1970

EC70-219 Nebraska Swine Report

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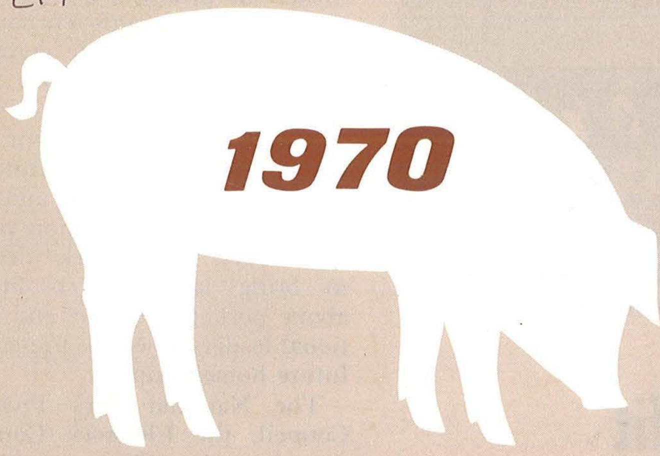
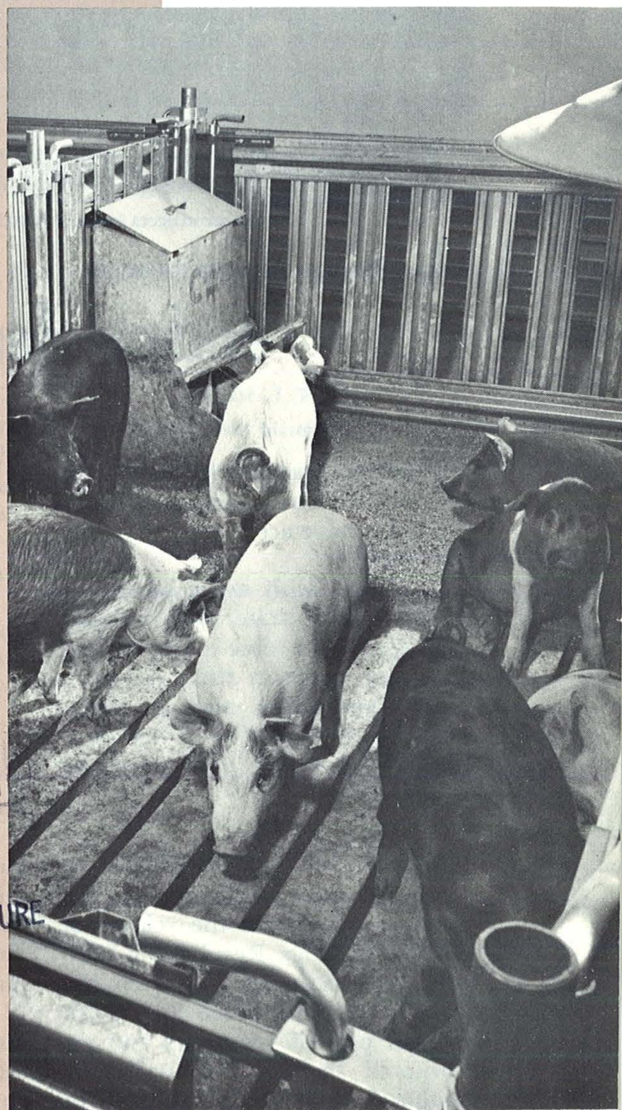


NEBRASKA SWINE REPORT



- Breeding
- Disease Control
- Nutrition
- Economics
- Housing
- Meats

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

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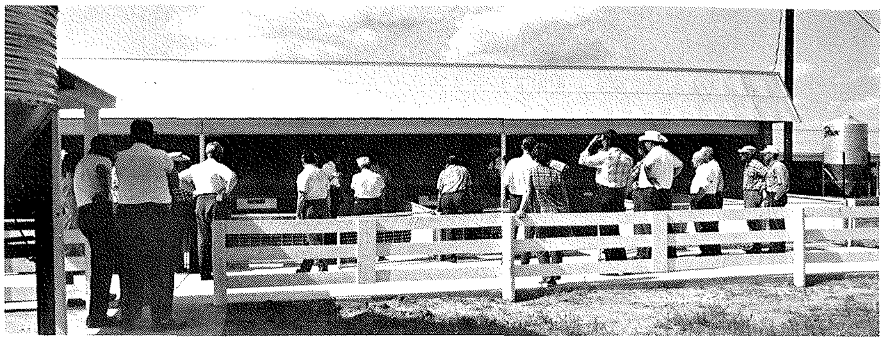


Swine producers inspect Northeast Station facilities.

Pork Industry Accomplishments

Nickels for Profit

By T. L. Schrick
Instructor (Swine)

A person cannot help but be amazed at what organized pork producers have accomplished in the past year.

As I work with swine producers at their local, state and national meetings, I can sense a very strong feeling of pride in their industry, their organization and in themselves for the founding of the local, state and national pork producer organizations.

Research Findings

One of the highlights of the year's activities was the release of research findings. Results of a year-long, four-sectioned, "research the research" project, based on a Pork Council poll of producers and co-sponsored by the National Pork Producers Council and the Federal Extension Service was released to the industry.

The huge effort designed to safeguard against duplication of research funds and efforts in the future resulted in a set of four "bibles." Each book contains a catalog of completed or "in progress" research in its specific area; a summary of "what is now known" from the combination of all previous research, and a listing of the "research voids" needing further research, study and testing.

Fact sheets of these findings were printed and made available for producer use. These fact sheets contain the "best and latest" findings affecting the four major areas facing hog men: (1) swine diseases, (2) reproductive efficiency, (3) carcass and pork quality and (4) housing and waste management.

Why was this work of particular importance?

1. This was one of the first efforts by a large agricultural industry to investigate and review current problems in their industry.
2. It showed that a self-help program like the "Nickels for Profit Program" can be an effective tool in giving guidance in research.
3. It showed that local, state and national pork producer organizations and the Federal Extension Service can effectively work as a team on a cooperative basis to solve industry problems.
4. This method can act as a new tool for the different segments of the agriculture industry to work out new problems.

Further work will be "researched" in 1970 by some of the nation's leading swine specialists.

Another area in which nickels were put to quick use was in a nationwide research study of consumer attitudes about pork and buying habits affecting their choice of foods. Using the research study, the National Pork Council market-tested a special advertising-promotion-merchandising campaign in six major cities, the results of which will be announced in the near future. This image research report will offer us targets in our growing campaign to increase consumption of pork products.

The National Pork Council used nickels to produce and distribute taped TV programs encouraging pork cookouts. These programs were used by TV stations in 18 states.

Nickels helped co-sponsor, with the American Meat Institute and the National Live Stock and Meat Board, a full color motion picture "New Facts About Pork" designed to bring late research findings about pork to medical and nutritional leaders as well as present and future homemakers.

The National Pork Producers Council, the Livestock Conservation, Inc., the USDA and Hormel worked together on a trichinosis program. Their work proved that trichinosis can be eradicated. This should further help increase our pork exports. All segments of the pork industry are continuing their cooperative efforts to eradicate hog cholera.

Nebraska Highlights

Three new counties were organized into two new area groups. Latest counties were the Phelps-Gosper organization called the Husker Chop Club. Lincoln County became the West Central Pork Producers. Five other counties are now organizing. These counties are Sheridan, Box Butte, Dawes, Hitchcock and Franklin. State membership has increased to 2,500 and national membership is now over 40,000.

Further research grants have been made by the state association. Previously, a $5,000 grant was made to the North Platte Station and a $1,000 grant to the Northeast Station at Concord. More recently, a $5,000 grant was made to the Veterinary Science Department at the University of Nebraska for T.G.E. research, and a $4,500 grant to the University for a nutrition research building at the Mead Station.

The Nickels for Profit Program is still in its infancy. The support of every hog buying station, market and pork producer is needed to provide a full-scale program. Please add your support . . . starting right now.

Hot Pork Processing—An Up-Date

By R. W. Mandigo
Associate Professor, Meats

T. L. Thompson
Associate Professor, Product
Processing and Systems Analysis

In December, 1966, the University of Nebraska Agricultural Experiment Station negotiated a research agreement with the Agricultural Research Service, Transportation and Facilities Research Division.

The purpose of this agreement was to adapt basic research ideas in hot pork processing to commercial processing plant conditions.

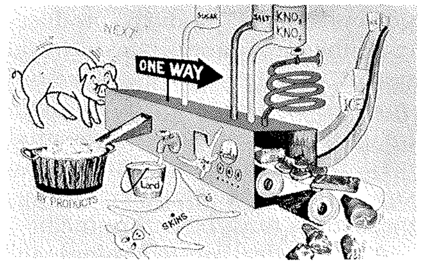
The three-year project involved the Animal Science and Agricultural Engineering Departments, and included the design and development of an experimental chilling chamber, as well as the many new and different procedures required to physically cut pork carcasses in the hot state before refrigeration.

Definition

A definition of hot pork processing is essential to any discussion on this subject. By definition hot pork processing involves the cutting, fabricating and final packing plant processing of pork products before any initial cracass chilling. Thus, carcass chilling as such is eliminated. The carcasses are cut within one hour of slaughter, processed to their finished wholesale cuts and then refrigerated in the rapid chilling chamber before shipment.

