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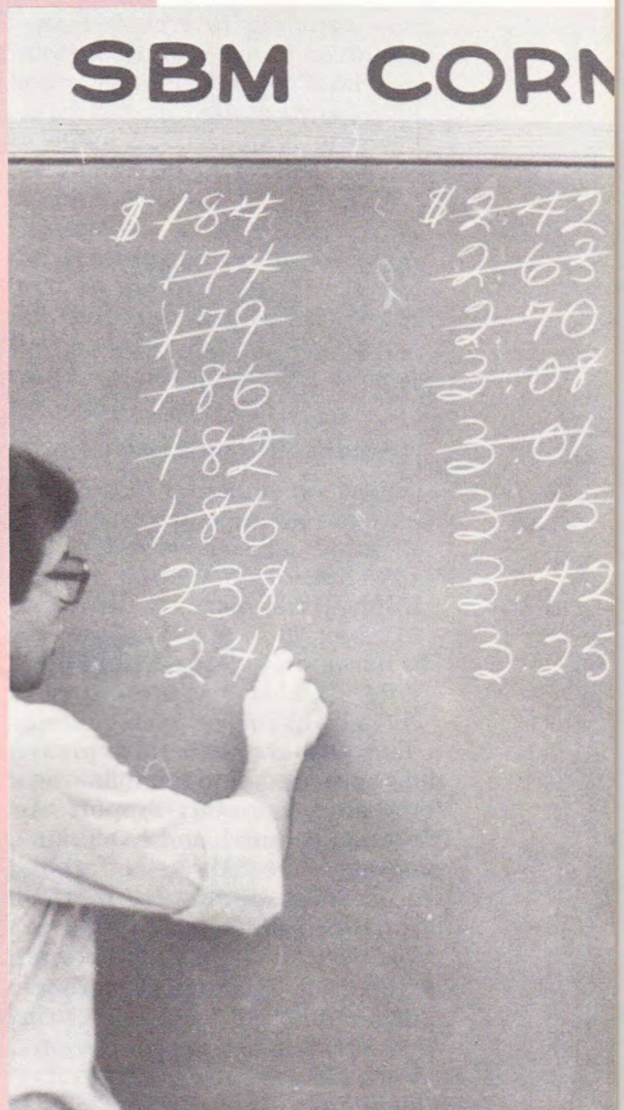
NEBRASKA SWINE REPORT



- Breeding
- Disease Control
- Nutrition
- Economics
- Housing

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For use in Extension, Teaching, and Research programs

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Raw Soybean Value for Gestating Swine

Mark Crenshaw
Murray Danielson[1]

Since the 1930's pork producers have known that raw soybeans contain anti-growth factors. Use of raw soybeans in swine diets has been discouraged because of decreased pig performance. Anti-growth factors in raw soybeans are destroyed when beans are heated at the proper temperature. The result is an excellent source of supplemental protein.

Soybean meal, a by-product of the soybean oil industry, has been effectively used by the swine industry as a source of supplemental protein. Soybean meal is produced from raw soybeans by processes requiring energy to remove the oil from the beans. Roasting and extruding raw soybeans also requires energy expenditure, adding extra cost to diets using these products.

Raw Soybean Advantages

Previous research has indicated that gestation diets supplemented with fat improved pig survival rate. At least three advantages could be realized if raw soybeans could be used in sow diets: (1) oil content of raw soybeans could increase the crude fat content of the diet without the mixing problems, (2) energy could be conserved, and (3) cost of the diet could be reduced.

Recent research at the North Platte Station shows that a practical approach for utilizing raw soybeans in swine diets may exist. Sixty crossbred gilts, about eight months of age, were bred and randomly allotted to two dietary treatments (Table 1). Diet I (SMB) contained 16.4% soybean meal whereas Diet II contained 25.4% raw soybeans (RSB). The difference in the percentage of raw soybeans and soybean meal in the diets is due to their protein content. Raw soybeans used in this study contained 32% crude protein compared to 44% in the soybean meal. Since these diets were formulated based upon a 14% crude protein diet, a greater quantity of raw soybeans was required than soybean meal.

Gilts were maintained in outside lots until 110 days of gestation. All gilts were fed their respective dietary treatments in a complete ground meal form in individual feeding stalls. They were fed four pounds per gilt per day. No antibiotic was fed in this study.

Grinding and mixing the raw soybeans created no problem. A ⅛" screen was used in a conventional stationary hammer mill. Raw soybeans contain about 18% fat or oil and require proper care and management during storage.

Table 1. Composition of gestation diets.

	Diet	
Supplement source[a]	I-SBM	II-RSB
Ingredient		
Corn	77.03	68.01
Soybean meal (44%)	16.42	-----
Raw soybeans	-----	25.38
Alfalfa hay	2.50	2.50
Limestone	.40	.63
Dicalcium phosphate	2.50	2.33
Salt (iodized)	.30	.30
Trace mineral mix[b]	.05	.05
Vitamin premix[c]	.80	.80
	100.00	100.00
Analysis		
Protein (calculated)	14.00	14.00
Fat (determined)	3.07	7.31
Calcium (calculated)	.90	.90
Phosphorus (calculated)	.80	.80
Lysine (calculated)	.69	.79
Est. ME(Kcal/lb) (calculated)	1442.00	1503.00

[a]SBM—Soybean meal and RSB—Raw soybeans.
[b]Calcium Carbonate Company, swine, 20% zinc.
[c]Contributed the following amounts per pound of complete diet: Vitamin A, 25051U; Vitamin D, 252 IU; riboflavin, 2.5 mg; niacin, 15 mg; calcium pantothenate, 9 mg; choline chloride, 250 mg; and Vitamin B_{12}, 7.5 mcg.

If ground raw soybeans are stored for any length of time, especially during warm weather, use an antioxidant to prevent deterioration in quality (rancidity) which could reduce palatability.

At 110 days of gestation gilts were moved to a central farrowing house. All were fed the same balanced diet ad libitum throughout lactation. Soybean meal provided the supplemental protein for the lactation diet.

After gilts were removed from the farrowing house, they were rebred on the first estrus cycle and fed the same diet as during the first gestation. Experimental procedure was maintained the same as for the first parity.

No Interference with Growth

Results of this study are discussed by parity. The values reported in the tables are average values for the two parities completed. For each parity, animals were weighed at breeding, again at 80 and 110 days, 24 hours post-partum, and at 21 day weaning (Table 2). After adjusting dam weights for the difference in breeding weights, there was no significant difference in the animal weights at any of the weigh periods. Gestation weight gain and lactation weight losses were not different between the two dietary groups for either parity. Since there was no difference in the gestation weight gain for either parity, it appears the anti-growth factors of raw soybeans did not interfere with the growth and maintenance of gestating gilts or sows.

Out of a possible 60 litters for each dietary group, (30 litters per parity), 59 were farrowed for the control group and 60 for the raw soybean group. There was no difference in the average number of pigs farrowed by each group. At day 7, 14, and 21 of lactation, there were more pigs in the raw soybean group than the group fed soybean meal (Table 3). For the first parity, gilts fed raw soybeans during gestation weaned about 10% more pigs than the gilts fed soybean meal.

(continued on next page)

Value of Raw Soybeans

(continued from page 3)

Survival percentage for the second parity was improved slightly (1.36%) for the raw soybean group compared to the group fed soybean meal. After two parities, average survival percent for the control group was 83.69% compared to 88.91% for the group fed raw soybeans during gestation. It appears from these data that when raw soybeans are used in gestation diets, the greatest response in percent survival may be observed for gilts rather than sows. One possible explanation for the 10% improvement in survival may be the higher energy value of raw soybeans. Gilts fed the raw soybean diet consumed more energy than gilts fed soybean meal.

Pigs were weighed at birth, 7, 14, and 21 days of age (Table 4). Average pig birth weight for the first parity was not significantly different. However, for the second parity, average pig birth weight was greater for pigs from dams fed raw soybeans during gestation. There were no differences in pig weight between the two dietary groups at days 7, 14, or 21. Since pigs from dams fed raw soybeans were heavier at birth, one might expect the pigs to be heavier at weaning. This would seem logical, but there was about one pig per litter more at weaning for the raw soybean group than the control group. Also, all sows were fed the same diet throughout lactation. No difference in animal feed consumption during lactation was observed for either parity.

Table 2. Dam weight response, average for two parities.

	Diet	
Supplement source	I-SBM	II-RSB
Animal weight (lb)*		
At breeding	312	295
80 days	366	356
110 days	405	391
Post-partum (24 hours)	371	356
At weaning (21 days)	355	336
Gestation weight change[a]	93	96
Post-partum weight change[b]	59	61
Lactation weight change[c]	−16	−20

[a]Gestation weight change = 110 day weight–breeding weight.
[b]Post-partum weight change = post-partum weight-breeding weight.
[c]Lactation weight change = weaning weight–post-partum weight.

Table 3. Average litter performance, average for two parities.

	Diet	
Supplement source	I-SBM	II-RSB
Litter performance		
No. litters	59	60
Avg. pigs farrowed live	9.66	9.92
Avg. pigs at 7 days	8.49	9.22
Avg. pigs at 14 days	8.17	8.97
Avg. pigs at 21 days	8.08	8.82
Survival, %	83.68	88.91

Raw Soybeans Can Be Effective

In summary, feeding raw soybeans compared to soybean meal as a source of supplemental protein from breeding to 110 days of gestation resulted in:

—No effect on sow weight changes during gestation or lactation.

—No effect on sow feed consumption during lactation.

—No effect on number of pigs farrowed live.

—Heavier pig birth weight for the second parity (sows).

—No effect on pig weaning weight for either parity.

—Improved pig survival rate of about 10% for the first parity gilts.

—Improved pig survival rate of about 5% for the average of two parities.

It appears that ground raw soybeans can be effectively used as a source of supplemental protein for gestating swine.

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[1]Mark Crenshaw is Swine Operations Manager, North Platte Station. Murray Danielson is Professor, Swine Nutrition, North Platte Station.

Table 4. Average pig weight, average for two parities.

	Diet	
Supplement source	I-SBM	II-RSB
Litter performance (lb)		
Birth weight	3.37	3.56
7 day weight	6.18	6.29
14 day weight	9.26	9.35
21 day weight	12.45	12.45

Raw Soybeans for Growing Finishing Pigs

Mark Crenshaw, Murray Danielsen[1]

The value of raw soybeans as a source of supplemental protein in diets of growing-finishing pigs has been studied for more than 50 years.

Previous research has shown raw soybeans to contain anti-growth factors for pigs, poultry, and rats. Considerable research has been devoted to identify the anti-growth properties of raw soybeans. No conclusive evidence has been reported identifying these properties. However, research has found methods of heating raw soybeans which destroy the anti-growth properties, yielding a product suitable as a swine diet supplement. These methods include roasting, extruding, and solvent extraction. The most common soybean meal product is produced at the expense of energy, equipment, and labor. Therefore, the processing of raw soybeans for protein supplement in swine diets may increase the cost.

Previous studies indicate acceptable use of raw soybeans for finishing pigs weighing in excess of 120 lb. The response of gestating gilts fed diets containing raw soybeans at the North Platte Station was enticing enough so that we broadened our studies to include the use of raw soybeans in growing and finishing diets.

Study Design

The study evaluated the effect of feeding diets containing raw soybeans to growing and finishing pigs in three weight ranges. Within each of the three weight groups there were three diet treatments. A total of 216 crossbred pigs were involved.

The three weight groups were 50, 100, and 150 lb. Pigs within each weight group were randomly assigned, six pigs per pen, with four replications to the three dietary treatments. Treatment I was a balanced corn-soy diet (control diet). Treatment II was the same as treatment I except that raw soybeans replaced the soybean meal on an equal weight basis. For treatment III, raw soybeans replaced soybean meal and the diet was formulated similar to treatment I in crude protein content. Diets were fed ad libitum.

Pigs allotted to the 50 lb weight group were initially fed diets based on an 18% protein diet. As each pen of pigs averaged about 100 lb, diets were formulated on a 16% protein basis. As the pigs in each pen averaged about 150 lb, they were fed diets based on a 14% protein level. Each replication was ended when pigs fed the control diet, treatment I, averaged about 210 lb.

Results and Conclusions

Regardless of the weight group, pigs fed diets supplemented with raw soybeans did not grow as well as pigs fed the diet supplemented with soybean meal (Table 1). Feed intake was reduced for pigs fed the raw soybean supplemented diets. Pigs that consumed the raw soybean supplemented diets required more feed per unit of gain than the pigs fed diets containing soybean meal.

Based on this study, the use of raw soybeans as a source of supplemental protein for growing and finishing swine diets is not recommended. However, since others have found that 150 lb pigs grow well on raw soybeans, further research is needed.

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[1]Mark Crenshaw is Swine Operations Manager, North Platte Station. Murray Danielson is Professor, Swine Nutrition, North Platte Station.

Table 1. Performance of growing and finishing pigs fed diets supplemented with raw soybeans.

