Management strategies to maximize sow longevity and lifetime performance

CRC Project 2D-104

Study 3: A large scale longevity study to compare the effects of lactation nutrition and litter size during first lactation on liveweight and body condition at first weaning and sow longevity and reproductive efficiency

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Introduction

The productivity from the genetically lean sow during her lifetime has remained relatively static (Smits *et al.* 2005a) and is well below her potential of at least 80-90 pigs weaned per sow per lifetime.

Currently, the Australian industry average is predicted to be 30-40 pigs weaned/lifetime. Similar poor sow reproductive performance is also reported in most other major pig producing countries (Close et al, 2005; Davidson 2005; Levis 2005). For many years it has been thought by most within the research community that the limitation to improved reproduction is simply a matter of improving the implementation of existing knowledge to producers. However, with national herd statistics showing that reproduction is not improving, pig producers are highlighting that this approach must be combined with both large scale studies that report on longevity and research into the fundamental nutritional and management requirements for genetically lean genotypes.

Premature culling of breeding sows falls into two distinct categories:

- Very early culling of gilts and parity 1 sows on the basis of reproductive failure and locomotor problems
- Culling around parities 3-5 for poor reproductive performance

A number of studies conducted around the world have tested the hypothesis that a lack of body fatness is the main reason for reproductive failure and poor sow longevity. This hypothesis is largely derived from the fact that the breeding female pig is much different from the breeder of yesteryear (Hughes and Varley 2003).

However, as reviewed by Edwards (1998) and Hughes and Varley (2003), modification of the gilt's fat reserves as she enters the breeding herd through protein restriction or increased feeding levels rarely demonstrates an improvement over several parities (Crisol *et al*., 1997; Glasgow *et al*., 1997; Simmins *et al*., 1992). Likewise, Hoppe *et al*. (1990) were unable to show an improvement in reproductive performance over four parities by increasing fatness in sows fed high-energy diets during successive pregnancies.

Increasing protein intake in gestation and lactation has also been recently studied in young sows. Tritton *et al* (1996) reported that litter size born subsequent to sows being fed high protein diets during the first lactation was positively correlated with lactation lysine intake. However, no benefit of high protein intake on weaning to conception interval was observed. This may be because the reproductive response is likely to be influenced by both lactational demand and length of lactation.

The relative importance of weight loss or protein loss during lactation as proposed by King (1987) or simply a critical amount of protein reserve at weaning (Smits *et al.*, 1997) continues to be debated. What has become clear is that the effects of nutritional intake and metabolic turnover of protein tissue during lactation on reproductive performance and longevity are likely to be confounded with absolute body protein and fat stores at the start of lactation and at weaning (see Quesnel *et al*, 2005). Unfortunately, the effect of body protein reserves on lifetime reproductive performance has not been reported, largely due to the problem of measuring protein mass in the animal.

The present study investigated the effects of lactation diet density and suckled litter size on body tissue status, post-weaning fertility/fecundity and longevity in parity one sows.

Project Objective

To identify lactation management strategies that minimise maternal tissue loss and maximize subsequent reproductive performance and sow longevity.

Hypothesis

Increasing gilt protein mass at first weaning enhances subsequent fertility and longevity regardless of how that protein mass was achieved.

Methods

The experiment was a 2 by 2 factorial, incorporating 2 lactation diets – standard (S) versus high (H) lysine (table 1 & appendix 1) and 2 suckling sizes – 7 versus 12 piglets per sow, with litter size maintained throughout the lactation by fostering.

Table 1. Energy and lysine content of the 2 lactation diets

Diet	Energy	Lysine
Standard (S)	14.3 MJ DE/kg	0.56g av. Lys / MJ DE
High lysine (H)	14.5 MJ DE/kg	0.90g av. Lys / MJ DE

Gilts were a mixture of F1 and F2 generation crossbreds.

Gilts were weighed and had backfat recorded at the P2 site upon entry to farrowing and were randomly allocated to the four treatments on this basis, group averages can be seen in table 2. There were no significant differences in entry weight or backfat thickness between treatments.

