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Department of Animal Science
South Dakota State University

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BROOKINGS, SOUTH DAKOTA

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South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-25

A COMPARISON OF THREE METHODS OF IRON ADMINISTRATION IN PREVENTING BABY PIG ANEMIA

R. D. Magstadt, R. W. Seerley and R. C. Wahlstrom

Baby pig anemia is a serious nutritional disease. It is primarily due to a lack of iron in the diet of the young pig.

Pigs are born with very little stores of iron in their bodies. Also, sow's milk does not contain enough iron to meet the pig's requirements. Therefore, young pigs which subsist on milk alone commonly become anemic at about three weeks of age. The fastest growing pigs are the first to show symptoms because they require more of this essential nutrient. Symptoms of anemia are: (1) respiratory difficulties shown by thumping of sides, (2) paleness of skin, (3) emaciation, and (4) roughness of the hair.

There are many methods available to prevent anemia in young pigs. The most common methods that have been used are: (1) iron injection given intramuscularly, (2) providing clean soil in the corner of the pen, (3) painting sows' udders with cupric sulfate paste, (4) giving iron orally, by mouth in the form of pills, (5) licking devices, and (6) compounds mixed into the drinking water.

The objectives of the trials reported here were to measure the relative effectiveness of an intramuscular iron dextrin compound, a ferrous choline citrate compound added at four different levels in the drinking water and a ferrous fumerate pellet implanted intramuscularly for the prevention of iron deficiency anemia.

Experimental Procedure

A total of 505 Hampshire, Yorkshire and Duroc pigs were used in this experiment. All pigs were raised in farrowing crates with their dam, and water was provided *ad libitum*. Birth weight, 5 week weaning weight and percent survival records were kept on all pigs. All pigs were bled at three days of age prior to treatment, at 2 weeks of age and at 5 weeks of age. Hemoglobin and hematocrit levels were determined from the blood samples.

The experimental treatments were:

1. Iron dextrin intramuscular injection of 200 mg. of elemental iron
2. Ferrous fumerate pellets implanted under skin of neck (4 pellets each contained 62 mg. of iron)
3. Ferrous choline citrate in drinking water - 15 gm./gal. of water (1500-1650 mg. available iron/gal.)
4. Ferrous choline citrate - 10 gm./gal. of water (1000-1100 mg. available iron/gal.)
5. Ferrous choline citrate - 5 gm./gal. of water (500-550 mg. available iron/gal.)
6. Ferrous choline citrate - 1 gm./gal. of water (100-110 mg. available iron/gal.)
7. Control - no supplemental iron

The iron injection and pellet implants were given at three days of age and ferrous choline citrate supplementation in the water was started on day three and given through day thirteen.

Results

A summary of the three trials is shown in table 1. The pigs given intramuscular iron injections and those given pellet implants had higher hemoglobin and hematocrit values, heavier 35 day weights and a higher percentage of survival than the control pigs or those given iron at a low level in the drinking water. Pigs receiving 10 or 15 grams of ferrous choline citrate had weaning weights similar to those pigs that received iron by implanted pellets or intramuscular injections. The level of hemoglobin and hematocrit did decrease, however, and percent survival was reduced.

Table 1. Effects of Three Methods of Iron Administration in Preventing Anemia of Pigs

		Ferrous choline citrate				Pellet	Iron
	Control	1 gm.	5 gm.	10 gm.	15 gm.	implant	injection
Birth wt., lb.	2.7	2.8	2.8	2.8	2.8	2.7	2.7
	(35)[a]	(34)	(69)	(77)	(100)	(89)	(101)
Weaning wt., lb.	19.2	16.1	19.6	21.9	21.1	22.2	20.9
	(28)	(30)	(58)	(65)	(83)	(80)	(92)
% survival	80.0	88.2	84.1	84.4	83.0	89.9	91.1
3 days prior treatment							
Hemoglobin, gm. %	8.9	8.4	8.6	8.8	9.1	9.4	9.4
Hematocrit, gm. %	28.6	30.8	30.4	31.0	31.3	29.3	31.5
14 days							
Hemoglobin, gm. %	7.5	7.7	8.3	8.8	9.1	10.1	9.9
Hematocrit, gm. %	25.8	24.3	29.3	30.4	32.0	32.2	33.5
35 days							
Hemoglobin, gm. %	7.0	7.3	8.3	8.9	9.3	11.1	10.8
Hematocrit, gm. %	23.2	24.9	32.3	35.5	35.5	36.3	37.2

[a] ( ) Number of pigs in each group average.

It was noticed in a high percentage of the litters, and especially large litters, that there was considerable variability of efficiency of the ferrous choline citrate in water at all levels. This was especially true of the lower levels. For an unknown reason one or two pigs in a big litter apparently would not drink enough water to prevent them from becoming anemic.

One gram of ferrous choline citrate in the drinking water was not enough to maintain adequate hemoglobin and hematocrit levels. Five grams per gallon of water did keep the pigs from showing clinical symptoms of anemia, but when blood samples were taken hemoglobin and hematocrit levels were lower than both injection methods and the 10 and 15 gm. level in water.

The control group which received no form of iron supplementation had a very high incidence of clinical symptoms of anemia. The pigs showed symptoms of anemia as was witnessed by a rough hair coat, slow growth, heaving or thumping of side and a pale skin color. The hemoglobin, hematocrit, 35 day weight and percent survival of the control pigs were very low.

This research illustrates that intramuscular iron dextrin injections, implants of iron-containing pellets and ferrous choline citrate supplied in the drinking water at the 10 and 15 gm. per gallon levels prevent anemia quite well. However, it appeared that the iron injection and the pellet implant method are more consistent and effective in preventing anemia.

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A. S. Series 67-26

ENERGY NEEDS OF GILTS AND SOWS DURING GESTATION

C. S. German, R. W. Seerley and R. C. Wahlstrom

During the past few years several experiments have demonstrated that gilts and sows do not need to be fed as liberally during the gestation period as was previously recommended. Overfeeding of the pregnant sow is not only an uneconomical practice but also can lead to difficulties at farrowing time and more pigs overlaid if sows are excessively fat.

Most experiments with feeding methods for pregnant gilts have limited the intake of all nutrients. The purpose of this study reported here was to determine the effect of restricting only the energy intake.

Experimental Procedure

The rations fed are shown in table 1. The intake of all nutrients, except energy, was the same for both groups of gilts. Protein, minerals and vitamins were adjusted so that the same amount of these nutrients was present in 3 lb. of feed fed to lot 1 as was present in 5 lb. of feed fed to lot 2. The added energy for lot 2 was obtained by adding corn starch to the ration. These same rations were fed during lactation at a level of 8 lb. per day during the first lactation and 9.5 lb. per day during the second lactation period.

Table 1. Ration Composition

Ingredient	Lot 1 3 lb./day	Lot 2 5 lb./day
Gr. yellow corn	69.80	41.88
Corn starch	---	40.00
Solv. soybean meal (48% protein)	25.00	15.00
Calcium carbonate	0.35	0.21
Dicalcium phosphate (26% Ca, 18.5% P)	3.75	2.25
Trace mineralized salt (0.8% zinc)	1.00	0.60
Vitamin premix[a]	0.10	0.06

[a] Supplied the following per ton of ration: 30 million I.U. of vitamin A, 2 million I.U. of vitamin D_2, 30 grams of riboflavin, 120 grams of pantothenic acid, 160 grams of niacin and 100 milligrams of vitamin B_{12}.

In trial 1 five Duroc gilts were randomly allotted to each treatment. All were paired littermates. The gilts that settled and farrowed were rebred for a second farrowing.

For trial 2 eight crossbred gilts were randomly allotted to each treatment. Most of these were also paired littermates. Only data from the first litter of these sows are available in this report since these sows did not farrow in time for the second farrowing data to be included.

The gilts were kept on plowed lots so no nutrients could be obtained from pasture. They were fed once daily in individual feeding stalls. Water was supplied in automatic fountains.

The gilts were weighed on the first day of breeding, at 110 days gestation, 1 to 2 days after farrowing and after 3 weeks of lactation. The pigs were weighed at birth and at 3 weeks. At birth the pigs were given a strength score ranging from 1 to 5, weak to strong, respectively. They were given 1 cc. (100 mg.) of iron dextran intramuscularly at 3 days of age.

Results and Discussion

In the first farrowing of trial 1 one sow in the lot fed 5 lb. of feed per day failed to settle; she was never detected in estrus. In the second farrowing only 4 sows in the lot fed 3 lb. and 3 sows in the lot fed 5 lb. provided complete data.

In trial 2 three sows failed to farrow the first time. In the lot fed 3 lb. one sow did not conceive, while in the lot fed 5 lb. one sow aborted two months after breeding and one sow died of an internal hemorrhage. Neither condition was attributed to the feeding treatment.

No significant differences were found between treatments for any of the data collected on the baby pigs. However, in trial 1 sows fed 5 lb. of feed per day farrowed and weaned slightly more pigs per litter in both farrowings than did those sows fed 3 lb. of feed per day. Birth weights also averaged heavier in litters from sows fed 5 lb. per day. In the second trial these differences were smaller but still favored the sows fed 5 lb. per day in litter size at birth and birth weight but at weaning time litter size was slightly higher in those sows fed 3 lb. of feed per day.

The sows receiving 5 lb. of feed per day gained significantly more weight during gestation than the sows receiving 3 lb. of feed per day. Also, the sows fed 5 lb. of feed daily gained more weight from breeding to weaning than did those sows fed 3 lb. of feed per day.

It is interesting to note that the gilts in trial 1 fed 3 lb. of feed daily gained 80 lb. during their first gestation period and 89 lb. during the second period while gilts in trial 2 gained 76 lb. This does indicate that this small amount of feed will support a relatively good gain in bred sows. Five pounds of feed daily produced gains of 148, 124 and 135 lb., respectively, for the corresponding groups. Slightly more weight was lost during lactation by those sows that had been fed 5 lb. per day during gestation than by those fed 3 lb. daily.

Although more sows need to be fed on these treatments before definite conclusions can be drawn, the data to date indicates that 3 lb. of feed daily may be sufficient for brood sows during gestation if adequate protein, minerals and vitamins are provided in the feed.

Table 2. Results of Limited Energy Intake to Gravid Sows, Trial 1

	3 lb./day		5 lb./day	
	First farrowing	Second farrowing	First farrowing	Second farrowing
No. of sows	5	4	5	3
Av. initial wt. at breeding	280	414	289	430
Av. farrowing wt.	360	503	437	554
Av. 1 day post-farrowing wt.	315	457	405	526
Av. 3 week lactation wt.	277	445	346	516
No. sows farrowing	5	4	4	3
Av. litter size, farrowed alive	9.8	10.5	11.3	10.7
Av. birth wt., lb.	2.3	2.6	2.4	2.9
Av. strength score at birth[a]	4.6	4.4	4.2	4.6
Av. litter size, 3 weeks	8.6	7.8	9.0	8.7
Av. 3 wk. weaning wt., lb.	13.2	10.4	11.4	10.5
Stillborn pigs	2	2	--	--

[a] The strength score is based on the vigor and activity of the pig; it is not related to birth weight.

