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Project Title: Evaluating the Effects of Meat & Bone Meal in Reproducing Sow Diets

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Introduction:

Although research conducted with the grower-finisher pig has evaluated the nutritional value of Meat & Bone Meal as a protein (amino acid) supplement, almost no research has been done with the reproducing animal during the past 3 decades. Previous research has shown that tryptophan was the first limiting amino acid in Meat & Bone Meal but when the diet was fortified with this amino acid, pig growth responses were similar to those pigs fed a corn-soybean meal diet.

Excessive heat not only destroys amino acids, but it also reduces their availability and overall quality of the product. The introduction of new drying technologies in several by-product industries, including the rendering industry, has produced superior products being manufactured. By regulating the fat and ash content of Meat & Bone Meal, its quality and consistency is markedly superior to products of the past.

A potential advantage of Meat & Bone Meal for reproducing animals is its higher fat content compared to that present in regular grain and protein supplies. Sows are most frequently culled from the breeding herd because of anestrus and failure to conceive than any other cause. The most likely reason of this is the low body condition or low fat reserves at breeding, particularly after parity 1. Energy deficiency as a major cause of culling in reproducing sows is well documented, and therefore Meat & Bone Meal might prove particularly beneficial to reproducing animals where energy deficiency can affect sow herd longevity. With a higher quality amino acid product and with a higher fat content its value for sows might prove to be very beneficial.

Previous reports have suggested that Meat & Bone Meal should not be included in sow diets in excess of 5% (Cromwell, 1998), but the origin of these and other guidelines are based on grower-finisher research. With product improvements and the added value of a higher fat content for reproducing sows the use of Meat & Bone Meal may be an attractive product for the reproducing sow.

The approach of this experimental project was to incorporate various levels of Meat & Bone Meal into the diets of gestating and lactating sows for 3 consecutive parities, and to have the amino acids from the highest level formulated to meet but not exceed (at least for the limiting amino acids) the NRC amino acids requirements. Because apparent amino acid digestibility seem the most appropriate to use because of the lower known digestibility of Meat & Bone Meal, the apparent digestibility's (AD) of the most limiting amino acids (e.g., lysine and tryptophan) were calculated with subsequent treatment diets and levels of Meat and Bone Meal based on these calculations.

Objective:

To evaluate the effects of Meat & Bone Meal as a protein (amino acid) source for reproducing sows on reproductive performance, changes in backfat thickness, nursing pig performance, and sow milk compositions over a 3 parity period.

Industry Summary: A total of 183 sows were used over a three parity period to evaluate the effects of Meat & Bone Meal in the diets of reproducing gilts and sows. Meat & Bone was obtained from an Ohio Renderer was used to formulate both gestation and lactation diets to known nutrient requirements established by NRC (1998). A basal diet composed of corn and soybean meal served as the positive control with levels of Meat & Bone Meal incorporated in subsequent treatment at low or high levels to replace the soybean meal of the positive control diet. Samples of Meat & Bone and diets were also analyzed for their nutrient content and showed that the product used was superior to those of the past. The reproductive data demonstrated that high levels of Meat & Bone could be used in gestating sow diets with the same performances as the positive control treatment group. During lactation, sows that were fed the positive control corn soybean meal diet consumed more daily feed than those fed Meat & Bone Meal. Although individual pig weights were the same for all treatment groups sows fed the Meat & Bone Meal diet did not perform as satisfactory as those fed the positive control diet. These results suggest that the digestibility of the Meat & Bone Meal might have been lower that published values used to obtain optimum performance responses. These results also imply that Meat & Bone Meal is a potentially good protein or amino acid source for reproducing swine, but amino acid digestibility values currently in use may not be valid.

