Phase Feeding for Pregnant Sows

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Overview

- Current status of sow feeding
- Amino acid requirements and availability
- Energy requirements and energy use
- Feeding recommendations

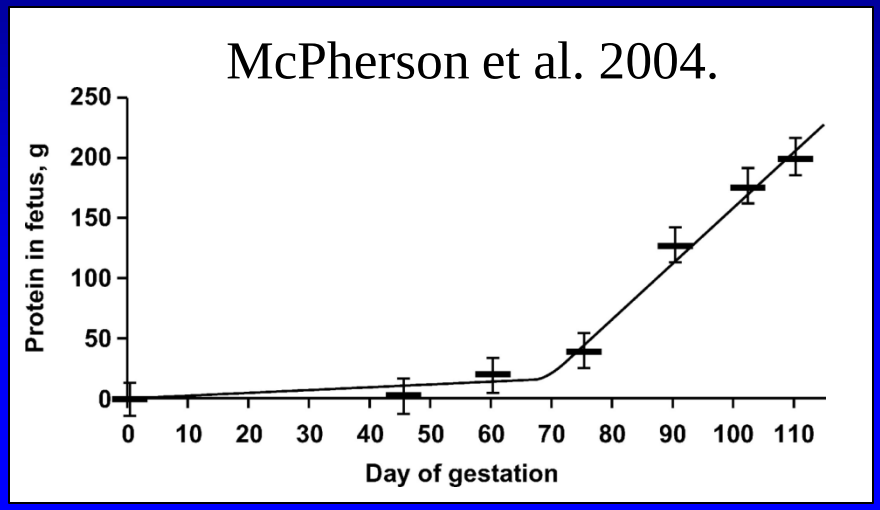
Current status

- NRC (1998) recommended:
  - Constant feed allowance during gestation
  - Constant amino acid requirement
  - Use of feedstuff energy contents and amino acid digestibility from grower pigs
- NRC recommendations currently being revised
  - Acknowledgement of new results and changed feeding practices

