1975

EC75-219 Nebraska Swine Report

William Ahlschwede
billahls@neb.rr.com

T. E. Socha
University of Nebraska-Lincoln

Alfonso Torres-Medina
University of Nebraska-Lincoln

A. J. Lewis
University of Nebraska-Lincoln, alewis2@unl.edu

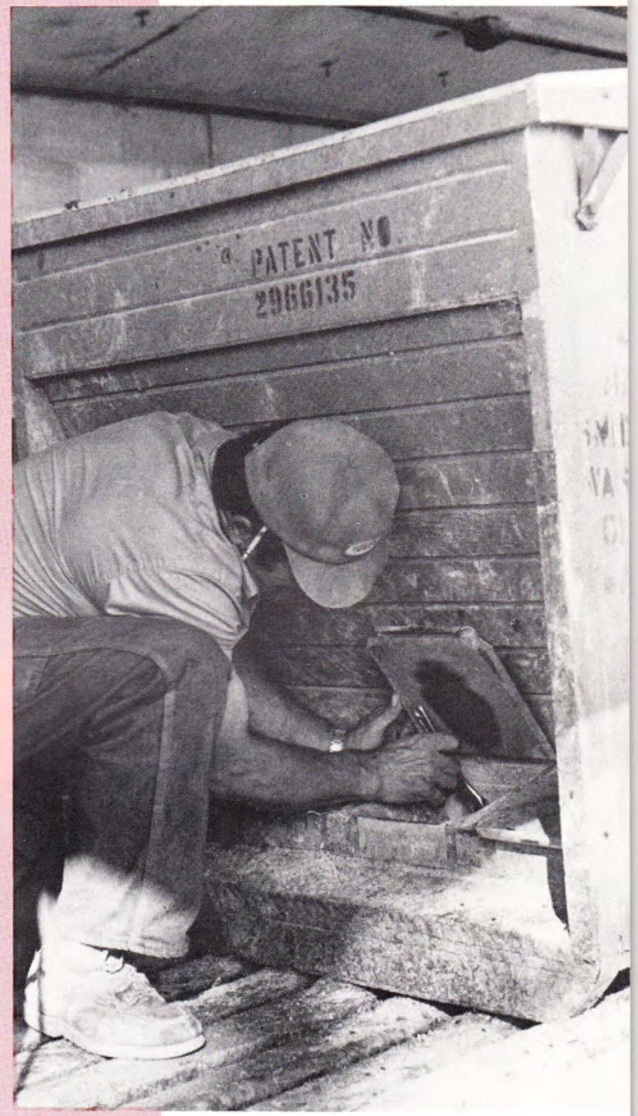
P.J. Cunningham
University of Nebraska-Lincoln

See next page for additional authors

E. C. 75-219

1975

NEBRASKA SWINE REPORT



- Breeding
- Disease Control
- Nutrition
- Economics
- Housing

Prepared by the staff in Animal Science and cooperating Departments for use in the Extension and Teaching programs

University of Nebraska-Lincoln
Institute of Agriculture and Natural Resources

J. L. Adams
Director of Extension

H. W. Ottoson
Director, Experiment Station

T. E. Hartung
Dean, College of Agriculture

Support Acknowledged

The authors wish to express their appreciation to the following for grant or product support of Nebraska Research and Extension programs. The dedicated effort of the support personnel in the laboratories and research units is acknowledged and appreciated.

American Cyanamid Company, Princeton, New Jersey

Bettcher Industries, Inc., Vermillion, Ohio

BZD Livestock Products, Inc., Lincoln, Nebraska

Calcium Carbonate Company Quincy, Illinois

Commercial Solvents Corporation, Terre Haute, Indiana

Dawes Laboratories, Inc., Chicago, Illinois

Diamond Shamrock Chemical Co., Newark, New Jersey

Eli Lilly and Company, Indianapolis, Indiana

Farmland Industries, Kansas City,Missouri

Fats and Protein Research Foundation, Inc., Desplaines, Illinois

Garnet-Ross Seed Company, Bethesda, Maryland

George A. Hormel Packing Company, Fremont, Nebraska

Hoffman-La Roche, Inc., Nutley, New Jersey

Merck and Company Rahway, New Jersey

National Pork Producers Council, Des Moines, Iowa

Nebraska Chapter, Sigma Zi

Nebraska Pork Producers Association

Pfizer, Inc., Terre Haute, Indiana

Pioneer Hi-Bred International, Inc., Des Moines, Iowa

Research Council University of Nebraska–Lincoln

Rhodia, Inc. (Hess and Clark Div.), Ashland, Ohio

Sargent Calcium Products Company, Weeping Water, Nebraska

S. B. Penick and Company, New York, New York

Shell Chemical Company, Agricultural Division, San Ramon, California

Starcraft Agri Products Division, Red Oak, Iowa

Townsend Engineering Des Moines, Iowa

Urschel Laboratories, Inc., Valparaiso, Indiana

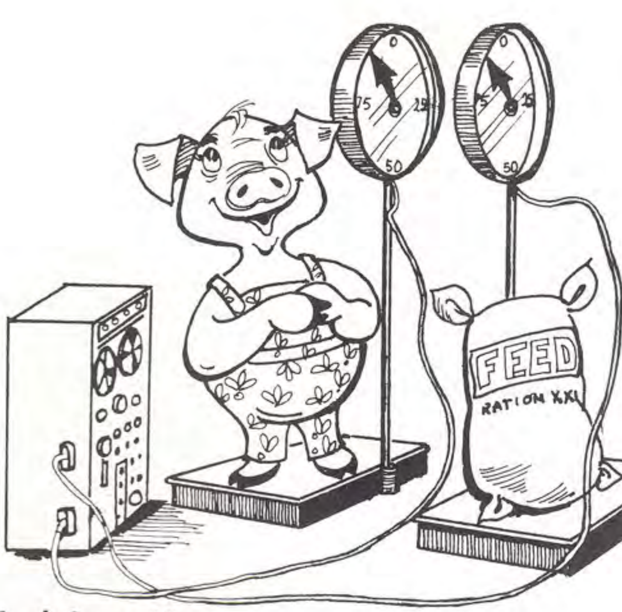
U.S.D.A., ARS, WRRL, Berkeley, California

Waldo Farms, DeWitt, Nebraska

Wilson Foods, Inc. Omaha, Nebraska

Contents

Issued January 1975, 10,000



Saving Feed Saves Money

Select for Feed Efficiency

W. T. Ahlschwede
Extension Livestock Specialist (Swine)

T. E. Socha
Instructor, Veterinary Science

Nebraska pork producers are aware that saving feed saves money. Saving feed becomes more urgent when feed prices are high relative to other production costs.

Many management factors affect feed utilization. Producers who keep self-feeders adjusted to prevent wastage, balance diets skillfully and provide adequate shelter will produce pork at a lower feed cost.

Genetic programs which result in improved feed utilization also can lower feed costs. The economic return from good genetic programs and wise selections does not come as rapidly as the saving from self-feeder adjustment, but they are more permanent.

Commercial producers can improve feed efficiency by careful boar buying. However, this improvement is limited unless boar producers also cause genetic improvement for feed efficiency.

Selection procedures for feed efficiency have not been well developed or put to use by either commercial pork producers or breeders. Test stations measure the amount of feed required by small groups of pigs, usually litter mates, during the growing period.

However, the emphasis in recent years on reduced fatness and altered structural conformation has masked these efforts to improve feed efficiency. With the industry's attention on other traits, little effort has been spent in developing and evaluating schemes for genetically improving feed efficiency. In addition, only limited research has been conducted in the last two decades which sheds light on this topic.

Six Procedures Evaluated

This report evaluates several procedures for genetically improving feed efficiency in growing-finishing pigs.

Three questions were considered, each of which plays an important role in the development of a sound genetic program.

1. Is individual feeding necessary to select for feed efficiency, or can feed efficiency measured on a pen of littermates be used?

2. How effectively can rate of gain and probe backfat thickness be used in selecting for feed efficiency?

3. How valuable is information collected on littermates, fed in the same pen or individually, in improving feed efficiency genetically?

Table. 1 Genetic and phenotypic parameters.

	Set 1	Set 2	Set 3
Heritabilities			
F/G	.35	.35	.3
ADG	.3	.3	.3
BF	.5	.5	.5
Standard deviation			
F/G	.25	.25	.25
ADG	.2	.2	.2
BF	.15	.15	.15
Genetic correlations			
F/G-ADG	−.6	−.8	−.5
ADG-BF	.1	.3	.3
BF-F/G	.3	.3	.15
Phenotypic correlations			
F/G-ADG	−.5	−.6	−.4
ADG-BF	.15	.3	.25
BF-F/G	.1	.1	.1

The problem of not knowing the exact relationships between feed efficiency, rate of gain and fat thickness was handled by using three different sets of genetic and phenotypic parameters (Table 1). Performance records from boar test stations indicate that, other things being equal, faster growing pigs use less feed and similarly, pigs with less fat use less feed. This evidence allows us to be certain that these correlations are favorable, but do not tell us whether the correlations are large or small.

In addition to direct selection for feed efficiency based on individual feeding, six alternate procedures were evaluated and compared to direct selection. Each of the six procedures were evaluated as selection indexes designed to maximize genetic improvement in feed efficiency. The component traits of the six indexes were:

1. Individual feed efficiency (F/G), average daily gain (ADG), and backfat probe (BF).

2. F/G, ADG, BF and the average feed efficiency of three individually fed littermates (SIB F/G).

3. ADG, BF and feed efficiency of the individual and three littermates fed together as a pen of four (PEN F/G) — a moderate pen effect on feed efficiency was assumed.

4. ADG, BF and PEN F/G — a small pen effect on feed efficiency was assumed.

5. ADG and BF.

(continued on next page)

Select for Feed Efficiency

(continued from page 3)

6. ADG, BF, average gain of three littermates (SIB ADG) and average backfat of three littermates (SIB BF).

New indexes were constructed for each of the three parameter sets. In all, 18 separate indexes or selection procedures were considered.

Index 4 is different from Index 3 in that a smaller pen effect was assumed for Index 4. One unknown factor about feed efficiency of G-F pigs fed in small groups is the effect that small groups have on feed efficiency. Index 3 includes a moderate pen effect, Index 4 a small pen effect.

Effectiveness figures in Table 2 are the expected improvement in feed efficiency as a percent of the improvement expected when selecting directly for feed efficiency with individually fed pigs. For example, parameter set 1, Index 1 would give 4% more response than direct selection. These projections assume that the same number of boars and gilts are tested and selected with each of the procedures.

Table 2. Effectiveness of alternate procedures.

Index components	Percent effectiveness compared to direct selection for F/G			
	Set 1	Set 2	Set 3	Av.
F/G Individual	100	100	100	100
1–F/G, ADG, BF	104	108	117	110
2–F/G, ADG, BF, SIB F/G	110	116	124	117
3–ADG, BF, PEN F/G	101	106	98	102
4–ADG, BF, PEN F/G	104	113	102	106
5–ADG, BF	71	96	60	76
6–ADG, BF, SIB ADG, SIB BF	76	106	65	82

Job Can Be Done

Selection figures in Table 2 indicate that an excellent job can be done in improving feeding efficiency even if individual feed consumption measurements are not available. When F/G from a pen of 4 littermates is augmented by the individual's own ADG and BF, more improvement can be expected than when individual F/G alone is used for selection. This procedure — Index 3 and Index 4 — is the procedure used by the boar test stations in Nebraska and Iowa. With parameter set 2, the resulting index is essentially the same as used by swine testing stations. Index 3 for parameter set 2 is I = C + 56 ADG − 50 BF − 54 F/G. The test station index is I = C + 50 ADG − 50 BF − 50 F/G (C is an arbitrary constant number).

The usefulness of ADG and BF in selecting for feed efficiency can be seen by looking at the effectiveness of Index 1 and Index 5. The effectiveness of Index 1 indicates that if we have individual F/G, the use of ADG and BF increases the improvement by about 10%. Index 5 indicates that without any measurement of feed consumption, consideration of ADG and BF will give about ¾ of the improvement expected from direct selection for F/G. In addition, if relationships between F/G and ADG are extremely favorable (Set 2), then ADG and BF can do nearly as well as selecting for F/G directly.

The advantage of using information on littermates can be easily seen by comparing Index 1 with Index 2 and Index 5 with Index 6. With individual feeding, consideration of the average F/G of three individually fed littermates increases the effectiveness an additional 7% (average over Set 1, Set 2, Set 3). When feed consumption is not measured, the addition of ADG and BF of 3 littermates to Index 5 increases the effectiveness an average of 6% (Index 6 vs Index 5).

The choices of procedures considered in this evaluation are somewhat limited when compared to the many variations which have been or will be used in attempts to genetically improve feed efficiency. Our procedures are similar to those used by the boar test stations. We chose to measure feed efficiency as pounds of feed per pound of gain or F/G. Others may choose G/F. Our calculations assume pigs are put on feed at a common weight and taken off feed at a common weight. We used an individual and three littermates, when practical considerations say that it should be more or less or variable. The procedures considered here give a reasonable basis to evaluate the effectiveness of the most logical alternates.

Choosing the appropriate set of parameters is a problem. Strong support can be found for each of the three sets used. Other sets may also be proposed. Parameter Set 1 represents the consensus of research reported in the 1950's and 60's. Parameter Set 2, which the authors prefer, is based on the most recently reported study with individually fed pigs. Parameter Set 3 is similar to parameters used in a recent report in the popular press. The three sets give quite different Index values for the cases considered. Set 2 favors the use of ADG and BF in selecting for F/G. Set 3 favors the use of information on littermates.

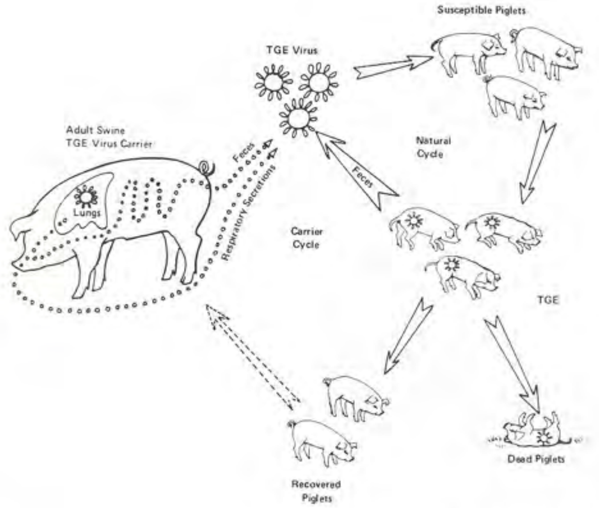
Conclusions

Important genetic improvement can be made in feed efficiency without measuring feed consumption. The average effectiveness of Index 6 indicates that only 20% of the improvement is lost by not measuring F/G directly.