Criteria	Diet treatment[a] I	II	III
Group I—50 lb, 98 day termination			
Avg. initial wt., lb	54.01	55.04	53.68
Avg. final wt., lb	213.25	134.13	134.16
Avg. daily gain, lb	1.63	.81	.82
Avg. daily feed intake, lb	5.27	3.65	3.83
Feed/gain ratio	3.25	4.49	4.73
Group II—100 lb, 56 day termination			
Avg. initial wt., lb	102.00	101.79	101.75
Avg. final wt., lb	210.00	166.00	172.42
Avg. daily gain, lb	1.93	1.15	1.26
Avg. daily feed intake, lb	6.90	5.67	5.85
Feed/gain ratio	3.58	4.95	4.64
Group III—150 lb, 28 day termination			
Avg. initial wt., lb	152.88	153.30	153.13
Avg. final wt., lb	203.96	190.08	187.88
Avg. daily gain, lb	1.83	1.32	1.24
Avg. daily feed intake, lb	7.42	6.66	6.48
Feed/gain ratio	4.15	5.23	5.32

[a]I—Balanced corn-soy diet.
II—Raw soybeans replaced the soybean meal in Diet I on equal weight basis.
III—Raw soybeans were used in place of soybean meal and the diet was formulated to be isonitrogenous with Diet I.

An Economic Problem

Rapid Return to Estrus

Duane Reese
E. R. Peo, Jr.[1]

Efforts to maintain a full farrowing house are futile when sows fail to come in heat shortly after weaning. Substituting gilts for sows that do not cycle on schedule will help minimize loss of production efficiency. However, delayed estrus following weaning occurs at a higher rate in first litter sows than multiparous sows. Thus, by substituting gilts for sows we are applying only a "temporary fix" to the overall problem.

The problem of delayed estrus has been reported since the late 1960's. Several studies indicate that the percentage of sows in estrus by 7 days postweaning ranges from 27 to 78%. We have conducted several experiments recently to determine why delayed estrus occurs and to find ways to solve the problem.

Energy the Problem?

The amount of energy consumed or used by the sow during lactation may contribute to delayed estrus. A total of 235 first and second litter crossbred sows were fed either 8,000, 12,000 or 16,000 kilocalories of metabolizable energy daily during lactation. These energy intakes correspond to a daily intake of 6, 9 or 12 pounds of a normal corn-soybean meal lactation diet. Following weaning sows were fed 4 pounds daily. They were heat checked once daily with boars.

As expected, sow weight and backfat loss during lactation increased as energy intake decreased (Table 1). Sows were utilizing body reserves to compensate for their inadequate energy intake. Also, fewer sows fed the low energy diet

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Return to Estrus

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during lactation were in estrus by 7, 14, 21 and 70 days postweaning compared to sows fed either the medium or high energy diet (Table 1). Data indicate that severe energy restriction (8,000 kcal of metabolizable energy/day) during lactation will delay the occurrence of postweaning estrus in sows. It is also important to note how rapidly sows fed the medium and high energy diet returned to estrus after weaning.

Seventy-four percent of the sows fed the low diet returned to estrus by 14 days following weaning and apparently were not affected by energy restriction. What was different about those that returned to estrus by day 14 postweaning than the 26% that did not?

To answer this question, sows fed the low energy diet that returned to estrus by day 14 postweaning were compared to those fed the same diet that did not return to estrus. Results from three studies are shown in Figure 1. In each experiment sows in the non-return group had less backfat at weaning (indicative of greater backfat loss during lactation) than those in the return group. The results demonstrate that if backfat loss in lactating sows can be minimized, the interval from weaning to return to heat will be reduced.

Effects of energy restriction were so severe that 14% of the sows fed the low energy diet did not express estrus by 70 days postweaning. These sows were suspected of being hyperthyroid because they were nervous and had some body weight and backfat loss (16.5 pounds and .1 in, respectively) from weaning to 70 days following weaning. Blood samples obtained on days 15 and 22 postweaning were analyzed for thyroxin and compared to serum values from six normal cycling sows fed the high energy diet during lactation. The normal cycling sows were bled on day 1 postweaning and they showed estrus by day 7 postweaning.

Table 1. Effect of energy intake during lactation on sow weight and backfat loss during lactation and the cumulative percentage of sows in estrus by various days postweaning.

Item	Diet energy Low	Medium	High
No. of sows	104	28	108
Daily energy intake Kcal ME	8,000	12,000	16,000
Weight change, lb	−51.7	−29.3	−3.6
Backfat change, in.	−.3	−.2	−.1
Percentage in estrus			
by 7 days	60	91	97
by 14 days	74	96	99
by 21 days	74	96	99
by 70 days	86	96	100

The blood thyroxine values suggest that the anestrus sows showing nervousness were hyperthyroid. Their thyroxin concentration was considerably higher than normal cycling sows (Table 2). Further research is necessary to determine the relationship between thyroxine (thyroid status) and delayed estrus following weaning.

Table 2. Blood thyroxin levels in anestrous and normal cycling sows.

Sow group	Thyroxin, µg/100 ml	Range, µg/100 ml
Anestrous[a]	6.0	4.0 to 8.0
Normal cycling[b]	2.6	2.3 to 3.1

[a]Sows that did not come in heat by 70 days postweaning.
[b]Sows that came in heat by 7 days postweaning.

Full Feed Recommended

From results of our research, we can conclude that energy restriction to 8,000 kcal of metabolizable energy/day (i.e., about 6 lb of feed) will delay return to estrus in sows. It is evident that loss of body fat during lactation is associated with the estrus delay problem. Therefore, to minimize loss of body reserves during lactation, sows should be on full feed by at least 4 to 5 days following farrowing. Energy consumption should be in excess of 12,000 kcal of metabolizable energy daily (i.e., at least 10 pounds of a normal corn-soybean meal fortified diet) to help assure a rapid return to estrus.

Recent reports indicate that some highly productive sows while on "full feed" during lactation will voluntarily consume only 6-9 pounds daily. Insuring that farrowing house temperatures remain in the range of 65-70°F, that fibrous feedstuffs (i.e., beet pulp, wheat bran, etc.) do not exceed 10% of the diet, that plenty of water is available, that feed quality is acceptable and that energy consumption by the sow during gestation is correct should promote adequate feed consumption during lactation.

[1]Duane Reese is a graduate student. E. R. Peo, Jr., is Professor–Swine Nutrition.

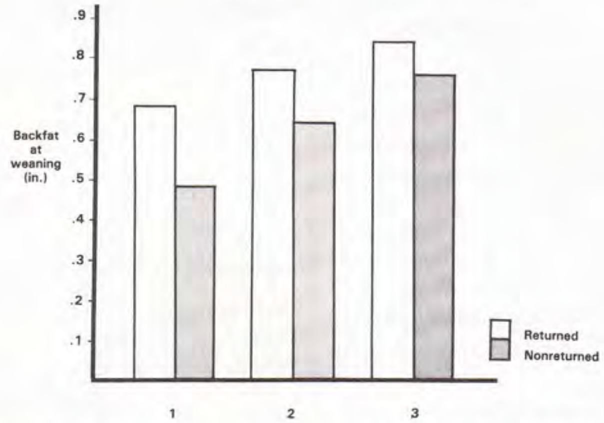

Figure 1. Backfat thickness at weaning of sows fed the low energy diet during lactation that returned or did not return to estrus by day 14 postweaning. Returned v. non-return groups differ (P<.10) in each experiment.

Adequate Energy Improves Sow Productivity

Jim L. Nelssen
Austin J. Lewis[1]

An important component of modern swine production is reproductive efficiency including the length of the interval from weaning to first estrus. A short interval is necessary to maximize the number of pigs marketed per sow per year.

Unfortunately, a delay in return to estrus following weaning is a common management problem, especially in first litter sows. University of Nebraska research has shown that energy intake during lactation can have a direct influence on the interval from weaning to estrus. In that research most sows were fed the equivalent of either 6 or 12 lb of a corn-soybean meal lactation diet per day. Severe feed restriction to 6 lb per day during lactation resulted in only 60% of the sows returning to estrus by 7 days following weaning. Feeding 12 lb per day resulted in 97% of sows in estrus by 7 days postweaning.

Evaluation

To further evaluate the effects of energy intake during lactation on sow and litter performance, 146 first-litter sows were fed either 10,000 (low energy), 12,000 (intermediate energy) or 14,000 (high energy) kilocalories (kcal) of metabolizable energy (ME) per day during a 28-day lactation. The energy intakes correspond to a daily intake of about 7.0, 8.5, or 10.0 lb of a corn-soybean meal diet fortified with minerals and vitamins (these feeding levels are not uncommon in commercial swine herds). Creep feed was not available to the litter. Following weaning, sows were given 4 lb of feed per day and were heat checked with a boar once daily.

Sow weight and backfat loss during the first 14 days, the second 14 days and the entire lactation period were progressively reduced as energy intake increased (Table 1). Sows fed the low energy diet were slightly delayed in return to estrus compared to sows fed either intermediate or high energy.

Average 14- and 28-day pig weights were reduced for pigs from sows fed low energy (10,000 kcal of ME per day) during lactation compared to sows fed either of the two higher energy intakes (Table 2). Likewise, litter weaning weights from sows fed low energy were less than those from sows fed high or intermediate energy levels. Even though the sows fed the low energy intake lost more weight, utilization of sow body reserves for milk synthesis and secretion did not adequately compensate for inadequate dietary energy intakes.

Table 1. Effect of dietary energy intake during lactation on sow performance.

	Diets, Kcal/day		
Item	10,000	12,000	14,000
Number of sows	49	49	48
Lactation wt change, lb			
0-14 day	−20.1	−10.6	−3.5
14-28 day	−20.5	−15.0	−7.9
0-28 day	−40.6	−25.6	−11.4
Lactation backfat change, in			
0-14 day	−.16	−.13	−.09
14-28 day	−.17	−.17	−.11
0-28 day	−.33	−.30	−.20
Percentage in estrus			
by 7 day	81.6	87.8	87.5
by 14 day	89.8	91.8	93.8
by 21 day	91.8	91.8	97.9
by 70 day	98.0	98.0	100.0

Table 2. Effect of dietary energy intake during lactation on pig performance.

	Diets, Kcal/day		
Item	10,000	12,000	14,000
Pig performance			
Avg pig 14 day wt, lb	8.2	8.6	8.8
Avg pig 28 day wt, lb	13.9	14.8	14.8
Pig survival, %			
3-14 day	94.0	93.8	93.5
14-28 day	98.4	99.2	99.1
3-28 day	92.5	93.0	92.7
Litter performance			
Number of litters	49	49	48
Avg litter 14 day wt, lb	76.7	80.7	80.9
Avg litter 28 day wt, lb	127.4	135.6	136.0
Litter size, 14 day	9.4	9.3	9.3
Litter size, 28 day	9.2	9.2	9.2

Blood Samples

To more fully understand the influence of energy intake during lactation on reproductive performance of first-litter sows a series of blood samples was collected at and after weaning to measure reproductive hormone concentrations. Blood serum concentrations of several reproductive hormones were low when energy intake was restricted to 10,000 kcal of ME per day.

An example of one of these reproductive hormones is shown in

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Adequate Energy

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Figure 1. Estradiol is a hormone secreted by the ovary that is necessary for proper reproductive function. Sows fed low amounts of energy that did not return to estrus (LE-Nonreturn) by day 7 following weaning did not have an increase in blood estradiol postweaning. Thus, energy restriction during lactation seems to affect the endocrine system, and may be one of the reasons for a delayed estrus. In addition, sows fed low energy that did return to estrus (LE-Return) by 7 days after weaning had lower peak concentrations of estradiol than sows fed intermediate or high energy during lactation. The results demonstrate that the endocrine mechanism is altered even in those sows restricted in energy intake during lactation that did return to estrus after weaning.

Based on the findings of this experiment, we recommend a minimum daily feed intake of 8.5 to 9.0 lb of a corn-soybean meal lactation diet for first-litter sows. Ideally, a sow should be full fed during lactation to prevent excessive body weight loss, maximize litter performance, and provide a rapid return to estrus after weaning.

Lactating sows often have poor appetites during hot weather, and heat stress on the sow has been identified as a major problem in the swine industry. Therefore, it is important to provide an environment that will minimize heat stress and ensure adequate feed intake during lactation.

A recent experiment at North Carolina State University indicates that first-litter sows full fed a corn-soybean meal lactation diet during summer consumed less than 10,000 kcal of ME per day. Supplementing the diet with fat increased energy intake somewhat and resulted in 59% of the sows returning to estrus by 10 days postweaning compared to only 34% for sows full fed the regular corn-soybean meal diet.

Suggestions

The following management suggestions may aid in increasing energy intake of lactating sows during hot weather:

* Ensure that farrowing house temperatures do not exceed 80°F and that the ventilation system removes excessive humidity from the farrowing house.

* Provide a high energy diet by including fat in the diet or by top dressing 0.5 lb of fat daily to the regular lactation diet.

[1]Jim L. Nelssen is a graduate student. Austin J. Lewis is Associate Professor–Swine Nutrition.

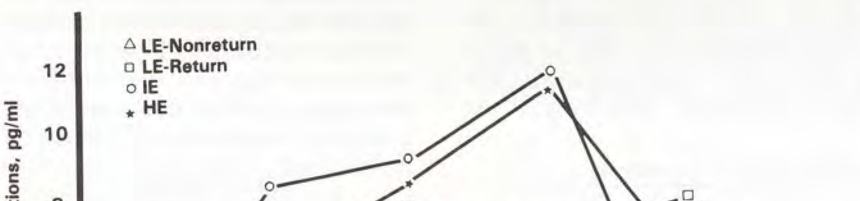

Figure 1. Effect of energy intake during lactation on mean concentrations of serum estradiol following weaning. LE, IE and HE = 10,000, 12,000 and 14,000 Kcal of ME per sow per day, respectively.