Table 3. Results of Limited Energy Intake to Gravid Sows, Trial 2

	3 lb./day	5 lb./day
No. of sows	8	8
Av. initial wt. at breeding	326	307
Av. farrowing wt.	392	441
Av. 1 day post-farrowing wt.	360	406
Av. 3 week lactation wt.	348	386
No. of sows farrowing	7[a]	6[b]
Av. litter size, farrowed alive	8.8	9.2
Av. birth wt., lb.	2.8	2.9
Av. strength score	5.0	4.9
Av. litter size, 3 wk. weaning	7.4	7.2
Av. weaning weight, lb.	12.0	13.1
Stillborn pigs	7[c]	0

[a] One sow did not settle.
[b] One sow died of an internal hemorrhage in the ileum. One sow did not settle.
[c] All from one sow; she also had 12 live pigs.

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A. S. Series 67-27

SUPPLEMENTAL LYSINE IN FEED AND WATER FOR GROWING-FINISHING SWINE

A. R. Taylor and R. C. Wahlstrom

At the 1966 South Dakota Swine Field Day information was reported (A.S. Series 66-22) on the effects of lysine in feed and water at comparable levels when the level of crude protein was slightly lower than normally recommended for the respective weight of the pigs. It was reported that pigs receiving lysine in the water gained slightly faster and considerably more efficiently than pigs that did not receive lysine or those fed lysine in the feed. In order to obtain more data on the effect of lysine in the feed or water for young pigs the experiment was repeated and is reported herein.

Experimental Procedure

Five experimental treatments of eight pigs each were used in this trial. Four barrows and four gilts were assigned to each group at approximately 3 weeks of age and averaging 16 lb. The groups were assigned at random to each treatment. The treatments were:

Lot 1 - Basal ration
Lot 2 - Basal ration + high level of lysine in water
Lot 3 - Basal ration + 0.1% lysine in feed
Lot 4 - Basal ration + low level of lysine in water
Lot 5 - Basal ration + 0.3% lysine in feed

An attempt was made to obtain equal intakes of supplemental L-lysine monohydrochloride in feed and water. Lysine was added to the basal rations of lots 3 and 5 at 0.1% and 0.3%, respectively. The levels of lysine in the water of lots 2 and 4 were adjusted to maintain a similar lysine intake to that of pigs fed 0.1 or 0.3% in the feed. Feed and water consumption was measured continuously and the quantity of lysine intake was calculated.

All pigs were self-fed the ration shown in table 1. The period of feeding each ration is also shown in the table. Water was provided *ad libitum* to all pigs. The pigs were kept on concrete in combination sleeping quarters and outside feeding pens. All animals were taken off test after 99 days due to lack of facilities for fall experiments and due to the wide variations between and within pens.

Results

The results of this experiment are shown in table 2. Average daily gain was improved 18.4 percent (from 0.87 to 1.03 lb. per day) when pigs received 0.1% lysine in either the feed or drinking water. Feed efficiency was also improved by this lower level of lysine. The improvement in feed efficiency was 5.2 and 6.6% when pigs received 0.1% lysine in the water or feed, respectively.

Table 1. Composition of Rations, Lb.

Feeding period	3 to 6 weeks of age	6 to 10 weeks of age	10 weeks to 75 lb.	75 to 150 lb.
Crude protein	18%	16%	14%	12%
Shelled corn	390	540	843	890
Rolled oats	300	300	--	--
Soybean meal (50%)	130	130	128	80
Dried skimmilk	100	--	--	--
Sugar	50	--	--	--
Dicalcium phosphate	15	16	16	18
Limestone	5	6	5	3
T. M. salt	5	5	5	5
Trace mineral	0.5	0.5	--	--
Vitamin-antibiotic premix	a	a	b	b

[a] Provided 1135 I.U. vitamin A, 340 I.U. vitamin D, 4 mg. riboflavin, 8 mg. calcium pantothenate, 16 mg. niacin, 20 mg. choline chloride, 10 mcg. vitamin B_{12} and 1.13 gm. SP-250 per pound of ration.

[b] Provided 1135 I.U. vitamin A, 340 I.U. vitamin D, 2 mg. riboflavin, 4 mg. calcium pantothenate, 9 mg. niacin, 10 mg. choline chloride, 7 mcg. vitamin B_{12} and 5 mg. chlortetracycline per pound of ration.

Table 2. Results of Lysine in the Feed or Water

	Control	Lysine in feed 0.1%	Lysine in feed 0.3%	Lysine in water (feed equivalent) 0.1%	Lysine in water (feed equivalent) 0.3%
Number of pigs	8	8	8	8	8
Av. initial wt., lb.	16.13	16.00	15.87	15.75	16.25
Av. final wt., lb.	102.38	117.88	139.00	117.75	137.00
Av. daily gain, lb.	0.87	1.03	1.24	1.03	1.22
Av. daily feed, lb.	2.49	2.75	3.13	2.79	3.09
Av. daily water, gal.	0.83	0.69	0.78	0.71	1.00
Av. feed per lb. gain, lb.	2.86	2.67	2.52	2.71	2.53
Av. daily lysine, gm.	--	1.25	4.26	1.13	4.15

Pigs receiving the 0.3% level of lysine in feed or water also performed quite similarly. Average daily gains of pigs receiving the 0.3% level of lysine were approximately 41.4% faster than those pigs fed the basal ration and 19.4% faster than those pigs receiving 0.1% lysine in feed or water. Feed efficiency was improved approximately 11.7 and 6.1% when pigs received 0.3% lysine as compared to those fed the basal ration or receiving 0.1% lysine.

The results of this trial indicate an improvement in rate of gain and feed efficiency of young pigs when fed lysine either in the feed or drinking water when their rations are minimal in protein content. A level of 0.3% lysine was more adequate than the lower level of 0.1% lysine. These results are not in complete agreement with previous work from this station which reported little response from lysine in the feed at either the 0.1 or 0.3% level and an equal response from pigs receiving lysine in the water at the 0.1 or 0.3% levels. It was noted in the present experiment that considerable variation existed among pigs within the same treatment group. It is possible that by reducing the protein level of the ration at periodic intervals more stress was placed on slower gaining pigs.

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-28

SUPPLEMENTAL LYSINE IN DRINKING WATER OF GROWING-FINISHING SWINE FED RATIONS OF TWO DIFFERENT PROTEIN LEVELS

A. R. Taylor, R. W. Seerley, R. D. Magstadt and R. C. Wahlstrom

Cereal grains do not contain an adequate amount of the amino acids (protein building blocks) to support optimum growth of growing-finishing pigs.

The protein present in cereal grains is of relatively "poor quality" since it does not contain the proper balance of amino acids to support optimum growth of growing-finishing swine. The most limiting amino acid in cereal grains is lysine. Protein supplements, such as soybean meal, contain larger amounts of the essential amino acids and thus are used to balance a cereal grain ration.

Previous research at this station, however, has shown that a corn-soybean meal ration can often be improved with lysine supplementation to the drinking water of growing pigs. These trials were conducted to obtain further information on the effect of adding 4 gm. of L-lysine monohydrochloride per gallon of drinking water to pigs fed corn-soybean meal rations of two protein levels.

Experimental Procedure

Four trials were conducted in this experiment. All pigs were self-fed the ration shown in table 1. Water was provided *ad libitum* to all pigs. The pigs were kept on concrete in combination sleeping quarters and outside feeding pens. At 210 to 220 lb. average lot weight each lot was individually weighed off the trials.

The four experimental treatments in all trials were:

Treatments	I	Low protein (12%)
	II	High protein (16%)
	III	Low protein (12%) + 4 gm. L-lysine per gal. of water
	IV	High protein (16%) + 4 gm. L-lysine per gal. of water

A total of 136 animals were used in this experiment. Sex differences were eliminated by randomly allotting equal numbers of barrows and gilts to each treatment.

Results

Trial 1

In trial 1, the addition of 4 gm. of lysine per gallon of water improved the average daily gain of the pigs fed the low protein rations by 20% and improved the feed efficiency by 19%. The difference in average daily gain developed early in the trial and was maintained throughout the feeding period. The rate of gain of the pigs fed the low protein ration and lysine in the drinking water was slightly less than the gain of those pigs fed the high protein rations with or without lysine supplementation. Feed efficiency, however, was similar to that of the pigs fed the high protein ration with lysine in the water.

Table 1. Composition of Rations, Lb.

Feeding period	Start to finish	Start to finish
Crude protein, %	16	12
Shelled corn, lb.	1590	1780
Soybean meal, 50%, lb.	350	160
Dicalcium phosphate, lb.	34	36
Limestone, lb.	12	6
Trace mineral salt, lb.	10	10
Vitamin-antibiotic premix[a]	2.5	2.5

[a] Provided 1135 I.U. vitamin A, 340 I.U. vitamin D, 4 mg. riboflavin, 8 mg. calcium pantothenate, 16 mg. niacin, 20 mg. choline chloride, 10 mcg. vitamin B_{12} and 1.13 gm. SP-250 per pound of ration.

The addition of lysine to the water of the high protein lots (16% C.P.) did not have the same effect. There was no difference in over-all average daily gain, but the pigs receiving the lysine addition to the water did show an increase in average daily gain during the early part of the trial when the animals' protein requirements would be slightly higher.

Lysine in the water appeared to have some effect on feed consumption and feed utilization when the protein content of the feed was held below the normal recommended requirement levels. The pigs supplied the lower protein ration with lysine in the water required 77 lb. less feed per 100 lb. gain than pigs fed the same ration without lysine in the water.

Table 2. Results of Lysine in Water, Trial 1

	High protein		Low protein	
	No lysine	Lysine	No lysine	Lysine
Number of pigs	8	8	8	8
Av. initial wt., lb.	66.3	64.9	65.4	65.8
Av. final wt., lb.	214.5	217.5	210.2	213.1
Av. daily gain, lb.	2.00	2.06	1.57	1.89
Av. daily feed, lb.	6.00	6.66	6.24	6.02
Av. daily water, gal.	1.39	1.26	1.18	1.40
Av. feed per lb. gain, lb.	3.00	3.23	3.96	3.19
Total lysine, gm.	---	2,984	---	3,500

Trial 2

The pigs used in trial 2 were heavier at the beginning of the trial than those in trial 1 (approximately 89 lb. vs. 66 lb.). Lysine addition to the water did not improve the average daily gain or the feed efficiency of either the low or the high protein groups. In this trial the low protein lot with added lysine had a slower rate of gain and higher feed requirement than did the control lot due to two pigs that did not grow at a normal rate. There was not any difference in the average daily gain between treatments at the high protein level.