Breeders can expect to make as much genetic improvement in F/G by pen feeding groups of littermates as by selecting directly for F/G if only F/G records are utilized.

Breeders willing to pay for individual feeding and use the records of sibs in selection can make accelerated genetic change. They can expect to beat simple selection on F/G by as much as 15%.

The evaluation of various procedures clearly indicates that valuable information can be gained by testing littermates and using this information in making selections.



Adult Pigs Carry TGE Virus

Alfonso Torres-Medina
Assistant Professor, Veterinary Science

Traditionally, swine transmissible gastroenteritis (TGE) has been regarded as a seasonal disease with most cases in winter and early spring and rarely seen the rest of the year.

Today, due to the trend of switching to continuous farrowing operations, TGE is encountered throughout the year.

Reasons for this are related to the increased number of highly susceptible animals present at one time on the farm followed by a continued supply of newly born susceptible piglets.

TGE virus can and does infect sows, boars, and feeder pigs. Generally, mature swine do not have marked signs of sickness or they are easily overlooked. One exception is nursing sows which can become very sick with loss of appetite and even mild diarrhea and vomiting. In addition, milk production is decreased, thus increasing the severity of the disease in TGE infected litters.

Pigs that have recovered from TGE develop immunity and are protected against reinfection by the TGE virus for probably the rest of their lives.

Persistent

The question of how the TGE virus persisted on some farms from one winter to the next, or from one farrowing to the next, did not have a conclusive answer until recently. One proposed answer was that the virus was protected by the snow and cold temperatures during winter which perpetuated the presence of the virus on farms. This was only a partial answer because the TGE virus is sensitive to warmer temperatures and sunlight; and therefore, the virus is rapidly destroyed in the summer.

Another possibility was that starlings feeding on infected feces on one farm could carry the virus to other farms. Under experimental conditions TGE virus was eliminated in the droppings of infected starlings after only 32 hours. So, although starlings can transport TGE virus from farm to farm during outbreaks, these birds were not responsible for the winter to winter survival of the virus. Dogs and foxes were found to behave similar to starlings as far as the dissemination of TGE virus is concerned.

Pigs the Culprit

Recent research conducted in the Department of Veterinary Science of the University of Nebraska–Lincoln under the direction of Professor Norman R. Underdahl demonstrated that the culprits for carrying the TGE virus are pigs themselves.

The discovery was made in a study of market weight pigs suspected of having mycoplasmal pneumonia. Laboratory tests failed to demonstrate mycoplasma but TGE virus was isolated from the suspected lungs. Similar results have been obtained from other pigs received at the Veterinary Diagnostic Laboratory in Lincoln, where TGE was as easily isolated from lungs as from the intestinal tract.

Controlled experimental infections of pigs with TGE virus indicate that TGE virus can be maintained in the respiratory tract of some recovered pigs for over 100 days after infection. These pigs eliminated the virus in expired air which infected susceptible pigs in contact with the infected pigs. It is probable that pigs under natural conditions could disseminate the virus over longer periods of time, thus carrying the virus from winter to winter.

Research at the National Animal Disease Center, Ames, Iowa, has confirmed these findings. NADC researchers reported that sows exposed to infected litters became infected and TGE virus was eliminated in nasal secretions, feces and milk for a few days after infection. In addition, virus was recovered more easily from the respiratory tract of the infected pigs at necropsy, than from the intestinal tract.

Addition to Knowledge

It is still not clear why some pigs become carriers of TGE virus after recovery from infection despite their apparent immunity. Research is currently under way in several research centers to devise methods for the detection of TGE carrier pigs, but the task is difficult.

Meanwhile, pork producers should be even more careful in the selection of herd additions. Pork producers should know the history of the pigs and the herd from which animals are acquired, especially if the buyer's farm has been TGE-free.

The discovery that TGE is a respiratory disease as well as an enteric one is a valuable addition to the knowledge of this very important disease of swine which has been so costly to the pork industry.

For Lactation

Protein Levels May Be Lower

A. J. Lewis
Research Associate, Swine Nutrition

Until recently, there has been little information about optimum feeding of sows during lactation. It is generally considered important that energy intake should be high and most authorities recommend feeding to appetite. Recommendations for protein are also generous, being higher for lactation than for any other stage of life except the baby pig.

Protein requirements for lactation listed by the National Research Council during the last 20 years are presented in Table 1. These levels are considered generally adequate; the minimum requirement has not been established. Recommendations have not changed much in 20 years, but the current figure (15% protein) is as high as at any time. The University of Nebraska also currently recommends 15% protein during lactation.

Table 1. National research council recommendations for lactation.

Year	Feeding level lb/day	Crude protein lb/day	Crude protein %
1953	12.5	1.75	14.0
1959	12.5	1.62	13.0
1964	12.5	1.62	13.0
1968	12.1	1.82	15.0
1973	12.1	1.82	15.0

Protein Requirement

Several research projects have been started to help define the protein requirement more precisely. As part of a cooperative experiment with several states in the North Central Region, the University of Nebraska has carried out a series of experiments in which different protein levels have been fed to sows during lactation. These studies are not yet complete, but some of the preliminary data are presented in Table 2. These data indicate that protein levels can be reduced to 12% without any reduction in sow productivity.

Table 2. Effect of protein level during lactation.[a]

Item	Protein level, %		
	12	16	20
No. of litters	22	27	22
Sow weight change, lb	-2.8	-0.4	+8.8
Average daily feed intake, lb	10.4	10.4	9.9
Pigs born alive per litter	9.1	9.1	8.4
Pigs alive at 2 weeks per litter	6.8	6.6	6.4
Average pig birth weight, lb	2.9	2.9	2.6
Average pig weight at 2 weeks, lb	7.5	7.5	7.5

[a] NCR-42 Cooperative Study–Nebr. Expt. 73410-420.

A slightly different picture is provided by experiments reported recently from Ohio in which five protein levels from 12% to 20% were compared. Feed intakes of sows and litter weight gains tended to be larger when sows were fed the higher protein levels during lactation. This effect was greater if a low (9%) protein gestation diet was fed.

Table 3. Amino acid requirements for lactation.

Amino acid	Requirement	Protein level needed[a]
Lysine	0.60	13.5
Tryptophan	0.12	12.0
Threonine	0.45	11.0
Methionine & Cystine	0.36	9.5

[a] Protein level needed to meet the amino acid requirement assuming a corn-soybean meal ration is fed.

Amino Acid Requirements

In experiments at the Iowa Station, requirements for the individual amino acids have been studied. Table 3 lists requirements for the amino acids that have been investigated so far. The table also lists protein levels needed to meet these amino acid requirements, when a corn-soybean meal diet is fed.

Lysine is the first limiting amino acid during lactation, and, provided sufficient protein is fed to satisfy the lysine requirement then, with normal types of diets, the requirements for all other amino acids will be met.

Summary

Recent research in several states has demonstrated that a ration containing 14% protein is adequate for the lactating sow fed 12 lb per day. A further reduction in protein level (to 12-13%) may be possible if the sow receives an adequate protein level during gestation.

Selection for Ovulation Rate

P. J. Cunningham
Assistant Professor, Swine Breeding

Dwane R. Zimmerman
Professor, Swine Physiology

Good reproductive performance is critical to the economic success of any swine enterprise. As is true for most traits of economic importance, genetic and environmental factors influence the level of performance obtained to varying degrees.

Research has indicated that differences in genetic makeup among animals are responsible for a relatively small proportion of the differences observed in reproductive performance. The low estimates of heritability suggest that selection would be ineffective in improving the genetic merit of a herd for reproductive traits. However, the economic importance of reproductive performance continues to serve as a stimulus to search for methods of genetically improving these traits.

Selection Experiment

The University of Nebraska, in 1967, began an experiment to determine the effectiveness of selection for ovulation rate (number of eggs ovulated) in swine. Ovulation rate was chosen as the selection criterion for several reasons:

1. Ovulation rate sets the upper limit for litter size.
2. Ovulation rate can be accurately measured by counting corpora lutea on the ovaries following laparotomy (surgical incision through the abdomen).
3. Selection can be practiced among individuals.
4. Environmental variation can be more easily controlled.

In addition, ovulation rate was selected over litter size because it was thought that it might be possible to make more genetic improvement if selection pressure was applied to one component trait rather than to the net effect of three traits. Variation in litter size is determined by differences in fertilization rate and prenatal survival rate as well as by differences in ovulation rate.

The selection for ovulation rate was practiced in the Gene Pool herd (composed of genetic material from 14 different breeds). The herd was established by introducing representatives from 13 breeds into a Hampshire female base population between 1958 and 1965 (Figure 1). The population was then closed to introductions and maintained until 1967 when selection was initiated.

Before start of the selection, attempts were made to develop appropriate management procedures for the experimental animals. Diets and methods of handling the animals were standardized and remained as similar as possible throughout the experiment.

Two Lines Designated

Two separate lines (Select and Control) were randomly designated at the start. Replacement gilts in the Select line were selected on the basis of their ovulation rate whereas Control line gilts were randomly selected. Random selection was practiced in order to maintain the Control line genetically constant. The Control line can thus be used to correct the Select line for

(continued on next page)

(Years in which breeds were inserted)

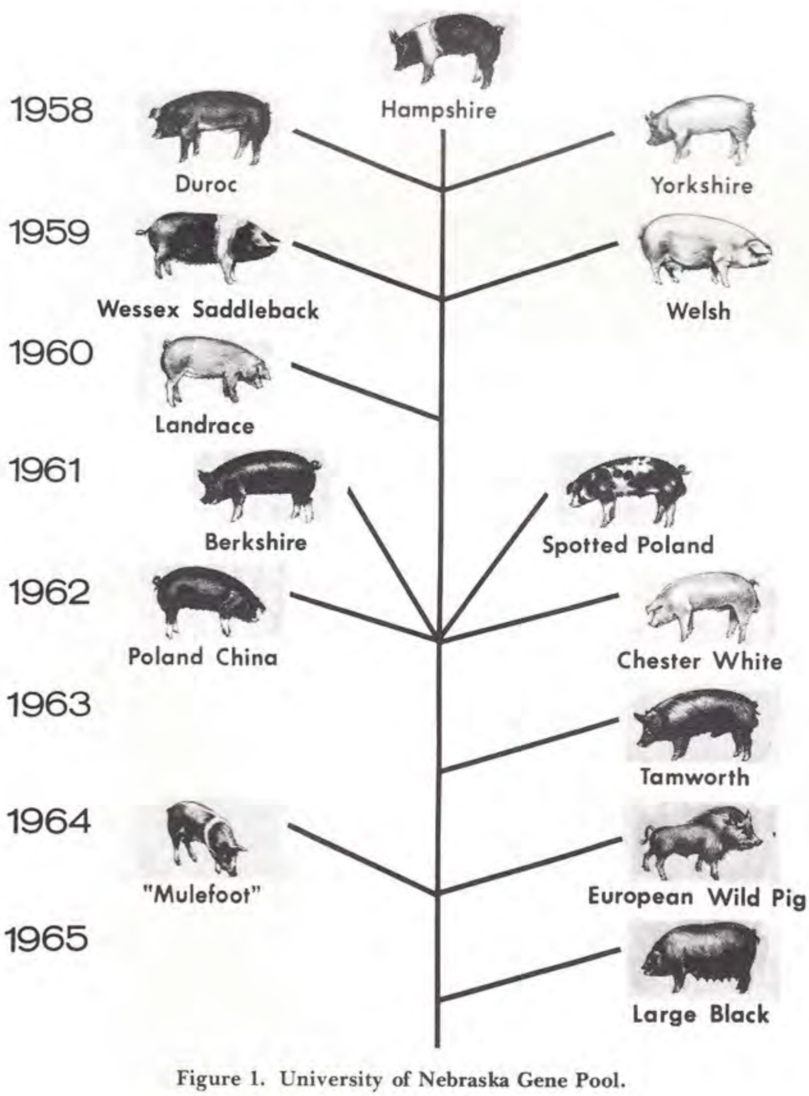


Figure 1. University of Nebraska Gene Pool.

Reproductive Performance

(continued from page 7)

environmental fluctuations occurring from year to year. This allows more accurate measurement of genetic changes. Replacement boars were randomly selected in both lines. Selection was practiced on only the gilts with about 50 gilts saved for breeding each year in each line. Gilts were hand mated during a 24-day breeding season.

Ovulation rate was determined for all gilts from both lines 9-11 days following second estrus. Each gilt was anesthetized, the ovaries visually inspected through an abdominal incision (laparotomy) and the corpora lutea counted. The number of corpora lutea present indicates the number of eggs released (ovulations) at the previous estrus. Sexual age was standardized to insure that this important variable did not cause variation in ovulation performance.

The means for the two lines for the first six generations of selection are presented in Table 1. A total of 1884 gilts have been laparotomized through these first six generations. An average of 135 gilts were available for selection each generation in each line. Numbers vary between generations for several reasons, but primarily due to conception rates obtained during the 24-day breeding period.

Initially, gilts randomly assigned to the Control line had a slightly higher ovulation rate than gilts in the Select line (14.63 vs 14.38). This initial difference would be considered a chance occurrence and not a real difference. The difference in ovulation rate between the two lines slightly favored the Select line in generation two and the advantage continued to increase through generation five. The line difference was 2.52 corpora lutea in generation five in favor of the Select line. In generation six, the line difference was only 1.84 corpora lutea (15.60 vs 13.96). This is a decrease of 0.68 corpora lutea compared to generation five. The exact cause of this decrease is impossible to determine, but adverse environmental conditions encountered during 1972–73 may have affected the Select line more than the Control line.