Table 2. Allocations to treatments were based on weight and backfat (P2) depth upon entry to farrowing

Parameter	Treatment				SED	p-value
	H12	H7	S12	S7		
Number	244	238	259	247		
Weight in (kg)	214.3	215.1	216.0	215.3	1.877	0.584
P2 (mm)	17.0	16.9	16.9	17.2	0.284	0.323

In this and all subsequent tables S and H refer to the standard and high lysine diets respectively

Reproductive information (total born, pigs born alive) was recorded for the first litter and litter size was adjusted according to treatment (i.e. 7 or 12) within the first 24 hours and the adjusted litter weight was recorded.

Daily feed intake for the sow was recorded. Feed was delivered via a calibrated scoop – re-calibrated on a fortnightly basis, and residual feed was also recorded. Feed was offered on a restricted step-up basis for the first 5 days of lactation moving towards an *ad libitum* basis for the majority of the lactation.

Sows were weaned at approximately 21 days with body weight and backfat depth recorded at weaning. Litter weaning weight was also recorded. Post-weaning sows were group-housed and mated on their first oestrus, wean-to-service interval, body weight and backfat depth was recorded.

For subsequent parities total born, born alive, farrowing rate and wean to service intervals are recorded as well as parity at culling and the reason for culling.

Data analysis was conducted on two sets of data. The first set comprised of all gilts that entered the program and farrowed, whilst the second set involved only those gilts that returned to service within 14 days of weaning.

Gilt weight upon entry was used as a covariate in both analyses.

Results

All-data analysis.

There were no significant differences in entry weight (Weight in), backfat depth (P2) or lactation length between treatments for either diet, suckle size or their interaction (table 3). Whilst the allocation of gilts to treatments was based solely on entry weight and backfat depth, there was an unselected for difference in reproductive performance in parity 1 (Total born, p=0.013; Born alive, p=0.002) between treatments when assessed on suckle size.

Losses in body condition, both weight and backfat depth occurred in all treatments (table 3). Dietary treatment had little significant influence on body condition with only the loss in backfat during the wean to re mate period (W-M P2 loss, p=0.056) being affected. Interestingly, this parameter was the only one where difference due to suckle number was not significant.

Losses in both live weight and backfat depth during lactation (F-W weight loss, p<0.001; F-W P2 loss, p<0.001) were significantly different between suckle size treatments (table 4) with gilts suckling 12 piglets losing 7.2kg more bodyweight than their counterparts suckling 7 piglets. Losses in backfat depth were consistent in magnitude with those for body weight. Interestingly weight loss post-weaning was higher in gilts suckling 7 piglets; similarly, losses in backfat depth were also higher in the ‘better’ high lysine (H) diet treatment during this period.

The average daily feed intake of sows during lactation (ADFI) was influenced by the dietary treatment (p=0.082) but not significantly influenced by suckling number (p=0.476) or the interaction between treatments. Sows on the high lysine (H) diet ate less than those on the standard (S) treatment (table 5), however when you calculate intake on a daily energy basis (Total Energy), there was no difference between treatments.

Suckle number significantly influenced the number of days it took gilts to return to service (WEI, p<0.001) with gilts suckling 7 piglets returning to service 2 days earlier than those suckling 12.

The growth of piglets was significantly influenced by suckling number, with piglets from litters of 7 being both heavier at weaning and gaining more weight during lactation than those from litters of 12 (table 4). In contrast total litter weight gain during lactation was some 42% higher (44.2 vs. 31.2 kg) for gilts suckling 12 piglets. These results further demonstrate that milk production in lactating sows is very much driven by the number and weight of the litter.

Table 3. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for dietary and suckle size factors and their interaction.

