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J. D. Crenshaw
University of Nebraska-Lincoln

E. R. Peo Jr.
University of Nebraska-Lincoln

R. D. Fritschen
University of Nebraska-Lincoln, bobnhaz@hotmail.com

Roy L. Carlson
University of Nebraska-Lincoln

Rodger K. Johnson
University of Nebraska-Lincoln, rjohnson5@unl.edu

See next page for additional authors

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- Breeding
- Disease Control
- Nutrition
- Economics
- Housing

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Contents

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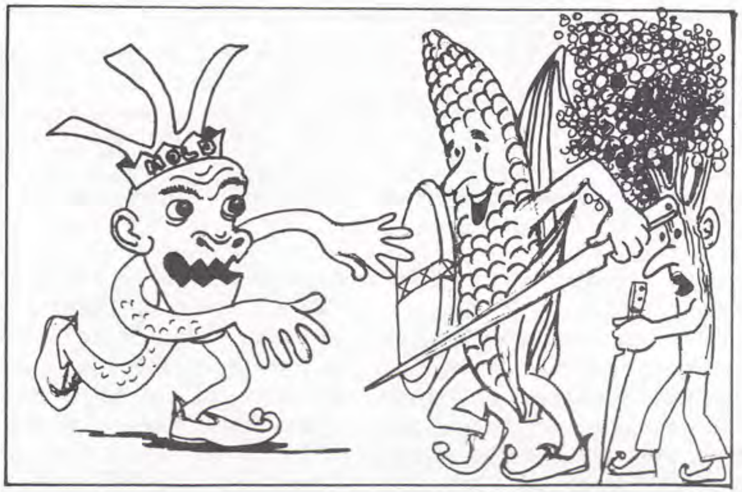
On the cover: Restructured pork products, based on UN–L technology, are a fast food hit.

The 1983 Nebraska Swine Report was compiled by William T. Ahlschwede, Extension Swine Specialist, Department of Animal Science.



Can We Prevent Moldy Feed?

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

Present climatic conditions in Nebraska and surrounding areas are favorable for mold infestation and spoilage of grain and livestock feed. Several species of molds produce mycotoxins that in swine cause loss of appetite, poorer feed conversion, reduced gain, reproductive disorders, gastrointestional disturbances, and death. These symptoms vary in severity with the type and amount of mycotoxins present and are not always easily detected. Molds are not always visible in grain or feed. Perhaps the most expensive effect of mycotoxin-contaminated feed is chronic undetected reduction in gain and feed efficiency. It is essential that the pork producer provide mold-free feed to pigs.

What Can Be Done?

What can be done to prevent spoilage of grain and feed? Very little can be done to prevent mold infestation of grain while it is still in the field. Therefore, it is best to avoid feeding swine moldy grain. However, we can reduce spoilage of grain during storage by either drying the grain to a moisture content of less than 14%, treating wet grain with organic acids, or storing wet grain in oxygen limiting storage facilities. Most molds will not grow at low moisture (less than 14%) levels or at low oxygen concentrations.

What happens to grain once it is removed from storage for use as feed? Most grain for swine is processed before feeding. Once the seed coat of grain is disrupted, it becomes more vulnerable to mold infestation, especially in the warm, moist environment commonly associated with swine confinement facilities. Dry feed placed in warm, humid conditions can absorb moisture rapidly, increasing chances of rapid mold growth. High moisture grain stored in oxygen-limiting storage will become moldy within 2 to 3 days after removal.

Mold Inhibitor Studied

Several commercial products are available which inhibit mold growth in feeds. However, little research is available on the use of dry mold inhibitors in high moisture grain diets for swine. This article reports on research to determine the effectiveness of sorbic acid as a mold inhibitor in high moisture and reconstituted sorghum grain (dry sorghum grain plus water) diets for weanling swine.

High moisture and reconstituted sorghum grain was ensiled in airtight containers at least 21 days before feeding. For experiment 1, dietary treatments were dry sorghum grain, dry sorghum + .1% sorbic acid, high moisture sorghum grain + .1% sorbic acid, and reconstituted sorghum grain + .1% sorbic acid. The dry sorghum grain diets were fed when needed. The high moisture and reconstituted sorghum grain diets were fed fresh from oxygen-limiting storage every 3 or 7 days. Any feed remaining after the third or seventh day was discarded. Moisture contents of the dry, high moisture and reconstituted sorghum grain diets were 13.5, 20.9 and 20.7% respectively. Ninety-six weanling pigs (4 weeks old) were assigned to the 6 treatments with 4 pigs per pen and 6 pens for the dry treatments and 3 pens for the high moisture and reconstituted treatments.

For experiments 2 and 3, dietary treatments were reconstituted sorghum grain of two moisture contents, each fed with 0, .05 and .10% (1 or 2 lb/ton) sorbic acid. Moisture contents of the complete diets were 17.7 and 20.5% and 19.7 and 22.5%, respectively. Ninety-six weanling pigs (3 to 4 weeks old) were assigned to 6 dietary treatments with 4 pens of 4 pigs/pen/treatment. Each diet was mixed and fed fresh from storage every 7 days with any remaining feed discarded after the seventh day. Pigs were weighed and feed

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Table 1. Performance of weanling pigs fed sorghum grain diets containing sorbic acid, Exp. 1. (NE Exp. 81407A).[a]

Grain type	Dry		High moisture		Reconstituted	
Exposure time (d)	---	---	3	7	3	7
Sorbic acid, %	0	.1	.1	.1	.1	.1
Criterion						
Avg. daily gain, (lb)	.77	.74	.81	.81	.90	1.01
Avg. daily feed intake (lb)[bc]	1.44	1.44	1.46	1.53	1.67	1.94
Feed efficiency[b]	1.87	1.95	1.80	1.89	1.86	1.92

[a]Dry treatments = 4 pigs/pen; 6 pens/treatment
High moisture and reconstituted treatments = 4 pigs/pen; 3 pens/treatment.
[b]Equivalent dry matter basis (100%).
[c]Trt comparisons: Dry vs High moisture + Reconstituted and High moisture vs Reconstituted ($P<.07$).

Can We Prevent Moldy Feed?

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intakes recorded weekly. The three experiments lasted 21, 19, and 28 days, respectively. Average daily gain, average daily feed intake and feed conversion on the basis of 100% dry matter was calculated.

Results

Results of experiment 1 are shown in Table 1. The only significant differences were for average daily feed intake. Pigs fed the high moisture and reconstituted sorghum grain diets ate more feed (dry matter basis) than those fed dry sorghum grain diets. Also, those fed the reconstituted diets consumed more feed than those fed the high moisture diets. Similar trends were observed for average daily gain and feed efficiency. There were no differences in performance traits between the dry diets, indicating sorbic acid had no adverse effects. For dry diets, sorbic acid may be useful as a mold inhibitor if potential mold problems exist.

Results of experiments 2 and 3 are shown in Table 2. Although differences between moisture levels and moisture-sorbic acid interactions were observed for some of the performance traits, no consistant trends were evident. However, there was a 5% improvement of feed efficiency for pigs fed diets containing .10% sorbic acid in experiment 3. Surprisingly, pigs fed diets containing 0% sorbic acid responded similarly to those fed diets containing sorbic acid, even though these diets became moldy within 4 to 5 days after feeding. However, no mycotoxins were detected in any of the dietary treatments. We do not suggest feeding moldy feed to swine even though results of these experiments showed no adverse effects. Mycotoxins can occur in dry feed at any time. They just were not present in the high moisture grains fed in these experiments.

Table 2. Response of weanling pigs fed reconstituted milo diets, Exp. 2 and 3 (NE Exp. 81417 and 81421).

Diet moisture, %	Sorbic acid (%) 0	.05	.10	
	Average daily gain (lb)			Avg. moisture
17.7[a]	.83	.81	.86	.83
20.5[a]	.83	.81	.86	.83
Avg. for sorbic acid	.83	.81	.86	
19.7[b,c,d]	1.10	.99	1.15	1.08
22.5[b,c,d]	1.01	1.04	1.04	1.04
Avg. for sorbic acid	1.06	1.01	1.10	
	Average daily feed intake (lb, dry matter basis)			Avg. moisture
17.7[a]	1.35	1.40	1.33	1.35
20.5[a]	1.26	1.26	1.24	1.26
Avg. for sorbic acid	1.31	1.33	1.28	
19.7[b,c,d]	1.89	1.67	1.91	1.82
22.5[b,c,d]	1.64	1.73	1.58	1.64
Avg. for sorbic acid	1.78	1.71	1.76	
	Feed to gain ratio (dry matter basis)			Avg. moisture
17.7[a,c]	1.61	1.70	1.57	1.63
20.5[a,c]	1.55	1.53	1.58	1.55
Avg. for sorbic acid	1.58	1.62	1.58	
19.7[b,c,e]	1.73	1.68	1.67	1.69
22.5[b,c,e]	1.62	1.69	1.53	1.61
Avg. for sorbic acid	1.68	1.69	1.60	

[a]Experiment 2, 19 day experiment, initial wt. = 13.1 lb. Means are the avg. of 4 pens/treatment.
[b]Experiment 3, 28 day experiment, initial wt. = 19.6 lb. Means are the avg. of 4 pens/treatment.
[c]Moisture levels differ; moisture × acid quadratic interaction ($P<.05$).
[d]Quadratic response to acid ($P<.05$).
[e]Linear response to acid ($P<.05$).

To further assess the effectiveness of sorbic acid as a mold inhibitor, we recorded temperature change of the experimental diets (for experiments 2 and 3) as an indication of mold growth. As mold growth increases, temperature of the diets increase. Approximately 50 lb of each dietary treatment was taken fresh from oxygen-limiting storage and placed in the nursery environment while the feeding trials were conducted. Thermometers were placed into the diets and temperature was recorded twice daily. A separate thermometer was used to record room temperature. Diets were considered moldy when the temperature of the diets was 3°C greater than room temperature.

Data in Table 3 show the number of days the diets remained mold-free after exposure to the nursery environment. Those diets containing no sorbic acid remained mold-free an average of 4.8 days. Diets containing .05 and .10% sorbic acid remained mold-free an average of 11.8 and 16.5 days, respectively. However, days of mold-free diets varied with moisture levels. Sorbic acid effectively extended the shelf-life of the reconstituted sorghum grain diets for at least 10 days after removal from oxygen-limiting storage. The decision to use a mold inhibitor in swine feed should be based primarily on the pork producer's feeding program and whether or not environmental conditions pose a potential mold problem.

Table 3. Days of mold-free feed after exposure to atmosphere, Exp. 2 and 3 (NE Exp. 81417 and 81421).

Sorbic acid (%)	Dietary moisture, % 17.7[a]	19.7[b]	20.5[a]	22.5[b]	Avg. acid
0	5	5	5	4	4.8
.05	15	10	12	10	11.8
.10	13	15	19	19	16.5

[a,b]Experiment 2 and 3, respectively.

[1]J. D. Crenshaw is Research Technician, Animal Science. E. R. Peo, Jr., is Professor, Swine Nutrition.

Feeding Scabby Wheat to Pigs

Robert D. Fritschen
Roy L. Carlson[1]

The 1982 growing season resulted in conditions producing plant diseases affecting both grain and forage. Perhaps none of the plant diseases were more pronounced than wheat scab as the disease reached epidemic levels in much of eastern Nebraska. Wheat scab by itself presents a problem generally characterized by reduced quality. However, scab-infected wheat may contain varying levels of mycotoxins that are by-products of the infection. In 1982 much of the scab-infected wheat was found to contain a mycotoxin known as vomitoxin.

It was not known if the scab-infected wheat would be acceptable for milling purposes. If it could not be used for milling, then it appeared likely it would be used in livestock feeds.

Table 1. Effect of vomitoxin-infected wheat on weaned pig performance.

	Percent scabby wheat			
	0	33	66	100
Avg. daily feed intake	2.16	1.83	1.08	0.54
Avg. daily gain, lb.	1.32	1.15	0.43	0.08
F:G	1.64	1.60	2.52	7.70

Problem Becomes Opportunity

Research on the effect and level of vomitoxin in swine feed is nearly nonexistent. In field cases when contaminated feed is consumed reports indicate feed refusal, vomiting, necrosis in the mouth and poor growth. Not all signs are observed in each case.

