Feeding strategies to improve sow satiety in pen gestation housing

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Summary
Feeding systems should focus on providing sows protection when eating and equal feeding opportunities to prevent competition. Sows should be allowed to consume their entire meal during a single visit to the feeder to minimize aggression at mealtime. Generally, 30% neutral detergent fiber has been recommended to increase satiety; however, soluble fiber on a gram per day basis may be more useful to determine optimal fiber source and inclusion levels to achieve sow satiety. When combining the limited data available, increasing soluble fiber above 100 g/d appears to have the greatest potential to improve satiety.

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As group housing systems for gestating sows continue to replace individual housing systems, strategies to manage social interactions have become increasingly important. Because gestating females are limit fed to prevent excessive weight gain rather than being fed to satiety, motivation to express foraging behavior often goes unmet. In response, sows may become increasingly frustrated, developing stereotypic behaviors that result in aggressive interactions towards pen mates. Social hierarchy establishment elicits intense aggression that is generally resolved 2 days after initial mixing, whereas aggression related to pen resources is more chronic and can occur throughout gestation, particularly when sow satiety is not reached. Sow satiety is often measured by assessing self-directed or substrate-directed stereotypic behavior. Self-directed behaviors include sham-chewing, teeth-grinding, and tongue-playing, while substrate-directed behaviors involve substrates such as floor rooting, chain manipulation, bar chewing, or interactions with pen mates. This practice tip will focus on feeding and management strategies that decrease stereotypic behavior immediately after mixing and throughout gestation.

Nutritional strategies

Feeding system
Feeding systems should offer sows protection from pen mates to avoid high levels of aggression during mealtime. This is particularly important for submissive sows that are more likely to be the recipient of aggressive behavior, which can lead to feeder displacement and subsequent reductions in feed intake and body condition compared to dominant sows. In general, electronic sow feeders (ESF) or free access stalls with hind

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gates offer sows more protection at mealtime and, therefore, greater access to feed resources within a pen compared to short stanchions or floor feeding. However, ESF systems require sows to eat in sequence, which goes against their natural tendency to feed in groups. This presents a unique set of challenges regarding feeding order and potential aggressive interactions around ESF systems. Hence, there is no perfect feeding system.

**Feed allowance**

The common practice of limit feeding gestating sows leads to increased activity around the feeder prior to mealtime. Daily feed allowance and number of feedings per day are important considerations when assessing ways to increase sow satiety and decrease aggressive behavior. The amount of feed individual sows receive depends on the energy concentration of the diet and should be based on achieving a target body condition score such that over conditioned sows receive less feed than under-conditioned sows. Unfortunately, the optimal number of feedings per day to meet the target daily allowance is less clear. In human studies, decreasing the time interval between meals helps sustain satiety; however, in group housed sows it appears that increasing meals from 1 to 2 or 2 to 6 times per day increased vocalization and decreased skin lesions with no effect observed in group housed gilts. Although significant, these differences were small. Hence, this response may be related to the natural eating habits of gestating sows who eat on average 1.17 meals per day when given a choice. Likewise, since aggressive interactions around the feeder increase at feeding time, one strategy which may provide a benefit would be to allow sows to consume their entire meal during a single visit to the ESF or stanchion rather than receiving multiple meals per day. In a similar fashion, since aggression is highest at the time of mixing, it may be helpful to feed sows their full daily allowance while in individual stalls immediately prior to mixing. This practice could ensure a level of satiety at mixing that may reduce aggressive interactions. Some also suggest that increasing feed allowance for up to 4 days after mixing is beneficial in reducing fights, although there is limited research available that supports this recommendation.

**Dietary fiber**

Outside of providing sows ad libitum feed, which can have negative consequences on body condition, fiber concentration in the diet has the greatest potential to increase sow satiety. The response to dietary fiber is largely dependent on source, inclusion rate, and physicochemical properties of the chosen fiber source. Present data indicate solubility (which is often a proxy for fermentability), fatty acid production, water-holding capacity, and digesta passage rate are the most important characteristics when selecting a fiber source. Solubility and fermentability are typically used interchangeably throughout the literature, but vary slightly in functionality, although these differences are not fully understood. Nevertheless, the main physicochemical properties that affect short-term and long-term satiety differ. Shortly after feeding, bulkiness or abdominal discomfort appears to elicit satiety, whereas fermentability and solubility have the greatest influence on long-term satiety. Sows fed ingredients that are high in slowly fermented or soluble polysaccharides, such as sugar beet pulp, soybean hulls, or resistant starch, exhibit prolonged reductions in physical activity (increased satiety) compared to other fiber sources such as pectin, inulin, guar gum, and lignocellulose. Fermentable fibers provide a gradual supply of glucose throughout the day due to increased gastrointestinal retention of nutrients. Likewise, increased water binding capacity and short-chain fatty acid (SCFA) production from fermentation in the colon may contribute to glucose and insulin stabilization, which increase satiety related hormones such as glucagon-like peptide-1 and peptide YY. For example, Serena et al observed a more uniform uptake of SCFA and less variation in blood glucose and insulin levels when feeding 111 g of soluble fiber per day to nonpregnant sows compared to 44 g of soluble fiber.

