K·STATE
Research and Extension

Breeding Herd Recommendations for Swine

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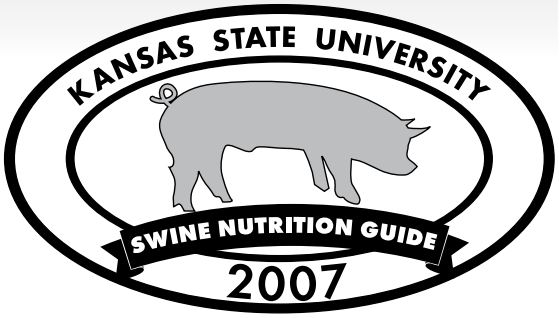

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Gestation Nutrition and Management

When designing a feeding program for gestating sows, remember overall goals for the nutrition program: 1) prepare sows to be in proper body condition at farrowing; 2) maximize reproductive performance (farrowing rate and litter size); and 3) meet the daily nutrient requirements at the lowest cost possible (measured as cost per sow per day).

Problems with overfeeding gestating sows include unnecessary expense, potential problems with impaired mammary development, and reduced feed intake in lactation. Over-conditioned sows used to be the main problem on many swine farms, but in recent years, thin sows have become a more prevalent problem. Too little body tissue reserves can reduce reproductive performance and increase sow mortality. Low backfat reserves also can be an animal welfare concern because thin sows have a greater chance of developing shoulder sores.

The success of a limit-feeding program depends on controlling the intake of each gilt or sow. Care must be taken to see that each female gets her daily allocation. Individual sow feeding stalls are an effective device for controlling boss sows. If sows are group fed, it is imperative that feed be spread across a large area to reduce fighting and ensure that all animals consume their feed allotment. In group housing systems, many managers will increase the specified feed allowance per sow by 10 to 15% to account for wastage and boss sows consuming more than their feed allowance.

How should sow feeding levels be determined during gestation?

Most agree on the importance of having sows in the correct body condition at farrowing. There is some disagreement, however, on whether ideal backfat level at farrowing should be 16 to 18 mm or 18 to 21 mm. The most important point is to have as few sows as possible under 15 mm or over 24 mm of last rib fat depth at farrowing. Nutritionists, veterinarians, and barn managers disagree on the best way to set feeding levels to make sure this happens.

Backfat scanning on commercial farms has convinced us that body condition score is a poor predictor of actual backfat levels. The best correlation found between backfat and condition score on any farm that we have measured is an r^2 of 0.23, suggesting that body condition score only explains about 23% of the variation in backfat depth. If body condition score is used to set feeding levels, feed usage should be tracked and backfat at farrowing should be monitored periodically to try to reduce wide swings in herd backfat thickness. If more than 75% of the sows are between 15 and 24 mm at farrowing, you are doing a good job of setting feeding levels during gestation.

Because of frustration with poor results with body condition scoring on many farms, we have tested and implemented a method to feed sows based on backfat and body weight estimates using concepts proposed by Dr. Frank Aherne. These methods are presented in the following section. Regardless of whether you feed sows based on body weight and backfat or on body condition score, it is important to understand sow energy requirements and energy level of the gestation diet to determine feeding range for your production system.

How much feed do gestating sows require?

The maintenance requirement of the sow accounts for the majority of the feed requirement. Thus, an estimate of body weight is extremely important to accurately feed the sow. Because weighing individual sows is not feasible on many farms, we have established weight categories that can be estimated by using a flank measurement. This measurement is taken immediately in front of the back legs from the point of one flank over the back of the sow to the point of the other flank. The flank measurement is much easier to obtain, especially when sows are housed in gestation crates. Because of the importance of body weight in determining daily feed allotment, it is essential that a high percentage of sows are measured for their body weight estimate. The daily feed requirement for sows to maintain body weight increases approximately 0.3 lb for every 50 lb increase in sow weight for sows fed a corn-soy diet (Table 1). The sows' maintenance requirement will increase as sows gain weight during gestation.

The next biggest component of the gestation feed requirement is the amount of weight or backfat that you want the sow to gain. If you feed sows the maintenance level, they will maintain body weight, but lose backfat. Sows require approximately ¼ lb of feed daily above the maintenance requirement for a small gestation weight gain and to maintain backfat. The daily feed requirement increases approximately 0.4 to 0.5 lb per day for every 3 mm increase in desired backfat gain during gestation (Table 2). Backfat can be measured at breeding with one of several ultrasound machines. The Renco® (*www.rencocorp.com*) machine is used on some farms because of the relatively low

Table 1. Energy and feed (lb/day) required to maintain body weight.

		Dietary energy, kcal/lb	
Sow weight, lb	ME, kcal	1,400	1,500
350	4,741	3.4	3.2
400	5,240	3.7	3.5
450	5,724	4.1	3.8
500	6,195	4.4	4.1
550	6,654	4.8	4.4
600	7,103	5.1	4.7

Table 2. Energy and feed (lb/day) required for backfat gain above requirement for maintenance.

		Dietary energy, kcal	
Backfat gain, mm	ME, kcal	1,400	1,500
0	342	0.24	0.23
3	991	0.71	0.66
6	1,649	1.18	1.10
9	2,307	1.65	1.54

cost. Real-time ultrasound is used by many farms that own these machines for pregnancy detection. Individuals conducting ultrasound measurements must be trained how to use the machine and where to take the measurement. Sows are scanned at the last rib approximately 4 in. (10 cm) off the midline. We recommend scanning the sow on both sides and averaging the values to determine backfat.