To learn more about this area, four pigs were randomly assigned to each of four treatments. Treatments were: (1) control, 100% of the grain portion from normal (1980 crop year) wheat, (2) 33% of the normal wheat replaced by scabby wheat, (3) 66% of the normal wheat replaced by scabby wheat and (4) 100% of normal wheat replaced by scabby wheat. The average beginning weight of the pigs was 22 lb. The trial lasted 10 days. Feed disappearance was measured every 24 hours. Results are shown in Table 1.

Pig performance showed a negative response as level of scabby wheat in the diet increased, except for feed: gain between the 0 and 33% scabby grain. Pig behavior was the same except for those recieving 100 percent scabby wheat. Here, the pigs rejected the feed except to occasionally approach the feeder, briefly taste the feed and turn away. Solid wood floors were provided for 72 hours and continuous surveillance of the pigs was made for the first 10 hours. We were unable to detect any vomiting.

Laboratory findings for vomitoxin (deoxynivalenol) levels, conducted at the Veterinary Diagnostic Center, showed levels of 0, 1.6, 1.6 and 3.2 ppm for the control, control plus 33 percent scabby wheat, control plus 66 percent scabby wheat and 100% scabby wheat diets, respectively. Even though laboratory results showed identical levels (1.6 ppm) of vomitoxin for the 33 and 66 percent scabby wheat, pigs responded differently as indicated in Tables 1 and 2. This difference between laboratory and animal results is unexplained.

Table 2. Feed disappearance per pig at 24-hour intervals.

	Percent scab infected wheat			
Day no.	0	33	66	100
1	1.37	1.60	0.72	0.31
2	1.60	1.10	1.20	0.45
3	1.66	1.75	0.90	0.35
4	1.77	1.88	1.07	0.35
5	2.20	1.45	1.03	0.43
6	2.86	2.02	1.15	0.70
7	2.20	2.13	0.93	0.70
8	2.40	2.10	1.18	0.95
9	2.60	2.20	1.20	0.82
10	2.80	2.20	1.40	0.65
Avg.	2.15	1.83	1.08	0.54

The average feed intake is shown by day in Table 2. This shows clearly that a refusal factor was present and that as the percent scabby wheat with vomitoxin increased in the diet the level of feed intake decreased. The question still remains, what level of vomitoxin-infected wheat can be fed to weaned pigs without negative performance.

Pig Response

The most notable pig response to feed with high levels of vomitoxin was feed refusal or reduced feed intake. The intake reduction was most likely responsible for reduced gain and increased feed per unit of gain with increasing levels of infected grain. There was no evidence of vomiting.

The limited data suggest that scabby wheat infected with vomitoxin can be diluted with normal grain to reduce the severity of the refusal factor. The level of dilution is not clear but it would seem that if pigs were fed a diet with 1 ppm vomitoxin, performance similar to the control diet could be expected. The effect of vomitoxin infected feed on pigs does not, in the short term, appear to cause mortality, but may cause morbidity. Therefore, it would be prudent to test feed scabby wheat to a small group of normal, healthy pigs for several days and observe results before feeding to a larger group. If vomitoxin is present, the pigs will react within a few minutes, or possibly a few hours.

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[1]Robert D. Fritschen is Extension Swine Specialist. Roy L. Carlson is Research Technician, Animal Science.

For Commercial Swine Production

Selection, Crossing Systems

Rodger K. Johnson
William T. Ahlschwede[1]

The trend today among pork producers is to use purchased or homegrown "white sows" in specialized breeding programs. But all white sows are not equal. Their output depends on breed composition, heterosis level and selection background.

The outcome of various crossbreeding systems was reported in the 1982 Nebraska Swine Report. Selection in seedstock and commercial herds was not considered in that report. Evaluation of these commercial crossbreeding strategies was expanded to determine how they are affected by selection for overall improved performance in seedstock herds and by selection for increased litter size in commercial herds. Breed performance levels (Table 1) reported by the North Central Region Swine Breeding Committee were considered base performance levels.

Gilt Selection

The long term effect of gilt selection for litter size in commercial herds is illustrated in Tables 2 and 3. In each case, it was assumed that genetic improvement of litter size in seedstock herds was occurring. Table 2 illustrates the average genetic merit of commercial sows when replacement gilts are selected at random. Table 3 shows commercial sows when replacement gilts are selected from the best sows.

Several interesting points can be made:

1. If producers continuously buy boars and mate them to home-selected gilts, the total improvement over many generations caused by gilt selection equals the average genetic superiority of mothers of the gilts selected in any generation (.2 pigs/litter). This can be seen by comparing commercial production in generation 6 under the two selection schemes (Table 2 vs Table 3).

2. It takes three or four generations of selection to approach the maximum response from gilt selection and, once attained, selection must be practiced every generation just to maintain the status quo.

3. If gilt selection is terminated (average gilts are selected), the genetic level of the commercial herd is two generations behind the genetic merit of the seedstock herd.

4. The rate of progress in the commercial herd equals the rate of progress in the seedstock herd.

These points are often not realized by commercial producers, but become more apparent when we realize that 87.5% of the genes in the present sow herd are from boars used the last three generations. Once this fact is accepted, it is clear that there can be virtually no genetic gain in commercial herds unless the seedstock industry improves.

Table 4 illustrates the total theoretical improvement that can be expected if all commercial gilt selection were for litter size. If a producer selects replacement gilts from 13% of the sows, and ranks sows on the average of all litters produced by each sow, the average selected sow is expected to have a genetic superiority of about .5 pigs/litter. However, if gilts are selected from one-third of the litters, selected sows are expected to have a superiority of about .35 pigs/litter. This represents the total improvement that could be realized from litter size selection at the commercial level.

Remember, these are theoretical expectations. Litter size is lowly heritable and, as yet, no experiment has shown that direct selection is successful. In fact, a recent experiment in France found no improvement after 10 generations of litter size selection. But the opportunity to select for litter size was considered in our simulation of the crossing systems that included on-farm development of sow lines.

Genetic Lag

Genetic lag (Figure 1), is the difference between the average merit of the seedstock industry and the commercial industry. Genetic lag may be a cost to commercial producers. A commercial herd that is

Table 1. Breed averages for performance traits used in analysis.

	Breed			
Trait	Hampshire	Duroc	Yorkshire	Landrace
Conception rate	0.85	0.85	0.72	0.69
Litter size born	9.00	9.60	10.80	10.00
Pig survival	0.66	0.66	0.72	0.84
Age at 220 lb	183.00	172.00	177.00	180.00
Backfat thickness	1.00	1.20	1.20	1.40
F/G	3.30	3.33	3.35	3.60

Table 2. Effect of no direct selection for litter size in commercial herds.[a]

		Commercial herd parents		
Generation	Seedstock herd	Boars	Sows	Commercial herd
0	10	10	10	10.
1	10.3	10	10	10.15
2	10.6	10.3	10.15	10.23
3	10.9	10.6	10.23	10.41
4	11.2	10.9	10.41	10.66
5	11.5	11.2	10.66	10.93
6	11.8	11.5	10.93	11.21

[a]Seedstock herd is improving at the rate of .3 pigs per generation. Replacement gilts selected at random in commercial herds.

Table 3. Effect of direct selection for litter size in commercial herds.[a]

Generation	Seedstock herd	Commercial herd parents		Commercial herd
		Boars	Sows	
0	10	10	10	10
1	10.3	10	10.2	10.1
2	10.6	10.3	10.3	10.3
3	10.9	10.6	10.5	10.55
4	11.2	10.9	10.75	10.83
5	11.5	11.2	11.03	11.11
6	11.8	11.5	11.21	11.41

[a]Seedstock herd is improving at the rate of .3 pigs per generation. Dams of selected gilts have a genetic superiority of .2 pigs per litter.

Table 4. Expected average response to litter size selection.

No. litters	h^2_n	$\sigma_{\bar{P}_n}$	Response	
			13%	33%
1	.10	2.5	.38	.27
2	.17	1.9	.48	.35
3	.21	1.7	.54	.38
4	.25	1.6	.59	.43
5	.28	1.5	.63	.45

h^2_n = heritability of litter size if selection is based on the average of n litters.

$\sigma_{\bar{P}_n}$ = standard deviation of litter size if selection is based on average of n litters.

Response = expected genetic superiority for litter size if best 13% or 33% of the sows are selected based on average *performance* in litter size from 1st to 5th litters.

turning over rapidly through frequent introductions from seedstock herds will have "newer model pigs" than a herd with a long generation interval. One producer may be marketing a 1979 model pig—another producer a 1977 model pig. If the seedstock industry is making genetic improvements in growth, backfat and food conversion ratio, the newer model pig should have a lower production cost than the older model pig.

We assumed that selection in the seedstock industry was improving the value of pigs at the rate of \$.75 per year through lower production costs caused by faster growth, less fat, and better food conversion. Estimates for the rate of this improvement in U.S. herds are unavailable, but recent British analyses indicate selection is reducing production costs by \$.75 to \$1.50 per pig per year.

In the analysis, we considered lag as the average difference in model year for commercial pigs and pigs produced by seedstock herds. This was calculated for each breeding system. No cost was charged to the system with the least lag and other systems were assigned costs proportional to the increased lag.

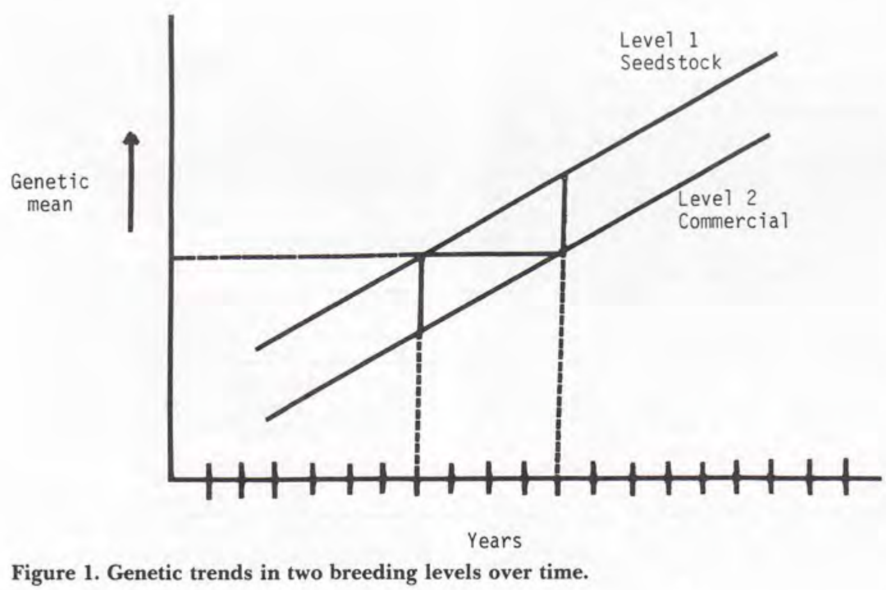

Figure 1. Genetic trends in two breeding levels over time.

Comparison of Systems

The projected outcome for six systems is presented in Table 5, including an economic projection for each system. All pigs were sold for \$.45 per lb, regardless of fat thickness. At base levels of production (80% farrowing rate, 7.5 pigs weaned at 40 lb each, 180 days to market and 3.5 food conversion ratio), production costs averaged \$.44 per lb. If replacement gilts are developed within the system, it was assumed the sow salvage value equaled the cost of a market gilt plus the cost of developing the gilt to breeding age.

System 1. This is the traditional rotation cross among Duroc, Hampshire, and Yorkshire. Average expectations over time are presented. However, breed composition varies considerably between generations; the breed of sire accounts for about 57%, the grandsire breed 28%, and the great-grandsire breed 14%. This causes noticeable changes in output per generation.

In fact, profit per 100 litters was about \$2,000 higher when sows were 57% Yorkshire than when sows were 57% Duroc or Hampshire. This fluctation is a very undesirable feature of the rotation, although if a premium were paid for less fat, this system would be better than projected here. The theoretical improvement from litter size selection in commercial herds is about \$6 per litter. Also, this system has the greatest genetic lag; however, the cost of lag is less than for System 3 because fewer pigs are produced.

System 2. This terminal cross involves buying F_1 females and mating them to F_1 Duroc-Hampshire boars and marketing all progeny. The net cost of a replacement gilt is \$130 (purchased gilt cost of \$250 minus salvage value of sow).

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Selection, Crossing Systems

(continued from page 7)

At a replacement rate of 20 per 100 litters, replacement gilts add a production cost of $26 per litter. If other replacement gilt costs are appropriate, producers can calculate their own expected net output for this system. The gross return by the system before replacement gilt costs were calculated was $11,091. Lag is least in this system and is considered the base to which other systems were compared.

