Effect of sow parity and weight at service on target maternal weight and energy for gain in gestation[1]

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ABSTRACT: The objective of this study was to evaluate targeted maternal weight gains in sows by parity group during gestation. Weight and backfat gains during gestation by parity, weight, and backfat groups also were analyzed. The data evaluated were a subset (374 sows) of a larger experiment that compared three methods of feeding sows during gestation on weight and backfat gains and subsequent reproductive performance. Feed allowances were based on modeled calculations of energy and nutrient requirements to achieve target sow maternal weight and backfat gains. Actual backfat gain for gilts and sows was regressed on maternal weight gain and estimated energy available for gain. The regression equations were then used to predict maternal weight gains for target backfat gains for three parity groups (gilts, Parity 1 and 2 sows, and Parity 3 and older sows). For gilts and Parity 1 and 2 sows, much greater target maternal weight gains are required to achieve 6 and 9 mm of backfat gain, whereas Parity 3 and older sows require maternal weight gains similar to those targeted to achieve the desired backfat gain. Given similar energy intake levels above maintenance, gilts gained more weight than multiparous sows, as gain was based more on protein and less on fat and thus was more efficient. Gilts required more maternal weight gain than sows to achieve similar backfat gains due to the higher protein and low fat contents of gain in younger, lighter sows compared with older parity sows. Low-backfat sows that needed to gain large amounts of backfat failed to achieve these large gains. We speculate this failure may be due to lower tissue insulation levels with the low backfat levels and higher activity levels of these sows compared with high-backfat sows. It seems that both parity and weight are individually important factors that influence energy and nutrient requirements for gestation in the modern sow.

Key Words: Backfat, Energy, Gestation, Parity, Sows

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Introduction

The dietary energy requirements of the gestating sow will vary with BW, target BW gain during gestation, and other management and environmental conditions. Aherne and Kirkwood (1985) and Williams et al. (1985) suggested that sows should be fed and managed so that they gain 25 kg of maternal BW throughout gestation for at least the first three or four parities. The weight of the placenta and other products of conception should be approximately 20 kg, for a total of 45 kg of gestational weight gain by the sow (Verstegen et al., 1987; Noblet et al. 1990). Maternal weight gain represents 15 to 20% of gestating sow's energy requirement (Aherne et al., 1999).

Models have been developed for sow nutrient requirements in gestation (Noblet and Etienne, 1987; Dourmad et al., 1998; NRC, 1998). These models attempt to partition nutrient requirements into three components: maintenance, products of conception, and maternal weight gain. In a companion paper (Young et al., 2004a), it was concluded that feeding sows in gestation based on modeled calculations of energy and nutrient requirements to achieve target sow maternal weight and backfat gain was a viable alternative to the common method of feeding sows in gestation based on BCS. However, Young et al. (2004a) observed that sows did not necessarily achieve the desired backfat gains with full precision. This was especially true for thin sows that needed

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to gain 6 to 9 mm of backfat to reach the targeted 19-mm goal. The objectives of the present study were to determine target maternal weight gains required to achieve target backfat gains by parity group. In addition, weight and backfat gains in gestation were analyzed by parity, initial weight, and backfat groups at service.

Materials and Methods

Data

The data analyzed in this study were a subset (374 sows) of a larger dataset (559 sows) from an experiment by Young et al. (2004a) that compared three methods of feeding sows over one gestation and the subsequent effects on lactation performance. In that study, there were three treatments and control gilts and sows were fed according to BCS based on a scale of 1 to 5 (1 = thin; 5 = fat). Treatments two and three used feeding levels based on backfat thickness (measured between d 0 and 5 after breeding) and weight at weaning for sows or weight at service for gilts to achieve target weight and backfat gains. Only data from sows fed based on backfat and BW were used for this analysis. Control gilts and sows were not included in the analysis as feeding levels were arbitrarily set based on BCS and not based on backfat and/or weight gain in gestation.

