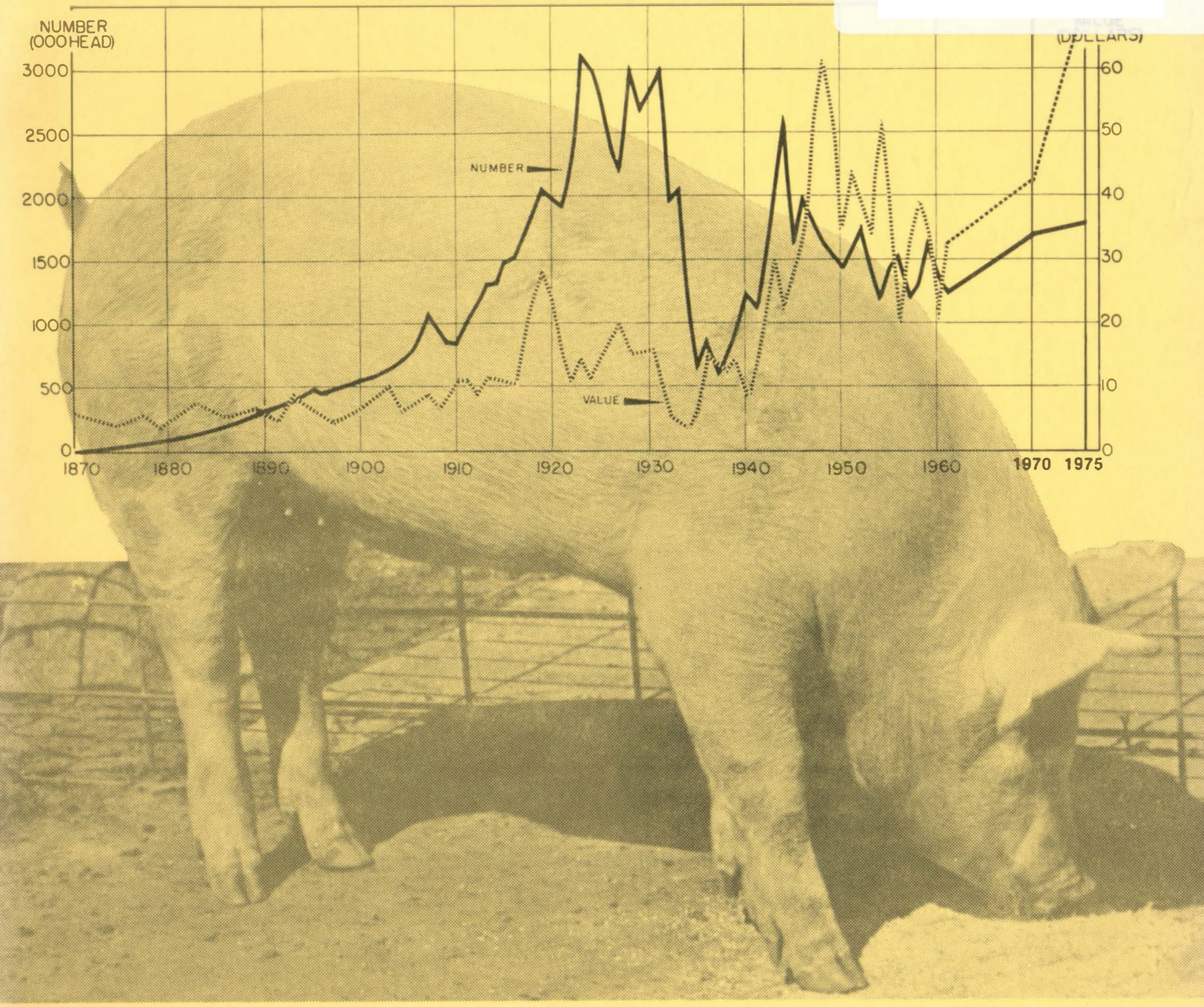
1976

Twentieth Annual Swine Day

Animal Science Department
South Dakota State University

Hogs on Farms and Value/Head, January 1
South Dakota, 1870-1975



20th Annual

Swine Day

Proceedings and Program

November 18, 1976--Stock Pavilion

Agricultural Experiment Station
Cooperative Extension Service
South Dakota State University

Saluting 100 Years of South Dakota Swine Production

PROGRAM

"Saluting 100 Years of South Dakota Swine Production"

L. J. Kortan, Chairman
Extension Swine Specialist

Ventilation Systems at Work -- Louis Lubinus, Extension Agricultural Engineer

The New Approach to Swine Carcass Evaluation -- Dr. Dan Gee, Animal Science Department

Current Disease Problem -- Dr. Martin Bergeland, Veterinary Diagnostic Laboratory

Fat Additions to Swine Rations -- Dr. George Libal, Animal Science Department

Lunch

Dr. Harold Tuma, Chairman
Head, Animal Science Department

How Hogs Are Really Fed Down On The Farm -- Dub Carlton, Doane Agricultural Service

A Look at Swine Production and Marketing in 1977 -- Dr. Gene Murra, Extension Economist

Vitamins, Trace Minerals and Feed Additives -- Dr. Richard Wahlstrom, Animal Science Department

Questions - Discussion

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Graph on front cover adapted from
South Dakota Crop and Livestock Reporting Service

South Dakota State University
Brookings, South Daktoa

Department of Animal Science
Agricultural Experiment Station

A.S. Series 76-25

Vitamins, Trace Minerals and Feed Additives

Richard C. Wahlstrom

Most swine diets are composed of one or more of the cereal grains and a protein supplement as the major feed ingredients to furnish the energy and protein needed. The quantitative need of swine for vitamins, trace minerals and feed additives is small compared to their need for energy and protein. Approximately 30 different vitamins and minerals are required by swine and each performs an important function despite the small amount which may be required.

Although natural feedstuffs supply varying amounts of most of the vitamins and trace minerals, practical diets for swine are generally supplemented with certain of these nutrients. This article will discuss those vitamins and trace minerals that need more attention in swine feeding and feed additives that are used for growth promotion.

Vitamins

Those vitamins that should be added to swine diets are the fat soluble vitamins A, D, E and K and the water soluble vitamins (also known as the B complex) riboflavin or B_2, pantothenic acid, niacin, choline and vitamin B_{12}. Recommended levels of these vitamins in swine diets are shown in table 1.

The vitamin A needs of swine can be met by either vitamin A or carotene. Vitamin A does not occur in plant products, but carotene present may be converted to vitamin A by the pig. Corn contains carotene but is not a dependable source because much may be destroyed in storage. Therefore, in formulating swine diets the carotene content of corn is disregarded. Other cereal grains are low or devoid of carotene. Dehydrated alfalfa meal, good quality alfalfa hay and green pastures are good natural sources of carotene. Supplemental vitamin A can be provided by the use of stabilized vitamin A supplements.

Vitamin D is known as the "sunshine vitamin," as animals having access to sunlight produce vitamin D by irradiation. With the exception of sun-cured hays, most feedstuffs are practically devoid of vitamin D. Therefore, fortification of diets with vitamin D is necessary when pigs are fed in confinement. Vitamin D is needed for efficient utilization of calcium and phosphorus. A lack of this vitamin results in stiffness, lameness, rickets, broken or deformed bones and general unthriftiness.

Although it is difficult to produce a vitamin E deficiency in swine fed practical diets, vitamin E deficiency symptoms have been reported. Grains low in selenium increase the need for vitamin E as the dietary level of one of these nutrients affects the requirement of the other. Deficiency symptoms in the growing pig are sudden death, jaundice, edema, white muscles and liver necrosis. Sows may show a high level of embryonic death.

Most natural feedstuffs contain vitamin K and it is also synthesized by intestinal microflora. However, a deficiency has been reported in practical swine diets and is frequently associated with moldy feeds. Internal bleeding is common and death may occur. Dehydrated alfalfa meal (2.5% of the diet) is a good source of vitamin K or it may be supplied by menadione sodium bisulfite.

The cereal grains and plant by-products such as soybean meal are relatively poor sources of the B vitamins riboflavin, pantothenic acid and B_{12}. Niacin in cereal grains occurs in a bound form and is largely unavailable to the pig. With practical diets deficiency symptoms most apt to occur would be poor growth or diarrhea. These nonspecific symptoms may be due to a low dietary level of all of these B vitamins. Vitamin supplements containing these four vitamins are readily available for use in mixing with natural feedstuffs.

Choline is needed in swine diets but the exact amount necessary has not been determined. Research has indicated that feeding supplemental choline increased litter size when pregnant sows were fed corn-soybean meal diets. It has been suggested that choline deficiency is the cause of spraddle legs in newborn pigs. However, this has not been proved in research so there apparently are other causes of the spraddle leg condition.

Trace Minerals

Most swine diets require supplementation with a source of calcium and phosphorus and salt to supply sodium and chlorine. In addition to these four minerals the pig requires at least ten more mineral elements in small amounts and these are called trace minerals. The natural feed ingredients in swine diets will usually furnish adequate amounts of cobalt, magnesium, potassium and sulfur. However, a trace mineral supplement may be needed to supply small amounts of copper, iodine, iron, manganese, selenium and zinc. These minerals may be provided in a trace mineral premix or by the use of trace mineral salt. Excessive feeding of minerals should be avoided as it can reduce performance as much as with a shortage of minerals. Table 2 gives suggested levels for these trace minerals in swine diets.