Abstract: A total of 183 high producing sows were used over a three parity period to evaluate the efficacy of Meat & Bone Meal in the diets of reproducing sows. The experiment evaluated a corn-soybean meal positive control diet and treatment diets with low and high Meat & Bone inclusion levels. Diets were formulated using tryptophan and lysine as the limiting amino acids. The highest level of Meat & Bone Meal level used matched NRC (1998) nutrient requirements on a total and apparent digestible amino acid basis. The study was conducted in three replicates over a three parity period. Statistical analysis was conducted with MIXED model of SAS. The results demonstrated that gestation reproductive performance was similar in regards to number of pigs born (total, live) but that as parity progressed the sows were heavier and perhaps fatter when Meat & Bone Meal was included in the diet. During the lactation period sow fed the positive control C-SBM diet weaned more pigs with heavier litter weaning weights, consumed more feed during the lactation than sows fed the Meat & Bone Meal diets. Sows fed Meat & Bone Meal had higher milk fat contents. Calculation of amino acid intake demonstrated that adequate quantities of amino acids were consumed during the gestation period, but that during lactation both lysine and tryptophan declined as the level of Meat & Bone Meal increased. The reduction in daily lactation feed intake during lactation was attributed more to the low amino acid intake rather than the additional body fat that the sows achieved during gestation. These results suggest that Meat & Bone Meal has good potential for reproducing sows because of its higher fat content, but the amino acid bioavailability and/or its digestibility of its amino acids needs to be more clearly defined before specific dietary inclusion levels recommendations can be made.

Key words: Meat and Bone Meal, Reproduction, Swine

Introduction: See above

Experimental Procedure:

Treatments

	Gestation	Lactation	Description
1.	C-SBM Mixture	C-SBM Mixture	Positive control
2.	+ Low level M&B	+ low level of M&B	Low inclusion of M&B
3.	+ High M&B	+ High level M&B	High inclusion of M&B

General:

There were 3 treatment groups over 3 different time periods. The first gestation treatment group was fed a positive control corn-soybean meal diet; the second group substituted approximately half of the amino acids from soybean meal with Meat & Bone Meal, and the third treatment group substituting approximately most or all of the amino acids from soybean meal with Meat & Bone Meal. In cases where the amino acid content could not be met with complete replacement of soybean meal (i.e. during lactation) with Meat & Bone Meal part of the diet contained a minimum amount of soybean meal to meet the amino acid requirements. Amino acid (NRC) recommendations were followed in each diet, but the critical amino acids (lysine, tryptophan) will not be provided in great excess in order to better test the quality of Meat & Bone Meal against the soybean meal positive control diet. Formulated diets used during gestation and lactation are presented in Table 1. Standard reproductive measurements for a 3 parity period will be collected on individual sows and litters. Colostrum and milk will be collected from each animal and analyzed for protein and milk fat. This study used a high producing sow line (Yorkshire X Landrace) with females artificially inseminated with a PIC (line 280) boar terminal line. The Meat & Bone Meal was obtained from an Ohio Rendering Plant (Wintzer & Son Rendering, Wapakoneta, OH).

Specific Animals Procedures:

1. Gilts (L X Y) were purchase from a seed stock producer (Temple Genetics) in groups of 30 at 3 different time periods (n = 90 total) to meet the projected breeding dates of 8 months of age. The gilts were fed commonly fed and fortified corn-soybean meal diets

during the grower development phases that met or exceed NRC (1998) nutritional standards.

2. At approximately 105 kg body weight the gilts were placed in individual gestation stalls and fed the finisher diet at a quantity so that the gilts weighed approximately 135 kg at the initial mating. Gilts were selected from the larger pool of 30 with 24-27 bred per group. Gilts were randomly allotted to one of the three dietary treatments at the time of breeding.

3. At mating (artificial inseminated with a PIC 280 line boar), the gilts were weighed, backfat measurement collected (last rib), and gilts ear tagged with a different color designation for each treatment group.

4. Gilts were fed their treatment diet once daily at approximately 2.0 kg during the first gestation and an additional 135 gram for each subsequent parity to maintain adequate body fat at the end of each gestation. Rations were individually weighed into plastic containers and offered once daily.