Many savings in the form of time, energy and resources were projected at the outset of the project. The purpose of the project was to determine if these projected efficiencies were, in fact, true and whether or not a successfully merchandisable product could be developed using the basic research techniques previously developed.

When you consider the inefficiencies in normal carcass chilling in the packing plant, it seems only logical that steps should be taken to eliminate this costly, inefficient processing step.



Hot pork processing.

Cooler Space

In most packing plants considerable cooler space is devoted to the chilling of pork carcasses as they leave the slaughter floor. Yet, in almost all cases, there is considerable wasted cooler space above and below the carcasses. Furthermore, the one to two inches of fat that surrounds the pork carcass serves as very efficient insulation. The effort required to chill carcasses is extensive when removing the heat through this very dense layer of fat.

Immediately following processing and breaking into wholesale cuts virtually all fat is removed from pork carcasses, ground and sent to the rendering plant. Thus considerable effort, expense and refrigeration have been used to chill fat which is promptly heated following cutting of the carcasses.

Cured, Smoked Meats

A second area of processing that appears to need improvement is in the area of cured and smoked meats. Following removal from the carcass, most hams and bacon are pumped with a brine, allowed to cure and then placed in a smokehouse where they are heated to a temperature of about 155° F.

Thus we are faced with the chilling of the carcass followed by the heating of it back to a temperature in excess of the body temperature of the live pig. In addition to the expenses of chilling and heating of the hams and bacon, the time factor and inventory control over these large quantities of product necessary for processing in most meat plants also prove to be inadequacies of the system.

Fresh pork cuts are normally removed from the cold carcass and wrapped for immediate shipment. As such they have had all the excessive fat removed, and in some cases the bone also. Why not do this on the hot carcass, and thus save time?

Since meat deteriorates in quality from the moment it is slaughtered until it is consumed, it seems logical that every effort be made to reduce the time it takes a piece of fresh pork to be converted from the live pig to a product on the consumer's table.

Questions Raised

Many questions were raised about the potential usefulness of many of the items and ideas in the hot pork processing system. One serious question raised dealt with the bacterial load and contamination in hot versus cold processed pork.

All meat contains microorganisms, and these bacteria and molds are a normal occurring contaminant. It is through proper processing that these contaminants in the meat product are kept at a minimum.

Most microorganisms that grow in meat products grow best at room temperature, not the high heat temperatures of cooking nor the low refrigeration temperatures of normal holding coolers.

One of the advantages anticipated in the hot pork processing system was that this range would be passed through only once for most products as compared with two and three times for many of the products that have to be processed.

The normal body temperature of swine before slaughter and immediately following slaughter is 104–105° F. Following slaughter the carcasses are normally chilled to 35° F., the first passage through the mesophilic (room temperature) range. After processing many cured and smoked meats will be subse-

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Hot Pork Processing

(continued from page 3)

quently heated to 155° F. to fully cook the product, thus the second passage. Following smoking and cooking, the meat items are then refrigerated back down to 35° F. for shipment, thus a third passage.

In the case of the hot processed cured and smoked meat items such as ham and bacon, the temperature at slaughter is still 104–105° F., but is not reduced to 35° F. before cutting. The 105° F. temperature has been found to fall at the most to 85 or 90° F. before the hams are injected with the brine and placed directly into the smokehouse.

While both processing systems pass through the mesophilic range, one passes through once and the other passes through three times, thus creating a potential difference in processing time and the amount of time the meat is in the dangerous mesophilic range.

It would be expected, and hopefully research will bear this out, that no great problem would occur in either hot or cold processing of cured and smoked meats, and fresh meats due to processing technique.

Product Yield

Clearly one of the greatest problems that needs to be analyzed and researched in the development of a new processing technique deals with the yield of finished product per ton of product put into the system.

We are talking about the pounds of red meat that can be sold from so many pounds of carcass of live hog purchased and put into the system. If 800 to 1,000 hogs are slaughtered per day, between 100,000 and 150,000 pounds of pork should be placed in the cooler. A one percent additional loss or gain due to a processing technique is a substantial gain or loss to nearly any processing step that could be designed.

Consequently considerable effort and time in any research project of this type must be expended to determine accurate yields of each meat product produced, and to isolate and identify gains and losses.

Another area that requires considerable study has to do with the adaptability of the processing technique to the various wide array of processed meat products produced from the meat products used in the system. Therefore the processing qualities of hams for canning, trim for ground meats or sausage products, frankfurters, whole hog sausage, polish sausage and many other meat items must be determined.

A great deal of trimmings and parts of the products such as the picnics, jowls, trimmings from the belly, trimmings from the ham, find their way into manufactured meat products such as sausage. This type of utilization creates greater return from each pork carcass. Any new processing technique must take into consideration its effect upon these and many other products in addition to the more conventional wholesale cuts.

Chilling Chamber

One important factor of the project was development of a chilling chamber which would properly chill all of the products being produced from hogs pushed into the system. The Agricultural Engineering Department and the Animal Science Department worked jointly to develop the necessary hardware to implement this research project. Considerable preliminary research had to be conducted to determine what temperatures, chilling rates and length of time, airflow rates and various other factors to use.

Following completion of the various design characteristics of the chamber, the U.S.D.A. Transportation and Facilities Division contracted with private industry to build and erect the chambers in the Meat Laboratory at the University.

Several types of products were tested at length through the system until it was apparent that the system provided us with the greatest versatility that could be obtained from the type of hardware designed.

Testing System

A cooperative agreement had been developed between the University and George A. Hormel and Company at Fremont, Nebraska. George A. Hormel and Company had agreed to help the University in the testing of the chill chamber and all other parts of the system.

This would involve the erection of the pilot chill chamber and other special equipment along with normal processing equipment from the Hormel packing plant at the packing plant. In addition, processing personnel and meat cutters from the packing plant would be used to process the meat under as near normal conditions as could be developed.

By the spring of 1969, in addition to the chill chamber, all of the testing equipment had been developed. The chilling chamber and its necessary supporting equipment were transferred to the George A. Hormel packing plant at Fremont, Nebraska, assembled and tested.

In May, 1969, processing of pork carcasses started, followed by a period of time when processed meats and carcass meats were processed at daily intervals at the packing plant. By the end of July, 225 test hogs had been submitted to the processing technique.

Samples were taken from hams, loins and smoked pork loins for microbiological evaluation of the product. Data collection has been completed and is currently being analyzed. Color stability of cured hams is now being evaluated. Samples of each of the various types of products also were taken for chemical analysis. These data are currently being collected in the laboratory and will be analyzed by the computer.

All these tests are being directed in an effort to determine what, if any, changes may occur in the chemical and physical composition of meat products during hot or cold processing of the pork products.

In the months to come, reports will be prepared which summarize and interpret data from this project. While it is doubtful a complete hot processing pork system will be built immediately, many of the ideas developed will find their way into commercial operations.

Home Cooked Soybeans for Swine

By L. S. Bitney
Extension Economist (Farm Management)

L. E. Lucas
Extension Livestock Specialist (Swine)

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Professor (Swine Nutrition)

Properly cooked whole soybeans are nutritionally equal or superior to soybean meal for swine. Since meal is the by-product of processing soybeans for their oil content, one would expect the whole bean to be nutritionally superior to the meal.

The key point is "properly cooked." Raw soybeans contain an anti-growth factor which is destroyed by heat. If the bean is not heated sufficiently, the antigrowth factor is still active. If heated too much, protein (amino acid) digestibility and/or availability are affected and as a consequence gain and feed conversion are reduced. This latter point applies to improperly processed soybean meal as well.

Results of studies conducted at Florida, Arkansas and Guelph, Canada, on the value of whole soybeans for swine are shown in Table 1.

In the Arkansas study, pigs fed extruded soybeans gained more rapidly and efficiently than those fed soybean meal. In the Florida and Canadian studies, the anti-growth factor of raw soybeans is very evident. However, the Florida work shows that older pigs apparently are more tolerant of the anti-growth factor and actually made better gains on raw soybeans than those on soybean meal (1.98 lb/day vs 1.77 lb/day). Considering gains and feed efficiency together, cooked soybeans were about equal to soybean meal for swine in both the Florida and Canadian work.

Since the nutritional value of properly cooked soybeans is excellent, the decision regarding on-the-farm use of soybeans becomes mainly one of economics. Formulation for using whole soybeans for 16% and 14% crude protein diets are shown in Table 2. Since whole soybeans are lower in protein than soybean meal, it will obviously take more pounds of whole beans to formulate the diets than it would with soybean meal.

Economic Feasibility

Three factors influence an economic evaluation of swine rations which utilize cooked soybeans as a protein source.

1. *Feed Efficiency*—Experiments which have compared the performance of rations containing cooked soybeans with those containing soybean meal have produced varied results. Consequently, we cannot conclude that rations containing cooked soybeans will produce a pound of gain with 5% or 10% less, or even the same amount of feed as a conventional ration.

Table 1. Value of processed whole soybeans for growing-finishing swine.