It has been shown that feeding pigs practical diets formulated from ingredients grown on low selenium soils can result in a selenium deficiency. The FDA has approved the addition of 0.1 part per million (ppm) of selenium to source diets. Most areas of South Dakota have adequate selenium present in the soil so that a deficiency of selenium should not exist. In fact, a few isolated areas have problems with excess selenium. However, the level of selenium added to swine diets, 0.1 ppm, is low enough that it should not cause any problems if added to diets formulated from South Dakota grown ingredients.

Feed Additives

Additives used in swine diets for growth promotion include antibiotics, arsenicals and nitrofurans. These compounds are not nutrients but are drugs and their use is regulated by the Food and Drug Administration. Many of these products are required by law to be withdrawn from the diet for a specified time before slaughter. Regulations concerning levels and withdrawal time are subject to change so it is important to follow the directions stated on the feed tag or package of the drug used.

These feed additives may also improve the health of the animal. Although feed additives can help control disease problems, they should not be considered a substitute for good management.

The greatest response from these additives is in pigs up to a weight of 100 pounds. High levels of antibiotics during the breeding season have been reported to increase conception rate, and feeding just prior to and following farrowing may improve pig livability and performance. Recommended levels of antibiotics range from 100 grams per ton in pig starter diets to 10 grams per ton for finishing pigs. Continuous feeding of the same additive may decrease its effectiveness. Periodic changing of drugs is a good practice. A list of feed additives approved for use in growth promotion of swine is shown in table 3.

Table 1. Recommended Vitamin Additions Per Ton of Swine Diets

Vitamin	Starter diet	Grower-finisher diet	Sow diet[a]
Vitamin A, IU	4,000,000	2,400,000	4,000,000
Vitamin D, IU	400,000	240,000	400,000
Vitamin E, IU	10,000	10,000	10,000
Vitamin K, g	2	2	2
Riboflavin, g	3	2.4	4
Pantothenic acid, g	16	12	16
Niacin, g	20	16	20
Vitamin B_{12}, mg	20	12	20
Choline, g	170	100	500

[a]Based on daily intake of 4 to 5 lb. for gestation and 9 to 12 lb. during lactation.

Table 2. Recommended Trace Mineral Additions Per Ton of Diet

Trace mineral	Level of mineral
Copper, g	5.4
Iron, g	54.0
Iodine, g	0.5
Manganese, g	18.0
Zinc, g	45.0
Selenium, mg	90.8

Table 3. Feed Additives Approved for Growth Promotion of Swine

Additive
Bacitracin
Zinc bacitracin
Bambermycin (flavomycin)
Chlortetracycline (aureomycin)
Erythromycin
Oleandomycin
Oxytetracycline (terramycin)
Penicillin
Streptomycin
Tylosin
Virginamycin
Carbadox (use to 75 lb. only)
Furazolidone
Arsanilic acid
3-nitro-4-hydroxyphenylarsonic acid (Roxarsone)

South Dakota State University
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Department of Animal Science
Agricultural Experiment Station

A.S. Series 76-26

Effects of Energy Source in Late Gestation on Pig Survival and Performance

Richard C. Wahlstrom and George W. Libal

Pig weight at birth can be influenced by the amount of feed fed to the sow during the gestation period. An increased energy intake by sows generally results in some increase in pig birth weight. Some recent research has indicated that the source of energy in the diet the last few weeks of gestation, particularly the type of lipid or fat source in the diet, may influence the livability of pigs after birth.

The objective of the experiment reported herein was to determine if the source of energy in the gestation diet during the last 4 weeks of gestation would have an effect on pig survival and performance.

Experimental Procedure

Thirty sows and gilts were allotted on the basis of parity, weight and ancestry into two treatment groups approximately 30 days prior to farrowing. The two dietary treatments were a concentrated high-energy diet containing corn, soybean meal and corn oil and a lower energy diet containing corn, soybean meal and alfalfa meal. The corn oil diet was fed at a rate of 4.5 lb. per day and the alfalfa meal diet fed at 5.6 lb. per day so that total energy intake was essentially equal. The composition of the diets is shown in table 1.

At 110 days of gestation the animals were moved to the farrowing house and placed in individual farrowing crates. The respective gestation treatment diets were fed through the first week of lactation and all sows were full-fed the same lactation diet during the next 2 weeks.

Results

Table 2 summarizes the data obtained in this experiment.

Both treatment groups received approximately the same energy intake during the last month of gestation. Gains during this period averaged slightly greater for the animals fed the higher energy diet, although average gain of sows was greater when fed the low energy diet and the reverse occurred with gilts. However, gains during the lactation period favored the gilts and sows on the high energy gestation treatment. These animals showed a gain at both 7 and 21 days of lactation, while those on the low energy treatment lost weight during the first 7 days of lactation and then essentially maintained their weight the next 2 weeks when both groups were fed the same lactation diet.

Although there was a significant difference in the number of pigs farrowed between treatments, this difference was due to chance as allotment occurred after the sows were nearly 3 months pregnant and there were no differences in number of stillborn pigs between treatments. At 7 days there appeared to be a trend for better survival of pigs from gilts fed the corn oil diet. One might expect somewhat better survival of this group since the pigs from sows and gilts fed the corn oil diet were significantly heavier at birth. These dams also farrowed less pigs per litter and it is known that litter size does affect pig birth weight. However, litter birth weights were slightly heavier for both gilts and sows fed the corn oil diet even though there were less pigs per litter. This would indicate that the dietary treatment may have had some effect on pig birth weights.

Summary

Thirty sows and gilts were fed diets differing in energy source during approximately the last 4 weeks of gestation and the first week of lactation. Both groups received the same lactation diet from 7 to 21 days of lactation.

Animals fed the higher energy diet containing corn oil as a fat source farrowed heavier pigs, which could have been due in part to farrowing less pigs. Litter weights were slightly greater when dams were fed corn oil. Survival rate of pigs at 7 days was 90.2% from gilts fed the corn oil diet and 79.3% when gilts were fed the alfalfa meal diet. There was little difference between treatments in percent survival of pigs farrowed by sows.

Table 1. Composition of Treatment Diets Last 30 Days of Gestation (Percent)

	High energy	Low energy
Ground yellow corn	81.5	68.2
Soybean meal, 48%	10.0	4.0
Corn oil	5.0	--
Dehydrated alfalfa meal, 17%	--	25.0
Dicalcium phosphate	2.0	2.1
Ground limestone	0.8	--
Trace mineral salt	0.5	0.5
Vitamin premix[a]	0.2	0.2

[a]Provided per lb. of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 3 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg and vitamin B_{12}, 5 micrograms.

Table 2. Effect of Energy Source During Late Gestation on Pig Survival and Performance

	Sows		Gilts	
	High energy	Low energy	High energy	Low energy
Avg. initial wt., lb.	444	448	448	460
Avg. gain, 25 days prefarrowing, lb.	18	24	27	15
Avg. gain, 0-7 days lactation, lb.	2	- 6	4	- 5
Avg. gain, 0-21 days lactation, lb.	12	- 6	15	- 4
Number live pigs				
Birth[a]	8.8	9.8	9.6	10.0
7 days	7.6	8.6	8.6	8.0
21 days	7.0	8.5	8.5	7.7
Percent survival				
7 days	87.3	86.8	90.2	79.3
21 days	81.2	85.4	88.3	76.2
Avg. litter wt., lb.				
Birth	30.4	29.9	32.3	30.9
7 days	31.1	30.9	36.5	36.2
21 days	67.0	90.8	86.1	82.7
Avg. pig wt., lb.				
Birth[a]	3.6	3.0	3.4	3.1
7 days	4.0	3.6	4.3	4.6
21 days	9.5	10.8	10.1	10.9

[a]Significant difference between treatments ($P<.05$).

South Dakota State University
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A.S. Series 76-27

Dehulled Oats and Hulless Barley in Diets of Young Weaned Pigs

Richard C. Wahlstrom and George W. Libal

Young weaned pigs have a higher requirement for protein than during later stages of the growth period. They also need a diet high in available energy for optimum gains. Cereal grains such as oats and barley are much higher in protein than corn and could be used to reduce the amount of supplemental protein needed in young pig diets. However, these grains are also higher in fiber and thus have less energy than corn. Hulless varieties or processing the grain to remove the hull are possible ways to obtain grains of a relatively high protein and energy value. These methods have not been too successful to date because most hulless varieties of barley do not yield well and dehulling oats removes about 30% of the weight of the original grain and therefore increases the cost of the product.

The objective of the experiment reported herein was to evaluate a dehulled high protein oats and a hulless barley in diets of young weaned pigs.

Experimental Procedure

One hundred eight crossbred pigs having an average initial weight of 25 lb. were allotted into 18 groups on the basis of ancestry and weight. Groups were randomly assigned to six experimental diets from three replicate groups. All pigs were housed, six pigs per pen, in an enclosed building with solid concrete floors that were bedded with wood shavings. The experiment was continued for 4 weeks with feed and water provided *ad libitum*.

