

## Animal Well-Being



# Group Housing Systems: Nutritional Considerations

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## Objectives

1. Describe energy requirement differences for different sow gestation housing systems
2. Discuss how different group-housing feeding systems may influence diet and feed characteristics
3. Outline gilt development nutritional programs

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## Introduction

While the nutritional program for group housed sows is generally viewed to be very similar to sows housed in gestation stalls, minor differences need to be taken into account. Because group feeding systems allow for individual (electronic sow feeding and gated stalls) or competitive (floor feeding and non-gated stalls) feeding, decisions on the type of feeding system can influence the overall dietary nutritional program. Due to the numerous options of group housed feeding systems available, simple changes in diet characteristics may allow for improved satiety and performance based on the feeding system utilized. Thus, determining and selecting the correct feeding level for the different types of feeding systems will allow for a more consistent and desired sow body condition. Finally, proper nutrition during gilt development for longevity and structural soundness is imperative given the conditions that sows can experience while in gestation group housing.

This factsheet does not provide specific nutrient recommendations or target dietary levels of energy intake, amino acids, vitamins and minerals for sows and developing gilts. Those values can be obtained from genetic suppliers and other readily available published sources [1,2].

## Energy requirement of group vs. stall housed sows

***Do sows housed in groups require more feed than sows housed in stalls?***

The answer to this question is complicated as it depends on the environmental temperature, flooring type, level of activity, and feed wastage. If sows housed in groups or in individual stalls were housed at temperatures within their thermoneutral zone and had the same level of activity, their requirements would be identical.

However, sows housed in groups in pens are often exposed to different temperatures and have different levels of activity. Thus, they can have different energy (feed) requirements. The NRC (2012) [2] is helpful to demonstrate this concept and to calculate energy requirement of sows housed under different conditions. We will use the NRC model to provide examples of how feeding levels would need to be changed for each of these variables (Table 1).

### ***Activity level***

As group housed sows are provided more space, they spend more time standing and walking and less time lying down [3]. The increased activity increases the feed requirements. As shown in the comparison between scenario 1 and 2 in Table 1, if sows spend 50% more time standing, their feed requirements increase by a little less than ¼ lb/day (100 g). It doesn't matter if the increased standing is in group pens (scenario 4) or individual stalls (scenario 2). Choosing a housing and feeding system that increases sow interaction and competition will further increase the activity level and increase energy requirements.

### ***Temperature and flooring type***

Decreasing the effective environmental temperature below the thermoneutral zone increases the feed requirement of sows to maintain body temperature. The lower critical temperature for sows housed individually in stalls is 68° F (20° C, Celsius). If sows are housed individually and exposed to low environmental temperature (scenario 3), their feed requirements increase dramatically. Lowering the environmental temperature to 50 °F (10° C) increases the feed requirements by 1.5 lb/day for sows housed individually. A rule of thumb can be that each 5° F reduction in temperature below the lower critical temperature increases feed requirements by approximately 0.4 lb/d.

**Table 1. Feed requirements for gestating sow<sup>a,b</sup>**

Scenario	1	2	3	4	5	6
<b>Housing system</b>	----- Individual -----			----- Group -----		
<b>Sow standing time, min/day</b>	240	360	240	360	360	360
<b>Temperature, °F</b>	68	68	50	68	50	50
<b>Floor type</b>	Slat	Slat	Slat	Slat	Slat	Straw
Feed intake (d 0 to 90), lb/d <sup>c</sup>	4.87	5.09	6.40	5.09	5.60	5.26
Avg feed intake (d 0 to 114), lb/d <sup>c</sup>	5.07	5.29	6.60	5.29	5.79	5.46
Energy required, kcal ME <sup>d</sup>	7,203	7,517	9,376	7,517	8,238	7,758

<sup>a</sup> Adapted from: NRC 2012 [2] models for estimating nutrient requirements of pigs.

<sup>b</sup> Example for parity 2 sow weighing 364 lb (165 kg) at breeding with target final body weight of 496 lb (225 kg) prior to farrowing. The total weight gain of 132 lb would include 80 lb of maternal gain and 52 lb of fetal and conceptus gain. Diet was assumed to contain 1,497 kcal ME/lb (3300 kcal ME/kg) and 9% fermentable fiber.

<sup>c</sup> Feed intake includes the required feed intake and an assumed 5% feed wastage. Feed intake is increased by 0.9 lb/d (400 g) from d 90 to 114.

<sup>d</sup> The energy requirement is average requirement over entire gestation period without feed wastage.

