Impact of increased energy and amino acids in sow lactation diets on piglet performance in large litters

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Introduction

Weaning weight is a critical factor in determining pig lifetime performance (Mahan and Lepine, 1991; Le Dividich et al., 2003)

- During the suckling period the pig is highly efficient at converting nutrients to lean gain (Pluske and Dong, 1998)
- An extra 1kg in weaning weight could reduce the days to slaughter by 10 days (Cole and Close, 2001)

Therefore, increased gain during this period will improve whole farm efficiency.

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Introduction

There are two main challenges to piglet weaning weight:

- Larger litter sizes
  - negative correlation between litter size and birth weight (Quiniou, 2002)
  - positive correlation between birth weight and weaning weight (Dunshea et al., 2003)
- Sow milk yield
  - Limiting to piglet growth
  - Suckling piglets have the potential to gain 576g/day if fed ad libitum (Hodge, 1974), but when suckling the sow piglet gains average 240g/day.

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Introduction

- Total litter weaning weight can be improved through increasing:
  - Energy (Walsh et al., 2012; Xue et al., 2012; Smits et al., 2013)
  - Lysine (Heo et al., 2008; Yang et al., 2009; Xue et al., 2012)
  - Valine (Riechert et al., 1996; Moser et al., 2000; Paulicks et al., 2003)

  in the sow lactation diet

- Valine has the greatest oxidation rate in the mammary gland of any amino acid (Trottier et al., 1996)
- Valine becomes the second limiting amino acid when sows do not mobilise body tissues (Kim et al., 2001)

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Introduction

- These studies are limited for commercial production due to the small litter sizes tested.
  - Very few papers (2008-2014) report nutritional requirements for sows based on litter sizes over 11.5 (Craig et al., 2015).
  - In 2013, the EU average for piglets born alive per litter was 13, with six countries attaining more than 13 pigs born alive per litter, the highest being Denmark at 15.4 (BPEX, 2014).

How do we feed these sows to achieve good weaning performance?

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Back to Basics!

- Milk yield = 4.2 x piglet growth (mean of several studies as estimated by van der Peet-schwering et al., in the Lactating Sow, 1998)
- Maintenance for a 250kg sow is 28.9 MJ ME (Noblet et al., 1998)
- Milk energy requirement is 5.4 MJ ME/kg (BSAS Nutrient Requirement Standard, 2003)
- Tables for lysine requirement as described in BSAS Nutrient Requirement Standard, 2003 (based on maintenance plus amount required for milk production)

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Back to Basics!

Therefore:

13 pigs growing from 1.5kg at birth to 9kg at 28d

- Will have an ADG of 3.48kg/day
- Require an average of 14.63kg of milk/day
- Total energy required by sow: 112.37 MJDE/d
- Lysine requirements: 91.7g total lysine /day

Intake requirements:

- 8kg/day (average over 28d lactation)
- 14MJ DE
- 1.15% lysine

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Back to Basics!

14 pigs growing from 1.5kg at birth to 9kg at 28 d

- Will have an ADG of 3.75kg/day
- Require an average of 15.75kg of milk/day
- Total energy required by sow: 118.69 MJ DE/day
- Lysine requirements: 99.2g total lysine /day

Intake requirements:

- 8kg/day (average over 28d lactation)
- 14.8 MJ DE
- 1.24 %lysine

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Aim of Current Study

- Provide the sow with a balance of energy and lysine, as recommended in the BSAS Nutrient Requirement Standards for Pigs (2003), to enable her to wean:
  - litters of 13 pigs
  - average of 9kg individual weight at weaning (28d)
- Test the effect of a higher Lysine:Valine ratio in lactation diets.
- Test the effectiveness of phase-feeding during lactation

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Materials and Methods

- *Animals:* PIC F1 or PB Landrace Sows representing parity 2-6 (n=109) were selected, based on weight and condition score. PIC 337 was the terminal sire used.

- *Measurements*:
  - Individual piglet weight at 0,5,7,10,14, 21 and 28 days
  - Sow milk composition at 0,5,7,10,14, 21 and 28 days
  - Sow blood urea nitrogen at 21 days
  - Daily sow feed intake
  - Sow BCS, P_2 and weight.