Feed Additives and Swine Diets

Murray Danielson
Mark Crenshaw[1]

Feed additives are widely used in livestock and poultry production. Their use is primarily determined by the improvement in performance and product quality resulting from their use.

This study compared the effects on growth rate and feed conversion of diets containing Stafac (Virginiamycin), BMD (Bacitracin Methylene Disalisylate), and no additive when fed to growing-finishing pigs.

Animals and Facilities

Ninety-six crossbred pigs, each weighing about 60 pounds, were used. Forty-eight gilts and 48 barrows were allotted by litter, sex, and weight outcome groups to the three treatments. Two pens of eight gilts and two pens of eight barrows were assigned to each treatment. The study lasted 98 days.

Pigs were fed in concrete pens with shelters, self-feeders, and automatic waterers. Individual pig weights and pen feed consumption were monitored at 14-day intervals. All other practices were consistent during the study. Results are shown in Table 1.

The three diet treatments consisted of a corn-soybean meal basal diet with 1) no medication; 2) 10

Table 1. Feed additive study scheme.

Criteria	Treatment[a] 1	2	3
Total no. animals	32[b]	32	32[c]
No. animals/pen	8	8	8
Total pens	4	4	4
Gilts	2	2	2
Barrows	2	2	2
Initial wt, lb	60.7	60.6	60.9
Gilts	61.8	61.6	62.2
Barrows	59.7	59.6	59.7
Termination wt, lb	228.8	228.9	232.7
Gilts	218.6	228.2	228.9
Barrows	238.4	229.7	236.1
Length of study, days	98	98	98

[a]1 = control—0 medication; 2 = Stafac—10 g/Ton; 3 = BMD—25 g/Ton.
[b]Gilt injured when caught in fence, removed from study.
[c]Lame gilt, removed from study.
[c]Gilt died—Diagnosis: necrotic enteritis—Campylobacter-Treponemasepticemia-*Corynebacterium* pyogenes-*Pastuerella multocida*.

g/ton Stafac; and 3) 25 g/ton BMD. Diets were fed in two phases. During Phase I, diets were formulated to contain 16% protein. During Phase II, beginning when pigs weighed 120 pounds, diets were formulated to contain 14% protein.

Live Animal Performance

Average daily gain and feed conversion are reported in Table 2. During Phase I, average daily gain for barrows was slightly improved by diets containing the additives. Gain of the gilts was not affected. Feed conversion was not affected.

During Phase II, the average gain of gilts was improved by the additives, but the barrows grew fastest on the control diet. Feed conversion was not affected.

When both phases of the study are combined, a slight positive response in growth rate was found for gilts that received additives. No differences were found among the barrows. Feed conversion was slightly poorer for gilts receiving the additive treatments. Pigs fed diets containing BMD used more feed per pound of gain than the other animals in the study.

Study results indicate a slight improvement in average daily gain when Stafac and BMD were incorporated in the diets. Neither additive improved feed efficiency. For an additive to be cost effective, the improvement in performance must return value greater than the cost of the additive. Feed additives should not be used to replace proper management and good husbandry practices.

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Table 2. Feed additive study, live animal performance.

Criteria	Treatment[a] 1	2	3
Avg. daily gain to 120 lb	1.68	1.71	1.73
Gilts	1.64	1.66	1.62
Barrows	1.71	1.75	1.82
Feed conversion to 120 lb	2.66	2.67	2.70
Gilts	2.62	2.73	2.71
Barrows	2.70	2.62	2.69
Avg. daily gain 120 lb to mkt wt	1.74	1.72	1.77
Gilts	1.58	1.72	1.74
Barrows	1.89	1.73	1.79
Feed conversion 120 lb to mkt wt	3.67	3.69	3.81
Gilts	3.68	3.67	3.65
Barrows	3.66	3.70	3.94
Avg. daily gain overall	1.71	1.72	1.75
Gilts	1.60	1.70	1.70
Barrows	1.82	1.74	1.80
Feed conversion overall	3.32	3.33	3.42
Gilts	3.30	3.34	3.34
Barrows	3.33	3.31	3.49

[a]Control—0 medication; 2 = Stafac-10 g/ton; 3 = BMD-25 g/ton.

Probe measurement of loin muscle depth.

Estimating Pork Carcass Lean

W. T. Ahlschwede
R. K. Johnson
R. W. Mandigo
C. T. Wang[1]

Pork carcass value is one ingredient in the economic equation of pork production. It is the basis of market value. Although the market often seems to pay the same for all carcasses, large value differences exist. We often need to describe the differences which exist among carcasses. Accurate, simple, and inexpensive carcass evaluation methods would facilitate these comparisons.

During the meat type hog development, weights of cuts were used to compare carcasses. However, changes in processing plants made that method of evaluation

(continued on next page)

Estimating Lean

(continued from page 9)

unsatisfactory.

In 1975, the NPPC (National Pork Producers Council) proposed evaluating pork carcasses based on lean content. It was reasoned that carcass value was based primarily upon its lean content. Although pork is not sold on a pounds of lean basis, a high proportion of the carcass reaches the consumer in a form that has a closely controlled fat content. The NPPC provided an equation for estimating pork carcass lean content based upon carcass weight, fat thickness over the loin muscle at the 10th rib, and loin muscle area. It was suggested that the measurements be made on ribbed chilled carcasses before processing.

In 1982, results of an NPPC supported cooperative study by the University of Wisconsin, Iowa State University, and the U.S. Meat Animal Research Center (WIM study) were reported. This study was designed to develop new lean estimation equations based on a larger and broader sample of carcasses than was available in 1975. The new equations and data collection procedures are similar to those of the previous method. Equations for both are shown in Table 1.

University Study

Simultaneously with the WIM study, research was conducted at the University of Nebraska to determine the appropriateness of the NPPC equations and to investigate other lean estimation procedures which might be more accurate, less disruptive in the packing plant, and easier to use. Data from the WIM study were made available to test the accuracy of the equations and procedures developed here.

The Nebraska study was based on the carcasses of 65 Gene Pool barrows. The barrows represent a population somewhat fatter than current industry standards. The leanest carcasses had fat thicknesses similar to current industry averages. Measurements were taken on the chilled hanging carcasses and on cut surfaces as the carcass was processed. Cold carcasses were broken into wholesale cuts, skinned, and deboned. The soft tissue—lean and fat—was ground and mixed. Lean content of the soft tissue was determined using an Analray, an x-ray device which determines fat content. Lean content in this study, as in the NPPC and WIM studies, was calculated on a 10% fat basis to represent the composition of lean tissue as it is found in the carcass.

Barrows in this study were slaughtered at the UN-L Loeffel Meat Laboratory. Shrunk live weight at slaughter averaged 217 lb. The group included several pigs weighing less than 200 lb and several weighing over 240 lb.

Measurements on the hanging carcass included midline backfat thickness at the 1st rib, last rib and last lumbar vertebra, probe fat thickness at the 10th rib and probe fat thickness on the rear of the ham. The depth of the loin muscle at the 10th rib was mechanically probed. Belly thickness was measured between the 10th and 11th ribs in the center of the body cavity with a graduated probe. The area of the loin muscle was measured when the carcass was cut for processing. Tenth rib fat thickness was measured on the cut loin, ¾ of the way out over the loin.

Multiple regression analysis was utilized to develop prediction equations for estimating carcass lean from the various carcass measurements. These equations are shown in Table 2. NE 1 is analogous to the NPPC and WIM equations in that it uses carcass weight, loin muscle area and 10th rib fat thickness over the loin muscle to predict lean content. NE 2 is an alternate to NE 1, substituting loin muscle depth and probe fat thickness for loin muscle area and 10th rib fat thickness. Equations 3 and 4 are more precise prediction equations which expand equations 1 and 2 by adding the rear ham fat thickness and belly thickness. NE 5 estimates carcass lean from last rib midline fat thickness and carcass weight.

The precision of these equations in the WIM and Nebraska data sets is shown in Table 3. The similarity of the precision of the first three equations in the two data sets is surprising. The statistic shown is the R^2, the proportion of the variation in leanness accounted for by the equation. The NPPC equation was developed from only 41 carcasses. Compared to the Nebraska data, the WIM data set was larger (185 carcasses) and represented market hogs more diverse in body type and weight. Yet each equation seems equally precise in either data set. The relative precision of NE 2 was also surprising. The R^2 for NE 2 indicates that a "blind" measurement of loin muscle depth is as helpful as loin muscle area in predicting pork carcass lean. The R^2 for NE 5 indicates that a single fat measurement along with carcass weight can provide a moderately precise estimate of carcass lean.

The difference in R^2 values of equations in the two data sets is due primarily to differences in weight distributions. In the NE data set, more pigs were of average weight than were heavy or light. In the WIM data set, slaughter was timed so that there were as many heavy and light pigs as there were average weight pigs. This

Table 1. NPPC and WIM equations for predicting pork carcass lean.

NPPC lean	= 2 + 0.45 carcass wt + 5 loin muscle area – 11 10th rib fat thickness
WIM lean	= 10.47 + 0.505 carcass wt + 2 loin muscle area – 14.864 10th rib fat thickness

Table 2. Equations for estimating pork carcass lean based upon current study.

NE 1 lean	= 9.0 + .37 carcass wt + 3.95 loin muscle area – 6.94 10th rib fat thickness
NE 2 lean	= 13.8 + .425 carcass wt + 5.79 loin muscle depth – 16.31 10th rib fat thickness
NE 3 lean	= 20.85 + .46 wt + 3.47 LMA – 3.33 10th rib fat probe + – 14.23 rear ham fat – 7.8 belly thickness
NE 4 lean	= 24.15 + .495 wt + 4.8 LM depth – 9.5 10th rib fat probe – 14.1 rear ham fat – 6.57 belly thickness
NE 5 lean	= 18.3 + .42 carcass wt – 9.0 last rib midline fat

Table 3. Accuracy of various prediction equations in two data sets.

Equation	NE data[a]	WIM data[a]
NPPC	.7361	.8793
WIM	.7132	.8884
NE 1	.7414	.8787
NE 2	.7357	
NE 3	.8286	
NE 4	.8007	
NE 5	.5890	

[a]Statistic shown is R^2

creates more variation in pounds of carcass lean. Since this variation was weight related, the equations effectively remove it, indicating a higher precision.

The rather close agreement among the R^2's of the first three equations in Table 3 is reassuring. This study was undertaken to check the precision of the NPPC equation. Both this study and the WIM study seem to indicate that the NPPC equation is reliable. Although the numbers in the three equations are somewhat different, they are statistically equivalent. Little evidence is provided to discontinue the use of the old NPPC equation.

The NE 1, NPPC, and WIM equations appear adequate for most carcass evaluation needs, if accurate measurements of loin muscle area are available at reasonable cost. They work sufficiently well for market hog carcass events and for most breeding stock evaluation programs.

Second Objective

A second study objective was to develop estimation procedures which would accurately predict carcass lean content without cutting the carcass. Current evaluations which split the loin are disruptive to the usual flow in the packing plant and cause considerable product value loss. The NE 2 procedure represents such an approach. NE 2 substitutes loin muscle depth for loin muscle area and 10th rib fat probe for the cut surface fat measurement with little compromise in precision. In this procedure, the fat thickness over the middle of the loin muscle is probed with a mechanical probe. Loin muscle depth is measured by extending a probe at the same site through the loin muscle until contact is made with the 10th rib about 2 inches off the back bone. This probe depth measures both the fat thickness and loin muscle depth. Loin muscle depth is then determined by subtracting the fat thickness.

The high R^2 associated wth the NE 2 procedure suggests that it can be substituted for procedures using loin muscle area without loss in precision. One doe not have the measurement of the loin muscle area with this method, but the procedure is considerably less expensive.

Equations NE 3 and NE 4 provide increased precision by using two additional new measurements. The two measurements, probe fat thickness on the rear of the ham (midway between the hock and the tailhead), and belly thickness (thickness of body cavity between the 10th and 11th rib midway between the backbone and sternum), attempt to measure the thickness of two other major fat depots. The added precision of these procedures would be useful in evaluating the composition of gain in research trials and in genetic improvement programs.

The simplest procedure, NE 5, utilized a single fat measure (last rib mid-line fat thickness) and carcass weight. It is also the least accurate of the procedures. It is sufficient for use on a group basis to monitor and evaluate production systems. It also would be attractive in a merit buying system where the objective is to price truckloads of market hogs.

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Nebraska's Swine Industry

Robert D. Fritschen
S. Kay Rockwell
Marilyn Goding[1]

Nebraska ranks fifth nationally in swine production. The importance of swine production to the state's economy totals in the millions of dollars. Other fragments of information characterizing the state's swine industry are known as well. But in depth information was lacking.

A survey of the state's swine in-

(continued on next page)

Shape of the Industry

(continued from page 11)

dustry was conducted in 1983. A total of 471 forms were returned. Objective of the survey was to gain baseline data to more accurately guide decision makers in research, extension, and teaching.

The Shape of the Industry

The Nebraska pork producer is 39.2 years old—about 10 years younger than census figures cited for the general farmer in Nebraska. The average producer has raised hogs for 17 years. Formal education levels reported show that 5.5% have 11 years or less, 25.3% have 16 years or more (B.S. degree or greater), and that the average level of formal education is 13.3 years.

Of those reporting, 33.6% had annual sales of 500 or less pigs in 1982, 31.2% sold between 501-1,000, and 15.4% sold over 2,000. The most popular method of selling market hogs is direct to packer (56.8%), followed by Auction Market (19.9%), and Terminal Market (12.8%). The most popular source for purchasing breeding stock was SPF (42.8%), with conventional or non-SPF accounting for 36.5%. Commercial seed stock companies garnered 16.5% of the sales.