If sows are housed in a group on concrete slats, their feed requirement only increases by 0.5 lb/day for the same 18° F (10° C) decrease in temperature (scenario 5 vs 4). Because sows housed in groups can exchange body heat with each other, they can be housed at temperatures as low as 61° F (16° C) before their feed requirements begin to increase. Adding straw to the pen provides sows with a means to maintain body heat. Thus, they can be housed at temperatures as low as 54° F (12° C) before their feed requirements begin to increase. Group-housed sows that are provided with straw would only require 0.17 lb/day more feed when housed at 50° F than group-housed sows maintained at 68° F (scenario 6 vs 4).

#### **Wastage**

Any feeding system that increases wastage will obviously increase the feed requirements of the sow. Feeding levels will likely need to be increased by 5 to 10% for wastage for sows that are floor-fed and to ensure that subordinate sows receive adequate feed [4].

#### **Adjusting body condition**

When sows are housed individually, their feeding level can be adjusted based on their body condition, body weight, backfat, or a combination of the three. Depending on the housing system, it may not be as easy to adjust feeding levels for the individual animal when sows are housed in groups. For example, when using a competitive feeding system, such as floor feeding or free-access stalls without rear gate, all feed provided is available to all sows in the pen. In this scenario, sows should be grouped by parity and body condition such that all sows in the pen have similar requirements. Even when sows in the same pen have similar requirements, feeding levels may need to be increased slightly to account for variation in feed intake that occurs in competitive feeding situations. If sows must be grouped in large sized com-

petitive pens that create variation in parity and body condition, the overall feeding level should be increased to prevent under conditioned sows from becoming even thinner. Thus, most sows are overfed to accommodate the thin sows. Inherently, the over and correct body conditioned sows also increase their fat stores which must be monitored. This situation obviously increases feed cost.

Ideally, sows in competitive feeding situations would also be grouped based on speed of eating so all sows in the pen would consume feed at the same rate; however, rate of consumption is not easy to measure. Trickle feeding decreases competition between sows at feeding time, but still makes it virtually impossible to adjust feeding levels for individual sows. If gated feeding stalls are used, individual sows can be marked such that extra feed can be provided to the individuals. Of course, extra labor is required as the extra feed must be provided by hand because multiple sows may use the same feeding stall over time. With electronic sow feeders, individual sows can be fed to their exact requirements as long as the person in the barn takes the time to adjust feeding levels based on the needs of the individual sow. For most group-housed systems, it is best to have the sows enter the pens with similar body condition. Thus, it is advantageous to house them in stalls until confirmed pregnant and feed them to achieve similar body condition or backfat levels at that time [5].

#### **Extra feed before and after mixing**

Providing high levels of feed just prior to and for the first couple days after mixing may be necessary to have sow's nearly full fed to reduce fighting. Although extra feed is not fed to the sows for a long period of time, this extra feed will increase feed wastage and cost.

## Diet and feeding characteristics for group housed sows

Besides potential increases in energy requirements, other diet and feeding changes have been suggested for group-housed sows, such as decreasing the energy density by adding fiber, increasing the number of meals per day, or changing the diet form from meal to pellets or providing feed in liquid form.

### *Dietary fiber or bulking of the diet*

Lowering the dietary energy density by adding high fiber, low energy ingredients has been suggested to provide gut fill and make the sows feel more comfortable and less likely to fight and show stereotypic behavior, such as sham chewing. Indeed, most research has demonstrated reduced stereotypic behaviors in gestating sows fed high dietary fiber [6-8]; however, not all research [9-10] has observed this response. Incorporating high dietary fiber levels reduces feeding rate to increase feeding time, which may be tied to the reduction in stereotypic behavior. Increasing feed consumption is thought to have the greatest impact on minimizing stereotypic behaviors [8], but has the obvious negative effects of creating excess sow body condition, reduced performance, and increased cost. Unfortunately, even if high fiber diets reduce stereotypic behavior, it doesn't necessarily mean that they reduce sow stress or aggression. For example, providing sows with straw or a high fiber diet has been found to reduce oral manipulative behaviors, but did not change the overall aggression level between sows [10]. In fact, bedding sows on straw actually increased aggressive interactions between sows when fed with a competitive feeding system. Increasing the dietary fiber level can reduce stereotypic behavior, but doesn't necessarily reduce sow stress or improve other negative behaviors such as fighting. To reduce the sows' stereotypic behaviors, high dietary fiber levels, such as a 30% neutral detergent fiber (NDF) diet, must be fed, with soluble fiber being more beneficial than insoluble fiber in increasing the sows' satiety or feeling full after feeding.