The last component of the gestation feed requirement is fetal and uterine gain. Fetal gain increases exponentially in late gestation and thus, feeding levels should be increased by 1 to 2 lb per day during the last two weeks of gestation to meet this need. The daily energy requirement for fetal and uterine gain (330 kcal) during the rest of gestation can be met by a relatively low amount of feed (0.25 lb).

The feed (energy) requirements for maintenance, weight or backfat gain, and fetal growth are then combined to determine the total daily feed requirement (Table 3).

How to set feeding levels using sow weight and backfat?

Once a week, the person responsible for setting feeding levels scans sows for backfat and determines the weight category for sows bred during the previous week. The backfat is written on the sow card, and the feeding level is adjusted using a table customized for the farm based on the energy density of their diet and volume of the feed boxes.

At approximately 7 weeks after mating, sows that visibly appear to be very thin are marked and scanned to determine if backfat gains are on target. Approximately 10 to 15% of the sows will have to be scanned at this time. If the sows are not

Table 3. Feeding levels (lb/day) for gestating sows based on backfat and weight category at breeding [a].

Flank to flank, inches	Estimated weight, lb	Backfat at breeding, mm			
		9 to 11	12 to 14	15 to 17	>18
< 36.3	> 325	5.0	4.4	3.9	3.4
36.4 to 39.2	325 to 400	5.5	5.0	4.4	3.9
39.3 to 41.8	400 to 475	5.9	5.4	4.9	4.3
41.9 to 44.0	475 to 550	6.4	5.9	5.4	4.8
> 44.0	550 to 650	6.9	6.4	5.8	5.3

[a] Based on a diet containing 1,500 kcal ME/lb (corn-soybean meal).

Feeding level should be increased by 2 lb per day on day 100 of gestation.

reaching targets, feed intake is increased by 1.0 lb per day. Sows remain on their feeding level until day 100 of gestation. On day 100, the feeding level is increased by 2 lb per day for the last 2 weeks before farrowing.

The procedure is relatively simple and easy to implement. The three main issues critical to be successful with this feeding method are: 1) A person must be trained to scan and estimate weight; 2) you must know the energy level of the gestation diet; and 3) you must know the accuracy of the feed drops over the expected range in feed allowances. More details on procedures and the calculation spreadsheet can be found at the Web site: *www.ksuswine.org* under the swine extension sow feeding tools link.

Is the pattern of feed intake important during gestation?

Feeding levels in particular stages of gestation have been shown to influence gilt productivity and offspring performance. The periods when excessive feed intake is most detrimental are immediately after breeding (day 0 to 2) and from day 75 to 90 of gestation for gilts. High levels of feed intake after breeding can reduce embryo survival in gilts. Providing gilts high levels of feed from day 75 to 90 of gestation can increase fat deposition in the mammary gland and reduce milk production. From a practical perspective, feeding pattern is less important than providing a total energy level over the entire gestation period that prevents excessive fat gain or inadequate body reserves at farrowing. There is no data available to suggest high feed intake from day 0 to 2 and from day 75 to 90 will be as detrimental in gestating sows as it is in gilts.

Should gestating sows be fed once or twice a day?

Although research on this subject is limited, feeding sows once versus twice a day doesn't appear to change production parameters. Thus, the choice of feeding frequency is up to the individual producer. Some cite improved sow satiety and decreased ulcer potential as the reason for choosing twice a day feeding. Others argue that feeding twice a day increases sow agitation and noise levels in the barn. An advantage with twice a day feeding is that synthetic amino acids can be used without worrying about the reduced utilization that occurs when sows are fed once a day. However, a concern with feeding twice a day is that most gestation boxes are relatively large and difficult to set accurately at the low feeding levels required with twice a day feeding.

Do gestating sows need to be fed every day or can they be fed every other day?

Interval feeding during gestation is a possible alternative to limit-feeding. Often interval feeding is used in group housing systems. Interval feeding is accomplished by feeding the sows every other or every third day. Of course, the amount fed is adjusted accordingly. For an example, instead of feeding 4 pounds each day during gestation, 8 pounds is fed every 2 days. With interval feeding, it is necessary to have sufficient feeder space. Research results have shown that a minimum of 2 to 6 hours out of every 72 hours is an adequate feeding time. Interval feeding is not recommended for gilts or during the last two weeks before farrowing.

Do the genetics or parity of the sow influence feed requirements?

Sow genotype doesn't have a major impact on the feed requirements for maintenance or fetal gain. However, different genetic lines of sows can vary in milk production and lactation feed intake. Sows with high levels of milk production and low lactation feed intake will require higher levels of feed during the subsequent gestation period to recover the weight and backfat lost during lactation. If the sows are fed with the weight and backfat procedure, feeding levels will automatically be adjusted to meet the requirement of different genetics.

Similarly, older sows require higher levels of feed intake to meet their maintenance requirement because they are heavier than younger sows. If feed levels are adjusted as sows become heavier, the higher feed requirements for older parities will automatically be met.

What dietary amino acid levels should be fed to gestating sows?