Farrowing crates with slotted floors were used by 51.2%. An additional 24.9% used crates without slotted floors. Nurseries that are elevated (flat decks) off the floor were used by 25.8%. However, when the question was asked, "If you could rebuild your nursery or construct a new one, what would you build?", 54.3% indicated they would build a flat deck nursery. A total of 40.1% reported growing-finishing facilities that were a modified open-front (MOF) or a MOF in combination with other styles of buildings. The National Pork Producers Council in a 1982 national survey reported that over 30% of the pigs are now finished in an MOF building, making this the most popular style swine finishing building in use in Nebraska and nationally.

Regarding bedding, 44.1% used bedding in farrowing, 38.7% in the nursery and 52.3% in growing and finishing. Only 9.6% reported they felt odors or gas levels were at a level in their buildings to cause a significant performance or health problem among their pigs. However, when asked if, "As a human are you bothered by hog house dust or odors," 47.5% said yes.

The average age at weaning was 4.4 weeks. However, 13.6% reported they weaned at three weeks or earlier, with 15% weaning at six weeks or older. High moisture grain is used by 12.4% while 27.2% reported they use or have used extruded or full-fat soybean meal. A vitamin-mineral premix is used by 50.7%.

Veterinarian Visits

Regarding frequency of veterinarian visits in 1982, out of 453 responses, 34.2% reported they did not have a visit, while 4.9% had visits twice a month. Within the last five years 59.4% reported they had used the services of a diagnostic laboratory, without specifying location of laboratory. Of those responding, 58.5% have had MMA in their herd and 37.1% reported experiencing TGE. Pseudorabies had been diagnosed in 7.6% of the herds.

The survey asked a question concerning preferred method to receive information. The choices were: newspaper and magazine, radio, television, workshop, or newsletter. The responses were 55.5, 4.9, 2.5, 12.0 and 25.1%, respectively. As to the best source of new ideas, extension specialist and extension agents were ranked first 41.4% of the time followed by veterinarian 34.8% of the time.

Where is Nebraska's swine industry headed? The information contained in this survey will help answer this. Similar surveys are needed at regular intervals to establish trends.

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Selection Increases Preweaning Survival?

William R. Lamberson
Rodger K. Johnson[1]

Increasing numbers of pigs weaned is a universal goal for pork producers. This goal may be reached by two methods—increasing number of pigs born, and increasing pig survival.

Selection for larger litters is practiced but progress is slow because of the low effective heritability of litter size. More effort is expended to increase pig survival through management techniques and disease prevention, but there has been little emphasis placed on improving this method by selection.

Several Nebraska producers have asked about the opportunity to improve baby pig survival by selection. In response to this, data have been analyzed to determine: 1) the potential of selection to increase preweaning survival directly, and 2) selection to influence traits which may be related to preweaning survival. Direct selection for increased survival may be applied to take advantage of genetic difference among pigs in their own propensity for survival, or selection may be applied to improve a female's maternal influences on litter survival.

Determining Potential

To determine potential for selecting for higher survival, heritability estimates that consider preweaning survival a trait of the pig or a trait of the dam were obtained from data from the Nebraska Gene Pool population. Data were collected from gilt litters only. Weaning was at 28 or 42 days. Stillborn pigs were considered mortalities.

Heritability of individual effects on survival to weaning was zero. This indicates that survival rate for progeny of different sires will be about the same. Variation among boars in survival rate of progeny is not caused by genetic differences among the sires and selection among the sires, or the offspring, is not expected to be effective.

Heritability of maternal effects was estimated to be .03. Although this heritability is positive, response to selection would not be expected because selection of pigs is based on the record of their dam, rather than their own record, and this halves the selection response. Selection pressure for increased preweaning survival will probably not result in increases in productivity.

The effect of a pig's birth weight on its own survival to weaning and the effects of the uniformity of birth weights of pigs in a litter on the proportion of pigs surviving to weaning were also studied. Pigs heavier than the population average had higher rates of survival up to a point (Figure 1). Highest survival was predicted to be at a birth weight of 3.2 lb, more than 1 lb above the population mean (Table 1). Survival rates tended to decline when birth weights exceeded 3.2 lb. Chances of survival are expected to be very low if birth weight is less than 0.7 lb.

The opportunities are limited to use genetic means to manipulate birth weight to increase survival. More than 80% of the variation in survival is unrelated to birth weight differences. Also, the heritability of birth weight is not high (about 15%).

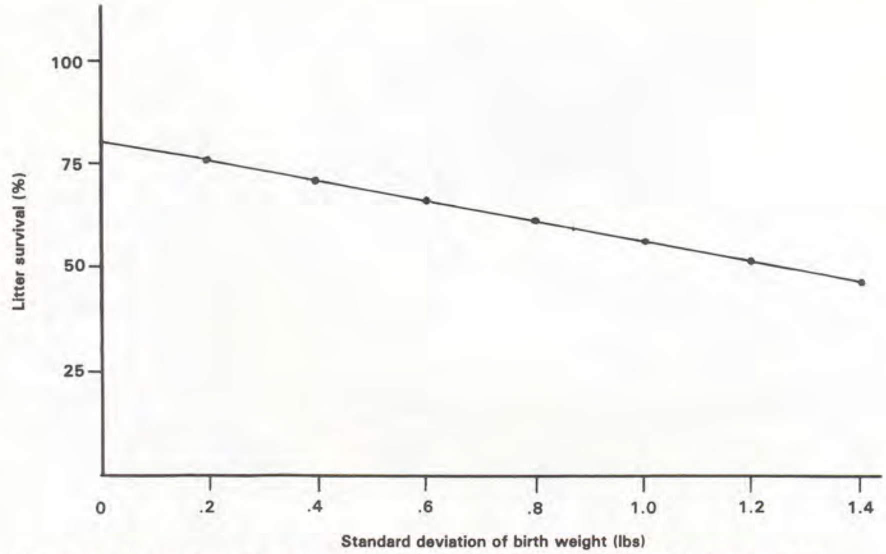

Figure 2. Regression of litter survival on standard deviation of birth weight.

Table 1. Population descriptive statistics.

Variable	N	Mean	Standard deviation	Range
Individual survival (%)	4,330	76.8	42.2	
Litter survival (%)	487	77.1	21.3	0-100
Birth weight (lb)	4,330	1.9	.85	.20-4.80
Birth weight standard deviation (lb)	487	.37	.20	0-1.4
Number born	489	8.9	2.7	1-19

Birth Weight an Indicator?

It has been suggested that birth weight of a pig relative to that of his sibs might be a better indicator of his opportunity for survival than birth weight alone. That is, if the average survival rate of pigs weighing 1.9 lb is 77%, a pig weighing 1.9 lb at birth may have a better chance for survival if the average birth weight of his litter was 1.9 lb than if it was 2.2 lb. To investigate this, uniformity of birth weights of pigs in a litter was measured (as the within litter birth weight standard deviation) and was related to the proportion of pigs from the litter surviving to weaning. Not surprisingly, it was found that as within litter variability in birth weight increased, mortality increased (Figure 2). However, less than 5% of the variation in survival could be accounted for by differences between litters in uniformity of birth weight.

Estimates of the heritability of within litter birth weight standard deviation were near zero. This indicates that there is very little opportunity to decrease variation in birth weight by selection of pigs from uniform litters. Variability of size of pigs reared together in a litter can be decreased by fostering. Although fostering to decrease variability in size would not affect survival of pigs at, and very shortly after, birth, it would have the effect of increasing survival by reducing stress caused by competition among pigs reared together during the preweaning period.

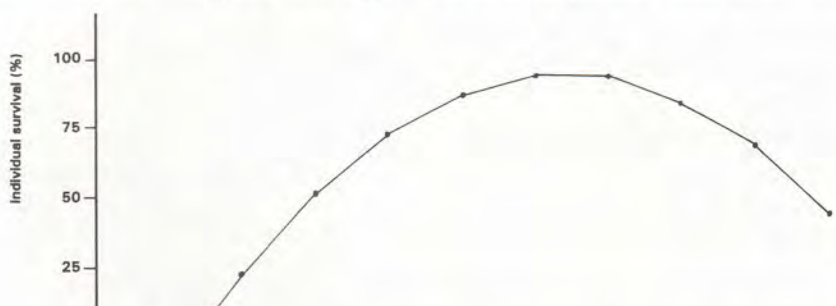

Figure 1. Regression of individual survival on birth weight.

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Alfalfa for Feeder Pig Diets

M. C. Brumm
E. R. Peo, Jr.[1]

Diets that contain oats have been recommended for newly purchased feeder pigs. However, availability of oats is limited and alternatives must be considered. Alfalfa hay or dehydrated alfalfa meal seem to be logical alternatives. Three experiments were conducted to measure performance of purchased feeder pigs when fed diets containing either dehydrated alfalfa meal or midbloom alfalfa.

In these experiments, 840 graded feeder pigs were bought from southern Missouri auction markets and transported 550-650 miles to the University of Nebraska's Northeast Station. Liveweight shrink from auction market payweight to arrival weight ranged from 8.4% to 12.7%.

In experiment 1, the receiving diets fed were: (1) a 16% crude protein corn-soybean meal diet (CS); (2) the CS diet with 20% ground whole oats; and (3) the CS diet with 9.4% dehydrated alfalfa meal (Table 1). Alfalfa meal was added at 9.4% to provide about the same energy and fiber content as the diet containing oats.

In experiment 2, the receiving diets were: (1) a CS basal diet and, (2) the CS basal diet with 10% dehydrated alfalfa meal. In experiment 3, the diets were: (1) CS basal, and (2) CS basal plus 10% midbloom third cutting alfalfa.

Diets Hand-Fed

In each of the experiments, the experimental diets were hand-fed twice daily for the first week according to appetite. During the second week, diets were fed *ad libitum* in a self-feeder. After the two week receiving period, all pigs were fed a 16% crude protein corn-soybean meal grower diet until 125 lb when they were switched to a 14% crude protein finisher diet.

Pigs were treated for worms during the first week with Tramisol in the drinking water. In experiment 1, pigs were retreated with Atgard in the feed three weeks later. In experiments 2 and 3, Tramisol was administered in the feed three weeks later. Pigs were sprayed for lice and mange with a lindane solution 10 days after arrival.

Pens of pigs were rated for severity of scours using a scale of 1 to 5 with 1 being a normal, firm stool and 5 being extreme diarrhea (scours). Three people scored the pens for 21 days after arrival in experiment 1. Two people scored the pens for 14 days af-

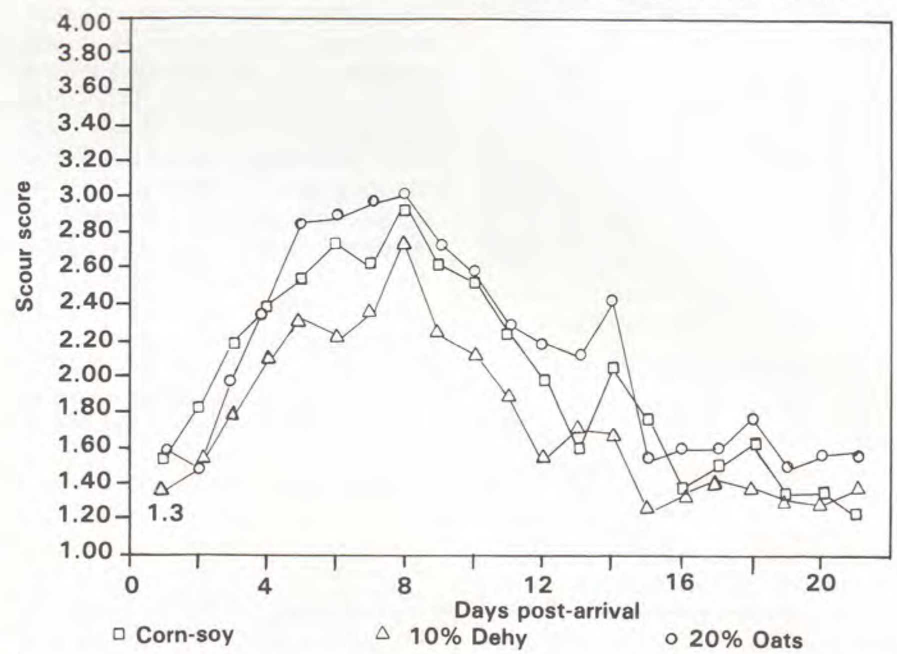

Figure 1. Effect of receiving diets containing oats or dehydrated alfalfa meal on post-arrival scours.

ter arrival in experiment 2 and 3.

In the first experiment, inclusion of either 20% ground whole oats or 9.4% dehydrated alfalfa meal in receiving diets did not affect rate of gain or feed conversion from purchase to market (Table 2). Pigs fed the receiving diets containing 9.4% dehydrated alfalfa meal had lower scour scores on days 6, 12 and 13 after arrival than pigs fed the receiving diet containing 20% ground whole oats (Figure 1).

In experiment 2, inclusion of 10% dehydrated alfalfa meal in the receiving diet resulted in poorer feed conversion for the first 14 days than the corn-soybean meal receiving diet (Table 2). The depression in feed conversion was accompanied by a slower rate of gain. As in experiment 1, pigs fed the dehydrated alfalfa meal receiving diet had lower scour scores on days 11 and 12 after arrival than the CS fed pigs (Figure 2).