Measurements, Feeding Levels, and Housing

Backfat was measured at the P2 position (last rib, 65 mm from the center line of the back) on both sides of the backbone using a Lean-Meater (Renco Corp., Minneapolis, MN). Values from the two measurements were averaged to obtain a single backfat measurement. Backfat thickness was measured between d 0 and 5 after breeding, and sows were weighed at weaning and gilts were weighed at service. Feed allowance was calculated to achieve a target backfat of 19 mm and a range of 19 to 21 mm at farrowing. The target of 19 mm of backfat at farrowing was selected so that sows could lose 3 to 4 mm of backfat during lactation and not fall below 13 mm of backfat at their subsequent service. Data from several studies have shown that low backfat levels at weaning (14 mm) compromise subsequent reproductive performance (Young et al., 1991; Hughes, 1993; Tantasuparuk et al., 2001). Previous research has illustrated a negative relationship between high backfat at farrowing and lactation feed intake (Mullan and Williams, 1989; Dourmand, 1991; Revell et al., 1998). In addition, Yang et al. (1989) observed that sows with backfat thickness of 20 mm at farrowing reared piglets that had higher growth rates than did sows with a backfat thickness of 12 mm when given restricted feed in lactation.

For feeding based on backfat and weight, target maternal weight gains were set at 12.7, 20.0, 27.5, and 35.0 kg for 0, 3, 6, and 9 mm of backfat gain, per Aherne (1999). Feeding levels were determined using the equations of Noblet and Etienne (1987; NE_m, MJ = $0.45 \times BW^{0.75}$, kg); Dourmad et al. (1996, 1997, 1998; energy for maternal gain, MJ = [$9.7 \times$ BW gain, kg ($54 \times$ P2 gain, mm]/0.75); and Noblet et al. (1985; energy uterus gain, MJ = [$4.8 \times$ fetus BW gain, kg]/0.5). For these equations, BW represents the average BW of the sow, which was calculated as weight at service plus half the targeted maternal weight gain plus half the products of conceptus and uterine gain in gestation. Backfat gain was the targeted increase in required backfat to achieve a target backfat of 19 mm with a range of 17 to 21 mm at farrowing.

Sows and gilts were weighed again between d 112 and 114 of gestation when they entered the farrowing barn. Backfat measurements were also taken between d 108 and 113 of gestation. Protein and fat mass were estimated using the prediction equations of Dourmad et al. (1997), Everts and Dekker (1995), and Whittemore and Yang (1989). Estimated protein mass at weaning and farrowing using the three equations was very similar, whereas estimated fat mass was numerically higher using the equations of Whittemore and Yang (1989) compared with those of Dourmad et al. (1997) and Everts and Dekker (1995). Nonetheless, the differences among treatments were similar regardless of which prediction equations were used. Energy in weight gain was determined using actual weights and by estimating protein and fat composition of gain, summing estimated protein gain multiplied by 10.6 (ME required for protein synthesis, Mcal/kg; Tess et al., 1984), and estimated fat gain multiplied by 12.5 (ME required for fat synthesis, Mcal/kg; Tess et al., 1984). Maintenance energy requirement as a percentage of ME intake was determined by dividing NE_m (MJ = $0.45 \times BW^{0.75}$, kg; Noblet and Etienne, 1987) by total ME intake. The estimated energy available for gain was determined as the total energy intake less energy required for maintenance and energy in products of conception.

The experiment was conducted from January to July 2002. Gestation barn temperatures averaged 19.8°C for the duration of the trial, with an average of 18.6°C from January to March and 20.9°C from April to June. For the first 35 d of gestation, all sows were housed in the in individual gestation sow stalls (0.61 m × 2.14 m). After pregnancy confirmation, they were moved to a second barn where they were housed in similar individual gestation sow stalls for the remainder of gestation. Both the barns were naturally ventilated and double-curtain sided with fully slatted flooring. In gestation, sows were individually fed from gestation feed boxes (Chore-Time Equipment, Mildford, IN) into an open concrete trough directly in front of the sows. Sows were fed once daily at 0700 with their individually daily feed allowance. For more details on experimental procedures see Young et al. (2004a).