Make similar calculations to those for energy to determine the requirement for amino acids. The individual amino acid requirements are influenced greatly by expected lean tissue gain during pregnancy. A mature sow gaining 45 pounds from breeding to farrowing requires less than 9 grams per day of lysine, similar to NRC (1988) requirement. Younger gilts bred at 285 lb with an expected gain of 65 lb would require 11 grams per day of lysine. As the expected weight gain increases, the lysine need may increase to as high as 14 grams per day in some first parity gilts. However, these levels can be achieved with a relatively low dietary lysine levels (0.60 to 0.65% total or 0.50 to 0.55% true ileal digestible (TID) lysine for most sows), depending on the level of feed intake.

If a farm uses parity segregation, two different gestation diets can be used. The gestation diet for first parity sows can be formulated to a higher lysine level (0.65% total lysine or 0.55% TID lysine), and the diet for older sows can be formulated to a lower lysine level (0.55% total lysine or 0.45% TID lysine). Excessive protein intake during gestation unnecessarily increases feed cost. In one trial, high protein intake during gestation actually reduced feed intake during lactation.

Because threonine requirements are higher for maintenance than many other amino acids, L-threonine must be added if L-lysine HCl is used in the diet. Research has shown that in sows fed one time per day, synthetic amino acids like L-lysine HCl are only used at about 50% efficiency.

What are the vitamin and mineral recommendations during gestation?

Recommended daily allowances for vitamins and minerals can be controversial because relatively little information is available on some vitamins and trace minerals to make recommendations. Our suggested vitamin and mineral levels are shown in amount per day and amount per ton in Table 4. These recommendations are met by using the KSU vitamin and trace mineral premix or base mix recommendations listed on our Web site at *www.ksuswine.org*. Diets in Table 5 will meet the suggested vitamin and mineral requirements when fed at the recommended levels.

How critical is water intake in gestation?

Like all areas of production, clean, fresh water should be made available at all times. While this suggestion seems simple, it can be a source of concern if water is not an area of focus. Plugged nipples, poorly designed water troughs, or incomplete filling of troughs because of feed blockage can all lead to inadequate water intake in gestation. A part of the daily schedule on sow farms should be to ensure that all sows have access to feed and water.

Should my diets include chromium and L-carnitine?

Some vitamins and minerals that aren't typically added to growing-finishing pig diets have been shown to improve sow reproductive performance. Nutrients that fit this description include biotin, choline, folic acid, and recently, chromium (trace mineral) and L-carnitine.

The FDA has allowed the use of chromium in gestation and lactation diets (200 ppb), and there are several sources available for use. Examples include chromium tripicolinate, chromium yeasts, chromium propionate and chromium nicotinate. Chromium has been found to improve the utilization of glucose by facilitating binding of insulin to its receptors. Studies have observed increased farrowing rate or number of pigs born to sows fed chromium in gestation and lactation. With the reduction in cost of chromium over time, its inclusion is frequently economically justified. As with all additives, evaluation of the cost and potential benefit (possibly involving on-farm evaluation) need to be considered.

Carnitine is a vitamin-like compound primarily responsible for transporting fatty acids across the mitochondrial membrane. Recent research has observed improvements in wean-to estrus interval, farrowing rate and(or) number of pigs born alive. Because carnitine has been observed to affect fat utilization, whereas chromium affects glucose metabolism, additive improvements in sow performance have been observed when used together in sow diets. More recently, feeding L-carnitine to gestating sows has been shown to influence fetal growth factors leading to increased birth weight, and growth rate of the offspring.

Lactation Nutrition and Management

It is well known that lactating sows need maximum intake of a good quality diet to optimize sow and litter performance. However, either intentionally or unintentionally, many lactating sows are limited in feed intake. Low feed intake in lactation results in decreased milk production and excessive sow weight/backfat loss that can impair subsequent reproductive performance. Therefore, the three main goals of the nutrition program for lactating sows are: 1) maximize intake of a properly formulated diet; 2) match the amino acid and other nutrient levels to the level of feed intake that is achieved; and 3) maintain a reasonable feed cost per weaned pig.

Should sows be full fed or restricted during lactation?

It is recommended that during lactation sows be full-fed in order to obtain maximum milk production. A lactating sow will normally consume 9 to 15 pounds per day. This intake will depend on diet composition, sow's body condition, previous gestation feed intake, water availability, and environmental temperature of the farrowing facilities. For maximum milk production, it is recommended that the sow be maintained in an environment of 60˚ to 70˚F. At higher temperatures, a reduction in feed intake will be evident. The full listing of rec-

Table 4. Recommended daily nutrient levels during gestation.

