MILK PRODUCTION AND NUTRITIONAL REQUIREMENTS OF MODERN SOWS

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INTRODUCTION

The modern white line sow has been selected for large litters and milk production and the evidence is clear on sow farms. Many sow farms have been increasing total born and weaning large litters with heavier pigs. With litter size continuing to improve and lactation length increasing to around 21 days, the demand for milk production must continue to increase to meet the increasing demand of heavier pigs. Modern sows can produce 10 to 12 kg milk/day (Aherne, 2007) with day 21 of lactation being the peak of production. In fact, sows can produce more milk per kg of body weight than cows. If a 182 kg sow produces 11 kg of milk/day that would be 0.06 kg of milk per kg of body weight. A 909 kg cow can produce 45.5 kg of milk/day that would be 0.05 kg of milk per kg of body weight (Goodband, personal communication).

Milk production by the mammary glands is influenced by genetics and nutrition (Tri-State Swine Nutrition Guide, 1998). To maximize milk production in sows, it takes many factors besides genetics and nutrition. Other factors include feed intake (frequency of feeding), environment (farrowing house temperature), length of lactation, body condition and water intake. One example of management that decreases milk production is restricting feed intake which will decrease milk production in gilts and sows (Pluske et al., 2009).

With the correct selection of genetics, the right environment and management there can be an increase in milk production and therefore heavier weaning weights.

POTENTIAL FOR MILK PRODUCTION IN COMMERCIAL UNITS

As sows have been selected for greater milk production and productivity levels have been improved in commercial units, both milk production and litter weaning weights have increased substantially. In USA, there are examples of units where sows are weaning total litter weaning weights of over 76 kg on 20 day lactation (Table 1). With increased potential for milk production, management and nutritional factors must be changed to meet these demands for lactation.

NUTRITIONAL REQUIREMENTS FOR OPTIMUM MILK PRODUCTION

Sows can achieve and maintain high levels of milk production throughout their productive life if given adequate levels of energy and nutrients. The most critical nutrients for maintaining

optimum lifetime milk productivity are energy and amino acids. Table 2 shows the predicted lysine needs of prolific first litter sows based on current estimated milk production potential.

Table 1. Commercial production for milk production (January – June 2007)[a].

Trait	Response
Number of Sows Farrowed	3029
Total Pigs Born	12.5
Total Pigs Born Alive	11.6
Litter Birth Weight, kg	20.9
Pre-Wean Mortality, %	7.0 %
Pigs Weaned/Litter	10.8
Weaning Age, Days	20.2
Litter Weaning Weight, kg	76.4
Litter Weight Gain, kg/d	2.74
Milk Production, kg/day[b]	10.99

[a]PIC Commercial Camborough 1070 Females located in Midwest USA.
[b]Assumes 4 g milk per gram of piglet growth.