Statistical Analyses

Data were analyzed as a randomized block design using the Mixed procedure of SAS (SAS Inst., Inc., Cary,

Table 1. Maternal weight gain (kg) required by parity to achieve the target backfat gains

		Target backfat gain, mm			
		0	3	6	9
		Current target maternal gains, kg[a]			
Parity	n	12.7	20.0	27.5	35.0
Gilts[b]	70	21.8	38.5	55.1	NA[e]
1 + 2[c]	121	8.6	25.5	42.4	59.3
3 +[d]	183	1.4	13.2	24.9	36.7
Average		6.1	23.9	36.2	48.7

[a]Target maternal gains for gilts and sows from Aherne (1999).
[b]Maternal weight gain, kg = 5.55 (target backfat gain, mm) + 21.8.
[c]Maternal weight gain, kg = 5.63 (target backfat gain, mm) + 8.6.
[d]Maternal weight gain, kg = 3.92 (target backfat gain, mm) + 1.4.
[e]Not available (NA): too few data points to model the data.

NC). Sow was the experimental unit of analysis. Parity group (n = 6), backfat group at service (n = 4), and initial weight group (n = 5) were the main effects tested. Using the Proc Reg procedure of SAS, actual backfat gain by the target backfat gain group (0, 3, 6, and 9 mm) was regressed on maternal weight gain. The regression equations were then used to predict maternal weight gain required for 0, 3, 6, and 9 mm of backfat gain for the three parity groups (gilts, Parity 1 and 2 sows, and Parity 3 and older sows). Least squares means, protected by significant *F*-tests, were compared using least significant difference tests. We considered $P < 0.05$ significant and $P > 0.05$ to $P < 0.10$ to be a trend.

Results and Discussion

New Target Maternal Weight Gains

Using the data from the current experiment, maternal weight gains to achieve 0, 3, 6, and 9 mm of backfat gain were determined for gilts, Parity 1 and 2 sows, and Parity 3 and older sows (Table 1). The new proposed target maternal weight gains for the zero backfat gain category are lower for all parity groups than those proposed by Aherne (1999), with the exception of gilts. For the 3- and 6-mm backfat gain categories, the new proposed maternal weight gains for gilts and Parity 1 and 2 sows are greater, whereas for Parity 3 and older sows were lower than the targets proposed by Aherne (1999). For the 9-mm backfat gain category, the new proposed target maternal weight gains for Parity 1 and 2 sows are much greater than those proposed by Aherne (1999), but similar for Parity 3 and older sows.

For the 6- and 9-mm backfat gain categories, the new proposed maternal weight gains for gilts and Parity 1 and 2 sows are greater than those used in our earlier experiment (Young et al., 2004a). One possible reason for the increased energy requirements was that sows with very little backfat have less insulation and tend to lose more energy in the form of heat than do sows with greater backfat thickness. Tissue insulation of thin sows was approximately 28% less than that of standard sows (deh Hovell et al., 1977). In addition, thin sows tend to be more active (stand up more often), thereby expending more energy. In a study by Bergeron and Gonyou (1997), sows that were classified as more active (Category 1) at the beginning of the experiment gained less ($P < 0.05$) weight (32.0 ± 7.75 kg) during gestation than less active sows (45.7 ± 8.15, 41.4 ± 11.18, and 45.7 ± 7.98 kg for Categories 2, 3, and 4, respectively). Similarly, Cronin (1985) reported that sows with high activity levels produce more heat and consequently retain less energy than sows with lower activity levels in gestation. The mean cost of standing activity determined by Noblet et al. (1993) is 0.07 kcal/(kg $BW^{0.75}$•min standing). For 200-kg sows standing for 100 or 200 min/d, the energy requirements increase from 0.5 to 1.0 Mcal/d, respectively, which is equivalent to 9 and 17.8% of maintenance energy requirements. Sows with low backfat tend to deposit less energy as fat and have lower fat depots. Thin sows can also be timid eaters, and more aggressive sows may steal feed from these sows. Thus, the actual energy intake of thin sows may be lower than targeted, contributing to the lower weight and backfat gains in gestation. Energy requirements above maintenance for weight and backfat gains for Parity 3 and older sows are much greater than those required by younger-parity sows (Dourmad et al., 1998). This is explained by the difference in composition of gain, with protein gain constituting a larger proportion of weight gain in younger sows compared with fat gain in older sows, which has a lower energetic deposition cost compared with fat gain (10.6 vs. 12.5 Mcal/kg; Tess et al., 1984). For a given energy supply, higher protein retention was measured in gilts than in multiparous sows (Dourmad et al., 1998). For primiparous sows gaining 30 kg BW throughout gestation, the composition of the BW (carcass) gain is approximately 75% lean and 25% fat (Shields et al., 1985; Whittemore and Yang 1989; Pettigrew and Yang 1997).