The experimental dietary treatments were as follows:

Diet 1--Corn-soybean meal (18% protein)
Diet 2--Oats replaced half of corn in diet 1
Diet 3--Dehulled oats
Diet 4--Dehulled oats plus 0.2% L-lysine
Diet 5--Hulless barley-soybean meal (18% protein)
Diet 6--Hulless barley replaced half of corn in diet 1.

The composition of the diets is shown in table 1. The Spear oats was a high protein variety that by chemical analysis contained 16% protein and 0.65% lysine in the whole kernel, while the dehulled oats analyzed 0.93% lysine. The hulless barley contained 0.50% lysine.

Results

Rate of gain, daily feed consumption and feed efficiency data are presented in table 2. There were significant differences in both rate and efficiency of gain among treatments. Pigs fed the corn-soybean meal, corn-oats and dehulled oats plus lysine diets (Diets 1, 2 and 4) gained at a similar rate, 0.88, 0.83 and 0.85 lb. per day, respectively, which was significantly faster than the 0.59 lb. per day gain of pigs fed the hulless barley diet (Diet 5). Significantly more feed was required per gain when pigs were fed the hulless barley diet than when pigs were fed Diets 1, 2 and 4. It would appear that the poor performance of pigs fed the hulless barley diet (Diet 5) was because of a deficiency of lysine. On analysis this diet contained only 0.71% lysine. Gain and feed/gain were improved when corn replaced half of the barley (Diet 6), but neither gain nor feed/gain were equal to those for pigs fed corn, corn-oats or dehulled oats plus lysine as the cereal grains, even though Diet 6 should have been adequate in lysine content.

Pigs fed the dehulled oats diet supplemented with 0.2% lysine (Diet 4) gained approximately 15% faster and required 27% less feed/gain than pigs fed the unsupplemented dehulled oats diet. These results suggest a deficiency of lysine in the dehulled oats. However, the analysis of 0.92% lysine would indicate that the diet should have been adequate in lysine unless the lysine in dehulled oats was not totally available.

Diets 1, 2 and 6 all contained equal levels of soybean meal and other nutrients and differed only in the energy source which was corn, equal parts of corn and oats and equal parts of corn and hulless barley, respectively. The hulless barley did not appear to be as good an energy source in the diet as corn or Spear oats as evidenced by slower gains and more feed/gain for pigs fed the barley-corn diet.

Summary

One hundred eight weanling pigs were fed diets containing corn, equal parts of corn and oats, dehulled oats, hulless barley and equal parts of corn and hulless barley as the cereal grains for a 4-week experimental period.

Supplementing the dehulled oats diet with 0.2% L-lysine increased rate and efficiency of gain. Pigs fed diets of corn, corn-oats and dehulled oats plus lysine gained significantly faster and required less feed/gain than pigs fed hulless barley as the grain source. Pigs fed the corn diet also required less feed/gain than pigs fed the dehulled oats diet without supplemental lysine.

Table 1. Composition of Experimental Diets (Percent)

Diet number	1	2	3	4	5	6
Ground corn	73.2	36.6	--	--	--	36.6
Ground oats	--	36.6	--	--	--	--
Dehulled oats	--	--	97.5	97.2	--	--
Hulless barley	--	--	--	--	90.6	36.6
Soybean meal, 48%	24.2	24.2	--	--	6.9	24.2
Dicalcium phosphate	1.4	1.4	1.1	1.1	1.1	1.4
Ground limestone	0.7	0.7	0.9	0.9	0.9	0.7
Trace mineral salt	0.4	0.4	0.4	0.4	0.4	0.4
L-lysine hydrochloride[a]	--	--	--	0.3	--	--
Premix[b]	0.1	0.1	0.1	0.1	0.1	0.1

[a]Supplied 0.2% L-lysine.
[b]Supplied per lb. of diet: vitamin A, 1800 IU; vitamin D, 180 IU; vitamin E, 3 IU; riboflavin, 1.5 mg; pantothenic acid, 6 mg; niacin, 9.6 mg: choline, 30 mg; vitamin B_{12}, 6 mcg; aureomycin, 50 mg; penicillin, 25 mg and sulfamethazine, 50 milligrams.

Table 2. Effect of Dehulled Oats and Hulless Barley on Performance of Young Weaned Pigs

	Dietary treatments					
	1	2	3	4	5	6
Number of pigs[a]	18	18	18	18	18	18
Avg. initial wt., lb.	25.3	25.2	25.2	25.2	25.1	25.4
Avg. final wt., lb.[b]	49.9	48.3	46.0	49.0	41.5	46.0
Avg. daily gain, lb.[b]	0.88	0.83	0.74	0.85	0.59	0.74
Daily feed consumed, lb.	1.85	1.96	2.30	2.03	2.10	2.07
Feed/gain[b]	2.10	2.38	3.08	2.23	3.57	2.80

[a]Three lots of 6 pigs each per treatment.
[b]Significant difference ($P<.01$) among treatments.

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A.S. Series 76-28

Supplemental Vitamin D in Pig Diets

Richard C. Wahlstrom and George W. Libal

Vitamin D is necessary for absorption and metabolism of calcium and phosphorus in the body. A deficiency of this vitamin will result in rickets. Most feedstuffs used in swine diets are essentially devoid of vitamin D. The animal can receive the necessary vitamin D if exposed to the ultraviolet rays of the sun. Therefore, pigs raised in confinement with no opportunity to be exposed to sunshine need supplemental vitamin D in their diets.

During the past year we experienced the death of several pigs at about 8 to 10 weeks of age. These pigs had been weaned at 4 weeks of age and fed diets that contained a vitamin D supplement. Some of these pigs died very suddenly without any previous symptoms, while later some exhibited a tetany-like condition, hypertension and soft bones. On analysis of the vitamin D supplement it was found that there was no vitamin D activity. Apparently the vitamin D activity had been lost during storage of the supplement. Blood analysis revealed a low blood calcium level. These symptoms indicated the possibility of a vitamin D deficiency. However, it seemed rather unusual to have this condition occur in pigs at this young age. Therefore, we conducted an experiment to study the effect of feeding diets that did not contain supplemental vitamin D to young weaned pigs confined in an enclosed building.

Experimental Procedure

Thirty-six crossbred pigs were weaned from sows that had been in a confinement barn during the lactation period. The pigs averaged about 5 weeks of age and 18 lb. when allotted on the basis of weight and ancestry to two treatments, each replicated three times so that there were six pigs per pen. The pigs were housed in an enclosed building having solid concrete floors that were bedded with shavings. Feed and water were provided _ad libitum_ and the experiment was conducted for 8 weeks.

The composition of the basal diet is shown in table 1. The experimental treatments were:

1. Basal diet - no vitamin D
2. Basal diet plus 200 IU vitamin D per lb.

Blood samples were obtained from the pigs after 28 and 56 days on the dietary treatments. Blood was analyzed for calcium, phosphorus and magnesium.

Results

Data on gain, feed efficiency and levels of calcium, phosphorus and magnesium in the blood are shown in table 2.

There were no significant differences in any of the traits measured in this experiment. Pigs fed the diet supplemented with vitamin D did gain slightly faster (1.05 vs 0.99 lb. per day) and required less feed/gain (2.15 vs 2.34). There were no visible signs of rickets or other vitamin D symptoms. Blood levels of calcium, phosphorus and magnesium were similar between treatments at both 28 and 56 days. The values obtained here are considered to be normal levels and also would not indicate any trend of a vitamin D deficiency.

These results are similar to those reported by others that have not shown any response from supplemental vitamin D in short term experiments. The results should not be interpreted to indicate that vitamin D is not necessary for confined swine, as over a longer period of time one might expect some symptoms of rickets to appear.

These results are difficult to relate with the problems observed previously in pigs fed a similar diet in the same facilities where vitamin D-like symptoms occurred in 4 to 6 weeks. A possible explanation might be that an anti-vitamin D metabolite was present in the problem diet which blocked all vitamin D metabolism in the body.

Summary

Thirty-six weanling pigs were divided into two treatments with one group being fed a diet devoid of supplemental vitamin D and the other group receiving a diet containing 200 IU of vitamin D per pound. The pigs were fed these diets for 8 weeks in an enclosed building.

No differences were observed in performance of the pigs or in blood levels of calcium, phosphorus and magnesium. There were no visible symptoms of vitamin D deficiency.

Table 1. Composition of Basal Diet

Ingredient	Percent
Ground corn	73.1
Soybean meal, 48%	24.2
Dicalcium phosphate	1.4
Ground limestone	0.8
Trace mineral salt	0.4
Premix[a]	0.1

[a]Supplied per lb. of diet: vitamin A, 2000 IU; vitamin E, 3 IU; vitamin K, 1.2 mg; riboflavin, 1.5 mg; pantothenic acid, 6 mg; niacin, 9.6 mg; choline, 30 mg; vitamin B_{12}, 6 mcg; aureomycin, 50 mg; penicillin, 25 mg and sulfamethazine, 50 milligrams.