	Treatment					p-value		
Parameter	H12	H7	S12	S7	SED	Diet	Suckle	Diet x Suckle
Number	244	238	259	247				
Weight in (kg)	214.3	215.1	216.0	215.3	1.877	0.453	0.994	0.584
P2 (mm)	17.0	16.9	16.9	17.2	0.284	0.509	0.624	0.323
Total born – P1	11.50	11.21	11.48	10.88	0.250	0.330	0.013	0.382
Born alive – P1	10.57	10.15	10.46	9.86	0.240	0.256	0.002	0.595
Lactation length	21.3	21.2	21.1	21.1	0.147	0.289	0.764	0.679
F-W weight loss (kg)	29.1	22.8	31.1	23.0	0.774	0.122	<0.001	0.246
F-W P2 loss (mm)	2.6	1.9	2.6	2.2	0.398	0.206	<0.001	0.332
W-M weight loss (kg)	4.7	8.5	5.5	6.1	1.181	0.337	0.010	0.059
W-M P2 loss (mm)	0.6	0.8	0.4	0.4	0.195	0.056	0.427	0.430
F-M weight loss (kg)	31.0bc	28.7ab	33.6c	27.2a	1.362	0.527	<0.001	0.034
F-M P2 loss (mm)	2.8	2.4	2.8	2.5	0.238	0.821	0.036	0.541
ADFI (kg)	5.63	5.57	5.70	5.70	0.079	0.082	0.476	0.608
Total Energy (MJ DE/d)	81.7	80.7	81.6	81.4	1.137	0.736	0.474	0.604
WEI	10.76	8.61	10.80	8.39	0.946	0.910	<0.001	0.848

	Treatment					p-value		
Parameter	H12	H7	S12	S7	SED	Diet	Suckle	Diet x Suckle
Ind litter wt 24hr (kg)	1.55	1.66	1.56	1.65	0.026	0.935	<0.001	0.460
Ind wean wt 21d (kg)	5.25	6.03	5.23	6.20	0.084	0.220	<0.001	0.117
Individual gain (kg)	3.71a	4.36b	3.67a	4.55c	0.073	0.077	<0.001	0.042
Total born – P2	10.91	11.50	10.76	11.31	0.302	0.418	0.008	0.935
Born alive – P2	10.11	10.58	9.96	10.47	0.286	0.525	0.016	0.933
Pigs weaned – P2	9.51	9.76	9.68	9.62	0.209	0.882	0.532	0.300

Dietary treatment had no significant influence on subsequent reproductive performance of gilts (sows?) in the second parity (table 3), although both total born and number born alive were marginally higher in the high lysine (H) treatment compared to the standard (S) treatment. Suckling number asserted greater influence on reproductive performance than did diet, with gilts rearing 7 piglets in their first lactation having a 0.5 piglet advantage in both total born (p=0.008) and born alive (p=0.016) in the second parity.

There was no effect on pigs weaned in the second parity as a result of diet or suckling treatment.

Table 4. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for significant suckle size factors.

	Suckle			
Parameter	7	12	SED	p-value
Number	485	503		
Total born – P1	11.04	11.49	0.177	0.013
Born alive – P1	10.0	10.52	0.170	0.002
F-W weight loss (kg)	22.9	30.1	0.774	<0.001
F-W P2 loss (mm)	2.0	2.6	0.144	<0.001
W-M weight loss (kg)	7.3	5.1	0.836	0.010
F-M weight loss (kg)	28.0	32.3	0.965	<0.001
F-M P2 loss (mm)	2.5	2.8	0.169	0.036
WEI	8.50	10.78	0.670	<0.001
Ind litter wt 24hr (kg)	1.65	1.55	0.018	<0.001
Ind wean wt 21d (kg)	6.11	5.24	0.060	<0.001
Individual gain (kg)	4.46	3.69	0.055	<0.001
Total born – P2	11.40	10.84	0.214	0.008
Born alive – P2	10.52	10.03	0.202	0.016

Table 5. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for significant dietary factors.

	Diet			
Parameter	S	H	SED	p-value
Number	506	482		
W-M P2 loss (mm)	0.4	0.7	0.138	0.056
ADFI (kg)	5.70	5.60	0.056	0.082

Differences were seen between treatments in the length of time it took gilts to return to service (table 6). Diet and suckling number both influenced the percentage of gilts that returned to service within the first 7 days post-weaning. More gilts receiving the high lysine (H) diet during lactation returned to service in the first week than those on the standard (S) diet however this advantage was not maintained into the second or third week, where there was no difference between dietary treatments.

Gilts suckling only 7 piglets maintained their advantage throughout the three week period, with the advantage growing form 5.0% during the first seven-days, through to 6.8% by the second week and up to an advantage of 7.4% more sows bred by 21 days.