Parity Group

For gilts and Parity 1 and 2 sows, estimated maternal weight gains were greater, whereas for Parity 3, 4, 5, and older sows, weight gains were lower than predicted.

Table 2. Weight, backfat, and estimated protein and fat mass change in gestation by parity group

Item	Parity group 0	1	2	3	4	5+	SE	P <
No. of sows	70	76	45	55	33	95	—	—
Average parity	0	1	2	3	4	7	—	—
Predicted[g]								
Maternal BW gain, kg	20.6[ac]	23.6[b]	22.3[bc]	21.2[ac]	20.7[ac]	20.1[a]	1.11	0.02
Backfat gain, mm	3.2[ac]	4.4[b]	3.9[bc]	3.5[ac]	3.3[ac]	3.0[a]	0.45	0.02
Total feed intake, kg (as fed)	228.1[a]	255.9[b]	274.4[c]	281.7[c]	281.5[c]	280.8[c]	4.41	0.01
Daily feed intake, kg (as fed)	2.0[a]	2.3[b]	2.5[c]	2.5[c]	2.5[c]	2.5[c]	0.04	0.01
Total gestation BW gain, kg[h]	59.8[a]	50.2[b]	49.0[b]	37.6[c]	35.4[c]	28.1[d]	3.17	0.01
Actual maternal BW gain, kg[i]	39.0[a]	29.4[b]	28.2[b]	16.8[c]	14.6[c]	7.3[d]	3.18	0.01
Sow backfat, mm								
Service	16.5[acd]	15.0[b]	15.7[abc]	16.1[bcd]	16.6[cd]	17.1[d]	0.64	0.02
Farrowing	19.3	18.2	19.2	18.9	19.3	19.3	0.76	0.54
Backfat gain	2.6	3.1	3.5	2.9	2.6	2.2	0.49	0.13
Estimated protein mass, kg[j]								
Initial	25.0[a]	29.3[b]	34.7[c]	38.8[d]	40.4[e]	45.2[f]	0.62	0.01
Farrowing	30.9[a]	33.5[b]	38.5[c]	40.9[d]	42.2[d]	45.7[e]	0.77	0.01
Gain	6.1[a]	4.2[b]	3.9[b]	2.0[c]	1.7[c]	0.6[d]	0.53	0.01
Estimated fat mass, kg[k]								
Initial	30.7[a]	33.4[b]	41.4[c]	47.0[d]	49.9[d]	56.9[e]	1.41	0.01
Farrowing	42.3[a]	43.6[a]	51.8[b]	54.2[bc]	56.4[c]	60.9[d]	1.60	0.01
Gain	11.7[a]	10.3[a]	10.4[a]	7.1[b]	6.3[bc]	4.1[c]	1.10	0.01
Estimated energy in gain, Mcal of ME[l]	210.9	173.3	171.3	110.0	96.8	57.6	—	—
Estimated maintenance as % total intake	81.6[ac]	77.8[b]	80.6[ab]	83.1[ac]	85.2[c]	91.4[d]	1.67	0.01
Estimated energy available for gain, Mcal of ME[m]	98.4[a]	154.6[b]	142.0[bc]	125.5[abc]	104.1[ac]	49.1[d]	17.2	0.01

[a,b,c,d,e,f]Means in the same row with different superscripts differ, $P < 0.05$.
[g]Predicted based on actual feeding levels provided in gestation (NRC, 1998).
[h]Prefarrowing BW – initial BW.
[i]Prefarrowing BW – 20.35, kg (fetal and uterine weight gain) – initial BW.
[j]Prediction equation from Dourmad et al. (1997): 2.28 + 0.178 × (live weight, kg) – 0.333 × (backfat, mm).
[k]Prediction equation from Dourmad et al. (1997): –26.40 + 0.221 × (live weight, kg) + 1.331 × (backfat, mm).
[l]Using actual weights, protein and fat mass gains were estimated. Estimated protein mass gain × 10.6 estimated fat mass gain × 12.5 (NRC, 1998).
[m]Total energy intake – energy required for maintenance – energy in products of conception.