Table 2. Effect of Vitamin D Supplementation on Pig Performance

	Supplemental vitamin D	
	0	200 IU
Number of pigs[a]	18	18
Avg. initial wt., lb.	18.0	17.9
Avg. final wt., lb.	73.3	76.9
Avg. daily gain, lb.	0.99	1.05
Avg. feed consumed, lb.	2.29	2.27
Feed/gain	2.34	2.15
Blood calcium, mg/100 ml		
28 days	9.8	10.2
56 days	10.4	10.6
Blood phosphorus, mg/100 ml		
28 days	9.0	9.5
56 days	9.1	9.6
Blood magnesium, mg/100 ml		
28 days	2.16	2.12
56 days	2.91	2.89

[a]Three lots of 6 pigs each per treatment.

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A.S. Series 76-29

Effect of Housing and Supplemental Dietary Iron on Performance of Growing-Finishing Pigs

Richard C. Wahlstrom and George W. Libal

In a previous experiment at this station reported at the 1975 Swine Day (A.S. Series 75-52), it was found that pigs housed in wooden houses with concrete floors and concrete outside pens gained faster during the finishing period than pigs housed in similar houses in dirt lots or in a confinement house with slatted floors. The increase in gain was associated with an increase in feed consumption. This experiment was conducted to see if this difference in performance was repeatable. The value of adding a high level of iron to the diet was also studied, since some swine producers had indicated improved performance of pigs fed supplemental iron.

Therefore, the objectives of this experiment were (1) to determine the performance of pigs fed in a confinement or open-front type building with concrete outside lots and (2) to determine the effect of 250 ppm of supplemental iron on gain, feed consumption and feed efficiency of growing-finishing pigs.

Experimental Procedure

Seventy-two crossbred pigs weighing approximately 80 lb. were allotted to eight lots of 9 pigs per pen. Replicated lots were assigned to the four treatments as follows:

Treatment 1 -- Confinement house, no supplemental iron
Treatment 2 -- Confinement house, 250 ppm supplemental iron
Treatment 3 -- Outside concrete pen, no supplemental iron
Treatment 4 -- Outside concrete pen, 250 ppm supplemental iron

The pens in the confinement house were 9 by 7.5 feet with 3.5 inch aluminum slats spaced 1 inch apart. The outside pigs were housed in 8 by 12 foot wooden houses having concrete floors and a 12 by 16 foot outside concrete lot where feeders and waterers were located. The experiment was conducted from August 18 to November 19. Composition of the basal diets is shown in table 1.

Results

The effects of housing type and supplemental dietary iron on rate of gain, feed consumption and feed efficiency are summarized in table 2. Pigs housed in the confinement house gained significantly slower than pigs with outside lots during both the growing and finishing periods. In both periods gain was reduced approximately 0.2 lb. per day as it was also for the entire experiment. During the growing period from 80 to 125 lb. there was no difference in feed consumption. Therefore, the pigs with access to the outside environment were more efficient, requiring about 14% less feed during this time. In the finishing period pigs in the confinement house consumed less feed per day but required 4% more feed than pigs with access to the outside. For the entire experiment both rate and efficiency of gain were significantly reduced for pigs in the confinement house.

The difference in performance of these pigs may be due to several factors. Although the pigs housed in confinement had a space allotment equal to that recommended for pigs on slatted floors, the nonconfined pigs had a total pen space (sleeping and eating) approximately four times larger. There was also a difference of concrete floors in outside housing and aluminum slats in the confinement building. Temperature, air movement, gases from the pit under the slatted floor, noise from exhaust fans and dust are a few other factors that would have varied and it is not known what these effects were on the performance observed here.

Supplementing the basal diet with 250 ppm of iron did not affect rate of gain, feed consumption or feed efficiency during either the growing or finishing periods. Performance was almost identical for both treatments during the entire experiment. Rate of gain was 1.68 lb. per day for both treatment groups and feed per gain was 3.61 and 3.63 for the unsupplemented and iron supplemented groups, respectively.

Summary

An experiment was conducted using 72 crossbred pigs fed corn-soybean meal diets with 0 or 250 ppm of supplemental iron from heptahydrated ferrous sulfate. Four lots of pigs received the iron supplemented diets and four lots the unsupplemented basal diet. In addition, two lots of pigs receiving each of these two diets were housed in a confinement building in pens with aluminum slatted floors and the other four lots were housed in wooden, open-front type buildings with access to an outside concrete lot for feed and water.

Pigs with access to the outside environment gained significantly faster and required significantly less feed/gain than those in the confinement building. There was no effect on pig performance by including 250 ppm of iron in the basal diets.

Table 1. Composition of Basal Diets (Percent)

	14% crude protein To 125 lb.	12% crude protein 125 to 225 lb.
Ground yellow corn	81.9	87.5
Soybean meal, 44%	15.0	9.3
Dicalcium phosphate	1.2	1.3
Ground limestone	0.9	0.9
Trace mineral salt[a]	0.5	0.5
Vitamin-antibiotic mix[b]	0.5	0.5

[a]Contained 1% zinc.
[b]Supplied per lb. of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 2.5 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg; vitamin B_{12}, 5 mcg and aureomycin, 10 milligrams.

Table 2. Effect of Type of Housing and Supplemental Dietary Iron on Pig Performance

	Type of housing		Supplemental iron	
	Inside	Outside	0	250 ppm
Number of pigs	36	36	36	36
Avg. initial wt., lb.	80.5	80.6	80.5	80.6
Avg. final wt., lb.	220.7	225.5	223.0	223.2
Initial to 125 lb.				
Avg. daily gain, lb.[a]	1.41	1.63	1.52	1.53
Daily feed consumed, lb.	4.83	4.79	4.73	4.88
Feed/gain	3.43	2.93	3.15	3.21
125 lb. to 225 lb.				
Avg. daily gain, lb.[a,b]	1.66	1.86	1.76	1.76
Daily feed consumed, lb.	6.30	6.95	6.70	6.55
Feed/gain	3.92	3.75	3.83	3.84
Initial to 225 lb.				
Avg. daily gain, lb.[a,b]	1.58	1.78	1.68	1.68
Daily feed consumed, lb.	5.77	6.17	6.00	5.94
Feed/gain[c]	3.76	3.48	3.61	3.63

[a]Significant difference ($P<.01$) due to type of housing.
[b]Significant difference ($P<.01$) due to sex.
[c]Significant difference ($P<.05$) due to type of housing.

South Dakota State University
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A.S. Series 76-30

Blood Meal and Meat Meal as Substitutes for Soybean Meal in Diets for Growing-Finishing Swine

Richard C. Wahlstrom and George W. Libal

Dried blood meal is an important by-product of the packing industry that contains over 80% protein. However, the conventional drying methods used in the past have used a high temperature batch drying process that has resulted in poor availability of certain amino acids, particularly lysine, and a product lacking palatability for swine. Recent research at South Dakota using blood meal dried by a continuous drying method in a rotary steam dryer has indicated a higher value for such blood meal.

This experiment was conducted to obtain additional data on the value of rotary steam dried blood meal and meat meal as alternative protein sources to replace soybean meal in diets for growing-finishing swine.

Experimental Procedure

Eighty-four crossbred pigs averaging 53 lb. were randomly allotted to four treatments in three replicates on the basis of sex, ancestry and weight. Each pen consisted of four barrows and three gilts. The pigs were housed in a totally enclosed confinement building in pens 5 feet by 15 feet. Feed and water were available *ad libitum*.

Diets were formulated to contain equal levels of lysine and are shown in tables 1 and 2. The lysine levels were 0.71 and 0.57% in the grower and finisher diets, respectively. The supplemental protein was furnished by soybean meal, blood meal and meat meal in various combinations as shown in tables 1 and 2.

Results

Table 3 summarizes the results of average daily gain, feed consumption and feed/gain of pigs fed the four experimental diets. Blood meal and meat meal were satisfactory replacements of soybean meal as a source of lysine and other essential amino acids as there were no significant differences in performance of pigs among treatments. There did appear to be an adverse effect on palatability when blood meal or meat meal was included in the diet during the growing period. Pigs fed the soybean meal diet consumed significantly more feed than those fed the diets containing soybean meal and blood or meat meal during this period. Slightly less daily feed was consumed by pigs fed diets containing blood meal during the 125 to 215 lb. period.

Summary

Eighty-four crossbred pigs weighing approximately 53 lb. were used to evaluate blood meal and meat meal as protein substitutes for soybean meal in diets for growing-finishing pigs.

The results of this experiment indicate that blood meal and meat meal are satisfactory replacements of soybean meal. The data reported here indicate that blood meal can constitute approximately 60% of the supplemental protein in diets where the remainder of the supplemental protein is supplied by soybean meal or meat meal.

Table 1. Composition of Diets Fed to 125 Pounds (Percent)

	Soybean meal	Blood meal-meat meal	Soybean meal-blood meal	Soybean meal-meat meal
Corn	79.9	87.5	84.6	82.9
Soybean meal, 44%	17.5	--	7.0	10.4
Blood meal	--	5.7	5.7	--
Meat meal	--	5.7	--	5.7
Dicalcium phosphate	1.2	0.4	1.4	0.2
Ground limestone	0.8	0.1	0.7	0.2
Trace mineral salt[a]	0.5	0.5	0.5	0.5
Premix[b]	0.1	0.1	0.1	0.1

[a]Contained 1% zinc.
[b]Supplied per lb. of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 2.5 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg; vitamin B_{12}, 5 mcg and tylan, 10 milligrams.