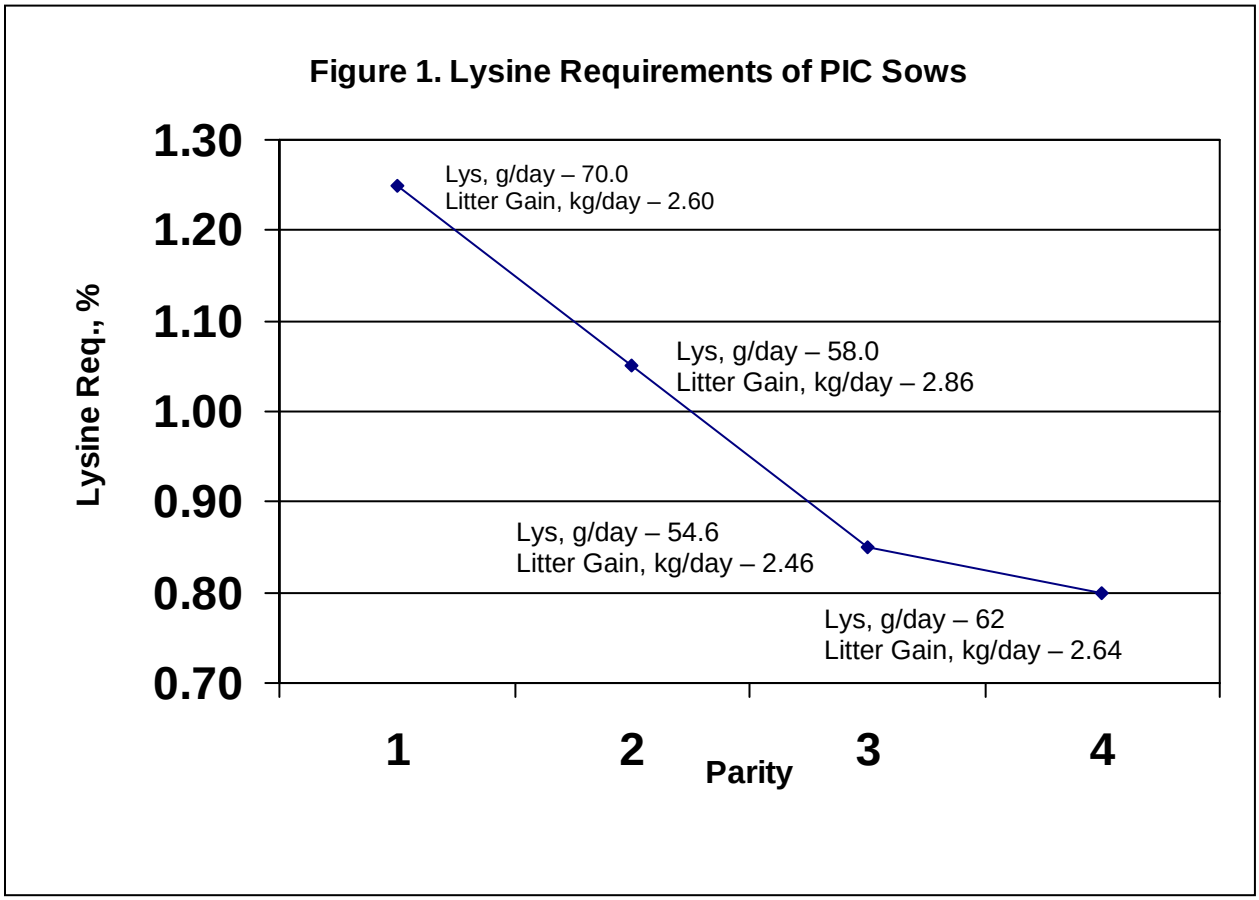
Table 2. Predicted lysine need for first parity sows[a].

Trait	Response
Body Weight at Farrowing, kg	182
Body Weight at Weaning, kg	163
Weight Loss, kg	11.1
Estimated Protein Loss, %	10
Litter Gain, kg/d	2.74
Lysine Needs, g/d	
Maintenance[b]	2.5
Milk Production[b]	73.4
Total	75.9
Lysine Supplied g/d	
Protein Mobilization, g/d	2.5
Diet, g/d	73.4
Feed Intake, kg/d	5.0
Total Lysine Requirement, %	1.22

[a,b]Adapted from Boyd et al., 2002 and Pettigrew, 1993.

These estimates for lysine needs have been validated in a series of studies designed to validate amino acid needs of PIC sows in commercial research conditions (Srichana et al., 2007). In these studies, PIC C-22 sows in parities 1 through 4 were fed isocaloric (3.46 Mcal ME/kg) corn soybean meal lactation diets ranging from 0.95 % to 1.35 % total lysine. Diets were given to sows from day 112 of pregnancy throughout the 19 day lactation period. Feed intake was recorded with a computerized feeding system that insured ad-libitum feed intake. Figure 1 demonstrates the estimated lysine requirement (% and g/day) and milk production (kg/day) for PIC C-22 sows in parities 1 through 4.

Figure 1. Lysine requirements of PIC sows.



In summary of these sets of experiments, total lysine intakes of 70 g/day or 62 grams of SID lysine/day optimize reproductive and milk production performance in PIC sows.