Systems 3 through 6. These systems are all variations of terminal crosses using Yorkshire-Landrace sows. In each case the specialized sow is produced in the commercial herd. For comparison, all systems utilize Duroc-Hampshire F_1 boars for the terminal cross.

System 3 produces replacement females by mating about 15% of the sow herd to Yorkshire-Landrace F_1 boars. The other 85% are terminally crossed. In this case, all sows are similar in genetic makeup.

The best sows, based on litter size, can be designated to be mated to Y-L boars. In this case, the theoretical maximum benefit from litter size selection is about .3 pigs per litter at weaning. Profit per 100 litters is expected to increase by $690. However, lag is about .9 years more than for System 2 and costs the system about $620, which just offsets the improvement to be expected from litter size selection.

System 4 produces replacement females from a rotation cross of Yorkshire and Landrace. This is done on about 15% of the herd; the remaining sows are terminally crossed. This is superior to System 3 because sows retain a higher level of heterosis. Lag time is almost equivalent to System 2 because purebred Yorkshire and Landrace boars used in the rotation can be obtained from the seedstock herd. Litter size selection can increase profit by about $6.90 per litter. Over time, the distribution of matings in this system will be about as follows:

- 7% Landrace ♂ × Y-L-Y ♀ → L-Y-L ♀ + mkt ♂
- 7% Yorkshire ♂ × L-Y-L ♀ → Y-L-Y ♀ + mkt ♂
- 43% DH ♂ × Y-L-Y ♀ → mkt pigs
- 43% DH ♂ × L-Y-L ♀ → mkt pigs

System 5 maintains three different kinds of matings at the commercial level. About 5% of the sow herd is purebred Yorkshire and is mated to a Yorkshire boar. These matings produce replacement Yorkshire gilts. Fifteen percent of the sows are purebred Yorkshire sows mated to Landrace boars. These matings produce replacement Y-L F_1 gilts. The remainder of the herd (80% of sows) are Y-L F_1 females terminally crossed to D-H boars.

Genetic lag is minimal in this system because purebred Yorkshire and Landrace boars can be obtained from the nucleus level. However, the system offers little opportunity to select for litter size. The best 5 of 20 Yorkshire sows can be chosen to be mated pure, but the improvement is halved when daughters of selected sows are crossed to Landrace to produce F_1 gilts. The approximate ratio of matings for this system is:

- 5% Yorkshire ♂ × Yorkshire ♀ → Yorkshire ♀ + mkt ♂
- 15% Landrace ♂ × Yorkshire ♀ → YL F_1 ♀ + mkt ♂
- 80% DH ♂ × YL F_1 ♀ → mkt pigs

System 6 utilizes a backcross sow that is produced in a manner very similar to that used for system 5. The matings in the herd are:

- 2% Yorkshire ♂ × Yorkshire ♀ → Yorkshire ♀ + mkt ♂
- 4% Landrace ♂ × Yorkshire ♀ → YL F_1 ♀ + mkt ♂
- 14% Yorkshire ♂ × YL F_1 ♀ → Y-YL ♀ + mkt ♂
- 80% DH ♂ × Y-YL ♀ → mkt pigs

The extra step increases lag, and there is almost no opportunity for gilt selection at the commercial level. The reduced heterosis in the sow, increased lag, and greater complexity of the system make it considerably less attractive than System 2, 4, or 5.

Systems 4 and 5 look superior to System 2. However, System 2 is very simple. On the other hand, Systems 3 and 4 require more management and more specific records and identification on sows. A cost of more than $15 to $20 per litter to manage Systems 3 and 4 would make System 2 the most attractive.

Another consideration is selection for litter size. These are theoretical expectations and there is no guarantee of success. One could easily keep the records, make selections and gain nothing. The net effect of litter size selection is small compared to using breeds systematicaly and maintaining high levels of heterosis. Practically, producers cannot afford much time and effort on gilt selec-

Table 5. Expected performance and projected outcome for various systems.[a]

	Mating	Farrowing	Litter size (base)		Litersize selection		Age at			Lag		Exp. return/100 litters	
System	Boar × Sow	rate	Born	Weaned	Born	Weaned	market	Fat	F/G	Years	Cost[b]	with LS sel.	without LS sel.
1	H-D-Y Rot.	83	10.81	8.18	.4	.3	167	1.11	3.27	4.44	570(598)	6265	5576
2	HD F_1 × YL F_1	87	11.65	9.55	-	-	166	1.18	3.33	3.51	(base)	8491	8491
3	HD × YL-YL...	86	11.02	8.87	.4	.3	166	1.18	3.33	4.42	605(629)	7966	7277
4	HD × Y-L...	86.5	11.38	9.08	.4	.3	165	1.18	3.33	3.54	-	9774	9085
5	HD × YL*	84	11.48	9.29	.2	.2	167	1.19	3.34	3.79	195(200)	9865	9605
6	HD × Y-LY	83	11.27	8.88	-	-	166	1.17	3.32	4.09	386	8491	8102

[a]Table values are weighted averages of all matings in the system.
[b]Figures in parentheses are cost of lag if litter size selection is practiced because of a tendency to keep replacement gilts from older sows.
*On-farm F_1 gilt production.

tion. Perhaps the expected returns without selection for litter size are the most useful for comparison purposes.

Conclusions

These analyses point out that selecting a good supplier of boars is more important than selection of gilts within commercial herds. If commercial producers are developing their own replacement gilts, an inexpensive, practical selection program is recommended. There is little to be gained from complex record systems that utilize lifetime sow performance. At birth, identify gilts from large litters—more litters should be identified than needed. Standardize litter size at birth and at weaning keep the daughters of sows that have been good mothers. These can be grown in separate pens and earmarked as replacements. Final selections can be made at market weight.

Genetic lag comes into play only if the seedstock industry is improving. However, differences in breeding programs can result in lag costs that can be as high as $6 per litter with moderate rates of genetic improvement in seedstock herds.

The production estimates and expected returns provided here are expectations that provide a reasonable guide to comparison of crossing systems. Expectations for System 5 are higher than for all others. This system could be simplified by buying the Yorkshire replacement gilts and eliminating one tier. Systems 4 and 5 are best suited to larger producers with the management ability to make them work. Mistakes in matings and other problems produced by the systems, but not modeled here, will make them less attractive. System 2 is very easy and virtually foolproof. It may have a slightly greater disease risk, but this should not be a major factor if gilts are always obtained from the same source.

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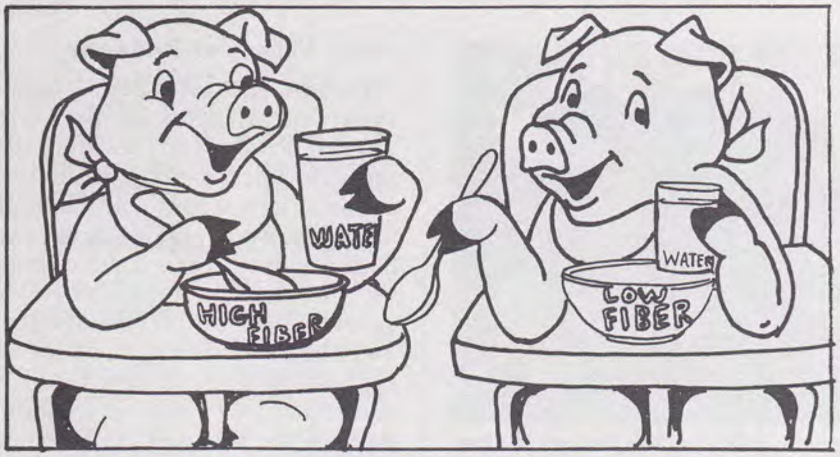
[1]Rodger K. Johnson is Professor-Swine Breeding. William T. Ahlschwede is Extension Swine Specialist.



More Fiber, More Water?

Roy L. Carlson
E. R. Peo, Jr.[1]

Articles in previous Nebraska Swine Reports indicated water savings by pigs of 40-60% depending on orifice size, and whether or not nipple waterers were pointed upward or downward at a 45° angle. Starter diets used in those experiments were 18% protein corn-soybean meal with 10% ground oats. This prompted the question of whether or not the additional fiber from the oats would cause the baby pig to drink more water.

The first experiment to evaluate the effect of oats on water consumption was conducted with six pens of four pigs per pen. Each pen was equipped with a feeder with 19″ of feeding space and a nipple waterer with a 2 mm orifice and pointing downward at a 45° angle. Water usage was measured by a meter for each set of three pens. Diets used were a simple corn-soy 18% starter diet as a control and a 18% starter diet with 15% ground oats. The second experiment was also conducted with six pens of four pigs per pen per treatment and with the same feeding and watering equipment. The diets fed were a simple 18% corn-soy starter and an 18% starter with 20% ground oats. Results are shown in Table 1.

There were no disease problems, diarrhea, or death loss in either experiment. Pigs receiving the oat diet made slightly better gains, had greater feed intake, showed better feed conversion than those fed diets with no oats. Each pig fed oats used about 2.8 gal more water for the 28-day trial than those fed diets without oats. We do not consider the difference important. If good quality oats are available and priced reasonably compared to corn they can be used up to a level of 20% of the diet without any detrimental effects on performance and also will not increase the need for extra water.

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[1]Roy L. Carlson is Research Technician, Animal Science. E. R. Peo, Jr., is Professor-Swine Nutrition.

Table 1. Effect of oats on water usage by baby pigs.[a]

	NE Exp. 82406		NE Exp. 82413	
Criterion[b]	Corn-soy basal without oats	Corn-soy basal with 15% oats	Corn-soy basal without oats	Corn-soy basal with 20% oats
No. pigs/pen[c]	4	4	4	4
No. pens/treatment	6	6	6	6
Avg daily gain, lb	0.84	0.90	0.93	0.96
Avg daily feed intake	1.74	1.72	1.81	1.87
Feed/gain	2.08	1.86	1.98	1.96
Water used/hd/day, gal	1.64	1.84	1.58	1.57

[a]28-day test.
[b]None of the differences were significant.
[c]Int. wt., 17.8 lb.

Figure 1. House mouse damage to fiberglass bat insulation inside a wall of a swine finishing building.

Rodent, Bird Pests on Hog Farms

Robert M. Timm[1]

Pigs are not the only animals that pork producers provide with food and shelter in Nebraska. House mice, house sparrows, Norway rats, starlings, and pigeons are commonly occurring pests.

A group of 105 randomly-selected pork producers from throughout Nebraska provided information on rodent and bird pests as part of a study conducted by the IPM (Integrated Pest Management) Vertebrate Pest Project. A large majority of producers reported house mice (92%) and house sparrows (93%) present on their farms. Less often but still frequently reported were Norway rats (54%), starlings (67%), and domestic pigeons (49%).

While some pests—house sparrows and pigeons—were often present year-round, other pests were more seasonal. Starlings are principally a pest in winter when cold weather and snow cover increases their food demands while decreasing food availability. Norway rats and house mice, although present year-round on many farms, are particularly noticed as a fall and winter problem. Each year the onset of cold weather causes these rodents to seek shelter and feed, and as a result they may be more likely to enter farm buildings at this time of year.

Variety of Problems

Rodent and bird pests cause a variety of problems for pork producers. Producers reported that rats and mice damage insulation, cause other structural damage, and consume and contaminate livestock feed. Structural damage includes such examples as rodent gnawing on buildings, feeders, and electrical wiring, and burrowing which undermines building foundations (Table 1). Rodent damage to insulated confinement facilities can be severe and costly. No insulation is known to be completely rodent-proof. Even fiberglass bat insulation can be severely damaged by rodents (Figure 1). We suspect the actual incidence of insulation damage is considerably higher than reported. Much of the damage may occur inside walls where it is unseen.

Producers reported that house sparrows are principally a sanitation problem and "general nuisance" because of their tendency to roost and build messy grass nests in buildings. In some instances, house sparrows also consume livestock feed and contaminate it with their droppings. In a few cases, house sparrows damage insulation (usually rigid foam) by pecking (Table 2).

Starlings create a general sanitation problem when they feed and roost on hog farms. They contaminate feed and water, consume feed, and some producers suspect them of transferring disease among swine herds (Table 3). Pigeons are regarded as a general sanitation problem. They also contaminate hog feed on some farms (Table 4).

Control Needed

Where pest damage is occurring or is likely to occur, control measures should be taken. The best control methods for a particular situation will depend on the species of pest present and other factors. In general, a combination of methods used together in an integrated system of pest control will give the best results.