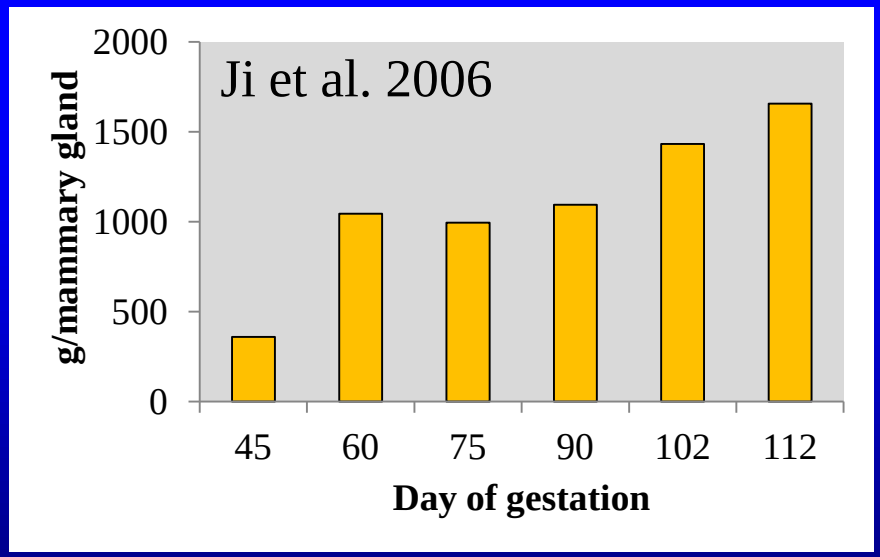
New development: phase feeding

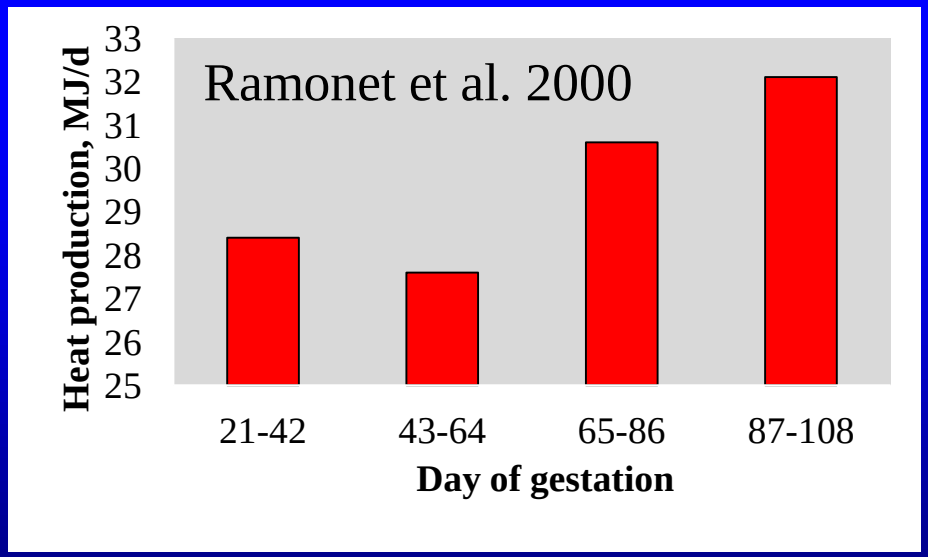
- Implemented by some producers
  - Increased feed allowance in late gestation
  - ‘Top dressing’ regular feed allowance
- Benefits aimed for
  - Maintain body composition
  - Better rebreeding
  - Greater longevity

as pregnancy progresses…



Fetal protein mass, mammary weight and sow heat production increase sharply after 70 days of pregnancy





Recent recommendations

- Modeling sow and conceptus growth, GfE (2008) and Kim et al. (2009) proposed:
  - Phase feeding pregnant sows
  - Feeding pregnant sows according to parity (GfE)
- GfE, Kim: differences in requirement values or when to change diets
- Experimental data needed to validate modeled requirement values

Supporting new data

- Srichana (2006): N balance
  - Lysine requirement for pregnant gilts
  - Use of Lys-HCl in sows
- Ball group (Franco, Levesque, Moehn, Samuel): Indicator amino acid oxidation and calorimetry
  - Amino acid requirement in pregnancy
  - Sow energy expenditure
  - Amino acid availability

New approach: Indicator oxidation with calorimetry

- Amino Acids - Indicator amino acid oxidation
  - Isotope tracer in feed, collect $^{13}CO_2$ in breath
  - Rapid: 2 days adaptation, 1 day measurement
  - 3 weeks – get mean req't and individual req'ts
- Energy - Indirect calorimetry
  - measure oxygen and carbon dioxide in breath
  - calculate heat production every minute for 24 h energy requirement

Experiments – Ball group

- Lysine, threonine, isoleucine maintenance requirement
- Amino acid requirement in gestation
  - Early gestation: ca. day 25-60 of pregnancy
  - Late gestation: ca. day 85-110 of pregnancy
- All experiments
  - 6 amino acid levels tested
  - Each sow received each amino acid level
  - Same Hypor sows used in early and late gestation