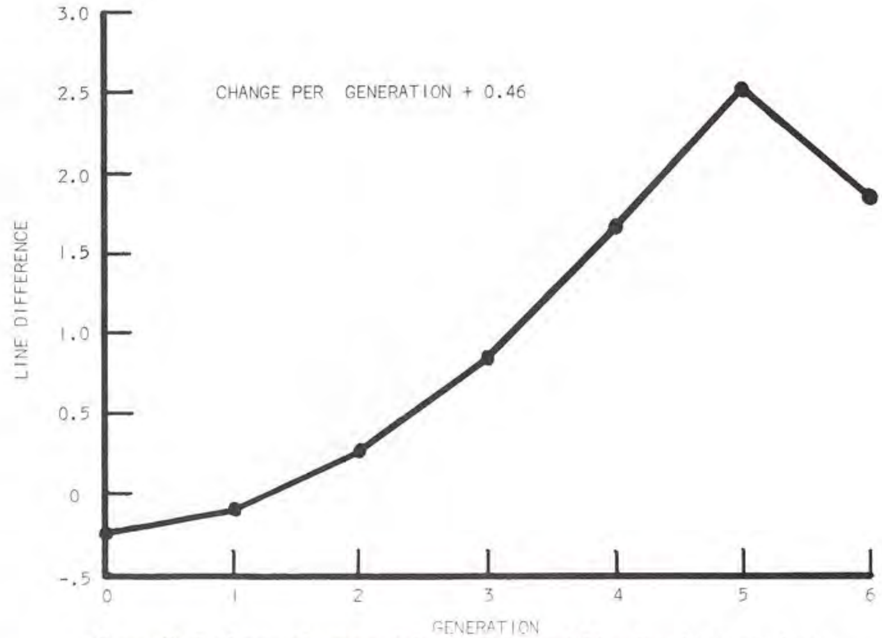


Figure 2. Difference between Select and Control Line for six generations.

Figure 2 graphically illustrates the difference in average performance for the two lines during the six generations. The average difference between the lines increased by 0.46 corpora lutea per generation. This rate of change depends on the number of gilts involved and indicates what has occurred in this population. Selection has increased ovulation rate in this population.

The heritability of ovulation rate estimated from the results of the first five generations of selection was about 40%. This is considered a relatively high heritability and indicates that selection should be effective in causing genetic improvement in ovulation rate.

Selection Effective

Single trait selection for ovulation rate has been practiced in a swine population for six generations. Lines differing by about two corpora lutea have been produced. The high heritability (40%) estimated from this study indicates selection should be effective in improving ovulation rate.

Even though selection has been practiced for six generations, this experiment is really just beginning. Line differences created in this experiment may provide some insight into additional questions:

1. What effect has selection for ovulation rate had on other components of performance, particularly litter size?
2. Biologically, what is the nature of the differences between the lines?
3. Is the difference in ovulation rate at second estrus manifested at later estrous cycles?
4. What are the genetic and phenotypic relationships among various components of performance?

Table 1. Ovulation rate means by line and generation.

Generation	Select line		Control line	
	Number	Mean	Number	Mean
0	109	14.38	121	14.63
1	124	13.97	123	14.08
2	97	14.68	122	14.41
3	164	14.75	148	13.91
4	207	15.60	180	13.93
5	144	16.19	151	13.67
6	99	15.80	95	13.96

Phosphorus Sources for G-F Swine

E. R. Peo, Jr.
Professor, Swine Nutrition

One of the most critical problems to "hit" the swine industry in recent years is the world shortage of feed phosphorus.

If protein is in short supply, feeding lower levels will not be particularly harmful but pigs will grow more slowly and less efficiently.

If phosphorus is in short supply, feeding diets low or inadequate in phosphorus will result in skeletal abnormalities (including broken bones) and decreased feed utilization.

Certain amino acids can substitute for part of the protein in swine diets when protein is in short supply or high priced. There is no similar substitute for phosphorus.

Not Out of the "Woods"

The acute shortage of phosphorus was caused in part by a poor fish harvest a couple of years ago, the energy shortage, and price controls. The problem is becoming less acute but we are not out of the "woods" yet.

Even with a lessening of the short supply, the cost of feed phosphorus has nearly doubled in the last two years. With current swine prices, the producer is forced to think of "minimum" rather than "optimum" levels of phosphorus for all swine classes. Such programs are not without hazards.

Cereal grains contain about 0.25-0.30% phosphorus. However, only 40% of the phosphorus in cereals is available to the pig. Since the pig's requirement for phosphorus varies from 0.50 to 0.70% of the diet depending upon class of swine, diets must be supplemented with phosphorus. Some commonly used sources of supplemental phosphorus are shown in Table 1.

Table 1. Phosphorus sources commonly used in swine diets.

Source	Percent calcium	Percent phosphorus	Availability of phosphorus for the pig
Dicalcium phosphate	24.0	18.5	Good
Steamed bone meal	24.0	12.0	Good
Defluorinated rock phosphate	33.0	18.0	Good
Monocalcium phosphate	25.0	21.0	Good
Disodium phosphate	......	20.5	Good
Monosodium phosphate	......	25.5	Good
Sodium tripolyphosphate	......	25.5	Good
Soft phosphate[a]	......	Variable	Limited
Meat and bone meal	10.0	5.0	Good
Tankage	6.0	3.0	Good
Fish meal	5.0	3.0	Good

[a] Soft phosphate has a poor availability of phosphorus for the pig. However, soft phosphates can be used to furnish 25% of the non-plant phosphorus in the ration, which is 10% of the total phosphorus requirement.

Other Sources Acceptable

When phosphorus is in short supply or high priced, the commonly used sources suddenly become unavailable. Two sources of phosphorus not used routinely in swine diets are monoammonium phosphate and fertilizer grade phosphate such as 0-46-0. Often swine producers have or can get ammonium phosphate or fertilizer phosphate. The question is "how good are they as sources of phosphorus for swine?" Two experiments have been conducted at the Nebraska Experiment Station to help answer this question.

In the first experiment, ammonium phosphate was compared with dicalcium phosphate as a source of phosphorus for G-F swine. Two levels of phosphorus were fed—0.50% and 0.70%. The calcium level was held constant at 0.65%. Ammonium phosphate was used to furnish all or half of the supplemental phosphorus. Results are shown in Table 2.

Pigs fed the unsupplemented basal diet (0.31% phosphorus) gained slower and showed poorer feed conversion than those fed diets supplemented with dicalcium phosphate or monoammonium phosphate. There was essentially no difference in performance of pigs fed dicalcium phosphate or ammonium phosphate singly or when each supplied 0.1% of the supplemental phosphorus (diet 6). There was a tendency for gains,

(continued on next page)

Phospnorus Sources

(continued from page 9)

feed intake and bone strength to be reduced when 0.2% phosphorus was added from a combination of dicalcium phosphate and ammonium phosphate (diet 7). On the basis of gains, feed conversion and bone strength, it appears that monoammonium phosphate is an acceptable source of phosphorus for growing-finishing swine.

Since monoammonium phosphate contains 11% nitrogen from ammonia (68.75% protein equivalent) using ammonium phosphate to supply 0.4% phosphorus did not add sufficient non-protein-nitrogen to be harmful to the animals. It required 31 pounds/ton of ammonium phosphate to add 0.4% phosphorus. This level furnished 1.1% protein equivalent or about 8% of the total protein (14%) in the diet. There is little need to exceed a total of 0.7% phosphorus in the diet of swine except perhaps when limit feeding brood sows. Thus ammonium phosphate appears to be a useable and safe source of phosphorus for G-F swine.

The second experiment compared fertilizer phosphate with dicalcium phosphate. Fertilizer phosphate (0-46-0 – 21% actual phosphorus) may be used as a source of phosphorus for G-F swine. However, as shown in Table 3, gains and feed conversion were reduced 9.7% and 7.2% respectively when fertilizer was the source of phosphorus as compared to dicalcium phosphate.

Table 3. Value of fertilizer phosphorus (0-46-0) for G-F swine.[a,b]

Ca, % / *P, %*	Level and ratio .50 / .40	.65 / .40	.50 / .50	.65 / .50	Av for source
Source			*Av Daily Gain, lb*		
Dicalcium phosphate[d]	1.58	1.58	1.62	1.56	1.58
Fertilizer phosphate[d,e]	1.46	1.45	1.38	1.47	1.44
Av for levels & ratios	1.52	1.52	1.50	1.52	
			Feed/Gain Ratio[c]		
Dicalcium phosphate[d]	3.42	3.47	3.13	3.28	3.32
Fertilizer phosphate[d,e]	3.58	3.83	3.58	3.27	3.56
Av for levels & ratios	3.50	3.65	3.36	3.28	
			Bone Breaking Strength, Force (kg)		
Dicalcium phosphate[d]	241	298	286	278	276
Fertilizer phosphate[d,e]	265	293	282	313	288
Av for levels & ratios	253	296	284	296	

[a] Peo, E. R., Jr., B. D. Moser and T. Stahly. 1974. Neb. Agr. Exp. Sta. Swine Nutr. Exp. 74401.
[b] Data are the av 2 pens/treatment; 8 pigs/pen. Int. wt. 66 lb Open Front Unit, 50% slats.
[c] Pigs on test 84 days.
[d] Supplied 0.1% and 0.2% phosphorus to diets containing 0.4% and 0.5% phosphorus, respectively.
[e] Added 136 ppm and 272 ppm fluorine to diets containing 0.4% and 0.5% phosphorus, respectively.

We feel the main problem with fertilizer phosphorus is its high content of fluorine. The fertilizer we used analyzed 2.73% fluorine and was added at rate of 10 and 20 lb per ton of complete feed. The fertilizer diets with 0.4% and 0.5% total phosphorus (0.1%–0.2% added phosphorus from the fertilizer source) contained 136 ppm and 272 ppm fluorine, respectively. The fluorine content of swine diets probably should not exceed 100 ppm.

The depressed performance of pigs on the fertilizer diets may have been due to the high fluorine content rather than a lack of available phosphorus. In fact, bone breaking strength data shown in Table 3 indicate that the phosphorus in the fertilizer was highly available to the pig since more force was required to break the metatarsal leg bones of pigs fed fertilizer phosphorus.

On the other hand, the pigs fed fertilizer phosphorus gained slower than those fed dicalcium phosphate. Previous work at the Northeast Nebraska Experiment Station by R. D. Fritschen showed a direct relationship between growth rate and bone strength—pigs that grew slowest had the strongest bones.

Analyze For Flourine

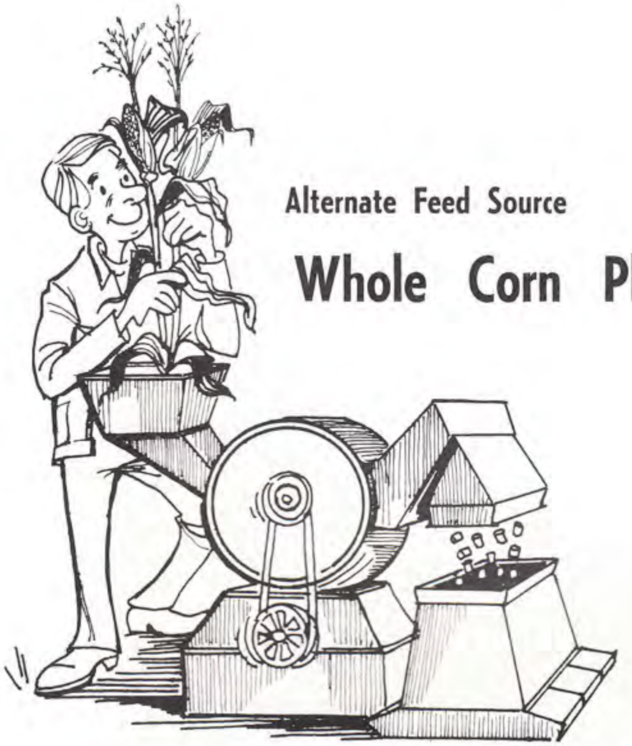
If fertilizer is used as a source of phosphorus for swine, it should be analyzed for fluorine. Once the fluorine content is known, the fertilizer can be used to supply phosphorus up to the level at which fluorine does not exceed 100 ppm.

Fluorine analysis is available from commercial laboratories in Nebraska or from the Laboratory of Biochemistry, % Dr. Robert Hill, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln for a nominal fee.

Table 2. Ammonium phosphate for G-F swine.[a,b,c]

Diet No.	Basal 1	Basal + Dical 2	Basal + Dical 3	Basal + Am Phos 4	Basal + Am Phos 5	Basal + ½ Dical ½ Am Phos 6	7
Ca, %	.65	.65	.65	.65	.65	.65	.65
P, %	.31	.50	.70	.50	.70	.50	.70
Average daily gain, lb	1.20	1.49	1.64	1.50	1.60	1.65	1.48
Average daily feed intake, lb	4.42	5.28	5.64	5.42	5.76	5.66	5.05
Feed/lb gain, lb	3.70	3.57	3.45	3.57	3.57	3.45	3.45
Bone strength, force (kg)	262	273	270	293	278	274	261
	(6)[d]	(10)	(11)	(10)	(13)	(12)	(8)

[a] Peo, E. R., Jr., B. D. Moser and P. Platter. 1971. Neb. Agr. Exp. Sta. Swine Nutr. Exp. 71409.
[b] Ammonium phosphate, 11% nitrogen; 25% Phosphorus.
[c] 2 pens, 8 pigs per pen. Int. wt. 45 pounds. Enclosed house, ⅔ slotted floor.
[d] Numbers in brackets = no. pigs used for determining strength of the 3rd & 4th metatarsal leg bones.



Alternate Feed Source

Whole Corn Plant Pellets

Larry K. McMullen
Graduate Assistant

Bobby D. Moser
Assistant Professor, Swine Nutrition

During a time of shortages and high feed cost, pork producers are looking for alternate feed sources which will provide adequate performance at a lower cost. Since the energy needs of the gestating female are relatively low, diets which contain a higher than normal amount of good quality roughage could supply much of these needs.

Danielson, in the 1974 Nebraska Swine Report, reported good reproductive performance from sows fed only alfalfa hay, minerals, and vitamins during gestation. The whole corn plant pellet is another high roughage feed that possibly could be utilized by the brood sow.

An experiment was conducted to determine the reproductive response of gilts fed whole corn plant pellets fortified with mineral and vitamins as the complete diet during gestation.

Table 1. Whole corn plant pellet analysis.

	High[a] lysine	Normal
Crude protein (%)	7.50	7.60
Calcium (%)	0.20	0.13
Phosphorus (%)	0.14	0.17
Dry matter (%)	93.80	92.30
Lysine (%)	0.38	0.24

[a] Courtesy of Garnett-Ross, Inc., Bethesda, Maryland.