	Noland et al., Arkansas		Combs and Wallace, Florida			Young, Guelph, Canada		
	Soybean meal	Extruded soybeans[a]	Soybean meal	Raw soybeans	Cooked soybeans[b]	Soybean meal	Raw soybeans	Cooked soybeans[c]
			0.88[d]	0.20[d]	0.70[d]			
Av. daily gain, lb.	1.48	1.56	1.32[e]	0.57[e]	1.00[e]	1.28	0.79	1.25
			1.77[f]	1.98[f]	1.99[f]			
			1.97[d]	3.50[d]	1.81[d]			
Feed/gain ratio	2.64	2.43	2.24[e]	3.61[e]	2.00[e]	2.40	3.00	2.44
			3.82[f]	3.85[f]	3.57[f]			

[a] Preconditioned to 212° F at 18-21% moisture, then high pressure and extrusion through a dye.
[b] Cooked 2 hours at 4 p.s.i. at 230° F.
[c] Cooked 90 lbs. soybeans in 15 gallons of water for 6 hours.
[d] Values are for pigs started at 3 weeks of age.
[e] Values are for pigs started at 9 weeks of age.
[f] Values are for pigs started at 16 weeks of age.

2. *Location*—The location of a swine producer in relation to a soybean crushing plant will affect his local soybean meal-soybean price relationship. A producer close to a crusher will likely realize a higher price for beans and a lower price for meal than will a producer located a considerable distance from a crusher. Transportation costs will usually cause the latter producer to receive a lower price for beans and to pay a higher price for meal.

3. *Cost of Cooking Soybeans*—The cost per ton of cooking soybeans will vary from farm to farm.

Thus, a single cost-of-gain budget cannot be developed for a cooked soybean ration vs. a conventional ration.

In the absence of conclusive research results, we can only explore "what if" situations and their consequences. Figure 1 explores the consequences of alternative soybean meal-soybean price relationships. It is intended to help the swine producer determine which is the cheaper protein source—cooked soybeans or soybean oil meal.

A corn price of $1.12 per bushel was used for each ration. A soybean cooking cost of $5.00 per ton was assumed. The 14% finishing rations shown in Table 2 were used.

To use Figure 1, select a soybean price on the vertical axis and a soybean meal price on the horizontal axis. These should be farm prices—the local soybean price less trucking and for soybean meal, a delivered price. Draw a line upward from the meal price and one to the right from the soybean price. Where these lines meet indicates which

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Home Cooked Soybeans

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Table 2. Formulations for diets using soybean meal or whole cooked soybeans.

	Protein level			
	16%		14%	
Corn or milo	1500.0	1396.0	1612.0	1534.0
Soybean meal (44%)	424.0	. . .	310.0	. . .
Cooked soybeans (37%)	. . .	530.0	. . .	388.0
Dicalcium phosphate (18.5%)	36.0	34.0	38.0	38.0
Ground limestone	8.0	8.0	8.0	8.0
Trace minerals	2.0	2.0	2.0	2.0
Salt	10.0	10.0	10.0	10.0
Vitamin-antibiotic mix[a]	20.0	20.0	20.0	20.0
	2000.0 lbs.	2000.0 lbs.	2000.0 lbs.	2000.0 lbs.

[a] For composition see Nebr. E.C. 69-210.

protein source is cheaper, given the prices you have chosen. For example:

Point A—results from a soybean price of $2.10 per bushel and a soybean meal price of $90 per ton. This point lies below the solid, "break-even," line, indicating that cooked soybeans are the cheaper protein source.

Point B—results from a soybean price of $2.50 per bushel and a soybean meal price of $75 per ton. This point is in the region which indicates that soybean meal is the cheaper source of protein.

Point C—results from a soybean price of $2.20 per bushel and a soybean meal price of $78 per ton. This point lies in the "grey area." Here, you must make a judgment regarding feed efficiency.

1. If you do not think that cooked soybean ration is more efficient, ignore the dotted line and grey area. This point is above the solid, "break-even," line, indicating that soybean meal is the cheaper protein source.

2. If you believe that a cooked soybean ration is more efficient—possibly that it will produce a pound of gain with 6% less feed, then use the dashed line as a "break-even" line. Doing this, Point C would be in the region which indicates that cooked soybeans are the cheaper protein source.

In general, if a point lies outside the "grey area" of Figure 1, feed efficiency is not extremely critical in decision-making. For points within the "grey area," your optimism or pessimism regarding feed efficiency becomes the deciding factor.

Figure 1 is based on a 14% protein ration. A different ration, another corn price, or a different soybean cooking cost would affect location of the break-even line. It is likely, however, that the largest tonnage of feed fed by most producers would be similar to this 14% finishing ration.

What Does It Cost?

Soybeans have been cooked in a variety of ways for use in feeding experiments. Interest in on-the-farm cooking of soybeans is currently centered on a soybean roaster being manufactured by Mix Mill, Inc. This machine, the Roast-A-Tron, retails for about $3,000 and has a rated capacity of 750 pounds per hour. The following cost analysis was based on this machine.

Fixed Costs. Once a producer purchases a machine, he must meet certain fixed costs. The amount of these costs is independent of the amount he uses the machine. But increased usage of the machine will result in a lower fixed cost per unit. In this case, the more tons he roasts, the lower the fixed cost on each ton.

The estimated annual fixed costs, often referred to as the "dirti" five (depreciation, interest, repairs, taxes and insurance), for the $3,000 machine and a $500 building for it total $572.50 (Table 3).

Costs shown in Table 3 do not include a propane source. If a propane tank is not presently on the farm, the purchase or rental of a tank should be taken into account when computing the costs. In addition, the costs of augers, spouts or conveyors to get soybeans to and from the roaster are not included.

Thus, the costs shown in Table 3 assume the installation of the roaster on a farm with an existing feed processing center and a pro-

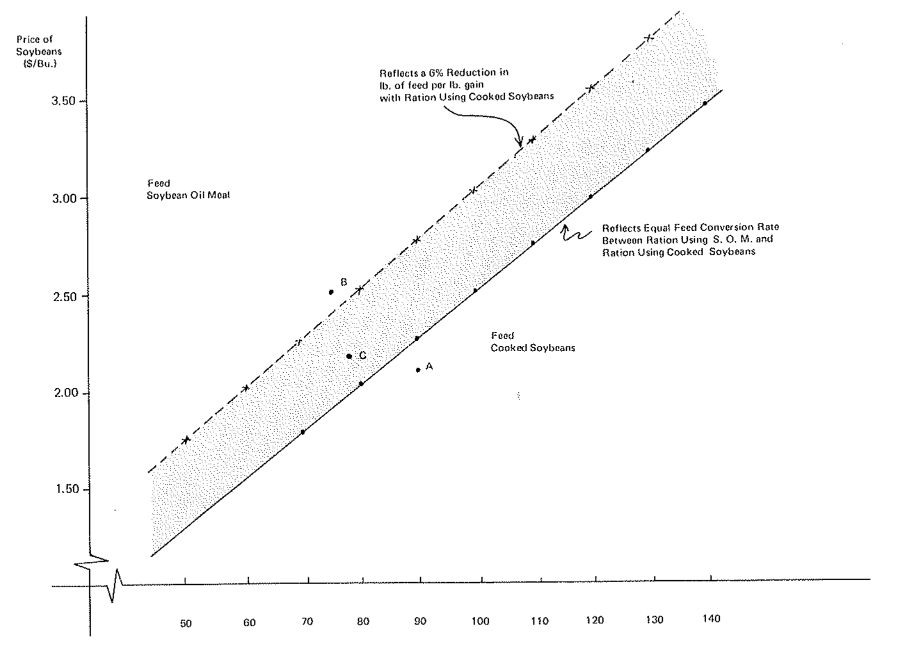

Figure 1. Breakeven prices of soybean oil meal and soybeans in a 14% swine finishing ration (corn price of $1.12 and soybean cooking cost of $4.00 per ton).

Table 3. Estimated annual fixed costs for a soybean roaster.

Item	Rate[a] (% of New Cost)	$/year
Depreciation	10%	$350.00
This depreciation rate (which assumes a 10-year life) was not used in expectation that the machine would be worn out in 10 years. Rather, with today's changing technologies, a 10-year pay off period (or shorter) is often used. Thus we want the machine to "pay off" in 10 years, so we use a 10% annual rate		
Interest	4%	140.00
8% annual rate on unrecovered cost		
Repairs due to ownership (machine only)	1%	30.00
Taxes	1%	35.00
Insurance	½%	17.50
	Total	$572.50

[a] New cost of $3,000 for roaster and $500 for building to house it.

pane source. On a farm without feed processing facilities, the soybean roaster must be evaluated as a part of a total feed processing system rather than as an individual unit.

Storage facilities to keep the soybeans until needed as feed are necessary if a producer is to feed the beans that he raises.

Variable Costs. Variable, or operating, costs are incurred only as a result of using the machine. In Table 4 L.P. gas and electricity costs were computed from machine specifications. It is difficult to estimate the repair cost on a new type of machine. The estimate of $.10 per ton shown in Table 4 is based on rule-of-thumb estimates for similar machines.