Because gilts eat 10 to 15% less than sows the percent SID lysine in the lactation must increase compared to a mature sow herd. Because we target 62 grams of SID lysine/day we must formulate based on feed intake and not only percent SID lysine. To prevent a Parity 2 dip, we must feed the gilt properly and allow full feed after farrowing. First, the gilt loses more than 10% of her body weight during lactation, then the subsequent litter will suffer with low production. Refer to Figures 2, 3 and 4.

Figure 2. Impact of body weight loss on subsequent performance (Parity 1 gilts).

Impact of Body Weight Loss on Subsequent Performance (Parity 1 Gilts)

	Body Weight Loss			P-value
Criteria	> 10 %	0 -10 %	Gained Wt.	
Number of Sows	31	191	66	
WEI, d	7.04	6.58	5.32	.21
Sows bred by day 7, %	67.4[a]	79.5[b]	86.3[b]	<.10
Total Born	11.17[a]	12.57[b]	13.04[b]	.07

[abc]Means within a row without a common superscript differ (P <.05)

Figure 3. Effect of dietary lysine intake on piglet ADG (g/d) of gilt litters.

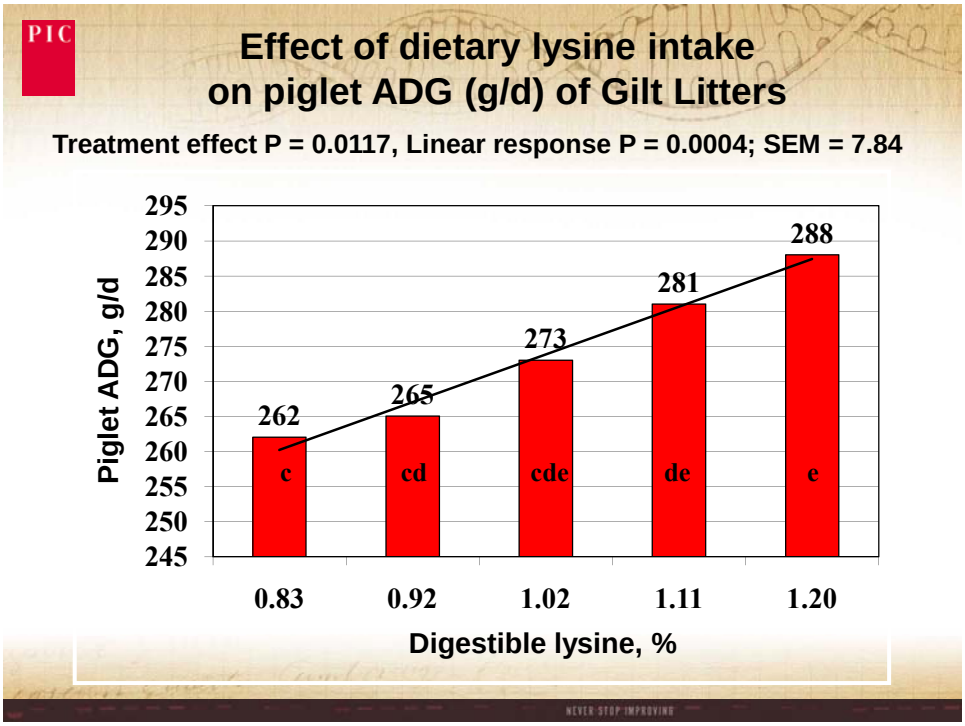
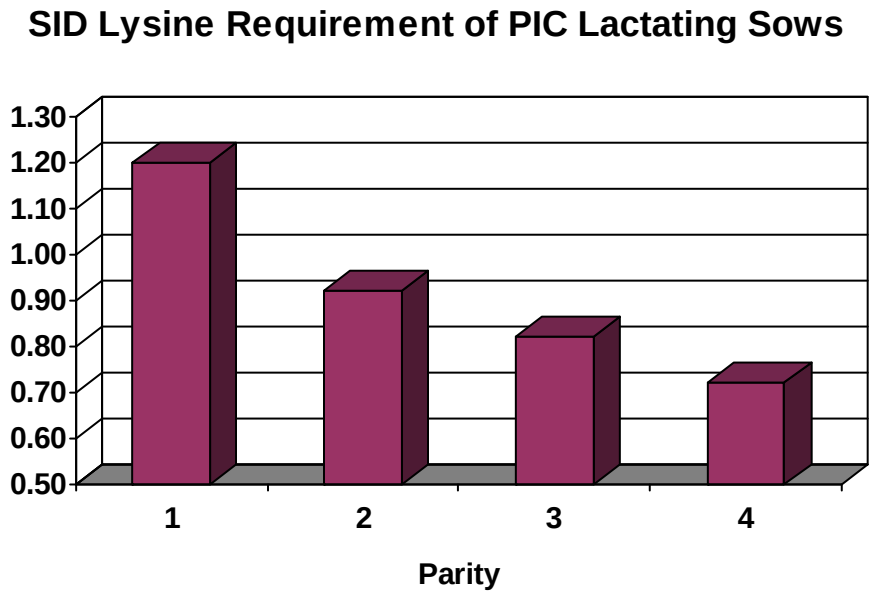


