Weaning Weight Variation and New Approaches to Feeding Gestating Sows

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I was asked to discuss new methods of feeding gestating sows with emphasis on research on increasing muscle fiber number in the offspring by feeding sows more feed during mid gestation. I will address this topic in the paper; however, most of my time will be spent with our efforts to change our producers management from a body condition system to a backfat based system of feeding gestating sows. Most of the credit for moving us in this direction must go to Dr. Frank Aherne, whose writings and research have led us to further explore this area.

When designing a feeding program for gestating sows, we must remember the 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).

We are well aware of the problems with overfeeding gestating sows, including the unnecessary expense, potential problems with impaired mammary development, and reduced feed intake in lactation. Over-conditioned sows used to be the main problem on swine farms. In recent years, thin sows have become a more prevalent problem. Too little backfat reserves can reduce reproductive performance and increase sow mortality.

Backfat scanning on commercial farms has convinced us that body condition score is a poor predictor of actual backfat levels. The best correlation that we have found between backfat and condition score on any farm that we have measured is an $r^2$ of 0.23. It has become apparent that an unbiased, objective, relatively simple method of determining feeding levels for gestating sows is needed.

Determining Feeding Levels

The equations used to set the feeding levels are described in detail in Appendix A. Using these equations, we can determine the energy requirements for maintenance, maternal gain, and uterine gain. An example of the results of these equations is shown in Table 1. The information is converted to a daily requirement of the sow and a feeding level for sows with various backfat levels in Table 2. Using these calculations in an excel spreadsheet, we develop a chart that can be laminated and placed in the barn for daily use. An example of such a chart, based on a diet with 3.1 Mcal ME/kg is presented in Table 3.

### Table 1. Total gestation energy requirement for a 195 kg sow with a litter birth weight of 15 kg.

<table>
<thead>
<tr>
<th>Target gain, kg</th>
<th>35</th>
<th>27</th>
<th>20</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target gain, mm</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>ME, Mcal</td>
<td>708</td>
<td>699</td>
<td>690</td>
<td>681</td>
</tr>
<tr>
<td>Maintenance</td>
<td>263</td>
<td>188</td>
<td>113</td>
<td>39</td>
</tr>
<tr>
<td>Maternal gain</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>1005</td>
<td>921</td>
<td>837</td>
<td>754</td>
</tr>
</tbody>
</table>

### Table 2. Daily gestation energy requirement for a 195 kg sow with a litter birth weight of 15 kg.

<table>
<thead>
<tr>
<th>Target gain, kg</th>
<th>35</th>
<th>27</th>
<th>20</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target gain, mm</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>ME, Mcal</td>
<td>6.16</td>
<td>6.08</td>
<td>6.00</td>
<td>5.92</td>
</tr>
<tr>
<td>Maintenance</td>
<td>2.29</td>
<td>1.63</td>
<td>0.98</td>
<td>0.34</td>
</tr>
<tr>
<td>Maternal gain</td>
<td>.30</td>
<td>.30</td>
<td>.30</td>
<td>.30</td>
</tr>
<tr>
<td>Total</td>
<td>8.75</td>
<td>8.01</td>
<td>7.28</td>
<td>6.56</td>
</tr>
<tr>
<td>Feeding level, kg/d</td>
<td>2.82</td>
<td>2.58</td>
<td>2.35</td>
<td>2.12</td>
</tr>
</tbody>
</table>

*Based on a dietary metabolizable energy level of 3.1 Mcal/kg
Procedures to Set Feeding Levels

Once each week, the person responsible for setting feeding levels scans sows for backfat and determines the weight category. 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 their feed boxes.

At approximately 7 weeks post mating, gestation rows are walked and 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 reaching targets, feed intake is increased by .5 kg/d. Sows remain on their feeding level until day 100 of gestation. On day 100, the feeding level is increased by 1 kg/day for the last 2 weeks before farrowing.

The procedure is relatively simple and easy to implement. The three main issues critical for the success of 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 volume (kg) being dropped at each feed box setting.

Feed Intake Pattern During Gestation

Is the pattern of feed intake important during gestation? High or low feed intake during particular phases during gestation can cause deleterious effects or have specific advantages. Each stage of gestation is discussed below.