Table 2. Composition of Diets Fed From 125 to 215 Pounds (Percent)

	Soybean meal	Blood meal-meat meal	Soybean meal-blood meal	Soybean meal-meat meal
Corn	85.1	90.4	88.3	87.2
Soybean meal, 44%	12.3	--	5.0	7.3
Blood meal	--	4.0	4.0	--
Meat meal	--	4.0	--	4.0
Dicalcium phosphate	1.3	0.7	1.4	0.5
Ground limestone	0.7	0.3	0.7	0.4
Trace mineral salt[a]	0.5	0.5	0.5	0.5
Premix[b]	0.1	0.1	0.1	0.1

[a]Contained 1% zinc.
[b]Supplied per lb. of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 2.5 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg; vitamin B_{12}, 5 mcg and tylan, 10 milligrams.

Table 3. Performance of Pigs Fed Diets Containing Blood Meal and Meat Meal

	Soybean meal	Blood meal-meat meal	Soybean meal-blood meal	Soybean meal-meat meal
Number of pigs[a]	21	21	21	21
Avg. initial wt., lb.	53.8	53.3	52.9	54.3
Avg. final wt., lb.	214.4	215.7	214.8	214.9
Avg. daily gain, lb.				
53 to 125 lb.[b]	1.54	1.44	1.52	1.52
125 to 215 lb.	1.74	1.71	1.71	1.83
53 to 215 lb.[b]	1.64	1.58	1.61	1.67
Avg. feed consumed/day, lb.				
53 to 125 lb.[c]	4.32	4.03	3.87	3.97
125 to 215 lb.	6.95	6.46	6.37	6.90
53 to 215 lb.	5.63	5.29	5.14	5.40
Feed/gain				
53 to 125 lb.	2.77	2.79	2.53	2.65
125 to 215 lb.	3.96	3.76	3.70	3.75
53 to 215 lb.	3.40	3.33	3.16	3.22

[a]Three replicates of 7 pigs each per treatment.
[b]Significant difference due to sex ($P<.05$).
[c]Significant difference due to treatment ($P<.05$).

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A.S. Series 76-31

Evaluation of Chelated Copper as a Growth Stimulant in Diets of Growing Pigs

Richard C. Wahlstrom and George W. Libal

Copper is an essential element that must be present in the diet for normal metabolic function of the pig. Research has also shown that when copper is included in the diet at high levels (125 to 250 ppm) a response in performance of growing pigs is noted. Chelated substances are more soluble and because of this it is assumed they may be absorbed and utilized at a higher rate than normal compounds.

The objectives of this experiment were to determine the effect of chelated copper on rate and efficiency of growing pigs and to evaluate different levels of chelated copper as a growth promotant.

Experimental Procedure

One hundred thirty-two crossbred pigs averaging approximately 69 lb. were allotted on the basis of weight, ancestry and sex to three replicates of six treatments. Replicates 1 and 2 contained 48 pigs and replicate 3 had 36 pigs. There were 4 barrows and 4 gilts in each lot in the first two replicates and 3 barrows and 3 gilts in each lot in replicate 3. The pigs were housed in an enclosed, slatted floor confinement building. The experiment was conducted for 10 weeks.

The composition of the basal diet is shown in table 1. The experimental treatments were as follows:

1. Basal diet
2. Basal diet + 12.5 ppm chelated copper
3. Basal diet + 25 ppm chelated copper
4. Basal diet + 50 ppm chelated copper
5. Basal diet + 200 ppm chelated copper
6. Basal diet + 200 ppm copper sulfate

Results

Growth and feed data for this experiment are summarized in table 2. The most rapid gains were made by pigs fed the highest levels of copper, either as chelated or nonchelated copper sulfate. The pigs fed these diets gained 1.83 and 1.85 lb. per day, chelated and nonchelated, respectively, which was approximately 0.1 lb. per day faster than pigs fed the lower levels of chelated copper and slightly faster than the 1.77 lb. per day gain of pigs fed the basal diet. However, none of the differences noted here were statistically significant.

There were no significant differences in feed consumption or feed/gain. The highest daily feed consumption was by pigs fed the basal diet. Feed/gain was highest for pigs fed 12.5 ppm of chelated copper (3.33) and lowest for pigs fed 200 ppm of nonchelated copper (3.14). Previous work at this station has shown that levels of 200 to 250 ppm of copper are more consistently beneficial than lower dietary levels. Also, previous research has shown that a greater response is obtained in the young growing pig with a starting weight of approximately 40 lb. and fed copper for about 8 weeks.

There was no benefit of the chelated copper sulfate compared to the non-chelated copper sulfate in this experiment as the low levels of chelated copper did not elicit a response in performance. Pigs fed diets of 200 ppm of copper performed similarly regardless of the form of copper used.

Summary

One hundred thirty-two pigs of an average initial weight of 69 lb. were fed diets of 0, 12.5, 25, 50 and 200 ppm of added copper. There were no significant differences among treatments in rate of gain, daily feed consumption or feed/gain. Pigs fed low levels of chelated copper, 12.5 to 50 ppm, gained about 0.1 lb. per day slower than pigs fed 200 ppm of chelated or non-chelated copper.

Table 1. Composition of Basal Diet

	Percent
Ground corn	79.6
Soybean meal, 44%	18.0
Dicalcium phosphate	1.1
Limestone	0.8
Trace mineral salt	0.4
Premix[a]	0.1

[a]Supplied per lb. of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 2.5 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 10 mg; choline, 25 mg and vitamin B_{12}, 7.5 micrograms.

Table 2. Effect of Copper on Performance of Growing Pigs

		Chelated copper				Copper sulfate
Copper, ppm	0	12.5	25	50	200	200
Number of pigs[a]	22	20	22	21	21	21
Avg. initial wt., lb.	68.7	69.6	68.9	68.6	69.3	68.7
Avg. final wt., lb.[b]	192.7	188.9	189.7	188.5	190.4	192.3
Avg. daily gain, lb.[b]	1.77	1.70	1.73	1.72	1.83	1.85
Avg. daily feed, lb.	5.76	5.69	5.57	5.51	5.60	5.54
Feed/gain	3.25	3.33	3.23	3.18	3.22	3.14

[a]Three replicates of 8, 8 and 6 pigs per pen initially. Data included only for those pigs that completed the experiment.

[b]Significant difference (P<.01) between barrows and gilts.

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A.S. Series 76-32

High Protein Oats in Pig Starter Diets

Richard C. Wahlstrom and George W. Libal

Previous research has shown that a variety (Dal) of high protein oats which contained over 16% protein and 0.66% lysine could be used to replace up to 60% of the grain in growing-finishing pig diets. In addition, it was possible to reduce the amount of supplemental protein in the diet because of the higher lysine content of this oats. Recently the South Dakota Station has developed a new oats variety (Spear) that is also high in protein and lysine, being similar to Dal oats in content of these nutrients.

The objective of this experiment was to determine the level of Spear oats that could be used in young, weaned pig starter diets when diets contained equal amounts of lysine.

Experimental Procedure

One hundred twenty-six crossbred pigs averaging approximately 18 lb. were allotted on the basis of weight and ancestry to three replicates of seven treatments. Each lot contained six pigs. The pigs were housed in an enclosed building having solid concrete floors that were bedded with shavings. Feed and water were provided *ad libitum* during the 4-week experiment.

The composition of the diets is shown in table 1. The Spear oats contained 15.6% protein and 0.65% lysine. All diets were formulated to contain 0.92% lysine. The experimental treatments were as follows:

1. Corn-soy diet (no oats)
2. 10% oats
3. 20% oats
4. 30% oats
5. 40% oats
6. 50% oats
7. 60% oats

Results

A summary of the results of this trial are shown in table 2. There were significant differences in rate of gain, feed/gain and daily feed consumption among treatments. Levels of 10 and 20% high protein oats resulted in faster and more efficient gains than those obtained when pigs were fed the control, corn-soybean meal diet. Both rate of gain and feed efficiency decreased progressively with increasing levels of oats above 20%. However, performance of pigs fed the 30% oat diet was similar to performance of pigs fed the corn-soybean meal diet. The oats in the 30% oat diet constituted approximately 40% of the grain portion of that diet. This diet also contained 4.2% less soybean meal than the control diet, but they were of equal lysine content.

Diets containing 40, 50 and 60% oats were quite bulky and some difficulty was experienced with these diets bridging in the feeders. Although feeders were checked several times a day to insure that feed was in the feed compartments, it is possible that some degree of feed restriction may have been imposed on these pigs.

Most pigs did not gain weight during the first week of the experiment. We have found that weaning pigs at a weight of approximately 18 lb., as in this experiment, results in about a 2-week adjustment period before they are eating and gaining well. However, the amount of oats in the diet did not appear to affect feed consumption during this adjustment period except for the levels of 50 and 60% oats. These two diets were not consumed as readily, possibly because of their high fiber level.