Labor is also a difficult cost to estimate for a new machine. The amount of labor required can substantially affect the variable cost per ton. If a $2 per hour man were to constantly supervise the roaster, a labor cost in excess of $5 per ton would result. In Table 4 a labor requirement of 12 minutes per ton was estimated. This results from 20 minutes of startup and supervision

Table 4. Estimated variable costs per ton for soybean roaster.

Item	Unit	$/Ton
L.P. Gas	7.2 Gal @$.12	.86
Electricity	2 KWH @$.02	.04
Repairs		.10
Labor	12 min. @$2.00/hr	.40
	Total	$1.40

time per 4-hour production run. A different value placed on an hour of labor will also affect the labor cost.

The total of variable costs per ton as estimated in Table 4 is $1.40 per ton.

Total Costs. Total cost per ton will include $1.40 of variable costs and some portion of the $572.50 fixed costs. The amount of annual fixed cost allocated to each ton will depend upon how many tons are roasted per year. Figure 2 shows the effect that different amounts of usage have on total cost per ton. If we locate an annual tonnage on the horizontal axis, draw a line upward to the total cost curve, and then to the left until we touch the vertical axis, we can read the cost per ton associated with that tonnage.

The lower horizontal scale in Figure 2 gives the approximate number of hogs that could be fed out with the respective tonnage shown on the upper scale. An average consumption of 133 pounds of soybeans per hog was assumed.

The dotted lines in Figure 2 show that the estimated cooking cost per ton for producers feeding less than 1,000 hogs per year would be in excess of $10 per ton. At about 2,300 head, the cost drops to $5 per ton ($5 per ton was used in the break-even comparison in Figure 1).

To take advantage of the economics of roasting larger quantities of beans with one machine, several small swine producers could own one roaster in partnership. Or a small producer could buy a roaster and do custom roasting to increase his volume. Local commercial feed mills could install a roaster as a part of their total feed processing installation. But in these cases, the trucking and labor costs of moving the beans to and from the cooker must be considered in the cost analysis.

Other Considerations

When a swine producer considers the investment in a soybean cooker, he should consider not only the

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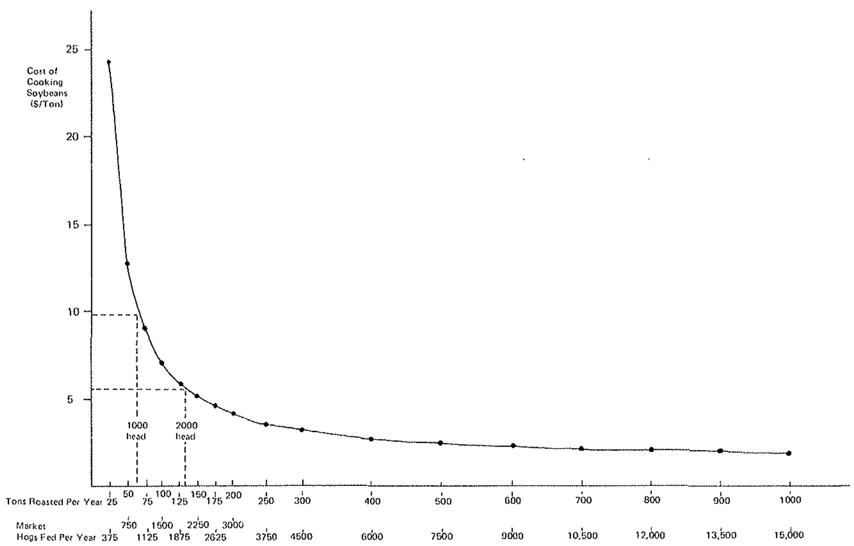

Figure 2. Estimated total cost per ton of cooking soybeans according to number of tons cooked per year (750 lb./hr. capacity machine, $3.000 original cost, 10-year payoff period, 12 min./ton labor).

Home Cooked Soybeans

(continued from page 7)

prices of soybeans and soybean meal today, but also the prices which he expects over the machine's pay-off period. A change in the price of soybean oil could affect the relationship between the price of soybeans and the price of soybean meal.

A substantial increase in soybean oil prices would likely increase the soybean price, and might decrease the price of soybean meal. This could make an investment in a soybean roaster unattractive. However, outlook reports do not indicate any prospect of a substantial continued soybean oil price rise.

Are supplies of soybeans available for feeding in Nebraska? Soybean production has increased in Nebraska in recent years. In 1960, less than 5 million bushels were produced on 164,000 acres. In 1968, 19 million bushels were produced on 829,000 acres. In 1969, a record state average yield of 33 bushels per acre is expected to result in a crop of 27 million bushels from 821,000 acres. In general, soybean production in Nebraska has been growing faster than crushing plant capacity.

Summary

In considering cooked soybeans as a protein source in swine rations, a producer should consider:

1. The size of his swine enterprise.
2. His location—as it affects his bean and meal prices.
3. The relative efficiency of cooked soybeans in swine rations.

More soybean cooking devices will probably be on the market in the future. Machines with a smaller capacity and lower cost may enable smaller producers to afford an on-the-farm cooker.

More research is needed and will no doubt be conducted on the matter of relative feed efficiency of rations containing cooked soybeans.

Pigs fed cooked whole soybeans appear to have a softer carcass. If packers start discriminating against pigs fed whole soybeans, this economic factor will have to be considered in the decision about processing soybeans on the farm.

Diets Compared

Wheat, Sorghum, Corn, Millet

By D. M. Danielson
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North Platte Station

There is no hard and fast rule that we should not change the type of concentrate in our swine diets.

However, initial cost doesn't necessarily justify use of a specific item —performance counts, too.

At the North Platte Station several studies have been made to observe what performance we can expect when substituting wheat, millet and/or grain sorghum for corn in a growing-finishing diet.

Growing-Finishing Study

In the first growing-finishing study Duroc gilts and barrows from the same farrowing, exposed to comparable managerial practices up to the time the study was begun, were used.

Ninety pigs averaging 64–65 lbs. were assigned by weight outcome groups to one of three treatments, each consisting of five diet treatments. There were 6 pigs per treatment pen.

Each treatment pen consisted of an 8 x 8 ft. wooden floored shelter with a 10 x 10 ft. concrete slab adjoining it equipped with a self-feeder and automatic waterer. The hogs were fed as much as they wanted. Other than the shelter no environmental control was provided. The treatment pens were not provided with bedding and were cleaned daily. Individual pig weights and feed consumed per pen were recorded at 2-week intervals throughout the 70-day study.

Composition of the five diets was based on a balanced 14% protein corn-soy basal diet (Table 1). Wheat and/or grain sorghum was substituted pound for pound for corn of the basal diet in each of the experimental diets with all other feed constituents remaining constant.

Table 2 indicates the comparative performance of pigs receiving respective diet treatments.

Table 2 shows that pigs which consumed the diet containing grain sorghum as the grain source, and pigs that consumed the diet containing ⅓ grain sorghum ⅔ wheat as the grain source, had the highest average daily gain.

Next highest were pigs receiving the diets containing ⅔ grain sorghum ⅓ wheat as the grain source and the diet containing corn as the grain source (basal diet). Their average daily gain was about 0.1 lb. lower.

However, the ⅔ grain sorghum ⅓ wheat diet fed pigs did require 0.13 to 0.16 lb. more feed per pound gain than did the all grain sorghum and ⅓ grain sorghum ⅔ wheat diet fed pigs. The all corn diet fed pigs required 0.2 lb. less feed per pound of gain than did the two previous mentioned diets.

Table 1. Composition of 14% growing-finishing diet.

Ingredients	Diet, %				
	1	2	3	4	5
Corn	79.55	...	...	...	...
Grain sorghum	...	79.55	53.1	26.45	...
Wheat	...	...	26.45	53.1	79.55
Soybean meal (44%)	13.1	13.1	13.1	13.1	13.1
Alfalfa hay	2.5	2.5	2.5	2.5	2.5
Meat and bone meal (50%)	2.5	2.5	2.5	2.5	2.5
Ground limestone	0.5	0.5	0.5	0.5	0.5
Steamed bone meal	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Trace minerals (high zinc, swine)	0.1	0.1	0.1	0.1	0.1
Vitamin premix[a]	0.75	0.75	0.75	0.75	0.75
Total	100.0	100.0	100.0	100.0	100.0

[a] Supplied the following per pound of complete diet: Vitamin A, 510 I.U.; Vitamin D_2, 90 I.U.; riboflavin, 1 mg.; calcium pantothenate, 2 mg.; niacin, 4.5 mg.; choline chloride, 5.25 mg.; and Vitamin B_{12}, 5 mcg.

Table 2. Performance of growing-finishing swine fed diets formulated with corn, grain sorghum and/or wheat.

Item	Experimental diets[a]				
	Corn	G.S.[b]	⅔ G.S. ⅓ wheat	⅓ milo ⅔ wheat	Wheat
No. of pigs	18	18	18	18	18
Initial wt., lb.	64.1	64.4	64.2	64.5	64.8
Final wt., lb.	199.2	207.1	199.6	206.7	196.3
Av. daily gain, lb.	1.93	2.04	1.93	2.03	1.88
Feed/lb. gain, lb.	3.40	3.60	3.73	3.57	3.46

[a] Refers to a balanced diet each differing in type of grain used.
[b] G.S. indicates grain sorghum.