Gestation experiments

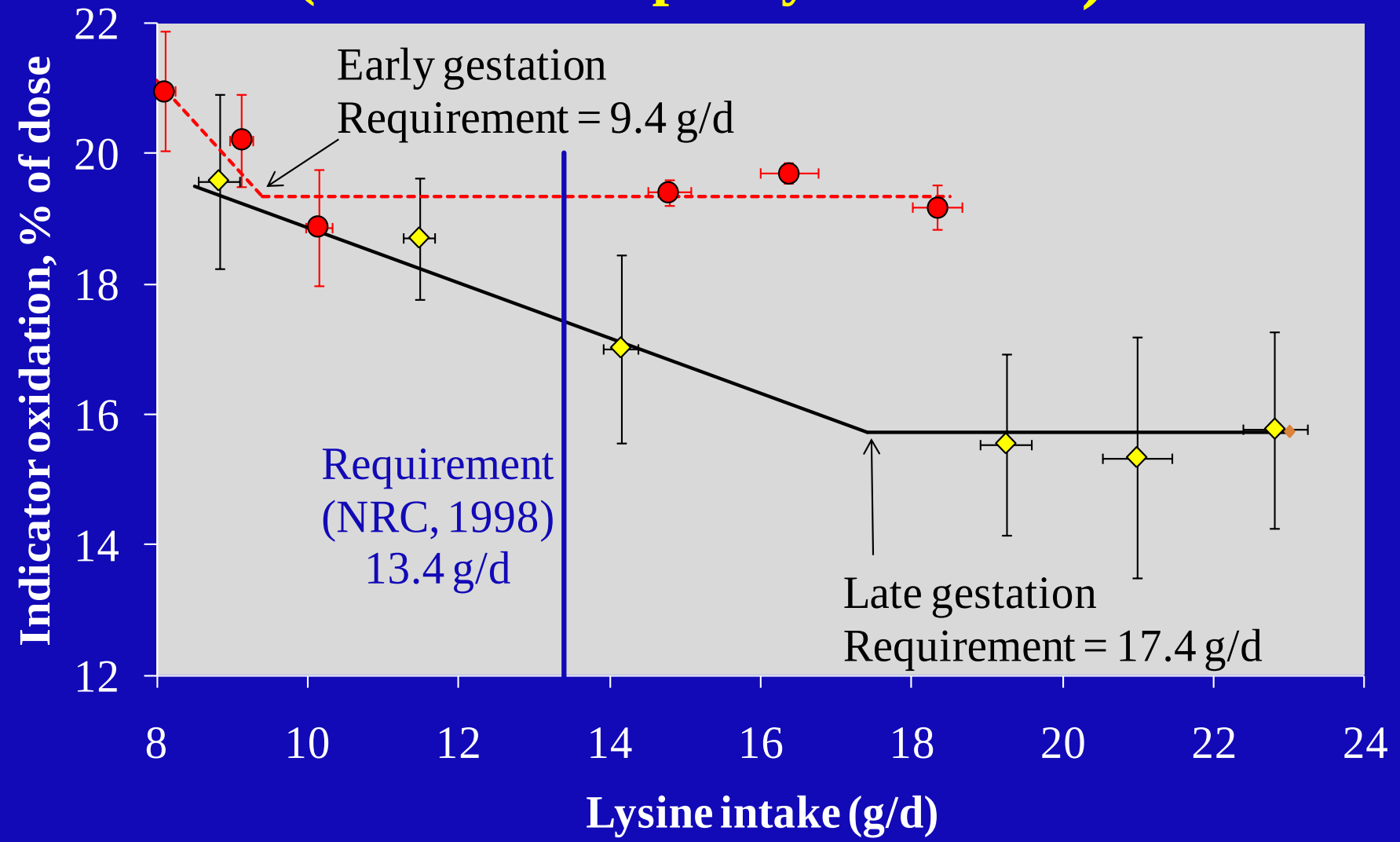
	Parity	n (sows)	n (obs.)	Breeding weight, kg	ME intake, MJ/d
Threonine	2	6	71	165.5	32.0
Threonine	3 - 4	8	92	209.8	33.2
Isoleucine	4	7	76	231.7	34.5
Lysine	2 - 3	7	78	185.7	33.7
Tryptophan	2	6	68	167.7	33.2

Sow performance[1]

Parity		BW, kg	Mat. gain, kg	PD, g/d	RE, MJ/d	Litter size	Litter wt., kg
2	EG	177	44	32	3.0	13.8	19.5
	LG	215		126	-0.7		
3	EG	205	40	38	1.2	13.6	20.1
	LG	244		119	-0.9		
4	EG	240	25	4	1.5	15.8	22.1
	LG	266		64	-1.3		