On hog farms where a considerable monetary investment in modern insulated confinement buildings is present, preventive control should be practiced. Ideally, buildings should be rodent- and bird-proof. These pests should never be allowed access to insulated walls, attics, or feed storage areas. Where necessary, permanent rodent bait stations filled with high-quality anticoagulant baits should be maintained and checked regularly. Such measures will prevent pest populations from reaching damaging levels.

For additional information on rodent and pest bird control, contact your local Cooperative Extension Service office. The Neb-Guides "Controlling Rats", "Controlling House Mice", and "Starlings and Their Control" are available upon request.

Table 1. Types of damage caused by house mice and Norway rats on hog farms.

Damage	Producers reporting damage (%)
Insulation destruction	10.5
Other structural damage	12.4
Livestock feed consumption	23.8
Livestock feed contamination	15.2

Table 2. Types of damage caused by house sparrows on hog farms.

Damage	Producers reporting damage (%)
General nuisance	63.2
General sanitation (droppings and nests)	27.4
Livestock feed consumption	9.5
Livestock feed contamination	5.3
Destroy insulation by pecking	3.2

Table 3. Types of damage caused by starlings on hog farms.

Damage	Producers reporting damage (%)
General sanitation	25.7
Livestock feed contamination	10.5
Water contamination	12.4
Livestock feed consumption	4.8
Suspected disease transfer	4.8

Table 4. Types of damage caused by pigeons on hog farms.

Damage	Producers reporting damage (%)
General sanitation	18.1
Livestock feed contamination	5.7
Livestock feed consumption	1.9

[1]Robert M. Timm is Extension Vertebrate Pest Specialist.

The Fly and The Pig

Murray Danielson
J. B. Campbell[1]

This study was conducted to determine the effect of controlling house and stable fly populations on live animal performance.

Housing and Animals

Forty crossbred growing pigs were allotted by weight outcome groups to each of two housing units (Pig-Pok). Twenty-three gilts and 17 barrows were included in each unit. The initial weight of the 80 animals was about 75 lb.

Each unit was modified by screening with housefly-proof screen. The screening provided one unit void of flies at all times and a second unit where a fly population could be introduced and regulated.

Feeding and Management

Pigs were fed a 16% corn-soybean growing diet *ad libitum* for the first 28 days. During the remaining 56 days, a 14% corn-soybean finishing formulation was fed. Nipple waterers provided water for the pigs at all times. A water fogger in each of the 100% slotted housing units was used on hot days. The study lasted 84 days. Pigs were weighed and feed consumption checked each 14 days.

Except for the difference in fly population, the two units were managed the same.

Table 1. Effects of house and stable flies on pig gain and feed conversion.

Reference	Pig-pok A-flies[1]		Pig-pok B-No flies	
No. of animals	40		40	
Duration of study, days	84		84	
Initial pig wt., lb	74.2		74.7	
Termination wt., lb	207.9		213.1	
28 day ADG[2]	1.71		1.80	
28 day FC[3]		2.92		2.88
29-84 day ADG	1.53		1.57	
29-84 FC		3.90		3.96
84 day ADG	1.59		1.65	
84 day FC		3.55		3.57

[1]Ratio 20 houseflies/1 stable fly.
[2]Averae daily gain, lb.
[3]Lb of feed required/lb of gain.

Fly Populations and Control

Colony-reared house and stable flies were released into one of the Pig-Pok units. Fly control measures were taken to keep the pigs in the second unit free of flies. Although units were screened, flies gained entrance, inadvertently, on weigh days or when it was necessary to enter the house.

Flies (pupae) were released in one of the swine units in numbers sufficient to provide an average number of 45 flies/animal at each daily count. The release ratio was 20 flies to 1 stable fly, a ratio commonly observed under natural conditions. The body counts on the pigs ranged from 10 to 55 houseflies and 0 to 2 stable flies with averages of 45 and 1, respectively. About 619,000 houseflies and 29,000 stable flies were released to maintain the desired number of flies/animal.

Fly control in the fly-free housing unit was accomplished primarily with methoprene as a residual and as a knockdown. This product was applied four times as a residual (0.1%) to point of run-off and resulted in control (75% reduction) for about 9 days per application. One application of the same product as a knockdown resulted in a 95% reduction of flies in 24 hours. Dichlorvos and naled knockdowns averaged 75 and 69%, respectively.

Pig Performance

Live pig performance (Table 1) during the initial 28-day phase of this study was in favor of the pigs housed in the unit containing no flies. At the termination of the study (84 days) there appeared to be no significant difference in either average daily gain or feed conversion of the pigs between the housing units.

[1]Murray Danielson is Professor, Animal Science (Swine), North Platte Station. J. B. Campbell is Professor, Entomology Research and Extension, North Platte Station.

High Lysine Corn in Growing-Finishing Diets

Gary L. Asche
Austin J. Lewis
A. Dale Flowerday
Warren W. Sahs[1]

Since discovery of high lysine corn in 1966 at Purdue University, there has been much research to evaluate its nutritional quality. Most high lysine corn varieties contain a mutant gene called opaque-2 which increases the content of some of the essential amino acids, especially lysine and tryptophan. Early research with high lysine corn showed that pigs fed high lysine corn needed about 2% less protein in their diets than when they were fed normal corn. Thus, the use of high lysine corn could result in considerable savings of protein supplement.

Some of the early interest in high lysine corn was lost because yields and test weights were below that of normal corn hybrids. Recently, high lysine varieties have become available with yields close to those of their normal counterparts.

Evaluation

In experiments here both the agronomic and nutritional aspects of the newer high lysine corn varieties have been evaluated. Corn in this study was produced using cultural practices and pest control methods expected to produce yields of 150 to 160 bushel per acre under irrigation and 100 to 125 bushel per acre without

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High Lysine Corn

(continued from page 11)

irrigation. Before harvest yield checks were made at four to six sites of each corn type under each production system. Non-irrigated yields of normal and high lysine yields were essentially equal. With irrigation, high lysine corn yields were slightly lower than yields of normal corn. Irrigated yields ranged from 140 to 180 bushels per acre while non-irrigated yields were in the 140 to 150 bushel per acre range.

Normal and high lysine corn varieties grown at the Mead Field Laboratory were tested with growing-finishing pigs. Eight diets were fed to 400 pigs (10 pigs/pen, 5 pens/dietary treatment) in a modified-open-front building. Four dietary levels of lysine were fed with each type of corn, normal and high lysine. Lysine levels were .60, .65, .70 and .75% for the growing phase and .45, .50, .55 and .60% for the finishing phase. The National Research Council (NRC) lysine requirements for the weight ranges used are .70% for the grower and .55% for the finisher. Consequently, the treatments involved lysine levels fed both above and below the NRC requirements.

Equal numbers of barrows and gilts with an initial weight of 38 lb were fed to an average weight of 120 lb before being switched to finisher diets. Pigs were terminated from the study at about 220 lb and carcass data were collected from the first 24 pens of pigs. The composition of the eight grower diets is shown in Table 1. All diets were balanced according to the lysine content of corn and soybean meal allowing protein to float, being sure that tryptophan did not become limiting. Diets were rolled to help avoid the dustiness that is common when high lysine corn is ground. The lysine analyses for normal and high lysine corn were .23 and .33, respectively. Because of the higher lysine content of the high lysine variety, less soybean meal was needed at each dietary lysine level. Finisher diets were similar to the grower, except for their lower lysine and protein contents.

Performance and carcass data in Table 2 indicate that pigs fed high lysine corn performed as well as those fed normal corn. Pigs fed high lysine corn had shorter carcases. Average daily gain, feed intake and feed conversions of the grower, finisher and overall phases were similar for pigs fed both types of corn, even though the high lysine corn diets contained about 3% less soybean meal than the normal corn diets. Average daily gain improved significantly for each of the growth phases with increasing levels of dietary lysine. Average daily feed

Table 2. Performance and carcass traits of pigs fed diets containing normal and high lysine corn.[a]

	Normal corn diets				Avg for normal corn	High lysine corn diets				Avg for high lysine corn
Criteria[b] Grower lysine, %	.60	.65	.70	.75		.60	.65	.70	.75	
Finisher lysine, %	.45	.50	.55	.60		.45	.50	.55	.60	
Performance										
Avg daily gain, lb (grower)[c]	1.44	1.54	1.53	1.59	1.52	1.46	1.44	1.58	1.60	1.52
Avg daily feed intake, lb (grower)	4.18	4.22	4.05	4.14	4.15	4.10	3.99	4.26	4.28	4.16
Feed/gain ratio (grower)[c]	2.91	2.73	2.66	2.62	2.73	2.82	2.76	2.70	2.67	2.74
Avg daily gain, lb (finisher)[d]	1.39	1.48	1.49	1.44	1.45	1.42	1.43	1.45	1.49	1.45
Avg daily feed intake, lb (finisher)	5.56	5.71	5.75	5.68	5.68	5.64	5.49	5.60	5.79	5.63
Feed/gain ratio (finisher)	3.99	3.88	3.86	3.95	3.92	3.99	3.85	3.87	3.89	3.90
Avg daily gain, lb (total G-F)[c]	1.41	1.51	1.50	1.50	1.48	1.44	1.43	1.51	1.54	1.48
Avg daily feed intake, lb (total G-F)	4.95	5.06	5.00	5.00	5.00	4.96	4.81	5.01	5.12	4.98
Feed/gain ratio (total G-F)[c,e]	3.50	3.36	3.33	3.33	3.38	3.46	3.36	3.32	3.33	3.37
Carcass traits										
Length, inches[f]	31.8	31.8	32.0	32.3	32.0	31.5	31.6	31.5	31.8	31.6
Adj loineye area[g], sq inches[c]	4.89	5.18	5.18	5.44	5.17	4.81	5.05	5.53	5.52	5.23
Adj avg backfat[g], inches[c]	1.51	1.52	1.45	1.36	1.46	1.51	1.54	1.46	1.49	1.50
Lean, %[c]	52.0	53.1	53.4	54.9	53.4	51.5	52.4	54.6	54.2	53.2

[a]5 replications per traeatment with 10 pigs/pen, total 50 pigs/treatment. Initial weight, 38 lb; final weight 220 lb.
[b]Performance data based on averages of 50 pigs/treatment; carcass data based on pigs slaughtered from the first three replications of the treatments.
[c]Linear effect of lysine levels ($P<.001$).
[d]Linear effect of lysine levels ($P<.05$).
[e]Quadratic effect of lysine levels ($P<.05$).
[f]Difference beteween corn types ($P<.01$).
[g]Values adjusted using an avg hot carcass weight (168.7 lb).

Table 1. Composition of the grower diets.[a]

	Normal corn diets				High lysine corn diets			
Lysine, %	.60	.65	.70	.75	.60	.65	.70	.75
Ingredient								
Normal corn	80.55	78.52	76.51	74.49	0	0	0	0
High lysine corn	0	0	0	0	83.75	81.66	79.56	77.47
Soybean meal (44%)	15.50	17.55	19.60	21.65	12.28	14.41	16.54	18.67
Dicalcium phosphate	1.52	1.48	1.43	1.39	1.57	1.53	1.48	1.44
Limestone	.83	.85	.86	.87	.80	.80	.82	.82
Salt (iodized)	.50	.50	.50	.50	.50	.50	.50	.50
Trace mineral mix	.05	.05	.05	.05	.05	.05	.05	.05
Vitamin premix	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Selenium premix	.05	.05	.05	.05	.05	.05	.05	.05
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Analysis								
Protein (determined)	13.28	14.20	14.88	15.69	12.23	12.82	13.56	14.15
Calcium (calculated)	.70	.70	.70	.70	.70	.70	.70	.70
Phosphorus (calculated)	.60	.60	.60	.60	.60	.60	.60	.60

[a]Finisher diets analyzed 11.50, 12.15, 12.85, 13.38, 9.56, 9.97, 10.86 and 11.91% crude protein, respectively for the eight diets. Lysine levels were .45, .50, .55 and .60, respectively for each corn type. Calcium and phosphorus levels were .65 and .50, respectively.

intake was not different among the diets in either period of the experiment.

The feed conversion data show that pigs required less feed per unit of gain as the level of lysine in the diet increased. The feed conversions in the finisher phase improved up to .55% lysine for the normal corn diets and .50% lysine for the high lysine corn diets and became somewhat poorer with increased lysine in the diet. For the overall trial, feed efficiency was essentially the same for both corn types at the two highest lysine levels.

