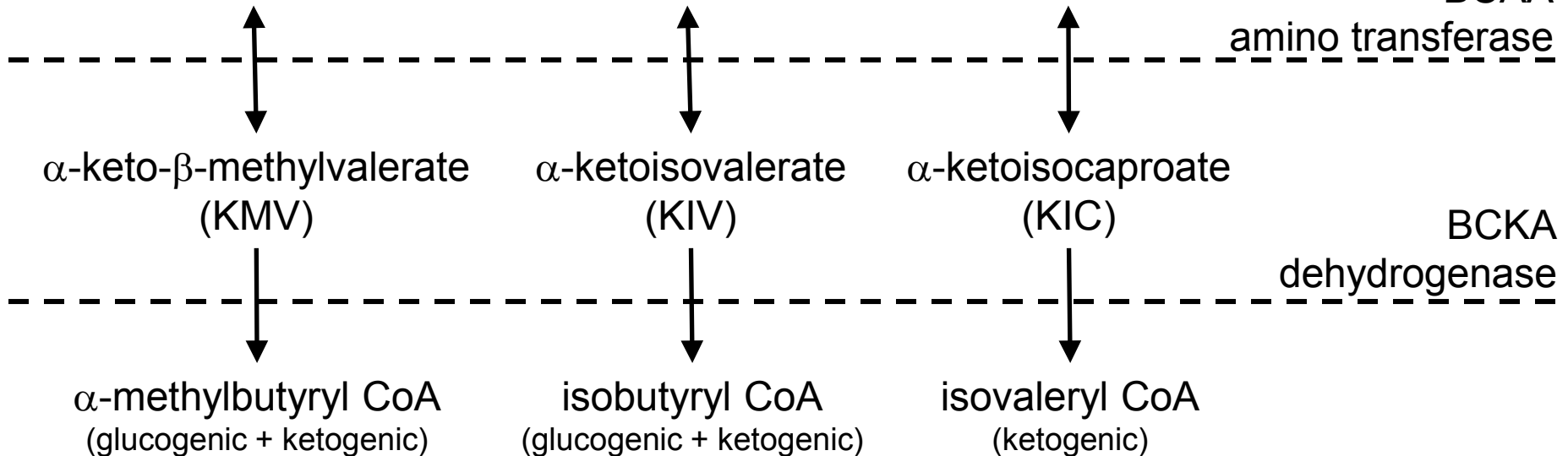
isoleucine



valine



leucine



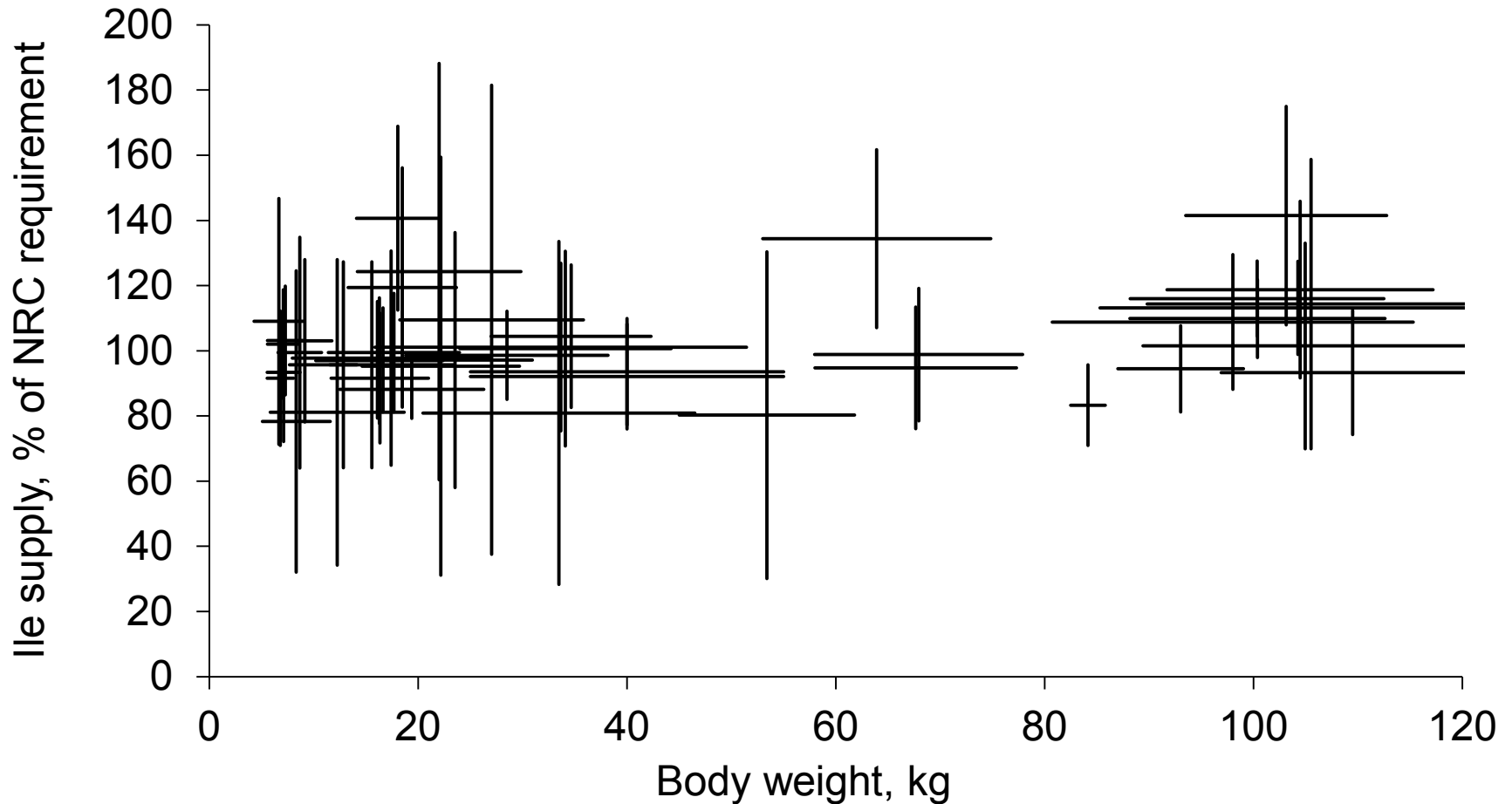
What do we know about branched-chain amino acid requirements in growing pigs?