[1]BW, body weight; PD, protein deposition; RE, retained energy

Gestation lysine requirement (2nd and 3rd parity combined)



Amino acid requirements (g/d)

	1st parity		2nd parity		3rd , 4th parity		NRC[5]
	EG	LG	EG	LG	EG	LG	
Lysine[1,2]	15.0	18.0	13.1	18.4	8.1	13.0	11.4
Threonine[3]			7.0	13.6	5.0	12.3	8.6
Tryptophan[4]			1.7	2.6			2.2
Isoleucine[4]					3.6	9.7	6.4

[1] Srichana 2006 (1st parity); [2]Samuel et al. 2010; [3] Levesque et al. 2011a; [4] Unpubl.; [5] greatest requirements listed in NRC 1998

Summary: AA requirements

- AA requirements are greater in late gestation than in early gestation, regardless of parity
- AA requirements decrease as sows grow older
  - Reduced sow growth
  - Applies to both early and late gestation
- Difference between EG and LG requirement increases from 1st to 4th parity

Consequence: AA ratios to lysine

	Early gestation	Late gestation	NRC (1998) Pregnant sows
Threonine, 2nd par.	54	74	76 - 94
Threonine, 3rd par.	63	95	
Isoleucine	44	75	58
Tryptophan	13	14	19

Change in AA ratios from EG to LG, between parities:

- Different AA may be first limiting
- Lysine may not be 1st limiting

Energy requirements

- Constant feed allowance leads to underfeeding in late gestation
  - Especially young sows
  - May reduce rebreeding success
- Issue is energy deficit:
  - Sows insulin resistant when given constant feed
  - Insulin resistance disappeared when 540 g/d starch were added to feed in LG (Bikker et al. 2007)