Carcass data from 220 pigs show that carcass length increased with increased dietary lysine, and that pigs fed normal corn had significantly longer carcasses than pigs fed high lysine corn. Loin eye area and percentage of lean were both improved with each higher level of lysine in the diet. Average backfat thickness decreased with increasing levels of dietary lysine.

Savings

These results indicate that some of the newer high lysine corn varieties produce yields comparable to normal corn hybrids. When diets were formulated on an equal lysine basis, pig performance was similar for normal and high lysine corn, even though normal corn diets contained about 3% more soybean meal than high lysine corn diets. The experiment also confirmed the importance of the total lysine content in growing and finishing diets.

Replacement of normal corn by high lysine corn saved about $3.20/ton of feed assuming equal cost for each corn type. This is equivalent to reducing the cost of production when feeding high lysine corn by about $1.00 per pig. Savings would be larger for high lysine corn with an even higher lysine content.

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[1]Gary L. Asche is Graduate Assistant, Animal Science. Austin J. Lewis is Associate Professor-Swine Nutrition. A. Dale Flowerday is Professor, Crop Production, Agronomy. Warren W. Sahs is Professor, Agronomy.

Genetic Improvement of Feed Efficiency

Selection for Lean Growth

William T. Ahlschwede
Rodger K. Johnson[1]

Feed efficiency has always been a concern of pork producers. While pork producers have not chosen to waste feed, the interest and intensity of efforts to reduce feed use has been periodic. When the price of pigs is high or the price of feed is low, little enthusiasm is generated for improving feed efficiency. When the price of pigs is low or the price of feed high, rewards for improved feed efficiency are more attractive.

While rewards for improving feed efficiency through management and nutritional choices are available immediately, rewards for improving feed efficiency through genetic change are a long run proposition. Breeding decisions made today have their effect on feed efficiency 1-5 years in the future.

During the 1960's and 1970's, the pork industry made great strides in reducing the fat content of pigs. The reduction in fat was accompanied by improvement in feed efficiency. Leaner pigs required less feed to produce a pound of gain.

Results from the most recent genetic studies involving methods for improving feed efficiency have not all been encouraging. One would think that the best approach to improving feed efficiency genetically would be to measure the feed efficiency of individual pigs and to select the more efficient pigs. Studies using this approach at Iowa State and in the United Kingdom have not found substantial genetic improvement. In Iowa, the small improvement found in the individually-fed boars was not found in the group-fed littermates. In the study in Scotland, the feed requirement of progeny of selected, individually-fed boars increased compared to the nonselected controls.

In contrast to the disappointing results from selection based directly on feed efficiency in individually-fed boars, efforts aimed at improving lean growth rate have been considerably more successful in improving feed efficiency. Apparently the most rewarding approach to improving feed efficiency genetically is to select for more rapid lean growth.

Lean Growth Selection

Results of a University of Nebraska study, reported in the 1981 Nebraska Swine Report, provide some insight into the opportunities for lean growth selection. The study, conducted during the 1970's, compared pigs produced through five generations of selection for improved lean growth rate to pigs from an unselected control line.

The selection procedure involved choosing replacement boars and gilts that had fast rates of gain and low backfat. Selections were made using an index of average daily gain and backfat. Figure 1 shows the response over the five-year period in the index and in the two component traits.

The response was not consistent from year to year in the component traits but the index continued to respond positively. Due to the biological variation in both genetic and other effects, more response was observed in growth rate in some years while in other years more response was observed in reduced backfat thickness. As expected, the selection also resulted in improvements in carcass composition. No ill effects from the selection were observed in other production traits. Gilts in the selected line farrowed and weaned more pigs each generation than those in the control line. Litter weights at birth and weaning were heavier in the selected line. The

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Selection for Lean Growth

(continued from page 13)

carcasses in the selected line were longer, had less fat and larger loin eyes.

The evaluation of feed efficiency conducted after the fifth generation of selection, indicated that the select line pigs ate less feed per pound of live weight gain. The select line had an advantage of .2 of an inch in backfat thickness and grew .15 pounds per day more rapidly. The evaluation experiment was conducted in a manner which reduced opportunities for feed wastage. The barrows evaluated were individually fed and were allowed access to the feeder for two one-hour periods during the day. When feed efficiency is expressed as pounds of feed required per pound of lean produced, the advantage of the select line is nearly 20%.

When results of several experiments aimed at improving the rate of lean growth are combined with the Nebraska study, they show that lean growth selection has been more than two and one-half times as effective in reducing feed required per pound of gain than selecting directly for feed efficiency. Although puzzling, the result is pleasing because it is much easier to select for lean growth than it is to select directly for feed efficiency.

There are no direct and simple explanations of the failure of direct selection to be more effective in improving feed efficiency. However, consideration of several factors makes this result more easily understood. The first is understanding the things that happen with individual feeding of pigs. The second has to do with understanding the biological nature of differences in feed efficiency.

Individual Feeding

Several aspects of pig behavior and the mechanics of measuring individual feed efficiency lead to questions regarding the validity of selection on individual pig feed efficiency. The number of pigs in a pen has an effect on performance, including feed efficiency. Pig appetite and activity in the pen can affect feed efficiency. It is possible that the genetic variation in individually-fed feed efficiency does not translate into genetic variation in group-fed feed efficiency.

From a mechanical point of view, errors in measuring feed efficiency for individually-fed pigs may be substantially larger than in measuring average daily gain and backfat. It may not be possible under farm conditions to weigh and record feed use of individual pigs with sufficient accuracy to be effective in selection.

The second area is the biological variation in feed use. Based on the Nebraska study results, studies at the U.S. Meat Animal Research Center at Clay Center, Nebraska, and studies conducted in Europe, it appears that the major components of genetic variation in feed efficiency are the components of lean growth rate.

The metabolic costs of the deposition of fat and lean, favor lean production. Partitioning of feed intake into that needed for maintenance and to that needed for change in weight indicates that more rapid gain is conducive to better feed utilization. The opportunities for genetically improving feed efficiency are much larger through improvement in the composition and rate of gain than those changes in the basic metabolic processes that control feed utilization. These two types of observations provide a rationale for understanding the more optimistic results from studies which attempted to improve lean growth rate.

For a swine industry with a long range goal of improving efficiency, this result is pleasant. Lean growth rate is much easier to measure than feed efficiency. Individual feed efficiency records are not needed to select for lean growth rate. The precision of feed measurements are not a problem. The mechanical problems of dealing with the feed efficiency data, adjustments for weights on and off test and concerns about the nutrient density of the diets are avoided. In contrast, selection for rate of lean growth utilizes equipment and techniques that are widely available and applied with much less cost and difficulty. The index used at Nebraska combining live weight gain on test and backfat thickness at the end of the test is

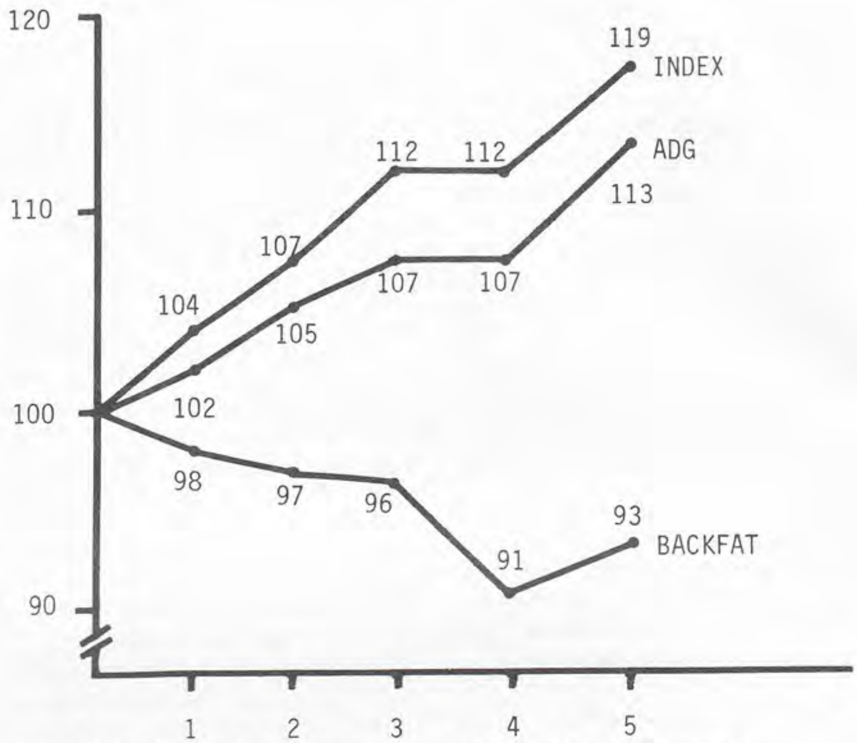

Figure 1. Select line performance as a percent of control line performance.

considerably easier to apply than measuring individual feed efficiency. The candidates for selection are fed and reared in typical group facilities. The testing procedures are similar to those used in the on-farm test programs already in place in Nebraska.

An additional advantage to selection on rate of lean growth is that the two primary component traits, daily gain and leanness of the carcass, are traits which we also seek to improve independent of feed efficiency. While some genetic antagonism exists between improved rate of live weight gain and reduced fat content of the carcass, improving these two traits are industry objectives. The results of these various studies suggest a simple procedure for genetic improvement in feed efficiency while at the same time improving other traits that are important.

Moving Ahead

Genetic improvement in the pork industry is everybody's business. We are currently in a period of low feed costs and little interest in improving feed efficiency. However, long range perspectives indicate that we should not plan on grain at bargain prices. The balance between world food needs and world food production leads us to believe that the cost of feed grains will be higher in the next decade than it was in the previous one. To be ready with improved feed efficiency lines for the next decade means that we proceed now to improve feed efficiency genetically. Failure to improve feed efficiency genetically during the next 10 years will threaten the existence of the pork industry.

The most effective genetic change in the pork industry will be that made by those producing the grandparents of the market hogs. Selection and genetic improvement at the grandparent level is the key to long range genetic improvement. To be certain, decisions made by commercial producers and by those who supply them their boars have an impact on the genetic merit of the market hogs produced, but the nature of the long range change is governed by seedstock producers. If it is to succeed, the industry will encourage more sophisticated testing and more dedicated selection for improving lean gain.

Seedstock Sources

A wider variety of seedstock is currently available in the pork industry than any time in history. In addition to the traditional purebreeds, crossbreds and numerous new private breeds are available. Breeding stock is available representing a wide variety of health programs. An even wider range exists in selection history and improvement objectives used to produce the boars and gilts for sale.

Breed, health programs, and improvement programs appear to be completely independent. Sales success will determine which of these sources is available in the future. For commercial producers, the strategy is to use boar-buying power to support the suppliers of breeding stock that have programs that will produce the genetic change needed for the next decade. Market surveys indicate that commercial producers prefer to buy boars from testing programs. The array of breeding stock available today allows producers to not only buy boars from testing programs, but also to insist that the testing programs are improvement programs.

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[1]William T. Ahlschwede is Extension Swine Specialist. Rodger K. Johnson is Professor-Swine Breeding.

Antibiotics for Swine—The Search Continues

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

Antibiotics will continue to play an important role in current and future swine feeding programs. Since the late 40's and early 50's when antibiotics were first added to swine feeds, researchers in the pharmaceutical industry and in universities have been searching for ways to improve the use of the so-called "old vintage" antibiotics such as penicillin, streptomycin, chlortetracycline and oxytetracycline in swine feeding programs. Scientists also have been seeking to identify new antibiotics that have potential for improving gains and feed conversion of swine.

The "old vintage" antibiotics have been used extensively in human medicine. Although the penicillins, the streptomycins and the tetracyclines continue to improve gains and particularly feed conversion in swine after 30 years of usage, there are those who would prefer that old antibiotics be used exclusively to treat human health problems, and that new replacement antibiotics be found to use only in swine feeds for gain and feed conversion enhancement. Researchers agree on one point—the search for new or effective combinations of antibiotics must continue.

At no time in the history of the pork industry have we had a product that is more nutritious and healthful for the consumer than now. The feeding of antibiotics to swine for the past 30 years has done much towards making the pork industry what it is today. Efficiency of production is the keynote of the pork industry. The loss of antibiotics or their effectiveness in swine feeding programs would be a tremendous blow. The result would be less product and more cost to the consumer. Neither the pork producer nor the consumer can afford such a setback.