Pigs fed the diet containing all wheat as the grain source indicated the lowest average daily gain. However, these pigs did reveal a feed conversion somewhat similar to the all corn diet fed pigs.

These data indicate that wheat and/or milo can be substituted for corn successfully in a balanced 14% protein corn-soy growing-finishing swine diet.

The second study involved 108 crossbred growing-finishing gilts and barrows fed diets where Proso millet replaced corn. Proso millet is known to be highly deficient in the essential amino acid lysine. Thus to obtain optimum performance when altering a swine diet with millet it is important to not neglect the absence of lysine.

In the study reported three of the six diet treatments contained additional lysine at one of three levels of the complete diet (.0005, .0010 and .0015%). The basal diet was a 14% corn-soy diet. Another diet was comparable to the basal with the exception that Proso replaced the corn portion of the basal diet.

Since the protein content of Proso millet was higher than the corn used in the basal diet where millet replaced corn pound for pound the over all diet formulation exceeded 14% protein. Thus another diet was included where the percent soybean meal was reduced until a 14% growing-finishing diet was obtained. The diet formulations appear in Table 3.

At the initiation of this study the animals averaged about 90–91 lbs. The management employed during this study was comparable to that previously described in the first study of this report.

At the duration of the 56-day period of this study the average final weight was 198–200 lbs. Performance of the animal is shown in Table 4. As indicated in Table 4 the performance in growth rate and feed conversion of pigs that received the millet diet containing .0015% lysine was comparable to the pigs that received the basal diet.

The pigs indicating the least desirable growth rate and feed conversion received the diet where millet replaced corn. Millet having a greater protein content than corn allowed this diet to contain an overall greater protein content than any of the other diet treatments.

In this study the animal performance would indicate that the protein content of the diets was not necessarily an important factor. It would, however, indicate that the proper balance of the essential amino acids in swine diets is necessary to obtain maximum performance.

Results

Again, with reference to Table 4, the successive additions of lysine to the 14% millet diets resulted in increased growth rate with a trend toward improved feed efficiency.

A continuation of utilizing millet in conjunction with other available cereal grains in swine diets are to be studied at this station.

Table 3. Composition of growing-finishing diets containing Proso millet with and without lysine.

Ingredients	Diet, %					
	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]
Corn	81.5	...	...	...	...	...
Millet (Proso)	...	81.5	84.75	84.75	84.75	84.75
Soybean meal (44%)	15.0	15.0	11.75	11.75	11.75	11.75
Ground limestone	0.5	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	1.0	1.0	1.0	1.0	1.0	1.0
Sodium tripolyphosphate	1.0	1.0	1.0	1.0	1.0	1.0
Iodized salt	0.5	0.5	0.5	0.5	0.5	0.5
Trace minerals (high zinc)	0.05	0.05	0.05	0.05	0.05	0.05
Vitamin premix[g]	0.45	0.45	0.45	0.45	0.45	0.45
Total	100.0	100.0	100.0	100.0	100.0	100.0

[a] Control (14% corn-soy diet).
[b] Millet replaced corn pound for pound.
[c] Millet replacing corn with diet protein content adjusted to 14%.
[d] Diet 3 plus 0.0005 lysine.
[e] Diet 3 plus 0.0010 lysine.
[f] Diet 3 plus 0.0015 lysine.
[g] Supplied the following per pound of complete diet: Vitamin A, 1200 I.U.; Vitamin D_3, 135 I.U.; riboflavin, 1.0 mg.; calcium pantothenate, 1.8 mg.; niacin, 4.5 mg.; choline chloride, 5.0 mg.; and Vitamin B_{12}, 5.0 mcg.

Table 4. Live animal performance of pigs fed Proso millet plus different levels of lysine.

Item	Treatments					
	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]
No. pigs	18	18	18	18	18	18
Av. initial wt., lb.	90.8	90.6	91.3	90	91.1	90.3
Av. final wt., lb.	206.9	194.5	202.2	192.7	202.9	205.3
Av. daily gain, lb.	2.06	1.86	1.98	1.85	1.97	2.04
Feed/lb. gain, lb.	2.88	3.14	3.07	3.00	2.88	2.93

[a] Control (14% corn-soy diet).
[b] Millet replaced corn pound for pound.
[c] Millet replacing corn with diet protein content adjusted to 14%.
[d] Diet 3 plus 0.0005 lysine.
[e] Diet 3 plus 0.0010 lysine.
[f] Diet 3 plus 0.0015 lysine.

Dietary Protein Level and Hormones

Effects on Carcass Leanness

By L. E. Lucas
Extension Livestock Specialist (Swine)

The pork industry has made great strides in the production of lean pork. Most of this improvement is the result of selection by breeders and producers of breeding stock with a higher percent of lean meat.

Although many factors may influence the leanness of the pork carcass, the genetic makeup of the animal is still the major factor and accounts for more than 50% of the variation between animals.

As a result of this change and trend to a leaner pig, the industry is raising the following questions:

1. Does the leaner pig require a higher protein level or more specific amino acids in the ration?
2. There are well documented differences in leanness of carcass between gilts, barrows and boars. Should they receive different protein levels in the ration?
3. How about the average pig? Should protein levels be changed?
4. Can hormones be added economically to the ration, and can they change lean-fat ratios in lean and/or average pigs?

The University of Nebraska, as well as other institutions, have research underway to answer these questions. This article will review only the effect of protein and specific hormones on carcass leanness—realizing that several other factors can be and are involved in carcass composition.

Protein Level

Several Experiment Stations and research workers have indicated that the level of protein in the diet can influence the leanness of the carcass. One of the most significant studies to date is the report *Protein Effect on Carcass Composition of Swine Selected for High and Low Fatness* reported by U.S.D.A. at Beltsville.

Pigs used in their test consisted of boars and gilts from the 12th generation of Durocs and 10th generation of Yorkshires selected for high and low backfat. Diets of 12% and 20% protein were fed to all lines. Figure 1 shows the amount of lean and fat tissue from lines selected for low backfat and high backfat fed 12% and 20% protein.

The carcasses of pigs fed the 20% protein ration contained significantly more lean and bone than did those of pigs fed the 12% diet. Also, the protein level-line (high and low fat) interaction was significant. Pigs selected for low backfat with 20% protein in diet had 31% more carcass lean than high-fat pigs, while the increase for low-fat pigs over high-fat pigs fed 12% diet was only 6%. This points out the value of selecting the correct protein level for finishing swine based on genetic ability to produce lean.

A factor of some concern when feeding higher protein rations is a reduction in marbling and tenderness. This factor appears to be in opposition to the desire of the pork industry to produce a lean product with adequate quality and marbling.

Protein—Sex Interaction

Many workers have reported that sex is an important factor in determining carcass leanness. In general, litter mate gilts are leaner than barrows, but boars are leaner than either barrows or gilts.

Data reported from Eli Lilly Research Farm suggest that rate and efficiency of gain were maximized at a dietary protein level of 12% for barrows, but 14% for gilts. For maximal carcass leanness 14% protein was required by barrows and 16% protein by gilts. This in general supports the idea that gilts require a higher level of dietary protein than barrows for both maximum performance and carcass leanness. This appears to be true regardless of the genetic ability of the line to produce lean.

Protein—Hormone Effects

In a recent University of Nebraska experiment, pigs from the gene pool herd were used to study the level of protein and the response from specific hormones and the interaction, if any, between the two. The gene pool pigs used in this study are from a line of pigs in which there is average or below leanness (35% to 39% ham and loin of carcass weight). The experiment included 128 barrows in which all pigs were started on a 16% protein ration, but were changed to 18, 16, 14 and 12% protein when the individual pigs weight within a pen averaged 130 lbs. The pigs were marketed at about 230 pounds.

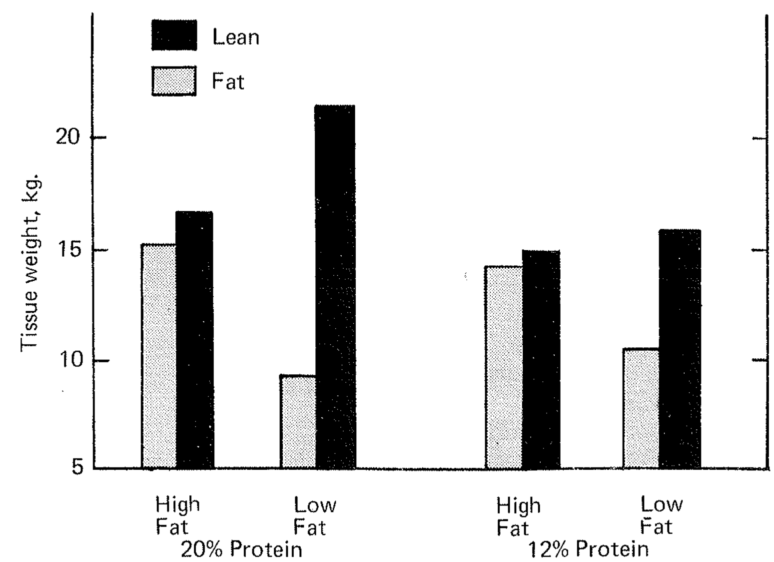

Figure 1. The average weight of physically separated carcass lean and fat of high- and low-fat pigs fed 12% and 20% protein diets.