	Ile	Val	Leu
Publications:	22	20	1 (+1)
- Peer-reviewed	12	9	1 (+1)
- Other	10	11	
Dose response experiments:	46	28	2 (+2)
- Peer-reviewed	24	15	2 (+2)
- Other	22	13	

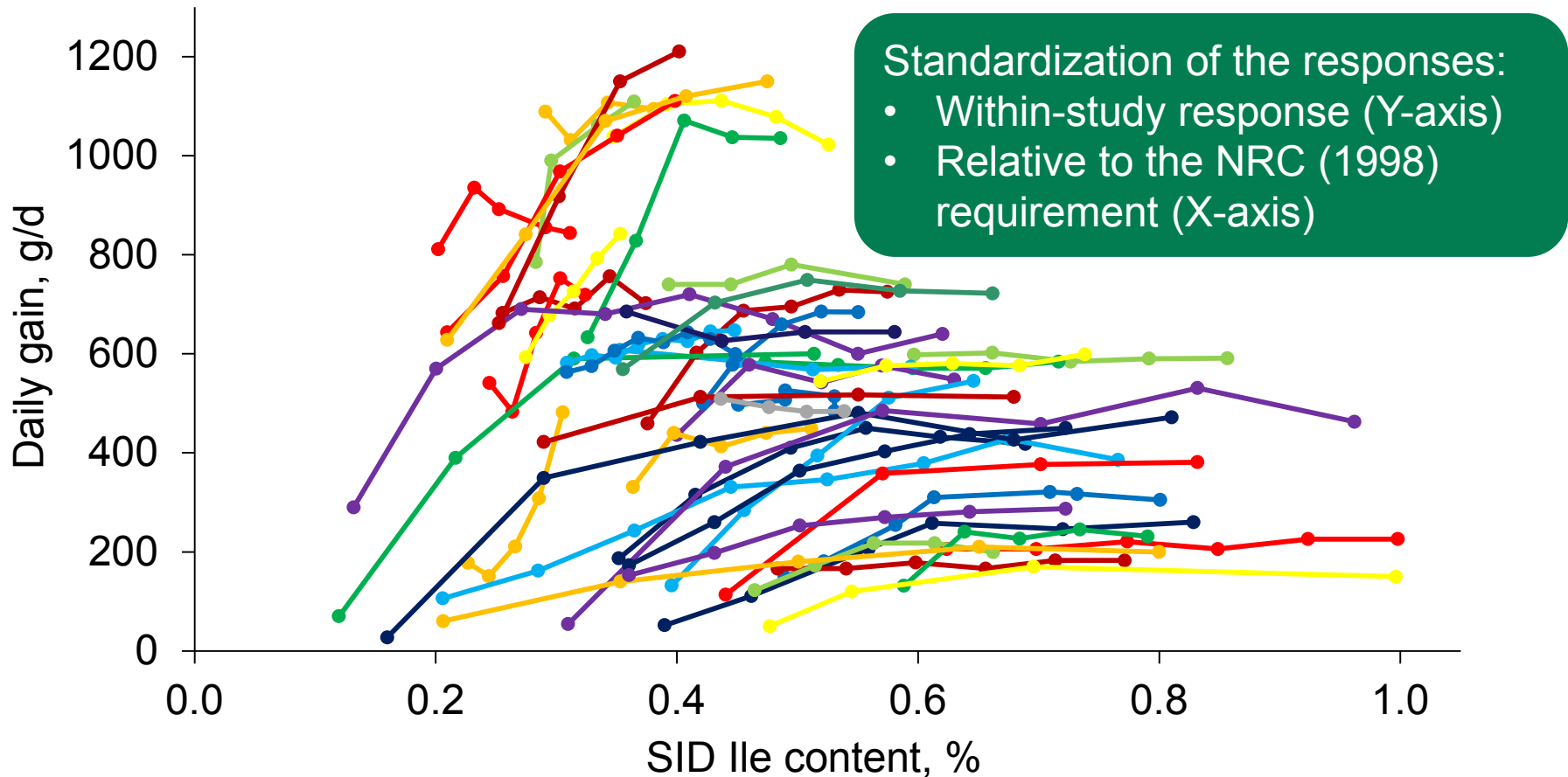
Meta-analyses to quantify the response to the Ile and Val supply