5. Gilts will be weighed at 35 day intervals with backfat measurements collected.

6. At approximately 110 day postcoitum, the gilts were weighed, backfat measurements collected, animals washed and moved into individual farrowing crates and fed the lactation diet until parturition.

7. Upon parturition, or within 12 hr, a sample of colostrum (i.e. 30 to 40 mL) from functional mammary glands was collected, frozen and saved for later determination of milk protein and milk fat content. The sample procedure was followed at weaning (i.e. 17 day postpartum).

8. Litter size was equalized within 3 days post farrowing between all sows. It was presumed that sow milk production is largely under genetic control and that the

nutritional demands on milk production would be more equalized between treatments if litters were similar and that a better assessment of the treatments could be made.

9. Sows were fed allocated amount of treatment feed during the initial 3-day postpartum period, but ad libitum fed their lactation treatment diet by day 3 postpartum and to the end of the lactation period. Weaning occurred on day 17 postpartum (± 1 day). Although sow feces were collected for salmonella analysis, there was no indication that scours was present and this was activity was discontinued.

10. Pigs were weighed individually at birth, 3 days and at weaning (17 days). At weaning milk samples were collected from each sow from the functional mammary glands. Sows were weighed and backfat thickness collected.

11. Sows were returned to their gestation pen, fed as much of their gestation diet as they would consume until bred. They were bred on their first estrum postweaning (PIC 280 line), weighed and backfat thickness collected, and fed approximately 2.08 kg of gestation diet for the duration of the second gestation and 2.22 kg during parity 3.

12. Similar management and measurement procedures were followed for sow and pigs during the second parity as in parity 1. Animals that became lame or failed to conceive, or were anestrus were removed from the experiment.

13. Because of the different number of sows completing the trial the data were analyzed using a MIXED procedure of SAS. Treatment contrasts evaluated the responses based on linear regression using the code (0, 50 or 100% replacement for soybean meal). Least square means are reported in tabular form for both main effects and individual treatment responses by parity. All probability levels were reported in the tables.

Results:

Meat & Bone and Dietary amino acid analysis

1. The treatment diets presented in Table 1 used NRC (1998) tabular values for total and apparent digestible lysine and tryptophan. The high level of Meat & Bone Meal diet was formulated using the minimum standards established by NRC (1998) so that the efficacy of the Meat & Bone Meal could be more accurately evaluated.
2. After completion of the experiment, samples from each of the Meat & Bone Meal procurements were composited and analyzed for amino acids, ether extract, crude protein, and ash content. The results presented in Table 2 indicate that the initial pre trial sample was substantially above the composited samples used in the experiment and published values in NRC (1998). In general, the composited Meat & Bone Meal samples were close to or slightly higher than published values in NRC (1998).
3. Diet analyses for amino acids for the various treatments are presented in Table 3. These values are generally close or above the calculated values, suggesting that the grain ingredients and/or the Meat & Bone Meal composition was slightly above published values. It is of interest to note that as Meat & Bone Meal increased in both gestation and lactation diets the total lysine was higher but the tryptophan level declined, suggesting that tryptophan may still be a limiting amino acid in these diets.

Gestation and Lactation Sow and Litter Performance

4. The main effects of Meat & Bone Meal level and Parity are presented in Table 4, while individual Meat and Bone Meal treatments means for each parity are presented in Table 5.

5. Gestation breeding weights of gilts for the various treatment groups were similar in the initial breeding (Table 5) but increased more for each ensuing parity as the level of Meat and Bone Meal increased. Body weights were generally greater at each measurement period as gestation progressed and when Meat & Bone Meal diets were provided. The greater weights were attributed to the greater fat content

in the gestation diet containing Meat and Bone Meal. Weight gains for gestation and weights during lactation were, however, similar for the various treatment groups. Weight losses during parity 1 of each treatment group was greater than at later parities.