Figure 4. SID lysine requirement of PIC lactating sows.



In addition to lysine requirements, the maximum amount of synthetic lysine in lactation diets and the ideal ratios of other amino acids have recently been validated (Shrichana et al., 2007). Not only will this improve performance but lower diet cost. Table 3 shows reproductive and milk production response to increasing levels of dietary synthetic lysine.

Table 3. Maximum use of crystalline amino acids in lactating sows[a].

L-lysine-HCL, %	0.000	.075	.150	.225	.300
Sow Body Wt Change, kg	1.4	2.9	3.0	4.6	4.4
Litter Gain, kg/d	2.27	2.29	2.38	2.23	2.41
WEI, d	7.1	6.4	5.5	5.9	5.5
Subsequent Reproductive Performance					
Total Born, pig	11.75	12.52	12.45	12.05	12.48
Born Alive, pig	10.95	11.47	11.41	11.42	11.62

[a]Shrichana et al., 2007. 283 Primiparous PIC C22 Sows. Total Amino acid ratios used in diets: Methinone+Cystine: Lysine, 58%; Threonine:Lysine,Tryptophan:Lysine, 18%; Valine:Lysine, 71%.

These studies indicate that up to 0.30 % synthetic lysine can be added to primiparous sow diets without deleteriously affecting reproductive or milk production performance. This response has also been validated in older parity sows (Allee, 2007 personal communication).

With updated nutrition requirements we have included updated SID amino acid ratios (Table 4).

Table 4. SID amino acid ratios.

SID Amino Acid Ratio	Gestation Herd	Lactation Gilt	Lactation Herd
Lysine	100	100	100
Methionine + Cystine	70	50	50
Threonine	76	64	64
Tryptophan	18	18	18
Valine	68	75	75
Isoleucine	58	56	56

FEEDING MANAGEMENT REQUIREMENTS FOR OPTIMUM MILK PRODUCTION

In addition to amino acid intake, proper energy intake is essential for maximizing milk production in sows. Both the amount of and type of energy can influence milk production. Several ways to increase feed intake have been evaluated in commercial sow production. Basic feeder design and feeding pattern have recently been evaluated in commercial conditions to evaluate methods to maximize feed intake and thus milk production.

Recently in the United States, various forms of self feeders have been evaluated in order to maximize feed intake. PIC has collaborated on various trials to determine the efficacy of newly designed self feeders in commercial systems. Although there exists various options within the industry, we have most extensively evaluated the INTaK Ad-Lib Lactation Feeding System (http://www.automatedproduction.com/english/swine/swine.htm). Commercial field research has demonstrated an improvement of 7 percent in feed intake compared with hand feeding systems, along with less labor required for feeding. Figure 5 represents an illustration of an automated feeder.