- Dose-response studies reported since the 1950s
- Criteria for selection:
 - Supplementation with ≥ 4 levels of L-Ile (or D-Ile), or L-Val (or D-Val)
 - Diet composition
 - Intake and growth response

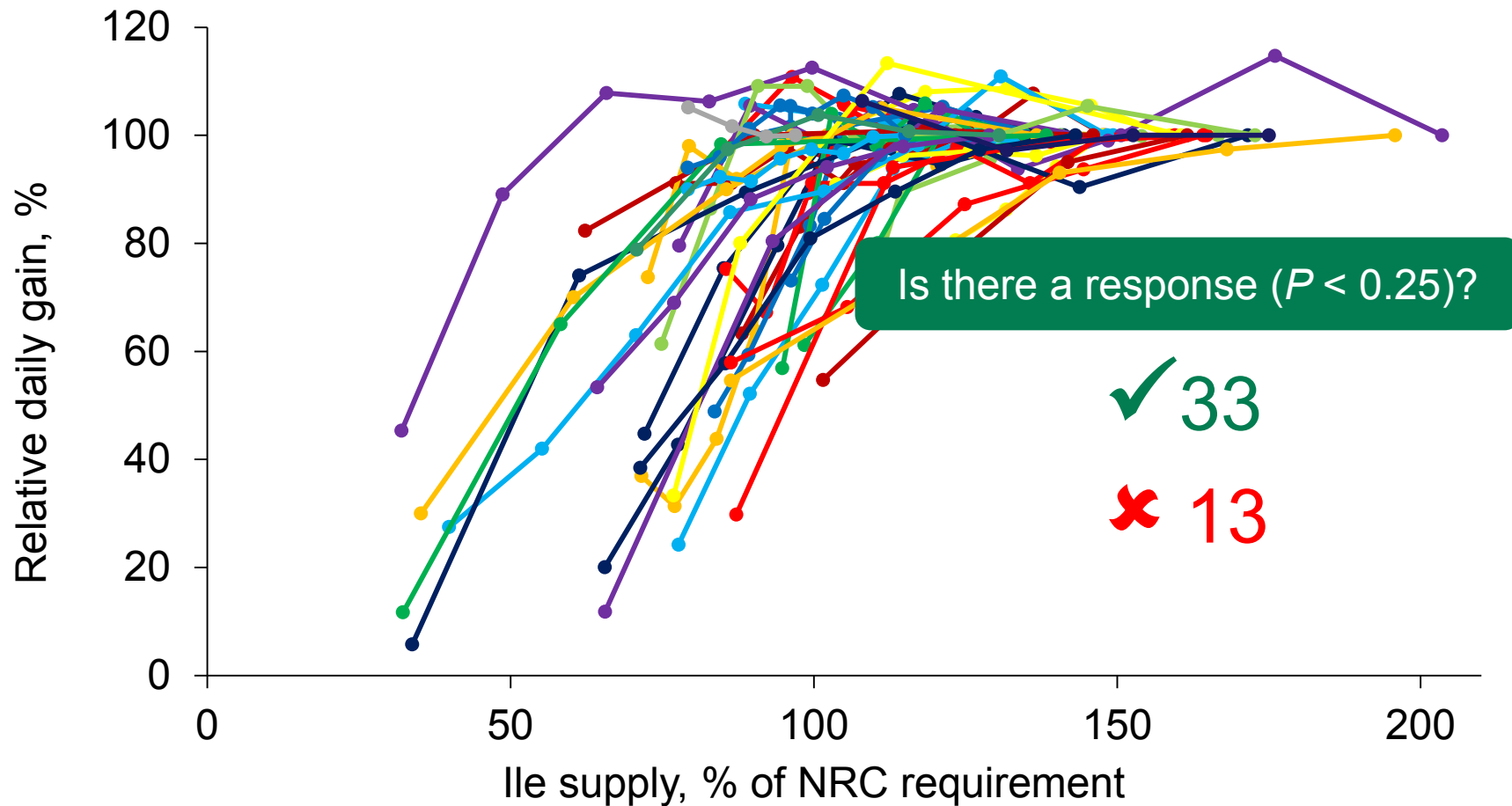
Meta-design of Ile dose-response studies