Summary

A trial was conducted using 126 crossbred pigs averaging 18 lb. to evaluate various levels of high protein (Spear) oats in starter diets for weanling pigs.

The results of this trial indicate that high protein oats can constitute at least 30% of the diet without significantly affecting performance of young pigs. Pigs fed diets of 10 or 20% oats gained faster and more efficiently than those fed corn as the only grain, while pigs fed diets of 50 or 60% oats gained less and required more feed/gain. Diets containing 40% oats or more did not feed down in the self-feeders as well as diets containing a lower level of oats. Approximately 5.5% less supplemental protein was needed with each 10% level of high protein oats in the diets or 10 lb. of oats replaced approximately 8.6 lb. of corn and 1.4 lb. of soybean meal.

Table 1. Composition of Diets (Percent)

Ingredients	Percent of high protein oats						
	0	10	20	30	40	50	60
Corn	73.1	64.4	55.8	47.4	38.8	30.2	21.7
Spear oats	--	10.0	20.0	30.0	40.0	50.0	60.0
Soybean meal, 48%	24.2	22.9	21.5	20.0	18.6	17.2	15.7
Dical	1.4	1.4	1.4	1.3	1.3	1.3	1.3
Limestone	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Trace mineral salt	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Premix[a]	0.1	0.1	0.1	0.1	0.1	0.1	0.1

[a]Supplied per lb. of diet: vitamin A, 2000 IU; vitamin D, 200 IU; vitamin E, 3 IU; vitamin K, 1.2 mg; riboflavin, 1.5 mg; pantothenic acid, 6 mg; niacin, 9.6 mg; choline, 30 mg; vitamin B_{12}, 6 mcg; aureomycin, 50 mg; penicillin, 25 mg and sulfamethazine, 50 milligrams.

Table 2. Effect of Various Levels of High Protein Oats on Performance of Young Weaned Pigs

	Level of high protein oats						
	0	10	20	30	40	50	60
Number of pigs[a]	18	18	18	18	18	18	18
Avg. initial wt., lb.	18.2	18.0	18.0	18.0	18.1	18.1	18.3
Avg. final wt., lb.[b]	33.2	36.0	36.2	33.1	32.1	30.3	28.7
Avg. daily gain, lb.[c]	0.54	0.64	0.65	0.54	0.50	0.44	0.38
Daily feed consumed, lb.[c]	1.28	1.38	1.39	1.26	1.15	1.28	0.96
Feed/gain[b]	2.37	2.19	2.26	2.36	2.40	2.95	2.72

[a]Three lots of 6 pigs each per treatment.
[b]Significant difference ($P<.05$) among treatments.
[c]Significant difference ($P<.01$) among treatments.

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A.S. Series 76-33

Lysine and Energy Levels in Growing and Finishing Swine Diets

James L. Girard, George W. Libal and Richard C. Wahlstrom

High feed prices the past few years have stimulated interest in adding fat to swine rations in an attempt to increase feed efficiency and improve rate of gain. Research has shown that, to get maximum utilization of added energy, protein levels in the diet also must be increased to maintain the calorie to protein ratio. In normal corn-soybean meal rations, lysine has been shown to be the first limiting amino acid. The experiment reported here was conducted to determine the lysine levels necessary in diets with and without fat and their effect on feed consumption, feed efficiency and rate of gain.

Experimental Procedure

The experiment consisted of a growing and a finishing trial. In the growing trial 108 crossbred pigs were allotted to 12 experimental treatments in two replicates on the basis of weight, sex and ancestry. In replicate 1 there were 5 pigs per treatment and 4 per treatment group in replicate 2. The growing trial was conducted for 5 weeks. Treatments consisted of two energy levels and six lysine levels within each energy level. Diets were as follows:

Diets 1-6--Low energy, corn-soy-starch
Diets 7-12--High energy, corn-soy-fat

	Lysine content, %
Diets 1 and 7	0.60
Diets 2 and 8	0.65
Diets 3 and 9	0.70
Diets 4 and 10	0.75
Diets 5 and 11	0.80
Diets 6 and 12	0.85

The compositions of the basal diets used in the growing trial are shown in table 1. A low protein (13%) diet containing 0.6% lysine was used with lysine supplemented at increments of 0.05% up to 0.85%.

In the finishing trial 96 crossbred pigs were allotted to 12 treatments, with 4 pigs per pen and two replicates per treatment. The trial was conducted for 5 weeks. Treatments again consisted of two energy levels and six lysine levels within each energy level. Diets were as follows:

Diets 1-6--Low energy, corn-soy-starch
Diets 7-12--High energy, corn-soy-fat

	Lysine content, %
Diets 1 and 7	0.40
Diets 2 and 8	0.45
Diets 3 and 9	0.50
Diets 4 and 10	0.55
Diets 5 and 11	0.60
Diets 6 and 12	0.65

The compositions of the 10% protein basal diets used in the finishing trial are shown in table 2. Lysine was added to the basal diet which contained 0.4% lysine in 0.05% increments up to 0.65%.

All diets were supplemented with minerals and vitamins to meet National Research Council recommendations. Feed and water were provided ad libitum. The animals were housed in uninsulated wooden buildings set on concrete. Feeders and waterers were located on the outside concrete lots to which animals had access at all times. The growing trial was conducted from the beginning of September to mid-October and the finishing trial ran from the end of October to mid-December. Blood samples were taken at the end of each trial for analysis of blood urea nitrogen (BUN).

Results

Growing

Results of the growing trial are shown in table 3. Means for average daily gains did not differ significantly among treatments for either lysine or energy levels and no interaction was observed. Feed efficiency data, although not significantly different, showed a trend toward greater efficiency when rations containing fat were fed.

Blood urea nitrogen (BUN) levels were significantly lower for the higher lysine diets. BUN levels are an indicator of optimum protein or amino acid levels. A lower BUN value indicates fewer amino acids are being used for energy. The higher values obtained for the low lysine diets (1, 7 and 2, 8) indicate these diets were probably deficient in lysine. Diets containing 0.7% lysine or more appeared to be adequate in lysine.

Finishing

Results of the finishing trial are shown in table 4.

Pigs fed the diets containing 5% fat (diets 7-12) were more efficient than pigs fed diets with 5% added corn starch (diets 1-6). No differences were observed in regard to feed efficiency due to different lysine levels.

One interaction between lysine and fat levels existed with respect to average daily feed consumption. As lysine levels increased in the rations without fat, average daily feed consumption decreased for the high lysine rations of 0.60 and 0.65%. For the rations with 5% fat a trend in the opposite direction was observed, as pigs fed the 0.65% lysine diet had the highest average daily feed consumption (figure 1). This may indicate an amino acid imbalance occurred in the starch ration as the lysine level increased.

Summary

One hundred eight crossbred pigs averaging 50.9 lb. were used in the growing trial and 96 crossbred pigs averaging 160.6 lb. in the finishing trial. Both trials were used to study the effect of dietary lysine and energy levels.

BUN values for the growing pigs indicate that optimum lysine levels are around 0.7% of the diet. No increase in requirement was observed with diets containing added fat.

The results indicate that dietary fat improved feed efficiency for finishing pigs and tended to have a similar effect when fed to growing pigs. An interrelationship was observed in the finishing diets between lysine and energy levels. Increasing lysine beyond 0.55% in diets that did not contain fat resulted in decreased consumption, while consumption increased with increasing lysine levels when pigs were fed diets of 5% fat.

Table 1. Composition of Growing Diets (Percent)

	Diet no.	
Ingredients	1-6	7-12
Corn	77.6	77.6
Soybean meal, 44%	14.1	14.1
Corn starch	5.0	--
Fat	--	5.0
Trace mineralized salt[a]	0.5	0.5
Dicalcium phosphate	1.3	1.3
Limestone	1.0	1.0
Premix[b]	0.5	0.5

[a] Contained 0.8% zinc.
[b] Supplied per pound of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 5 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg; vitamin B_{12}, 5 mcg and aureomycin, 10 milligrams.

Table 2. Composition of Finishing Diets (Percent)

Ingredient	Diet no. 1-6	Diet no. 7-12
Corn	86.0	86.0
Soybean meal, 44%	6.2	6.2
Corn starch	5.0	--
Fat	--	5.0
Dicalcium phosphate	1.1	1.1
Limestone	0.7	0.7
Trace mineralized salt[a]	0.5	0.5
Premix[b]	0.5	0.5

[a]See table 1.
[b]See table 1.

Table 3. Effect of Lysine and Fat on Performance of Growing Pigs[a]

Lysine %	0.60	0.65	0.70	0.75	0.80	0.85	Means for energy
Average daily gain, lb.							
Low energy	1.42	1.58	1.40	1.50	1.48	1.44	1.47
High energy	1.50	1.52	1.55	1.43	1.63	1.53	1.53
Means for lysine	1.46	1.55	1.47	1.47	1.55	1.48	
Average daily feed, lb.							
Low energy	4.21	4.58	4.08	4.38	4.03	4.05	4.22
High energy	3.90	4.44	4.01	3.92	4.37	4.04	4.11
Means for lysine	4.05	4.51	4.04	4.15	4.20	4.04	
Feed/gain, lb.							
Low energy	3.00	2.92	2.90	2.96	2.76	2.81	2.89
High energy	2.64	2.96	2.60	2.78	2.70	2.67	2.73
Means for lysine	2.82	2.94	2.75	2.87	2.74	2.74	
BUN, mg %[b]							
Low energy	15.15	13.02	11.95	12.22	12.37	11.06	12.63
High energy	14.89	13.06	12.11	11.74	10.56	11.13	12.25
Means for lysine	15.01	13.04	12.03	11.98	11.46	11.09	

[a]Nine pigs per treatment--average initial weight 50.9 lb., average final weight 103 lb.