Nutrient	Amount/head/day	Amount/ton
TID Lysine	9.5 g	.53 %
TID Met & Cystine	6.2 g	.34 %
TID Tryptophan	1.8 g	.10 %
TID Threonine	7.1 g	.39 %
TID Valine	6.4 g	.36 %
Calcium	16 g	.90 %
Available Phosphorus	9 g	.45 %
Salt	9 g	.50 %
Trace minerals[a]		
Copper	30 mg	15 g
Iodine	0.54 mg	.27 g
Iron	300 mg	150 g
Manganese	72 mg	36 g
Selenium	0.54 mg[b]	.27 g
Zinc	300 mg	150 g
Chromium	0.36 mg	181 mg
Vitamins		
Vitamin A	20,000 USP	10,000,000 USP
Vitamin D	2,500 USP	1,250,000 USP
Vitamin E	120 IU	60,000 IU
Vitamin K[c]	8 mg	4,000 mg
Riboflavin	15 mg	7,500 mg
Niacin	90 mg	45,000 mg
d-Pantothenic acid	50 mg	25,000 mg
Vitamin B12	0.07 mg	25 mg
Folic acid	3 mg	1,500 mg
Biotin	0.4 mg	200 mg
Choline	1,000 mg	500,000 mg
Pyridoxine	9 mg	4,500 mg
Carnitine	90 mg	45,000 mg

[a] Trace minerals and vitamins levels added to the diet.

[b] Legal addition if fed at 4 lb per head per day.

[c] Menadione.

ommended minimum nutrient levels is provided in Table 6.

What is the best way to maximize the feed intake of lactating sows?

The most practical method of increasing energy intake is to increase total feed consumption. While most nutritionists and veterinarians agree that maximal intake throughout lactation is the desired goal, considerable debate exists on the method to achieve maximum intake. The debate concerns how quickly feed intake should be increased in early lactation. Some advocate feeding extremely low levels of feed (2 lb or less) before and immediately after farrowing. Field experience indicates that extremely low intake during this period limits the producer's ability to increase feed intake rapidly during early lactation. In extreme cases, the extended period of low intake around farrowing can create ulcers. After the long period without feed, sows often overeat if provided free access. This can result in sows going off feed or a noticeable dip in intake. To compensate for this dip, 5 to 10 days into lactation, people prescribe limit feeding as a cure instead of correcting the management practice that caused the problem — the extended period of little or no feed intake pri-

Table 5. Example gestation diets.

	Mixed parity diet			
Ingredient	Corn-soy diet	Soy hull diet	Young parity diet	Old parity diet
Corn or milo	1,626	1,548	1,548	1,617
Soybean meal, 46.5% crude protein (CP)	291	271	271	202
Soy hulls	—	100	100	100
Monocalcium Phosphate, 21% P	32	31	31	29
Limestone	28	27	27	29
Salt	10	10	10	10
Vitamin premix with phytase	5	5	5	5
Trace mineral premix	3	3	3	3
Sow add pack	5	5	5	5
TOTAL	2,000	2,000	2,000	2,000
Calculated Analysis				
TID Lysine, %	0.56	0.55	0.55	0.46
Total lysine, %	0.65	0.65	0.65	0.55
TID Lysine:ME ratio, g/Mcal	1.71	1.71	1.71	1.44
TID Isoleucine:lysine ratio, %	85	85	85	88
TID Leucine:lysine ratio, %	217	214	214	237
TID Methionine:lysine ratio, %	38	38	38	41
TID Met & Cys:lysine ratio, %	78	78	78	85
TID Threonine:lysine ratio, %	76	76	76	80
TID Tryptophan:lysine ratio, %	23	22	22	23
TID Valine:lysine ratio, %	101	100	100	107
ME, kcal/lb	1,484	1,451	1,451	1,451
Protein, %	13.7	13.4	13.4	12.1
Calcium, %	0.90	0.90	0.90	0.90
Phosphorus, %	0.66	0.64	0.64	0.61
Available phosphorus, %	0.39	0.38	0.38	0.35
Available phosphorus equiv, %[a]	0.45	0.44	0.44	0.42
Avail P:calorie ratio, g/mcal	1.39	1.39	1.39	1.31

[a] The available phosphorus equivalency includes the phosphorus released due to inclusion of phytase in the vitamin premix.

or to and immediately after farrowing. Therefore we recommend that immediately before farrowing, feed sows at least 4 lb per day, and after farrowing, step up feed allowance to ad libitum within three days of farrowing.

Many different feeding methods will work to obtain maximum feed intake. The most important facet of any feeding method is to ensure that the sow always has access to feed. A new procedure many producers are adopting is the use of ad libitum sow feeders. This may involve retro-fitting existing farrowing barns with feed lines and drop boxes. Some have installed a feed line in the farrowing house and simply extended PVC tubing from the feed line to the feeder for ad libitum access to feed. There are also specifically designed ad libitum sow feeders that can be used. If automatic feeding systems are not available, we recommend that lactating sows should be fed three or four times per day to ensure that fresh feed is always available. We suggest using the procedure in Table 7, which is outlined below, to maximize sow feed intake:

Morning Feeding — All sows are fed 1 scoop (4 pounds) if small amount of feed is left in the feeder, and 2 scoops if the feeder is empty.

Late Morning Feeding — Feed a second time later in the morning or immediately after lunch using the same scheme (1 scoop if a small amount of feed remains and 2 scoops if the feeder

Table 6. Recommended nutrient levels for lactating sows and gilts[a].