Duration of satiety may also be affected by energy intake, which decreases with the addition of fiber in the diet. This is a particular concern if daily feed allowance is not increased as fiber concentration of the diet is increased. Inclusion of fiber without changing dietary energy supply has been shown to decrease stereotypic behaviors and general restlessness shortly after feeding, but such effect tends to decrease over time. This is likely a result of gastrointestinal distension wearing off over time and the metabolic energy demand of the sow not being met. Specifically, glucagon-like peptide-1 and peptide YY are secreted from the gut in relation to caloric intake, thus if the caloric density of the diet is reduced because feed allowance is maintained or feed intake is limited, satiety related hormones could also be reduced. More recent studies have shown that increasing fermentable fiber in the diet improved satiety regardless of lower metabolizable energy intake. This may be a result of the physicochemical property of the fiber sources fed. Despite these inconsistencies, it is important to ensure that the energy requirements of the sow are being met when high-fiber diets are fed to prevent reductions in body condition. This can be achieved by increasing feed allowance, or if economically feasible, adding fat to the diet. The level and source of fiber in the diet will determine to what extent feed allowance should be increased to maintain body condition. In general, 30% neutral detergent fiber (NDF) is recommended to increase satiety. However, this level of NDF is difficult to achieve using a single fiber source unless a high fermentable ingredient, such as soybean hulls or sugar beet pulp, is fed where a 40% or 60% inclusion level is needed, respectively. At these levels, bulkiness of the diet increases and there is risk that physical capacity for feed intake could be reached prior to meeting the energy requirements of the sow leading to reductions in body condition. Likewise, significantly decreasing the bulk density of the diet will require more feed deliveries because less weight is delivered per truck load. Therefore, it may be more practical to feed a diet containing 20% NDF which can be achieved by feeding 25%, 15%, or 5% soybean hulls in a corn-soybean meal diet containing 0%, 20%, or 40% dried distillers’ grains with solubles (DDGS), respectively. As soybean hulls in the diet decrease and DDGS increase, NDF on a gram per day basis decreases from 440 to 396 g/d when adjusting for a metabolizable energy intake of 6.0 Mcal/d. Unfortunately, the literature available on the benefit of feeding a diet with less than 30% NDF to reduce stereotypic behavior is not consistent. It appears that satiety inducing responses observed are dependent on basal diet formulation, source of fermentable fiber, level of inclusion, duration of feeding, and feed allowance.
A review by Reese et al\(^2\) suggested that feeding 350 to 400 g/d NDF could improve sow reproductive performance. While sow behavior and reproductive performance are two separate traits, Sapkota et al\(^3\) used a similar approach to assess sow satiety by evaluating NDF on a gram per day basis rather than a percentage. Three diets containing either sugar beet pulp, soybean hulls, or resistant starch were formulated to a constant energy level to achieve a 17.5% NDF or 350 g/d NDF (using Reese et al\(^2\) as a reference) and fed for 21 days prior to mixing. A significant reduction in biting frequency was observed in sows fed resistant starch in the first hour after mixing compared to the other fiber treatments, but no differences were observed thereafter. This response is likely tied to the soluble fiber percentage as resistant starch diets contained 11% (221 g/d) soluble fiber and sugar beet pulp and soybean hull diets contained less than 5% (under 100 g/d) soluble fiber. However, this did not affect long-term satiety. In the same review, Reese et al\(^2\) suggested that sows did not need to consume more than 46 g/d of soluble fiber to elicit a reproductive benefit, but soluble fiber levels appear to be required at higher levels to elicit satiety. This is supported by the work of Serena et al\(^1\) in which 111 g of soluble fiber was needed to decrease variation in glucose and insulin levels when sows were fed once per day. Hence, using soluble fiber intake on a gram per day basis may be a better approach to determine the optimal fiber source and inclusion level needed to achieve sow satiety in group housing systems compared to percent NDF. Regrettably, limited trials specifically designed to test this hypothesis are available. Lastly, some suggest that feeding high-fiber diets prior to mixing will increase fullness, therefore reducing aggression at mixing; however, the responses observed using this strategy have been minimal.\(^5\)\(^,\)\(^9\)

Management considerations

To ensure successful husbandry of group housed females, parity differences should be considered. In group housing systems, increased aggression is observed in sows of parity 3 or greater compared to younger sows resulting in increased injury scores in gilts when older parity sows are housed with gilts.\(^28\) Likewise, it is suggested to house parity 1 and 2 sows separate from older parity sows.\(^29\) Because gilts eat slower than sows.\(^13\) Aside from parity, timing of mixing is one of the most important management tools to minimize the consequences of mixing aggression and subsequent reduction in gestation feed intake. While much of the available literature contradicts itself, it is best to avoid high levels of stress from day 11 to 16 post insemination when maternal recognition of pregnancy occurs.\(^1\) Hence, females should either be mixed within the first week of insemination or 3 to 4 weeks following insemination. Floor space allowance, group size, and pen layout also contribute to the social behaviors of group housed sows. When combined, the primary goal is to ensure group pens allow for separate sleeping, eating, and defecating areas, while also providing enough space for sows to avoid one another and escape aggression as needed.\(^4\) A more detailed review on these management strategies can be found elsewhere.\(^1\)

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Conflict of interest

None reported.

Disclaimer

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* Non-refereed reference.