[b]Significant difference due to lysine, mg % decrease at decreasing rate as lysine increases (linear, $P<.005$; cubic, $P<.05$).

Table 4. Effect of Lysine and Fat on Performance of Finishing Pigs[a]

Lysine %	0.40	0.45	0.50	0.55	0.60	0.65	Means for energy
Average daily gain, lb.							
Low energy (starch)	1.84	1.93	1.93	1.95	1.75	1.62	1.84
High energy (fat)	1.74	1.81	1.96	1.97	1.98	1.96	1.90
Means for lysine	1.79	1.87	1.95	1.96	1.86	1.79	
Average daily feed, lb.[b]							
Low energy	7.58	8.44	8.00	8.05	7.23	6.52	7.64
High energy	7.32	7.56	7.38	7.48	7.52	7.84	7.52
Means for lysine	7.46	8.00	7.69	7.76	7.38	7.18	
Feed/gain, lb.[c]							
Low energy	4.14	4.42	4.14	4.12	4.13	4.04	4.17
High energy	4.22	4.18	3.78	3.80	3.80	4.00	3.96
Means for lysine	4.18	4.30	3.96	3.96	3.96	4.02	
BUN, mg %							
Low energy	13.59	14.71	15.38	16.94	14.53	11.94	14.51
High energy	15.61	15.94	14.14	11.39	11.39	12.60	13.71
Means for lysine	14.60	15.32	14.76	14.17	13.54	12.27	

[a]Eight pigs per treatment--average initial weight 160.6 lb., average final weight 225 lb.
[b]Interaction between fat and lysine ($P<.05$).
[c]Significantly greater feed/gain for low energy than for high energy ($P<.05$).

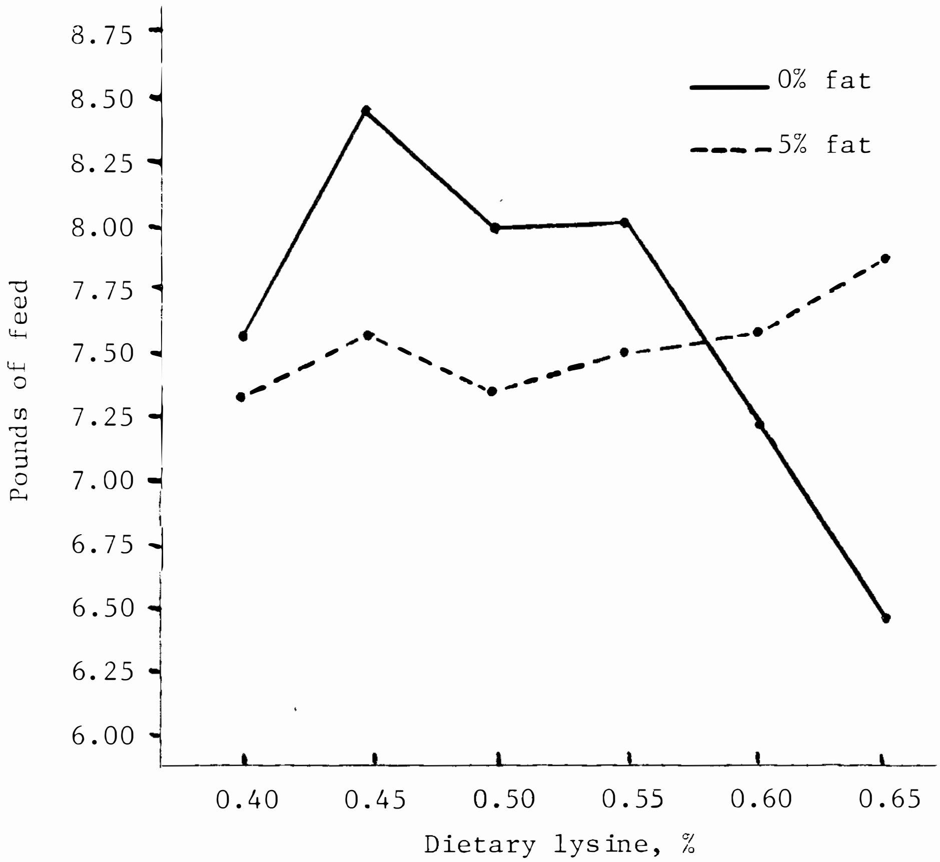

Figure 1. Effect of dietary lysine level and fat control.

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A.S. Series 76-34

Procedures to Evaluate Market Pigs

Dan H. Gee

For a number of years there has been a growing demand for a uniform system of market hog evaluation. The pork industry wanted a system where the basic figures from production and carcass information could be combined and results obtained for industry comparison. After 2 years of study by the National Pork Producers Council in cooperation with the American Meat Science Association, a new system of market hog evaluation based on percent or pounds of lean muscle in total carcass weight was initiated. The National Pork Producers Council hopes the system will meet the demands of the pork industry for a uniform evaluation system.

Percent of muscle in total carcass weight replaces percent of ham and loin as the standard. The percent of muscle figure along with age is used to determine the number of days pigs require to produce 85 lb. of lean. Age required to produce 85 lb. of lean serves as an arbitrary base to compare pigs. A 156 lb. carcass that has 4.4 sq. in. of loin eye area and 0.8 in. fat at the tenth rib will yield about 85 lb. of muscle or 54.5% of carcass weight in lean muscle.

To find percent or pounds of muscle, three measurements are used: hot carcass weight (lb.), loin eye area (sq. in.) and fat depth (in.) at the tenth rib. The tenth rib fat measurement replaces the average backfat measurement which was the average of measurements at the first rib, last rib and last lumbar vertebrae.

The guidelines that have been developed are an attempt to identify market pigs that excel in production efficiency and carcass desirability. The following guidelines as established by the National Pork Producers Council include methods for combining production records, live visual appraisal and carcass characteristics.

Recommended Procedures to Evaluate Market Pigs

Step 1 -- The pig should first meet the following MINIMUM STANDARDS:

A. Production information--provided by the producer.
   1. Birth date. When desired by the management, each producer should provide an age certificate which has been verified by a representative designated by the management.
   2. Minimum litter size of eight pigs if first litter and nine if produced by a sow.
   3. Minimum litter weight at 21 days of age of 95 lb. if first litter and 110 lb. if produced by a sow.
   4. When available a maximum of 3 lb. feed required per live lb. of gain from 60 lb. to slaughter.

B. Live Visual Observations--established by one or more experienced and knowledgeable evaluators.
   1. Free from obvious infections, injuries, hernias and blindness.
   2. Minimum score of 2 in structural soundness of feet and legs (1 = structurally unsound, 2 = slight structural abnormality, 3 = sound).
   3. Should not be a late castrate.
   4. Free of symptoms related to porcine stress syndrome.

C. Carcass Traits--established by one or more experienced and knowledgeable evaluators.
   1. Free of arthritis, abscesses and other obvious diseases and abnormalities.
   2. Free of cryptorchidism.
   3. Minimum carcass length of 29.5 inches.
   4. Minimum adjusted hot carcass weight of 140 lb.
   5. Maximum trim loss of 3% of carcass weight.
   6. Muscle color score should range from 2 to 4 (1 = pale, 2 = slightly pale, 3 = normal, 4 = slightly dark, 5 = dark).
   7. Muscle marbling score should range from 2 to 4 (1 = traces, 2 = slight, 3 = small, 4 = moderate, 5 = abundant).
   8. Muscle should be firm and free of excess surface juices.
   9. Should meet the following breed certification standards: Carcasses should meet minimum carcass certification standards established by the breed associations. For interbreed competitions including crossbreds, the standards should be those established by the National Association of Swine Records. The following certification standards are based on 220 lb. live weights. Adjustments should be made for pigs not weighing 220 pounds.

Breed	Carcass length (inches)	Average backfat skin-on, (inches)	Loin eye area (10th rib, sq. in.)	Days to 220 pounds
Hampshire	29.5	1.5	4.50	175
Spotted swine	29.5	1.5	4.75	180
All other breeds and crossbreds	29.5	1.5	4.50	180

Step 2 -- If the pig meets the standards established in Step 1, then it is ranked according to the following procedure:

A. Determine age of pig in days.

B. Determine total pounds of muscle in carcass by using the following formula (to determine percent muscle, divide pounds of muscle by hot carcass weight):

Pounds of muscle = 2.0 + (hot carcass weight, lb., x 0.45) + (loin eye area, sq. in., x 5.0) - (10th rib fat, in., x 11.0)

C. Determine the number of age units required to produce 85 lb. of muscle. Use the following formula:

$$\text{AGE UNITS REQUIRED TO PRODUCE 85 POUNDS OF MUSCLE} = \left[\frac{(85 \times \text{age at slaughter}) - 5100}{\text{Pounds of muscle}}\right] + 60$$

D. Except under special circumstances (i.e., poor underlines), it is not recommended to exhibit market gilts. However, if permitted by the management, the age units required to produce 85 lb. of muscle should be adjusted by subtracting two units for gilts.