Nutrient	Amount/head/day	Amount/ton
TID Lysine	48 g	0.87 %
TID Met & Cystine	26 g	0.47 %
TID Tryptophan	9 g	0.16 %
TID Threonine	30 g	0.55 %
TID Valine	43 g	0.78 %
Calcium	49 g	.90 %
Available Phosphorus	24.5 g	.45 %
Salt	27 g	.50 %
Trace minerals[b]		
Copper	90 mg	15 g
Iodine	1.6 mg	.27 g
Iron	900 mg	150 g
Manganese	216 mg	36 g
Selenium	1.6 mg	.27 g
Zinc	900 mg	150 g
Chromium	1.09 mg	181 mg
Vitamins		
Vitamin A	60,000 USP	10,000,000 USP
Vitamin D	7,500 USP	1,250,000 USP
Vitamin E	360 IU	60,000 IU
Vitamin K[c]	24 mg	4,000 mg
Riboflavin	45 mg	7,500 mg
Niacin	270 mg	45,000 mg
d-Pantothenic acid	150 mg	25,000 mg
Vitamin B12	0.21 mg	35 mg
Folic acid	9 mg	1,500 mg
Biotin	1.2 mg	200 mg
Choline	3,000 mg	500,000 mg
Pyridoxine	27 mg	4,500 mg
Carnitine	270 mg	45,000 mg

[a] Assumes 12 lb/day feed intake of a diet containing 0.87% TID lysine.

[b] Trace minerals and vitamins levels added to the diet.

[c] Menadione.

is empty). If no feed has been consumed since morning, examine the sow to determine if she has a fever, retained pig, or other detectable reason for being off feed.

Afternoon/Evening Feeding — A similar scheme is used for the afternoon/evening feeding, but use judgment if there is some feed left in the feeder. Sows that have had good appetites before this feeding, but still have greater than 2 lb of feed remaining should receive one scoop. Sows that have eaten all or that have 2 lb or less of previously provided feed should receive two scoops, and again if the feed has not been touched since the last feeding, investigate to see if there is a detectable reason for the sow being off feed. During the summer when sows tend to eat more feed in the evening, managers may want to consider adding an extra scoop in the afternoon feeding.

The only deviation from this pattern is for day 0 to 2 after farrowing. During this time, the decision is to give zero or one scoop at each meal. Sows should not receive two scoops at a single feeding during this period.

A key to this method of feeding is developing a communication method between various employees to gauge an individual sow's appetite

Table 7. Feeding strategy for lactating sows.

Number of 4-pound scoops to feed at each feeding from day 0 to 2 of lactation

Feed in Feeder	Feeding	
	AM	PM
Empty	1	1
< 2 lb	0	0.5
> 2 lb	0	0

Number of 4-pound scoops to feed at each feeding from day 2 to weaning

Feed in Feeder	Feeding		
	AM	Noon	PM
Empty	2	2	2
< 2 lb	1	1	2
> 2 lb	0	0	1

for the previous 2 or 3 meals. Communication aids in deciding how long the sow has been off feed. Various methods are used including daily feed intake recording. For example a clothespin can be clipped on the feeder or at different locations to indicate either good or poor intake. Changing the position of the farrowing card is another way to indicate poor appetite in previous meals.

How do I determine the appropriate dietary lysine level for my sow lactation diets?

To customize lactation diets based on sow productivity, dietary lysine level can be calculated if a producer knows the average litter weaning weight and sow feed intake averaged over the entire lactation period. Daily litter weight gain can be calculated by dividing litter weaning weight by lactation length. Sows require approximately 11.9 grams of lysine per pound of daily litter weight gain. Table 8 can be used to determine the approximate lysine dietary level to accommodate the herd's average milk production.

If the previous lactation diet being fed on the farm is higher in lysine than the recommended level from Table 8, it may be possible to reduce the dietary lysine level without sacrificing performance. If the previous lysine level being fed is lower or the same as the recommendation, the producer may want to increase the lysine (protein) level and reexamine performance records to determine whether litter weaning weight increases. This relatively simple approach allows the sow lactation diet to be customized to an individual farm.

What about other amino acids?

Considerations of other essential amino acids critical to lactation performance that may become limiting include; isoleucine, methionine, threonine, and valine. More research is needed to determine estimate requirements of these amino acids; however, results to date indicate these amino acids must be carefully considered in diet formulation to prevent costly limitations during lactation. In practical diet formulation, we formulate to meet the lysine requirement of the sow and attempt to maintain threonine, valine, isoleucine, and methionine as high as possible without incurring excess cost. Usually, this is accomplished by limiting use of synthetic lysine in these diets. Practical ratios that can be used when formulating diets for gestating and lactating sows are provided in Table 9.

Should the lactation diet contain added fat?

Adding fat to the lactation diet is an effective means of increasing the fat content of the milk and improving litter weaning weight, but it will

Table 9. Suggested TID amino acid ratios for sows.

	Gestation	Lactation
Lysine	100%	100%
Methionine	28%	28%
Met & Cys	70%	55%
Threonine	80%	62%
Tryptophan	20%	19%
Isoleucine	60%	55%
Valine	67%	90%

Table 8. Dietary TID lysine level based upon litter weaning weight and sow feed intake.

Adj. 21-day litter weaning weight, lb	Lactation feed intake, lb/day								Lysine, grams/day	
	8	9	10	11	12	13	14	15	TID	Total
100	0.88	0.78	0.71	0.64	0.59				32	36
110	1.02	0.91	0.82	0.74	0.68	0.63			37	42
120		1.03	0.93	0.84	0.77	0.71	0.66		42	48
130			1.04	0.94	0.86	0.80	0.74	0.69	47	53
140				1.04	0.96	0.88	0.82	0.76	52	59
150					1.05	0.97	0.90	0.84	57	65

not benefit sow reproductive performance. It is important to remember that dietary fat is preferentially used by the mammary gland and results in production of "high fat" milk rather than being used by the sow as an energy source. Use of high dietary fat levels during lactation will improve litter weaning weights, but may actually impair subsequent reproductive performance by reducing the number of LH peaks in early lactation. Therefore, although some added fat (0 to 5%) may be beneficial to improving litter performance, high levels of added dietary fat (greater than 5%) should not be used as a remedy for poor lactation feed intake.