The deviation between predicted (NRC, 1998) and estimated maternal weight gain in gestation decreased with increasing parity number up to Parity 3 and increasing BW range from 215 to 250 kg (Table 2). Similar to the results found by Cooper et al. (2001), the NRC (1998)-predicted maternal weight gains underestimated maternal gain in gestation for younger, lighter sows and overestimated maternal gain for older, heavier sows. There are a number of possible explanations for the difference in actual and predicted maternal weight gain. The first and most obvious reason was the difference in the composition (lean and fat) of gain between younger and older sows. Estimated protein mass gain decreased from 15.6 to 8.2% of estimated maternal gain, whereas estimated fat mass gain increased from 30 to 56.2% of estimated maternal gain as parity increased from gilts to Parity 5 and older sows. The NRC (1998) model underestimates maternal weight gain in smaller, younger sows because gain was based more on protein and less on fat, and was thus more efficient than predicted by the NRC (1998) model. Overestimation of maternal weight gain in older, larger sows may be explained by the less efficient use of gain, suggesting a higher than predicted (NRC, 1998) proportion of fat gain. There may also be genetic factors that might affect the composition of gain (Sauber et al., 1998). Because the model does not adjust for the proportion of protein and fat accretion based on genetics, age, and size of the sow, this may account for the deviation between the estimated and predicted maternal weight gain in gestation.

For all parity groups, actual backfat gains were lower than predicted. The estimated maintenance energy requirement as a percentage of total energy intake was greater ($P < 0.05$) and energy available for gain was lower ($P < 0.05$) for Parity 5 and older sows than for younger sows. Estimated maintenance energy requirement as a percentage of total energy intake was greater ($P < 0.05$) for gilts compared with Parity 1 sows, which was unexpected. Estimated energy in gain was much greater than the estimated energy available for gain in gilts. A possible explanation may be that maintenance energy requirements are lower for gilts than multiparous sows; thus, the current estimate may be overestimating maintenance and underestimating energy available for gain. Beyer et al. (1994) reported that energy requirements for maintenance increase from 389 kJ in the first parity to 435 kJ in second parity and to 473 kJ of ME/kg of $BW^{0.75}$ in the fourth parity. The estimated energy in gain was determined using energy

Table 3. Weight, backfat, and protein and fat mass by backfat group at service

Item	Backfat group at service, mm					
	<12	12 to 14.9	15 to 17.9	>18	SE	P <
No. of sows	33	98	139	104	—	—
Average parity	2.8	3.2	2.6	3.8	—	—
Predicted[e]						
Maternal BW gain, kg	32.9[a]	26.8[b]	20.2[c]	14.3[d]	0.26	0.01
Backfat gain, mm	8.2[a]	5.7[b]	3.1[c]	0.7[d]	0.12	0.01
Total feed intake, kg (as fed)	308.4[a]	286.8[b]	256.8[c]	243.9[d]	4.01	0.01
Daily feed intake, kg (as fed)	2.7[a]	2.5[b]	2.2[c]	2.1[d]	0.04	0.01
Total gestation BW gain, kg[f]	49.1[a]	43.4[a]	45.3[a]	36.9[b]	3.07	0.01
Actual maternal BW gain, kg[g]	28.3[a]	22.6[a]	24.5[a]	16.0[b]	3.05	0.01
Backfat, mm						
Service	10.4[a]	13.5[b]	16.3[c]	20.5[d]	0.22	0.01
Farrowing	14.9[a]	16.9[b]	19.0[c]	22.2[d]	0.44	0.01
Gain	4.5[a]	3.4[b]	2.7[c]	1.7[d]	0.40	0.01
Protein mass, kg[h]						
Initial	34.7[ab]	36.0[ab]	34.0[b]	38.0[a]	1.34	0.02
Farrowing	38.3	39.0	37.4	40.2	1.13	0.05
Gain	3.5[a]	2.8[ab]	3.4[a]	2.2[b]	0.51	0.05
Fat mass, kg[i]						
Initial	31.8[a]	38.9[b]	41.3[b]	53.5[c]	1.75	0.01
Farrowing	43.9[a]	48.3[ab]	50.0[b]	59.1[c]	1.57	0.01
Gain	11.9[a]	9.2[ab]	8.6[b]	5.5[c]	1.00	0.01
Estimated energy in gain, Mcal of ME[j]	185.9	144.7	143.5	92.1	—	—
Estimated maintenance as % total energy intake	69.0[a]	76.4[b]	83.6[c]	95.5[d]	0.92	0.01
Estimated energy available for gain, Mcal of ME[k]	279.0[a]	181.1[b]	97.8[c]	–4.6[d]	7.74	0.01

[a,b,c,d]Means in a row with different superscripts differ, $P < 0.05$.