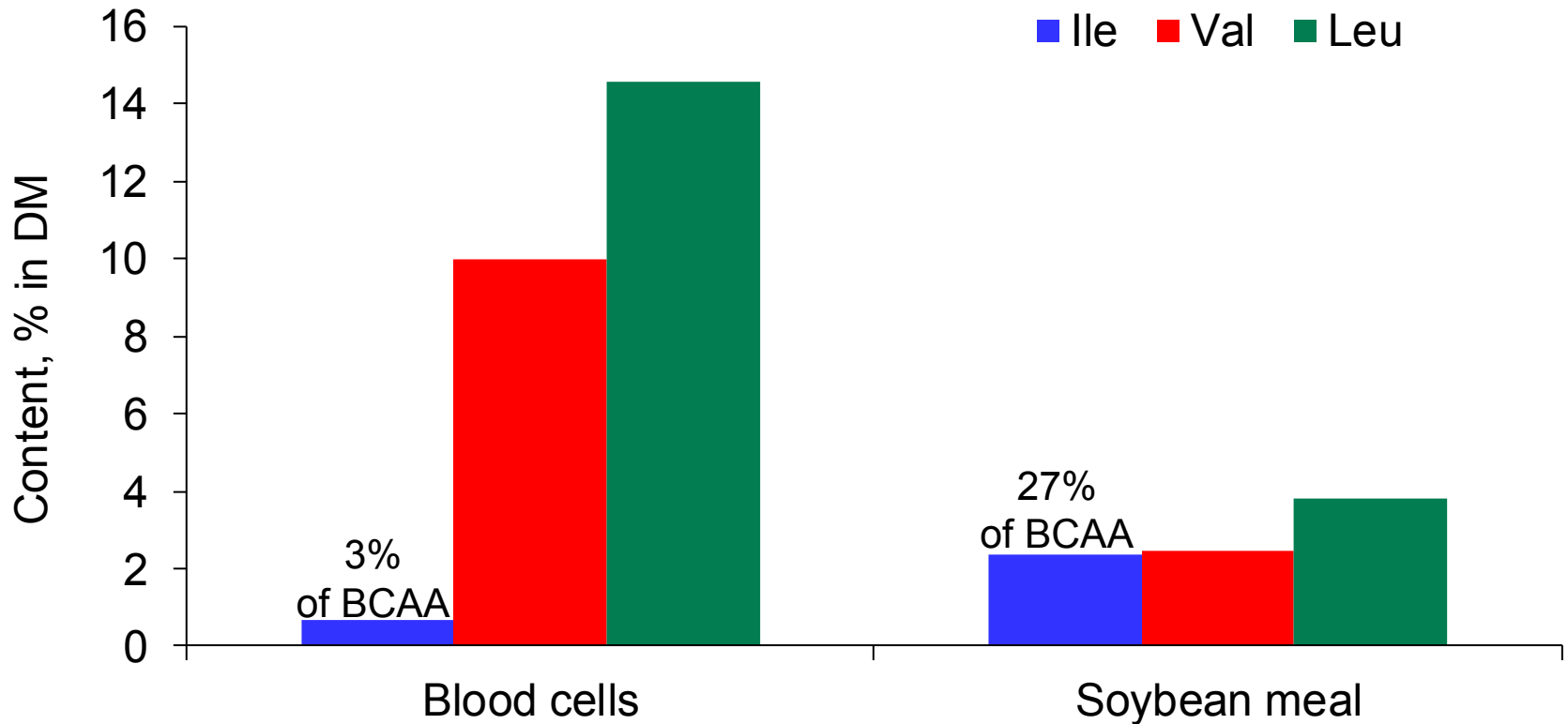
Response to the Ile supply



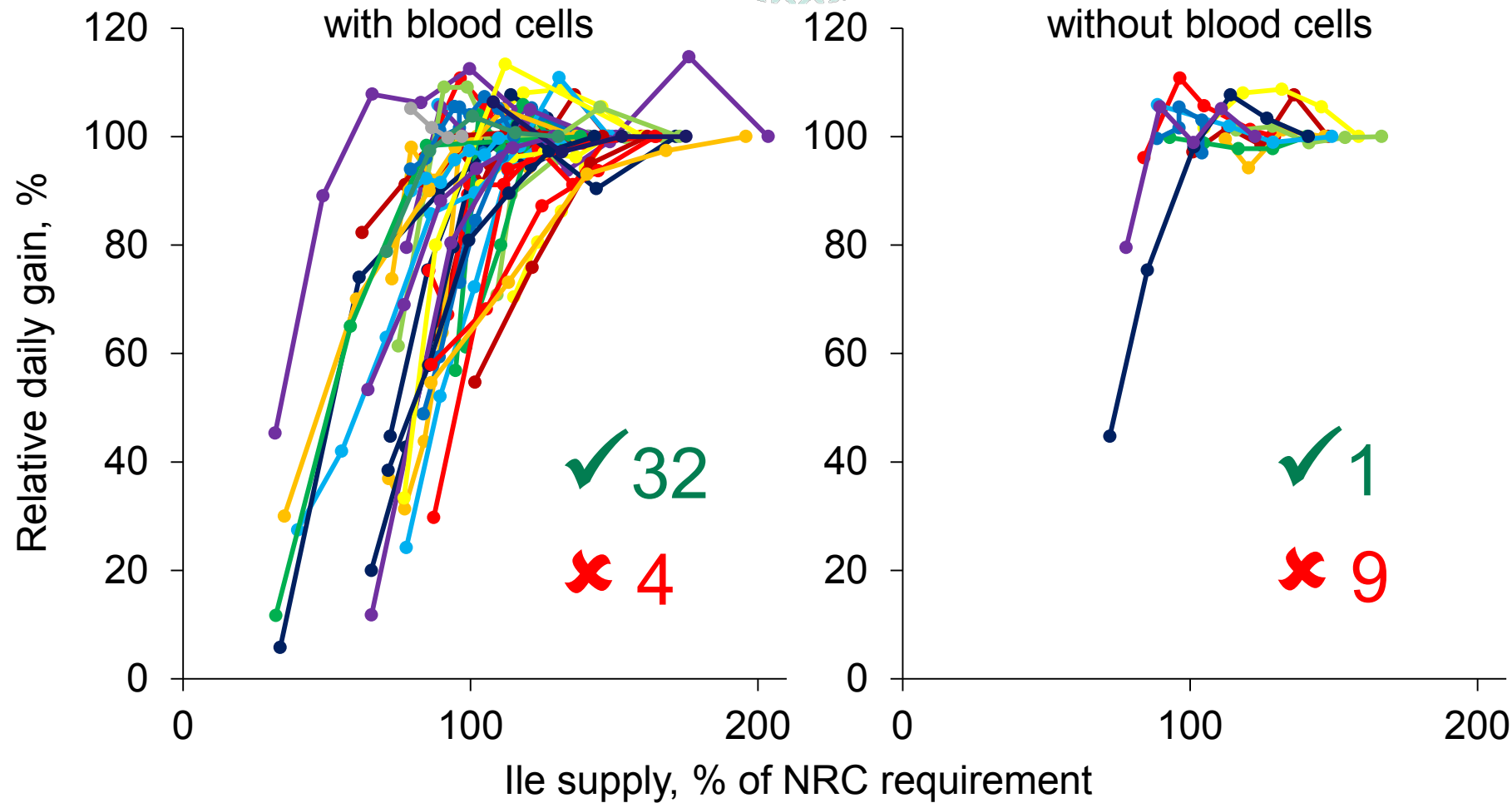