Reducing the suckling size to 7 also increased the farrowing rate for the second parity and the retention rate, by 2.2% and 2.3% respectively (table 6). Retention rate was calculated as the percentage of animals that farrowed as a gilt and were retained in the herd and farrowed a second litter.

Analysis of gilts that returned during days 0-14 post-weaning.

When analysis was restricted to only those animals that returned to service within the first 14 days post-weaning, results for most parameters remained similar as for the analysis of all data (tables 8-10). Gilts rearing 7 piglets lost less body condition, both weight and backfat depth, than those rearing 12 piglets. Piglet performance was better for those reared in the smaller litter size. Gilts that reared 7 piglets returned to service faster than those rearing 12 piglets and had much better reproductive performance in the second parity.

In this subset of gilts diet did not influence either the farrowing rate in the second parity or retention rate. However, those gilts that suckled only 7 piglets during the first lactation had a 3.4% higher farrowing rate and 7.1% higher retention rate than those rearing 12 piglets.

Table 6. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for dietary and suckle size factors and their interactions for all gilts that returned to heat

	Treatment							
Parameter	H12	H7	S12	S7	S	H	7	12
% bred by 7 days	72.2	76.2	68.0	74.0	70.9	74.2	75.1	70.1
% bred by 14 days	80.9	87.0	80.1	87.7	83.8	83.9	87.3	80.5
% bred by 21days	82.6	90.6	83.4	90.3	86.8	86.5	90.4	83.0
Parity 2 Farrowing Rate	90.1	92.1	90.9	93.2	92.1	91.1	92.7	90.5
Retention rate#	85.7	87.9	85.3	87.6	86.4	86.8	87.8	85.5

Percentage of animals that farrowed as a gilt that were retained in the herd and farrowed a second litter.

Table 7. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for dietary and suckle size factors and their interaction for gilts that returned to heat within 14 days

	Treatment							
Parameter	H12	H7	S12	S7	S	H	7	12
% bred by 7 days	89.2	87.6	85.0	84.4	84.7	88.4	86.0	87.1
% bred by 14 days	10.8	12.4	15.0	15.6	15.3	11.6	14.0	12.9
Parity 2 Farrowing Rate	88.2	92.3	89.1	92.0	90.6	90.3	92.1	88.7
Retention rate#	67.2	74.6	66.4	73.2	69.7	70.9	73.9	66.8

Percentage of animals that farrowed as a gilt that were retained in the herd and farrowed a second litter

Table 8. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for dietary and suckle size factors and their interaction for gilts that returned within 14 days of weaning.

	Treatment					p-value		
Parameter	H12	H7	S12	S7	SED	Diet	Suckle	Diet x Suckle
Number	186	194	193	197				
Weight in (kg)	214.6	213.4	216.3	215.4	2.069	0.202	0.479	0.940
P2 (mm)	17.1	17.0	17.2	17.3	0.323	0.286	0.968	0.649
Total born – P1	11.56	11.13	11.59	10.99	0.283	0.798	0.009	0.664
Born alive – P1	10.65	10.13	10.59	10.00	0.271	0.642	0.004	0.854
Lactation length	21.4	21.3	21.4	21.2	0.220	0.750	0.396	0.685
F-W weight loss (kg)	28.4	22.4	30.5	22.8	1.223	0.145	<0.001	0.323
F-W P2 loss (mm)	2.6	1.9	2.6	2.2	0.237	0.238	<0.001	0.395
W-M weight loss (kg)	6.0a	9.7b	7.0ab	7.0ab	1.422	0.400	0.074	0.063
W-M P2 loss (mm)	0.8	0.9	0.5	0.5	0.239	0.065	0.750	0.552
F-M weight loss (kg)	34.8b	30.8a	37.8c	29.3a	1.427	0.485	<0.001	0.026
F-M P2 loss (mm)	3.3	2.6	3.2	2.7	0.279	0.931	0.003	0.482
ADFI (kg)	5.68	5.56	5.76	5.74	0.089	0.034	0.292	0.449
Total energy (MJ DE/d)	82.3	80.7	82.4	82.1	1.266	0.383	0.284	0.440
WEI	5.44	5.33	5.72	5.52	0.183	0.063	0.229	0.722