Table 1. Daily gain.

Level of protein	Hormone		Average of protein
	With	Without	
18	1.73	1.84	1.79
16	1.74	1.73	1.73
14	1.79	1.90	1.84
12	1.67	1.86	1.77
Average	1.73	1.83[a]	

[a] Significantly different at the P<.005.
Protein-Hormone interaction significant at P<.05.

The hormone used in this study is a combination of diethylstilbestrol (DES) and methyltestosterone (MT) produced by Eli Lilly Company. The product is presently available only on an experimental basis. Table 1 shows the effect of the hormone combination on daily gain.

The hormone combination significantly reduced daily gain by .1 lb. per day. There was little or no differential response from the four levels of protein used with the pigs in this experiment. Additional research not reported here indicates that the weight at which the hormone is added will greatly influence gains. Gain depression is small when hormones are added to the ration at pig weight of 140 pounds.

Table 2 reports the effect of dietary protein level and hormone combination on ham and loin percentage. The DES and MT combination significantly increased ham and loin percentage over all levels of protein. However, protein level did not significantly effect lean percentages in this study with gene pool pigs. These results may support the view that higher levels of protein (16% or higher) do not increase carcass leanness of barrows with average or below genetic ability to produce leanness.

Current works under way at this station with pigs selected for lean composition and the U.S.D.A. work at Beltsville indicate that lines of pigs selected for lean or low backfat have a greater response to higher dietary protein levels than non-selected pigs.

Table 2. Percent ham and loin (carcass).

Level of protein	Hormone		Average of protein
	With	Without	
18	36.66	35.65	36.15
16	37.13	35.27	36.20
14	36.54	35.40	35.97
12	36.59	35.33	35.96
	36.73	35.41[a]	

[a] Significantly different at the P<.005.

Summary

1. Increasing protein levels during the finishing ration may or may not increase carcass leanness depending upon the selection and genetic makeup of the animals in question.
2. The response from protein level during the finishing ration may be influenced by the sex of the animals being used or fed. Gilts and boars appear to have a higher requirement.
3. With animals that have been selected for high lean value (40%–45% ham and loin) at least a 14% protein ration should be *considered* and fed for maximum feed conversion and carcass leanness during the finishing period.
4. The use of 16% protein diet during the finishing period may be considered for breeding animals, particularly for boars.
5. With hogs of average ability in terms of producing *lean carcasses,* there seems to be little advantage of raising the protein level over 12% for market barrows during the finishing period. However, since gilts seem to have a higher requirement of protein, it may be advantageous to split the barrows and gilts and feed a higher level of protein (14%) to the gilts during the finishing period.
6. It appears that diethylstilbestrol and methyltestosterone can reduce backfat and increase carcass leanness in both hogs of average lean content and those selected for high lean content. However, there may be some reduction in daily gain with the DES/MT combination. For maximum improvement in carcass leanness and for minimal reduction of gains, DES + MT hormone combination should be added at about 130 to 140 lbs. in weight. It appears this hormone combination has a greater influence of increasing lean value when pigs are marketed at heavier weights.

Hog Cholera Eradication In Nebraska

By E. C. Howe
Extension Animal Hygienist

Hog Cholera eradication began in Nebraska in earnest with a meeting at the Nebraska Center in early April 1962. Out of this meeting, called by Dean E. F. Frolik of the College of Agriculture and Home Economics, grew the Nebraska Hog Cholera Committee and an advisory group.

The program has progressed from phase I (awareness of the problem), through phase II (elimination of infection), into phase III (stamping out outbreaks of cholera with depopulation of infected herds and indemnity payments to producers).

Present committee members are: Senator Willard Waldo, Chairman, Mr. Dale Jacobsen, Mr. Henry K. Krivohlavek, Mr. Everett Holstein, Mr. Martin Shonka, Mr. Paul Pedersen, Dr. James Barbee, Mr. Robert Cunningham, Mr. Fritz Johnson, Dr. A. A. Lidolph, Mr. Rey Brecht, Dr. H. E. Hedlun, and Mr. William Krejci.

Advisory group members are: Dr. M. J. Twiehaus, Mr. Arnold Peterson, Dr. Crosby Howe, Mr. Don Ringler, Mr. Clarence O'Brien, Mr. Glenn Kreuscher, Mr. Marvin Rus-

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Hog Cholera

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sell, Dr. E. H. Nordstrom, Dr. C. C. Bickley, Dr. S. H. Flora, Dr. M. K. Jarvis, Mr. Elton Berck, Mr. Jacob A. Wiebe, Mr. Gordon Zellers, Mr. Elmer Schlaphoff, Mr. Roland Nelson, Mr. Richard Goodding, Mr. James Rosse, Mr. Lyle Hansen, Mr. Verdon H. Petersen, Dr. Leo Lucas, Mr. Dan Lutz, Mr. James Volk and Dr. Elmer Metcalfe.

Program Highlights

Some highlights of the program in Nebraska were:

Development of the Nebraska test. A test utilizing fluorescent staining of fresh tissues of suspected hog cholera cases to make rapid, accurate diagnosis.

Nebraska was the first major pork producing state to discontinue use of modified- live hog cholera vaccines and, later, inactivated vaccines.

No vaccination for hog cholera of Nebraska hogs has been practiced since October 20, 1967. With discontinuance of vaccination, indemnity payments to owners of hogs infected with cholera virus were begun.

A summary of hog cholera cases by calendar year with numbers of hogs and amount of indemnity is shown in Table 1.

There is food for thought in this simplified report on the number of outbreaks, number of swine involved and the dollar cost in indemnities.

Practically all of these cases of hog cholera were unnecessary. The reason they were unnecessary is that they resulted from the importing of feeder pigs that were exposed to or were in the incubation stage of hog cholera when shipped. Some of the cases were spread from one herd to another by people moving from farm to farm or from market to their home farm or to other farms.

During 1968, most of the 25 outbreaks were in the York area and resulted from illegal movement of swine and the unrestricted movement of people from hog lot to hog lot without any semblance of sanitation.

Table 1. Summary of hog cholera cases, numbers and indemnity paid.

Cases	Number of hogs	Indemnity
	(October 20–December 31, 1967)	
13	1871	$ 30,383.82
	(1968)	
25	2681	$ 68,150.46
	(1969 to Nov. 1)	
15	5836	$152,328.00

To quote from a letter sent out by Senator Willard Waldo, "Three outbreaks of hog cholera, all involving feeder pigs shipped in from southern Missouri, occurred in Nebraska in June. They were in Dodge, Nemaha, and Adams Counties. Only one other outbreak previously in 1969 indicates that Nebraska pork producers are doing an excellent job in the eradication program. Seven additional breaks in July were in Butler, Cuming, and Adams Counties. The cost of indemnity payments in June and so far in July to the state is approximately $36,256. Some of these outbreaks involved pigs from southern Missouri and the rest are suspected of coming from the same area but were sold by a pig dealer from Iowa who represented the pigs to the buyer as coming from Nebraska. He has not been willing to give any details as to the exact origin to officials or the buyers.

"An order issued June 13 by Elmer Schlaphoff, Director of Agriculture and Dr. Flora, State Veterinarian, prohibited the importation of feeder pigs from Missouri and Arkansas. A week later the order was extended to temporarily discontinue issuing permits for all importation of all swine except those going directly to slaughter.

"The real problem now is a handful of unscrupulous pig dealers residing out of the state who bring pigs of questionable quality and disease status into Nebraska. They have been forced to curtail business in other states. These dealers violate our laws and regulations, misrepresent the source of the pigs (often claiming they originate in Nebraska), cheat on weights, and give a guarantee that means nothing. Later the dealer cannot be located at the address or phone number left with the buyer.

"Usually the pigs are sorted, medicated and look fairly good on arrival, but too often they soon show symptoms of pneumonia, intestinal diseases, parasites or other diseases besides hog cholera.

"Nebraska feeders should buy only feeder pigs of known origin. Legislation and regulations compelling all pig dealers to meet the same requirements Nebraska has for all livestock auction markets would help. A better system of detecting violators and prosecution of repeat violations is needed."

This points up the problem and indicates the means of prevention.

The Nebraska Bureau of Animal Industry has placed more stringent restrictions on the importation of feeder pigs into Nebraska. Probably as a result of these restrictions there has not been a case of hog cholera in Nebraska since October 1, 1969.

As you can see the small number of hogs involved in relation to the total swine production in Nebraska is just a drop in the bucket, so if producers will forego importing feeder pigs for a period of 10–12 months until States that supply feeder pigs bring their hog cholera under control, it will then be possible to import feeder pigs to supply needs of Nebraska feeders.

Another alternative would be for Nebraskans to produce feeder pigs to supply the need in our state.