Response to the Ile supply



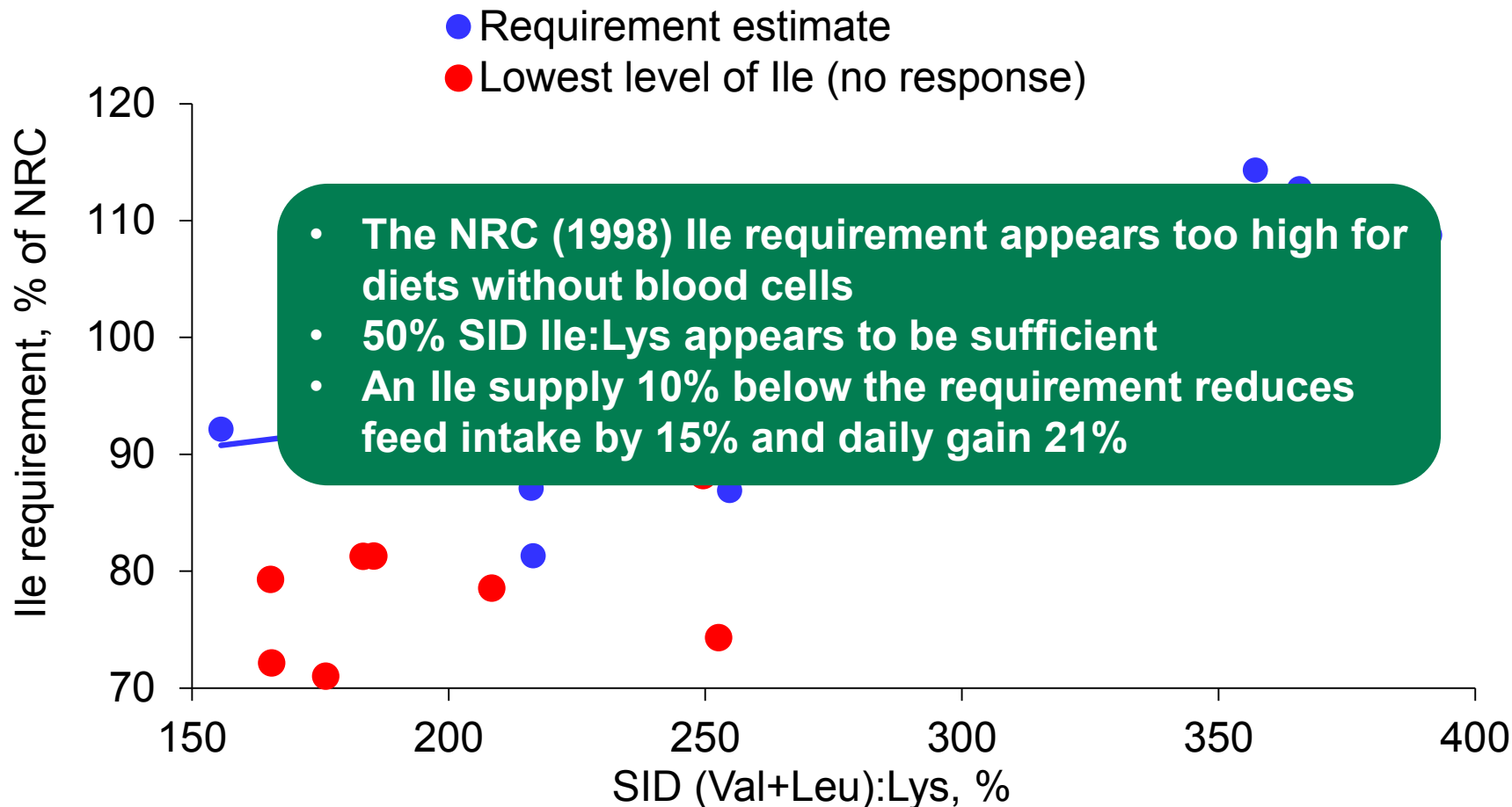
Protein sources used to study the Ile requirement