6. Backfat measurement collected at the various weigh intervals during gestation and lactation did not differ as much as body weight. There was a general increase in backfat thickness as gestation progress in all treatment groups and a decline during lactation, but there was no significant difference between the treatment variables.

7. The number of pigs born was considered good for the overall experiment. Although there was a somewhat greater number of total pigs born when sows were fed Meat & Bone Meal, the treatment response was not significant. The number of stillbirths was somewhat higher when Meat and Bone Meal were fed, but again the responses were not significant.

8. Litter and individual pig weights were similar for the various treatment groups. Weights for litters and pigs were considered good for all groups.

9. Milk colostrum had similar fat and crude protein contents for the various treatments, however, milk fat was higher when Meat and Bone was used in the diets. This suggests that the added fat from Meat & Bone Meal and consumed during the lactation period was readily transferred to the mammary tissue and used in milk fat synthesis. During gestation, the higher fat content was probably deposited in sow tissue, but was not readily mobilized such that it increased sow colostrum fat content.

10. Sow feed intake (total or ADFI) was lower when Meat and Bone Meal was included in the lactation diet. This suggests that the inclusion of Meat & Bone Meal contained a limiting amino acid or that the sow's amino acid requirements for some of the amino acids are not known.

11. Litter size was standardized by 3 days of age thus allowing the milk production in individual sows to reflect dietary treatments. Litter size at weaning was, however, lower as the level of meat and Bone Meal increased, suggesting that sows could not maintain milk production at the higher litter size and some pig were lost from the litter. Although litter weights were lower when Meat and Bone was fed this was a reflection of their lower litter size. Individual pig weights were similar for the various groups.

Discussion

12. The analyzed and calculated treatment composition data were used to compile the actual amino acid intake of gestating and lactating sows and are reported in Table 6.

13. During gestation the quantity of lysine and tryptophan needed for reproductive purposes appeared to be adequate for lysine, but the amount of tryptophan (total and apparent digestible) appeared to be below that needed to meet the needs for reproductive performances. However, our data showed that reproductive performance was the same for the various treatments suggesting that the above conclusion may be in error. When the scientific literature is reviewed it becomes evident that the gestating gilt can completely meet all reproductive needs using body labile protein reserves, thus masking any effect supplied by the gestation diet. Although our reproductive data and subsequent conclusion are apparently not in agreement, it is possible that the sow overcame the deficiency, during gestation from that provided by the diet, by mobilizing sow tissues to maintain fetal development and thus litter birth weights. Consequently, the results are not surprising nor in conflict. In addition, it is well established that sows that are borderline deficient or deficient in any amino acid, that tissues reserves at the onset of lactation will have a negative affect on lactation milk production and subsequent litter performance.

14. The calculated amino acid intakes during lactation from the various treatments as compared to NRC (1998) recommended intakes and reported in Table 6 suggest that both the lysine and tryptophan are below what is needed to obtain optimum performance. Apparent digestible lysine and tryptophan in all treatment groups declined as the Meat & Bone level increased with the more extreme decline in tryptophan in the high Meat & Bone Meal diet. Although each of these intakes are estimates of that needed for a production level, it is apparent that both lysine and tryptophan could be limiting in the Meat & Bone Meal diets, the order of limitation is, however, not known. Because daily feed intake declined with increasing amount of Meat & Bone Meal, it suggests that the amino acids needs were not met with the addition of Meat & Bone Meal.

General conclusions

Meat & Bone Meal is comprised of two major components, both having potential benefit to reproducing sows. These are its fat content and the other its protein or amino acids. Although it is clear that sows that are fat at the end of gestation have lower feed intakes during the subsequent lactation period, none of the sows in this study were considered fat as evidence by having similar backfats or by observation of the sows body condition score. Although the reduced feed intake of lactating sows may have been influenced by the larger weights and thus were of greater fat content, this was not considered to be the limiting factor affecting sow lactation feed intake in this experiment. The high level of fat present in Meat & Bone Meal may in fact be a benefit for reproducing sows. More sows are energy deficient at the end of lactation and the high loss of weight of sows due to this energy deficiency is perhaps the primary reason sow are culled from the breeding herd. Thus the inclusion of Meat & Bone Meal would be considered a benefit when the additional fat is added.