[e]Predicted based on actual feeding levels provided in gestation (NRC, 1998).

[f]Prefarrowing BW – initial BW.

[e]Prefarrowing BW – 20.35, kg (fetal and uterine weight gain) – initial BW.

[h]Prediction equation from Dourmad et al. (1997): 2.28 + 0.178 × (live weight, kg) – 0.333 × (backfat, mm).

[i]Prediction equation from Dourmad et al. (1997): –26.40 + 0.221 × (live weight, kg) + 1.331 × (backfat, mm).

[j]Using actual weights, protein and fat mass gains were estimated. Estimated protein mass gain × 10.6 + estimated fat mass gain × 12.5 (NRC, 1998).

[k]Total energy intake – energy required for maintenance – energy in products of conception.

cost of protein and fat deposition of 10.6 and 12.5 Mcal ME/kg (Tess et al., 1984); these values were determined with growing pigs, but these may be different for sows contributing to the difference in estimated energy in gain vs. energy available for gain.

Backfat Group at Service

Sows were categorized into four backfat groups at the time of service: <12, 12 to 14.9, 15 to 17.9, and >18 mm. Estimated maternal weight gain was lower ($P <$ 0.05) for sows in the high backfat group (>18 mm) at service compared with sows in the three lower backfat groups (Table 3). Although sows in the low backfat group (<12 mm) at service received more ($P < 0.05$) feed throughout gestation than the sows in the 12 to 14.9 and 15 to 17.9 mm groups, they failed to gain significantly more weight. As daily feed intake increased, backfat gain increased ($P < 0.05$), but sows predicted to gain large amounts of backfat (8.2 and 5.7 mm) failed to achieve predicted gains. Higher activity levels and greater energy loss in the form of heat due to lower insulation was a likely cause of these sows failing to achieve the predicted backfat gains. Young et al. (2004b) reported a large range in standing duration for gestating sows ranging from less than 150 to greater than 500 min/d, which resulted in activity heat production varying from 60 to 200 kJ/(kg BW$^{0.75}$·d). The difference in the lowest and highest activity heat production reported in this experiment was equal to 735 g/d of a corn–soybean meal diet for a 200-kg sow, which equates to 42% of maintenance requirements needed for physical activity. High levels of physical activity may account for sows failing to meet backfat gain targets in gestation.

As backfat group at service increased from <12 mm to >18 mm, the estimated maintenance energy requirement as a percentage of total energy intake increased ($P < 0.05$), whereas estimated energy available for maternal gain decreased ($P < 0.05$) as energy intake decreased. For sows in the low-backfat group, estimated energy available for gain was much greater than energy in gain, which was probably due to the greater energy loss in the form of heat and higher activity levels of the low- compared with high-backfat sows. In contrast, the estimated energy in gain for the high-backfat group was greater than the energy available for gain. Also, actual backfat gain was greater than predicted for the high-backfat group at service. Some possible explanations for the higher than expected backfat gains are

Table 4. Weight, backfat, and estimated protein and fat mass by initial weight group