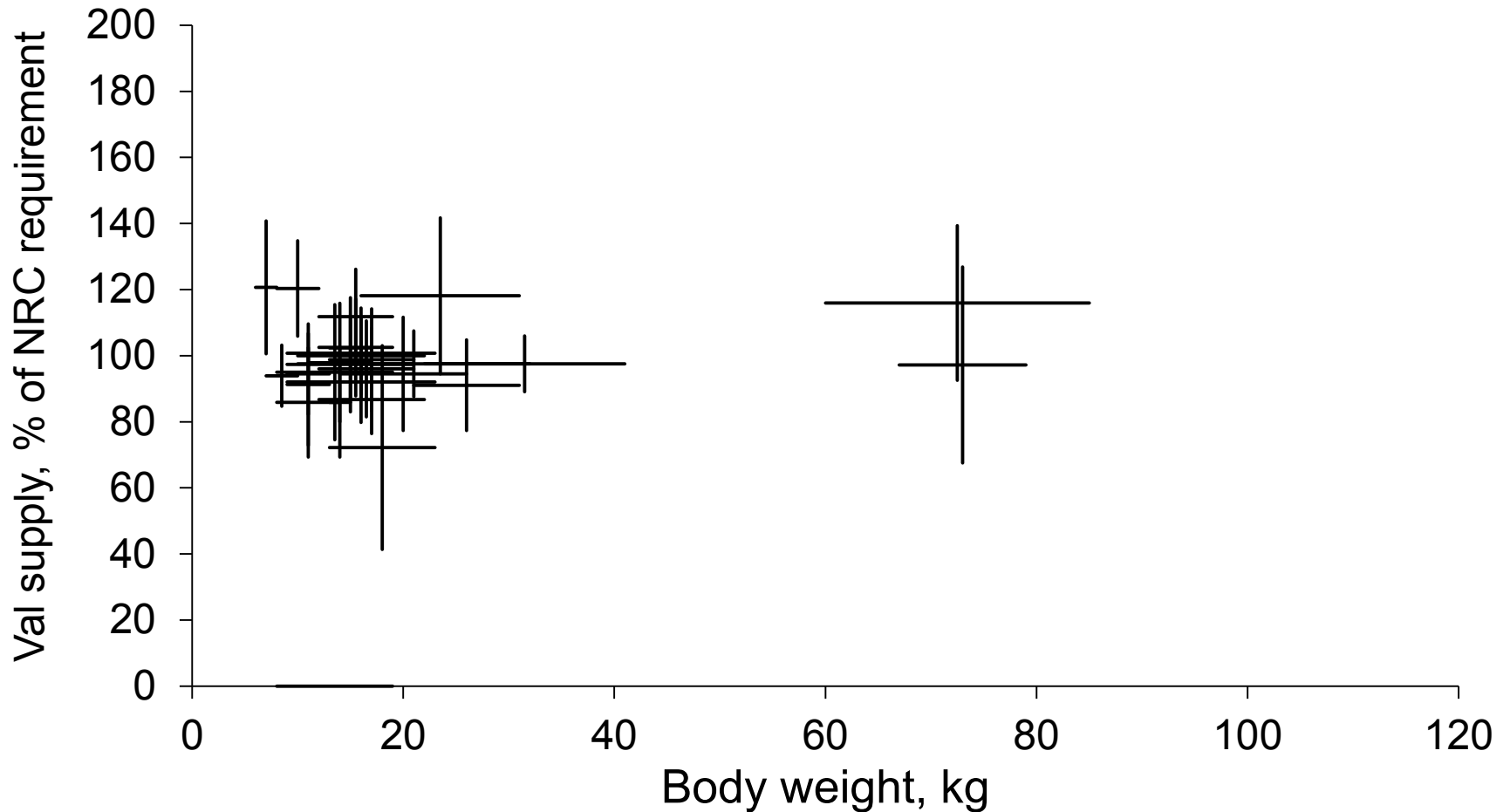
Response to the Ile supply



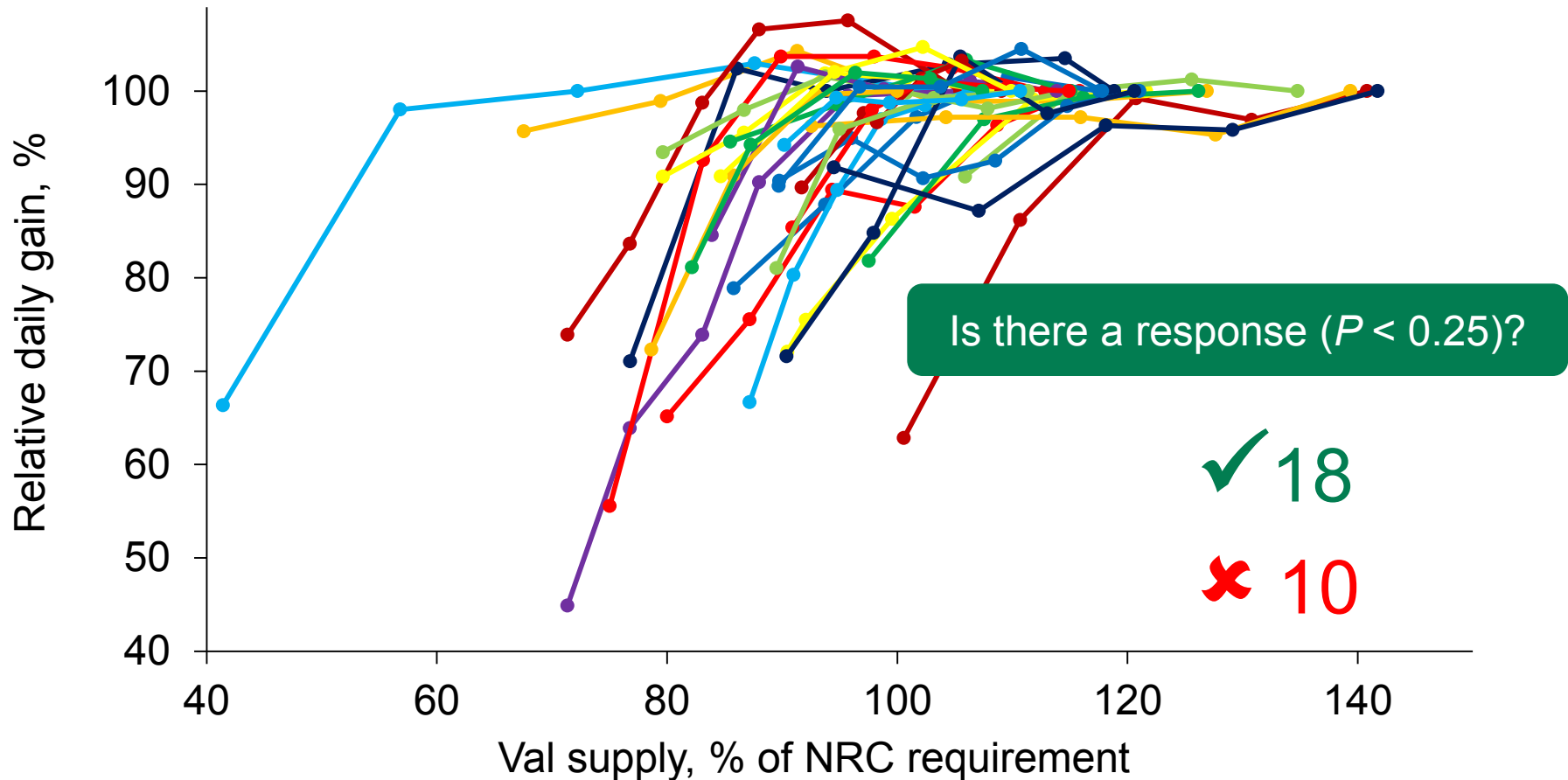
The Ile requirement depends