Perhaps the factor that is most limiting in Meat & Bone Meal for reproducing sows was the quality of protein and the digestibility of its amino acids, particularly lysine and tryptophan. It is well accepted that the digestibility of amino acids in Meat & Bone Meal is lower than other protein sources. This has been attributed to the high heat used to produce a product of acceptable quality. From observations of the product obtained from the rendering plant, the quality of the product was considered good to excellent and the resulting amino acid composition of the Meat & Bone Meal (Table 3) bears this out. However, based on the data of this experiment, the apparent digestibility values used to formulate the diets may have overestimated the value of at least lysine and tryptophan. The apparent digestibility values were undoubtedly conducted with grower-finisher pigs, and the intestinal tact of the sow is longer, one would suspect that the apparent digestibility values should have been higher than for grower finisher pigs. Our data suggest that this was not the case. Our results imply that with lactating sows with high feed intakes and a more rapid feed passage rate through the digestive tract, the digestibility of amino acids may be lower than when evaluated with animals at other production phases.

Several things could be involved in reducing the apparent digestibility of the amino acids. First the apparent digestibility value of Meat & Bone Meal reflects the heating temperature and the ratio of the components within that meal. Our product contained a mixture of beef, pork, and turkey meat products. Thus the desirable heating temperature for each of these products may be different than if one product *per se* was dried. Because the observable quality of the product from the Renderer was considered good, it may also reflect that 1) the apparent digestibility values may be too low for a lactating sow, or 2) the sow's amino acid requirements may have not been estimated correctly by NRC (1998). It is most probable that both factors played a part in these results.

Overall, these results suggest that Meat & Bone Meal has great potential in providing a high quality protein source for pigs, and that reproducing sows are an excellent animal where the product can be used. Our results suggest that gestating sows may have most if not all of the amino acids provided from Meat & Bone Meal, but studies need to be conducted that would clearly show that the recommended level would also support later lactation performance. This experiment suggests that identifying the level of Meat & Bone Meal that would be most effective for either gestating or lactating sow's is not yet known. Simply using digestibility values may not be the best way to evaluate Meat & Bone Meal or any protein source with lactating sows.

Table 1. Experimental Diets, (%, as fed basis)

Ingredient	NRC Reqr. (1998)	Gestation diets: Control (C-SBM)	Gestation diets: Meat & Bone Meal Replacement for SBM: Low	Gestation diets: Meat & Bone Meal Replacement for SBM: High	NRC Reqr. (1998)	Lactation diets: Control (C-SBM)	Lactation diets: Meat & Bone Meal Replacement for SBM: Low	Lactation diets: Meat & Bone Meal Replacement for SBM: High
Corn		82.15	82.45	82.35		67.70	68.10	68.15
Soybean meal, 48%		13.75	7.00	0.00		28.25	22.00	15.50
Meat and bone meal		0.00	8.25	16.25		0.00	7.50	15.00
Salt		0.50	0.50	0.50		0.50	0.50	0.50
Dicalcium phosphate		2.10	0.90	0.30		1.75	0.70	0.00
Limestone		0.85	0.25	0.00		0.95	0.35	0.00
Se premix		0.15	0.15	0.15		0.15	0.15	0.15
Trace mineral		0.10	0.10	0.10		0.10	0.10	0.10
Vitamin premix		0.25	0.25	0.25		0.25	0.25	0.25
Antibiotic		0.05	0.05	0.05		0.25	0.25	0.05
MTB-100		0.10	0.10	0.10		0.10	0.10	0.10
Calculated compositions, %								
Lysine (total)	(0.54)	0.56	0.57	0.56	(0.97)	0.98	0.98	0.97
Lysine (A Digest. value)	(0.42)	0.48	0.47	0.45	(0.79)	0.83	0.81	0.80
Tryptophan (total)	(0.11)	0.17	0.15	0.13	(0.17)	0.25	0.23	0.21
Tryptophan (A Digest. value)	(0.08)	0.13	0.10	0.08	(0.13)	0.19	0.17	0.13
Ca	(0.75)	0.89	0.90	1.10	(0.75)	0.90	0.90	1.05
P (total)	(0.60)	0.71	0.70	0.74	(0.60)	0.70	0.70	0.76
Fat, %	(-)	3.62	4.33	5.01	(-)	3.50	4.14	4.76