	Treatment					p-value		
Parameter	H12	H7	S12	S7	SED	Diet	Suckle	Diet x Suckle
Ind litter wt 24hr (kg)	1.54	1.66	1.56	1.63	0.030	0.936	<0.001	0.231
Ind wean wt 21d (kg)	5.24	6.03	5.22	6.18	0.096	0.357	<0.001	0.214
Individual gain (kg)	3.70a	4.37b	3.66a	4.55c	0.087	0.300	<0.001	0.074
Total born – P2	10.75	11.36	10.31	11.14	0.357	0.188	0.004 0..	0.666
Born alive – P2	9.92	10.48	9.58	10.39	0.340	0.367	0.004	0.616
Pigs weaned – P2	9.57	9.90	9.58	9.86	0.236	0.888	0.068	0.878

Table 9. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for significant suckle size factors for gilts that returned within 14 days of weaning.

	Suckle			
Parameter	7	12	SED	p-value
Number	391	379		
Total born – P1	11.05	11.58	0.200	0.009
Born alive – P1	10.07	10.62	0.191	0.004
F-W weight loss (kg)	22.6	29.5	0.864	<0.001
F-W P2 loss (mm)	2.0	2.6	0.168	<0.001
W-M weight loss (kg)	8.3	6.5	1.005	0.074
F-M weight loss (kg)	30.0	36.3	1.009	<0.001
F-M P2 loss (mm)	2.7	3.2	0.197	0.003
Ind litter wt 24hr (kg)	1.65	1.55	0.021	<0.001
Ind wean wt 21d (kg)	6.11	5.23	0.068	<0.001
Individual gain (kg)	4.46	3.68	0.061	<0.001
Total born – P2	11.25	10.52	0.252	0.004
Born alive – P2	10.43	9.75	0.240	0.004
Pigs weaned – P2	9.88	9.57	0.167	0.068

Table 10. Parameter values for CHM Alliance Pty Ltd sow longevity experiment showing treatment means and p-values for significant dietary factors for gilts that returned within 14 days of weaning.

	Diet			
Parameter	S	H	SED	p-value
Number	390	380		
W-M P2 loss (mm)	0.5	0.8	0.169	0.065
WEI	5.62	5.38	0.130	0.063
ADFI (kg)	5.75	5.62	0.063	0.034

Discussion

This experiment showed that we have the ability to influence tissue loss in gilts during the first lactation.

In this experiment, where gilts had a good daily feed intake during lactation, we could not influence either the body tissue status, the retention of the breeding sow in the herd or the subsequent reproductive performance of the gilt by delivering more nutrients. From an energy perspective, gilts appeared to limit their intake to meet an energy requirement, with differences in ADFI offsetting the minor differences in diet specifications, whilst increasing average daily dietary lysine from 45g to 73g did not influence tissue loss.

We were however able to influence the gilt by changing the lactational demand. When the suckling size was reduced from 12 piglets to 7, losses in both body weight and backfat depth were significantly lreduced. Lowering the lactational demand also improved the wean to service interval and resulted in better piglet performance.

However, the biggest benefit to reducing this demand was a 0.5 to 0.75 increase in total born in the second litter and improvements in both the farrowing rates in the second parity and an improved rate of retention.

Further research opportunities identified

1. Subsequent effects of improved parity 2 performance during parity 3 and 4 and on longevity
2. Critical number of suckled piglets to preserve body reserves during the first lactation
3. Effects of weaning heavier piglets at 15-16 days of age on longevity and subsequent reproduction
4. Critical weight loss during lactation to maximize subsequent reproduction and longevity
5. For discussion

Appendix 1.