Pork producers want and need an objective appraisal of the value of antibiotics for swine feeding programs. In addition, it is neces-

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Antibiotics for Swine

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sary to continually monitor the level of improvement obtained from various antibiotics or drug combinations. To help maintain the proper perspective regarding the use of antibiotics in swine feeding programs, the Nebraska Agricultural Experiment Station (as well as other Experiment Stations) has been continuously evaluating old as well as new antibiotics for swine. Results of three recent experiments conducted at the Nebraska Agricultural Experiment Station on the value of "old" and "new" antibiotics for swine are shown in Tables 1, 2 and 3.

Table 2. Effect of virginiamycin on gains, feed conversion and carcass merit of swine (NE Exp. 82407).

	Treatments	
Drug	None	Virginiamycin
Grower, g/ton	0	25
Finisher, g/ton	0	10
Criterion		
Grower[b]		
Avg daily gain, lb[c]	1.36	1.50
Feed/gain	2.55	2.44
Finisher[b]		
Avg daily gain, lb	1.90	2.00
Feed/gain	3.18	3.04
Combined Grower-Finisher		
Avg daily gain, lb[c]	1.65	1.73
Feed/gain	2.94	2.86
Carcass		
Length, inches	31.4	31.4
Backfat, inches	1.37	1.40
Loineye area, inches	5.02	5.06
% lean	53.29	53.34

[a]105-day test; 6 pens of 8 pigs/pen/treatment; Int. wt. 30 lb.
[b]Grower period, 49 days; finishing period 56 days.
[c]Differences sig. (P<.05).
[d]Difference sig. (P<.10).

"Old" and "New"

In the first experiment (Table 1) pigs fed chlortetracycline (CTC) during the grower phase (where most often a response is seen) gained the same as pigs fed no antibiotic and required 3% more feed per pound of gain. CTC has been used in our feeding program for a long time and nearly always has resulted in improved gains and feed conversion. This time it did not.

Tylosin, on the other hand, resulted in a 2-3% improvement in gain and feed conversion in one study (Exp. 81401) during the grower phase. The advantage was lost or reduced during the finishing phase so that overall, there was little or no advantage to feeding CTC and only a 3% advantage to using Tylosin in one of the studies.

The results are not surprising. Continual use of the same antibiotics in swine facilities seems to result in a lowered response than was obtained when the antibiotics were first used. Some believe that the lowered response is due to an increased resistance by bacteria to the antibiotics or to an improvement in microbial cleanliness of the facilities. It is probably due to both. Regardless, it seems that the lack of responsiveness to an antibiotic may not be permanent. For example, we did not obtain much of a response from feeding virginiamycin to swine a couple of years ago. However, as you can see from the results of an experiment just completed with virginiamycin (Table 2), gains and feed conversion were improved 10.3% and 4.5%, respectively, during the grower phase, 5.2% and 4.6% during the finishing phase and 4.8% and 2.8% over the entire growing-finishing phase. Virginiamycin has also been reported to increase carcass leanness. We did not find this to be true in our studies.

A third experiment was conducted to monitor the effectiveness of carbadox (Mecadox) and a worming compound, pyrantel tartrate (Banminth), fed alone or in combination on gains and feed conversion of swine. Carbadox is a chembiotic and can be fed only up to 75 lb of body weight. Our pigs have responded well to carbadox. As shown in Table 3, the response continues to be there. Pigs fed carbadox gained 12% faster on 7% less feed per pound gain than those not fed carbadox during the grower phase (to 75 lb body weight). However, the advantage for carbadox essentially disappeared by the time pigs reached market weight. We do not know why the gain and feed conversion advantage was lost. Continuing the pigs on an antibiotic (50 g/ton, oxytetracycline) during the finishing phase (treatment 6) was not effective in maintaining the

Table 1. Effect of antibiotics on gains and feed conversion of G-F swine.[a]

	Treatments (Exp. 81401)						Treatments (Exp. 81402)		
Antibiotic	None	CTC[b]	CTC[b]	Tylosin	Tylosin	Bambermycins	None	Tylosin	Tylosin
Grower, g/ton	0	50	50	40	40	4	0	40	40
Finisher, g/ton	0	20	0	20	0	2	0	20	0
Criterion									
Grower[c]									
Avg daily gain, lb[d]	1.46	1.47	1.46	1.50	1.51	1.41	1.49	1.60	1.57
Feed/gain[d]	2.69	2.78	2.78	2.62	2.64	2.76	3.28	3.10	3.17
Finisher[c]									
Avg daily gain, lb[d]	1.84	1.90	1.82	1.74	1.80	1.87	1.78	1.76	1.78
Feed/gain[e]	3.34	3.34	3.50	3.39	3.36	3.33	3.78	3.79	3.78
Combined Grower-Finisher									
Avg daily gain, lb	1.65	1.70	1.66	1.64	1.66	1.64	1.62	1.67	1.67
Feed/gain	3.07	3.11	3.18	3.04	3.05	3.10	3.51	3.41	3.43

[a]4 pens, 8 pigs/pen/treatment. Int. wt., 40 lb.
[b]Chlortetracycline.
[c]Grower period, 53 days; Finishing period 42 days (Exp. 81401); 56 and 42 days, respectively (Exp. 81402).
[d]None of the differences in gain were significant for both experiments (P>.10).
[e]CTC vs Tylosin sig. (P<.05) during grower phase; CTC vs no CTC in finishing phase sig. (P<.05); No antibiotic vs antibiotic, CTC vs Tylosin and CTC and Tylosin during grower phase vs no CTC or Tylosin during finishing phase sig. (P<.05).

Table 3. Effect of carbadox and pyrantel tartrate on gains and feed conversion of swine (NE Exp. 81416).

	Drug	None	Carbadox	Pyrantel tartrate	Carbadox/ pyrantel tartrate	Carbadox/ pyrantel tartrate	Carbadox/ pyrantel tartrate /OTC[b]
	Grower, g/ton	0	50	96	50/96	50/96	50/96/0
	Finisher, g/ton	0	0	0	0/0	0/96	0/0/50
Criterion							
Grower[a]							
Avg daily gain, lb[c]		1.32	1.54	1.36	1.50	1.50	1.48
Feed/gain[b]		2.49	2.30	2.44	2.32	2.28	2.30
Finisher[a]							
Avg daily gain, lb[d]		1.72	1.64	1.68	1.65	1.62	1.60
Feed/gain[d]		3.90	4.09	4.06	4.02	4.17	4.05
Combined Grower-Finisher							
Avg daily gain, lb[e]		1.57	1.60	1.55	1.59	1.56	1.55
Feed/gain[a]		3.50	3.48	3.59	3.48	3.56	3.50

[a]98-day test; 34-day grower; 64-day finisher period. Int. wt. 35 lb. 4 pens of 8 pigs/pen/treatment.
[b]Ocytetracycline.
[c]Trt 1 vs rest sig (P<.05); 3 vs 2456 sig (P<.05).
[d]Trt 1 vs rest sig (P<.05).
[e]None of the differences were significant (P>.10).

gain and feed conversion advantage obtained during the grower phase. Our pigs are SPF. This may be a factor related to the response observed. We plan to conduct research directed at trying to maintain any advantage gained during the grower phase when feeding antibiotics or chembiotics to swine.

Pyrantel tartrate is an excellent wormer. We did not obtain any improvement in gains or feed conversion from feeding this wormer. The pigs (and their dams) used in the experiment were reared in confinement on concrete with partial slatted floors. The worm load in the pigs was low. Upon slaughter, the livers of all pigs were judged to be of high quality and free of any round worm damage, regardless of treatment.

Antibiotics Important

Without question antibiotics are extremely important to successful modern swine production.

It is also evident from the research that the search for new antibiotics, for new combinations of old antibiotics and for systematic ways to use antibiotics in swine diets must continue if the swine industry is to remain a nutritious, healthful and economical source of protein for the consumer.

[1]E. R. Peo, Jr., is Professor-Swine Nutrition. J. D. Crenshaw is Research Technician. A. J. Lewis is Associate Professor-Swine Nutrition.

Water Medications for Stressed Pigs

M. C. Brumm[1]

Water medication of stressed feeder pigs is routinely recommended by many veterinarians, swine specialists and others to prevent or reduce sickness and death losses. Water medication can be a major expense, often costing $1 or more per pig. There are many medications available including antibiotics, vitamins, electrolytes, sulfas and combinations.

Studies were conducted to evaluate the effect of two commercial water medications administered for five days after arrival on health and performance of stressed feeder pigs.

Does Water Medication Work?

For this research, mixed and graded feeder pigs were purchased from auction markets in southern Missouri. They were transported 600 miles in a covered vehicle to the research facility at the University of Nebraska Northeast Station Swine Center, Concord, NE. Pig shrink was considerable. Arrival weight at the research facility was 12 to 13% less than the Missouri pay weight.

Pigs were grouped 10 pigs per pen in 6 ft x 16 ft partially slotted pens. Water medication was provided by means of an in-line proportioner pump through nipple waterers. All pens had water meters installed for the first two weeks after arrival with water use recorded after 5 and 14 days.

Pens of pigs were rated for incidence and severity of scours by three people working independently for two weeks after arrival. A scale of 1 to 5 was used with 1 being a normal, firm stool and 5 being extreme diarrhea.

All pigs were treated for worms on day 6 with Tramisol in the drinking water. They were retreated three weeks later with Atgard in the feed. All pigs were sprayed with a lindane solution for lice and mange control 10 days after arrival.

In experiment 1, a flavored sulfa-electrolyte solution[2] provided 650 ppm sulfathiazole, 19 ppm EDDI, 89 ppm Na, 67 ppm K, .80 ppm Mg and .65 ppm Ca. In addition, the grower diets contained either 50g/ton Mecadox or 250g/ton ASP-250. The finisher contained 2g/ton Flavomycin.

In experiment 2, a flavored electrolyte-vitamin solution[3] provided 46 ppm Na and 42 ppm K. The diet fed in experiment 2 contained 50g/ton Mecadox to 75 lb, followed by 2g/ton Flavomycin to market weight. For both experiments, a second trial or replication was conducted.

Results

In experiment 1, there was no treatment difference in water consumption. Water medication did not affect either the severity or duration of scours in either of the trials.

There was no effect on performance due to water medication (Table 1) either for the first 14 days after arrival or for the entire

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Water Medications

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period from purchase to market.

Also, the sulfa-eletrolyte medication was not effective in reducing death loss or the number of pigs treated (Table 2). Pig deaths, determined by gross autopsy, were from a variety of causes including mycoplasma pneumonia, pasteurella pneumonia and gut edema. Individual pigs were treated as needed. All pigs were examined routinely by a veterinarian.

In experiment 2, there was no difference between treatments in water consumption. As in experiment 1, water medication did not affect either the duration or severity of scours.

Water medication had no effect on animal performance from purchase to market in experiment 2 (Table 3). However, in both trials water medication improved feed efficiency for the first 14 days. This improvement in efficiency disappeared by the end of both trials.

The vitamin-electrolyte medication was not effective in reducing either death loss or the number of pigs treated (Table 4). Causes of death were varied and not related to experimental treatment.

Table 3. Effect of electrolyte-vitamin water medication on performance of purchased feeder pigs.

	Experiment 2					
	Trial 1		Trial 2		Avg	
Item / Medication[a]:	+	−	+	−	+	−
Pig weight, lb.						
Initial	38.9	38.9	40.1	40.0	39.5	39.5
14-day	50.3	51.1	55.0	56.0	52.7	53.6
Final	203.8	204.0	216.2	222.8	210.0	213.4
ADG, lb.						
14-day	.81	.87	1.06	1.14	.94	1.01
Final	1.31	1.31	1.26	1.30	1.29	1.31
F/G						
14-day[b,c]	2.20	2.04	2.04	1.92	2.12	1.98
Final	3.36	3.34	3.47	3.38	3.42	3.36

[a]Vitamin-electrolyte water solution for five days at arrival.
[b]60 pigs/treatment/trial.
[c]Treatment means within trial differ P<.056.

Table 4. Effect of electrolyte-vitamin water medication on relative health of purchased feeder pigs.

	Experiment 2					
	Trial 1		Trial 2		Total	
Item / Medication[a]:	+	−	+	−	+	−
Pigs treated, no.	1	2	10	3	11	5
Pigs dead, no.[b]	1	0	5	5	6	5

[a]Vitamin-electrolyte water solution for five days at arrival.
[b]60 pigs/treatment/trial.

Table 1. Effect of sulfa-electrolyte on performance of purchased feeder pigs.