The expense of hog cholera can be removed from the swine industry by each swine producer preventing the importation of cholera into his herd. He can do this by:

Maintaining a closed herd. Should breeding or feeding stock be required, purchase only from clean stock and move such replacements from farm of origin direct to farm of purchaser. Replacement stock should be isolated for 30 days from any hogs on the premises.

Allowing only necessary traffic onto and around the feedlot and adjacent premises. Do not allow feed trucks or rendering trucks to enter any livestock lot.

Preventing unauthorized personnel from entering swine production areas.

Clean and disinfect footwear and change outer clothing before entering your hog lots if you have been to a neighbor's lot, to market, or any other place where other producers may have been.

These procedures will help prevent diseases other than hog cholera so that they should be a routine part of procedure on all livestock farms. The old adage, "An ounce of prevention is worth a pound of cure" is still true. In fact, disease prevention can easily mean the difference between profit or loss in any livestock operation.

Simplified Diets x Modern Production Systems

Complex Nutrition Problems

By E. R. Peo, Jr.
Professor (Swine Nutrition)

The "in" thing today in swine production is intensified, slatted floor confinement housing for rearing swine throughout their entire life cycle plus a feeding program using simplified diets.

Although we have made remarkable gains in nutrition knowledge during the last 20 years, problems have developed in confinement systems which may be directly or indirectly related to nutrition.

Also, in using simple diets such as corn, soybean meal, minerals and vitamins, we may have eliminated some unknown "plus" factors gained from using a variety of feedstuffs in swine diets.

However, there is no question about it—a simplified corn-soybean meal diet is "hard to beat." But, we must continue to research and analyze confinement problems to determine if we have overlooked this vitamin or that mineral which was not a problem when pigs had access to pasture, soil or even manure.

Vitamin E, biotin and selenium are three nutrients which were of little concern until recently. It was generally felt that the three were adequate in most swine diets so no emphasis was made to be sure that diets were fortified with them. Modern grain harvesting and processing methods, simplification of swine diets and confinement rearing of swine have caused us to become concerned about levels of vitamin E, selenium and biotin in swine diets because problems involving them have developed.

Lesions Identified

Recently, lesions typical of vitamin E and/or selenium deficiency were identified in pigs from several Michigan swine herds. The pigs had died suddenly and showed a generalized edema of body and lungs, liver damage and pale skeletal and heart muscles.

Table 1. Effect of vitamin E on performance of growing-finishing swine and on MMA in sows. (D. E. Ullrey, Mich. State AH-SW-693 and 695)

	Basal (Corn-Soy)	Basal + Vit. E
G-F Swine		
Av. daily gain	1.65	1.77
Gain/feed ratio	0.30	0.32
Gilts and Sows		
No. animals	16	14
Pigs born	10.5	10.5
Pigs at 3 wks.	6.4	8.9
MMA, %	50	14

Table 2. Selenium content of corn. (Feedstuffs, November 15, 1969)

State	Selenium content (Parts per million)
Ia.	.05
Ind.	.04
Ill.	.05
MICHIGAN	.03
Minn.	.09
Mo.	.05
NEBRASKA	.35
S. Dak.	.40
Wis.	.04

The pigs had been raised in confinement on corn-soy diets and frequently their dams had been raised in confinement without access to pasture (a decline in use of pasture may have reduced vitamin E or selenium intake from natural feeds).

Adding 10,000 to 20,000 I.U. of vitamin E per ton of feed prevented or appreciably reduced the incidence of the disease. The results of work at Michigan on vitamin E for growing pigs and the relationship between E and mastitis-metritis-agalactia (MMA) in sows are shown in Table 1.

How does the Michigan problem relate to Nebraska? It may be fortunate that we are close to South Dakota where the problem is one of selenium toxicity rather than deficiency. Table 2 shows that Nebraska corn is 12 times as high in selenium as Michigan corn. This may explain why vitamin E or selenium deficiency has not been identified as a major problem in Nebraska.

It is perhaps fortunate, too, that Nebraska corn is high in selenium since the federal Food and Drug Administration *has not approved* the use of selenium to fortify swine diets. Thus, by law we could not add selenium to diets of swine even if we wanted to.

Biotin Needed

Biotin is a vitamin considered to be of little consequence until recently. It is generally felt that the pig synthesizes all the biotin it needs within the body. However, some researchers think that synthesis occurs so far down the intes-

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Nutrition Problems

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Table 3. Biotin content of some common feedstuffs.

Ingredient	Biotin—Micrograms/pound
Alfalfa meal (17%)	150
Corn	30
Distiller's solubles	540
Dried brewer's yeast	730
Dried whey	270
Meat and bone meal	70
Milo	80
Soybean meal	140
Wheat	50

tinal tract that biotin is eliminated from the body before the animal can use it.

Thus, before the advent of confinement systems with slatted floors, the pig may have gleaned enough biotin from rooting in manure and/or bedding to meet his needs. And, as indicated earlier, simplification may have eliminated some sources of biotin from swine diets.

For example, alfalfa meal is not used as extensively now in swine diets as it was once. Of the commonly used feed ingredients, alfalfa meal ranks well as a natural source of biotin (Table 3). Dried brewer's yeast and distiller's solubles are excellent sources.

Some possible biotin deficiency symptoms in swine are loss of hair, dermatitis and cracking of the soles and hooves. The deficiency may be complex.

The biotin requirement of the pig has not been determined. However, recent research on biotin may serve as a guide for practical feeding levels.

Combs of the Florida Station (Table 4) obtained slight growth and feed conversion responses with 25 and 50 micrograms of biotin per pound of diet, although in trial 1, 50 micrograms was not effective.

In a study just completed at Nebraska, early-weaned pigs fed a simplified 16% crude protein corn-soybean meal diet and reared in a unit with partial slats responded to the addition of biotin to the diet. The results are summarized in Table 5.

Biotin is an expensive vitamin. Therefore, since only a slight response was obtained and no deficiency symptoms were observed, it is our judgment and recommendation to add biotin only if a biotin-like problem develops or as a safety factor.

If you decide to add biotin to your feed, we recommend 100 milligrams per ton of complete feed (50 micrograms per pound). Until the price of biotin is lowered, it may be more economical to use alfalfa meal (up to 5% of diet) or other natural sources of biotin in diets for growing-finishing swine or sows.

Although research has enlarged our knowledge about the nutritional requirements of swine during the last 20 years and thus has allowed for the simplification of swine diets, it is equally true that the complexities of modern swine production systems will be equally challenging to swine researchers during the next 20 years.

Table 4. Effect of biotin supplementation on pig performance. (Combs, Florida Exp. Station)

	Biotin level—Micrograms/lb. diet				
	Trial 1			Trial 2	
	0	*25*	*50*	*0*	*50*
Av. daily gain, lb.	1.36	1.44	1.36	0.66	0.72
Feed/gain ratio	2.10	2.03	2.18	1.95	1.86

Table 5. Effect of biotin supplementation to simplified pig starter diets. (Nebraska Exp. 69406)

	Biotin Level—Micrograms/lb. diet		
	0	200	400
Av. daily gain, lb.	0.69	0.75	0.76
Gain/feed ratio	0.48	0.49	0.49

Research Points Way

By D. L. Ferguson
Associate Professor, Parasitology
M. J. Twiehaus
Chairman, Veterinary Science

Recent research techniques suggest the possibility that another swine disease may soon fall prey to an eradication program. Trichinosis is one of the oldest known diseases of swine and humans.

The swine industry has eradicated certain infectious diseases of swine from the United States. These include foot-and-mouth disease and vesicular exanthema. It now appears that hog cholera will be eradicated.

Eradication of these diseases has been of tremendous economic importance to the swine industry—not only in reducing actual losses, but also in providing markets that otherwise would have restricted the movement of pork. When hog cholera is eradicated additional foreign markets will become available. Trichinosis is another disease that results in the embargo of pork to certain foreign markets.

Investigators recently have developed a practical procedure for the detection of larvae of the small, thread-like worm (*Trichinella spiralis*) in hogs slaughtered under commercial meat packing conditions. This method is known as the pooled sample digestion technique.

Detection Method

This method of detecting the disease was developed by Dr. W. J. Zimmerman of the Veterinary Medical Research Institute at Iowa State University. The method is rapid and economical, considering the speed of slaughter and processing in a modern meat packing plant.

Here's how it works: On the kill floor, immediately after slaughter, hog carcasses are divided into lots of 20, with each carcass identified by lot. A 5-gram sample of the diaphragm is removed from each carcass and taken to laboratory facilities for processing. Here the 20

to Eradication of Trichinosis in Swine

portions are mixed and ground, digested in pepsin-Hydrochloric acid solution for 12 hours, and examined microscopically for trichinae. Thus, 20 pigs can be examined with a single test (Figure 1).

If a single trichina larva is found, the 20-carcass lot is retained and carcasses are examined individually by the same procedure. Infected carcasses are processed to kill the trichina larvae by prescribed meat inspection methods, while negative carcasses are released for normal processing.

Infected hogs are traced back to the farm of origin. USDA veterinarians will then try to determine how the hogs became infected with trichinae and will work with the farmer to eliminate the source of infection.