In experiment 3, pigs fed a receiving diet containing mid-bloom alfalfa ate more feed for the first 14 days (1.80 *vs* 1.67 lb/day) and gained faster from purchase to market (1.34 *vs* 1.30 lb/day) than CS fed pigs (Table 2). Feeder pigs fed the 10% mid-bloom alfalfa receiving diet had lower scour scores than CS fed pigs on days 3, 9, 10, 11, 12, 13 and 14 post-arrival (Figure 3).

Response Positive

Results of these experiments indicate that adding either 9.4% or 10% dehydrated alfalfa meal in feeder pig receiving diets is not harmful to purchased feeder pigs and may result in a reduction in the severity of post-arrival scours. The positive response in feed intake for the first 14 days and in gain from purchase to market weight of feeder pigs fed receiving diets containing 10% mid-bloom alfalfa is encouraging. These results indicate that the inclusion of good quality alfalfa hay in feeder pigs receiving diets may benefit Nebraska feeder pig finishers.

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Table 1. Composition of feeder pig receiving diets.

	Diets, %					
	Experiment 1			Experiments 2 & 3		
Item	Corn soybean meal	20% oats	9.4% dehy	Corn soybean meal	10% dehy	10% alfalfa
Corn	75.74	57.36	68.80	74.88	67.75	67.70
Soybean meal (44%)	20.72	19.12	18.48	21.72	19.17	19.20
Dehydrated alfalfa			9.44		10.00	
Mid-bloom alfalfa						10.00
Ground oats		20.00				
Dicalcium phosphate	.90	.86	.96	.87	.91	.93
Limestone	1.04	1.06	.72	.98	.62	.62
Salt / Vitamins / Trace minerals	1.60	1.60	1.60	1.55	1.55	1.55

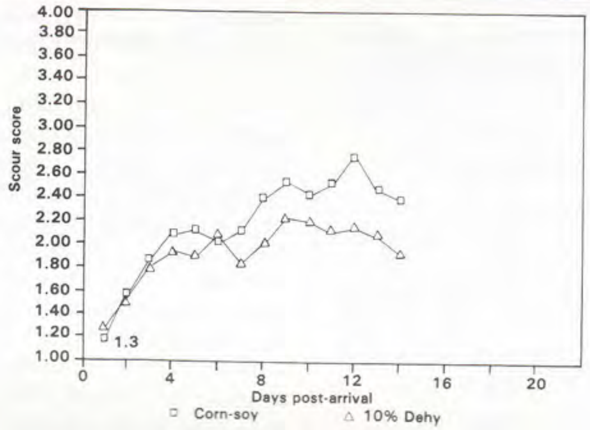

Figure 2. Effect of receiving diets containing dehydrated alfalfa meal on post-arrival scours.

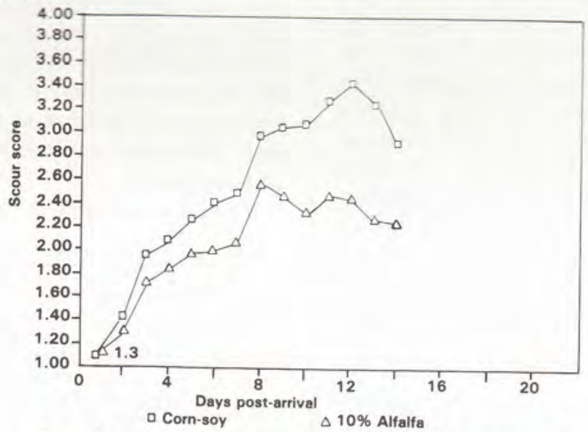

Figure 3. Effect of receiving diets containing mid-bloom alfalfa on post-arrival scours.

Table 2. Effect of receiving diets containing alfalfa products on performance of purchased feeder pigs.

	Experiment 1			Experiment 2		Experiment 3	
Item Diet:	CS	20% Oats	9.4% Dehy	CS	10% Dehy	CS	10% Alfalfa
Pig wt., lb[a]							
Initial	36.4	36.8	36.6	42.1	42.0	37.0	36.9
14 days	51.6	52.1	53.3	55.0	53.5	47.3	48.0
Final	216.6	213.0	211.7	206.1	203.7	200.0^{b}	206.4^{c}
ADG, lb							
14 days	1.06	1.10	1.11	.92	.84	$.75^{b}$	$.79^{c}$
Final	1.36	1.36	1.35	1.34	1.34	1.30	1.34
F/G							
14 days	1.96	1.91	1.87	2.15^{b}	2.33^{c}	2.30	2.43
Final	3.15	3.16	3.13	2.17	3.25	3.17	3.11

[a]10 pigs/pen; 12 pens/diet.
[b,c]Means within experiments with different superscripts are different ($P<.05$).

Helping Young Boars with Mating

Donald G. Levis
Ronald K. Christenson[1]

Will young, inexperienced boars become more efficient breeders when provided with help during their first matings? The answer has commonly been, yes. However, there have been no scientific studies conducted to confirm this. This study determined if helping young boars during their first four matings would help them become more skillful at mating later in life.

Evaluation Procedure

Duroc, Spot and Hampshire boars were used. They had been reared in all male groups beginning at 10 weeks of age. At six months of age, they were moved, four to six per group, to lots (12′ x 32′) with concrete shelters (7′7″ x 7′5″).

When boars averaged 8.3 months of age, seven boars each were assigned to the assisted and unassisted treatments. Boars were evaluated twice per week (two consecutive days) for two weeks. Assisted boars were aided with intromission only during the first two weeks of evaluation. During the next four weeks, the boars were evaluated twice per week. Boars were evaluated, again, for two weeks at 12 and 13.6 months of age.

A standardized boar evaluation procedure was used. It consisted of a 2-minute pre-test familiarization period. The boar was in the test pen with a tethered, estrous-induced ovariectomized gilt in a separate pen within the test pen (Figure 1). After the familiarization period, the boar was allowed access to the side and rear of the tethered gilt for 15 minutes. The test pen design prevented the boar from making a head mount. The courtship behavior traits evaluated for each boar were nose-to-nose contact, ano-genital sniffing, nosing gilt's side, chanting by boar, time to first mount, mounting gilt's side, mounting gilt's rear and occurrence of successful mating. A successful mating was recorded when copulation lasted more than 1.5 minutes.

Results

At the start of the evaluation period (8.3 months of age), 14 boars were evaluated. Two boars assigned to the assisted treatment did not permit help and were excluded from further analysis. Boars helped with mating accomplished a 95% success rate during the initial period. Unassisted boars accomplished a 57.1% mating success rate during the same two-week period (Table 1). However, mating success during the next four weeks and at 12.0 and 13.6 months of age were similar for assisted and unassisted boars (Table 1). Considerable variation was observed among boars for percentage of successful matings. Five of the 12 boars achieved a mating success rate of 50% or less during the study. When the boars did have a successful mating, the time to copulation was not different between assisted and unassisted boars.

The elapsed time to first mount was similar for both groups of boars after the initial period (Table 2). The wide variation in the time to first mount makes this trait unsuitable as a simple and reliable measure of mating success.

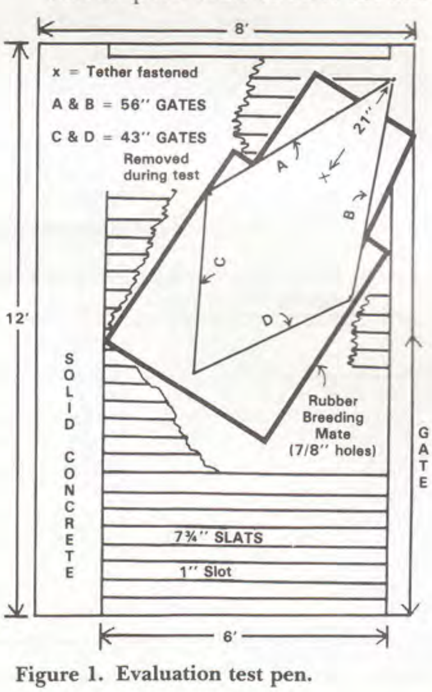

Figure 1. Evaluation test pen.

When boars were unsuccessful at mating they repeatedly mounted the test gilt as indicated by the average time to last mounting attempt and number of mounts (Table 2). Generally, when boars did not accomplish intromission within a few thrusts, they would dismount and realign themselves with the gilt before remounting.

The only significant difference that occurred between assisted and unassisted boars during an unsuccessful mating was time to last mount (assisted, 13.2 min; unassisted, 6.9 min) at 13.6 months of age. This difference was caused by one unassisted boar. This boar was extremely uninterested in the test gilt. During three of the four evaluations, his time to last mounting attempt occurred at an average of 2.9 minutes from the beginning of the evaluation.

The average number of mounts required for a successful mating did not differ between the two treatment groups of boars, except at 13.6 months of age. Boars that received assistance at 8.3 months of age required more mounts than unassisted boars (7.4 vs 2.3). There was a trend during the study for assisted boars to mount more times to acquire a successful mating (Table 2).

Three boar behavior problems were observed during this experiment. Rectal ejaculation was observed in 5 of 5 assisted and 4 of 7 unassisted boars. However, repeated incidences were low except for one boar in each treatment group who showed a high incidence of rectal ejaculation (assisted boar, 3 of 16; unassisted boar, 7 of 16). The incidence of coitus interruptus (penis becoming limp) was low except for one unassisted boar where this problem was observed during 7 of 12 evaluations. The observed frequency of masturbation was low for both assisted and unassisted boars.

Table 1. Mating success for assisted and unassisted purebred boars.

Item	Assisted[a]	Unassisted
No. of boars	5	7
Boar age: 8.3 months		
Mating success, %	95.0[b]	57.1
Time to copulation, min.	1.2	3.8
Boar age: 9.2 months		
Mating success, %	67.5	58.9
Time to copulation, min.	3.0	2.7
Boar age: 12.0 months		
Mating success, %	60.0	60.7
Time to copulation, min.	2.4	1.6
Boar age: 13.6 months		
Mating success, %	75.0	75.0
Time to copulation, min.	5.0	2.6

[a]Assistance was provided only during tests at 8.3 months of age.
[b]Significantly different (P<.005) for assisted and unassisted boars.

Conclusions

1. Under these experimental conditions, helping the 8-month-old boars with their first four matings did not improve mating success later in life. Considerable variation was found in mating success for both assisted and unassisted boars.

2. Time to first mount and time to copulation were not different for assisted and unassisted boars.

3. Mounting activity was not different for assisted and unassisted treatments.

[1]Donald G. Levis is Reproductive Physiologist, South Central Station. Ronald K. Christenson is Research Physiologist, U.S. Meat Animal Research Center.

Table 2. Mounting performance for assisted and unassisted purebred boars.

Item	Assisted	Unassisted
Number of boars	5	7
Boar age: 8.3 months		
Time to first mount, min.	.9	1.8
Time to last mount, if failed to copulate, min.	12.8	8.9
Avg. mounts for boars with:		
Successful mating	1.4[a]	2.3
Unsuccessful mating	9.0[b]	4.0
Boar age: 9.2 months		
Time to first mount, min.	.4	.4
Time to last mount if failed to copulate, min.	11.7	11.1
Avg. mounts for boars with:		
Successful mating	3.3	3.1
Unsuccessful mating	8.7	10.0
Boar age: 12.0 months		
Time to first mount, min.	.5	.3
Time to last mount, if failed to copulate, min.	12.6	11.6
Avg. mounts for boars with:		
Successful mating	3.0	2.2
Unsuccessful mating	10.0	5.8
Boar age: 13.6 months		
Time to first mount, min.	.3	.5
Time to last mount, if failed to copulate, min.	13.2[c]	6.9
Avg. mounts for boars with:		
Successful mating	7.4[c]	2.3
Unsuccessful mating	13.4	6.4

[a]One boar would not allow assistance; therefore, first mount data was not included.
[b]One boar would sit down after being helped with intromission.
[c]Significantly different (P<.025) for assisted and unassisted boars.

Does Reduced Light Delay Puberty in Confinement?

Dwane R. Zimmerman
Colleen Kelly
Jack Kopf[1]

Age at puberty (expression of first estrus and ovulation) is delayed in confinement-reared gilts, but the factors responsible for the delay have not been identified. Researchers at the U.S. Meat Animal Research Center (MARC) compared the effect of confinement (totally enclosed housing) and outside rearing in a number of breeds and breed crosses and reported that confinement-reared gilts were delayed reaching puberty as compared to gilts reared outside (Table 1). Nebraska and Georgia previously reported that gilts removed from confinement during development and relocated outside, a practice many producers follow, expressed first estrus earlier than gilts remaining in confinement.

Factors in the confinement environment that are lacking or are inhibitory to the expression of estrus in gilts have not been identified. Inadequate light exposure (duration and intensity of daily light period) may be a contributing factor. Confinement housing often severely restricts the amount of light exposure. Gilts born in the fall and nearing puberty in the spring when daily light exposure is increasing attain puberty at an earlier age than gilts born in the spring and nearing puberty when daily light exposure is decreasing in the fall.

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Reduced Light

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Objectives

Objectives of this study were to: 1) determine whether puberty is delayed in gilts reared in the UN-L swine confinement facility at Mead (a totally enclosed, environmentally regulated building), 2) evaluate whether day-length (photoperiod) influences age at puberty in confinement-reared gilts, 3) compare the responses to confinement and day length of two different genetic lines.