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Treatments 2 x 2+1 factorial design:

- **Control** (13.5 MJ DE/kg, 0.88% Lysine, 0.66% Valine)
- **Flat** (14.4 MJ DE/kg, 1% lysine) *or* **Phased** (Flat diet offered until day 14 of lactation followed by a second diet containing 15MJ DE/kg, 1.1% lysine until 28 days)
- **High** (Lys:Val 1:1.1) *or* **Normal** (Lys:Val 1:0.68) lysine:valine ratio

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Materials and Methods : Diets

Formulated and Actual Analysis

		Flat		Phased	
	Control	Norm Valine	High Valine	Norm Valine	High Valine
Formulated Composition					
DE (MJ/kg)	13.5	14.4	14.4	15	15
CP (%)	17.0	19.8	19.8	19.9	20
Lysine (%)	1.0	1.25	1.25	1.4	1.4
Valine (%)	0.82	0.95	1.50	1.10	1.68
Lysine:Valine	1:0.82	1:0.76	1:1.2	1:0.79	1:1.2
Actual composition					
DE (MJ/kg)	13.6	14.1	14.4	14.9	15.1
CP (%)	14.4	15.9	17.4	15.6	16.2
Lysine (%)	0.88	0.92	1	1.11	0.96
Valine (%)	0.67	0.62	1.2	0.77	1.03
Lysine:Valine	1:0.76	1:0.67	1:1.2	1:0.69	1:1.07

Results

- Average lactation length - 28.2 days
- Mean sow parity - 3.6
- Average number of pigs after cross-fostering - 13.4
- Average number of pigs weaned - 12.8

- Daily feed intake was significantly different (P=0.003) between the control group (7.1kg) and the treatment groups (7.7kg) and was used as a covariate for production analysis.

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Interactive effects of diet on litter and pig performance

		Flat		Phased			Interactions
	Ctrl	Norm Valine	High Valine	Norm Valine	High Valine	SEM	(P Value)
Litter weight(kg)							
Day 0	18.98	20.99	19.23	19.59	19.51	0.672	0.208
Day 28	102.1	111	109.3	108	111.7	2.490	0.272
Litter ADG (kg)							
Day 0-28	2.96	3.17	3.19	3.16	3.27	0.077	0.547
Individual Piglet Weight (kg)							
Day 28	8.22	8.32	8.59	8.65	8.70	0.081	0.178
Individual Piglet ADG (kg)							
Day 0-28	0.239	0.243	0.252	0.255	0.257	0.003	0.169

No Interactions between treatments

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Control vs Treatment effects of diet on litter performance

		Flat		Phased			
	Ctrl	Norm Valine	High Valine	Norm Valine	Norm Valine	SEM	Effects (P-Value)
Litter weight (kg)							
Day 0	18.98	20.99	19.23	19.59	19.51	0.672	0.285
Day 14	58.09	65.01	64.82	60.00	63.74	1.682	0.007
Day 28	102.1	111	109.3	108	111.7	2.490	0.006
Litter ADG (kg)							
Day 0-14	2.79	3.06	3.20	2.89	3.12	0.101	0.015
Day 14-28	3.39	3.54	3.42	3.69	3.69	0.126	0.161
Day 0-28	2.96	3.17	3.19	3.16	3.27	0.077	0.008

Treatments improved Weight at Weaning by 7.8%

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Control vs Treatment effects of diet on pig performance

		Flat		Phased			
	Ctrl	Norm Valine	High Valine	Norm Valine	High Valine	SEM	Effects (P-Value)
Individual Piglet Weight (kg)							
Day 14	4.70	4.70	4.90	4.83	4.91	0.044	0.005
Day 21	6.54	6.61	6.86	6.84	6.88	0.063	<.001
Day 28	8.22	8.32	8.59	8.65	8.70	0.081	<.001
Piglet ADG (kg)							
Day 0 - 14	0.218	0.216	0.231	0.228	0.232	0.003	0.003
Day 14-28	0.255	0.261	0.266	0.279	0.275	0.004	<.001
Day 0 - 28	0.239	0.243	0.252	0.255	0.257	0.003	<.001

Treatments improved weight at weaning by 4.2%

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Flat vs. Phased feeding regime effects on litter and pig performance