High fiber ingredients have been suggested to use in self-feeding programs for sows. In theory, if the diet contained enough fiber, sows would not be able to continue to increase consumption and would self-regulate their feed intake. This concept works with sugar beet pulp [11]. However, lack of sugar beet pulp availability limits application of this concept for most producers. Unfortunately, when other fiber sources were used to create the high fibrous diets to regulate sow feed intake, such as barley straw, oat hulls, malt sprouts, rice bran, or wheat bran, sows simply increased their feed intake and reached excessive weight gain levels in very short periods of time [11]. High fiber diet impact on increasing fecal excretion and difficulties in manure handling systems also must be considered when designing feeding programs for gestating sows.

### *Meals per day*

Increasing the number of meals per day for sows has been suggested as a means to reduce sow stereotypic behaviors and enhance welfare. Research has indicated that increasing feedings from one

to two meals may actually increase rather than reduce the time that sows exhibit stereotypic behaviors [12]. Some producers with group sow housing systems have suggested that further increasing meals per day from 2 to 6 may reduce negative behaviors if meals are grouped to provide three small meals in the morning at 30 to 60 minute intervals with another round of 3 small meals in the afternoon. Unfortunately when researched, increasing the feeding frequency from 2 to 6 times daily did not have a negative or positive impact on performance or welfare of group-housed gilts and sows that were floor fed [13]. More research needs to be conducted to determine if increasing the number of meals provides any benefits in sow welfare under different housing conditions.

### *Diet form*

There is limited research examining diet form effects on gestation sow behavior. In one trial, providing liquid instead of dry feed reduced aggression [14]. The authors hypothesized that the reason for the reduced competition may have been because portions were larger with liquid feeding and sows were full and didn't have reason to fight, or because all the sows finished eating at the same time. Providing feed as a liquid increases eating speed, which may allow the subordinate sows to finish eating or nearly finish eating by the time the dominant sow finishes her meal. More research is required with liquid feeding as other attempts to shorten meal duration have increased other welfare attributes that are perceived as negative, such as stereotypic behaviors.

### *Calibrating feeding levels*

Most feeding systems for gestating sows deliver feed based on volume rather than weight. Thus, whether using feeding drop hoppers (boxes) or electronic sow feeders, the quantity delivered must be adjusted as the bulk density of the diet changes to provide the proper amount of feed to the sow. Feed drop hopper design and angle of installation both can influence the quantity of feed delivered [15]. Regardless of housing option chosen, proper feeding system calibration is required to prevent under- or over-feeding of sows.

## Gilt Development

The principles and feeding strategies for replacement gilts are unlikely to change based on the gestation housing system. It is important to recognize that the developing period can impact longevity regardless of housing system and that proper nutrition for a productive reproductive life is essential. Detailed below are specific areas to consider when assembling a nutrition program for developing gilts. Expanded replacement gilt diet recommendations and feeding management practices have been previously published [16].

### *Amino Acids*

The recommendation for dietary amino acid levels for developing maternal gilts is estimated to be between high and medium lean terminal growing and finishing pigs [1]. Historically most maternal lines would have been classified as medium or low lean based on their protein accretion, but as genetic suppliers continue to place emphasis on feed efficiency, selection for leaner maternal

lines have evolved. While overall little research has evaluated the true amino acids requirements for developing gilts, only extremes of excessive or restricted lysine levels have shown negative effects on reproductive [17] or joint development [18]. Also, the ratios of amino acids relative to lysine for developing gilts used in formulation are generally similar to that of terminal pig recommendations. While limited work has evaluated optimal amino acids ratios, increased levels of methionine and threonine have been shown to reduce the severity of osteochondrosis (irregularity in underlying growth cartilage that has improperly calcified) in developing gilts [18-19]. However, the ideal level needs further investigation for economic feasibility.

### **Energy**

The practice to full feed gilts during the growth stages is common for producers and can allow for a moderate growth rate without the gilts becoming over conditioned prior to first breeding. This can be done by regulating the dietary energy concentration so that they do not develop excessive fat stores at first mating that may reduce their longevity in the herd by decreasing structural soundness. Most often, developing gilts are full fed until 30 days prior to breeding when they are relocated to the gestation facility where they remain on full feed or reduced slightly if becoming over conditioned and/or over weight. Then approximately 2 week prior to breeding gilts should be “flushed” or fed an increased amount of feed (close to full feed) to improve their ovulation rate to increase first litter size [17]. General recommendations for first breeding are that gilts be approximately 300 lb at 210 d of age and be on their 2nd or later estrous cycle at first mating. If bred at an older age, gilts often become too heavy and fat in many production systems.

