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Restricting the amount of energy a pregnant sow consumes during gestation has been accepted as a very desirable management practice. One benefit of limiting energy is increased litter size at birth because of more fertilized eggs being implanted, less early embryonic death loss and less stillbirths at parturition. Another benefit, particularly at a time of extremely high feed costs, is the economic advantage of less feed consumed during gestation when energy is restricted. At the present time the National Research Council (NRC) recommends 6340 Kcal of metabolizable energy (ME) daily for the gestating sow. The study reported herein was conducted to evaluate sow reproductive performance when ME was reduced to an even lower level than recommended by the NRC.

Materials and Methods

Three trials were conducted (trials 1 and 3 were summer trials, trial 2 was a winter trial) to evaluate ME levels of 4000, 5000, 6000 and 7000 Kcal per day for the gestating sow. The calculated composition of the experimental diets and the feeding levels of each gestation diet are shown in table 1. The gestation diet was based on corn, soybean meal and dehydrated alfalfa meal. A feeding level of 3 lb. of complete feed provided 4000 Kcal of ME per day. Each additional 1000 Kcal increment of ME was provided by 0.7 lb. of corn starch, resulting in daily dietary energy levels of 4000, 5000, 6000 and 7000 Kcal of ME. Daily consumption of protein, minerals and vitamins were kept constant and the only nutritional variant was energy. In all three trials, feed was weighed for each individual sow and sows were fed in divided individual feeding stalls to insure accurate consumption. During the summer trials the sows were housed in wooden frame houses with concrete floors and a connecting concrete outside pen on which the feeders and waterers were located. No bedding was used in these trials. During the winter trial the sows were in large, open dirt pens with portable buildings with wooden floors and straw was provided for bedding.

Sows were hand bred once when in full standing estrus and after weighing were placed in the experimental pens where they remained until brought into the farrowing barn. On the 110th day of gestation sows were brought into the farrowing barn, weighed, washed with soap, rinsed with disinfectant and placed either in farrowing crates or in farrowing pens with guard rails. Until they farrowed sows were fed about 6 lb. of the lactation diet which contained 10% beet pulp (table 1). After farrowing the sows were allowed ad libitum consumption of the lactation feed. Sow weights were obtained before farrowing, after farrowing and after 21 days of lactation.

As the sows farrowed, the pigs were removed and placed in a box under a heat lamp. After the entire litter was dry, they were weighed and returned to the sow. The number of live, stillborn and mummified fetuses was recorded. General

management of the litter including clipping needle teeth, placing tincture of iodine on the umbilical cord and ear notching at birth. Iron dextran injections supplying 100 mg of elemental iron were given the third day after birth. Weaning weights were taken on the 21st day of lactation.

Results and Discussion

The number of sows bred for each treatment group within each trial, the number that farrowed and the calculated percent of the sows bred that farrowed are shown in table 2. Although the data are not included, a limited number of gilts were fed the same gestation diets and used as replacements in trials 2 and 3. Trial 1 utilized second and third litter sows. All sows which successfully completed gestation on trial 1 were utilized in the second trial with the addition of second parity sows which had been carried on the same gestation treatment as gilts during the previous gestation. In the same manner trial 3 consisted of sows from the previous trial plus second parity sows which had received the same diets during their first gestation.

Sow weight changes prior to and at farrowing are shown in table 3. There were no significant differences in starting weight between sows. Weight gain during gestation was positive for all treatments in all trials. Three of the sows receiving 4000 Kcal of ME and one of the sows receiving 5000 Kcal of ME became emaciated and were removed from the test during the winter trial. Average sow weight after 110 days of gestation and gestation weight gain were significantly affected by gestation treatment. The greatest gain occurred in the group of sows receiving 6000 Kcal of ME. It would appear that 4000 Kcal of ME per day is marginal based on sow weight gain during gestation. Since weight gain was greatest for sows receiving 6000 Kcal of ME and gain was not excessive, it would appear that 6000 Kcal of ME would be close to optimum based on gain. No differences in farrowing weight loss were observed.

Farrowing performance of sows receiving the varying levels of energy is summarized in table 4. Number of live pigs born was significantly affected by treatment in a linear manner with decreasing number of pigs as gestation energy levels were increased. Number of pigs stillborn and number of mummified fetuses at birth were unaffected by treatment. It was found that correlation between gestation weight gain and number of live pigs born was very small. However, number of stillborn pigs was correlated with gestation weight gain ($r = 0.76$), indicating additional reproductive loss with higher rates of gain during gestation.