Day 0 to 30. Several researchers have reported high intake before day 30 of gestation decreased embryo survival. The increased embryo mortality was attributed to a reduction in plasma progesterone concentration due to increased blood flow and hepatic clearance of progesterone caused by the high feed intake. Further research (Jindal et al., 1996) indicates the critical window to reduce feed intake to prevent embryo mortality may be during the first 48 to 72 hours after mating. The safest recommendation is to limit feed intake from breeding until day 12 after breeding.

The body condition or energy state of the sow also influences the response to high levels of feed intake after mating. Embryo mortality is only increased when high levels of feed are provided to sows in good body condition. Embryo mortality was actually reduced by providing extra feed for the first thirty days after breeding to sows in poor body condition due to low lactation feed intake. Therefore, feeding according to body condition during the first 30 days of gestation is critical for minimizing embryo mortality. Recent unpublished data from Australia also credits high feeding during early gestation with increasing farrowing rate during the summer months when seasonal infertility is a problem.

By following the feeding guidelines listed above, sows that are in good body condition will not be fed high levels immediately after breeding. During the period from breeding until backfat is measured, a safe recommendation is to feed all sows approximately 6.8 Mcal of ME (2 to 2.2 kg/day of gestation diet).

Day 30 to 75. Current understanding of this period during gestation is poor; however, recent research indicates this is a critical period for muscle differentiation of the developing fetuses. Sterle et al. (1995) found injections of porcine somatotropin (pST) between day 30 and 43 increased placental weight and weight of the lightest fetuses. The authors hypothesized that pST increased nutrient uptake and utilization by the fetuses by increasing nutrient transfer across the placenta. In another trial, pST injections from day 28 to 40 increased embryo survival, embryo weight, and specific gene expression for certain muscles (Kelly et al., 1995). Offspring from the sows injected with pST for the specific window of gestation (day 28 to 40) had reduced backfat and heavier trimmed loin weight at market than pigs from the control sows. Dwyer et al. (1994) observed a similar response by doubling feed intake (2.5 vs. 5.0 kg/day) from day 25 to 80 of gestation. The high feed intake increased the number of secondary muscle fibers and improved growth rate and feed efficiency of the offspring during the growing period (day 70 to 130 of age). We have conducted two experiments to further validate the benefit of high feed intake during mid gestation on fetal muscle fiber development and subsequent body composition at market weight. The results have been conflicting with a benefit to high levels of feed intake in one experiment (Musser et al., 1999) and no response in a second experiment (Musser et al., 2000a). Feeding large quantities of feed has some practical limitations. First, sows can become over conditioned limiting feed intake during lactation. Also, the extra feed intake adds cost and an extra management burden.

The research on high feed intake levels and pST indicates that the goal may be to increase levels of metabolic hormones, such as IGF-1 or IGF-2. In subsequent research, we have found that specific nutrients, such as carnitine, may be beneficial to increase IGF-1 levels in mid gestation without the negative effects of excessive energy intake. We have found that adding L-carnitine to the

### Table 3. Feeding levels (kg/d) for gestating sows based on backfat and weight category at breeding

<table>
<thead>
<tr>
<th>Girth cm</th>
<th>Estimated Weight, kg</th>
<th>Backfat at Breeding, mm</th>
<th>9 to 11</th>
<th>12 to 14</th>
<th>15 to 17</th>
<th>&gt;18</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 to 120</td>
<td>115 to 150</td>
<td>2.3</td>
<td>2.0</td>
<td>1.8</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>120 to 130</td>
<td>150 to 180</td>
<td>2.5</td>
<td>2.3</td>
<td>2.01.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>130 to 138</td>
<td>180 to 215</td>
<td>2.7</td>
<td>2.5</td>
<td>2.3</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>138 to 152</td>
<td>215 to 270</td>
<td>2.9</td>
<td>2.7</td>
<td>2.5</td>
<td>2.3</td>
<td></td>
</tr>
</tbody>
</table>

*a Based on a diet containing 3.1 Mcal ME/kg.

Feeding level should be increased by 1 kg/d on day 101 of gestation.