These results indicate that the response to lysine is expressed at a younger age and lighter weight when pigs are fed rations of the type used here.

Table 3. Results of Lysine in Water, Trial 2

	High protein		Low protein	
	No lysine	Lysine	No lysine	Lysine
Number of pigs	8	8	8	8
Av. initial wt., lb.	87.8	89.8	89.0	88.9
Av. final wt., lb.	210.0	211.6	213.8	214.6
Av. daily gain, lb.	1.94	1.93	2.01	1.72
Av. daily feed, lb.	6.35	6.04	6.44	6.11
Av. daily water, gal.	1.46	1.51	1.43	1.18
Av. feed per lb. gain, lb.	3.28	3.12	3.20	3.55
Total lysine, gm.	---	3,048	---	2,752

Trial 3

In trial 3 lysine addition to the water did not significantly improve the average daily gain of the pigs fed the high protein ration. However, pigs receiving lysine in water and the low protein feed gained 8% faster than those fed the low protein feed without lysine. It should be noted that all four groups gained at a very rapid rate (1.99 to 2.24 lb. per day).

Pigs fed the high protein ration with lysine in water required 34 lb. less feed per 100 lb. of gain than did those without the lysine. Feed efficiency was improved 5.4 and 10.2% when pigs received lysine and the low and high protein rations, respectively.

Table 4. Results of Lysine in Water, Trial 3

	High protein		Low protein	
	No lysine	Lysine	No lysine	Lysine
Number of pigs	6	6	6	6
Av. initial wt., lb.	66.5	66.0	66.7	66.5
Av. final wt., lb.	221.8	220.5	220.2	220.3
Av. daily gain, lb.	2.19	2.24	1.99	2.17
Av. daily feed, lb.	7.29	6.70	6.97	7.18
Av. daily water, gal.	1.62	1.23	1.29	1.20
Av. feed per lb. gain, lb.	3.33	2.99	3.50	3.31
Total lysine, gm.	---	2,032	---	2,040

Trial 4

The pigs used in trial 4 were approximately the same weight as those used in trials 1 and 3. This trial was set up as two experiments, one experiment at each protein level. Therefore, all comparisons should be made within the protein groups and not between them.

The addition of lysine to the water did not improve the average daily gain or feed efficiency of pigs fed the high protein ration. Pigs fed the low protein ration and lysine in the water gained approximately 7.2% (average of both replicates) faster than those that did not receive lysine in water. Feed efficiency was improved approximately 9% in both replicates receiving the lysine water.

Table 5. Results of Lysine in Water, Trial 4

	No lysine		Lysine	
	Rep I	Rep II	Rep I	Rep II
	High Protein			
Number of pigs	6	6	6	6
Av. initial wt., lb.	64.17	66.17	64.17	63.67
Av. final wt., lb.	202.67	202.00	200.83	199.53
Av. daily gain, lb.	1.90	1.86	1.77	1.86
Av. daily feed, lb.	5.95	5.95	5.49	6.04
Av. daily water, gal.	1.43	1.37	1.26	1.51
Av. feed per lb. gain, lb.	3.14	3.20	3.09	3.25
Total lysine, gm.	---	---	2,324	2,644
	Low Protein			
Number of pigs	6	6	6	6
Av. initial wt., lb.	54.00	54.83	53.50	54.50
Av. final wt., lb.	200.60	202.83	199.30	205.00
Av. daily gain, lb.	1.61	1.57	1.68	1.73
Av. daily feed, lb.	5.38	5.58	5.09	5.53
Av. daily water, gal.	1.02	1.01	0.96	1.15
Av. feed per lb. gain, lb.	3.33	3.55	3.04	3.20
Total lysine, gm.	---	---	2,000	2.396

Summary

The results of these trials indicate that a 16% protein corn-soybean meal ration is not improved by the addition of 4 gm. of lysine per gallon of drinking water.

The results of these trials indicate that the performance of pigs weighing 60 lb. or more is not improved by adding lysine to the drinking water when they are fed a 16% protein corn-soybean meal ration. However, pigs weighing from 53 to 66 lb. when started on experiment did gain faster and more efficiently when they received 4 gm. of lysine per gallon of water along with a 12% corn-soybean meal ration. In most cases pigs fed the lower protein ration plus lysine performed equal to those fed the higher protein ration. Pigs weighing 89 lb. initially did not respond to lysine on the 12% protein ration indicating that amino acid requirements do decrease with age and weight of the pigs.

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Agricultural Experiment Station
A. S. Series 67-29

FISH SOLUBLES IN RATIONS FOR EARLY WEANED PIGS

L. M. Anderson, R. W. Seerley and R. C. Wahlstrom

This experiment was a continuation of a project covering several aspects of the nutrition of young pigs. The results of previous work reported at the 1966 Swine Field Day (A.S. Series 66-21) showed that a simple corn-soybean meal fortified ration was equal to a more complex diet that also contained rolled oats, dried skimmilk and sugar. Therefore, the current experiment was designed to compare a basal corn-soybean meal type ration with a similar ration containing 3% fish solubles. Fish solubles are a good source of high quality protein and also may contain an unidentified growth factor(s). The experiment was designed to study the effect of fish solubles on palatability of the ration as well as its effect on growth and feed conversion.

Experimental Procedure

Three trials were conducted to compare the two rations when fed separately and simultaneously to pigs weaned at 3 weeks of age and fed for 6 weeks. The treatments were:

Lot 1 - S-2 ration (corn-soybean meal)
Lot 2 - S-3 ration (corn-soybean meal + 3% fish solubles)
Lot 3 - S-2 and S-3 rations simultaneously in separate feeders

The composition of the rations is shown in table 1. In trial 1 all of the pigs remained inside during the entire period. In the second and third trials, which were conducted simultaneously, the pigs were allowed to go outside on adjacent concrete floored pens. Water and feed were provided *ad libitum*. In an effort to keep the feed fresh, small amounts of ground feed were placed in the feeders frequently. Pigs were weighed weekly and weekly feed consumption data were collected.

Table 1. Composition of Rations

	S-2	S-3
Gr. shelled corn	690	685
Soybean meal (50%)	275	250
Fish solubles	--	30
Dicalcium phosphate	20	20
Limestone	6	6
T. M. salt	5	5
Trace mineral	0.5	0.5
Vitamin-antibiotic premix[a]	+	+

[a] Premix provided 1135 I.U. vitamin A, 340 I.U. vitamin D, 4 mg. riboflavin, 8 mg. pantothenic acid, 16 mg. niacin, 20 mg. choline, 10 mcg. vitamin B_{12}, 40 mg. chlortetracycline, 4.0 mg. sulfamethazine and 20 mg. penicillin per lb. of ration.

Results

Results of the experiment are reported in tables 2 and 3. Because of the excessive feed wastage in trial 1 the results of this trial are discussed separately.

In trial 1, pigs fed the ration containing fish solubles gained about 6% faster than those fed the corn-soybean meal ration while those pigs having access to both rations gained approximately 20% faster than the corn-soybean meal group and 13% faster than the pigs fed the fish solubles ration. It would appear that the difference in daily gains might be due to increased feed consumption even though there was excessive feed wastage in these pens.

Feed conversion was considerably better for the pigs fed the corn-soybean meal ration. However, the feed efficiency of the other two lots was not an accurate figure because of the feed wastage.

In trials 2 and 3 all lots of pigs gained very similarly except for those pigs fed the two rations simultaneously in trial 3. This lot of pigs gained only 0.81 lb. per day compared to 0.97 to 1.03 lb. for the other five lots. This group of pigs appeared to have more trouble adjusting to the weaning stress.

Feed consumption and feed efficiency were more variable between trials. In trial 2 pigs fed the corn-soybean meal ration consumed less feed but were more efficient in feed conversion than those pigs fed the fish meal ration while in trial 3 the reverse was true with more of the corn-soybean meal ration being consumed than the ration with fish solubles and feed efficiency favored those pigs fed the fish solubles. In both trials the rations fed simultaneously were consumed in greater quantities than when either was fed alone. Pigs fed both rations also had the highest feed requirement of all lots in both trials.

Table 2. Results of Fish Solubles in Creep Ration (Trial 1)

	S-2 Corn-soybean meal	S-3 Corn-soy-fish solubles	S-2 and S-3 simultaneously
Number of pigs	6	6	6
Av. initial wt., lb.	12.8	12.9	12.8
Av. final wt., lb.	48.8	51.0	56.2
Av. daily gain, lb.	0.86	0.91	1.03
Av. daily feed, lb.	1.60	2.22	2.72
Av. feed per lb. gain, lb.	1.87	2.45	2.63

Table 3. Effect of Fish Solubles in Creep Ration (Trials 2 and 3)

	Trial	S-2 Corn-soy	S-3 Fish sol.	S-2 and S-3 simultaneously
Number of pigs	2	6	6	6
	3	6	6	5
Av. initial wt., lb.	2	17.3	17.2	17.0
	3	15.3	15.0	16.2
Av. final wt., lb.	2	59.5	58.0	60.2
	3	56.3	56.7	50.2
Av. daily gain, lb.	2	1.00	0.97	1.03
	3	0.98	0.99	0.81
	Av.	0.99	0.98	0.93
Av. daily feed, lb.	2	1.85	1.94	2.29
	3	2.02	1.72	2.03
	Av.	1.93	1.83	2.18
Av. feed per lb. gain, lb.	2	1.84	1.99	2.23
	3	2.06	1.74	2.50
	Av.	1.95	1.86	2.34

Another aspect of this study was the performance of the pigs for one feed over another feed when both were fed simultaneously. Figure 1 shows the consumption pattern for the 6 week period. As can be seen from the graph the pigs seemed to prefer the ration containing fish solubles until about the fourth week and then showed a sharp reduction in this preference. The corn-soybean meal ration was not really consumed to any great extent until between the fourth and fifth weeks. However, there seemed to be a sharp increase in their preference for this ration as the pigs grew older. This might suggest that the pigs might prefer a change of ration after about four weeks. These trials indicate that a ration that is preferred when offered simultaneously with other rations may not be consumed in greater amounts when each ration is fed alone.