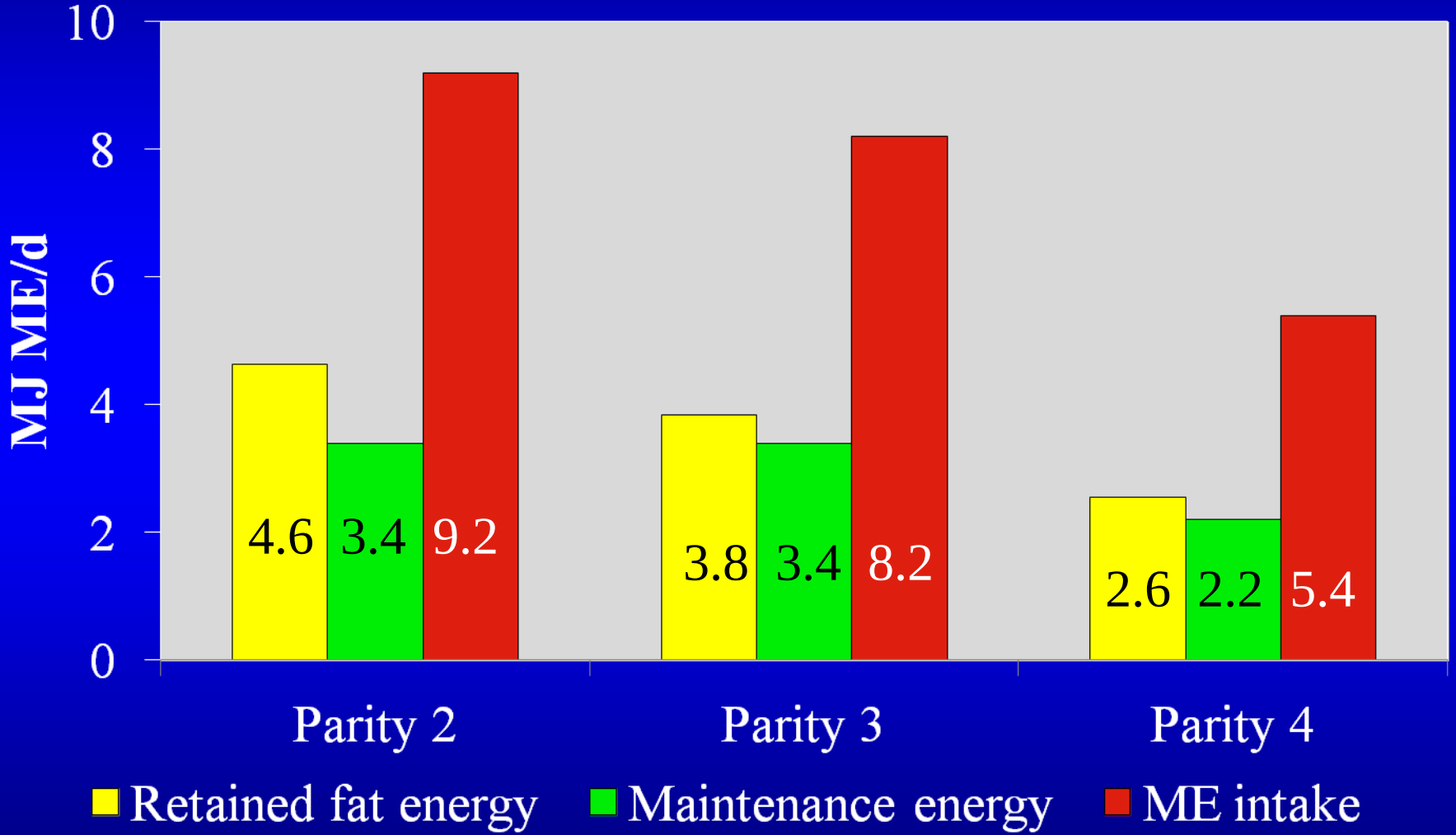
Parity and back fat

- At constant feed allowance during gestation, young sows lose back fat in late gestation:
  - Gilts lost 140 g/d fat (Close et al. 1985)
  - 2nd parity but not 3rd parity sows lost back fat (McMillan 2003)
  - 2nd parity sows increased heat production in LG compared to EG (Samuel et al. 2007)
  - Multi parity sows reduced energy retention but did not lose back fat in LG (Ramonet et al. 2000)

Increase in energy intake in LG

- Suggested increase in energy allowance:
  - 6.0 - 8.0 MJ/d in last 4 weeks (GfE 2008)
  - 7.5 MJ/d needed to prevent 140 g/d fat loss
  - Bikker et al. (2007): ~9 MJ/d more in LG
  - 9.8 MJ/d more in LG for 2nd parity sows (Samuel et al. 2007)
    - 1.5 MJ/d more maintenance energy
    - 2.5 MJ/d more heat associated with growth, equivalent to 8.3 MJ ME at k_{pf} = 0.7

Difference EG - LG:
Fat retention and maintenance



Extra feed needed

- GfE (2008): barley-based rations
  - 750 g/d 1st to 3rd parity
  - 500 g/d 4th parity and older
- Our estimate:
  - Corn-soybean meal rations, approx 13.6 MJ/kg
  - 600 g/d for 1st parity
  - 500 g/d for 2nd parity
  - 400 g/d for 3rd parity and older sows

Phase feeding

- Offering feed in two phases:
  - Early and mid gestation: up to day 84
  - Late gestation: day 85 to put up
- Increased feed allowance in late gestation:
  - Covers increased energy requirement
  - Maintains sow body condition
  - Can prevent sows starting lactation in catabolic state
  - No effect on lactation feed intake (Miller et al. 2000)

Early and mid gestation

- U of A: constant feed allowance during gestation maintains body composition
- Feed allowance marginal in LG
- Therefore, maintaining body composition means overfeeding in early/mid gestation
- For phase feeding, feed allowance:
  - Reduce below constant allowance in EG
  - Makes ‘space’ for increased feed allowance in LG

Suggested feed allowance (kg/d)

	1st parity	2nd parity	3rd parity and older
Early gestation (day 1 to 84)	1.8	2.2	2.4
Late gestation (day 85 to 112)	2.4	2.7	2.8
Average daily feed:			
Phase feeding	1.95	2.32	2.50
Constant allowance	2.00	2.40	2.50

Based on corn-soybean meal diets.
Assuming average sows in good condition

Lactation weight loss?