		Flat		Phased			
	Ctrl	Norm Valine	High Valine	Norm Valine	High Valine	SEM	Effects (P Value)
Litter weight (kg)							
Day 28	102.10	111.00	109.30	108.00	111.70	2.490	0.879
Litter Gain (kg)							
Day 0-28	2.96	3.17	3.19	3.16	3.27	0.077	0.691
Individual Piglet Weight (kg)							
Day 14	4.7	4.7	4.9	4.83	4.91	0.044	0.12
Day 21	6.54	6.64	6.86	6.84	6.88	0.063	0.045
Day 28	8.22	8.32	8.59	8.65	8.7	0.081	0.007
Individual Piglet ADG (kg)							
Day 14-28	0.255	0.261	0.266	0.279	0.275	0.004	<.001
Day 0-28	0.239	0.243	0.252	0.255	0.257	0.003	0.005

Phased feeding increased weight at weaning by 2.6%

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High vs. Low Lys:Val effect on litter performance

		Flat		Phased			
	Ctrl	Norm Valine	High Valine	Norm Valine	High Valine	SEM	Effects (P Value)
Litter weight (kg)							
Day 0	18.98	20.99	19.23	19.59	19.51	0.672	0.164
Day 14	58.09	65.01	64.82	60	63.74	1.682	0.298
Day 28	102.10	111.00	109.30	108.00	111.70	2.490	0.699
Litter Gain(kg)							
Day 0-14	2.79	3.06	3.20	2.89	3.12	0.101	0.069
Day 14-28	3.39	3.54	3.42	3.69	3.69	0.126	0.628
Day 0-28	2.96	3.17	3.19	3.16	3.27	0.077	0.412

No significant effect at litter level

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High vs. Norm Lys:Val effect on pig performance

		Flat		Phased			
	Ctrl	Norm Valine	High Valine	Norm Valine	High Valine	SEM	Effects (P Value)
Individual Piglet Weight (kg)							
Day 10	3.91	3.91	4.04	3.93	4.01	0.075	0.004
Day 14	4.7	4.7	4.9	4.83	4.91	0.044	<.001
Day 28	8.22	8.32	8.59	8.65	8.7	0.081	0.049
Piglet ADG (kg)							
Day 0-14	0.218	0.216	0.231	0.228	0.232	0.003	0.002
Day 14-28	0.255	0.261	0.266	0.279	0.275	0.004	0.937
Day 0-28	0.239	0.243	0.252	0.255	0.257	0.003	0.053