Producers should take all steps possible to increase lactation feed intake whether fat is added to the diet or not. As a general guideline, if it is economical to add fat to the late nursery diets, it will be economical to use 3 to 5 percent fat in the sow lactation diet.

Do vitamin and mineral requirements change for lactation?

Producers can use similar levels of added dietary vitamins and minerals for both gestation and lactation. While the daily requirement for vitamins and minerals increases approximately 1.5 to 3 times in lactation compared to gestation, feed intake is higher in lactation, thus the need for additional fortification above the gestation diet is not necessary. Our suggested vitamin and mineral levels are shown in amount per day and amount per ton in Table 6. Suggested diets in Table 10 will meet the suggested vitamin and mineral requirements when fed at recommended levels.

What grain particle size should be used?

In lactation, research clearly shows that nutrient utilization, milk production, and weaning weights decrease with increasing particle size. Also, if grain particle size is too fine, ulcers may develop, which may jeopardize performance and/or sow health. We recommend that lactation sow diets have grain particle size ranging from 600 to 800 microns, similar to growing-finishing pigs. However, little evidence suggests that larger particle sizes in gestation adversely affect sow performance. While the ideal particle size has not been identified, it is a practical recommendation that grain particle size may be slightly greater in gestation than in lactation.

Should all sows receive the same lactation diet?

First parity sows require special consideration when formulating lactation diets. Typically, feed intake level is about 20% less than the herd average. Thus, if the average sow is consuming 12 lb per day, the first parity sows will average about 10 lb per day. Using Table 8, first parity sows would require approximately 0.20% higher lysine lactation diet to maintain the same level of litter weaning weight. Researchers also have demonstrated that first parity sows require higher lysine for maximum reproductive performance than required for maximal milk production.

When all sows are housed in the same facility, management is faced with a choice. They must either provide higher amino acid levels than required by the multiparity sows in order to meet requirements of young sows, or formulate closer to the requirements of the older sows and not meet the requirements of the young sows. In most situations, the choice is to formulate closer to the requirements of the young sows and oversupply nutrients to the older sows. An advantage of segregated parity flow is that old sows can be fed diets formulated closer to their nutrient requirements in gestation and lactation, resulting in reduced feed cost.

What about adding laxatives to the lactation diet?

Feed ingredients with high fiber content such as soy hulls, beet pulp, oats, wheat bran, and wheat midds may be used as laxatives to keep sows from becoming constipated. However, they also reduce the energy density of the diet and limit sow energy intake and may increase diet cost. To our knowledge there is no data to suggest a beneficial improvement in sow performance by adding a laxative to the diet. If laxatives must be used, topdressing individual sows would be the preferred method. This could be done by having a bag of soyhulls or wheat midds in the farrowing complex for individually topdressing a sow's feed. Chemical laxatives, such as magnesium-, potassium-, or sodium-sulfate, are also an option for controlling constipation problems. The recommended level of magnesium sulfate (Epsom Salts) is 10 to 20 pounds per ton or topdressing about 1 to 2 tablespoons per feeding.

Can the gestation and lactation diets be the same?

We discourage the use of the same diet for both gestation and lactation. In smaller swine operations, it may not be practical to use two different diets for the sow herd. The lactation diet, if properly formulated, can be fed at the rate of 4 to 6 pounds per sow per day during gestation. Feed cost will be higher if the lactation diet is fed during gestation and research has shown that feeding excess protein during gestation can reduce feed intake during lactation.

Table 10. Example lactation diets.

	TID Lysine, %					
Ingredient, lb/ton	0.80	0.85	0.90	0.95	1.00	1.05
Corn	1,435	1,395	1,356	1,316	1,277	1,238
Soybean meal, 46.5% CP	486	526	566	605	645	685
Choice white grease[a]	0 to 5%	0 to 5%	0 to 5%	0 to 5%	0 to 5%	0 to 5%
Monocalcium Phosphate, 21% P	28.5	28.5	28	28	28	27.5
Limestone	28	27.5	27.5	27.5	27	27
Salt	10	10	10	10	10	10
Vitamin premix with phytase	5	5	5	5	5	5
Trace mineral premix	3	3	3	3	3	3
Sow add pack	5	5	5	5	5	5
Total	2,000	2,000	2,000	2,000	2,000	2,000
Calculated Analysis						
TID Lysine, %	0.80	0.85	0.90	0.95	1.00	1.05
Total lysine, %	0.91	0.97	1.02	1.08	1.13	1.19
TID Lysine:ME ratio, g/Mcal	2.35	2.49	2.64	2.79	2.93	3.08
TID Isoleucine:lysine ratio, %	79	79	78	77	77	76
TID Leucine:lysine ratio, %	177	172	168	164	160	157
TID Methionine:lysine ratio, %	32	31	30	30	29	28
TID Met & Cys:lysine ratio, %	65	64	62	61	60	59
TID Threonine:lysine ratio, %	69	68	68	67	66	66
TID Tryptophan:lysine ratio, %	22	22	22	22	22	22
TID Valine:lysine ratio, %	90	88	87	86	85	84
ME, kcal/lb	1,547	1,547	1,547	1,547	1,547	1,547
Protein, %	17.1	17.9	18.7	19.4	20.2	20.9
Calcium, %	0.90	0.90	0.90	0.90	0.90	0.90
Phosphorus, %	0.66	0.67	0.67	0.68	0.69	0.69
Available phosphorus, %	0.36	0.37	0.36	0.37	0.37	0.37
Available phosphorus equiv, %[b]	0.48	0.48	0.48	0.48	0.48	0.48
Avail P:calorie ratio, g/mcal	1.40	1.41	1.40	1.41	1.41	1.41