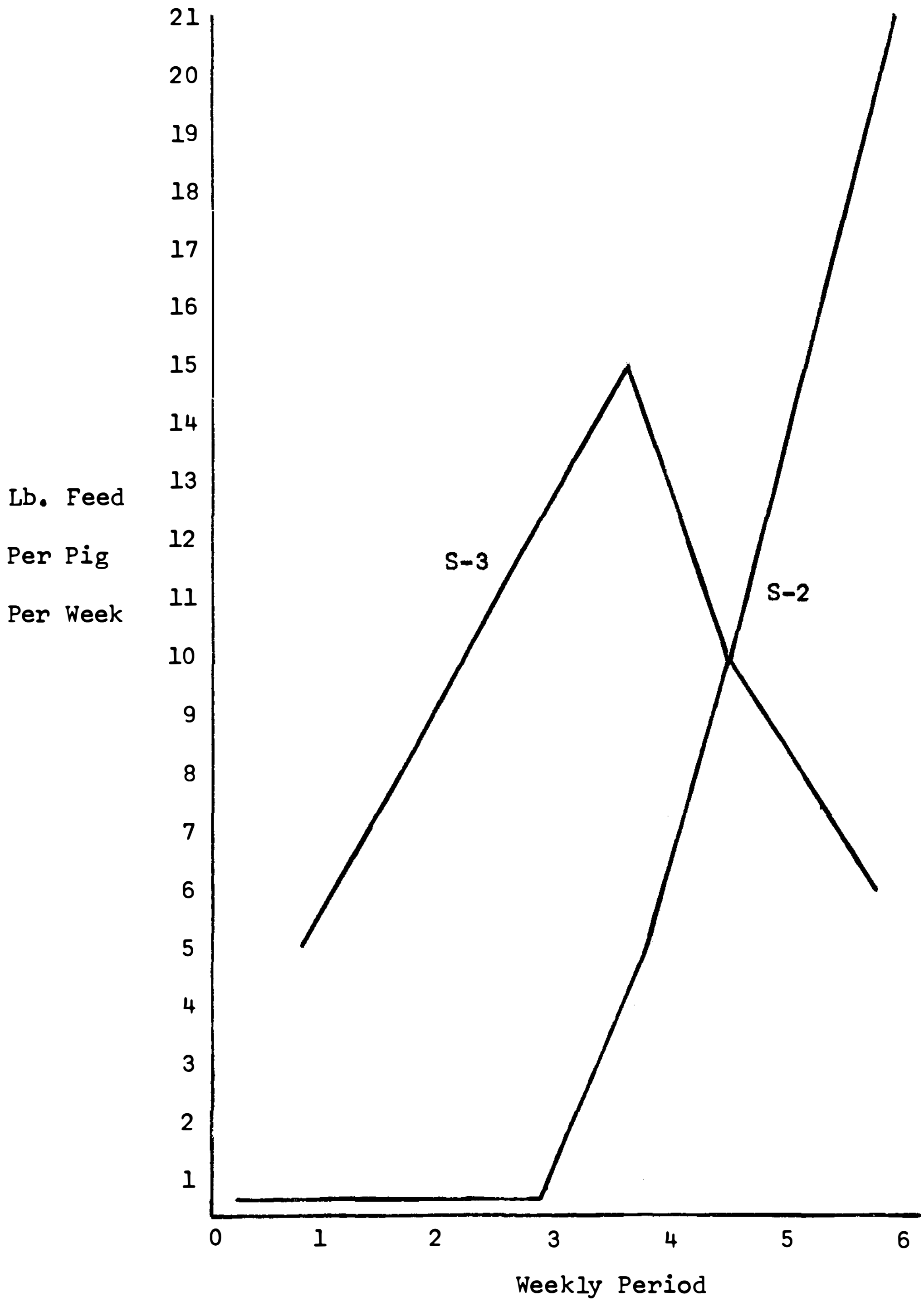

Figure 1. Average feed consumption by pigs fed both rations simultaneously.

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Brookings, South Dakota
Department of Animal Science
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A. S. Series 67-30

DEHYDRATED ALFALFA MEAL IN GROWING-FINISHING SWINE RATIONS

L. M. Anderson, R. W. Seerley and R. C. Wahlstrom

It has been suggested by many investigations that certain ingredients contain unidentified growth factors of benefit to the growing pig. One of the ingredients that has been suggested as a source of unidentified growth factors is alfalfa meal.

This trial was part of a larger experiment participated in by several states in the North Central region. The objectives were to determine the effects of low levels of dehydrated alfalfa meal in a corn-soybean meal type ration fed to growing-finishing swine.

Experimental Procedure

Thirty-six Hampshire-Yorkshire crossbred pigs approximately 50 lb. in weight were randomly allotted into six lots of six pigs each. Equal numbers of barrows and gilts were in each lot. The three experimental treatments were:

1 - Corn-soybean meal basal
2 - Basal plus 2.5% dehydrated alfalfa meal
3 - Basal plus 5% dehydrated alfalfa meal

The composition of the rations fed is shown in table 1. The pigs were self-fed and water was provided *ad libitum* in 80 gallon tank-type waterers. Feed consumption was recorded. The pigs were fed on concrete with adjoining houses.

Table 1. Composition of Rations

Ingredient[a]	Basal (S-15)	2.5% alfalfa (S-16)	5.0% alfalfa (S-17)
Shelled corn	824.0	807.0	790.0
Dehydrated alfalfa meal[b]	--	25.0	50.0
Soybean meal (50%)	150.0	143.0	136.0
Dicalcium phosphate	8.5	8.5	8.5
Limestone	7.5	6.5	5.5
Trace mineral salt	5.0	5.0	5.0
Vitamin-antibiotic premix	5.0	5.0	5.0
Total	1000.0	1000.0	1000.0

[a] Thirty-five milligrams of zinc oxide were added to each lb. of ration.
[b] Guaranteed analyses were crude protein, minimum of 17%, crude fat, minimum of 3%, and crude fiber, maximum of 27%.

Results

Results of the experiment are shown in table 2. Although there were no real differences in performance when analyzed by statistical procedures, the following trends were observed. Pigs fed the corn-soybean meal basal ration and those fed 5% alfalfa gained 10.0 and 3.3% faster, respectively, than pigs fed 2.5% added alfalfa. The pigs fed 2.5% alfalfa meal in the first replicate did not gain as well as the other pigs in this experiment and account for the lowered average gain of this treatment. In replicate two they gained essentially as fast as those on the control ration. The slower gains of the pigs fed the 2.5% level of alfalfa appeared to be due to a lower feed intake by this group. In previous work at this station this trend had not been noted as pigs will generally compensate for a lower energy ration by eating more of the ration. The feed efficiency was slightly better when pigs were fed the corn-soybean meal ration. Efficiency of the corn-soybean ration was 2% and 5.2% better than the rations containing 2.5 and 5% added alfalfa meal, respectively.

These results are essentially in agreement with our previous work which indicated no consistent effect in rate of gain when alfalfa meal was included in rations at these levels. Levels of 5% or more do lower feed efficiency because of the higher fiber content and lower energy intake.

Table 2. Results of Feeding Dehydrated Alfalfa Meal to Growing Swine

	Replicate	Basal	2.5% alfalfa	5.0% alfalfa
Number of pigs	1	6	6	6
	2	6	6	6
Av. initial wt., lb.	1	51.2	50.5	50.5
	2	48.7	50.0	49.3
Av. final wt., lb.	1	203.7	200.5	201.7
	2	200.8	201.0	207.3
Av. daily gain, lb.	1	1.98	1.67	1.82
	2	1.98	1.96	1.90
	Av.	1.98	1.80	1.86
Av. daily feed, lb.	1	5.64	4.96	5.40
	2	5.82	5.77	5.96
	Av.	5.73	5.33	5.68
Feed per lb. gain, lb.	1	2.85	2.98	2.96
	2	2.94	2.94	3.13
	Av.	2.90	2.96	3.05

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Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-31

ADAPTATION OF ULTRASONICS IN THE SELECTION PROGRAM

L. M. Anderson, L. J. Kortan and R. C. Wahlstrom

A useful selection tool available to swine producers in recent years has been the ultrasonic animal tester, more commonly called the Sonoray. Increasing numbers of swine producers across the nation have adapted the sonoray to their selection programs in an attempt to more accurately evaluate breeding herd replacements. This report is intended to demonstrate ways that a South Dakota swine producer could use the sonoray in a selection program for total herd improvement.

The use of the sonoray could aid the purebred producer in three ways. Number one, the sonoray could be used to select the best gilts after a preliminary selection has been made. Secondly, the information is an aid to prospective breeding stock customers. Third, the producer could utilize ultrasonic information when selecting herd sire replacements.

The examples presented in this article are taken from actual data that were collected during the period September 1, 1966, to September 7, 1967, in the South Dakota State University swine herds as well as in swine producers' herds throughout the state. Table 1 reports the data from 203 gilts and 65 boars in 10 sonoray groups. Reported are the sonorayed loin eye area average for all animals sonorayed in the group as well as dividing each group into above and below average groups and computing the appropriate loin eye area averages. These divisions were made to point out the differences that may exist within a herd. Selection differentials between the divisions can be calculated using the appropriate group averages.

Selection by ultrasonics should be an additional tool rather than a replacement for other commonly used selection traits such as rate of gain, average backfat, feed efficiency, littermate cut-out and general soundness of the animal. However, after the producer has made a preliminary selection, ultrasonics can give an indication of the meatiness of the animal and help to separate those look alike animals. An example of the possible benefit gained by using the sonoray information can be shown by examining sonoray group 2 of table 1. The preliminary selection program left 43 gilts as possible herd replacements. The 43 head averaged 5.28 sq. in. of estimated loin eye area. The 28 gilts above the average had an estimated loin eye area of 5.73 sq. in. or 0.45 sq. in. more than average. The 15 head below the average had loin eye averages of 4.43 sq. in. or 0.85 sq. in. lower than average and 1.30 sq. in. lower than the top 28 gilts. Thus, with a heritability estimate of 0.5, the top 28 should contribute 0.225 sq. in. increase while the average of the 15 on the lower end would tend to contribute a 0.425 decrease in loin eye area from the current year's average or nearly 0.60 sq. in. decrease from the average of the top 28 gilts.

The second use of the ultrasonic method is that of providing additional information for prospective breeding stock buyers. This information could be collected at the same time as the sonoray work for selection purposes and thus

Table 1. Summary Results of Ten Sonorayed Groups

Group number	Number of animals	Sex	Group average LEA[a,b]	Above average LEA[c]	Below average LEA[d]	High LEA	Low LEA
1	42	G	4.78	5.17	4.40	5.82	3.80
2	43	G	5.28	5.73	4.43	6.42	3.10
3	14	G	4.83	5.13	4.43	5.80	4.11
4	11	G	5.66	6.11	5.29	6.60	5.00
5	10	G	4.77	5.03	4.39	5.40	4.16
5	21	B	5.08	5.43	4.81	5.87	4.16
6	23	G	4.93	5.19	4.65	5.47	4.10
6	27	B	4.74	4.94	4.49	5.36	3.72
7	13	G	5.41	5.80	5.08	6.50	4.50
7	7	B	5.45	5.55	5.32	5.67	5.20
8	10	B	4.44	4.57	4.24	4.76	4.00
9	10	G	4.92	5.23	4.72	5.50	4.51
10	37	G	4.82	5.20	4.38	6.25	3.90

[a] LEA is the abbreviation for Loin Eye Area.
[b] Group average LEA is the average of all animals sonorayed in the group.
[c] Above average LEA is the average LEA of those animals which were higher than the group average.
[d] Below average LEA is the average LEA of those animals which were lower than their group average.