1:1.1 Lys:Valine improved weight at weaning by 1.8%

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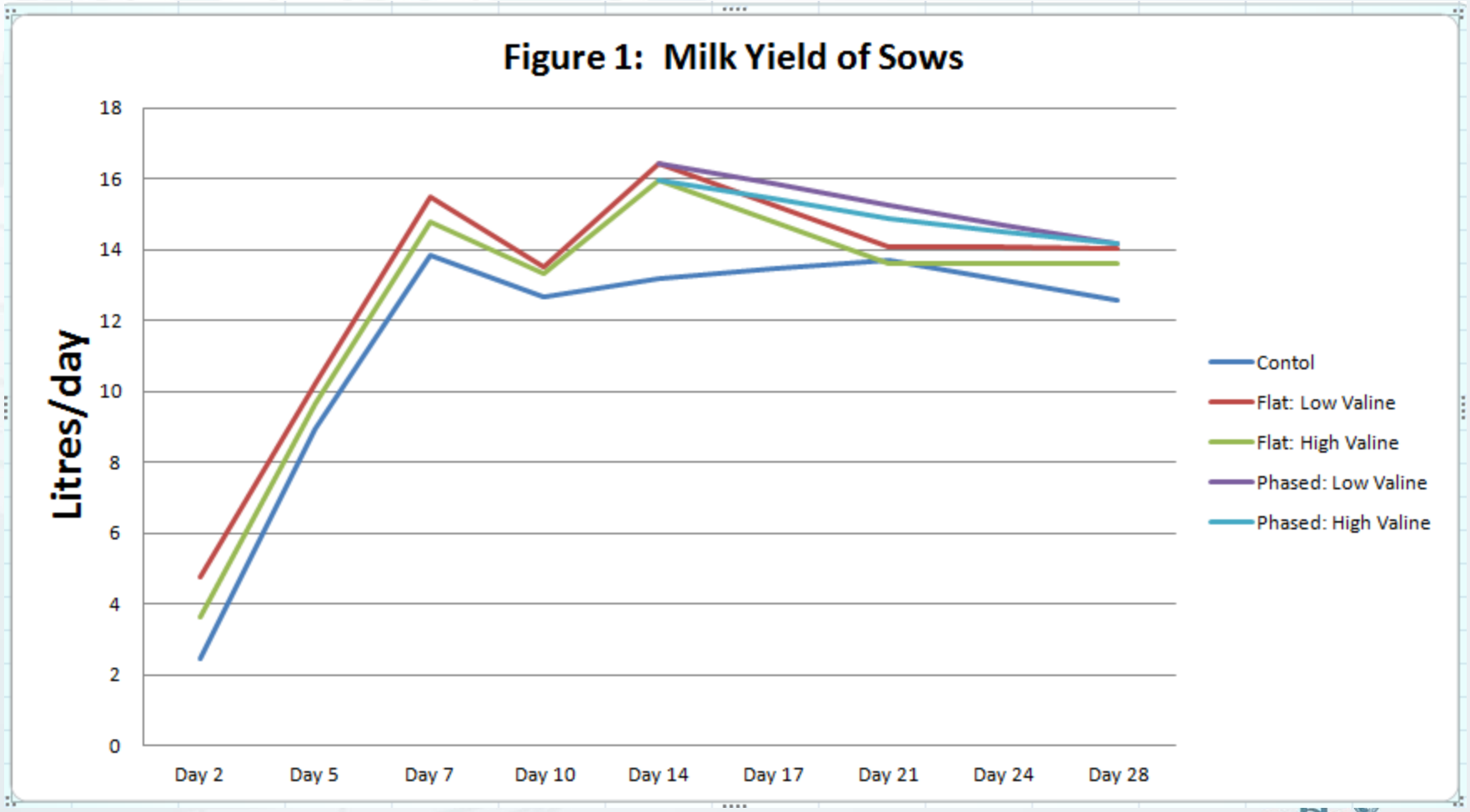
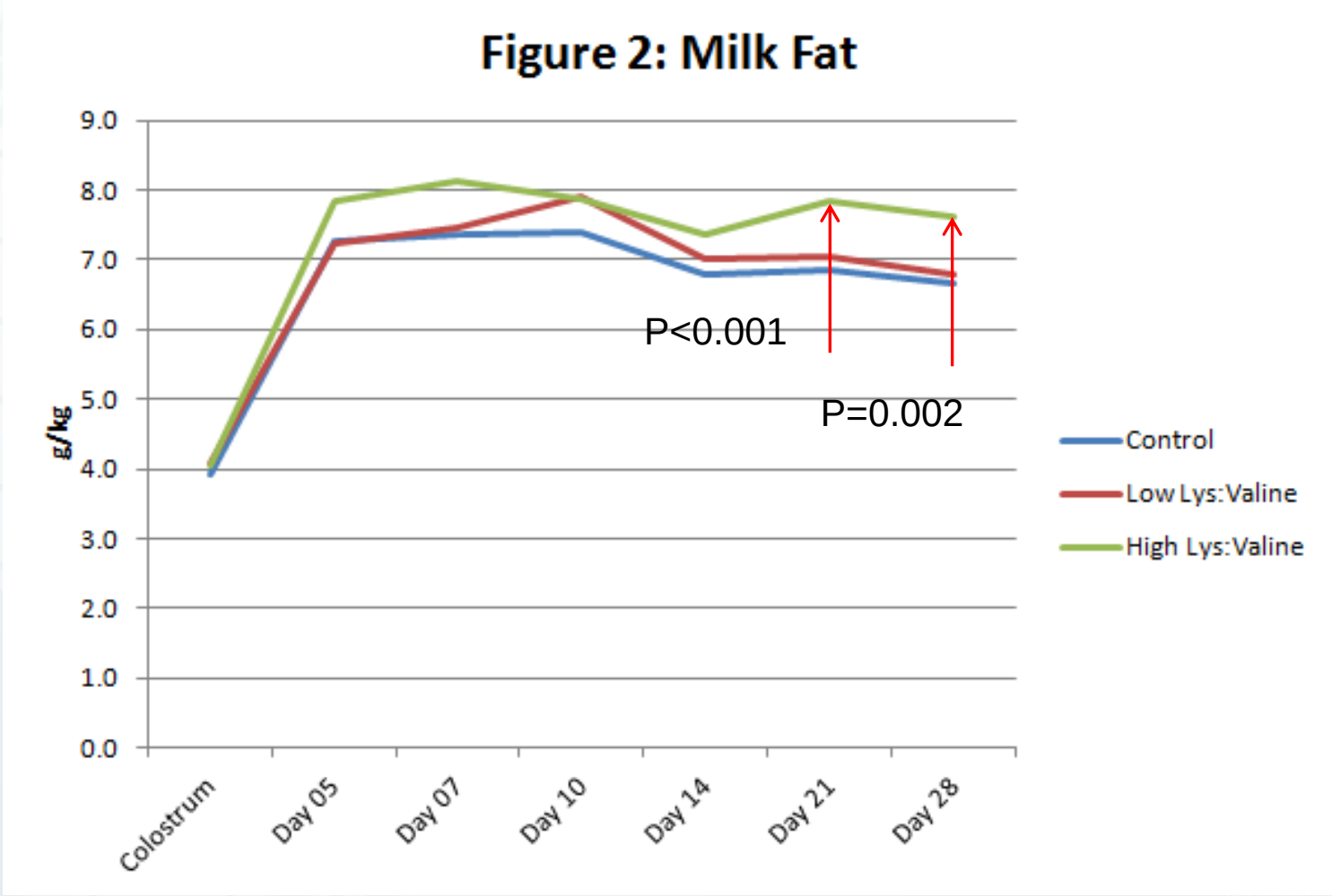
Milk Yield