- To regain weight lost, increase feed allowance
  - Throughout gestation?
  - Place regaining weight by increasing feed in early/mid gestation by increasing feed ?
- GfE (2008) suggests for each 10 kg lactation weight loss:
  - 1.5 g /d Lys, 0.9 g/d Thr, 2 MJ/d ME
  - Or 150 – 200 g/d extra feed throughout gestation

Dietary AA contents (% of diet)

		1st parity	2nd parity	3rd parity and up
Early gestation	Lys	0.83	0.60	0.34
	Thr		0.32	0.21
	Trp		0.08	
	Ile			0.15
Late gestation	Lys	1.00	0.84	0.54
	Thr		0.62	0.51
	Trp		0.12	
	Ile			0.40

Total diet AA contents given the suggested feed allowances

Amino acid availability

- Lys and Thr standardized ileal digestibility:
  - Corn: greater for sows than growing pigs
  - Barley, wheat, canola: similar for sows and GF pigs (Stein et al. 2001)
- Thr availability in corn:
  - Greater for sows than GF pigs (Levesque et al. 2011b)
- Safer to assume same digestibility for sows and growing pigs

Free amino acid in sow diets?

- Feeding once daily reduces utilization of free Lys-HCl in growing pigs
- Srichana (2006): pregnant sows can fully utilize up to 0.2% Lys-HCl in diet
- Data for other free amino acids not available
  - It can be expected that moderate levels of free amino acids can be fully utilized

Diet ingredients (%) and limiting AA

	Parity:	1	2	3 and up
Early gestation	Corn	75.0	83.3	92.7
	Soybean meal	21.0	12.7	3.3
	Limiting AA[1]	Lys	Lys	Lys, (Trp ?)[2]
Late gestation	Corn	68.8	74.1	81.1
	Soybean meal	27.2	21.9	14.9
	Limiting AA	Lys	Thr	Thr