Whole Corn Plant Pellets?

What are whole corn plant pellets? They are the entire corn plant finely chopped, dehydrated and compressed into a ¼ inch diameter pellet that is about 93% dry matter.

Normally, the corn plant is chopped in the well-eared dent stage and processed at a dehydration plant in a manner similar to alfalfa.

Nutrient analysis of the whole corn plant may vary depending upon factors such as variety of corn, type of corn (normal or high lysine), stage of maturity, fertilization and ear to plant ratio. The chemical analysis of the whole corn plant pellet used in this experiment is given in Table 1.

With the dehydration industry of high economic importance in Nebraska, the dehydration of the whole corn plant would lengthen the dehydration season and make available to the pork producer a feed source locally grown and processed.

Sixty first-litter crossbred gilts weighing about 285 pounds were allotted to two replications of four treatments:

1. Corn-SBM 14% protein.
2. High lysine whole corn plant.
3. Normal whole corn plant.
4. Ground high lysine corn.

Table 2. Description of experimental diets.

Experimental diets[a]	Feeding rate during gestation[b]
Corn-soybean meal 14% protein, meal form	4.0 lb/sow/day
High lysine, whole corn plant pellet 7.5% protein[c]	6.0 lb/sow/day
Normal corn plant pellet 7.6% protein[c]	6.0 lb/sow/day
Ground high lysine corn grain, 10% protein, meal form[c]	4.0 lb/sow/day

[a] All diets fortified with minerals and vitamins to meet the needs of the gestating sow.
[b] Hand-fed daily from breeding to 110th day of gestation.
[c] No supplemental protein.

All diets were fortified with minerals and vitamins and no supplemental protein was added to either of the whole corn plant diets nor to the high lysine grain diet (Table 2).

The 14% corn-SBM and the 10% high lysine grain diets were in meal form and fed at a rate of 4.0 lb/sow/day while the whole corn plant pellets were fed at 6.0 lb/sow/day. The whole corn plant diets were fortified with minerals and vitamins by top dressing the pellets with a premix. These diets and feeding rates were fed once daily from breeding to 110th day of gestation. The sows were then moved into the farrowing house and immediately changed to a corn-SBM, meal diet during lactation.

Weight Gains

Whole corn plant diets produced less weight gain during gestation than the 14% corn-SBM or the 10% high lysine grain diets (Table 3). This suggests that the energy value of the whole corn plant was less than first estimated. No significant difference was observed between the gestation diets for measurements considered at farrowing (Table 4). However, gilts fed the 10% high-lysine grain diet tended to farrow more pigs per litter and those fed the 14% corn-soy diet produced larger pigs at birth. Similar results were observed during lactation, in which no significant difference was observed in sow or pig performance.

(continued on next page)

Table 3. Gilt weight response to gestation diets.

	Normal corn soybean meal	Whole corn-plant High lysine	Whole corn-plant Normal	High lysine corn
No. of gilts	16	15	14	15
Initial weight, lb	284.2	287.2	288.6	277.8
Pre-farrow wt., lb	363.4	336.8	339.4	352.6
Gestation wt. gain, lb	79.2	49.6	50.8	74.8

Whole Corn Plant Pellets

(continued from page 11)

A trend did exist for gilts fed the 14% corn-soy diet to wean more pigs and with a slightly larger pig at 2 weeks of age.

Sows fed the whole corn plant pellet did not adjust easily to the abrupt change from the high fiber, pelleted, gestation diet to the high concentrated, meal, lactation diet, as some scouring and poor milk production was observed. This could explain the reduced litter size and smaller pig weight at weaning for those sows fed the whole corn plant pellet.

Summary

Results indicate that the whole corn plant pellet, either normal or high lysine, can be utilized to some extent by the gestating sow if properly fortified with protein, minerals and vitamins.

At present one might expect a slight reduction in litter size and pig weight at weaning. More research is being conducted to determine if this is due to the effect of the corn plant on fetal development or simply due to the failure of sows to adjust when switched abruptly from the high fiber pellet diet to the high concentrated meal diets. A gradual change-over in diets is recommended.

The extent to which the whole corn plant is used will depend upon the availability of other feedstuffs and the economics involved. When conventional feedstuffs are in short supply and high in cost the whole corn plant may be an economical source of feed for brood sows. However, to maximize efficient use of the product, digestibility must be determined for the various nutrients found in the corn plant pellet.

Table 4. Effect of whole corn plant pellet and high lysine corn fed during gestation on farrowing and lactation performance.

	Normal corn soybean meal	Whole corn plant High lysine	Whole corn plant Normal	High lysine corn
Farrowing Response[a]				
No. of gilts	16	15	14	15
Total pigs farrowed	8.4	8.5	8.5	9.8
Live pigs farrowed	7.9	7.5	8.1	9.4
Stillborn pigs/litter	0.5	1.0	0.4	0.4
Mummies/litter	0.6	0.6	0.7	0.3
Av. live birth wt., lb	3.3	2.8	2.9	2.9
Lactation response[b]				
No. of gilts	14	15	13	15
Lactation wt. loss, lb	21.3	4.0	14.8	12.2
Live pigs started	8.9	7.5	8.2	9.4
One week response				
Total pigs	8.5	6.5	7.3	8.1
Av. pig wt., lb	5.4	4.7	4.9	5.1
Weaning response[c]				
Total pigs	8.3	6.3	7.0	7.8
Av. pig wt., lb	7.9	6.9	7.2	7.1

[a] Data based on 60 gilts that farrowed.
[b] Data based on 57 gilts that completed a lactation.
[c] Pigs weaned at two weeks of age.

Treatment, Control

Donald L. Ferguson
Associate Professor, Parasitology

Internal parasites continue to be one of the major problems confronting pork producers. In 1965, the United States Department of Agriculture estimated an average annual loss of $65,739,000. Internal parasites responsible for the annual loss were:

Large Intestinal Roundworm— *Ascaris suum*	$34,812,000
Kidney Worm— *Stephanuris dentatus*	17,059,000
Nodular Worm— *Oesophagostomum spp.*	6,836,000
Lungworm— *Metastrongylus spp.*	3,584,000
Threadworm— *Strongyloides ransomi*	2,731,000
Whipworm— *Trichuris suis*	717,000

Recent surveys indicate that the incidence of swine parasites has not decreased during the past 20 years. Data from a nationwide survey taken on 309 farms in 1972 indicated a prevalence of ascarids on 86% of the farms surveyed, whipworms on 64%, lungworms on 17%, a group which included both nodular and stomach worms at 77%, and threadworms on 30% of the farms in the South. In addition, coccidial oocysts were observed on 67% of the farms. Every type of building and management system was included in the survey.

Ecological and environmental conditions play a significant role in determining the incidence and distribution of parasites within the different geographical areas of the United States. Therefore, it is important that each pork producer become familiar with the endemic species of worms in his area. Most farms usually have a problem with two or more species of worms.

Large Intestinal Roundworm

In Nebraska, the most common internal parasite of pigs is the large intestinal roundworm, *Ascaris suum* (Fig. 1). You will find this worm in almost every swine herd in Nebraska and it is not unusual to find several hundred worms per pig. In a wormer trial

for Internal Parasites of Swine

at the North Platte Station, we recovered 532 ascarids from the small intestine of a 140-day-old pig.

Life Cycle: Pigs become infected with ascarids by consuming food and water contaminaed with infective worm eggs. They rupture in the small intestine and the infective larvae are liberated.

The larvae leave the small intestine by burrowing into the gut wall and entering the blood stream which carries them to the liver. After a period of growth in the liver, the larvae travel in the bloodstream through the heart on the way to the lungs.

In the lungs larvae leave the blood, burrow through the lung tissue, and enter air passages. Coughing forces the young worms into the throat where they are swallowed and pass into the small intestine—this time to grow to adults.

Clinical Signs: In pigs infected with ascarids, clinical signs are usually directly associated with the migratory phase of the larvae in the lungs. Typical signs are a dry, nonproductive cough, loss of appetite and weight, rough hair coat, rise in temperature, and an increased rate of respiration accompanied by thumping.

Adult worms in the intestine rob the pig of food, block the gut, and excrete substances which hinder digestion. They may migrate into the bile duct, stopping the flow of bile. Worms in the bile tract cause the spread of bile into the flesh. Bile-colored pork is not edible. These carcasses are condemned and destroyed.

Common respiratory diseases are much more severe when worms are present. Mycoplasma pneumonia is 10 times more severe in pigs with ascarids than in pigs without these worms.

Diagnosis: Microscopic identification of the characteristic eggs in the feces. Adult worms are easily seen upon postmortem examination of intestinal contents.

Treatment and Control: Piperazine, Hygromycin B, Atgard V, Tramisol, and Banminth are currently available for treating pigs infected with ascarids.

To prevent worms, keep your pigs from eating worm eggs. Regular treatment will kill the egg-laying worms and stop the spread of worm eggs. Control worm eggs already on the hog lots. Scrub the sow before farrowing. Farrow in a recently cleaned house. Keep the baby pigs away from worm eggs.

Figure 1. The large intestinal roundworm of swine, *Ascaris suum*.

Figure 2. Whipworms attached to the lining of the large intestine.

Whipworms

Mature female whipworms lay eggs in the lumen of the cecum and large intestine. The eggs pass from the body in the manure and under favorable conditions of moisture and temperature, develop to form infective larvae in 21 days.

Upon being swallowed by a pig, the young larvae burrow into the mucosa of the cecum and large intestine. Within a few days, the young worms emerge, attach to the lining of the cecum or large intestine and grow to maturity. The prepatent period (from egg to egg) is 70-90 days.

Clinical Signs: Whipworms attach to the lining of the cecum or large intestine of the pig where they obtain nourishment from body fluids (Fig. 2). They may cause considerable inflammation and irritation at the site of attachment. When large numbers are present, they cause a severe diarrhea.

Diagnosis: It is made by microscopically demonstrating worm eggs in the feces, or by recovery and identification of the worms at necropsy.

(continued on next page)

Parasite Treatment

(continued from page 13)

Treatment: Atgard V — an effective wormer for removing whipworms is available for use in swine.

In Nebraska many pork producers worm their pigs with piperazine. This wormer will effectively remove ascarids and nodular worms, but it will not effectively remove whipworms. Repeated use of a wormer that is effective against only one or two species may result in the build-up of other species. Because of the repeated use of piperazine in Nebraska swine, whipworms have become a serious problem in certain herds.

On February 7, 1972, a live 4-month-old pig was brought to the Diagnostic Laboratory at the University of Nebraska. The pig came from a lot of 90 pigs being raised in a hog house with a dirt floor.

The 90 pigs were wormed at 3 months of age with piperazine. Numerous ascarids were observed on the dirt floor, but the pigs didn't seem to gain weight following treatment. They seemed to be eating all of their feed, but continued to lose condition.

At necropsy, the pig was examined grossly for pathological lesions. A massive whipworm infection was observed in the cecum and large intestine. The whipworms were removed and the total count was 4,451 worms.

If this producer had used a wormer designed to remove whipworms (Atgard V), then the parasite problem could have been prevented. This case history demonstrates the importance of obtaining a correct diagnosis from your veterinarian before treatment.

Lungworms

Three species of lungworms (*Metastrongylus*) are commonly found in pigs in various parts of the world. Two of these species are found in Nebraska: *Metastrongylus apri* and *Metastrongylus pudentotectus.*

Life Cycle: Lungworms are thread-like, white worms which may reach 2½ inches long, although some are considerably shorter.

Figure 3. Lungworms in the bronchioles of the lungs.

Female lungworms live in air passages in the lungs (Fig. 3). Here, they produce large numbers of thick-shelled eggs, which are coughed up by the pig, swallowed and passed in the manure. Various species of earthworms swallow the lungworm eggs, which then hatch inside the earthworm. The lungworm larvae enter the walls of the esophagus, crop, gizzard, and intestine of the earthworm. The larvae develop and become infective to pigs in 3 or 4 weeks. The earthworm does not appear to suffer from even very large numbers of larvae inside its body. We have found up to 4,000 larvae in a single earthworm.

Pigs become infected by eating earthworms which harbor the infective larvae. The larvae penetrate the pig's intestinal wall and are carried by the lymph and blood to the lungs. Here, they complete their development and mate. The female worms produce embryonated eggs about 21-24 days after the pig eats the infected earthworms.

Clinical Signs: Signs of lungworm infection arise from irritation and obstruction of air passages by adult worms and presence of larvae in the air sacs. The most consistent clinical sign is abnormally fast breathing. Rapid, shallow breathing is characteristic of both light and heavy infection. Affected animals usually develop a loose, husky cough derived from excessive mucus formation and have an increased nasal discharge.

Lungworm infection may be the direct cause of verminous pneumonia or a predisposing cause of viral or bacterial pneumonia. In swine, lungworm larvae may serve as actual carriers of influenza virus.

Diagnosis: It is made by demonstration of eggs or larvae from feces passed or larvae in nasal secretions.

Diagnosis of lungworm infection in the herd is best done on postmortem examination. Lesions and worms are characteristically found in the posterior lobes of the lungs.

Treatment and Control: Tramisol —an effective wormer for removing lungworms—is now available for use in swine.

Remove infected pigs from lots on which they acquired lungworms and put in dry, clean pens that have slatted or concrete floors. Moving the pigs to temporary pastures that have not been used for several years will help in preventing further infection. Supply sick pigs in isolation with nutritious feed, safe drinking water, and good bedding.

Lungworm infection in swine can be prevented by keeping pigs in lots where they cannot come in contact with infected earthworms. This may be accomplished by eliminating manure piles, wet bedding, and straw stacks in hog lots.

Cut Feed Costs

Use Alfalfa In Growing, Finishing Diet

Phil Grabouski
Assistant Professor (Outstate Testing)

Murray Danielson
Associate Professor (Swine)

Increased feed costs have narrowed already slim profit margins for livestock producers. Pork producers could reduce feed costs by using alfalfa meal as a partial replacement for corn and also to replace part of the protein requirement usually provided by soybean meal.

For many years pork producers have been aware of the feeding value of alfalfa in the swine diet, whether in the form of pasture, dehydrated pellets or hay. Usually it was fed to gestating or lactating sows. Recently, diets which contained all alfalfa plus proper vitamins and minerals have been fed to gestating sows with excellent success. Since alfalfa hay is relatively high in fiber, it has not been generally used in greater concentrations than 2.5% of complete feed in growing and finishing diets.