	Experiment 1					
	Trial 1		Trial 2		Avg	
Item[a] / Medication[b]:	+	−	+	−	+	−
Pig weight, lb.						
Initial	30.7	30.9	42.4	42.4	36.5	36.6
14-day	40.9	40.9	54.7	54.7	47.8	47.8
Final	211.1	210.8	212.1	212.2	211.6	211.5
ADG, lb.						
14-day	.73	.70	.88	.88	.81	.79
Final	1.33	1.33	1.46	1.46	1.40	1.40
F/G						
14-day	1.80	1.93	2.20	2.17	2.00	2.05
Final	3.22	3.24	3.05	3.11	3.14	3.17

[a]120 pigs/treatment/trial.
[b]Sulfa-electrolyte water solution for five days at arrival.

Table 2. Effect of sulfa-electrolyte water medication on relative health of purchased feeder pigs.

	Experiment 1					
	Trial 1		Trial 2		Avg	
Item[a] / Medication[b]:	+	−	+	−	+	−
Pigs treated, no.	11	10	11	9	22	19
Pigs dead, no.	5	3	3	4	8	7

[a]120 pigs/treatment/trial.
[b]Sulfa-electrolyte water solution for five days at arrival.

Discussion-Conclusion

These results indicate that routine water medication of comingled transported pigs is not always of benefit. In these experiments, there was no improvement in performance or decrease in death loss to the addition of either a sulfa-electrolyte or electrolyte-vitamin solution to the drinking water for five days post-arrival.

Other combinations of drugs, dosages and days administered might have resulted in a response and merit further research. Whether or not producers decide to routinely medicate, it is recommended that a water medication system be available for use if needed.

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[1]M. C. Brumm is Extension Swine Specialist, Northeast Station.
[2]Zole-Lite M. International Multifoods, Minneapolis, MN 55402.
[3]Prom-A-Pak™-Swine. International Multifoods, Minneapolis, MN 55402.

Figure 1. View of the individual calorimeters with pens and infrared heaters.

Infrared Heat and the Weaned Pig

James A. DeShazer
Douglas G. Overhults[1]

The period immediately after weaning is a critical time in the life of a pig. It is consistently a source of economic loss to the producer. In comparison to older pigs, the young weanling pig loses more heat from its body per unit of body mass and has less capability to respond to environmental extremes. The nutritional adjustment caused by weaning also limits the pigs metabolic response to provide thermal comfort.

For pigs weaned at two or three weeks of age, recommended air temperatures range from 80 to 90°F and varies based on air velocity. Maintaining these high temperatures makes the nursery for weanling pigs one of the most energy intensive buildings in a swine production system. Infrared radiant heaters are routinely used in all phases of swine production and have been suggested as a method to allow lower nursery temperatures, thus reducing the supplemental heating requirement. However, the extent to which radiant heat can compensate for lower building temperatures is not fully known.

Level of Heat Needed

To evaluate the level of infrared heating needed for weanling pigs, an experiment was developed to measure rates of feed energy intake, heat production, and energy retention for gain in response to infrared heat.

A 68°F air temperature was selected for the base temperature for the reduced supplemental heating environment and an 82°F air temperature was used for the recommended environment. The 68°F air temperature was combined with infrared heating levels of 0, 9, 16 and 21 W/ft^2. The radiant heat levels were measured three inches above the floor and were supplied by metallic-sheathed electric heaters suspended above each individual pen (Figure 1). Each pen was placed in a calorimeter to measure the heat production of the pig.

A total of 30 Yorkshire × Landrace barrows were selected from groups of 6-10 litters farrowed at 7-10 day intervals for the five treatments. Ground creep feed was available for a week before weaning. Feed was available in the calorimeters on an *ad lib* basis. No more than two pigs were chosen from any one litter. The average age and weight at weaning was 21 days and 14 lb, respectively. Measurements were made on days 1, 2, 4 and 6 following weaning.

Findings

For each pig, data were reduced to 24-hour average values of heat production, energy intake and energy retention and are presented in Table 1. Data are identified by treatment codes (e.g. 68F09). The first two digits (68) of the code are air temperatures in the pens and the last two digits (09) are the infrared heating level.

Energy intakes were near zero for the first day and increased to the highest levels on the sixth day post-weaning. The most rapid increases were exhibited in treatments 68F00 and 82F00.

As shown in Table 1, all treatments had the highest rate of total heat production during the first day after weaning. The heat production declined to a minimum value on the second or fourth day post-weaning and increased only 3 to 6 percent above the minimum on the sixth day. Infrared heat equal to or greater than 16 W/ft^2 with an air temperature of 68°F provided an environment warmer to the pig than the 82°F environment. Heat losses in treatments 68F16 and 68F21 were significantly lower than the heat loss in the 68F09 environment.

However, warmer might not be better. The energy intake of the pig decreased more rapidly than

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Table 1. Heat production, energy intake and energy retention.

Measurement	Day	Treatment				
		68F00	68F09	68F16	68F21	82F00
Total heat production (W/lb$^{0.75}$)	1	3.4	3.0	2.8	2.6	2.8
	2	3.3	2.8	2.3	2.3	2.7
	4	3.3	2.9	2.2	1.9	2.4
	6	3.4	3.0	2.4	1.9	2.5
Energy intake (W/lb$^{0.75}$)	1	0.4	1.3	0.2	0.6	0.7
	2	2.9	0.9	1.0	2.2	2.9
	4	3.6	4.0	3.1	2.0	3.5
	6	5.8	5.5	4.4	3.4	5.6
Energy rentention (W/lb$^{0.75}$)	1	−3.0	−1.7	−2.6	−2.0	−2.2
	2	−0.4	−1.9	−1.3	−0.1	0.2
	4	0.3	1.1	0.9	0.1	1.1
	6	2.4	2.5	2.0	1.5	3.1

Infrared Heat

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the heat loss as the amount of the infrared heat increased. Therefore, energy retained for gain (the difference between energy intake and heat loss) decreased with increasing radiation. Because of the variability of feed intake, there was no statistical difference between the treatments for energy intake and energy retention for gain.

Energy retention, the difference between metabolizable energy intake and total heat production, is the key to production. Initially, all pigs had a negative energy retention because energy intake was very low.

In analyzing the energy retention for days 2 through 6, the 82°F treatment with no infrared radiation produced the best performance. The next best performance is a composite of infrared heating treatments being 68F21, for day 2 and a 43% reduction in infrared heat to 68F09 for days 4 and 6. These data are consistent with the current concept of reducing heat with increasing age. These results suggest that reduction of infrared heat could take place more rapidly than previously thought. These experiments were conducted in calorimeters that were draft free. Hence, the lower infrared heating level may not be sufficient for production buildings.

This study has shown it is important to watch the amount of infrared heat provided to nursery pigs. Too much infrared heat might be as bad as too little infrared heat.

The results of this study show both too much infrared heat and too little heat can reduce performance. Hence, management strategies which allow adjustment of heating levels are suggested. Heating arrangements which allow the pig to seek warmer or cooler spots are also effective.

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[1]James A. DeShazer is Professor-Livestock Environment, Agriculture Engineering, University of Nebraska. Douglas G. Overhults is Assistant Professor, Agricultural Engineering, University of Kentucky.

Select Boars for Litter Size?

Roger J. Kittok
James E. Kinder
Rodger K. Johnson[1]

Increasing litter size would significantly reduce production costs. However, selection for litter size is hampered by its low heritability. At present, selection of boars for litter size is done on the basis of litter size of dam and sibs. Identification of traits expressed by boars that are correlated to reproductive traits of their daughters would be of great importance to improving rate of response to litter size selection.

Reproductive hormones have potential of being traits that may satisfy the above need. These hormones, luteinizing hormone (LH) and follicle stimulating hormone (FSH), are referred to as gonadotropins since they affect the functions of the gonads of the male (testis) and female (ovary). Steroid hormones (estrogen and testosterone) can decrease circulating gonadotropin concentrations through negative feedback. However, exact mechanisms and the sensitivity of those mechanisms that the animal uses to regulate gonadotropin secretion are not understood.

To provide more insight into the control of LH in the developing boar, a series of three studies was completed. In the first experiment, six boars (15 weeks old; 82 lb) were given ethanol, ethanol with 50 μg of estradiol (a potent estrogen), or ethanol with 1000 μg of testosterone. These treatments were given intravenously through an indwelling jugular catheter and blood samples were taken through the same catheter. These samples were analyzed for LH content.

In this trial, it was determined that estradiol depressed LH secretion for approximately 3 hours. Testosterone, given at 20 times the dose of estradiol, did not change LH secretion. From the results of this trial, it was decided to investigate only estradiol's influence on LH secretion.

The next study involved five pairs of littermates. One boar of each pair was implanted with a slow release device filled with estradiol. These pigs were 12 weeks old and weighed 60 lb at the time of study. After the implant was in place for 3 days, blood was collected every 15 min over an 8-hour period through a catheter and LH concentration was determined. Although the estradiol implant did not significantly change serum estradiol, it did alter LH secretion. Figure 1 illustrates the effect of the estradiol implant on a representative pair of littermates. The effect of the implant was observed in the reduced variation in LH concentration of samples collected over the 8-hour period. The average concentration of LH was not affected by the implant.

In the third study, 12 boars (3 boars from each of 4 litters) were

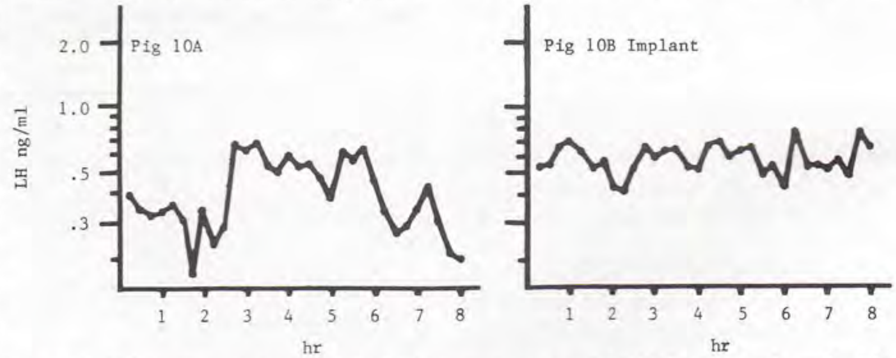

Figure 1. LH in a representative pair of littermates, one of which was implanted with estradiol.

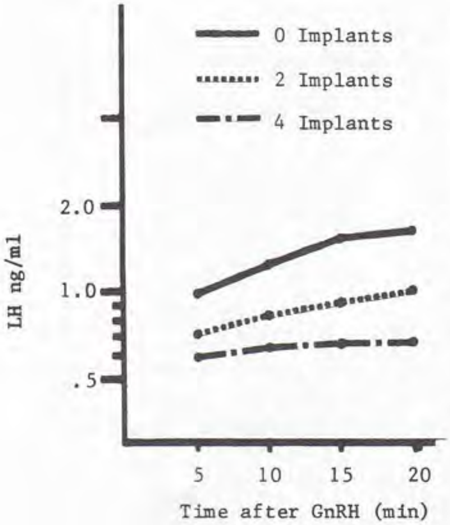

Figure 2. LH response after GnRH in boars with 0,2, or 4 estradiol implants.

randomly assigned within litter to a latin-square design. Each boar was given 0, 2 or 4 estradiol implants on various days. Blood samples were taken at five min intervals for one hour before and after a gonadotropin releasing hormone (GnRH) challenge. The sampling was initiated 40 to 46 hours after the boars were implanted. After sampling, implant numbers were adjusted according to the design and the boars were resampled two days later This procedure was repeated until each boar was subjected to the three levels of implants.

The implants significantly depressed the concentration of serum LH in the samples taken before the GnRh challenge and affected the LH response to the challenge (Figure 2). During the first 20 minutes after GnRH, the type of LH profile observed was related to the number of implants the boar had at the time of sampling. If a boar had no implants, there was an increase in LH over this period. However, if a boar had four implants, LH concentrations were either stable or decreasing during the period. The responses of individual boars with two implants were varied and did not fit a single profile.

It was concluded from these studies that the secretion of LH in the developing boar is sensitive to estradiol. A small change in estradiol can effect a change in LH. The negative feedback of estradiol is, at least in part, at the level of the pituitary. The individual variation observed after two estradiol implants indicates that individuals probably have different degrees of sensitivity to the negative feedback of estradiol. The variation in sensitivity was not apparent when the exposure to estradiol increased. If the variation observed is genetic in nature, then the possibility exists for use of hormone level to improve the accuracy of selection of boars for litter size.