Notes about diet formulation.

1. Meat & Bone Meal was obtained from Wintzer & Son Rendering (Wapakoneta, OH).
2. Diets were formulated to meet minimum standards for the NRC (1998) amino acid standards for both the gestating and lactating sow.
3. Aureomycin was used in gestation, Bacitracin MD was used in lactation.

Table 2. Analyzed composition of Meat & Bone meal used in experiment (%, as fed basis)

Item	Meat & Bone Meal		
	Pre-trial	Composite	NRC (1998)
No. of samples	1	6	NA
Dry matter	-	94	93
Crude protein	50.1	51.8	51.5
Fat	NA	14.3	10.9
Ash	NA	22.7	
Essential amino acids			
Threonine	1.83	1.63	1.59
Valine	2.37	2.38	2.04
Tryptophan	0.51	0.39	0.28
Phenylalanine	1.87	1.89	1.62
Lysine	2.86	2.80	2.51
Isoleucine	1.58	1.51	1.34
Leucine	3.48	3.38	2.98
Methionine	0.80	0.71	0.68
(Cysteine)	0.47	0.34	0.50
Arginine	3.32	3.47	3.45
Histidine	1.28	1.29	0.91

Table 3. Analyzed essential amino acid composition of experimental diets (% total, as is basis).

Amino acid	Gestation, M & B level			Lactation, M & B level		
	0	Low	High	0	Low	High
Phenylalanine	.59	.66	.71	.96	.97	.96
Valine	.59	.70	.76	.94	.98	1.01
Threonine	.46	.53	.58	.73	.75	.79
Methionine	.21	.26	.26	.31	.34	.35
(Cysteine)	.24	.25	.23	.34	.33	.33
Arginine	.75	.87	.93	1.31	1.31	1.37
Tryptophan	.16	.14	.13	.26	.23	.21
Histidine	.34	.39	.43	.53	.55	.58
Isoleucine	.48	.52	.53	.82	.82	.79
Leucine	1.17	1.37	1.55	1.72	1.79	1.85
Lysine	.62	.71	.75	1.10	1.12	1.16

[a] Analyzed by University of Missouri analytical laboratories.

Table 4. Main effects Meat & Bone meal inclusion level in reproducing sow gestation and lactation diet on sow and litter performance responses.