### **Minerals**

The level of both macro and micro minerals fed during gilt development is higher than in diets for terminal pigs. This practice is to help develop and strengthen bone and joints for gestation and lactation. While most research has focused on optimal levels of dietary mineral concentrations in gestation and lactation, there is no evidence to support different levels are needed based on gestation housing system either in gilt development or during reproduction.

*Calcium and phosphorus.* While many minerals are involved in bone metabolism, calcium and phosphorus are the most recognized for bone development and structure. Although specific requirements for replacements gilts are not published [2], many genetic suppliers and other published resources provide recommended dietary levels [1]. Recommended levels of calcium and phosphorus are derived from bone strength or composition analysis rather than performance data as terminal requirements are established. Thus, dietary available phosphorus recommendations are generally between 0.05 to 0.10% higher than for terminal pig diets. Likewise, dietary total calcium is recommended to be increased in the range of 0.05 to 0.10% in early finishing to 0.10 to 0.20% in late finishing compared with terminal pig diets. There is

no evidence that dietary levels of calcium and phosphorus need to be altered based on gestation housing system during development or during gestation and lactation.

*Trace Minerals.* Added levels of trace mineral levels are most often held constant throughout the growing and finishing diets for developing gilts by not changing the inclusion level of the trace mineral premix. Often this is the same level of trace minerals included in gestation and lactation diets. This allows for increased levels of zinc, iron, copper, manganese, selenium and iodine in middle and late finishing when their dietary levels are generally decreased in terminal diets [20]. While again there is little to support specific requirements of trace minerals for developing gilts certain trace mineral can affect bone and joint development such as copper, manganese and zinc.

While added copper above the basal requirement has shown to improve growth rates when fed at levels of 100 to 250 ppm of the diet, research has also shown that added copper can improve joint development. In fact, when fed at 250 ppm copper from copper sulfate during the finishing period the severity of osteochondrosis in joints decreased [19]. This same research examined added manganese due to its involvement in bone and joint development and reported decreased joint osteochondrosis when fed at 100 ppm. Manganese is essential for the synthesis of chondroitin sulfate, a component of mucopolysaccharides in the organic matrix of bone [21]. Therefore, added copper and/or manganese may both provide advantages in growth and longevity during the development period, but more work needs to be done to more confidently define dietary levels to achieve this effect. Copper and zinc are also stored in developing fetuses during late gestation, thus decreasing maternal body stores [22] if inadequate levels are fed.

Chelated forms of some trace minerals are designed to enhance the absorption of the trace mineral. However there is variation in chelated mineral bioavailability's compared to inorganic forms, where they are not always greater. Research evaluating inorganic and organic trace minerals in sow diets over 6 parities reported that dietary micro-mineral source had a minimal effect on sow body and liver mineral contents or in colostrum and pigs at birth, except Se, which was greater when the organic form was fed [23]. Also, research has compared two separate 6400 head sow farms, one that received all inorganic trace minerals while the other was fed organic copper, zinc and manganese replacing 50% of the inorganic portion. The dietary mineral treatments were applied during gilt development and followed through 4 parities. These results showed that gilts and sows fed the organic trace minerals had decreased removal due to locomotion issues, improved sow retention, and farrowing rate and a cumulative increase over 4 parties of total born, live born, and stillbirths [24-25]. Organic forms of certain trace minerals will continue to receive more interest; however, usually the inorganic forms of trace minerals are most economical [20].

### ***Vitamins***

Similar to trace minerals, added vitamin levels are usually held constant throughout the growing and finishing phase rather than decreasing over time as typical in terminal finishing diets. Also, in order to supply maternal vitamins not fed during the finishing period to developing gilts, gilts should be fed similar vitamin levels as sows for 30 days prior to breeding. This is generally accomplished by the transfer of gilts to the gestation or breeding facilities where they begin to receive the gestation diet. While emphasis of some vitamin roles in bone structure (Vitamin D), early embryo development (folic acid) or hoof health (biotin), no data is published that would suggest that dietary levels of any vitamin should be different based on gestation housing system.

### **Summary**

Gestating sows housed in groups may require different diet formulation techniques to increase diet fiber, feeding per day, and diet form that may allow for less aggression and more satiety. However, the amount of energy provided daily generally increases for group housed sows compared to stall housing systems due to increased activity level, more feed wastage, and a slight overfeeding of most sows to assure thinner sows get adequate feed to build body condition. Developing gilts for group housed gestation will require little to no changes from current feeding programs for conventional stall housed gestation systems.

**Disclaimer:** Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by the authors or National Pork Board is implied for those mentioned.

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