Item	Initial weight group, kg					SE	$P <$
	<150	150 to 180	180 to 215	215 to 250	>250		
No. of sows	21	92	64	96	101	—	—
Average parity	0.2	0.5	1.7	3.5	6.7	—	—
Predicted[f]							
Maternal BW gain, kg	23.6[a]	22.1[a]	23.3[a]	21.3[a]	19.2[b]	1.12	0.01
Backfat gain, mm	4.5[a]	3.8[a]	4.3[a]	3.5[a]	2.6[b]	0.45	0.01
Total feed intake, kg (as fed)	227.9[a]	238.5[a]	268.1[b]	285.5[c]	276.7[d]	4.48	0.01
Daily feed intake, kg (as fed)	2.0[a]	2.1[a]	2.3[b]	2.5[c]	2.4[d]	0.04	0.01
Total gestation BW gain, kg[g]	62.7[a]	55.7[b]	48.0[c]	39.5[d]	27.3[e]	2.91	0.01
Actual maternal BW gain, kg[h]	41.9[a]	34.8[b]	27.2[c]	18.7[d]	6.5[e]	2.91	0.01
Backfat, mm							
Service	14.6[a]	15.8[ab]	15.2[ab]	16.0[b]	17.8[c]	0.64	0.01
Farrowing	17.9	18.7	18.5	18.9	20.0	0.76	0.09
Gain	3.3	2.9	3.2	2.9	2.1	0.48	0.08
Protein mass, kg[i]							
Initial	23.2[a]	26.5[b]	32.4[c]	38.7[d]	45.8[e]	0.43	0.01
Farrowing	29.5[a]	31.7[b]	36.1[c]	41.0[d]	46.2[e]	0.59	0.01
Gain	6.3[a]	5.1[a]	3.7[b]	2.3[c]	0.4[d]	0.49	0.01
Fat mass, kg[j]							
Initial	24.9[a]	31.1[b]	37.5[c]	46.7[d]	58.6[e]	1.02	0.01
Farrowing	38.2[a]	42.3[b]	47.3[c]	54.3[d]	62.4[e]	1.41	0.01
Gain	13.3[a]	11.2[ab]	9.8[b]	7.6[c]	3.9[d]	1.04	0.01
Estimated energy in gain, Mcal of ME[k]	237.0	192.8	165.1	121.7	64.4	—	—
Estimated maintenance as % total intake	77.8[a]	79.9[ab]	78.7[a]	82.0[b]	93.5[c]	1.55	0.01
Estimated energy available for gain, Mcal of ME[l]	126.8[ab]	122.5[a]	155.3[b]	137.2[ab]	27.0[c]	16.43	0.01

[a,b,c,d,e]Means in a row with different superscripts differ, $P < 0.05$.
[f]Predicted based on actual feeding levels provided in gestation (NRC, 1998).
[g]Prefarrowing BW – initial BW.
[h]Prefarrowing BW – 20.35, kg (fetal and uterine weight gain) – initial BW.
[i]Prediction equation from Dourmad et al. (1997): 2.28 + 0.178 × (live weight, kg) – 0.333 × (backfat, mm).
[j]Prediction equation from Dourmad et al. (1997): –26.40 + 0.221 × (live weight, kg) + 1.331 × (backfat, mm).
[k]Using actual weights, protein and fat mass gains were estimated. Estimated protein mass gain × 10.6 + estimated fat mass gain × 12.5 (NRC, 1998).
[l]Total energy intake – energy required for maintenance – energy in products of conception.

that sows with higher backfat levels (>18 mm) may have lower maintenance requirements than sows with lower backfat levels (Sundstøl et al., 1979).

Weight Group at Weaning

Sows were also categorized into five weight groups: <150, 150 to 180, 180 to 215, 215 to 250, and >250 kg. For sows in the <150, 150 to 180, and 180 to 215 weight groups, estimated maternal weight gain was greater than predicted, whereas for the highest initial weight group, estimated maternal weight gain was lower than predicted (Table 4). Actual backfat gains were lower than predicted for all weight groups. Estimated energy in gain was much greater than energy available for gain for the two lower initial weight groups. One of the reasons for the difference may be due to the higher protein and lower fat composition of maternal gain in these lighter-weight sows resulting in greater weight gain compared with older, heavier sows. Maintenance energy requirements averaged 82.6% of total energy intake, which was within the range (75 to 85%) reported by Noblet et al. (1990), with sows in the heaviest weight group having the highest maintenance requirements.

Implications

At similar energy intake levels above maintenance, gilts gain more weight than multiparous sows due to the difference in the composition of weight gain. Gilts require more maternal weight gain during gestation to achieve backfat gains similar to those of multiparous sows. Sows with low backfat levels are less efficient at utilizing energy for weight and backfat gain than those with high backfat levels. Both parity and weight are each individually important factors that influence energy and nutrient requirements in gestation. These factors should be considered to help to improve the precision in modeling gestation nutrient requirements.

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