Litter weight at birth was significantly affected by energy treatment with the lightest litters occurring from sows receiving 7000 Kcal per day. This can be partially explained by the fact that the smallest litters were born to this group. Sows with the greatest gestation gain produced the heaviest litters at birth. There was a significant treatment effect for average pig birth weight with the heaviest average pig birth weights occurring with the higher energy diets which also produced the smallest litters. It would appear that among the treatments studied 6000 Kcal of ME was most adequate from the standpoint of total litter weight at birth and average pig weight at birth.

Sow and pig weaning performance is summarized in table 5. No statistical differences in number of pigs weaned were observed due to treatment. However, the winter trial showed comparatively better results for the 7000 Kcal group than

the summer trials, indicating the possibility of a higher energy requirement during the winter than the summer.

Litter weight and average pig weights at weaning were highest for the 6000 Kcal group of sows and followed a significant quadratic pattern, increasing from the 4000 Kcal treatment group to the 6000 Kcal treatment group and decreasing again for the 7000 Kcal treatment group. These results indicate that among the levels of energy studied 6000 Kcal appears to be most optimum.

A consistent negative relationship between gestation weight gain and lactation weight gain was observed. The lowest sow lactation gain after 21 days of lactation was found in the 6000 Kcal group in all trials.

Summary

A total of 124 sows was utilized in three trials (two summer and one winter) to evaluate metabolizable energy levels of 4000, 5000, 6000 and 7000 Kcal for sows during gestation. Within the levels studied metabolizable energy at the 4000 Kcal level appears to be too low for gestating sows during the winter but is nearly adequate during the summer. The metabolizable energy level of 6000 Kcal appears to be nearly optimum for gestation weight gain, litter and average pig birth weight and litter and average pig weaning weight. Sow weight change during lactation is directly related to sow weight gain during gestation. Sows gaining the most during gestation gained less or lost weight during lactation. The energy level fed had an effect on number of live pigs born. Larger litters were obtained with the lower energy levels.

Table 1. Composition of Experimental Diets (Percent) and Feeding Levels

Ingredient	Gestation diet	Lactation diet
Ground yellow corn	54.5	68.5
Soybean meal (44%)	31.0	--
Soybean meal (48.5%)	--	18.5
Dehydrated alfalfa meal (17%)	10.0	--
Ground beet pulp	--	10.0
Dicalcium phosphate	1.8	2.0
Ground limestone	1.2	0.8
Trace mineralized salt	0.5	0.5
Vitamin premix	1.0	0.2
	100.0	100.0

	Gestation Feeding Levels[a]			
Gestation diet, lb.	3.0	3.0	3.0	3.0
Corn starch, lb.	--	0.7	1.4	2.1
Total feed/day, lb.	3.0	3.7	4.4	5.1
ME, Kcal/day	4000	5000	6000	7000

[a] Provided 280 g protein, 15 g calcium, 10 g phosphorus, 8200 IU vitamin A, 550 IU vitamin D, 3 IU vitamin E, 44 mg niacin, 33 mg calcium pantothenate, 8 mg riboflavin and 28 mcg vitamin B_{12} daily.

Table 2. Number of Experimental Observations

	Treatments (Kcal of ME)				Total	
	4000	5000	6000	7000	Trial	Overall
			Number of Sows Bred			
Trial 1	8	8	8	9	33	
2	11	11	11	13	46	
3	9	13	10	13	45	
Total	28	32	29	35		124
			Number of Sows Farrowing			
Trial 1	6	6	5	7	24	
2	6	9	7	12	34	
3	8	12	10	13	43	
Total	20	27	22	32		101
			Percent Sows Bred That Farrowed			
Trial 1	75	75	63	78	73	
2	55	82	64	92	73	
3	89	92	100	100	95	
Average	73	83	76	90		80