Selection differentials between the groups can be computed by finding the difference between the groups.
The high LEA and low LEA determine the range in the herd and help to demonstrate the within herd variation.

would result in minimum additional expense, labor and time. This extra effort on the part of the producer has been well spent as many of the customers are willing to pay a little more if they can be reasonably sure that they are purchasing a meatier animal.

The third use is that of using the information when adding replacements to the sonorayed herd. There would be little justification for the producer who owned herd number 2 to select out the gilts with the potential to increase the meatiness of his herd and then randomly buy a boar with no information. A more logical choice would be to make the selection from the top end of group 5's boars. For example, if the selected boar had an average loin eye area of 5.87 sq. in. as opposed to the boar group average of 5.08 or a selection differential of 0.79 sq. in., an expected 0.395 sq. in. increase could be passed on to the offspring by this sire. The results of mating the above boar with the top gilts from group 2 are summarized in table 2.

Since boars and gilts each contribute one-half of the inheritance of their pigs, then the total expected progress is Average Selection Differential of 0.61 multiplied by the heritability estimate of 50% or an expected increase of 0.31 sq. in. of loin eye area. This would tend to be a fairly substantial increase and justification for the extra selection effort.

Table 2. Expected Progress

Trait: Loin Eye Area	
Boar group average	5.08 sq. in.
Selected boar average	5.87 sq. in.
Gilt group average	5.28 sq. in.
Selected gilts average	5.73 sq. in.
Boar Selection Differential	0.79 sq. in.
Gilt Selection Differential	0.45 sq. in.
Average Selection Differential	0.61 sq. in.

In conclusion, the following are considered as summary recommendations for use of the sonoray in a selection program.

1. The sonoray is not a replacement for the good production selection traits commonly used but is an additional aid.

2. Select out the top end of the herd at 180 to 220 lb. or at 4 1/2 to 5 1/2 months of age.

3. Sonoray the selected group and make final selections using these results as a guide.

4. Provide information for potential customers.

5. Use ultrasonic information when purchasing replacements if the high frequency sound information is available.

6. Primarily a tool which has the greatest use in the purebred seedstock producer's herd.

Note: Inquiries regarding sonoray work should be directed to L. J. Kortan, Extension Livestock Specialist, South Dakota State University, Brookings, South Dakota.

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-32

THE INFLUENCE OF ALFALFA COUMESTROL ON THE REPRODUCTIVE PERFORMANCE OF GILTS

R. H. Anderson, D. R. Shelby, R. W. Seerley and G. M. Loper

In Australia during the early 1940's, a syndrome known as "clover disease" was observed in sheep grazing subterranean clover. This syndrome was characterized by a marked reduction in fertility which was later proved to be due to a high content of estrogenic substances in the clover. Alfalfa has since been shown to contain varying levels of these plant estrogens. The most important of the plant estrogens present in alfalfa is coumestrol because of its relatively greater biological potency than the other plant estrogens and because of its more frequent occurrence. Plant physiologists have shown that alfalfa infected with certain fungus diseases contains a level of coumestrol which increases with the amount of disease present in the alfalfa plants.

Since alfalfa meal is such an important source of nutrients for farm animals and is often included in swine rations, this study was conducted to determine if alfalfa plants with coumestrol levels in excess of 100 parts per million (ppm) would have any effect on the reproductive performance of gilts when included in their ration.

Experimental Procedure

Forages are the only available source of coumestrol, because it cannot be produced commercially at the present time. This made it necessary to locate alfalfa hay with a high level of coumestrol for use in this study. A field of alfalfa infested with a fungus disease was examined and samples taken from the field showed the coumestrol content to be in excess of 500 ppm. Hay from this field was obtained and stored for use in compounding the high coumestrol ration. Although the preharvesting samples indicated that the hay obtained would be quite high in coumestrol, the amount actually measured in the hay and feed during the experiment were much lower than had been anticipated. Therefore, it was necessary to carry out this study with a lower level of coumestrol in the high coumestrol ration than had been originally planned.

The composition of the two rations used in this experiment is shown in table 1. The only difference between the two rations was that the control ration contained a commercial source of dehydrated alfalfa meal while the high coumestrol ration contained alfalfa hay which had been pelleted and ground before mixing with the rest of the ration. Since the coumestrol content of the hay varied somewhat from bale to bale, it was impossible to hold the coumestrol content of each batch of ration at a constant level. The level of coumestrol fed to the high coumestrol group during the prebreeding period was 37.5 ppm. During the breeding and postbreeding periods, the coumestrol level fed to this group varied from 27.8 to 32.3 ppm. The level of coumestrol in the ration of the control gilts varied from 9.4 to 14.6 ppm during the experiment.

Table 1. Composition of the Rations[a]

Ingredient	Pounds of Ingredient	
	High coumestrol	Control
Ground yellow corn	620	620
Ground oats	640	640
Dehydrated alfalfa meal[b]	--	600
Pelleted and ground alfalfa hay[c]	600	--
Soybean meal (44%)	70	70
Meat and bone scraps	20	20
Dicalcium phosphate	20	20
Trace mineral salt	10	10
Vitamin-antibiotic premix[d]	20	20

[a] Chemical analysis showed the rations contained 13.5% crude protein.
[b] Chemical analysis of the four batches of ration showed the coumestrol content to be 9.8, 10.7, 9.4 and 14.6 ppm, respectively.
[c] Chemical analysis of the four batches of ration showed the coumestrol content to be 37.5, 27.9, 27.8 and 32.3 ppm, respectively.
[d] The premix provided 2000 U.S.P. units vitamin A, 4 mcg. vitamin B_{12}, 5 mg. choline, 4.5 mg. niacin, 2 mg. pantothenic acid, 1 mg. riboflavin, 250 U.S.P. units vitamin D_3 and 5 mg. chlortetracycline per pound of ration.

In the fall of 1966, 44 six month old Yorkshire gilts from 16 litters were allotted at random within litters to the two treatment groups. During the first five weeks of the experiment, all gilts were self-fed the control ration and were checked daily for signs of estrus. Two gilts in each group failed to show estrus and were discarded from the experiment leaving 20 gilts in each treatment group. Beginning the sixth week of the experiment and continuing through the twentieth week, the control group was self-fed the control ration and the high coumestrol group was self-fed the high coumestrol ration. The gilts were checked for estrus each day and breeding was begun on November 16 after the gilts had been on the treatment rations for five weeks.

Six Yorkshire boars were allotted at random to breed the 40 gilts in pairs of two so that a boar bred one gilt from the control group and her littermate from the treatment group. The gilts were bred on the second day of estrus and only received one service per estrus. If the gilts returned to estrus 21 days after mating, they were rebred to the same boar. If the gilts did not return to estrus by 25 days after mating, they were sent to slaughter and their reproductive tracts were recovered for further examination. The experiment was terminated ten weeks after breeding began. At that time, all remaining gilts were slaughtered and their reproductive tracts recovered. The reproductive tracts of all gilts were examined closely for abnormalities, and the number of corpora lutea and normal embryos present in each gilt were recorded.

Results

All gilts continued to exhibit normal estrous cycles during the course of the experiment. There was no effect of treatment on the regularity or length of the estrous cycle of any of the gilts. No noticeable difference was observed between treatment groups in the mating behavior of the gilts.

A summary of the reproductive performance of the gilts is shown in table 2. None of the differences between treatment groups were statistically significant. However, it was observed that the gilts on the high coumestrol diet required more services per conception and ovulated more eggs than the control gilts. On the other hand, the control gilts had more embryos implanted in their uterine cornua than did the gilts on the high coumestrol diet.

Table 2. Summary of the Reproductive Performance of the Gilts[a]

	High coumestrol	Control
Number of gilts	20	20
Number open[b]	4	3
Number pregnant	16	17
Average number of services per pregnant gilt	1.31	1.11
Average number of corpora lutea	15.38[c]	14.00
Average number of embryos	10.23[c]	11.35

[a] None of the differences between treatment groups were statistically significant.
[b] One open gilt from each group was found to have a structural abnormality of the reproductive tract not associated with treatment which would have prevented conception. The other five open gilts were bred to two boars which were only able to settle three of the eight gilts to which they were mated.
[c] These values are the average of 13 pregnant gilts because the reproductive tracts of three pregnant gilts from the high coumestrol group were lost at the packing plant.

Estrogen in sufficient quantities is known to prevent implantation and interrupt pregnancy. Although the high coumestrol gilts had fewer embryos present than the controls, which is the effect that would be expected, the level of coumestrol used in this study was not high enough to have any significant detrimental effects on the reproductive performance of the gilts.

Summary

Under the conditions of this study, a level of coumestrol in the feed of up to 37.5 ppm did not significantly affect the reproductive performance of Yorkshire gilts.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station A. S. Series 67-33

INFLUENCE OF THE BOAR ON LITTER SIZE

D. R. Shelby

Although the role of the boar in achieving a high conception rate among sows in a herd has long been recognized, the sow has generally been considered to be solely responsible for litter size. Litter size is determined by (1) the number of eggs ovulated, (2) the quality of eggs ovulated as evidenced by the ability of the eggs to be fertilized and develop into normal embryos, (3) the ability of the uterus to provide the proper environment for implantation and the development of normal embryos during pregnancy and (4) the number and quality of sperm received by the female at mating as evidenced by the ability of the sperm to fertilize the eggs and insure normal development of the embryo. The factors which determine litter size may be affected by nutrition, age of animals, temperature, light, hormone balance, disease and various other stresses on the animal.

This study was made to determine if differences in fertility level exist among boars and to determine whether these differences, if they exist, can affect litter size.

Experimental Procedure

During the past year, the reproductive tracts from 91 pregnant crossbred gilts have been recovered at slaughter between the 25th and 32nd day of pregnancy. These tracts were examined and the number of corpora lutea and normal embryos present in each tract were counted and recorded. Since one corpus luteum normally grows in to fill up the empty antrum of a follicle after ovulation, the assumption was made that each corpus luteum observed represented the ovulation of one egg from a mature follicle. It was assumed that the gilts used in this study were of equal fertility, because only pregnant gilts were examined and there were no significant differences among gilts in the number of ova shed.

These 91 crossbred gilts, along with several other gilts, had been bred at random to nine Yorkshire boars by natural service. No attempt was made to mate an equal number of gilts to each boar. Three of the boars were not retained in the herd very long, so there were fewer litters by these boars. The gilts were self-fed a bulky ration containing 30% dehydrated alfalfa meal and 13% crude protein during the prebreeding and postbreeding periods. The boars were hand-fed 5 lb. of the same ration daily.