Two experiments were conducted with 1981 and 1982 summer born gilts from the UNL gene pool and white line populations. Gilts were assigned at random within genetic group and litter to two photoperiodic regimens (6 hours light:18 hours darkness, short days vs 18 hours light:6 hours darkness, long days) and to a control group maintained outside in drylot with natural daylight

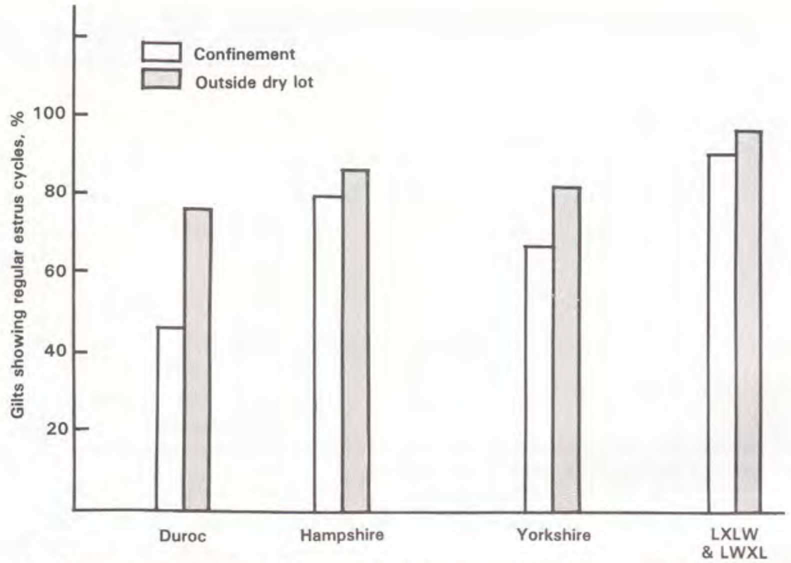

Figure 1. Percentages of gilts cycling regularly by 9 months of age as affected by confinement and breed (adapted from Christenson, R. K., 1981. J. Anim. Sci. 52:821)

ranging between 10.75 and 12.5 hours per day during the experiment (fall-winter season). Involved in the experiments were 363 gilts, approximately equally distributed by year and line.

Treatments were started at 100 days of age. Gilts were observed once daily for estrus with the aid of mature boars starting at 135 days of age. Termination of the experiment was at 240 days in Exp. 1 and 250 days in Exp. 2. Gilts were *ad libitum* fed a 14% protein corn-soybean meal diet until all pigs in a replicate (age group) reached 150 lb. They were then put on a limited feeding program by providing four hour access to self-feeders every other day.

Gilts reared outside showed a higher overall cycling rate by eight months of age than gilts reared in confinement in both experiments (Table 2). However, the two genetic lines seemed to respond differently to confinement. Gene pool gilts that cycled before the end of the experiment reached puberty at a younger age when reared outside in both experiments. In contrast, white line gilts reared outside were either delayed in attaining puberty (experiment 1) or were comparable in age with confinement-reared gilts (experiment 2).

The difference in response to confinement may be related to the environment in which the parental breeds evolved. The gene pool line, derived from breeds that evolved under pasture systems of management, performed better under non-confinement conditions. White line gilts, derived from parental stocks (Large White and British Landrace) that evolved

Table 1. Influence of confinement housing on pubertal response of gilts at USMARC.

Trait	Housing type: Outside drylot	Housing type: Confinement	Difference
No. gilts	222	188	
Cyclic % by 9 months	85.2	71.3	13.9
Avg. age at puberty, d[a]	191.4	197.5	−6.1

[a]Prepubertal and behaviorally anestrous gilts excluded.

Table 2. Effect of confinement rearing on percentage of gilts in estrus by termination and average age at puberty (days).

Experiment	Genetic group	Rearing environment: Confinement	Rearing environment: Outside	Difference
1	Gene pool	92.5%	100%	
		177.1	161.7	15.4
	White line	88.9%	100%	
		184.0	195.5	−11.5
2	Gene pool	93.4%	100%	
		192.0	170.3	21.7
	White line	93.8%	93.8%	
		188.2	187.3	0.9

Table 3. Effect of photoperiod on average age at puberty in confinement-reared gilts (days).

Experiment	Genetic group	Photoperiod regimen: 6L:18D	Photoperiod regimen: 18L:6D	Difference
1	Gene pool	174.4	180.5	−6.1
	White line	189.3	179.6	9.7
2	Gene pool	187.8	188.0	−0.2
	White line	183.8	185.8	−2.0

under confinement management, performed as well or better in confinement than they did under outside dry lot conditions. The difference in response of the white line gilts between years to outside conditions may be associated with severity of the winter. Although provided adequate shelter and bedded well with straw, white line gilts seemed to suffer from the severe cold encountered in the winter of 1981-82.

Researchers at MARC also observed differences among breeds in response to confinement. Puberty in Duroc and Yorkshire gilts was markedly delayed by confinement whereas in Hampshire and Large White-Landrace reciprocal crossbred gilts, puberty was little affected by confinement rearing (Figure 1). The Large White-Landrace crosses evaluated at MARC and the synthetic white line gilts used in the present study both failed to show a positive response to rearing outside.

Results

Long days (18 hours light) in confinement failed to stimulate earlier puberty than short days (6 hours light). Gene pool gilts showed little response to photoperiod in either experiment (Table 3). In contrast, white line gilts showed a positive response to long days in experiment 1. This was not confirmed, however, when retested in experiment 2. Thus, in this study, as well as several previous studies conducted at Nebraska, we have been unable to confirm the data of Canadian researchers who reported that long days have a stimulatory effect on puberty in gilts. It is concluded from this and other studies that:

1. Confinement generally delays puberty in swine but some genetic stocks are not affected by confinement.

2. Reduced photoperiod is not the cause of delayed puberty in confinement-reared gilts.

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[1]Dwane R. Zimmerman is Professor–Swine Physiology. Colleen Kelly is Research Assistant. Jack Kopf is Research Technician.

A Rapid Chilling Method

Accelerated Pork Processing

Chris R. Calkins
C. B. Frye
R. W. Mandigo[1]

Rapidly processing pork carcasses before chilling (accelerated processing) has several economic advantages. This method allows more rapid movement of product through the plant, reduced cooler space requirements, and reduced energy usage by not chilling bones and fat.

The process, however, does have some drawbacks. The muscle may toughen if proper precautions are not taken to prevent the detrimental shortening that can occur in rapidly chilled muscle. If this can be overcome, a desirable method of pork processing can be achieved.

Research at Nebraska has shown that hot processing does not result in undesirable changes in the cured products. The objective of the present research was to evaluate a method of rapid chilling that would allow for early mechanical portioning of fresh loins. If acceptable, accelerated processing techniques would be available for most cuts of the pork carcass.

New Chilling Method

Rapid chilling by immersion of a hot, boneless loin into a supercooled brine (14°F) was compared to the more conventional method of blast freezing. Some loins were chilled hot off the carcass and some were chilled in a cooler for 24 hours before freezing. All loins were allowed to freeze and then temper back to 28°F before the process was continued. Tempered loins were then pressed in a Bettcher press and cleaved into uniform, portion-controlled chops using a Bettcher cleaver.

Loins from 40 hog carcasses were allocated according to the format in Table 1. One side from each carcass was rapidly chilled while the opposite side was chilled in the conventional manner before freezing. Groups were established to allow comparison of the chilling methods for each of the pre-chill treatments (hot vs chilled).

Cooked chops were subjected to physical and sensory evaluation.
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Table 1. Allocation of pork loins to treatments.

	Hot processed loins		Cold processed loins	
Group	Brine chill	Blast freeze	Brine chill	Blast freeze
I	10		10	
II	10			10
III		10	10	
IV		10		10

Table 2. Mean values for Warner-Bratzler shear force values and sensory ratings.

		Pre-Rigor			Post-Rigor	
Trait	Group	Brine chill	Blast freeze		Brine chill	Blast freeze
WBS (kg)	I	4.67		**	3.34	
	II	5.38		*		4.41
	III		5.40	*	4.03	
	IV		8.81	**		6.96
Tenderness	I	7.94		**	10.20	
	II	7.38		**		9.17
	III		9.05		9.23	
	IV		7.66	**		10.17
Juiciness	I	6.62			7.35	
	II	9.28		*		8.01
	III		9.06	*	7.57	
	IV		8.81	**		6.96

*Means in the same row are significantly different (P<.05).
**Means in the same row are significantly different (P<.01).

Table 3. Mean values for thaw loss, cook loss and cook times.

		Pre-Rigor			Post-Rigor	
Trait	Group	Brine chill	Blast freeze		Brine chill	Blast freeze
Thaw loss (%)	I	8.42			7.86	
	II	5.83				7.20
	III		5.71	*	8.54	
	IV		6.16			7.89
Cook loss (%)	I	19.86			22.23	
	II	20.89				21.55
	III		21.02		21.06	
	IV		20.20			19.05
Cook time (min)	I	29.80			30.55	
	II	31.46				30.96
	III		31.67		31.89	
	IV		29.78			30.22

*Means in the same row are significatnly different (P<.05).

Rapid Chilling

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Chops were cooked to an internal temperature of 158°F for Warner-Bratzler shear force determination and taste panel ratings for tenderness and juiciness. Thaw loss, cooking loss, and cooking time were recorded.

Meat Less Tender

Results of tenderness and juiciness evaluations are in Table 2. In all but one treatment group, hot processed chops were less tender than slow chilled chops. This was true regardless of the rapid chilling method used. This suggests that the chilling methods used were too severe or were applied too early in the normal chilling cycle. Rapid chilling, when it occurs too early in the chilling cycle, can be detrimental to tenderness because of muscle shortening. These data suggest that muscle shortening did occur. It is interesting to note that the rapid chilling technique for hot processed loins resulted in more juicy chops in three of the four comparisons.

No major differences were detected in thaw loss, cooking loss, and cooking time (Table 3). It appears that rate of chilling of pork muscle does not play a primary roll in determining the thaw loss, cooking loss, or cooking time of a chop.

Conclusions

Study results suggest that rapid chilling of hot processed pork loins may be detrimental to tenderness if the loins are exposed to severe chilling conditions early in the processing scheme.

It is possible that rapid chilling methods may be applied in a more moderate fashion or at a better time to allow for mechanical portioning of hot processed loins. Further research is underway to answer some of these questions.

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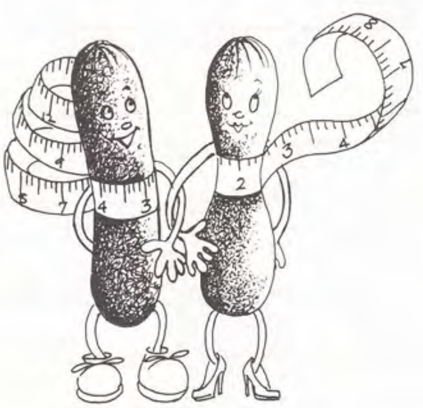
[1]Chris R. Calkins is Assistant Professor–Meats. C. B. Frye is a graduate student. R. W. Mandigo is Professor–Meats. The Nebraska Pork Producers Association and the National Pork Producers Council partially funded this project.

Reducing Fat—Its Effect on Eating Quality



Roger W. Mandigo
Chris R. Calkins
Raymond A. Valvano[1]

The Senate's Select Committee on Nutrition and Human Needs has indicated reduction of present fat intake levels as part of their "Dietary Goals for the United States." As a result consumers have become more conscious of their fat intake, and have made efforts to reduce it. Many medical doctors recommend that patients with coronary heart diseases and obesity problems reduce their fat intake.

This area of animal fat consumption and related dietary illnesses has become controversial. When medical and political concerns are separated from the meat products, there remain unanswered questions about the meat. While these concerns cannot

Table 1. New England brand sausage formulation.

		Sample		
Ingredients		A	B	C
Pork trim		18 lb	18 lb	18 lb
Beef trim		2 lb	2 lb	2 lb
Water		2 lb	2 lb	2 lb
Seasoning		1.3 lb	1.3 lb	1.3 lb
Cure (6.25%	0 hours	.025 lb	.05 lb	.05 lb
nitrite)	48 hours	.025 lb		

Table 2. Smokehouse schedule for New England brand sausage.

Time (min)	Dry bulb (F)	Wet bulb (F)	RH[a] (%)	Dampers	Smoke
60	130	0	0	open	off
60	140	110	40	closed	on
60	155	124	40	closed	on
60	170	137	40	closed	on
[b]	180	150	45	closed	off
15	cold water				

[a]RH = Relative Humidty

[b]Cooked to internal temperature 150F. Steam cook procedure was used.

Table 3. Sensory panel evaluation for salt level, chewiness, and overall acceptability.*

Treatment		Salt level	SE	Chewiness	SE	SE	Overall acceptability	SE
Fat level	5%	5.14[a]	.10	4.78[ab]	.13	5.10[a]	,10	
	15%	4.70[b]	.11	5.02[b]	.10	4.79[b]	.11	
	25%	3.95[c]	.12	4.42[a]	.12	3.84[c]	.12	
No preblend		4.75[x]	.09	4.83[x]	.10	4.73[x]	.09	
Preblend		4.45[y]	.10	4.83[x]	.09	4.42[y]	.10	

*Sensory panel scores are based on a hedonic scale of 1 = dislike, 4 = neutral, and 7 = like extremely.

[a b c]Means in the same column for different fat levels with superscripts are significantly different (P<.05).