on the supply of the other branched-chain amino acids



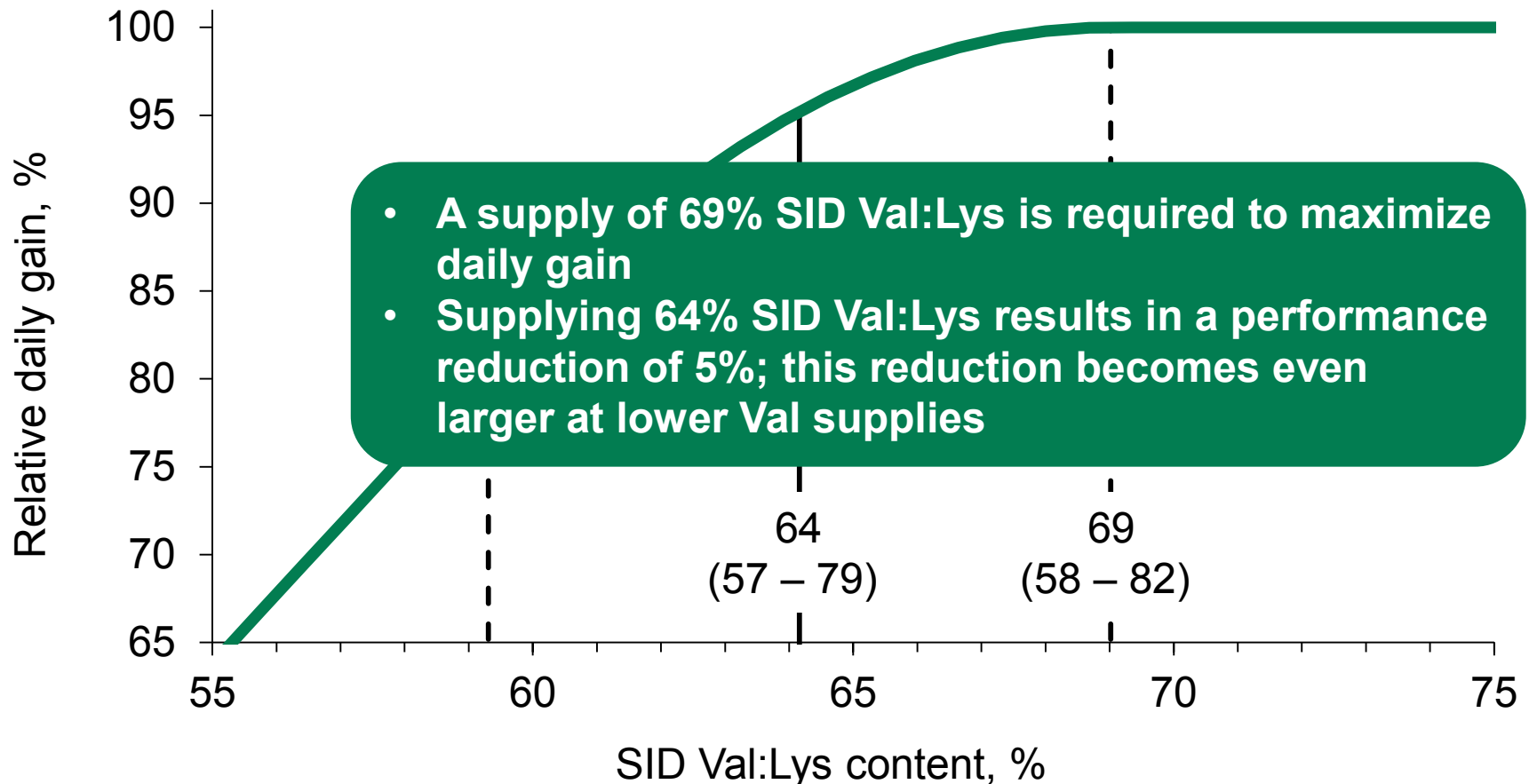
Meta-design of Val dose-response studies