Table 3. Sow Weight Changes Prior to and at Farrowing

	Treatments (Kcal of ME)				Mean	
	4000	5000	6000	7000	Trial	Overall
			Avg. Initial Weight, Lb.			
Trial 1	412.8	397.3	378.6	393.4	395.5	
2	393.7	405.6	412.7	433.5	411.4	
3	371.9	392.0	363.4	406.5	383.4	
Average	393.8	398.3	384.9	411.2		396.8
			Avg. Weight, 110 Days Gestation, Lb.[a,b]			
Trial 1	443.0	446.8	487.0	502.2	469.7	
2	405.2	449.7	477.6	461.8	448.6	
3	434.8	475.8	466.9	509.0	471.6	
Average	427.6	457.4	477.2	491.0		463.3
			Avg. Weight Gain, 110 Days Gestation, Lb.[a]			
Trial 1	30.2	50.8	138.4	108.7	74.5	
2	11.5	44.1	50.6	35.5	35.4	
3	56.6	82.2	103.5	96.3	84.6	
Average	32.8	59.0	87.5	80.2		64.9
			Avg. Daily Gain During Gestation, Lb.			
Trial 1	0.26	0.10	1.25	0.99	0.68	
2	0.11	0.40	0.46	0.33	0.33	
3	0.51	0.75	0.95	0.88	0.77	
Average	0.31	0.53	0.79	0.73		0.59
			Avg. Farrowing Weight Loss, Lb.			
Trial 1	43.3	39.2	52.2	46.5	45.3	
2	31.2	39.5	46.5	38.0	38.8	
3	41.6	48.9	47.5	42.7	45.2	
Average	38.7	42.5	48.7	42.4		43.1

[a] Significant treatment effect (P<.005).
[b] Significant trial effect (P<.005).

Table 4. Farrowing Performance

	Treatments (Kcal of ME)				Mean	
	4000	5000	6000	7000	Trial	Overall
			Avg. No. of Pigs Born Alive[a]			
Trial 1	12.8	10.3	11.6	9.4	11.0	
2	12.6	12.3	11.3	10.9	11.8	
3	10.8	12.8	12.3	9.0	11.2	
Average	12.1	11.8	11.7	9.8		11.4
			Avg. No. of Pigs Stillborn			
Trial 1	1.00	0.50	1.20	0.86	0.89	
2	0.17	0.44	0.00	0.25	0.22	
3	0.13	0.92	0.30	0.85	0.55	
Average	0.43	0.62	0.50	0.65		0.55
			Avg. No. of Mummified Fetuses			
Trial 1	0.00	0.17	0.20	0.57	0.23	
2	0.00	0.00	0.00	0.08	0.02	
3	0.13	0.17	0.00	0.00	0.07	
Average	0.04	0.11	0.06	0.22		0.11
			Avg. Litter Weight at Birth, Lb.[b]			
Trial 1	30.4	25.6	28.4	26.0	27.5	
2	29.7	31.5	35.2	30.2	31.7	
3	26.4	30.4	34.6	25.1	29.1	
Average	28.8	29.0	32.6	27.1		29.5
			Avg. Pig Birth Weight, Lb.[a]			
Trial 1	2.40	2.53	2.51	2.78	2.56	
2	2.40	2.56	3.13	2.90	2.73	
3	2.58	2.40	2.84	2.82	2.67	
Average	2.44	2.49	2.82	2.82		2.64

[a] Significant treatment effect (P<.005).
[b] Significant treatment effect (P<.05).

Table 5. Weaning Performance

	Treatments (Kcal of ME)				Mean	
	4000	5000	6000	7000	Trial	Overall
	Avg. No. of Pigs Weaned, 21 Days[a]					
Trial 1	8.2	8.6	8.3	5.6	7.7	
2	8.7	9.1	9.1	9.0	9.0	
3	7.6	7.6	9.4	6.5	7.8	
Average	8.1	8.4	8.9	7.1		8.1
	Avg. Percent Survival, 21 Days					
Trial 1	65.0	75.0	69.8	57.5	66.8	
2	69.3	73.9	80.9	85.0	77.3	
3	68.4	59.2	78.3	71.0	69.2	
Average	67.6	69.4	76.3	71.2		71.1
	Avg. Litter Weight at Weaning, Lb.[a]					
Trial 1	74.4	90.5	107.7	57.9	80.4	
2	95.6	109.7	126.4	111.8	110.8	
3	81.3	80.6	107.5	76.4	86.6	
Average	83.9	93.6	111.0	82.2		92.5
	Avg. Pig Weight at Weaning, Lb.[b]					
Trial 1	8.94	10.44	12.11	10.44	10.48	
2	10.88	11.94	14.16	10.42	11.85	
3	10.81	10.64	11.52	12.20	11.30	
Average	10.22	11.01	12.60	11.01		11.21
	Avg. Sow Gain, 21 Days, Lb.[b]					
Trial 1	33.7	28.2	-12.1	11.5	15.4	
2	37.7	27.1	9.7	25.6	24.9	
3	28.9	30.6	22.5	37.7	29.7	
Average	33.5	28.6	6.6	24.9		23.3

[a] Significant treatment effect (P<.005).
[b] Significant treatment effect (P<.05).