In addition to evaluation of self feeders, we have evaluated optimum feeding pattern for maximizing lactation intake in commercial systems. In a recent study, the following feeing patterns were evaluated with self feeding systems (Tables 5 and 6 - Kummer, PIC Symposium 2007).

Data from Tables 5 and 6, demonstrate the mild restriction for 3 days followed by full feeding from day 4 through the end of lactation resulted in increased feed intake and reduced body weight loss. Based on these data, the recommendation for feeding PIC sows is to scale feed at 1.8, 1.8, and 2.7 kg for days 0,1, and 2, respectively of lactation followed by ad-libitum access to feed. These data also more fully illustrate the potential for feed intake and milk production for PIC females in parities 1 and 2.

Figure 5. Illustration of self feeder.

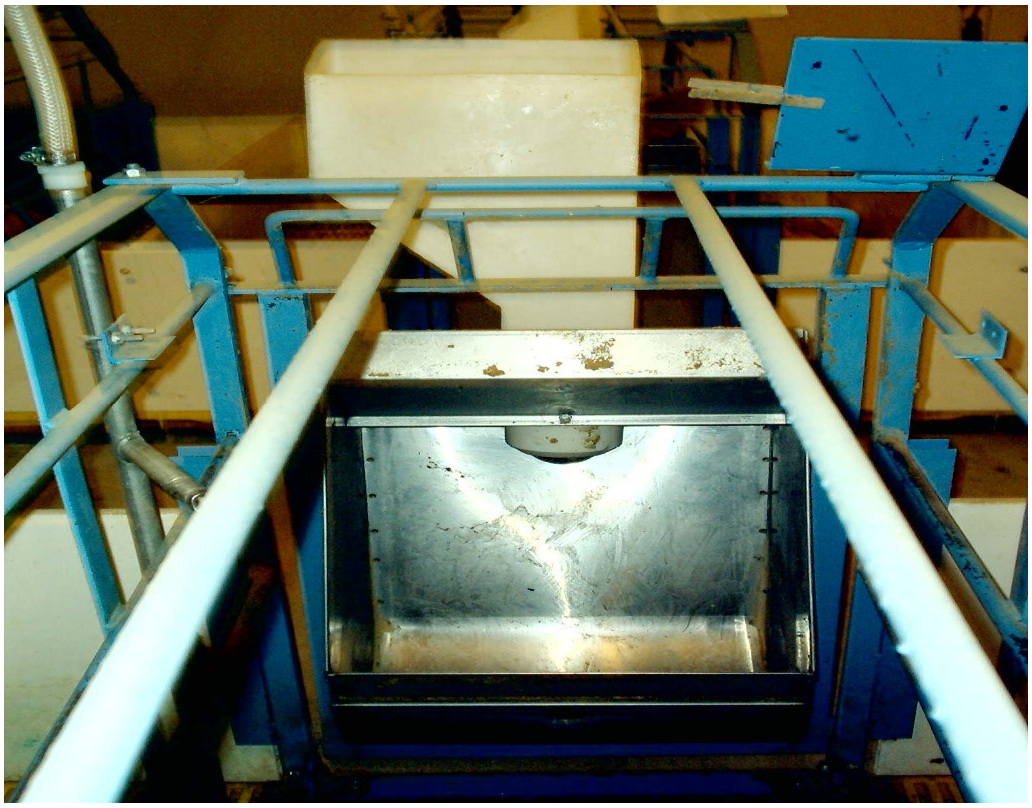


Table 5. Evaluations of various lactation feeding patterns[a].

	Day of Lactation								
Feeding Treatment	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1, kg fed	1.8	1.8	2.7	2.7	3.6	3.6	4.5	4.5	Full
2, kg fed	1.8	.9	1.4	1.8	2.3	2.7	3.2	3.6	Full
3, kg fed	1.8	1.8	2.7	2.7	Full	Full	Full	Full	Full

Table 6. Response to lactation feeding patterns[a].