There were no significant effects of season on litter size; therefore, the data were pooled over seasons and analyzed by Chi-square.

Results and Discussion

The results of this study are shown in table 1. There were significant differences ($P<.01$) among boar groups in the percent of ovulated eggs which were present as embryos after 25 days of pregnancy and in the number of embryos present. The average number of embryos per gilt was used as an indication of litter size.

Table 1. Influence of the Boar on Litter Size

Boar	Number of gilts	Eggs ovulated	Embryos present	% eggs present as embryos[a]	Mean number of embryos per gilt[a]
267	18	278	235	84.5	13.1
507	15	248	152	61.2	10.1
333	14	204	144	70.5	10.3
714	11	182	120	65.9	10.9
442	10	161	93	57.7	9.3
487	9	151	85	56.3	9.4
268	5	77	55	71.4	11.0
504	5	68	52	76.4	10.4
718	4	66	55	83.3	13.8
Total	91	1435	991	69.1	10.9

[a] The differences among boar groups in percent eggs present as embryos and in mean number of embryos per gilt were significant at $P < .01$.

Although the major source of variation in litter size comes from the sow, the boar can affect litter size. Sperm must be capable of fertilizing an ovum and they must contribute genetic material to the egg at fertilization to insure the development of a normal embryo. A loss of either of these functions from the sperm will result in a reduced number of embryos implanting in the uterus and, therefore, will result in a reduction in litter size. Although this study was not designed to separate the effects of these two functions of the sperm, it is apparent that variability in the completion of these functions exists among boars which can affect litter size.

Summary

The results of this study indicate that boar differences in fertility level do exist, and therefore the boar can have a significant influence on litter size.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-34

RELATIVE OVULATION FREQUENCY IN THE RIGHT AND LEFT OVARY OF THE SOW

D. R. Shelby

The reproductive tracts of 115 sows were examined to determine if one ovary was more active than the other in the production of ova. The ovaries of these sows appeared to be functioning normally. An average of 8.58 corpora lutea were found in the left ovaries compared with an average of 7.57 corpora lutea in the right ovaries. Statistical analysis using the t-test showed these differences to be significant ($P < .01$). The left ovary of these sows was the more active and was responsible for ovulating 53.2% of the eggs ovulated by these sows at their last estrus prior to slaughter.

Seventy-five of the sow tracts examined were found to be pregnant and the number of embryos present in the uterine horns were counted and recorded. Although the left horn averaged slightly more embryos than the right (5.49 vs. 5.41), the differences in the number of embryos in the two horns were not statistically significant. This indicates that although significantly more eggs may be produced in the left ovary than in the right, these eggs, when fertilized, migrate between horns prior to implantation until there is an equal distribution of embryos between the horns.

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Agricultural Experiment Station A. S. Series 67-35

EFFECT OF RESTRICTED FEEDING ON GRAVID SOWS

C. S. German, R. W. Seerley and R. C. Wahlstrom

In recent years the restriction of the feed intake of pregnant gilts and sows has become an accepted management practice. However, no one has yet determined the proper feeding levels for given phases of the gestation period.

This report is a continuation of a study to compare two feeding plans using the same ration for both plans. The total feed consumed was the same for both groups of sows.

Experimental Procedure

For trial 1, eight Hampshire and eight Yorkshire gilts were randomly allotted into two groups. Four of each breed were in each group and most were paired littermates.

In the second trial, twelve Hampshire and ten Duroc sows were randomly allotted to two equal groups. Six Hampshire and five Duroc sows were assigned to each treatment. Most of the sows were paired littermates.

The sows were housed on brome pasture lots and fed in individual stalls to control feed intake. Both lots were fed the ration shown in table 1. The feeding plan for the two lots is given in table 2. Each sow in each group consumed approximately 505 pounds of feed. The sows were fed once daily and water was supplied in automatic fountains.

Table 1. Composition of Ration

Ingredient	Percent
Gr. yellow shelled corn	65.5
Gr. oats	10.0
Dehydrated alfalfa meal (17%)	10.0
Soybean meal (44%)	12.0
Dicalcium phosphate	1.8
Trace mineralized salt	0.5
Vitamin-antibiotic premix[a]	0.2

[a] Added 2270 U.S.P. units of vitamin A, 224 I.C. units of vitamin D, 4 mg. of riboflavin, 8 mg. of pantothenic acid, 18 mg. of niacin, 20 mg. of choline chloride, 6.6 mcg. of vitamin B_{12} and 5 mg. of chlortetracycline per pound of ration.

The sows were weighed at the start of breeding, on the 110th day of pregnancy, 1 to 2 days after farrowing and after 3 weeks lactation. The 70 day weight taken in trial 1 was dropped in trial 2.

The pigs were weighed at birth and at 3 weeks of age at weaning. At birth the pigs were given a strength score based on the vigor and activity of the pig. Birth weight was not related to the strength score. The value ranged from 1 to 5, weak to strong, respectively. The pigs were given 1 cc. of iron dextran intramuscularly at 3 days of age.

Table 2. Levels of Feeding Prior To, During, and After Gestation

Feeding scheme	Lot 1 Lb./day	Lot 2 Lb./day
Prebreeding	4.0	4.0
2 weeks before to 1 week after breeding (3 weeks)	5.0	5.0
To 70 days pregnancy	4.0	3.0
To 93 days pregnancy	5.0	4.0
To term	5.0	9.0
Lactation	Full-fed	Full-fed

Results and Discussion

In trial 1 three sows in each group failed to provide complete data. They either aborted or farrowed very weak pigs. Four of these six sows were littermates and were bred to a related boar. None of the other Hampshire sows in the herd aborted or farrowed weak pigs. Therefore, a genetic relationship was suspected.

In the second farrowing two sows in lot 1 and one sow in lot 2 did not conceive. The other losses were due to death and injury on ice.

The sows in lot 1 were heavier at the start of breeding but the weight gains during gestation were similar for both groups during the first gestation. However, during the second gestation period the sows in lot 1 gained more than sows in lot 2.

There were no significant differences found in the data collected on the pigs. However, during the first farrowing the sows in lot 2 farrowed slightly heavier pigs and the pigs were stronger at birth. At weaning the sows in lot 2 had slightly heavier pigs, but the sows in lot 1 had more pigs at 3 weeks.

During the second farrowing the birth weights and strength scores were similar. The trends in pigs weights and litter size were the same as the first farrowing.

Table 3. Results of the Two Pregnancy-Lactation Periods, Trial 1

	First pregnancy		Second pregnancy	
	Lot 1	Lot 2	Lot 1	Lot 2
No. of sows	8	8	7	8
No. of sows farrowing	5	5	4	6
Wt. at start of breeding, lb.	323	290	418	418
Wt., 70 days later, lb.	374	344	471	452
Wt., 109 day gestation, lb.	405	376	534	500
Wt., 2nd day post farrowing, lb.	356	329	482	455
Wt., 3 weeks post farrowing, lb.	346	316	435	411
Av. no. live pigs per litter	10.60	10.80	10.20	10.66
Av. birth wt., lb.	2.25	2.68	2.94	2.72
Av. strength score	4.05	4.96	4.85	4.93
Av. litter size, 3 weeks	9.20	8.40	9.25	8.66
Av. 3 week wt., lb.	12.1	12.7	14.2	16.0
Av. stillborn and mummified pigs at birth	0	0	0.25	0.83

In the second trial four sows in each group failed to farrow at the first farrowing. Three sows in lot 1 and 1 sow in lot 2 failed to conceive. One sow in lot 1 aborted about 2 months after breeding and three sows in lot 2 died. One dislocated her pelvis, another died of an internal hemorrhage and the third died in the farrowing crate.

The sows in lot 2 gained slightly more weight during gestation, farrowed an average of 1.5 more pigs that were heavier at birth than those from sows in lot 1. This difference in litter size and pig weight was still in evidence at 3 weeks of age.

During the second gestation period the sows in lot 1 gained more than those in lot 2. This was similar to the trend noted in trial 1. Differences in litter size farrowed and pig birth weights were not as great as those noted in the first farrowing. Actually the lot 1 sows farrowed larger litters but the pigs were not quite as heavy as those from sows in lot 2.

Combining data from all sows that farrowed in both trials indicates that sows that were restricted in feed intake to a greater degree during the first three months of gestation and fed more liberally the last three weeks farrowed about 0.5 more pig per litter, pigs were slightly heavier and stronger at birth and also slightly heavier at 3 weeks of age. The differences observed are admittedly small but would suggest that the feeding plan followed for lot 2 sows should be considered.

Table 4. Results of the Two Pregnancy-Lactation Periods, Trial 2

	First pregnancy		Second pregnancy	
	Lot 1	Lot 2	Lot 1	Lot 2
No. of sows	11	11	7	6
No. of sows farrowing	7	7	4	5
Wt. at start of breeding, lb.	301	291	439	460
Wt., 110 day gestation, lb.	437	432	551	540
Wt., 1 day post farrowing, lb.	394	405	488	462
Wt., 3 week post farrowing, lb.	351	361	*	*
Av. no. live pigs per litter	7.9	9.4	11.3	10.4
Av. birth wt., lb.	2.7	3.1	3.0	3.2
Av. strength score	4.8	4.8	4.9	4.9
Av. litter size, 3 wk.	7.1	8.0	*	*
Av. 3 week wt., lb.	11.5	12.1	*	*

* 3 week data not available.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-36

REPRODUCTIVE PERFORMANCE OF GILTS AND SOWS FED DAILY, TWICE WEEKLY OR WEEKLY DURING GESTATION

J. W. McCarty and R. W. Seerley

Feed management for gestating gilts and sows and the effect on performance and production costs has been the subject of considerable research in recent years. The object of these studies has been to cut production costs without adversely affecting sow performance in terms of pig numbers and weights at farrowing and weaning.

Bred females have been satisfactorily managed with as little as three pounds of feed per head daily for part of the gestation period. Management which avoids hand feeding by giving sows access to a self-feeder for periods such as every third day has not consistently resulted in important feed savings but has also not been detrimental to sow performance.

The trials reported here were conducted to determine the comparative performance and feed consumption for gilts and sows self-fed or hand-fed daily and self-fed for either one or two 24-hour periods during a week.

Procedure

One set of Duroc and Yorkshire females was used for two successive gestation periods during the winter of 1966-67 and the summer of 1967. In the fall of 1966, 50 Duroc and 57 Yorkshire gilts were assigned in approximately equal numbers to 10 breeding lots. Five Duroc and five Yorkshire boars were used as sires, one boar per lot. These 10 breeding lots were randomly assigned to five gestation treatments, two lots per treatment. The rations used and the treatments are shown in table 1.