Standard Diet

Raw material		%	[Kg]
13240	SORGHUM 11.0	52.205	1044.1
16040	MILLRUN 18.0	24.55	491.0
34640	SOYBEAN MEAL 48.0	7.15	143.0
40100	BLOOD MEAL 90.0	2.35	47.0
40620	MEAT MEAL 48.0	6.65	133.0
45100	TALLOW	5.5	110.0
47000	LIMESTONE (FINE)	0.45	9.0
49005	SALT (FINE)	0.2	4.0
52810	CHOLINE CHLORIDE 60%	0.125	2.5
52950	BETAINE (BETAFIN)	0.2	4.0
53000	DL METHIONINE	0.005	0.1
53150	LYSINE SULPHATE (51% LYSINE)	0.285	5.7
59100	OPTISWEET	0.03	0.6
62000	BIOFIX/MYCOFIX PLUS(BIOMIN)	0.1	2.0
CPCBREED	CHM PFP4008 PIG BREEDER PREMIX	0.2	4.0
		100.0	2000.0

Analysis

[VOLUME]	%	100.0	LYSINE	%	1.026332	SODIUM	%	0.161607
DRYMATTER	%	88.844775	METHION	%	0.265416	SALT	%	0.396126
MOISTURE	%	10.955225	THREONINE	%	0.659403	CHOLINE	MG/KG	1502.73
PROTEIN	%	19.117205	TRYPTOPHAN	%	0.194814	FAT/EE	%	8.71774
NITROGEN	%	3.024088	M+C	%	0.551485	#AILYS/DEP		0.057926
C_FIBRE	%	3.975805	ASH	%	5.735735	#MET/LYS		0.258606
NDF	%	0.0	CALCIUM	%	0.980471	#M+C/LYS		0.537336
E_NDF	%	0.0	PHOSPHORUS	%	0.82212	#TRY/LYS		0.189816
ADF	%	0.0	AV_PHOS	%	0.398973	#THR/LYS		0.642485
DE_PIG_MJ	MJ/KG	14.313835	#CAL/PHO		1.192614	#ISO/LYS		0.650443
DE_PIG_MC	MCAL/KG	3.410524	#CAL/AVPHO		2.457487			

High-lysine Diet

Raw material		%	[Kg]
13240	SORGHUM 11.0	45.1	902.0
16040	MILLRUN 18.0	14.3	286.0
33160	CANOLA MEAL 38.0	3.85	77.0
34640	SOYBEAN MEAL 48.0	15.0	300.0
35140	F/F.SOYABEAN 37.0	7.5	150.0
40100	BLOOD MEAL 90.0	3.0	60.0
41200	FISH MEAL 60.0	5.0	100.0
45100	TALLOW	3.2	64.0
47000	LIMESTONE (FINE)	1.1	22.0
48250	KYNOPHOS 21	0.9	18.0
49005	SALT (FINE)	0.2	4.0
52810	CHOLINE CHLORIDE 60%	0.03	0.6
52950	BETAINE (BETAFIN)	0.2	4.0
53000	DL METHIONINE	0.005	0.1
53150	LYSINE SULPHATE (51% LYSINE)	0.275	5.5
53200	L-THREONINE	0.01	0.2
59100	OPTISWEET	0.03	0.6
62000	BIOFIX/MYCOFIX PLUS(BIOMIN)	0.1	2.0
CPCBREED	CHM PFP4008 PIG BREEDER PREMIX	0.2	4.0
		100.0	2000.0

Analysis

[VOLUME]	%	100.0	LYSINE	%	1.547352	SODIUM	%	0.159735
DRYMATTER	%	88.8887	METHION	%	0.400929	SALT	%	0.40753
MOISTURE	%	10.8933	THREONINE	%	0.96254	CHOLINE	MG/KG	1510.625
PROTEIN	%	24.889355	TRYPTOPHAN	%	0.294709	FAT/EE	%	7.15405
NITROGEN	%	3.94768	M+C	%	0.77922	#AILYS/DEP		0.089524
C_FIBRE	%	3.9726	ASH	%	5.45795	#MET/LYS		0.259107
NDF	%	0.7125	CALCIUM	%	0.94824	#M+C/LYS		0.503583
E_NDF	%	0.0	PHOSPHORUS	%	0.79154	#TRY/LYS		0.19046
ADF	%	0.0	AV_PHOS	%	0.388815	#THR/LYS		0.622057
DE_PIG_MJ	MJ/KG	14.510875	#CAL/PHO		1.197969	#ISO/LYS		0.644414
DE_PIG_MC	MCAL/KG	3.405401	#CAL/AVPHO		2.438795			