E. Rank pigs on the basis of adjusted number of age units required to produce 85 lb. of muscle. The pig requiring the fewest number of units would rank first.

A barrow, 160 days of age, that met all minimum standards and produced a 160 lb. carcass with 5.0 sq. in. of loin eye area and a fat depth of 1.0 in. would, according to the formula in Step 2-B, yield 88 lb. of muscle. The final step would be to determine age units required to produce 85 lb. of muscle. According to the formula in Step 2-C, the barrow would require 157 days or age units to produce 85 lb. of lean.

Local circumstances will often not permit attainment of all the information covered in this evaluation format. If the available information is put in standard form, it would provide a degree of standardization for the industry. It is hoped that these guidelines can be used in part or in total by anyone in the industry at any location to make comparisons of animals, test station pigs, etc. It should also improve the efficiency of administering contests, especially in the collection and interpretation of carcass data.

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A.S. Series 76-35

Compensatory Growth of Swine Following Protein Insufficiency

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It has been observed (A.S. Series 71-39) that, when pigs are fed abnormal protein sequences of low protein followed by high protein diets, they tended to compensate somewhat for the poorer performance during the early stage of growth by improved performance during the later growth period. If protein level sequence can be altered in this way, it would mean less supplemental protein necessary and more economical production.

The study reported herein was designed to study the ability of the pig to compensate for reduction in gain and efficiency of gain due to a low protein diet during an early growth period when fed adequate or excess protein during a later growth period.

Experimental Procedure

One hundred twenty-six pigs with an average starting weight of 55 lb. were used in three replicates of six dietary treatments. Each pen consisted of four gilts and three barrows. The pigs were randomly allotted on the basis of sex, weight and ancestry. The pigs were housed in an environment-modified building with slatted floors. The six dietary treatments were protein sequences fed during growth periods from 55 to 115 lb., 115 to 175 lb. and from 175 lb. to market weight of approximately 230 pounds. The treatments and dietary sequences were:

Treatment	Protein sequences (%)
1	12 - 12 - 12
2	12 - 14 - 12
3	12 - 16 - 12
4	16 - 12 - 12
5	16 - 14 - 12
6	16 - 16 - 12

During the first growth period, optimum performance was expected from pigs receiving 16% protein and poor performance was expected from pigs receiving 12% protein. During the second growth period 12% protein was considered inadequate, 14% protein adequate and 16% protein in excess of the pig's requirement. During the third growth period, all pigs received 12% protein diets. Composition of the three diets is shown in table 1.

Results

The average daily gain response to dietary protein levels is shown in table 2. Average daily gain is listed by growth periods and on an accumulative basis from the start of the trial. The table lists the response due to dietary protein during the first growing period (left side), second growing period (middle), and the combination of all growing periods (right side).

Pigs receiving 12% protein from 55 to 115 lb. live weight gained significantly slower, 1.41 lb. per day vs. 1.77 lb. per day, than those receiving 16% protein during this period. However, during the second and third growth periods the average gain of pigs in treatments 1, 2 and 3 was slightly, but not significantly, faster than the average gain of pigs in treatments 4, 5 and 6. On an accumulative basis, the difference in gain due to protein levels during the initial growth period still existed at the end of the experiment. Daily gains for the total experiment averaged 1.57 and 1.66 lb. for pigs fed 12 or 16% protein, respectively, during the initial growth period.

Gains were significantly different due to protein levels fed during the second growth period. Pigs receiving 16% or 14% protein diets during this period gained faster than those pigs receiving 12% protein, indicating that 16% and 14% protein were adequate or in excess of the pig's protein requirement from 115 to 175 pounds.

During the third growth period all treatment groups were fed the 12% protein diet and gains were equal for pigs which had received the three different protein levels during the second growth period. On an accumulative basis no difference in gain was observed at market time due to the different protein levels fed during the 115 to 175 lb. period.

Average daily gains of the six treatments varied considerably during the three growth periods. However, accumulative gain for the entire experiment indicates that pigs fed the 12-12-12% protein sequence had the poorest daily gains, 1.48 lb., compared to gains of 1.60 to 1.69 lb. for the other treatments. Compensatory gains of pigs fed the 12-16-12% protein sequence occurred during the 115 to 175 lb. period when these pigs gained 1.83 lb. daily compared to 1.66 lb. for pigs fed the 16-16-12% protein sequence. For pigs fed the 12-14-12% protein sequence, compensatory gains occurred during the 175 to 230 lb. period when they gained 1.75 lb. per day compared to 1.45 lb. for pigs fed the 16-14-12% protein sequence.

Feed efficiency (table 3) followed the same pattern as average daily gain. Feed/gain was better for pigs receiving 16% protein during the initial growth period and for pigs receiving either 14% or 16% protein during the second growth period. When the treatments were combined, no significant differences were observed due to protein sequence. However, the poorest performance again was observed when pigs received the 12-12-12% protein sequence. Pigs receiving the 12-14-12% and 12-16-12% protein had a closer feed/gain ratio to those pigs that received 16% protein during the initial growth period. This hints at compensatory performance when adequate or excess protein follows suboptimum performance from inadequate protein.

Summary

One hundred twenty-six pigs were utilized to study compensatory performance due to a low protein diet during an early growth period followed by higher protein levels during the subsequent growth period. Pigs receiving 16% protein during the 55 to 115 lb. growth period gained faster and more efficiently than pigs receiving 12% protein. During the 115 to 175 lb. growth

period pigs receiving 14% or 16% protein performed better than pigs receiving 12% protein. The data showed a trend for compensatory performance when pigs had received a protein-deficient diet from 55 to 115 lb. and an adequate or excess protein level during the 115 to 175 lb. growth period.

Table 1. Composition of Experimental Diets (%)

Ingredient	Protein levels 12%	14%	16%
Corn	87.5	81.9	76.2
Soybean meal, 44%	9.3	15.0	20.7
Dicalcium phosphate	1.3	1.2	1.2
Limestone	0.9	0.9	0.9
Trace mineral salt, 1.0% zinc	0.5	0.5	0.5
Vitamin premix[a]	0.5	0.5	0.5

[a]Supplied per lb. of diet: vitamin A, 1500 IU; vitamin D, 150 IU; vitamin E, 5 IU; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg; vitamin B_{12}, 5 mcg and aureomycin, 10 milligrams.

Table 2. Average Daily Gain by Periods and Accumulative

	Treatments											
	1,2,3	4,5,6	1,4	2,5	3,6	1	2	3	4	5	6
	Protein %											
55-115 lb.	12	16				12	12	12	16	16	16
115-175 lb.			12	14	16	12	14	16	12	14	16
175-230 lb.						12	12	12	12	12	12
	Average Daily Gain by Period, Lb.											
55-115 lb.	1.41	1.77**	1.62	1.58	1.58	1.41	1.38	1.45	1.84	1.77	1.71
115-175 lb.	1.69	1.63	1.55	1.69	1.74**	1.54	1.70	1.83	1.55	1.68	1.66
175-230 lb.	1.62	1.59	1.62	1.60	1.61	1.53	1.75	1.59	1.71	1.45	1.62
	Average Daily Gain Accumulative, Lb.											
55-115 lb.	1.41	1.77**	1.62	1.58	1.58	1.41	1.38	1.45	1.84	1.77	1.71
55-175 lb.	1.55	1.69**	1.57	1.63	1.65	1.47	1.54	1.63	1.68	1.72	1.67
55-230 lb.	1.57	1.66**	1.59	1.61	1.63	1.48	1.60	1.61	1.69	1.63	1.66

**Significant difference P<.01.

Table 3. Feed/gain by Periods and Accumulative

	Treatments										
	1,2,3	4,5,6	1,4	2,5	3,6	1	2	3	4	5	6
	Protein %										
55-115 lb.	12	16				12	12	12	16	16	16
115-175 lb.			12	14	16	12	14	16	12	14	16
175-230 lb.						12	12	12	12	12	12
	Feed/gain by Periods										
55-115 lb.	3.21	2.49**	2.94	2.83	2.79	3.35	3.21	3.08	2.53	2.45	2.49
115-175 lb.	3.38	3.33	3.70	3.14	3.22*	3.83	3.21	3.11	3.58	3.06	3.34
175-230 lb.	4.04	3.81	4.13	3.79	3.86	4.54	3.60	3.99	3.72	3.97	3.74
	Feed/gain Accumulative										
55-115 lb.	3.21	2.49**	2.94	2.83	2.79	3.55	3.21	3.08	2.53	2.45	2.49
55-175 lb.	3.29	2.90**	3.32	2.97	3.00*	3.59	3.19	3.09	3.04	2.74	2.91
55-230 lb.	3.57	3.18*	3.58	3.27	3.28	3.91	3.43	3.38	3.26	3.10	3.18

*Significant difference P<.05.
**Significant difference P<.01.