Sows were maintained during gestation in dry lots equipped with portable houses, self-feeders and heated water fountains. Feed for sows hand-fed daily was placed in sow feeding stalls, one stall per sow. All other sows ate from self-feeders. Feed restriction to one or two days per week was accomplished by locking the sows away from the self-feeder with portable panels. Hay for sows fed once or twice a week was placed on the ground. Treatments were continued until the 109th day of gestation when the sows were moved into farrowing pens. While in the farrowing house, all sows were fed the bulky ration A (see table 1) for which feed consumption was not recorded. Within a few days after farrowing, sows and spring litters were moved to alfalfa pasture lots in groups of not more than six litters. Fall litters and their dams were placed in dry lots during the growing period. Lactation allotment was made so that sows received the same ration until weaning as had been fed during gestation but sow groupings were not the same as during gestation. All sows had full access to self-feeders during the lactation period. Pigs were weaned by removing sows from growing lots at approximately 35 days.

Table 1. Rations and Treatments For This Study

Lot	1	2	3	4	5
Treatment	Continuous self-fed	Hand-fed 4 lb. per head per day[b]	Self-fed 2-24 hr. periods per week alfalfa hay[c]	No hay	Self-fed 1-24 hr. period per week alfalfa hay[d]
Ration	A	B	C	C	C
Ingredients[a]					
Shelled yellow corn	282.5	850		780	
Oats	300	---		---	
Alfalfa hay	350	---		---	
Soybean oil meal (44%)	50	100		175	
Dicalcium phosphate	10	35		20	
Ground limestone	---	---		10	
Trace mineral salt (high zinc)	5	10		10	
Vitamin-antibiotic premix[e]	2.5	5		5	
Calculated protein, %	13.6	12.2		14.7	

[a] Per 1000 lb. ground mixture.

[b,c,d] Limited amounts of alfalfa hay were provided for these lots as a "pacifier" because of feed being restricted otherwise. Lot 2 received 1/2 lb. per head per day of ground alfalfa hay. Lot 3 was fed two bales per week of loose alfalfa, one bale the second day after access to the self-feeder. Lot 5 was fed one bale on each of the second and fifth days after access to the self-feeder.

[e] Each pound of premix provided .6 gm. of penicillin, 3 gm. of streptomycin, 600,000 U.S.P. units of vitamin A, 60,000 U.S.P. units of vitamin D_2, 400 mg. of riboflavin, 1000 mg. of d-pantothenic acid, 3000 mg. of niacin, 23044 mg. of choline and 3 mg. of vitamin B_{12}.

Sow weights were recorded at the beginning of the trial, on the 109th day of gestation, within a week after farrowing and when pigs were weaned. Pigs were individually ear notched at birth. Records included sex and individual weights at birth and 35 days.

Trial 1 - Gilt Litters

Gestation treatments for first litter gilts began December 19, 1966, following a lot breeding period of 33 days. During the breeding period all gilts were self-fed a bulky ration similar to ration A (see table 1). Self-fed and hand-fed treatments were imposed at the start of the trial and continued as outlined above. All other gilts were placed on restricted feed by a step-wise plan. That is, time off feed was extended an additional day after each day on the self-feeder until achieving the planned treatment. No problems were encountered by this procedure.

Trial 2 - Sow Litters

Gestation treatment for second litters was begun immediately following weaning of first litters without any "flushing" period. Sows were re-allotted into the same groups and mated to the same boars as for the first gestation period. Boars remained in treatment lots for a fifty day breeding period. Facilities and other management were the same as for the first gestation.

Management during farrowing was as described for first litters. As soon as practical after farrowing sows and litters were placed in dry lots (rather than on pasture) until weaning near 35 days of litter age when the sows were removed. Sows were not weighed at weaning so that weight changes during lactation could not therefore be reported.

Results and Discussion

Trial 1

The results of trial 1 are summarized by treatment in table 2. Data for the 2 lots per treatment were pooled since lot differences did not appear important.

Gilts self-fed during gestation farrowed and raised the most pigs and produced the most total pounds of pigs at weaning. These gilts also had the greatest daily feed consumption which was more costly than either hand feeding or weekly feeding. Reproductive performance of gilts on all restricted treatments, while lower than for self-fed gilts, was not unsatisfactory.

Limiting feed to two days per week was not detrimental in terms of productivity. Average daily feed consumption for gilts fed twice a week was only about one pound less per head than for self-fed gilts, and since this higher energy ration was more expensive per unit, total feed costs were greatest for these two treatments. There is no indication that providing loose alfalfa hay was beneficial for gilts fed twice weekly nor was it noticeably helpful with respect to behavior of the gilts for the days away from the self-feeder. Feeding the alfalfa probably added cost rather than providing essential nutrients.

It is interesting that restricting gestating gilts to feed one day per week was necessary to limit feed consumption to the level comparable to daily hand feeding in this trial. Behavior of these gilts was somewhat unexpected since they tended to become less active as the period off feed became longer. They were, of course, restless on days when gilts in nearby lots were fed. Water was available continuously, but consumption decreased as the time off feed increased. These gilts worked over rather thoroughly the area where loose hay was fed. There was a gradual reduction in condition as gestation progressed, so that gilts continued to gain. However, it is clear from table 2 that most of the gain was associated with the developing litter. Condition did not deteriorate to the point that gilts looked dangerously thin. Late in gestation, and after 4 or more days off feed, some gilts were shaky when moving. There were no unusual problems at farrowing and the gilts came to milk satisfactorily.

Gilts hand fed daily were continually restless and hungry such that any activity near their pens caught their attention and brought them to the feeding stalls. They maintained adequate thrifty condition and it was the herdsman's observation that these gilts produced the strongest, most vigorous pigs.

Table 2. Summary of Sow and Pig Performance and Feed Consumption by Treatments, Spring Litters

	Self-fed	Hand fed	Fed twice per week		Fed once per week
			Loose hay	No hay	Loose hay
Gilts allotted	22	23	19	20	23
Gilts farrowing litters[a]	17	16	16	14	16
Pigs per litter					
Farrowed, total	11.6	9.3	8.8	10.9	9.3
Farrowed, alive	10.6	8.5	8.2	9.9	8.5
Weaned (35 days)	8.7	6.4	7.1	7.7	7.3
Av. pig wt.					
Farrowed alive	2.8	3.0	3.0	2.7	2.6
Weaned	18.0	18.2	16.7	17.4	14.4
Av. initial wt. per sow, lb.	328	320	336	331	315
Av. wt. 109 day of gestation, lb.	444	418	430	426	359
Gain on treatment, lb.	116	97	94	96	44
Wt. loss during farrowing, lb.	50	45	42	42	36
Av. wt. at weaning, lb.	339	369	390	387	350
Wt. change during lactation, lb.	-55	- 4	+ 2	+ 2	+27
Feed per head per day during gestation					
Mixed feed only/day of treatment period	7.0	4.0	6.2	5.8	3.5
Alfalfa hay only/day of treatment period	--	0.4	1.1	--	1.3
Mixed feed/day fed	7.0	4.0	20.1	18.7	18.1
Hay only/day fed	--	0.4	3.6	--	6.8
Feed cost/head/day, cents	15.6	12.3	20.9	18.6	12.6
Lactation feed/sow/day, lb.	13.4	11.9		12.5[b]	

[a] Of the 28 gilts which did not farrow, 17 were removed for reasons independent of this trial, 8 did not settle, 2 lost their litters, 1 had an umbilical hernia. There was no indication that there was a treatment effect resulting in these losses.

[b] Sows being fed ration C could not be grouped during lactation as they had been during gestation.

Daily feed costs were least for gilts hand fed daily. Although average daily feed costs were slightly higher for gilts fed once a week than for those hand fed, this treatment appears to be somewhat detrimental to over-all sow and pig performance. Pigs from gilts fed once weekly were lighter at both birth and weaning, and their weaning weights particularly suggest that the dams, while able to farrow reasonably strong pigs, did not have sufficient reserves to milk adequately for the nursing pigs.

Trial 2

Seventy-four of the seventy-nine sows allotted for treatment farrowed second litters. Of the five sows not farrowing again, two did not settle, one was removed because of an udder tumor, and one did not recover from a difficult farrowing of her first litter. Each of these losses occurred on a different treatment and the loss did not appear to be related to the treatment. The fifth sow died 10 days after weaning. She was on the one feeding per week treatment and may have starved. Because of this loss sows on this treatment were fed a total of 6 days rather than 2 days for a two week period, then the once per week feeding was resumed.

Performance and feed data for the second litters are summarized in table 3.

Table 3. Summary of Sow and Pig Performance and Feed Consumption by Treatment, Fall Litters

	Self-fed	Hand fed daily	Fed twice per week: Loose hay	Fed twice per week: No hay	Fed once per week: Loose hay
Sows allotted	17	16	16	14	16
Sows farrowing litters	17	15	15	13	14
Pigs per litter					
Farrowed, total	11.5	10.4	10.4	10.5	10.1
Farrowed, alive	11.1	10.0	9.9	10.0	9.5
Weaned (35 days)	7.6	7.6	6.9	7.4	7.1
Av. pig wt.					
Farrowed alive	3.3	3.4	3.2	3.0	2.9
Weaned	17.2	19.4	18.3	17.5	16.7
Av. initial wt. per sow, lb.	339	369	390	387	350
Av. wt. 109 day, lb.	549	489	516	475	413
Gain during gestation, lb.	210	120	126	88	63
Wt. loss during farrowing, lb.	-54	-43	-45	-41	-35
Feed per head daily during gestation					
Mixed feed per day, lb.	12.9	4.0	7.4	7.0	4.9
Alfalfa hay only, lb.	--	0.5	0.7	--	0.8
Feed cost per head/day, cents	29.0	12.1	22.9	20.8	15.3
Feed cost per head for 114 day gestation	33.06	13.79	26.11	23.71	17.44

Generally, response to the five treatments was similar to that for first litters. Sows self-fed again farrowed the largest litters, while sows on restricted treatments all farrowed more pigs (characteristic of mature sows) than in their first litters. Litter size for second litters was similar to that usually observed for sows. However, fewer pigs were weaned on all treatments because of losses from enteric infections which proved difficult to control.

Pigs from sows fed once per week were lighter at both birth and weaning than were pigs on other treatments. These differences were smaller, however, than were the same comparisons for pigs in spring litters. Sows are apparently better able to adapt to feed restriction of this kind than are gilts.

Large differences were observed among treatments in sow weight gains during gestation. Sows self-fed gained more than three times as much weight as sows fed once per week. Pig performance for all treatments suggests that such weight gains are unnecessary and that important amounts of feed are wasted by self feeding treatments of the kind used in this study.

Sow weight losses during farrowing were comparable to those for their first litters.

Feed consumption differences were more striking for these dams as sows rather than as gilts. Feed consumption and costs for self-fed sows are clearly extravagant considering the small differences in productivity among the treatments. For the entire gestation period it cost $19.27 less per sow for hand feeding than for self feeding. Hand fed sows farrowed fewer pigs than those self-fed but raised equally as many and their pigs were heavier at weaning.