[xy]Means in the same column for different blending treatments with different superscripts are significantly different (P<.05).

be ignored, there are opportunities to improve the meat products. Technology development is needed so that pork products remain palatable, cost and value competitive, and at the same time, meet medical, political, and consumer preferences.

Research Objectives

Research began in 1981 to address some of these concerns. Objectives of that research project were:

1. Identify and characterize textural changes that occur in manufactured and processed meats when the fat content is substantially reduced.

2. Develop alternate technologies to control juiciness, mouth feel and other textural properties in low fat meat products.

3. Characterize the palatability changes and make modifications where needed to processing technology for manufactured and processed meats.

In meat processing, preblending involves adding salt, water and the cure [sodium nitrite] to the meat 12 hours to several days before final production of the sausage product. Advantages of this practice include greater protein bind, better water balance and improved color. While these advantages were important in this project, it was anticipated that preblending would also allow texture control in products with reduced fat contents.

Design of the research project included three product fat levels—5%, 15%, and 25%, and three preblending procedures. Preblending methods were: A) preblending with half the nitrite and all the salt for 48 hours then adding the remaining nitrite at the time of processing; B) immediate processing after blending and C) the addition of all the nitrite and salt for 48 hours before processing. The difference between methods A and C is in the addition of the nitrite. It was postulated that saving half of the nitrite [A] for the final blending step would retain more color in the finished products.

Three different sausage formulations were developed to produce a sliced luncheon meat item known as New England Brand Sausage (Table 1).

New England sausage is commonly made by finely communiting the beef to form an emulsified fraction which is mixed into the coarser chopped or ground lean pork. The mix is stuffed into large diameter casings and smoked (Table 2) before chilling, slicing, and packaging. A substantial amount of New England brand sausage is produced in the U.S. each year. This luncheon meat has a mild ham-like flavor and has traditionally been less expensive than boiled ham for luncheon meat application.

Following processing, products were sliced and served to consumer sensory panels to determine differences in texture and palatability. Other samples were analyzed for various chemical and physical properties.

Results and Discussion

Three blending methods and three fat levels were investigated to determine the effects each has on New England brand sausage. Blending method had an influence on the amount of color and color stability. Nitrite levels decreased, as expected, for the six-week storage shelf life study. However, preblending for 48 hours lessened the decrease. Color components were evaluated. The preblended samples maintained color better through shelf life storage than the non-preblended products. Rancidity was significantly delayed in the preblended samples. As expected, the fatter the product, the greater the increase in development of rancidity.

Effects of preblending on the physical and sensory attributes of the New England brand sausage indicate that the impact of preblending may not have been as great as anticipated. Preblending did not influence the emulsion stability of the 5 and 15% fat samples. There was a difference between the emulsion stability of the 15 and 25% samples. Flavor of the 5 and 15% samples was different than at 25%. The primary difference was due to the increased fat level, often commented upon as being "greasier".

The 5 and 15% products were not as tender as the 25% fat products, an effect commonly seen with low fat formulas. However, acceptably tender products were

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Reducing Fat

(continued from page 21)

produced from the 5 and 15% fat products.

Table 3 illustrates the sensory panel responses to the three fat levels and the preblend and non-preblended products.

Reduction of fat in the formulation of New England brand sausage can be accomplished. The reduction does present problems in the sausage textural properties. However, the processing procedures can be modified to produce acceptable products. Panel scores were at or above the midpoint for essentially all of the sensory score ranges for all traits measured. This indicates that the product was acceptable. Although panelists felt that the low fat samples were saltier, they were perceived as having a more desirable salt level. The overall acceptability levels of the New England brand sausage produced in this study favored the lowered fat levels.

The non-preblended treatment received higher salt perception and overall acceptability scores than the preblended treatments. These differences indicate that a reduction in salt level can occur in non-preblended samples that have lowered fat content. There are definite adjustments that can be made to produce acceptable lowered fat formulations in processed pork products.

[1]Roger W. Mandigo is Professor—Meats. Chris R. Calkins is Assistant Professor—Meats. Raymond A. Valvano is a former graduate student. This project was partially supported by the Nebraska Pork Producers Association.

Chelated Zinc for Swine

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A. J. Lewis[1]

Trace elements are essential for normal growth, development, and health of all animals. Knowledge of the availability of various chemical forms is essential to ensure that diets are adequately fortified.

Trace mineral-amino acid complexes first appeared on the commercial feed market in the mid-1970's. It was assumed that these complexes would be more biologically available to animals than inorganic mineral sources. Research data to support this assumption is limited.

Picolinic Acid

In the late 1970's a compound called picolinic acid, a chelator that strongly binds to zinc (and other elements) was found in human milk and digestive juices of the pancreas. Researchers suggested that picolinic acid, a breakdown product of the amino acid tryptophan, promotes the absorption of zinc from the intestine. Other research suggested that picolinic acid increased zinc uptake in humans but not in calves. Little is known about the value of chelated zinc sources for swine. Therefore, we conducted two experiments to compare the performance of pigs fed diets with no supplemental zinc (only zinc from diet ingredients) with those fed diets supplemented with zinc sulfate ($ZnSO_4$), zinc methionine (ZnMet) and zinc methionine with picolinic acid (ZnMet w/PA).

In the first study, the unsupplemented diet contained 30 ppm Zn. The other diets were supplemented with 15 ppm Zn from the various zinc sources. In this study 96 crossbred barrows and gilts averaging 28 lb were fed for 28 days.

In the second study 240 crossbred barrows and gilts averaging 16 lb were fed for 21 days. Then, 96 of the pigs were continued for an additional 112 days to an average slaughter weight of 210 lb. In this study the unsupplemented diet contained 25 ppm Zn and the other diets were supplemented with an additional 15 ppm Zn from the zinc sources.

The zinc levels used in these studies were below recommended levels. The low levels were chosen to amplify any possible differences in growth and performance due to

Table 1. Effect of zinc source on gains and feed conversion of pigs (exp. 1)[a,b]

		Zn-Supplement		
	No zinc	$ZnSO_4$	ZnMet	ZnMet w/PA
ADG, lb	1.52	1.50	1.41	1.58
ADFI, lb	2.16	2.13	1.94	2.35
F/G ratio	1.41	1.42	1.38	1.48

[a]28-day test; initial wt 28 lb.
[b]6 pens of 4 pigs/pen.

Table 2. Effect of zinc source on gains and feed conversion of pigs (exp. 2)

		Zn-Supplement		
	No zinc	$ZnSO_4$	ZnMet	ZnMet w/PA
Nursery phase (16-36 lb)[a]				
ADG, lb	0.92	0.88	0.88	0.92
ADFI, lb	1.54	1.50	1.45	1.54
F/G ratio	1.67	1.72	1.63	1.66
Grower phase (36 lb to 110 lb)[b]				
ADG, lb	1.36	1.36	1.41	1.41
ADFI, lb	3.43	3.32	3.41	3.26
F/G	2.51	2.42	2.43	2.32
Finisher phase (110 lb to 210 lb)[b]				
ADG, lb	1.63	1.74	1.78	1.80
ADFI, lb	5.04	5.26	5.41	5.61
F/G	3.08	3.04	3.05	3.10

[a]21-day test, 12 pens of 20 pigs/pen.
[b]Grower-finisher phase was 112 days; 6 pens of 8 pigs/pen/trt.

the different zinc sources. The recommended level of zinc is 100 ppm.

In the first study average daily gain (ADG) and average daily feed intake (ADFI) were lower in pigs fed ZnMet than in pigs fed ZnMet w/PA (Table 1). Neither was different from pigs fed the unsupplemented diet or the diets with zinc sulfate. Although there was a slight improvement in ADG and ADFI for pigs fed the picolinic acid, there was no improvement in feed conversion.

During the second study nursery period pigs fed the two zinc methionine sources showed a slight improvement in feed/gain but not in ADG or ADFI (Table 2). No differences in performance were observed during the grower period (36 lb to 110 lb). It was not until the finisher period (110 lb to 210 lb) that a slight improvement in ADG and ADFI was recorded for pigs fed the three zinc supplemented diets. There were no differences in feed conversion. Serum zinc levels were higher during the later phases of the second study in pigs fed diets supplemented with zinc than in pigs fed the unsupplemented diet.

Analysis

At the end of the second study, half of the pigs were slaughtered and the bones from their hind legs were analyzed for mineral content. Less zinc was found in bones of pigs fed the unsupplemented diet than in bones of pigs fed diets supplemented with zinc.

These results suggest that the biological availability of zinc from zinc sulfate, zinc methionine, or zinc methionine with picolinic acid are similar for nursery age or growing-finishing pigs. It should also be noted that the levels of zinc fed in these studies are lower than NRC (1979) requirements and current University of Nebraska allowances and are not meant to be used as recommended levels.

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Does it Pay?

Sows in Stalls During Gestation

Roger J. Kittok
Dwane R. Zimmerman[1]

Confinement of sows and gilts in stalls during gestation is becoming an accepted practice. Stalling eliminates effects of a "pecking-order" that occurs when sows are grouped, and also allows attention to individual animals. However, the benefits or detriments of confinement in stalls on sow productivity have not been well documented.

The present study compared the number and weight of live pigs farrowed and weaned by sows housed in stalls, inside group pens (4 or 5 sows/pen), and outside group lots (9 sows/lot) during their second and third gestations. The same treatment was maintained for each sow during both gestations.

Procedure

Sows used were from the University of Nebraska Gene Pool population. The stalls (22 in. x 7 ft.; gated back) and pens (6 x 16 ft.) were located in each of two rooms in a totally enclosed confinement facility. The outside lots (50 x 120 ft.) were equipped with a concrete apron and feeding stalls. Portable shelters were available to the sows in the outside lots. These shelters were bedded with straw during cold weather. All sows were fed a 14% protein, corn-soybean meal diet at the rate of 4 lb daily during the first 90 days of gestation and 6 lb daily thereafter. The feed allowance of sows maintained in the outside lots was increased to 4.5 lb daily in cold weather to compensate for assumed higher maintenance requirements. Sows in stalls and outside lots were individually fed while sows in confinement pens were group fed on the floor.

After weaning their first litter, all sows were confined to stalls in the breeding barn until two days after breeding. They were then transferred from the breeding stalls to their assigned gestation locations. Treatments were assigned on a rotational basis as the sows were detected in estrus. There was no attempt to hold sows in the breeding stalls to assemble a group to be put into either pens or lots.

The sows farrowed in July and December of 1982. Pig and sow performance data from each farrowing were pooled and are presented in combined form in Table 1. All sows farrowed in crates and were fed the same diet ad libitum during lactation. Eighteen sows were bred and assigned to each treatment. All were bred and returned to the same treatment for the second season. Data were collected on 27, 30, and 32 litters from sows that gestated in stalls, inside pens and outside lots, respectively.

Effect of Housing

Type of housing during gestation did not affect the number of pigs born alive, number weaned,

(continued on next page)

Table 1. Effect on productivity of housing sows in stalls, pens, or outside lots during gestation.

Measurement	Treatment		
	Stalls	Pens	Lots
Pigs born alive	9.8	9.6	9.5
Pigs weaned	8.9	9.1	8.9
Birth wt (lb)	2.8[a]	3.0[ab]	3.0[b]
Weaning wt (lb)	11.2	12.0	11.7
Sow prefarrowing wt (lb)	376.8[a]	404.7[b]	416.2[b]
Sow wt loss during lactation (lb)	52.7[a]	72.6[b]	72.3[b]

[a,b]Within a variable, values with different superscripts differ ($P<.05$).

Sows in Stalls

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or weaning weight in this experiment. However, prefarrowing sow weight and birth weight of pigs were lower in sows housed in stalls than in sows in the other treatment groups.

The lower prefarrowing sow weight and lower birth weight of pigs from sows housed in stalls may be due to lower feed consumption and possibly greater heat loss rather than to lack of adaptation to confinement. Sows housed inside (stalls and pens) were provided similar amounts of feed. Sows maintained in stalls tended to waste feed and may have suffered from reduced feed intake. Sows housed in pens and outside lots had the opportunity to recycle fecal material and to huddle to keep warm. Sows maintained outside also had the opportunity to consume bedding material. Additionally, placement of nipple waterers in the stalls allowed sows to drip water onto the floor, producing a damp or wet condition. Unfortunately, these problems were not totally eliminated during the experiment.

Effect of Farrowing Season

The effect of farrowing season was significant for several measurements. In December, more pigs were born alive and weaned at a heavier weight, sows weighed more before farrowing and after weaning and lost more weight during lactation. However, the effect of season was confounded with parity. It is likely that most of these differences were the result of the additional maturity of the sows. That is, third-litter sows produced more pigs, were larger and lost more weight during lactation than second-litter sows.

The trend of fewer sows farrowing after being housed in stalls is supported by a study at Kansas State University. In that study, both farrowing rate and litter size were improved when sows were maintained in pens rather than stalls during the first 30 days of gestation. However, litter size was not affected by type of housing in the present study.

In conclusion, the present experiment did not indicate any advantage in the number of pigs born alive or in the number of pigs weaned when sows were housed in stalls, pens, or outside lots during gestation. Although the pigs from sows housed in stalls were lighter at birth, no weight disadvantage was detected at the time of weaning. Further research is needed to establish whether farrowing rate is affected by maintaining sows in stalls or pens during gestation.

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Probiotics—Are They Here to Stay?