Alfalfa hay of good quality will have a protein level of at least 15.0% on a dry matter basis but level depends on many conditions which vary considerably during growth, harvesting, storage and processing prior to its addition to the swine feed. Alfalfa is rich in Vitamin K and believed to contain unidentified growth factors. Both are important in the growing and finishing diets of swine.

Sixty-pound feeder pigs from the North Platte Station were fed sun-cured alfalfa meal in their diets until market weight. Diet formulations appear in Tables 1 and 2. Alfalfa meal was used as a replacement for yellow corn in a corn-soy diet at the 25% level and also with additions of 0, 1.25, 2.50 and 3.75% lard, respectively. The lard was incorporated into the diets containing 25% alfalfa in an

(continued on next page)

Table 1. Percentage composition of 16% diet.

Ingredients	Diets A	B	C	D	E
Sun-cured alfalfa meal	25	25	25	25	2.5
Ground yellow corn	59.20	57.60	56.05	54.75	78.40
Soybean meal (44%)	12.30	12.65	12.95	13.25	15.05
Dicalcium phosphate	2.00	2.00	2.00	1.75	1.75
Calcium carbonatt	....	....	....	....	.80
Lard	....	1.25	2.50	3.75	....
Iodized salt	.5	.5	.5	.5	.5
Trace minerals	.075	.075	.075	.075	.075
Vitamin premix[a]	.925	.925	.925	.925	.925
Chemical analysis					
Dry matter	90.30	90.25	90.48	90.58	89.80
Gross energy k cal/lb	1675.00	1784.00	1814.00	1831.00	1774.00
Protein	16.88	17.19	17.44	17.12	15.94
Ether extract[b]	2.64	3.94	4.92	6.43	2.92
Calcium	.82	.88	.90	.76	.67
Phosphorus	.77	.76	.77	.70	.72
Ash	7.85	7.69	7.84	7.40	5.40
Crude fiber	7.80	8.09	7.36	7.61	3.19

[a] Suppled the following per kilogram of diet: Viatmin A, 3300 IU; Vitamin D_2, 446 IU, Vitamin B_{12}, .022 mg; riboflavin 2.20 mg; niacin, 17.60 mg; calcium pantothenate, 10.02 mg; choline chloride, 2.20 mg.
[b] Crude fat.

Table 2. Percentage composition of 14% diet.

Ingredients	Diets A	B	C	D	E
Sun-cured alfalfa meal	25	25	25	25	2.5
Ground yellow corn	53.45	52.90	50.35	49.10	72.85
Soybean meal (44%)	18.05	18.35	18.65	18.90	20.60
Dicalcium phosphate	2.0	2.0	2.0	1.75	1.75
Calcium carbonate	....	....	....	....	.80
Lard	....	1.25	2.50	3.75	....
Iodized salt	.5	.5	.5	.5	.5
Trace minerals	.075	.075	.075	.075	.075
Vitamin premix[a]	.925	.925	.925	.925	.925
Chemical analysis					
Dry matter	89.32	89.67	89.70	89.88	88.64
Gross energy k cal/lb	1783.00	1826.00	1850.00	1881.00	1790.00
Protein	14.80	14.60	14.82	14.74	13.80
Ether extract[b]	2.86	3.90	5.23	6.20	3.24
Calcium	.72	.74	.73	.67	.66
Phosphorus	.67	.68	.67	.65	.63
Ash	6.79	6.42	6.22	6.20	4.48
Crude fiber	8.29	8.12	8.21	8.43	3.70

[a] Supplied the following per kilogram of diet: Vitamin A, 3300 IU; Vitamin D_2, 446 IU; Vitamin B_{12}, 11 mg; riboflavin, 2.20 mg; niacin, 17,60 mg; calcium pantothenate, 6.68 mg; choline chloride, 2.20 mg.
[b] Crude fat.

Alfalfa in GF Diet

(continued from page 15)

attempt to improve the total digestible nutrient level since alfalfa is low in TDN. The TDN values of the high fiber diets A,B,C, and D were similar to the corn-soy positive control diet E. Diet A was called the negative control.

Alfalfa is readily available and usually priced reasonably in the central part of Nebraska. At the time this study was started animal fats were in surplus and reasonably priced. The live pig performance was good (Table 3).

Procedure

Ninety crossbred pigs were stratified by weight and sex and randomly assigned to the five diets in three replicates of six pigs per pen.

Pigs were fed a 16% protein diet for about 30 days and then finished on a 14% diet. The basal diets (14 and 16% protein composition) and their analyses are shown in Tables 1 and 2. Vitamins and trace minerals were added to give equivalent amounts in each of the five diets.

Facilities for the pigs on each of these diets were comparable. Each pen of six pigs had like shelter, self-feeders and automatic waterers. The pigs were on feed from 76 to 90 days depending on when they reached a market weight of 220 pounds. The heavy replication of pigs had a beginning weight of 70 pounds.

Results and Discussion

Table 3 shows the average daily gain for each treatment based on 2 week intervals except for the final weight period, which was 7 days. The addition of 25% alfalfa meal alone or with lard in place of corn reduced average daily gain.

The pigs receiving diet E, the 2.5% alfalfa meal corn-soy had the highest daily gain of 1.99 pounds. Pigs fed diet D gained 1.86 pounds per day. The small difference suggests that this higher level of lard may not have been as attractive to the pig since the pigs on diet C gained 1.91 pounds/day. Pigs receiving 25% alfalfa meal diet gained 1.85 pounds per day.

Feed Conversion

Pigs fed the 25% alfalfa diet, as was expected, consumed 3.85 pounds or 16% more feed per pound of gain than the pigs fed the corn-soy diet as shown in Table 3. Since supplemental fat did not increase the growth rate of pigs on the alfalfa meal diets lard did not improve feed consumption per pound of gain.

The individual daily feed consumption (Figure 1) ranged from 6.42 pounds for the corn-soy group to 7.11 pounds for pigs fed the 25% alfalfa diet. The feed consumption for pigs fed diets with added lard ranged from 6.86 pounds for the low fat diet to 7.06 for the pigs consuming the intermediate lard diet. The latter group had a more rapid daily gain and consumed the least feed per unit of gain. The high lard diet apparently approached the pigs' energy requirements since the daily gains were not significantly different from the other lard added treatments and the feed consumption per day was less per pig. The high lard diet may not have been as palatable to the pigs consuming it, thus restricting their intake.

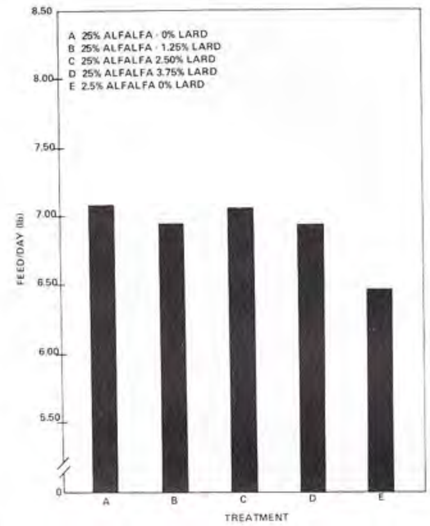


Figure 1. Individual average daily feed consumption for the trial period.

Early in the study the corn-soy fed pigs (Diet E) consumed the greater quantity of feed per day. Apparently the high fiber content and/or some other factor present in the alfalfa meal limited feed intake. As the pigs developed, the alfalfa meal fed pigs' digestive systems changed in some way, improving their ability to metabolize the high fiber diet.

Summary

This study indicates that alfalfa diets can be used effectively to reduce costs for the swine producer in periods of high protein and energy costs, however, the producer must weigh the effect of slow gain against low diet costs. The pigs must be maintained for an extra 5-10 days. The decision should be weighed carefully by the pork producer to determine which system is the most profitable for him. The addition of lard to the alfalfa containing diets did not compensate for the reduced performance.

Preferably the pigs should weigh 120 pounds before they are fed a 25% alfalfa diet. As would be expected the pigs fed the alfalfa had lower dressing percentages because of somewhat heavier mid-sections but did have less backfat and higher grading carcasses.

Table 3. Live animal measurements.

	Treatments[a]				
	A	B	C	D	E
No. of pigs	17	17	17	18	16
Initial wt, lb	66.25	66.40	66.15	66.22	66.16
Final wt. lb	228.43	230.10	235.60	233.50	236.22
Av. daily gain, lb[b]	1.85	1.82	1.91	1.86	1.99
Feed/gain[c]	3.85	3.81	3.70	3.73	3.24

[a] Treatments were: (A) 25% alfalfa, 0 lard; (B) 25% alfalfa, 1.25% lard; (C) 25% alfalfa, 2.50% lard; (D) 25% alfalfa, 3.75% lard; (E) 2.5% alfalfa, 0 lard.

[b] Significantly different ($P < .05$)

[c] Significantly different ($P < .01$)

"Mad Itch"

Pseudorabies On Increase?

Charles W. Francis, D.V.M.
Extension Veterinarian

An acute Pseudorabies outbreak in Iowa in March, 1973, stimulated new concern about the seriousness of this disease. According to Iowa veterinarians, the disease may be widespread because 20-40% of the hogs marketed in the state have been exposed during their lifetime. This would indicate Pseudorabies is present in Iowa swine herds and causing no detectable problems.

A few cases have been diagnosed in two counties in Nebraska. Its prevalence here may be more widely spread than anyone realizes. At the present time, however, the diagnosed incidence of the disease is not high enough to consider it an economically important disease to the swine industry in Nebraska. Currently, pork producers should acquaint themselves with the symptoms of the disease and watch for it.

Symptoms

Pseudorabies is caused by a virus of the herpes group. Natural infections occur in cattle, sheep, swine, cats, dogs, birds, raccoons, rats and mice. Man is resistant to the virus.

The Pseudorabies virus apparently spreads from the nasal cavity to the tonsils and the nerves running to the brain. It gains entrance to the brain by the perineural lymphatics and/or the lymphatics emptying into the blood stream so that a viremia (virus in blood) develops.

The susceptibility and death rate of young pigs depend on the age of the pig. The natural disease most commonly affects piglets during the first four weeks of life. Death rate is highest in piglets up to two weeks of age. From this time forward, death rate declines. By four weeks of age, a majority of pigs recover from the disease—

one of the few animal species that do.

Pigs less than four weeks of age exhibit various signs. They can have a fever up to 106°F, become listless, go off feed, develop a rough haircoat, drool saliva, develop diarrhea and difficult breathing. As they approach death, they may develop nervous symptoms such as incoordination and muscular tremors. Some pigs will circle and will pivot on their hind legs. As time progresses they may be on their sides, paddle their legs, convulse and die. The death rate in the group can run 80% or higher.

It is uncommon for severe clinical signs to appear in adult pigs. Affected sows usually go off feed, exhibit dullness, become constipated, and have a fever up to 106°F. A fever may not always be present, or may be so transient as not to be readily detected. Vomiting, itching and self-mutilation are uncommon but do occur. Affected sows may show slight incoordination if forced to move. Complete paralysis in the hind quarters may be exhibited by the more severely affected.

Common side effects of infected pregnant sows are either abortions or farrowing of stillborn piglets or mummified fetuses at term. Mummified and living feti may be found adjacent to one another within the uterus. Abortion usually occurs 10-20 days after the onset of clinical signs.

Diagnosis

According to Dr. Hibbs, Diagnostic Laboratory, North Platte, tentative diagnosis is made by eliminating other diseases of similar signs and by the absence of gross lesions. Confirmation of diagnosis is made by histologic examination of the brain, fluorescent antibody examination of the tonsil and brain and by animal inoculation. Virus isolation may also be necessary.

Pseudorabies must be differentiated from rabies, transmissible gastroenteritis (TGE), hog cholera and SMEDI virus.

Control

Control of Pseudorabies is accomplished by sanitation procedures: eliminate outside human traffic, control cats, dogs, rats, mice, raccoons, birds, etc. New herd additions should be isolated and introduced into the herd according to the recommendations for SMEDI.

At the present time in the United States, no vaccine is available.

Managing Swine Odors

Ventilation Design Critical

L. F. Elliott
Assistant Professor, Soil Microbiology

J. A. DeShazer
Associate Professor, Livestock Facilities

Completely enclosed swine housing units using anaerobic manure pits do smell. During the past year, we have been investigating some of the odor compounds in these units and the effect of ventilation on the distribution of these compounds.[1]

Ammonia has been implicated as an important odor compound

[1]Contribution from the Animal Waste Management Research Unit, North Central Region, Agricultural Research Service, USDA, and the Nebraska Agricultural Experiment Station, Lincoln.

(continued on next page)

Ventilation Design

(continued from page 17)

but our studies have usually found it at levels lower than the human nose can detect.

Odors "Cling"

However, related nitrogen-containing compounds, to which the nose is 1,000 to 10,000 times more sensitive, are present at approximately 1.5 to 8 times higher concentrations than ammonia. These compounds generally are extremely odorous and many have the tendency to "cling," which may account for the lingering of swine odors after one leaves the unit. It is important to be able to measure these compounds so that management systems can be developed to lower this group of N-containing compounds in the unit.

Hyrdogen sulfide is another compound investigated. It is toxic as well as odorous. It has caused some swine deaths during anaerobic manure pit agitation and pumpout. Presently, we are attempting to assess the hazard and to determine what conditions and building design factors may cause a hydrogen-sulfide hazard. We have found low hydrogen sulfide during day-to-day operations, usually in the area of 0.1 to 0.4 ppm. We have measured hydrogen-sulfide concentrations up to 43.4 ppm during manure pumpout, which is below the extreme toxic level of 1,000 ppm. However, these data do not mean that a hazard does not exist. More data need to be collected from different units several times during the year.

It appears that some management schemes will allow accumulations of toxic levels of hydrogen sulfide. Once these are determined, it should be relatively easy to solve the problem. Remember—never go into a manure pit after pumpout, and be sure the area is well ventilated during manure agitation and pumpout.

Another measurement being used to assess odors is total volatile sulfur. This is an indirect measurement of odorous compounds

called mercaptans. The compound used to "tag" natural gas is a mercaptan, as is the characteristic odor of skunk musk. The measurement of total volatile sulfur, hydrogen sulfide, and aerial nitrogen compounds will provide valuable measures of odors in the swine units and should prove valuable for measurement of odors from beef areas, also.