Feeding one day per week did not produce feed savings as great as for hand feeding, and sow and pig performance was also less desirable. Restricting feed in this manner, while effective as compared to self feeding, is somewhat detrimental to performance--although not seriously so--and could lead to inadequate supervision of the sow herd during gestation. Within the limits of this trial there were no permanent undesirable effects on the sow.

Conclusions

Restricting feed intake of gilts and sows during gestation, including self feeding only one day per week, is not seriously detrimental to sow and pig performance and results in important savings in the cost of maintaining the breeding herd. Under the treatments used in this trial, hand feeding 4 pounds per head daily or self feeding two days per week with or without additional alfalfa hay would support satisfactory performance. However, self feeding two days per week did not produce worthwhile savings in feed.

Productivity of gilts self-fed one day per week was less satisfactory than the same treatment for sows. While this treatment is usable, it did not result in feed savings as compared to hand feeding and is a less desirable way of managing sows during gestation with respect to continuous attention to them. For gilt productivity to be profitable, they would need to be in good condition at the initiation of once a week feeding.

Results of this trial support the findings of other work that both gilts, and particularly sows, can be carried during gestation on 4 pounds per head daily of a well balanced, high energy ration without loss of productivity.

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station

A. S. Series 67-37

LYSINE AND PROTEIN SUPPLEMENTATION OF BARLEY RATIONS FOR GROWING-FINISHING SWINE

J. W. McCarty, R. C. Wahlstrom and Albert Dittman

Barley is an important crop for north central South Dakota. It is higher in protein content than corn, ranging from 11 to 15 percent. However, it is lacking in adequate quantities of the amino acid lysine to support normal growth of growing-finishing pigs. A series of trials have been conducted at the North Central Substation, Eureka, using barley as the only grain in rations for growing-finishing swine. These trials have indicated a moderate improvement in gain and feed efficiency when barley-soybean meal rations have been supplemented with lysine.

The objective of the experiment reported herein was to study the influence of lysine in the drinking water when pigs were fed a barley ration without additional protein and to compare this ration with barley-soybean meal rations of low (12%) and high (16%) protein content.

Procedure

One hundred forty-four SPF crossbred barrows and gilts were assigned to two replicates of four treatments. Allotment balanced sex, litter and weight among the pigs, all of which were by one sire. Pigs were grown out in one-third acre pasture lots equipped with portable houses, self-feeders and hog fountains. All rations were complete ground mixtures. Composition of the rations is shown in table 1.

Results and Discussion

Performance for pigs in this trial is summarized in table 2. Although pigs were fed in eight lots, two lots per treatment, data have been combined because lot differences were small, emphasizing the treatments which were studied.

The value of lysine in barley rations was quite clearly demonstrated in this experiment. Pigs fed the unsupplemented barley ration but receiving 4 gm. of lysine per gallon of water gained an average of 0.2 lb. per day faster than those fed the same ration but without lysine in their drinking water (1.69 vs. 1.49 lb. per day). These pigs receiving lysine also gained slightly faster than those pigs fed the low protein barley-soybean meal ration and nearly equal to those fed the high protein barley-soybean meal ration. These data would indicate that for pigs of the weight used in this trial barley is deficient in lysine but probably adequate in other amino acids. It also points out the possibility of decreasing needs of protein supplemental feeds for swine in the future if amino acid, particularly lysine, costs are reduced to where they would be economical to use in swine rations.

Table 1. Composition of Rations

Rations	No protein Grower and finisher	Low protein		High protein	
		Grower	Finisher	Grower	Finisher
Treatment	1 and 2[a]	3		4	
Feed ingredients[b]					
Barley	975	932	956	823	908
Soybean oil meal (44%)	0	40	20	150	70
Dicalcium phosphate	10	15	11	15	11
Ground limestone	7	5	5	5	4
Trace mineralized salt (high zinc)	5	5	5	5	5
Vitamin-antibiotic premix[c]	2.5	2.5	2.5	2.5	2.5

[a] Per 1000 pounds ground mixture.
[b] Lysine provided in drinking water at the rate of 4 gm. per gallon.
[c] Each pound of premix provided 0.6 gm. penicillin, 3 gm. streptomycin, 600,000 U.S.P. units vitamin A, 60,000 U.S.P. units vitamin D_2, 400 mg. riboflavin, 1000 mg. d-pantothenic acid, 3000 mg. niacin, 23,044 mg. choline, and 3 mg. vitamin B_{12} activity.

Grower ration supplied until the lot averaged approximately 110 pounds live weight.

Table 2. Performance of Pigs Fed Barley Rations With Different Levels of Protein Supplementation

	High protein	No protein	No protein + lysine	Low protein
Pigs per treatment	36	36	36	36
Av. initial wt., lb.	68.1	67.2	66.6	67.4
Av. final wt., lb.	206.9	197.2	210.5	204.1
Av. daily gain, lb.	1.71	1.49	1.69	1.63

Note: Feed consumption and efficiency data were not available for this summary.

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Agricultural Experiment Station
A. S. Series 67-38

RELATIONSHIP OF SOME SEMEN CHARACTERISTICS OF THE BOAR TO FECUNDITY OF THE SOW

W. L. Singleton and D. R. Shelby

As the price-cost squeeze becomes more critical to the pork producer, every factor which affects net profit must be critically weighed. The profit making potential of a swine herd increases directly with an increase in the number of live offspring produced per sow. The production of large litters is dependent on high fertility in both the sow and the boar. The fertility of boars will vary from complete sterility to high fertility. An actual breeding test is the only highly reliable method of those used to measure fertility level in the boar, but boars of complete sterility can usually be detected by semen testing. Since an actual breeding test is a very expensive method of determining the fertility level of a boar, it would be highly desirable to develop a rapid inexpensive method for determining the fertility level of boars so that boars of low to moderate fertility could be eliminated from the herd before use.

The purpose of this study was to determine the relationship between certain measures of semen quality in the boar and fecundity in the sow and to measure the variation among boars with respect to these measures of semen quality.

Experimental Procedure

During June of 1967, semen was collected from six Yorkshire boars unselected for fertility. These boars were collected every 48 hours with three boars being collected each day until all boars had been collected eleven times. The sperm-rich fractions of the ejaculates were extended in a yolk-glucose-bicarbonate extender and aliquots of each collection were incubated for 3 hours at 38° C. in a constant volume respirometer. The remainder of the extended semen from each collection was divided into 50 ml. aliquots and stored at 8° C. until subsequent use for insemination.

The following data were obtained from each semen sample:

(1) Oxygen uptake by the sperm at 30 minute intervals during the incubation period
(2) Percent progressive motility (rated on a 0-10 basis and estimated immediately after collection and at the end of the incubation period)
(3) Sperm concentration (measured by a turbidometric method)
(4) pH of the extended semen (measured in a pH meter at the beginning and end of the incubation period)
(5) % normal sperm (all morphology observations were made from aniline blue-eosin B stained smears)
(6) % abnormal heads
(7) % midpiece defects
(8) % bent tails
(9) % loose heads
(10) % cytoplasmic droplets

Sixty Duroc-Yorkshire crossbred gilts which had been cycling normally were mated at random to the six Yorkshire boars by artificial insemination. Each gilt was inseminated once with 50 ml. of extended semen which had been collected that day. The gilts were slaughtered and their reproductive tracts were recovered 25 days after insemination. The number of corpora lutea and embryos present in each tract were counted, and the number of normal embryos present in the uterus after 25 days of pregnancy as a percentage of the number of eggs ovulated was used as a measure of fecundity in the gilts. Correlations between the various semen characteristics measured and fecundity of the gilts were computed.

The gilts were self-fed a bulky ration containing 13% crude protein and 30% dehydrated alfalfa meal during the prebreeding and postbreeding periods. The boars were hand-fed 5 lb. of the same ration daily.

Results and Discussion

The correlations between the various semen characteristics and fecundity of the gilts with means and standard deviations for the semen characteristics studied are shown in table 1. Also shown are the levels of significance of the differences among boars and among ejaculates within boars for the semen characteristics measured. Although there were significant differences ($P < .01$) among boars for all semen characteristics measured except percent cytoplasmic droplets and among boar groups of gilts in fecundity, only sperm concentration ($r = .61$, $P < .01$) and percent morphologically normal sperm ($r = .29$, $P < .05$) were significantly correlated with gilt fecundity. The significant differences among ejaculates within boars for most of the semen characteristics measured coupled with the lack of a relationship between these characteristics and fecundity of the gilt suggests that considerable variation in these semen characteristics can exist from one ejaculate to the next without affecting the over-all fertility of the boar.

In this study, only sperm concentration exerted any significant effect on fecundity of the gilts as evidenced by the high correlation between these two factors. This is not to say that some of the other characteristics measured cannot or do not affect fertility level in the boar, but, under the conditions of this study, the other semen characteristics did not appear to be good indicators of fertility level.

Summary

Significant differences in the semen characteristics measured in this study were found to exist among boars and among ejaculates within boars. Of the semen characters measured, only sperm concentration and percent morphologically normal sperm were significantly correlated with fecundity in the gilt.

Table 1. Means and Standard Deviations of Semen Characteristics of Boars and the Relationships Between These Characteristics and Sow Fecundity

Characteristic measured	Mean	Standard deviation	Differences among boars[1]	Differences among ejac./boars[1]	Correlation coefficient[2]
O_2 uptake after 1 hr.[3]	40.4	19.0	0.01	0.01	0.09
O_2 uptake after 2 hr.	62.2	29.7	0.01	0.01	0.04
O_2 uptake after 3 hr.	79.5	37.7	0.01	0.01	0.01
Initial % motility	79.4	15.7	0.01	0.01	0.06
Final % motility	49.1	25.0	0.01	0.01	-.02
Sperm concentration[4]	90.4	13.9	--	--	0.61**
Initial pH	7.30	0.27	0.01	0.01	0.21
Final pH	7.61	0.27	0.01	0.01	0.13
% normal sperm	71.2	7.6	0.01	0.01	0.29*
% abnormal heads	6.2	2.7	0.01	NS	-.08
% midpiece defects	6.2	3.6	0.01	0.01	-.17
% bent tails	8.6	7.1	0.01	0.01	-.19
% loose heads	4.5	4.2	0.01	NS	-.11
% cytoplasmic droplets	2.4	2.0	NS	NS	0.07
% eggs ovulated present as embryos	60.5	27.5	0.01	--	1.00

[1] Level of significance of differences among boars or among ejaculates within boars; 0.01 means $P < .01$, NS means not significant.

[2] Correlation between percent of eggs ovulated which were present as embryos and the semen characteristics listed.

[3] Oxygen uptake is measured in microliters per 10^8 sperm.

[4] Millions of sperm per milliliter.

** Significant at $P < .01$; * Significant at $P < .05$.