[1]Roger J. Kittok is Associate Professor-Physiology. James E. Kinder is Assistant Professor-Beef Physiology. Rodger K. Johnson is Professor-Swine Breeding.

Moving and Transporting Hogs

Temple Grandin[1]

Most pork producers have encountered the frustration of attempting to load a group of hogs when several of the animals are piled up and wedged at the bottom of the loading chute. Learning a little hog psychology will help prevent such problems. Hogs have a strong flight reaction. When a hog is prodded, it will attempt to escape by moving forward or running back into the herd. If the hog is in a confined space such as the funnel of a crowding pen or on the loading ramp it is often difficult to make one hog back up so another hog can pass.

Hogs will follow the leader and maintain visual and physical contact with each other. They also have a strong desire to return to a previous location. If a gate to a pen the hogs have just left is open, they will try to return to the pen.

Hog Vision

Hogs have 310-degree panoramic vision and can see behind themselves without turning their heads. They will often balk at shadows, bright spots, puddles, and people up ahead of them. The leader animals will often balk at a shadow but after the leader crosses the rest will follow. Eliminating shadows and other distractions in crowding pens and chutes will reduce balking.

Lighting conditions at the loading ramp or sorting chute will affect the incidence of balking. When hogs are handled under artificial lighting, they will move more readily from a darker area to a lighter area.

Hogs raised in confinement under artificial light are often difficult to move. They will often balk at bright sunlight. An enclosed loading ramp will make it easier to load these hogs. If a covered ramp is not available, covering the ramp with plywood and canvas will improve the flow of hogs. This solves the handling problem on the farm, but does not solve the serious problems packers have handling hogs from dimly illuminated buildings. In many finishing build-

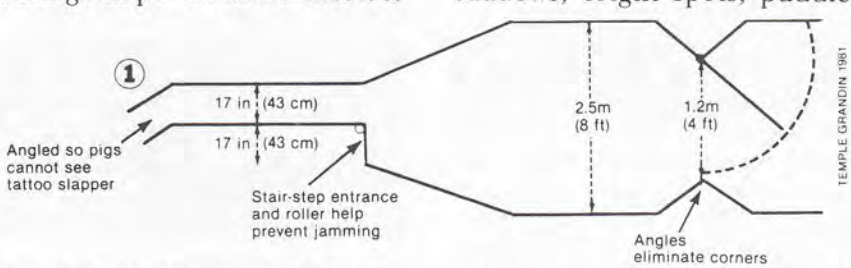

Figure 1. A plan for a tattoo chute with a stairstep entrance to prevent jamming. The angled fences at the rear gate eliminate corners where hogs can bunch up. The chute is angled to prevent incoming hogs from balking when they see the tattoo-slapper.

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ings more light during the final phases would reduce handling problems.

Hogs will often load onto a truck more easily at night. A lamp installed at the entrance to the loading ramp will attract the hogs. The lamp must illuminate the ramp and not shine into the eyes of approaching hogs. Lighting the inside of the truck will also help.

Preventing Pile Ups

Pile ups often occur when the hogs become wedged in a funnel shaped crowding pen. The most common cause of pile ups is chasing and pushing large groups of hogs from the rear of the group. Wedging and jamming can be reduced by redesigning the crowding pen. A well designed crowd pen also reduces the usage of electric prods. Shocking a hog repeatedly with an electric prod will cause its heart rate to increase. The resulting stress can result in heart failure and death.

Research in Holland has shown that jamming problems in the crowding pen can be reduced by replacing the funnel type crowd pen with a stairstep design. In the stairstep design, the chute is initially wide enough to accommodate three hogs. It then narrows to accommodate two and then one hog. The stairstep design forces one hog to step aside to allow another hog to pass.

Although the stairstep design is better than a funnel crowd pen, the hogs tend to linger or turn around in the steps. Figure 1 illustrates a crowd pen layout with a single stairstep at the entrance to the single file chute. This design will usually work better than multiple steps.

Figure 2. The sides of the pen and the gate are solid to block distractions from outside. Using this system, two handlers can move 600 hogs per hour.

Solid Fences

The sides of the crowding pen should be solid to prevent the hogs from seeing distractions outside the pen (Figure 2). The animals should be able to see only one pathway of escape up the loading or sorting chute. The crowding gate must also be solid, otherwise the hogs will turn and face the gate instead of the entrance to the chute. Hogs have been observed to turn back towards a 2-inch crack in a gate in an attempt to return to their pens.

To prevent pile ups, no more than 25 hogs should be placed in the crowd pen. Non-slip flooring is essential to prevent injuries in areas where hogs are sorted or handled. A non-slip floor can be easily made by imprinting the pattern of expanded steel mesh in the wet concrete. Use a stamp made from expanded metal with a ¾ by 1½ inch mesh.

Experience in large slaughter plants indicates that hogs can be moved most readily when two single file chutes are located side by side. This enables the hogs to pick an entrance and reduces pile ups. This same type of system can also be used to load market hogs on farms (Figure 3). Bunching can be further reduced by installing a wedged shaped partition between the two chute entrances (Figure 4). The wedge forces one hog to step aside to allow another hog to pass.

When two single file chutes are installed side by side, the two outer walls should be solid to block outside distractions. The inner partition between the two chutes should be constructed from bars. This design promotes following behavior. When one hog moves, the hog in the adjacent chute will follow.

Loading Ramp Tips

A hog's heart beats faster when

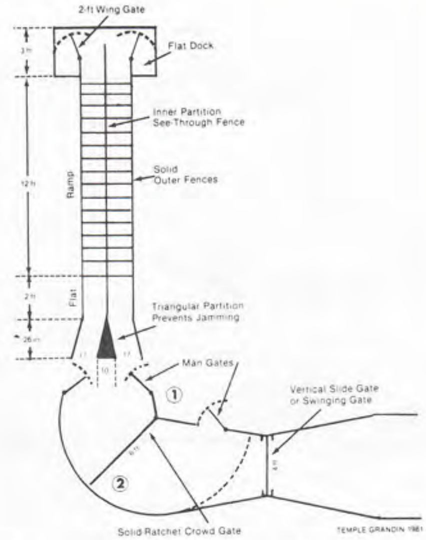
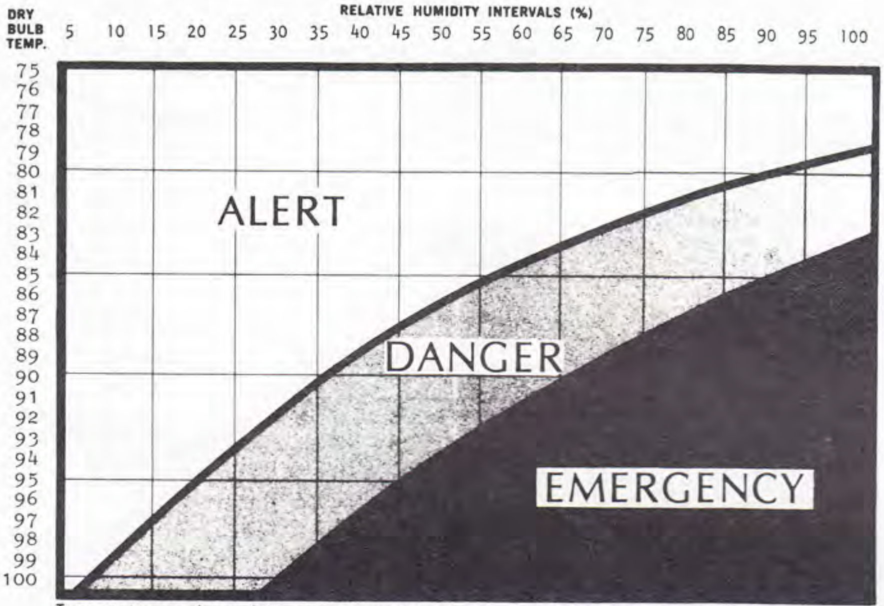


Figure 3. A loading ramp with two single-file chutes. The handler stands at (1) when the crowding pen is full and directs the leaders into the chutes. As the pen empties, the handler steps through the man-gate into position (2) and swings the gate around.

it is climbing a ramp than when descending. To prevent strain on the heart, the angle of the ramp should not exceed 20 degrees on a nonadjustable ramp. Twenty-five degrees is the maximum angle for an adjustable ramp. Concrete stairsteps are recommended on permanent ramps. The recommended dimensions are a 2- to 3-inch rise and a 10-inch tread width.

A stationary loading ramp should have a flat dock at the top. This provides the hogs with a level surface to walk on when they enter or leave a truck. The dock should

Figure 4. A wedge-shaped partition installed between the two single-file chute entrances prevents jamming. The wedge enables one hog to pass another.



Temperatures above 100 are always "Danger" and if the relative humidity is above 20-25 per cent, the situation is "Emergency."

Figure 5. Livestock weather saftey index (Livestock Conservation Institute).

be three feet wide and equipped with solid-hinged wing gates. The wing gates are swung against the truck to prevent hogs from jumping out through the gap. A self-aligning dock bumper is also recommended to block up the gap when a truck backs in crooked.

Hog Losses

Approximately 70% of market hog deaths occur during transit or during loading and unloading. Deaths during transit to the packing plant kill one to two hogs per 1,000 head transported. Death losses often double on hot, humid days. Delays during unloading after the hogs reach the packing plant are another major cause of death, especially during hot weather.

WINDSPEED IN MPH	ACTUAL AIR TEMPERATURE 50	40	30	20	10	0	-10
5	48	36	27	17	5	-5	-15
10	40	29	18	5	-8	-20	-30
15	35	23	10	-5	-18	-29	-42
20	32	18	4	-10	-23	-34	-50
25	30	15	-1	-15	-28	-38	-55
30	28	13	-5	-18	-33	-44	-60
35	27	11	-6	-20	-35	-48	-65
40	26	10	-7	-21	-37	-52	-68
45	25	9	-8	-22	-39	-54	-70
50	25	8	-9	-23	-40	-55	-72

Figure 6. Wind chill chart.

The Livestock Conservation Institute Weather Safety Index (Figure 5) can be used by farmers and truckers to determine when summer temperatures become dangerously hot for hogs. The chart shows the relationship between temperature and humidity. When the daytime temperatures and humidity reach the "Alert" level, deliver hogs to market by 11:00 AM. When the temperature and humidity reach the "Danger" level, haul hogs at night. When the "Emergency" level is reached, postpone your hog shipments.

Wind chill can kill hogs. They must be protected from the cold wind during travel. Exposed hogs which are travelling down the road at 50 mph with a temperature of 40 degrees are exposed to a wind chill factor of 8 degrees F. Figure 6 is a wind chill chart for hogs.

Temperatures near freezing can be especially dangerous. Freezing rain can kill many animals on a truck if it blows through the sides and soaks the animals.

Trucking Tips

1. When the temperature is over 60 degrees F, use wet sand for bedding to keep the hogs cool. Use straw when the temperature is under 60 degrees to keep the hogs warm.

Minimum Hog Space Requirements

Av. Weight	Number Hogs per Running Foot of Truck Floor (92-in. truck width)
100 lbs.	3.3
150	2.6
200	2.2
250	1.8
300	1.6
350	1.4
400	1.2

Figure 7. Minimum hog space requirements.

2. If the temperature is over 80 degrees F, sprinkle the hogs before loading to keep them cool.
3. During the summer, remove grain slats and open nose vents to keep hogs cool. During winter, replace the grain slats and close the nose vents to protect your hogs from the wind.
4. During hot weather, unload and load promptly. Do not allow drivers to stop at the cafe with a load of hogs. Heat can build up to lethal levels in a parked truck very quickly.
5. Avoid sudden stops and starts.

Space Requirements

Hogs weighing 200 lb need a minimum of 3.5 sq. ft. per animal during shipment. During hot weather they need more room. When the temperature is above 75 degrees and the Weather Safety Index is at the "Alert" or "Danger" level, load 10% to 20% fewer hogs. The recommendations in Figure 7 are for temperatures under 75 degrees. When the temperature and humidity are high, a 230 lb hog requires 4.4 sq. ft.

If the hogs will be slaughtered on the same day, withhold feed for 12 hours before loading. If they will be slaughtered the next day, feed them lightly before loading. Hogs with full stomachs are more likely to die during transit. Continuous access to water is recommended.

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[1]Temple Grandin, Animal Science Department, University of Illinois.

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