Response to the Val supply



Response to the Val supply



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How far can we go with precision protein?

Exp. 1: Nitrogen balance

- Nitrogen balance, 2 weeks
- 6 blocks of 4 barrows (12-16 kg)
- ~80% of ad libitum feed intake
- Soybean meal exchanged by cereals and free AA
- SID Lys, 1.15%

CP, %	19.7	16.6	14.0	12.7
L-Lys HCl	0.34	0.59	0.90	1.04
DL-Met, L-Thr, L-Trp	+	++	+++	++++
L-Val		+	++	+++
L-His, L-Ile, L-Leu, L-Phe			+	++

Gloaguen *et al.*, unpublished

How far can we go with precision protein?

Exp. 1: Nitrogen balance

CP, %	19.7	16.8	14.0	12.7	RSD	P
Feed intake, g/d	513	529	524	525	24	0.90
Gain, g/d	375 ^a	364 ^a	323 ^b	305 ^b	41	<0.01
G:F	0.73 ^a	0.69 ^{ab}	0.62 ^{bc}	0.58 ^c	0.10	<0.01

CP, %	19.7	16.8	14.0	12.7	RSD	P
N balance, g/d						
• Intake	15.5 ^d	13.8 ^c	11.5 ^b	10.5 ^a	0.8	0.90
• Digested	13.3 ^d	11.7 ^c	9.7 ^b	9.0 ^a	0.7	<0.01
• Retained	9.9 ^c	9.8 ^c	8.3 ^b	7.5 ^a	0.8	<0.01
N efficiency, %						
• Digestion	85.8	84.8	84.3	85.7	2.3	0.47
• Retention	74.4 ^a	83.8 ^b	85.6 ^b	83.3 ^b	3.7	<0.01

Gloaguen *et al.*, unpublished

How far can we go with precision protein?

Exp. 2: Growth trial

- 14 blocks of 6 barrows and females (12-22 kg)
- Ad libitum feeding, 3 weeks
- 1.0% SID Lys

Ingredients	Cereals – SBM – AA				Cereals – AA	
	17.6	15.6	13.5	11.8	13.0	14.0
CP, %						
L-Lys HCl	0.28	0.46	0.72	0.92	1.00	1.00
DL-Met, L-Thr, L-Trp	+	++	+++	++++	++++	++++
L-Val		+	++	+++	++++	++++
L-His, L-Ile, L-Leu, L-Phe			+	++	+++	+++
L-Glu					+	++
L-Arg, L-Gly, L-Pro					+	+

Gloaguen *et al.*, unpublished

How far can we go with precision protein?

Exp. 2: Growth trial

Ingrediets	Cereals – SBM – AA				Cereals – AA		RSD	P
	17.6	15.6	13.5	11.8	13.0	14.0		
CP, %	17.6	15.6	13.5	11.8	13.0	14.0		
Feed intake, g/d	766	775	779	734	810	782	96	0.60
Gain, g/d	450 ^b	454 ^b	442 ^b	358 ^a	420 ^b	451 ^b	67	0.55
G:F	0.59 ^b	0.59 ^b	0.57 ^b	0.49 ^a	0.52 ^a	0.58 ^b	0.06	<0.01

Gloaguen *et al.*, unpublished

Conclusions

- There is still a great potential to reduce the protein content in the diet
- Knowledge about the requirements (and responses) of secondary amino acids and nitrogen is limited
- There is variation among pigs in the response to a limiting amino acid supply:
 - Some “safety margin” may be required to fulfill the needs of all animals, but at what cost
 - A potential for precision feeding systems?

Acknowledgements



AJINOMOTO

AJINOMOTO ANIMAL NUTRITION

AJINOMOTO EUROLYSINE S.A.S.



INDUKERN, S.A.