[a] If adding fat, substitute for grain on an equal weight basis.

[b] The available phosphorus equivalency includes the phosphorus released due to inclusion of phytase in the vitamin premix.

Is there a simple way to determine gestation and lactation sow feed intake for a farm?

Regardless of whether backfat and weight or body condition scoring is used to set the daily feed allowance for each sow, it is useful to get an overall picture of gestation feed usage for a swine farm to determine if any long-term trends towards over or under-feeding exist. This can be done relatively easy by dividing the total feed delivered for a specific period by the number of gestation places in the farm and the number of days in the period. Certainly, if sow space is not fully utilized on the farm, this measure will need to be adjusted for actual inventory, but for most farms simply knowing the number of gestation spaces is adequate. This calculation is especially useful in production systems with multiple sow farms to determine if one sow farm routinely feeds more feed than another when provided the same gestation diet. In reality, most farms should have gestation feed usage of 7.2 to 7.8 Mcal ME per sow per day, which equates to 5.1 to 5.5 lb per day of a gestation diet containing 1.4 Mcal ME/lb (milo-soybean meal or corn-soybean meal and soy hulls) or 4.8 to 5.1 lb of a diet containing 1.5 Mcal ME/lb (corn-soybean meal). If feed usage for the farm is outside of these bounds, reasons for the discrepancy should be explored.

For example, a 3,000 sow farm with 2,800 gestation crates used 1,210 tons of feed in a 6 month period. The calculated gestation feed intake is:

$$\frac{\text{Total Feed}}{\text{Crates X Days}} = \frac{1{,}210 \text{ tons} \times 2{,}000 \text{ lb}}{2{,}800 \text{ crates} \times 182 \text{ days}} = 4.75 \text{ lb/d}$$

For lactation feed intake, calculations are similar, but two calculations are helpful to determine actual lactation feed intake. The first calculation uses crate days and feed delivery and estimates the lowest amount of feed disappearance per sow per day. The second calculation relies on the number of farrowings and lactation length and estimates the highest amount of disappearance that could have occurred. The average of these two values should be used as the feed intake estimate.

Because these calculations rely on feed delivery, which can be sporadic, a period of 4 to 6 months should be the shortest period used for the calculations. A six month rolling average is a good way to view feed intake when using this method.

For example, over a 6-month period, a 3,000-sow farm, with 450 farrowing crates, farrows 3,615 litters with an average litter weaning weight of 101 lb at 19 days of age. During this 6-month period, 419 tons of lactation feed were delivered to the farm.

The first method using crate days estimates feed disappearance as:

$$\frac{\text{Total Feed}}{\text{Crates X Days}} = \frac{419 \text{ tons} \times 2{,}000 \text{ lb}}{450 \text{ crates} \times 182 \text{ days}} = 10.2 \text{ lb/d}$$

The second method using number of lactating days estimates feed disappearance as:

$$\frac{\text{Total Feed}}{\text{Litters X Lactation Length}} = \frac{419 \text{ tons} \times 2{,}000 \text{ lb}}{3{,}615 \times 19 \text{ d}} = 12.2 \text{ lb/d}$$

The first method should underestimate average lactation feed intake because of days that crates are empty or contain prefarrowed sows that are eating lactation feed. The second method over estimates lactation feed intake because the feed to prefarrowing sows is counted as feed fed to lactating sows. The true daily lactation feed intake should be somewhere between 10.2 and 12.2 lb.

Gilt Nutrition and Management

Research has shown that growth rate of developing gilts should neither be too slow or too fast. The goal for many different sow lines is to have a 300 lb gilt at 210 days of age (eligible for breeding). To achieve this goal, developing gilts can be fed diets similar to normal grow-finish diets except calcium and phosphorus levels should be greater to increase bone mineralization. In some cases the added fat typically used in finisher diets can be decreased or eliminated from the diet.

For at least the last 30 days before breeding, gilts should also receive the vitamins normally added to only sow diets (biotin, folic acid, pyridoxine, chromium, and carnitine). Thus, after gilts reach approximately 220 lb the sow add pack should be added to the diet or gilts should be switched to the gestation diet. An example of a series of gilt developer diets is provided in Table 11. These diets can be used in either a five- or three-phase program following the feed budgets provided in Table 12.