Effect of Lysine:Valine on Milk Fat



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Results

- Milk Composition:
  - The control group had increased urea nitrogen in milk on day 7 (P=0.03) and 10 (P=0.009) compared to the treatment groups.
  - There was no overall effect of treatment on the protein, casein or lactose content of milk.

- Blood Urea Nitrogen.
  - No significant difference between treatments.

Discussion

- This study demonstrates that increasing energy and lysine levels above 13.6 MJ DE and 0.88% lysine (Control) in the lactation diet enabled sows to:
  - raise a larger litter (12.8)
  - wean piglets at an acceptable weaning weight (>8.5kg)
  - without compromising body condition and tissue breakdown.

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Discussion

Treatment sows produced an extra 8kg (7.8%) of litter weight at weaning compared to control sows:

- This could reduce slaughter age by 5 days/pig
- May have economic advantages
  - If a finisher pig eats 2.5kg/d
  - 5 days x 2.5kg = 12.5kg
  - 13 pigs x 12.5kg = 162.5kg
  - Cost = €50/litter (€312/tn)
  - **OR** €11,000 per 100 sows per year...!

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Discussion

- Phase feeding improved performance by 220g/piglet or 2.6% (P=0.007) compared to flat rate feeding.
- This could equate to an increase of 2.34kg in litter weight for a litter of 13.
- Possibility for more gain if phase feeding started earlier in lactation

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Discussion

- Increased Lys:Val greatly improved piglet growth between day 7 and 14.
- Effect reduced after day 14, but was still evident at weaning (P=0.049)
- High Lys:Val (1:1.1) increased pig weight at weaning by 160g (1.8%) compared to normal Lys:Val (1:0.68)
- Total Valine consumed: 47.7 - 92.4 g/day

What can a sow do?

	Average	Top 25%	Top 5%
Litter Weaning Weight	108kg	122kg	131kg
Number Weaned	12.8	13.3	13.7
ADFI	7.6	7.8	8.3
BCS Loss	-0.4	-0.5	-0.6
P_2 Loss	-3.6	-4.2	-4.7

Conclusion

- This study demonstrates that sows are able, if given the correct nutrition, to achieve weaning outputs of 110kg per litter.

- In practice, this equates to 13 pigs weaned at 8.5kg which is acceptable for good lifetime performance.

Conclusion

- Consumption of 108MJ DE and 77g of lysine (Flat: Normal Valine) per day is effective at achieving this performance

- Increasing this intake has potential to further improve performance:
  - Phase feeding
  - Increased lys:val

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