Ventilation

Another area of investigation has been swine-unit ventilation. We have found air distribution can vary considerably within a unit and will affect gas concentrations which, in turn, might affect pig performance.

By combining gas concentrations and ventilation data, we will be able to provide better ventilation designs for these units. Obviously, the building must be ventilated to remove the gases and moisture. Therefore, don't turn off the ventilation system to conserve heat because of improper heater size, working of the heater, or partial animal loading of the house.

Acceptance of Pork

Portioning May Be The Answer

R. W. Mandigo
Professor, Meats

W. J. Goldner
Graduate Research Assistant

Good merchandising of fresh pork will enable the pork industry to receive a larger share of an expanding market.

Today's institutional markets such as hotels, restaurants, and fast food outlets have not given fresh pork wide exposure. Most pork used in these markets is in the form of cured products such as ham and bacon or processed meat items such as franks and bologna.

Reasons for Poor Showing

Reasons given for pork's poor showing in the institutional market place include:

1. Diet.
2. Religious customs.
3. Lack of uniformity in tenderness and portion control.

Though dietary considerations and religious custom concern some people, the major factor restricting a wider acceptance of fresh pork in institutional markets is the lack of uniformity in tenderness and lack of an automated uniform portion cutting system.

Mechanical tenderization and the press/cleave portioning system is becoming more widely accepted by the meat industry and thus the problems of lack of uniformity in tenderness and portion size can be controlled.

Mechanical Tenderization

Methods of mechanical tenderization have been known for some time. Reciprocating needle mechanical tenderization is relatively new. With this kind of mechanical tenderizer, boneless meat is passed along a conveyor where fixed needles pierce the meat at specific intervals. The intervals at which meat is pierced is determined by conveyer speed. Reciprocating needle tenderization differs from more traditional forms of mechanical tenderization since the appearance of the meat is relatively unchanged after tenderization.

Press/cleave portioning requires four production steps:

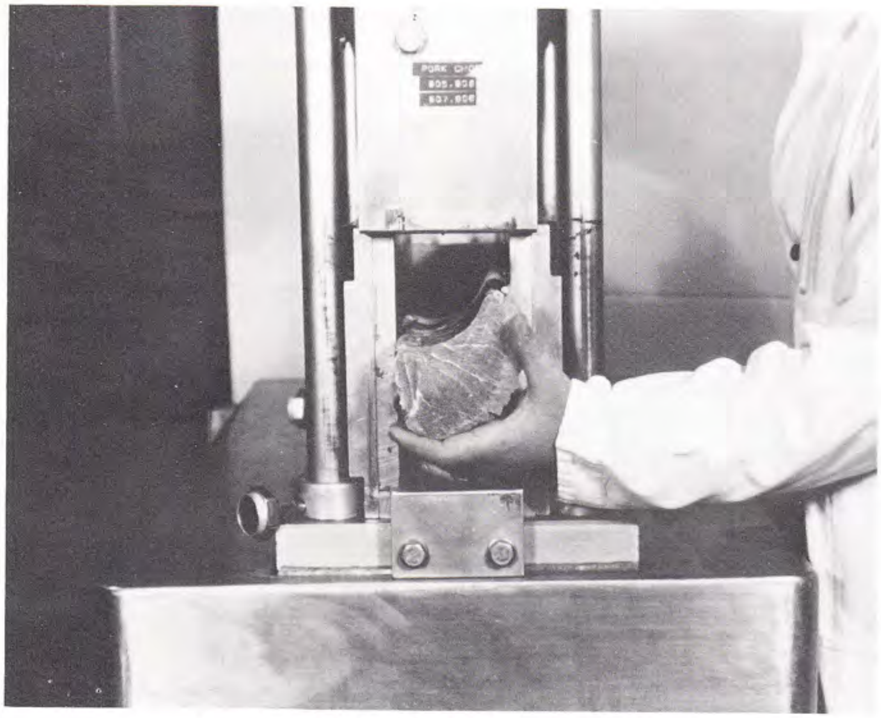
1. Freezing.
2. Tempering.
3. Pressing.
4. Cleaving.

Freezing of the meat takes place over a few hours. Then the meat is removed and placed in a tempering cooler, usually around 25°F for pork loins, until the meat is maintained at the constant temperature.

Maintaining proper temperature going into the pressing operation is critical because if the meat is too cold it will not form properly and if it is too warm excess shrink losses are seen during pressing.

The meat is then put into a hydraulic press where the intact muscle is pressed into the desired size and shape. Pressing takes muscles which lack uniformity and makes them into uniform logs of meat.

The final step in the press/cleave process is to place this uniform log of meat into a mechanical cleaver where it is sectioned into chops which are uniform in weight as well as thickness.



Boneless pork loin pressed into uniform shape.

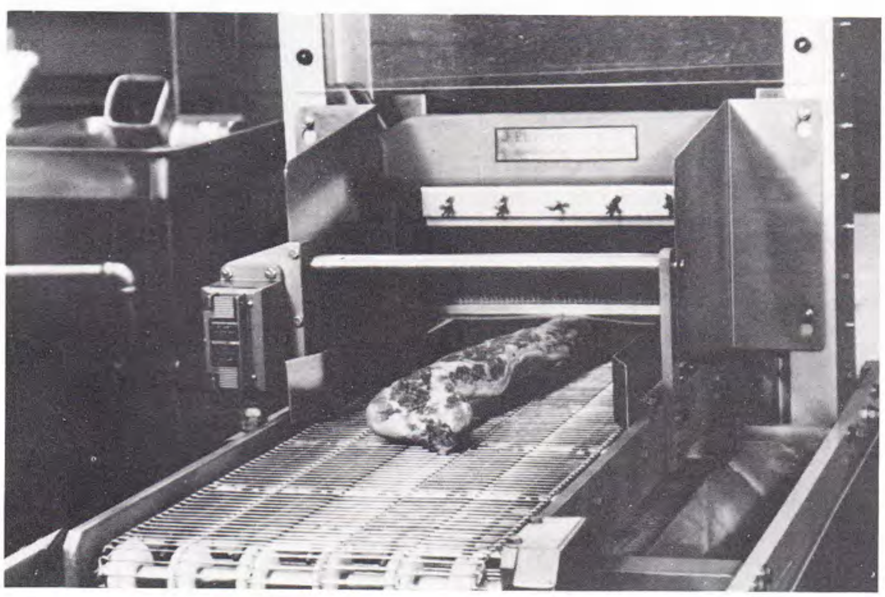
Study Continues

In recent studies at the University of Nebraska we have looked at mechanical tenderization in conjunction with hand portioning (a conventional method of portioning) and press/cleave portioning. Criteria studied included processing, performance and storage, and cooked properties of pork.

Table 1 shows the effects of tenderization and press/cleave portioning on processing losses and retail yield. Losses due to mechanical tenderization are minimal —important to the packer since losses of this type mean a loss in profit. Retail yields are lower in press/cleave loins and this loss in yield can be directly attributed to the cleaving operation. Though less retail yield can be expected in press/cleave loins, the increase in efficiency seen in the press/cleave system may make it more economical.

Data in Table 2 show storage and cooking losses encountered due to mechanical tenderization and press/cleave portioning in boneless pork loins. Slightly less freezer loss was encountered due to press/cleave portioning and

(continued on next page)



Mechanical tenderization of boneless pork loin.

Portioned Pork

(continued from page 19)

mechanical tenderization had no effect on freezer loss.

No differences in thaw loss were seen due to press/cleaving or mechanical tenderization. Fresh drip losses are higher in press/cleave pork and these increases can be attributed in part to the freezing and thawing cycle essential to the press/cleave portioning system. Cooking losses are also higher in press/cleave pork but mechanical tenderization had no effect on cooking loss. The higher drip loss and cooking losses were not seen as a problem in the acceptance of press/cleave pork in the institutional market place since they were well within the acceptable range.

Chop firmness and tenderness values for mechanical tenderization and press/cleave pork loins are shown in Table 3. Chop firmness in pork loins was not affected by mechanical tenderization. When chops were evaluated after fresh storage there was an increase in firmness in press/cleave pork loins.

No differences in firmness were seen due to press/cleave portioning when chops were evaluated after thawing. The freezing and thawing cycles encountered in press/cleave pork were the cause of increased firmness in the freshly stored press/cleave chops. Only slight increases in tenderness were seen in loins which had undergone mechanical tenderization. The failure of loins to respond to any great amount to mechanical tenderization may be due to the fact that pork usually has sufficient tenderness. Press/cleave portioning has no effect on pork loin tenderness.

Studies are currently underway at the University of Nebraska looking at the effects that mechanical tenderization and press/cleave portioning have on uniform tenderness, size and appearance. At this time mechanical tenderization in conjunction with press/cleave portioning may help increase the acceptance of fresh pork in the institutional markets.

Table 1. Processing losses and retail yields due to mechanical tenderization and press/cleave portioning in boneless pork loins.

	Hand portioned		Press/cleave portioned	
	Untenderized	Tenderized	Untenderized	Tenderized
Mechanical tenderization loss %		0.16		0.13
Freezing and tempering loss %			0.71	1.21
Pressing loss %			0.36	0.31
Cleaving loss %			5.66	5.82
Hand portioning loss %	3.20	3.61		
Retail yield %	96.78	96.21	93.26	92.66

Table 2. Mechanical tenderization and press/cleave portioning effects on storage losses and cooking losses in pork loins.

	Hand portioning		Press/cleave portioning	
	Untenderized	Tenderized	Untenderized	Tenderized
Freezer loss %	0.59	0.54	0.33	0.40
Thaw loss %	1.06	1.62	1.15	1.31
Fresh drip loss %	0.92	0.97	2.64	2.06
Cooking loss %	22.66	23.93	30.39	29.01

Table 3. Mechanical tenderization and press/cleave portioning effects on pork loin firmness and tenderness.

	Hand portioning		Press/cleave portioning	
	Untenderized	Tenderized	Untenderized	Tenderized
Fresh chop firmness[a]	4.15	4.41	2.08	2.25
Thawed chop firmness	2.77	2.56	2.09	2.02
Warner-Bratzler shear tenderness, lb ¾ core[b]	10.53	9.51	11.19	9.64

[a] Higher values are less firm.
[b] Higher values are less tender.

Press/cleave boneless pork chops.

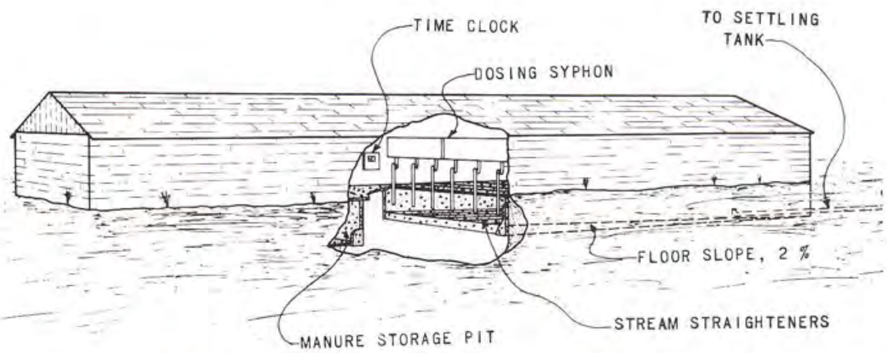


Figure 1. The deep pit swine waste management system was modified to determine cost, construction and operational feasibility.

Swine Wastes

Store It and Spread It, Or Flush It and Store It?

A healthy outlook for Nebraska's swine industry means larger production units. Combine this with an industry shift to the housed type confinement and the need for waste management becomes apparent.

Since research has not adequately defined the optimum waste management system, a team of U.S.D.A and University researchers initiated a research program to help meet one obligation of the pork industry: production compatible with preserving environmental quality.[1]

Waste Management Alternatives

There are four basic types of waste management for housed swine units:

1. Deep pits below slatted floors.
2. Oxidation ditch below slatted floors.
3. Lagoons, holding ponds, and oxidation ponds.
4. Industrial techniques

All systems have been used with varying degrees of success. The more common method has been the deep pit system with slatted floors. The pit volumes were designed to store manure for 3-12 months. Manure is then removed with a wheeled tanker for field disposal at the operator's discretion. This system was attractive to the pork producers because the initial investment was comparatively low. However, operators were plagued by several problems, including odor control, poor animal response, field disposal on wet and frozen cropland, and fly control.

The oxidation ditch method has been well documented with research and has been popular in the Eastern cornbelt for several years. Recent research has shown that direct feeding of wastes from the oxidation ditch is possible and may influence development of this type of waste management system in the future. Disadvantages of the oxidation ditch and the paddle wheel include high initial investment, operational and maintenance costs.

Use of lagoons, holding ponds and oxidation ponds have gained popularity because the waste is removed from the animal's environment as it is produced. The waste is then processed or disposed of at a time convenient to the operator by use of pumping equipment, rather than batch hauling and field disposal.

Digestion of swine wastes by application of industrial type techniques is possible, but the high initial investment and sophistication of management required for operation has limited its application. The advantages include gas recovery, odor control and complete waste stabilization. These sophisticated methods, however, are limited somewhat to the larger units and will not have application to small units for some time.

Swine Waste Management Situation

The most prominent waste handling system in Nebraska is the deep pit system. However, odor and materials handling problems are reducing rather than enhancing production.

General objectives of the study were to develop procedures for modifying deep pit swine manure management systems; to develop alternate methods of manure transport, processing and storage; and to determine the effect of swine waste management on the environment within and surrounding swine production units.

Research Underway

The totally enclosed swine finishing house used for nutritional studies at the Field Laboratory utilizes the deep pit manure management method. The house is separated into two compartments so that different manure management systems can be compared. Half of the house was converted to a flush type system under the slotted floor, while the remaining half was managed as in the past. Figure 1 illustrates a schematic of the system installed.

Storage of wastes within the building appeared to be one of the major causes for environmental problems. It was therefore decided that the waste must be removed as fast as it was produced and the simplest method was to flush all wastes from the building. A primary consideration was energy required for flushing.

Large volumes of water are required at high velocities (300-500 GPM) to flush waste from a building. Since the pit was 16 feet wide without slope, modification in-

(continued on next page)

[1]Contribution from Soil, Water and Air Sciences, North Central Region, Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Nebraska Agricultural Experiment Station, Lincoln. Additional information may be obtained from Department of Agricultural Engineering and Animal Science, University of Nebraska, Lincoln.