Boar Nutrition and Management

Naturally mated or on-farm boars that are collected, can be fed a grain-soybean meal diet fortified similarly to a gestation diet. The daily feeding rate should be changed to reflect differences of season, condition, and boar workload. Boars under heavy use should be fed 6 pounds per head per day of that diet to provide enough protein and energy to maintain body condition and proper sperm production. Avoid underfeeding micronutrients and protein when limit-feeding boars (less than 4 pounds per day) with the sow gestation diet. Formulate a separate diet for boars in a boar stud. Due to the relatively low cost of the boar diet and the importance of boar sperm production in the stud, we fortify the boar diet with higher levels of protein and vitamins. We must caution that few trials have been conducted to determine nutrient requirements of boars. The diets in Table 13 are examples of rations that have worked well in boar studs.

Similar to the gestating sow, a factorial approach can be used to determine boar energy requirements. These requirements include components for maintenance, weight gain, semen production, and mating activity. The flank to flank measurement used for gestating sows appears to accurately predict weight of boars as well. Suggested feeding levels for boars of different weight ranges are provided in Table 14. An accurate weight estimate can also be useful in determining medication dosages for boars.

Table 11. Example gilt developer diets.

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
	Gilt Development Weight Range, lb				
	50	75	130	170	220
Ingredient	75	130	170	220	250
Corn	1,360	1,465	1,580	1,652	1,695
Soybean meal, 46.5%	584	481	369	298	250
Monocalcium Phosphate, 21% P	22	20	17	16	14
Limestone	18	18	18	18	18
Salt	7	7	7	7	7
Vitamin premix with phytase	3	3	3	3	5
Trace mineral premix	3	3	3	3	3
Sow add pack	—	—	—	—	5
Lysine HCl	3	3	3	3	3
TOTAL	2,000	2,000	2,000	2,000	2,000
Calculated Analysis					
TID Lysine, %	1.05	0.92	0.78	0.69	0.63
Total lysine, %	1.18	1.03	0.88	0.78	0.72
TID Lysine:ME ratio, g/Mcal	3.16	2.77	2.34	2.07	1.89
TID Isoleucine:lysine ratio, %	69	70	70	71	71
TID Leucine:lysine ratio, %	150	158	169	179	187
TID Methionine:lysine ratio, %	27	28	30	31	33
TID Met & Cys:lysine ratio, %	55	58	62	65	67
TID Threonine:lysine ratio, %	60	61	62	63	64
TID Tryptophan:lysine ratio, %	20	19	19	19	18
TID Valine:lysine ratio, %	78	79	82	84	85
ME, kcal/lb	1,506	1,508	1,511	1,513	1,509
Protein, %	19.5	17.6	15.4	14.1	13.2
Calcium, %	0.67	0.63	0.59	0.57	0.54
Phosphorus, %	0.62	0.58	0.53	0.50	0.47
Available phosphorus, %	0.30	0.28	0.24	0.22	0.20
Available phosphorus equiv, %	0.40	0.37	0.34	0.32	0.31
Avail P:calorie ratio, g/mcal	1.21	1.12	1.01	0.96	0.94

Table 12. Example gilt feed budgets for five- and three-phase programs.

Diet, lb/pig	Five phase	Three phase
Diet 1	53	- - -
Diet 2	137	240
Diet 3	116	- - -
Diet 4	165	230
Diet 5	109	110
Total	580	580

Table 13. Example boar stud diets.

Ingredient	Low Energy	High Energy
Corn	1,305	1,496
Soybean meal, 46.5% CP	364	418
Soy hulls	250	—
Monocalcium Phosphate, 21% P	35	38
Limestone	22	24
Salt	7	7
Vitamin premix with phytase	7	7
Trace mineral premix	3	3
Sow add pack	7	7
TOTAL	2,000	2,000
Calculated Analysis		
TID Lysine, %	0.68	0.72
Total lysine, %	0.81	0.83
TID Lysine:ME ratio, g/Mcal	2.21	2.21
TID Isoleucine:lysine ratio, %	80	81
TID Leucine:lysine ratio, %	184	189
TID Methionine:lysine ratio, %	33	34
TID Met & Cys:lysine ratio, %	68	69
TID Threonine:lysine ratio, %	71	71
TID Tryptophan:lysine ratio, %	22	22
TID Valine:lysine ratio, %	92	93
ME, kcal/lb	1,397	1,481
Protein, %	15.4	16.1
Calcium, %	0.89	0.90
Phosphorus, %	0.70	0.75
Available phosphorus, %	0.43	0.46
Avail P:calorie ratio, g/mcal	1.95	1.94

Table 14. Feed allowance for boars based on body weight and energy density of the diet.

			Feed allowance (lb/day) based on diets in Table 13	
Flank to flank, in	Estimated wt, lb	Energy required, Mcal of ME/day	Low energy	High energy
< 36.3	> 325	7.72	5.5	5.2
36.4 to 39.2	325 to 400	8.04	5.8	5.4
39.3 to 41.8	400 to 475	8.33	6.0	5.6
41.9 to 44.0	475 to 550	8.60	6.2	5.8
44.1 to 46.2	550 to 625	8.85	6.3	6.0
46.3 to 48.2	625 to 700	9.08	6.5	6.1
48.3 to 50	700 to 775	9.31	6.7	6.3
50.1 to 51.7	775 to 850	9.52	6.8	6.4
> 51.8	> 850	9.72	7.0	6.6

Notes

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