	Meat & bone meal, level					Parity				
	0	Low	High	SEM	P	1	2	3	SEM	P
No. of sows	67	60	56	-		74	61	48	-	
Sow weight, kg										
Breeding	164	165	171	2.5	.07L	147	172	181	1.7	.01Q
35 d	177	178	182	2.5	.15L	161	180	196	1.7	.01L
70 d	195	196	199	3.7	.38	185	192	213	2.3	.01Q
110 d	220	220	228	2.7	.03L	208	215	245	1.9	.01Q
Gain	54	55	56	1.6	.46	61	43	62	1.4	.01Q
Farrow	207	206	216	2.8	.03L	194	203	231	1.7	.01Q
Wean (17 d)	200	196	206	3.4	.09Q	184	197	220	1.9	.01Q
Loss	-7.1	- 9.6	-9.2	1.3	.22	-10.1	-6.1	-8.7	1.1	.01Q
Sow backfat, mm										
Breeding	14	14	13	.5	.58	15	13	12	.4	.01L
35 – d	14	14	14	.6	.78	16	13	13	.4	.01Q
70 – d	15	15	16	.6	.25	17	14	15	.5	.01Q
110 – d	16	17	16	.6	.56	17	15	17	.4	.01Q
Farrow	15	16	16	.6	.65	17	14	16	.4	.01Q
Wean	14	14	15	.6	.38	15	14	15	.4	.01Q
Milk composition										
Colostrum										
Protein	11.76	11.09	11.11	.89	.77	11.38	10.49	12.09	.60	.12
Fat	7.66	8.03	7.49	.46	.67	8.27	7.98	6.94	.38	.01L
Milk (17 –d)										
Protein	5.29	5.30	5.34	.08	.72	5.67	5.37	4.88	.06	.01L
Fat	7.08	7.93	7.98	.26	.01L	8.51	7.57	6.90	.24	.01L
Sow feed, kg										
Total	98.2	94.2	92.0	2.9	.12L	85.1	102.1	97.3	2.3	.01Q
ADFI	5.75	5.57	5.46	.16	.21	5.05	6.00	5.72	.13	.01Q
Birth data										
Pigs born, no./litter										
Total	11.58	11.77	12.01	.51	.55	11.87	11.25	12.26	.39	.07Q
Live	11.16	11.14	11.42	.50	.86	11.22	10.87	11.64	.37	.16
Stillborn	.45	.66	.62	-	-	.68	.41	.65	-	-
Litter wt, kg.	17.6	18.8	18.0	.70	.26	17.0	17.7	19.6	.50	.01Q
Pig wt., kg	1.55	1.66	1.56	.05	.16	1.56	1.46	1.65	.03	.01Q
Pig no. (3 d)	11.52	11.43	11.50	.14	.88	11.51	11.38	11.56	.14	.67
Litter wt. (3 d)	23.2	23.8	22.8	.50	.35	21.37	23.84	24.64	.44	.01L
Pig wt. (3-d)	2.04	2.08	2.00	.05	.48	1.86	2.11	2.14	.04	.01Q
Wean data										
Pigs weaned, no.	11.12	10.98	10.94	.13	.35	11.00	10.87	11.17	.13	.10
Litter wt.	62.2	61.9	59.5	1.3	.12	58.1	63.0	62.5	1.0	.01Q
Pig wt., 17-d	5.60	5.65	5.46	.10	.29	5.30	5.79	5.63	.07	.01Q
Pig gain (3-17 d)	3.57	3.58	3.47	.07	.42	3.44	3.68	3.50	.05	.01Q

Table 5. Treatment response of sow reproductive and litter performance responses over a 3-parity.