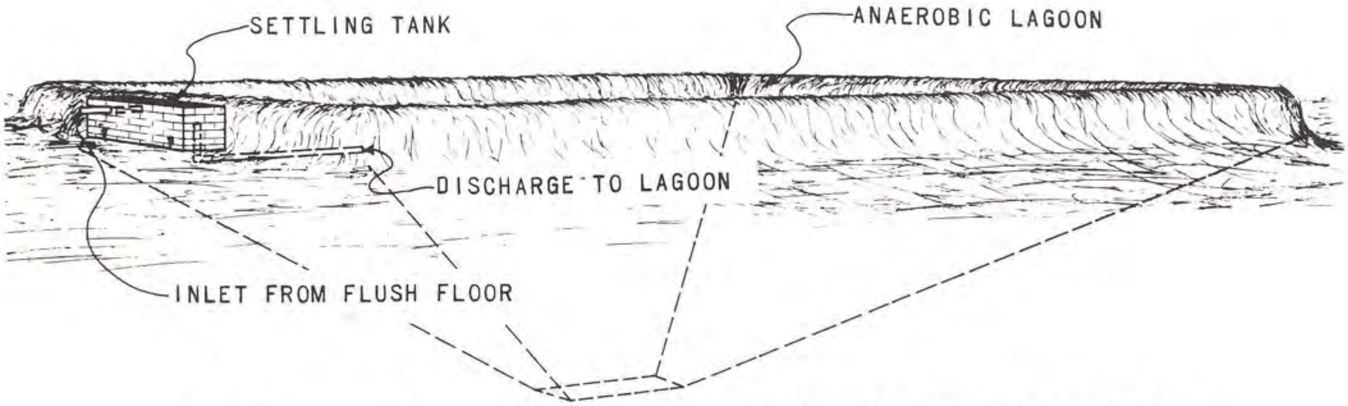


Figure 2. An anaerobic lagoon with a solids removal system designed to reduce the odor problem.

Swine Wastes

(continued from page 21)

cluded raising the floor to a uniform 2% slope. Stream straighteners were installed to reduce width of the gutter (Figure 1).

Iowa research indicated 24- to 30-inch runways are feasible widths for flush gutters on the surface, therefore, six 28-inch wide channels were installed using adjustable stream straighteners. Since pumping equipment was not available, the "dosing syphon" was incorporated for flushing this system. A dosing syphon consists of a reservoir of water, and a piping system to control the tank discharge.

Preliminary data showed the dosing syphon could deliver high velocities of water. However, it was not known what the discharge rates would be from various sizes of pipes used in the system, or the effect of these rates on waste removal. Pairs of two-inch, three-inch and four-inch diameter syphons were therefore installed to compare the efficiency of solids removal from the building.

The quantity of water necessary to flush wastes from a gutter and the number of flushings necessary per day were also unknown. Time clocks were included to vary the number of flushings from one a day to once every 15 minutes.

The next problem was to develop a method of handling the wastes efficiently with minimum management problems. Since Nebraska is in an area where freezing does occur, the complete system must allow for this. Aerobic lagoons require large surface areas for adequate operation, and odors will occur during spring thaws. Therefore, an anaerobic lagoon was designed and installed with a solids removal system to reduce the odor problems associated with anaerobic digestion (Figure 2). Laboratory work had shown that hydraulic settling was feasible, so a hydraulic settling tank was installed to remove about 50 percent of the solids flushed from the building. Suspended and dissolved solids would be stored in a lagoon for later disposal onto the field (Figure 1).

The system has been in operation since September, 1973. The dosing syphon has worked, and flushing with the dosing syphon appears to be a method which may be incorporated into a modified deep pit system for removal of wastes from the building. Further research is needed to determine the feasibility of solids settling, materials handling requirements, and further processing necessary for efficient operation.

Liquid Storage of Boar Semen

Dwane R. Zimmerman
Professor, Swine Physiology

Preservation of semen is necessary to insure efficient utilization and effective distribution of semen harvested for artificial insemination.

This is especially important for swine because greater numbers of spermatozoa are required for insemination of pigs than for other species. For liquid semen, a minimum of 2 billion motile spermatozoa are required to obtain acceptable fertility. This compares to 5 million motile cells needed for cattle insemination.

Greater than minimal numbers of spermatozoa are normally inseminated under field conditions where the timing of the insemination and handling of the semen may not always be optimal.

A single collection of high quality bull semen contains enough spermatozoa to inseminate more than 100 cows while a single ejaculation of high quality boar semen is adequate for inseminating only 15 to 20 sows. This problem, coupled

Table 1. Composition of Beltsville L1 (BL1) extender.

Ingredient	BL1[a] (grams)
Glucose	2.9
Sodium citrate dihydrate	1.0
Sodium bicarbonate	0.2
Potassium chloride	0.03
Dihydro streptomycin sulfate	0.1
Potassium Penicillin G	1000 I/U ml

[a] Ingredients dissolved and brought to 100 ml with distilled water.

with the lack of an approved method of estrus synchonization in swine, has increased the need for effective methods of semen preservation.

Liquid Storage

Liquid storage was the only successful method of preserving the fertilizing ability of boar semen before 1971. Early methods were patterned after those successfully employed in cattle A.I. Most of the extenders contained glucose and egg-yolk in combination with either citrate or bicarbonate buffers. Heated homogenized milk was also employed successfully as a short-term extender. Preservation of boar semen at 41-46F in extenders of this type usually lowered pregnancy rate and/or embryo survival when storage was extended beyond 24 hours.

Storage of semen at temperatures above 59F has generally been more successful in maintaining fertility. English researchers (Bennett, O'Hagan and Stewart, 1968) reported essentially no decline in farrowing percentage and litter size performance when semen was stored at 59-68F for 4 or 5 days in a CO_2-saturated, modified IVT (Illinois Variable Temperature) extender.

U.S.D.A. researchers (Pursel, Johnson and Schulman, 1973) have reported favorable results with a new semen extender known as Beltsville L1 (BL1). The composition of the extender (Table 1) is based on the ability to maintain normal acrosome morphology rather than motility. The BL1 extender maintained the fertilizing capacity of boar spermatozoa for 102 hours. Fertilization of ova by spermatozoa stored for this period of time did not increase the incidence of embryonic or fetal mortality.

Findings Confirmed

Research at the University of Nebraska has confirmed and extended the findings with the BL1 extender. Objectives were to evaluate the effectiveness of the BL1 extender for preserving the fertilizing ability of boar semen for 4 or 5 days and to compare semen stored in BL1 under two temperature environments.

The Beltsville workers indicated that the BL1 extender performs best at temperatures above 59F but this is a difficult temperature to maintain under farm conditions. This problem was evaluated by comparing semen stored in a conventional refrigerator in which the temperature varied between 46-54F with semen stored in an incubator maintained at a constant 59F.

The semen handling and storage procedures were patterned after those described by the U.S.D.A. workers. Semen was collected from a mature boar two to four times weekly. The sperm-rich fraction obtained at each collection was evaluated for motility and concentration.

Immediately after evaluation, aliquots of semen containing 5 billion spermatozoa were placed in 25 ml screw-top vials and the vials filled with BL1 extender and sealed. Samples to be used fresh were allowed to cool to room temperature. Samples to be stored were placed in a polystyrene container before being cooled in the incubator or refrigerator.

Just before insemination each semen sample was extended to 100 ml with the BL1 extender.

Table 2. Reproductive performance.

Trait	Fresh	Stored 59 F	Stored Refrig.
Preg. rate	31/33 (94)	24/29 (83)	23/27 (86)
Emb. surv., %	74	65	71
No. live emb.	11.2	9.7	10.9
Ovulation rate	15.2	13.5	15.6

Females were inseminated 8-16 hours after estrus was detected using a spiral-tip rubber catheter. The females were slaughtered 27-33 days post-insemination.

Results are summarized in Table 2. Insemination of stored semen decreased pregnancy rate as compared to fresh semen but there was no difference between the two types of stored semen. Prenatal survival was not significantly affected by semen type, but there was a trend toward greater survival in the females inseminated with fresh semen. No significant differences were observed for total number of live fetuses. The apparent smaller litter size for the semen stored at 59F resulted from their lower ovulation rate (as indicated by number of corpora lutea) and is a chance occurrence rather than a semen effect.

Liquid Storage Effective

The fertilizing capacity of boar semen can be successfully maintained for as long as five days at 59-68F with either modified IVT or the BL1 extender. These extenders have two things in common.

1. Neither extender contains the egg yolk commonly included in extenders for bull semen and in the early extenders used for boar semen. Egg yolk has recently been reported to have a damaging effect rather than a protective influence on boar spermatozoa.

2. Both methods employ storage temperatures above 59F. Storage at the higher temperature prevents most of the damaging effects of cold shock on the acrosomes of boar spermatozoa and consequently, more effectively maintains the fertilizing capacity of boar semen.

Advantages, Disadvantages

The necessity of CO_2 saturation of the modified IVT extender is one disadvantage of this method of preservation as compared to the BL1 extender; this procedure being especially cumbersome under farm conditions. However, French workers have eliminated CO_2 saturation and are success-

(continued on next page)

Semen Storage

(continued from page 23)

fully using the modified IVT for shorter term storage.

Storage of boar semen above 59F is being successfully practiced on a commerical basis in European countries but is not as convenient as lower temperature (41-46F) storage in this country. Conventional refrigeration available on most farms would not be capable of maintaining temperature at 59F but should be able to maintain temperatures above 46F.

Based on preliminary findings at the University of Nebraska, the BL1 extender appears to be capable of maintaining the fertilizing capacity of boar spermatozoa stored at 46-54F for 4 or 5 days. Consequently, this would appear a feasible method for short-term liquid storage of boar semen on the farm.

Although boar semen was successfully deep frozen in 1971, the technology of deep freezing is still being perfected and is not yet ready for widespread application. Field trials with boar semen frozen by the University of Minnesota and Beltsville methods are presently being conducted.

It is still too early, however, to assess performance of frozen semen in the field. Damage to the sperm cells caused by the freezing process makes it necessary to inseminate considerably greater numbers of spermatozoa and further limits the number of inseminations obtainable from a single ejaculate. This problem will need to be solved if frozen semen is to become widely available.

Protein - - Expensive Energy Source For Swine

E. R. Peo, Jr.
Professor, Swine Nutrition

In mid-1974, an unusual price situation developed where soybean meal cost less per pound than corn. Since soybean meal is generally used as a source of supplemental protein in swine diets, the price caused swine producers to ask "can I feed soybean meal as a source of energy?" and "if soybean meal can be used for energy, will the resulting high protein diets cause scours?"

Soybean meal can be used as a source of energy for swine. Soybean meal is essentially 44-49% protein and 40-45% starches, sugars and some fat. The animal body can and will use excess protein for energy.

Once the pig's requirement for protein has been met, all of the soybean meal (including protein) will be used for energy. However, it requires energy to derive energy from protein. Although theoretically protein and carbohydrates yield the same amount of energy (4 kilocalories per gram), feeding trials indicate it requires more feed per pound of gain when extremely high levels of protein are fed to swine.

Research workers at the Illinois Station reported that gains and

Table 1. Excess protein levels for G-F swine.[a]

	Protein levels, %[b]		
	16-12	32	48
No. pigs/treatment[c]	6	6	6
Av. daily gain, lb	1.54	1.41	1.21
Av. daily feed intake lb	5.30	4.88	4.22
Feed/gain ratio	3.45	3.48	3.50
Lean cut yield, %	50.1	53.5	55.5

[a] From Sugahara, M., D. H. Baker, B. G. Harmon and A. H. Jensen. 1969. J. Animal Sci. 29:598.
[b] Corn-soy diets. 32% and 48% protein diets contained 56.7 and 97.4% soybean meal, respectively.
[c] Individually-fed pigs. Int. wt. 40 lb. Fed to a weight of 200 lb.

Table 2. High protein diets for G-F swine.[a]

	Protein levels, %[b]			
	14	22	30	38
No. pigs/treatment[c]	16	16	16	16
No. pigs finished test[c]	15	15	15	15
Av. daily gain, lb	1.74	1.55	1.72	1.44
Av. daily feed intake, lb	6.04	5.76	6.24	5.29
Feed/gain ratio	3.48	3.70	3.62	3.67

[a] Peo, E. R. Jr., T. Stahly and B. D. Moser. 1974. Neb. Agr. Exp. Sta. Swine Nutr. Exp. 74411.
[b] Diets made up of 13.4, 33.5, 54.0 and 73.6% soybean meal for 14, 22, 30 and 38% protein, respectively.
[c] 2 pens, 8 pigs/pen. Pigs on test 75 days. Experiment conducted in a MOF unit, 50% slotted floor. Int. wt. 59.0 lb.

feed conversion (Table 1) were decreased markedly when the protein content of diet was increased from a normal level (16-12%) to 32% or 48%. The last two diets contained about 57% and 97% soybean meal. Percent lean cuts was increased with the high protein diets. Since all pigs were fed to the same final weight (200 lb), the increase in percent lean cuts is a reflection of the ratio between fat and lean in the carcass. Pigs on the high protein diets had less backfat. Researchers also reported a persistant diarrhea in pigs on the high protein diets which they attributed to a laxative effect from the soybean meal.

In an experiment just completed at the Nebraska Station, pigs were fed diets containing 14%, 22%, 30% and 38% protein (13.4, 33.5, 54.0 and 73.6% soybean meal). Gains were similar for pigs fed 14 and 30% protein but were reduced with 38% protein. The average gain on 22% protein was intermediate and variable among pigs. Feed conversion followed a pattern similar to gain but pigs fed the high protein diets (22 to 38%) required about 5% more feed/lb gain than those fed 14%. The depression in gains with 38% protein was consistent and appears to be a real effect of feeding this high level of protein (Table 2).

In contrast to the Illinois research, no diarrhea was evident in the pigs fed the high levels of protein. However, those fed 38% protein had dirtier pens and the manure was soft and pasty-like in appearance and texture.

Economics again will determine what level of protein (soybean meal) to feed. It is obvious from the Nebraska study that high levels of protein are not toxic to G-F swine and do not produce scours. Based on feed conversion, it appears that the animal body does not obtain energy as efficiently from protein as it does from starch or sugars. If this is true another factor must be added to the cost to determine whether protein (soybean meal) or grain is the most economical source of energy for swine.