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gestation diet increased circulating IGF-1 concentrations in mid gestation and carcass leaniness of the offspring (Musser et al.; 2000b). In another trial, Musser et al. (2001) found that adding L-carnitine to the diet increased total muscle fiber number in the offspring at birth. Further research is needed to validate these results and determine whether other nutrients may have similar responses.

**Day 75 to 100.** This period is critical for mammary development. Excessive energy intake during this period increases fat deposits and reduces the number of secretory cells, DNA, and RNA in the mammary gland (Weldon et al., 1991). The result is lower milk production during lactation. Excess feed intake should be avoided during this time.

**Day 100 to 112.** Feed intake should be increased by 1 to 2 kg (2 to 4 lb) from day 100 to 112 of gestation to prevent sows from losing weight during this period of rapid fetal growth. Failure to increase feed intake during this period results in sows in an extremely catabolic state at farrowing. The catabolic state contributes to gorging and sows “going off feed” during lactation.

**Day 112 to 114.** Feeding pattern during the last few days of gestation is a controversial area. We prefer to feed 2 kg or more from day 112 to 114. Field experience indicates that extremely low intake of 1 kg or less during this limits the producers ability to increase feed intake rapidly during early lactation. In extreme cases, ulcers can be created by the extended period of low intake around farrowing. After the long period without feed, sows often overeat if provided free access to feed. The sows will go off feed or have a noticeable dip in feed intake. Many people prescribe limit feeding as a cure for the sows going off feed instead of correcting the problem that originally caused the problem (the extended period of little or no feed intake prior to and immediately after farrowing).

**Conclusion**

Feeding levels in particular stages of gestation have been shown to influence sow productivity and performance of their offspring. However, the periods where excessive feed intake is most detrimental is immediately after breeding (d 0 to 2) for gilts and sows in good body condition and from day 75 to 90 of gestation. 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. Feeding sows based on backfat and weight category at breeding is a method that can help producers reach this goal.

**References**


Appendix 1
Determining Gestation Energy Requirements

The equations listed below allow for the calculation of the daily energy requirement for a gestating sow. To ease calculation, we use an excel spreadsheet, whereby you can change the energy density of the diet and the feed levels are automatically recalculated. In the current example 35 kg of body weight gain is required to get 9 mm of backfat gain.

Body Weight at Service, kg = 195 = (430 lb)
Diet ME, Mcal/kg = 3.3 = (1497 kcal/lb)

Uterine Contents
Per pig, kg = 1.85 = (4.08 lb)
Birth weight
Pper pig, kg = 1.15 = (2.53 lb)
Body Weight
(BW) gain, kg = 35 = (77.16 lb)
Backfat (P2)
At breeding, mm = 10 = (0.39 in.)
Expected Backfat
(P2) gain, mm = 9 = (0.35 in.)
Efficiency of ME Use for Maternal Gain = 0.75
Efficiency of ME Use for Fetal Gain = = 0.50
Total born = 11

Gestation Uterine and fetal gain, kg
= Uterine contents per pig * Total born
= 1.85 * 11
= 20.35

ME for Maternal gain, Mcal
= (9.7 * BW gain, kg + 54 * Backfat gain, mm)/Efficiency of ME use for maternal gain
= ((9.7 * 35 + 54 * 9)/0.75)/4.184

ME for Uterus gain, Mcal
= (4.8 * Fetal BW gain, kg)/Efficiency of ME use for fetal gain
= ((4.8 * 11 * 1.15)/0.5)/4.184
= 29.0 (Noblet et al., 1985b).

Total ME for Maternal + Uterine gain, Mcal = 263.1 + 29 = 292.1

ME for Maintenance per day, Mcal
= 0.45 * Bw0.75, kg where, BW = BW at service + ½ gestation BW gain + ½ uterine and fetal gain
= (0.45 * (195 + ½ (35) + ½ (20.35))0.75)/ 4.184
= 6.2 (Noblet and Etienne, 1987b).

Total ME requirement for gestation, Mcal
= (ME for Maintenance per day * 115) + ME for Maternal and Uterine gain
= (6.2 * 115) + 292.1
= 1005.1

Daily ME requirement for gestation, Mcal
= 1005.1/115
= 8.74

Daily ME requirement for gestation, kg
= 8.74 Mcal/3.3 Mcal/kg
= 2.65