Item	Diet:	Meat & bone, 0%			Meat & bone, low			Meat & bone, high				
	Parity:	1	2	3	1	2	3	1	2	3	SEM	PxML
No. sows												
Sow weight, kg												
Breeding		144	169	179	147	169	179	149	176	187	2.9	.25
35 – d		161	178	192	163	177	193	160	184	203	2.9	.01L
70 – d		181	189	212	187	197	212	189	213	212	4.3	.24
110 – d		206	210	243	209	213	241	210	221	252	3.5	.18
Gain		60	40	63	61	42	62	61	45	61	2.3	.27
Farrow		193	200	227	193	199	227	196	211	238	3.0	.11
Wean (17-d)		184	196	220	181	191	216	187	204	226	3.6	.24
Loss		-9.5	-4.5	-7.4	-11.8	-6.8	-10.1	-9.0	-6.9	-8.6	1.9	.91
Sow Backfat thickness, mm												
Breeding		15	14	13	15	11	13	15	13	13	.7	.25
35 – d		16	13	13	16	13	13	16	13	14	.7	.17
70 – d		16	13	14	16	14	14	17	15	17	.7	.68
110 – d		17	15	16	17	14	16	17	15	17	.7	.36
Farrow		17	14	15	17	14	15	17	15	16	.7	.59
Wean (17-d)		15	13	15	15	13	15	15	15	15	.7	.48
Sow feed intake, kg												
Total		90.8	102.1	101.7	81.8	102.9	98.0	82.5	101.3	92.3	3.6	.48
ADFI		5.34	5.97	5.93	4.87	6.08	5.74	4.95	5.95	5.47	.23	.61
Milk composition												
Colostrum, %												
Protein		12.73	10.52	12.05	9.60	10.49	13.18	11.83	10.43	11.06	1.30	.19
Fat		7.76	8.04	7.18	8.68	7.98	7.49	8.37	7.90	6.20	.67	.59
Milk (17-d), %												
Protein		5.54	5.36	4.96	5.72	5.38	4.78	5.77	5.36	4.90	.10	.16
Fat		8.12	6.83	6.29	8.65	8.20	6.95	8.77	7.69	7.49	.38	.65
Birth data												
Pigs born, no./litter												
Total		11.26	11.76	11.72	11.86	11.15	12.31	12.50	10.83	12.71	.7	.46
Live		10.85	11.38	11.24	10.92	10.81	11.69	11.87	10.41	11.97	.7	.42
Stillborn		.44	.37	.55	.92	.40	.65	.66	.50	.76	-	-
Litter wt., kg		16.4	17.6	19.0	17.6	18.4	20.4	17.1	17.3	19.5	.9	.90
Pig wt., kg		1.49	1.52	1.64	1.52	1.72	1.72	1.37	1.71	1.60	.06	.02Q
Pig no. (3-d)		11.49	11.33	11.74	11.48	11.23	11.58	11.58	11.55	11.38	.23	.83
Litter wt. (3 - d)		21.86	23.27	24.49	21.78	23.76	25.99	20.49	24.51	23.43	.80	.10
Pig wt. (3-d)		1.91	2.08	2.10	1.89	2.11	2.22	1.78	2.13	2.07	.07	.22
Wean data (17-d)												
Pigs weaned, no.		11.13	10.91	11.30	11.07	10.75	11.11	10.79	10.93	11.10	.21	.83
Litter wt., kg		59.7	63.2	63.6	58.9	62.0	64.8	55.6	63.9	59.1	1.9	.07
Pig wt.		5.38	5.76	5.66	5.35	5.77	5.83	5.16	5.81	5.39	.13	.24
Pig gain (3-17d)		3.47	3.68	3.56	3.47	3.66	3.59	3.38	3.69	3.34	.10	.61

Table 6. Calculated total and apparent digestible intakes of sow fed the various dietary treatments.

Item	NRC Reqr.	Gestation, M & B 0	Low	High	NRC Reqr.	Lactation, M & B 0	Low	High
No. sows	-	67	60	56	-	67	60	56
ADFI, kg	-	2.22	2.22	2.22	-	5.75	5.57	5.46
Diet composition, % of diet								
Lysine (total)[a]	(.54)	.62	.71	.75	(.97)	1.10	1.12	1.16
Lysine (AD)[b]	(.42)	.48	.47	.45	(.79)	.83	.82	.80
Tryptophan (total)[a]	(.11)	.16	.14	.13	(.17)	.26	.23	.21
Tryptophan (AD)[b]	(.08)	.13	.10	.08	(.13)	.19	.17	.13
Amino acid intake, g/d								
Lysine (total)[a]	(12.3)	13.8	15.8	16.7	(64.7)	61.3	62.4	63.3
Lysine (AD)[b]	(7.9)	10.7	10.4	10.0	(50.4)	47.7	45.7	43.7
Tryptophan (total)[a]	(4.3)	3.5	3.1	2.9	(10.7)	14.5	12.8	11.5
Tryptophan (AD)[b]	(1.4)	2.9	2.2	1.8	(8.4)	10.9	9.5	7.1

[a] Analyzed composition (Table 3).
[b] Calculated values from Table 1.