Table 1. Effect of fat additions on growth, feed conversion and carcass merit.

	Winter performance[a]			
	Normal corn (16-14%)[b]		High lysine corn (14-12%)[c]	
Fat additions[d]	0%	5%	0%	5%
No. of pigs[e]	15	16	14	14
Initial wt., lb	67.7	65.3	68.8	67.7
Final wt., lb	205.6	206.2	202.6	206.0
Av. daily gain, lb	1.58	1.68	1.54	1.65
Av. daily feed, lb	5.31	4.87	5.39	4.67
Av. feed/gain	3.37	2.91	3.50	2.83
No. of carcasses[f]	14	13	13	14
Backfat, in.	1.34	1.40	1.41	1.41
Ham-loin, %[g]	41.2	41.5	41.0	40.9

[a] Feb. 2 to May 24, 1974 in a modified-open-front building.
[b] 16% protein to 120 lb then 14%.
[c] 14% protein to 120 lb then 12%.
[d] 5% fat added as lard.
[e] 5 pigs died during experiment.
[f] 5 pigs did not reach carcass weight at termination of experiment.
[g] % of hot carcass weight.

Excellent Emergy Source

Fat Addition to Swine Diet

Bobby D. Moser
Assistant Professor (Swine Nutrition)

Fat coming from lard or tallow is an excellent energy source (value 2.25 times that of starch from feed grains).

With the price of corn and other feed grains higher than normal, alternate energy sources for swine diets become important. High feed costs also make necessary the most efficient utilization of the diet.

Two experiments were conducted to determine the effect of fat addition to growing and finishing diets on growth, feed conversion and carcass merit, when fed during the winter and summer.

Crossbred Pigs Used

One hundred and twenty eight crossbred pigs were used to determine the effect of fat addition on growing-finishing performance.

In the first experiment 64 pigs weighing about 67 pounds were allotted to four experimental treatments:

1. Normal-corn 16-14% protein, 0% added fat.
2. Normal corn 16-14% protein, 5% added fat.
3. High lysine corn 14-12% protein, 0% added fat.
4. High lysine corn 14-12% protein, 5% added fat.

(continued on next page)

Table 2. Effect of lard additions on growth, feed conversion and carcass merit.

	Summer performance[a]			
	Normal corn (16-14%)[b]		High lysine (14-12%)[c]	
Fat additions[d]	0%	5%	0%	5%
No. of pigs	16	16	16	15[e]
Initial wt., lb	79.3	79.4	80.0	79.9
Final wt., lb	204.7	214.3	205.2	214.4
Av. daily gain, lb	1.61	1.73	1.61	1.74
Av. daily feed, lb	5.56	5.44	5.54	5.30
Av. feed/gain	3.46	3.16	3.45	3.06
No. of carcasses[f]	15	15	14	15
Backfat, in.	1.56	1.67	1.55	1.74
Ham-loin, %[g]	39.2	38.0	39.0	38.4

[a] July 8-Sept. 30, 1974 in an environmentally regulated building.
[b] 16% protein to 135 lb then 14%.
[c] 14% protein to 135 lb then 12%.
[d] 5% fat added as lard.
[e] One pig died during experiment.
[f] 4 pigs did not reach market weight at termination of experiment.
[g] % of hot carcass weight.

Fat and Swine Diets

(continued from page 25)

Pigs were housed in a modified-open-front building from February-May.

The second experiment was conducted in an environmentally regulated building during July-September. In this experiment 64 pigs weighing about 80 pounds were allotted to the same treatments used for the winter experiment.

Response of pigs to the addition of 5% fat was exactly the same when added to either a high lysine or a normal corn diet and when fed during the winter or summer (Tables 1 and 2). Table 3 presents the combined performance for both the winter and summer trials.

Pigs fed diets containing 5% added fat gained significantly faster (1.71 lb vs 1.59 lb) and required significantly less feed (3.00 vs 3.45) than those fed diets containing no added fat. This is a 7.5% improvement in gain and a 13% improvement in feed conversion. Also, 5% added fat significantly increased backfat thickness (1.56 in. vs 1.47 in.) compared to 0% added fat, a 6.2% increase. Percentage of ham-loin was decreased slightly, but the difference was not significant.

Table 3. Effect of lard additions on growth, feed conversion and carcass merit for G-F swine.

	Winter and summer combined[a]			
	Normal corn (16-14%)		High lysine corn (14-12%)	
Fat additions	0%	5%	0%	5%
No. of pigs	31	32	30	29
Initial wt., lb	73.5	72.4	74.4	73.8
Final wt., lb	205.2	210.3	203.9	210.2
Av. daily gain, lb[b]	1.60	1.71	1.58	1.70
Av. daily feed, lb	5.44	5.16	5.47	5.00
Av. feed/gain[b]	3.42	3.04	3.48	2.95
No. of carcasses	29.0	28.0	27.0	29.0
Backfat, in.[c]	1.45	1.54	1.48	1.58
Ham-loin, %	40.2	39.8	40.0	39.7

[a] Neb. Exp. 74403 (winter) and 74407 (summer) combined.
[b] 0% vs 5% added fat significantly different ($P < .01$).
[c] 0% vs 5% added fat significantly different ($P < .05$).

Fat Increases Gains

Five percent added fat to growing-finishing swine diets increased average daily gain by 7.5%, decreased feed required per pound of gain by 13%, increased backfat thickness by 6.2% and slightly decreased, but not significantly, percent ham-loin.

These results show that fat added at the 5% level should be considered as an energy source for swine if the price is economical and in times when maximum gain and feed efficiency is critical.

Lameness - - A Major Problem in Confinement

R. D. Fritschen
Dist. Ext. Specialist (Animal Science)

Gary Zoubek
County Extension Agent, O'Neill

Lameness among pigs housed in confinement is a major problem.[1] The problem has been reported in the 1973 and 1974 Nebraska Swine Reports. Those reports indicated that not all types of surfaces or slats resulted in the same level of injury. For example, aluminum slats resulted in a greater degree of claw injury than concrete or steel slats and pigs reared on soil had claws that had very few injuries.

What is the importance of claw injuries in terms of gain and feed efficiency? For the growing-finishing pig the level of claw injury reduces performance very little. Indeed, the faster gaining pig may have a relatively severe claw injury. Perhaps the reason claw injuries are not expressed as reduced gain is that the confined pig has a very short distance to move for feed and water.

Claw Injuries

Claw injuries are important however, in that the pig suffering

Typical claw injury.

[1]The National Pork Producers Association has identified feet and leg problems among confined swine as one of the major problems. This project is supported in part by a National Pork Producers Council grant.

Table 1. Experimental procedure.

Type floor	No. of pens	No. pigs per pen	Total pigs	Sq. ft. per pig	Av. bg. wt.-lb	Av.final wt.-lb
50% solid concrete-50% concrete slats[a]	3	5	15	8.8	25.9	202.8
50% solid concrete-50% plastic slats[b]	2	10	20	9.2	25.8	193.5
100% plastic slats[c]	4	5	20	9.0	25.8	192.4
100% steel slats[d]	1	20	20	9.2	25.3	194.2
100% aluminum slats[d]	1	20	20	9.2	25.7	191.1

[a] Slats 4" wide, 1" slot with round edges and laid at right agle to long dimension of pen.
[b] Slats 5" wide, ¾" slot, PVC solid surface slats laid parallel to long dimension of pen.
[c] Same is [b] only 100% slatted.
[d] Slats 3" wide with ⅞" slot.

Table 2. Effect of slat percent and type on claw injury level.[a]

Amount and type of slat	Front claws		Rear claws		Average claw injury score
	Outside claw	Inside claw	Outside claw	Inside claw	
50% plastic slats—50% solid concrete	1.81	1.97	1.23	2.70	1.93
100% plastic slats	2.42	2.17	2.05	3.35	2.50
50% concrete slats—50% solid concrete	2.77	2.50	1.87	3.33	2.62
100% steel slats	3.12	3.10	2.12	2.95	2.82
100% aluminum slats	3.52	3.62	2.17	3.52	3.21

[a] The greater the degree of injury the greater the numerical value.

from them walks and stands in an abnormal manner and in general lacks mobility. Further, a study at this Station and another study in Europe, showed there is a relationship between claw injuries and infections that lead to knots and swelling in the knee and hock region. Since bacteria are allowed access via the claw lesions, infection may localize elsewhere in the body reducing the carcass value. To a few producers rearing hogs in confinement the feet and leg problem is of major conern, and to others it is at the least a nuisance.

A study was designed utilizing some of the same floor materials reported in last year's Swine Report. In addition, plastic slats with a five inch surface were included for the first time. Experimental procedure is outlined in Table 1.

A scoring system to determine the degree of claw injury was established three years ago. The scoring system used in this study was: Normal = 1; Scuff = 2; White Line Lesion = 3; Laceration = 4; Sand Crack = 5; Ulceration = 6. This system gives a larger numerical value to a relatively greater degree of injury.

Table 2 shows the result of amount and type of slat on claw injury. The 50% plastic slats/50% solid concrete floor resulted in the lowest combined injury score, while the 100% aluminum slats resulted in the greatest degree of injury. Pigs on 50% plastic slats/50% solid concrete floors appeared to be more mobile and comfortable while walking than those on 100% plastic slats.

Pen floors with 100% plastic slats, while resulting in the second lowest injury score, appeared to be slippery for the pigs to walk on. This seemed to be particularly true for the finishing period (120 lb to market). The highest injury scores on the aluminum slats is a repeat of their performance in the earlier study. The reason these aluminum slats cause the greatest injury is not evident. While the slats are slightly ribbed, there are no sharp edges that could cause mechanical injuries.

Pen floors that were 50% concrete slats and 50% solid concrete were slatted with some of our original slats with a smooth surface and a rounded edge. This type of slat and floor arrangement resulted in an intermediate degree of claw injury.

Since pigs were housed in three different buildings, comparisons of gain and feed efficiency and their relationship to claw injury level should be made with care. Direct comparisons between the 50% plastic slats/50% solid floors and the 100% plastic slats can be made. Similarly, the steel and aluminum slats were in the same

(continued on next page)

Table 3. Relationship between performance and claw injury.

Amount and type of slat	Average injury score	ADG	F/G
Building F			
50% plastic slat 50% solid concrete	1.93	1.44	3.18
100% plastic slats	2.50	1.42	3.04
Pig Poke			
100% steel slats	2.82	1.44	2.97
100% aluminum slats	3.21	1.41	3.08

Table 4. Frequency of injury classification.

Injury classification	50% plastic slats/ 50% solid concrete	100% plastic slats	50% concrete slats/ 50% solid concrete	100% aluminum slats	100% steel slats
Normal	72[a] (40.0)[b]	36 (16.3)	28 (16.1)	11 (4.5)	17 (6.2)
Scuff	74 (41.1)	123 (55.6)	80 (46.0)	150 (62.0)	140 (51.5)
White line lesion	15 (8.1)	11 (5.0)	25 (14.3)	13 (5.4)	17 (6.2)
Laceration	11 (6.4)	49 (22.2)	34 (19.5)	55 (22.8)	81 (29.8)
Sand crack	4 (2.2)	0 (0)	1 (.7)	11 (4.5)	10 (3.7)
Ulceration	4 (2.2)	2 (.9)	6 (3.4)	2 (.8)	7 (2.6)

[a] Frequency of classification. More than one classification or type of injury possible on any one claw except when "normal."
[b] Percent of total classifications for that floor type.

Lameness

(continued from page 27)

building. This provides two comparisons (Table 3) from which to judge the relationship between performance and claw injury score.

These two comparisons, plus inferences, confirm earlier observations from this Station that degree of claw injury has little direct effect on gain or feed efficiency. However, this does little to convince the pig that he may not be in pain or that he should stand or walk better. Nor does it alter the observation that a pig with sore claws may stand in an incorrect manner to relieve the pain or discomfort and in so doing, may develop a stance or walk that may permanently reduce its usefulness, especially as a breeding animal.

Table 4 indicates the frequency of each injury classification for each floor type. It is difficult to visualize how 49 lacerations could occur among pigs reared on 100% plastic slats. The conclusion was made in an earlier report from this Station that the primary cause of claw lesions was the absence of resilience in the surface material that the pig must stand, walk or lie on. This study tends to confirm and reinforce this conclusion. However, slats with sharp, or chipped edges or floors that are excessively rough almost certainly contribute to the incidence of sore claws.

Conclusions

1. Floors that were 50% plastic slats (solid surface slats with five-inch surface) and 50% solid concrete had the lowest incidence of claw injuries.

2. Floors that were 100% aluminum slats resulted in the greatest incidence of claw injuries. Since the earlier study comparing the effect of slat type resulted in the same conclusion, it may be assumed that this particular type of aluminum slat is conducive to a relatively high incidence of claw injury.

Swine Related Research

Research related to pork production at the University of Nebraska is being conducted by personnel in four departments — Animal Science, Veterinary Science, Agricultural Engineering, and Agricultural Economics. Many studies are team efforts involving two or more departments. The following indicates some of the types of research being conducted.

Northeast Station, Concord, Nebraska

Swine Housing and Management: The performance, health and economics associated with different structures, floors, ventilation systems and equipment.

North Platte Station

Nutrition and Management: Digestibility, amino acid balance and relative value of feed grains; soybean cooking, baby pig management; calcium and phosphorus evaluation.

Lincoln and Mead

Veterinary Science—Disease and Parasite Contol: Isolation of TGE causing agents and their control; control of *E. Coli* scours; treatment of mycoplasmal pneumonia with antibiotics; control of parasites with new and existing drugs; disease syndromes found in SPF herds.

Agricultural Engineering—Environmental Control: Gas levels associated with swine houses; effects of ventilation systems upon gas levels; methods of waste disposal.

Animal Science—Genetics and Physiology: Selection for ovulation rate; hormone levels associated with reproductive status; management effects on sexual development. Nutrition: Value and utilization of high lysine corn; amino acid requirements of baby pigs; tryptophane availability in feed grains; alternate sources of phosphorus; roughage feed for sows; hormonal control of amino acid utilization; high dietary protein levels; effects of processing on grain utilization.

Meats—Evaluation of processing methods; influences of genetics, nutrition and management on pork quality.