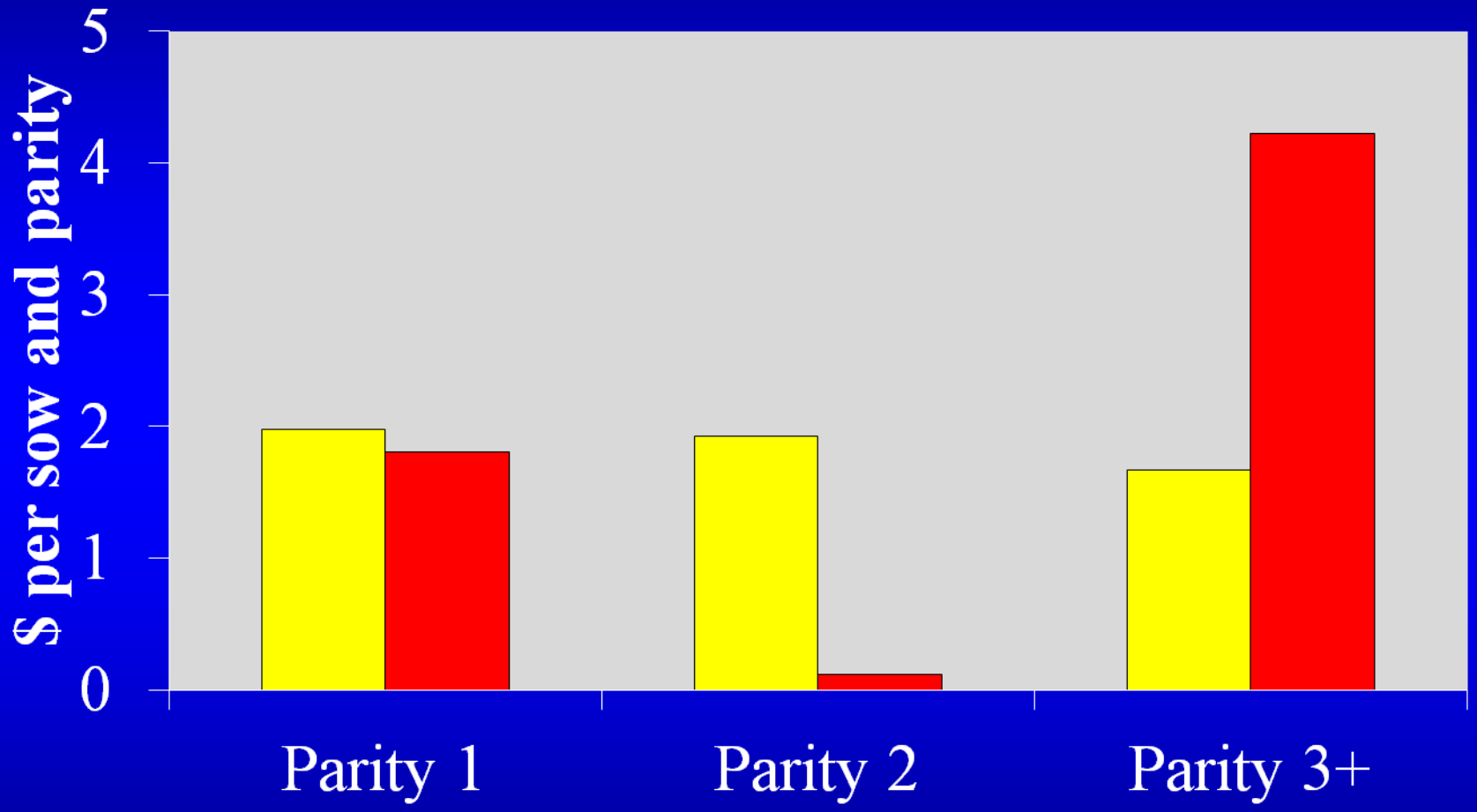
[1]Amino acid determining the necessary soybean meal content

[2]Tryptophan content was calculated as 0.077%

Feeding regimen

- Use low/high diet?
  - To cove the minimum/maximum nutrients required
  - Feed proportionally for intermediate requirements
  - Suitable for electronic sow feeders
- Other possibilities lose out on benefits:
  - Two diets: one for greater, one for lower req’ts
    - Better parity 1, 2 vs. older than EG vs. LG
  - Top dressing – soybean meal

Phase feeding: cost savings



Corn-soybean meal diets. Low and high price difference

Different diets for gilts and older sows but constant feed allowance

Feed cost advantage

- Greater for older sows
  - Lower AA requirements means cheaper diets than when feeding a single diet
- Dependent on price ratio soybean meal to corn
  - High ratio – phase feeding more advantageous
- Basis of comparison: current feeding regimen
  - Different diets for gilts and older sows
  - Add feed in LG without adjustment in EG

Parity-segregated phase feeding

- Correct supply of nutrients for pregnant sow throughout her life
  - Better body condition when entering lactation
  - Possibly larger piglets in 1st litter (Soto et al. 2011)
  - Better rebreeding success after 1st litter (Shelton et al. 2005)
  - Possibly prolonged sow use - save restocking cost
- Reduced feed cost
  - Estimated up to $10 per sow and year

Summary

- Amino acid requirements
  - Greater in late than in early and mid gestation
  - Greater in young than in older sows
- Energy requirement increases in late gestation
- **Parity-segregated phase feeding**
  - The right amounts of nutrients at the right time
  - Saves feed cost and improves production
  - Thus, results in improved production economics

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