	Feeding Curve		
	1	**2**	**3**
Sow Performance			
Post Farrow Wt, kg	216	216	216
Wean Wt, kg	210	206	211
Weight Loss, kg	6.8[b]	9.3[c]	6.1[b]
Feed Intake			
0-10 Days	4.16	3.39	4.39
1-19 Days	5.17[b]	4.75[c]	5.28[b]
Litter Performance			
Piglets Started/Sow	11.7	11.7	11.7
Piglets Weaned/Sow	10.82	10.72	10.82
Piglet Weight Initial, kg	1.63	1.66	1.66
Piglet Weaning Weight, kg	6.06	6.01	6.2
Litter Gain/kg/day	2.52	2.45	2.58

[a]Adapted from Kummer, 2007. 200 PIC Camborough P1 and P2 sows.
[b,c]Means with different superscripts differ, P<.05

BUMP FEEDING IN LATE GESTATION

There is limited research data on increasing feed in late gestation. However it is common practice to increase feed by 0.5 to 1.0 kg the last 2 to 3 weeks of gestation to support the increased litter growth. When sows are in proper body condition, bump feeding is recommended. However, if sows and gilts are over condition, bump feeding is not recommended. With the increase in feed costs, many producers are questioning the importance of bump feeding as it could save $3.00 to $5.00 per sow in feed costs.

A recent trial conducted by Shelton et al. (2009), used 108 PIC Camborough gilt and sows for a bump feeding trial. The researchers increased feed by 0.90 kg at day 90 of gestation or did not increase feed. The birth weight of pigs from gilt litters that were bump fed had increased ($P < 0.01$, Feed Level) weights. However there were no differences in birth weight from sows that were fed increased levels. The researchers concluded little response to bump feeding.

One area to point out is the amount of feed that was fed from day 35 to 90 of gestation. Table 7 shows that the sows were fed 2.60 kg per day of a corn-soybean meal diet. In most production systems sows are fed 2.0 kg from day 35 to 90 of a lower energy diet with wheat midds, soy hulls or DDGS. This may have caused some over conditioning.

If sows and gilts are being fed 1.8 to 2.0 kg per day in gestation, then the recommendation is to bump feed at day 90. If gilts and sows are over conditioned then do not bump feed.

More research is needed to better obtain a conclusion.

Table 7. Bump feeding in late gestation.

	Gilt		Sow		P < Level x Parity
	Normal	+ 0.90 KG	Normal	+ 0.90 KG	
Gestation Feed Intake, d 35	2.1	2.1	2.6	2.6	-
Gestation Feed Intake, d 90	2.1	3.0	2.6	3.5	-
Total Gestation Feed Intake, kg	237.5	260.8	299.0	321.9	0.99
Gestation Feed Cost, $	50.85	55.82	64.01	68.91	0.99
Total Born	14.6	14.0	11.9	12.9	0.20
Pig Birth Weight, kg	1.41	1.49	1.53	1.42	0.04
Overall Litter Weight Gain, kg	51.2	51.5	47.7	46.8	0.72

ADDED FAT IN LACTATION

This is another area of limited research. An abstract from the 2010 Midwest Animal Science meetings by Rosero et al. (2010) used 337 sows (PIC Camborough) in Oklahoma during the months of July to September with added fat levels of 0, 2, 4, and 6%. The fat source was an animal-vegetable blend.

The researchers reported that when caloric intake was increased there were no beneficial effects on any measured criteria, except for improved litter gain in P3+ sows.

Another internal research trial was conducted with 1,020 PIC gilts and sows with two treatment levels of 0 and 5% added fat. The weaning weight from pigs that nursed from gilts and sows fed 5% added fat were 0.18 kg heavier ($P < 0.001$). However the difference in weight was not maintained at 22 weeks after weaning. There were no differences in sow performance reported.

CONCLUSIONS

The modern sow has a tremendous capacity for milk production given proper nutrition and feeding management. Milk production levels of over 11 kg/day can be achieved in commercial situations. To achieve these levels, specific needs for lysine and energy intake must be achieved. These levels are well defined for PIC females and are supported by commercial research. This paper serves as a guide for nutritional and feeding management for PIC sows.

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