E. R. Peo, Jr.
J. D. Crenshaw
A. H. Lewis[1]

A new concept in regulation of microbial populations in the intestinal tract called "probiotics" has been introduced to the swine feeding industry. For nearly 35 years, swine producers have been living in the "antibiotic age". Antibiotics control intestinal microbial populations by inhibiting or destroying microorganisms. Probiotics influence microbes by introducing beneficial bacteria to the intestinal tract which hopefully swing the balance from "bad" to "good" bacteria.

When antibiotics were first introduced as feed additives for swine, it was common to obtain a 15% improvement in gains and feed conversion. Since the early years of fantastic performance improvements, pig response to antibiotics has settled down to a respectable 5% improvement in gains and feed conversion. The response does vary depending on the antibiotic being fed and the age of the pig. Nothing as spectacular as even a routine 5% im-

Table 1. Value of Biomate FG for swine[a]

	Phase								
	Grower[b,e]			Finisher[c,e]			Combined (G-F)[d,e]		
Treatment	ADG, lb[e]	FI, lb[e]	F/G[e,f]	ADG, lb[e]	FI, lb[e]	F/G[e]	ADG, lb[e]	FI, lb[e]	F/G[e,h]
1. (None)	1.36	3.28	2.40	1.46	5.11	3.55	1.41	4.52	3.18
2. Biomate FG (1.0lb/Ton grower; 0.5 lb/Ton in finisher)	1.36	3.19	2.34	1.46	5.09	3.50	1.43	4.45	3.12
3. Biomate FG (*none* in grower; 0.5 lb/Ton finisher)	1.34	3.22	2.37	1.41	5.09	3.61	1.41	4.50	3.20
4. Biomate FG (1.0 lb/Ton in grower; none in finisher)	1.34	3.09	2.30	1.39	4.83	3.49	1.37	4.25	3.12

[a]Chr Hansen, Milwaukee, WI.
[b]4 pens of 10 pigs/pen. Int. wt. approx. 31 lb.
[c]4 pens of 10 pigs/pen. Int. wt. approx. 88 lb.
[d]Study conducted in a MOF unit; 40% slatted floor. 16% corn-soybean meal diet fed during the grower phase; 14% corn-soybean meal diet fed during the finisher phase.
[e]ADG = avg daily gain; FI = avg daily feed intake; F/G = Feed/unit of gain.
[f]Difference between treatments 1 + 3 vs 2 + 4 sig. (P<.005).
[g]Difference between treatments 2 vs 4 sig (P<.06).
[h]Difference between treatments 1 + 3 vs 2 + 4 sig (P<.08).

provement in pig performance has been reported for probiotics. In fact, most research indicates little or no response to probiotics.

For example, we recently completed a study on the value of Biomate FG[2] for growing and finishing swine. Biomate FG contains mostly *Lactobacillus acidophilus*. The presence of large numbers of *Lactobacillus acidophilus* in the gastrointestinal tract may be desirable. The *Lactobacillus acidophilus* in Biomate FG is said to be encapsulated so that it will not be destroyed in the stomach and will be released in the intestinal tract for colonization or competitive inhibition of the "bad" organisms.

Results of the study are shown in Table 1. Average daily gain was not affected by feeding 1.0 lb/ton of Biomate FG during the grower period or 0.5 lb/ton during the finisher phase. However, the withdrawal of the lactobacillus product during the finisher phase (treatment 4) resulted in a 3% reduction in overall gains for this treatment.

There was a consistent improvement in feed conversion (2.8%) when lactobacillus was included in the grower diet, but using Biomate FG only during the finisher phase (treatment 3) depressed feed conversion by a similar amount (2.8%). When considered over both the grower and finisher phases, there was a slight improvement in feed conversion in favor of the treatments in which *Lactobacillus acidophilus* was fed. However, it is unlikely that the slight improvement in feed conversion would be economically justifiable.

Do the results of our research and that of others mean that probiotics have no role to play in modern swine production? We believe the "jury" is still out. More research is needed to understand the nature of probiotics and how they can be best utilized (if at all) in swine feeding programs.

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Economics of Raw Soybeans in Brood Sow Diets

Larry L. Bitney[1]

Research at the University of Nebraska North Platte Station has shown that ground raw soybeans can effectively provide all of the protein supplement needed in a brood sow diet, eliminating the need for soybean meal. The objective of this article is to determine if it is profitable to feed brood sows ground raw soybeans instead of soybean meal.

Rations and Performance

A diet containing soybean meal and another containing raw soybeans were each formulated to contain 14% crude protein. These diets (Table 1) were fed to different groups of females for the first 110 days of gestation at the rate of four pounds per head per day. All animals received a soybean meal diet through the remainder of their gestation and throughout lactation.

Feeding raw soybeans as a source of supplemental protein from breeding to 110 days of gestation compared to soybean meal resulted in: (1) no effect on sow weight changes during gestation or lactation; (2) no effect on the number of pigs farrowed live; (3) increased pig birth weight; (4) no effect on the weaning weight of pigs; and (5) a five percent improvement in baby pig survival rate.

Table 1. Brod sow diets.

Ingredient	Diet using soybean meal	Diet using raw soybeans
	%	%
Corn	77.03	68.01
Soybean meal, 44% crude protein	16.42	----
Raw soybeans, 32% crude protein[a]	----	25.38
Alfalfa hay	2.50	2.50
Dicalcium Phosphate	2.50	2.33
Calcium carbonate	.40	.63
Salt, iodized	.30	.30
Vitamin and trace mineral premix	.85	.85
	100.00%	100.00%

[a]This was the protein content of the soybeans used in the North Platte experiment. It is advisable to have the protein content checked before formulating rations.

Economic Analysis

The value of raw soybeans in brood sow diets depends on: (1) price of soybean meal; (2) price of corn; and (3) the increased value of a litter of weaned pigs due to the anticipated increase in pig survival rate with raw soybean rations. A formula with these factors as variables was developed to show the value of raw soybeans at alternative corn and soybean meal prices and pig survival rates. This value of raw soybeans can then be compared with the market price of soybeans to determine if it would be more profitable to feed raw soybeans or soybean meal.

When evaluating any new practice, it is advisable to evaluate some "what if" situations. Even though experiment results show a consistent 5% improvement in baby pig survival rate with raw soybean diets, a producer may ask, "How much of an improvement in survival rate is necessary to justify feeding raw soybeans"? If no increase is necessary, the producer should feed raw soybeans regardless of the change in survival rate. If the full 5% is necessary, the producer may be doubtful about adopting the practice. Results shown in Figure 1 allow you to evaluate your situation.

To use Figure 1, locate your price for soybean meal on the horizontal axis, and draw a vertical line upward from that point. The dashed line drawn upward from $250/ton is shown in Figure 1 as an example. Then, locate the price of raw soybeans and draw a horizontal line to the right of that price. A price of $8.50/bu was used as an example in Figure 1.

The diagonal lines in Figure 1 are break-even lines for different increases in pig survival rates. A

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Economics of Raw Soybeans

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point on any one of these lines reflects an economic break-even between feeding raw soybeans or feeding soybean meal at that increase in the survival rate. Points falling above that line favor feeding soybean meal, while points falling below that line favor feeding raw soybeans.

In the Figure 1 example, using $250 soybean meal and $8.50 soybeans, the lines meet at point A. This indicates that an increased survival rate of between 1 and 2 percent would be necessary to justify feeding raw soybeans.

If the increase in survival rate is 5% (Point B), raw soybeans would be worth $12.63 per bushel in brood sow diets, and would clearly be advantageous if the market price of soybeans is anything less than that.

The example also shows that if no increase in pig survival rate is experienced (Point C), raw soybeans are only worth $6.24/bushel in brood sow diets. If the market price of soybeans is $8.50/bushel, soybeans should be sold and a soybean meal diet should be fed.

A corn price of $3.50/bushel was used in Figure 1. The value of raw soybeans is affected somewhat by changes in the corn price. An increase of $1/bushel in the corn price increases the value of a bushel of raw soybeans by 38¢. Decreases in the corn price likewise decrease the value of raw soybeans in a brood sow diet.

It is important that a producer use prices of soybeans, soybean meal, and corn at the point where the feed is processed. If the producer processes feed on the farm, these should be on-farm prices.

The determination of weaned pig value is important in this analysis. A pig price of $30/head was used in Figure 1. During periods such as the fall of 1983, the value may be less than $30. At other times, it may be more. A farrow-to-finish producer may want to attribute the profit from additional market hogs sold to the increased survival rate. However, the approach used in this analysis was to value the pigs resulting

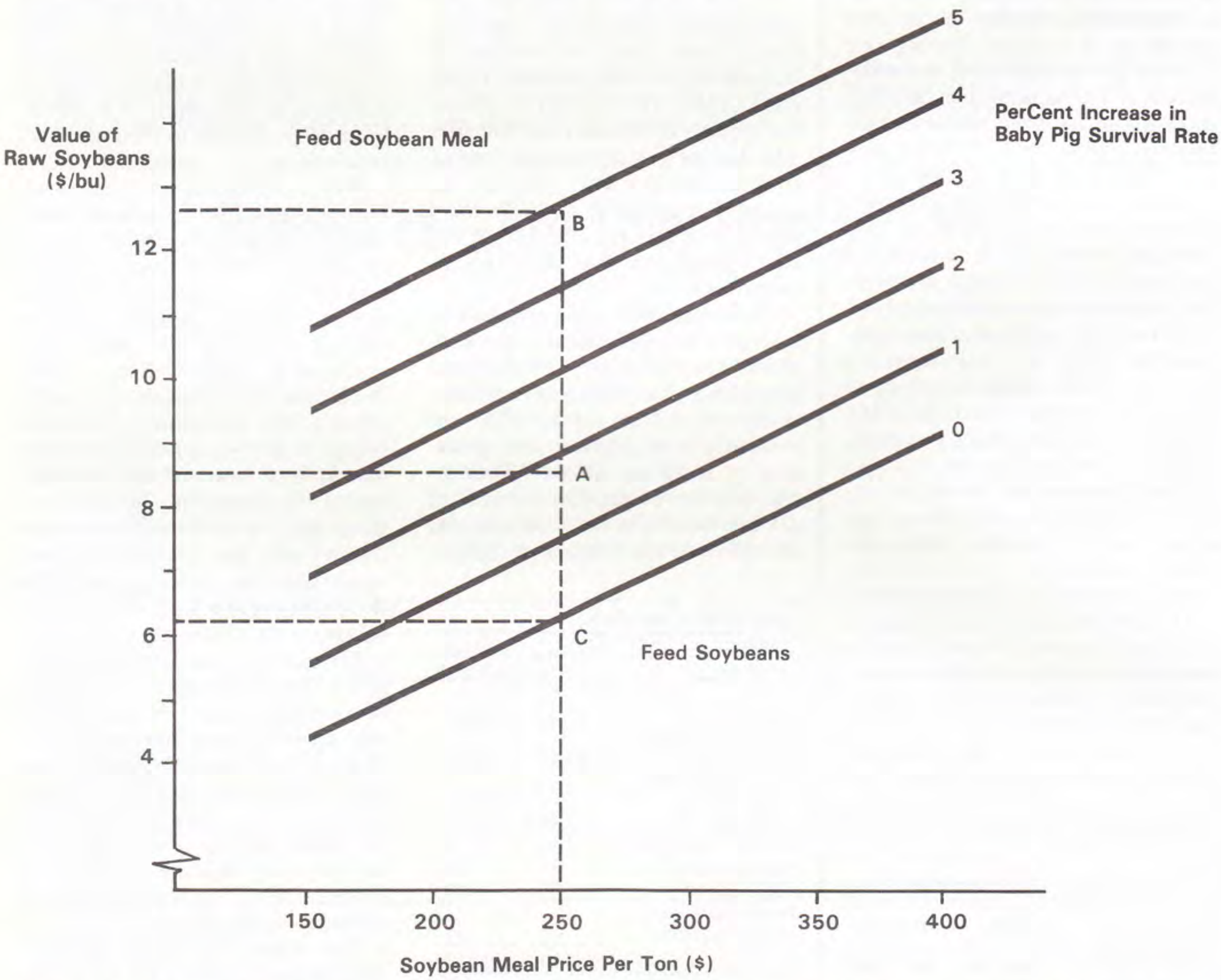

Figure 1. Value of raw soybeans in brood sow rations at alternative soybean meal prices and baby pig survival rates ($3.50/bu corn price, $30/head value of weaned pigs).

from the increased survival rate at the first point that they became a marketable product—at weaning. Figure 1 could be used to evaluate how much the weaned pig must be worth to justify feeding raw soybeans. If a weaned pig is worth 60% of the $30/head price, or $18/head, this would correspond to 60% of the 5% survival increase, or 3%. Thus we could use the "3% line" in Figure 1. Using the $250/ton soybean meal price and the 3% break-even line, we can see that raw soybeans would be worth approximately $10.00/bushel.

The formula which was used to develop Figure 1 can be programmed into a computer. Such a program allows computations using varying price situations to be made conveniently.

Conclusion

Feeding of raw ground soybeans to gestating sows has been shown to be an economic decision rather than a nutritional factor. Given a normal range of price relationships between soybeans and soybean meal, some increase in the survival rate of baby pigs is necessary to justify feeding raw soybeans to brood sows. However, an increase in the pig survival rate of only about 2% makes it profitable to formulate brood sow diets with raw soybeans. A 5% increase in survival rate, which was realized in the North Platte experiments, definitely makes feeding raw soybeans more profitable than feeding soybean meal in brood sow diets.

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