Early in July 1968, a pilot project to test the effectiveness of the pooled sample digestion technique under commercial meat packing conditions got underway at the Hormel Company meat packing plant in Fort Dodge, Iowa. The pilot project ended in February 1969. More than 482,000 hogs were examined. Only 42 infected animals were found: .009 percent or 1 infected hog out of 11,500 examined.

At present this program for eradication of trichinae from hogs in the United States is making its way through the U.S. Department of Agriculture and is nearing the stage when swine industry support will be needed to move it to and through the legislative appropriation stages.

How Trichinosis Spreads . . .

Trichinosis occurs when warm-blooded mammals eat raw or insufficiently cooked flesh that contains encysted larvae of *Trichinella spiralis.* The most common source of human trichinosis is the consumption of uncooked pork, although some outbreaks have been traced to the meat of bear, walrus and wild boar.

Pigs usually get trichinosis by consuming infected meat scraps in raw garbage or garbage that has not been properly cooked, or by eating the carcasses of infected wildlife. Pigs may also get trichinosis if they eat feces passed by other infected pigs or infected animals that contains infective larvae, but this is not a common method of spreading the disease.

The importance of wildlife as a reservoir of infective encysted larvae of *Trichinella spiralis* is not known, since there are no accurate incidence figures. However, encysted larvae have been found in a number of different animals, including rats, mice, dogs, cats, foxes, raccoons, skunks, squirrels, bears, and wolves.

The chain of infection is perpetuated in nature by carnivorous animals feeding on each other. Swine enter this chain when they are allowed to eat the carcasses of wild animals that are infected with trichinae. In the past, rats have been accused of being an important reservoir of infection for swine, but current information indicates that this method of spread may have been overemphasized. Nevertheless, strict rodent control would eliminate a possible source of infection.

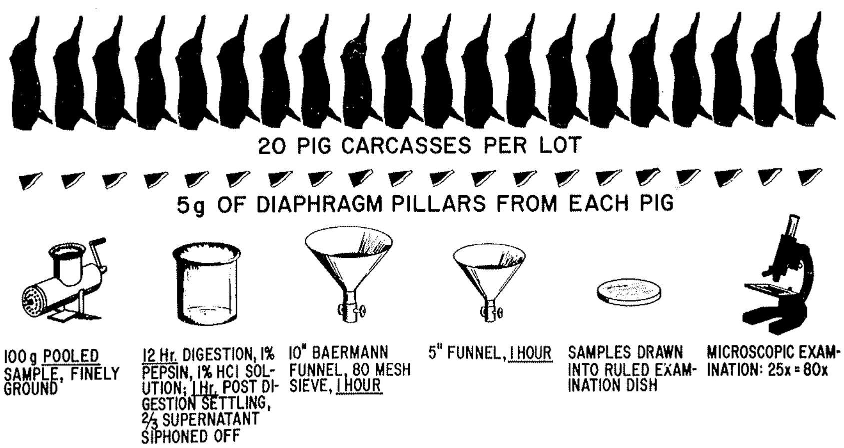

Figure 1. Pooled-sample Trichiniasis diagnostic technique (schematic outline).

Incidence in Swine

Garbage-fed pigs have long been implicated as the primary source of trichinosis pork—and hence, of human trichinosis. Because the feeding of raw garbage to pigs in the past provided a very easy way for the parasite to perpetuate itself, swine fed in this manner have been regarded as a vast reservoir of trichinae.

The latest information shows that 0.5 percent of garbage-fed hogs in the U.S. are infected with trichinae.

Today, based on the most recent incidence figures, between 80,000 and 90,000 trichinae-infected hogs are marketed yearly. Most of these are grain-fed hogs—because although infection is higher in garbage-fed hogs, these animals account for only 1.5 percent of all marketings. The great majority of infected hogs do not pose a threat to human health—because of the very low intensity of infection. Perhaps only 6,000 hogs per year are marketed which could cause trichinosis in humans.

Pigs usually tolerate this parasite quite well. Although clinical signs similar to symptoms seen in humans have been produced experimentally, they are seldom, if ever, seen in natural infections in swine. Thus, trichinosis is practically never diagnosed in living swine, because other, better-known diseases show similar signs.

Incidence in Humans

The incidence of trichinosis in humans in the United States has been falling steadily since 1953. The latest information (1968) indicates that 4 to 5 percent of the population carry trichinae in their bodies. With the legal requirement

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Trichinosis

(continued from page 15)

that all garbage must be thoroughly cooked the incidence should be lowered even further.

Most individuals who have trichinae in their muscles are completely unaware of it because these larvae, present in small numbers, do not cause any clinical signs, or the signs are so slight the patient recovers without the disease being diagnosed.

This decrease in human incidence is supported by figures from the U.S. Public Health Service on the number of confirmed cases of human trichinosis. From 1960 to 1967, there was an average of 180 cases of trichinosis reported yearly.

Human Symptoms

The number of live trichina larvae in meat that is eaten usually determines the seriousness of the disease. Eating moderate amounts of lightly infected raw or imperfectly cooked meat may produce only slight or no illness, but eating even small quantities of undercooked or raw meat that contains large numbers of larvae may produce a painful and serious case of trichinosis (Figure 2).

If the initial infection is relatively heavy, a person may have an upset stomach, vomiting, diarrhea, and other symptoms within 24 to 48 hours. However, these symptoms are often absent.

The symptoms characteristically associated with trichinosis occur during the period of migration and encystment of the larvae. This starts about one week after infection and may continue for a month or more. When large numbers of larvae travel through the body at one time, the person may have muscular pain, rising fever, headache, and prostration.

When the larvae reach the muscles, other symptoms develop. These include swelling of the face and other parts of the body, sore eyes, hemorrhages under the skin, sore throat, headache, fever, and difficult breathing. Stiffness of the muscles may also occur in severe infections.

Clinical Diagnosis in Humans

One of the best and earliest clinical signs of trichinosis in humans is an eosinophilia—increased numbers of a certain type of white blood cells in the blood.

Several other laboratory and biological tests are available for diagnosis, but their usefulness is limited because they are usually negative early in the course of the disease and may become negative in longstanding infections. These tests include the intradermal test, complement-fixation test, several flocculation tests, and a fluorescent antibody test. All of these tests depend on the interaction between an antigen made from the tissues of the parasite and a specific antibody

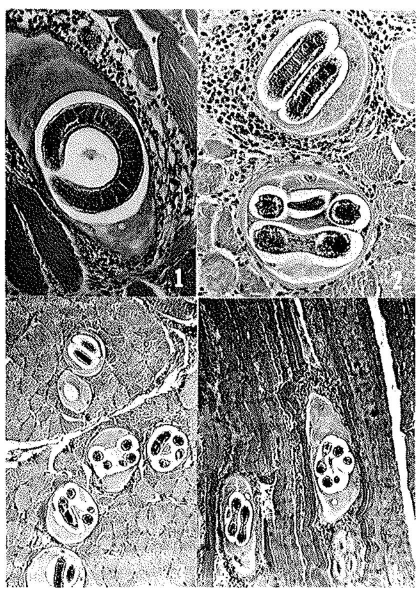

Figure 2. (1). Longitudinal section of muscle showing encysted trichinella larva and moderate pericapsular inflammation 42 days after inoculation (X300). (2). Transverse section of typical trichinella capsules showing several morphological regions of the parasites (X300). (3). Heavily parasitized section of muscle showing minimal cellular infiltration 77 days after inoculation (X125). (4). Larva showing infiltration on mononuclear cells at the polls of a capsule, 42 days after inoculation (X125). Courtesy of Merck & Co.

formed in the tissues of the host as a result of the infection.

Treatments for trichinosis are directed towards relieving the distressing symptoms of the disease. None are presently known which will alter the course of the disease.

Thiabendazole has been reported to reduce intestinal and muscle infections of trichinae in animals under experimental conditions. It has also been used to treat a few cases of humans trichinosis, but it has not been fully evaluated for this purpose.

Preventing Trichinosis

In the United States, preventing trichinosis in the human population has been based on an educational campaign stressing the importance of properly cooking pork, coupled with meat inspection procedures which assure that any pork used in products customarily eaten without further cooking has been treated so as to kill all trichinae.

The most effective way to destroy trichinae in meat is to heat it to a minimum temperature of 135° F throughout. Trichinae may also be destroyed by freezing. Destruction in any case depends on time, temperature, and the size of the piece of meat.

The best way to keep trichinosis out of swine herds is to eliminate all possible sources of infection. All garbage fed to pigs—including household scraps—should be cooked. Garbage should be boiled for 30 minutes before it is fed. This not only kills trichinae, but it eliminates other disease organisms such as tuberculosis and hog cholera. Carcasses of dead animals should not be fed to hogs—they should be buried or sent to a rendering plant. Strict sanitation and rat control programs will also help eliminate possible sources of infection.

The cooking of raw garbage has played a significant role in reducing the incidence of trichina in our pork. It is the writer's opinion that in the near future the feeding of garbage will probably be outlawed. This would further reduce the incidence of trichinosis in our swine population.

The swine industry should take under consideration the feasibility of an eradication program for trichinosis. It appears that the cost of eradicating trichinosis from our swine population would be small when compared to the cost of eradicating vesicular exanthema and foot-and-mouth disease.

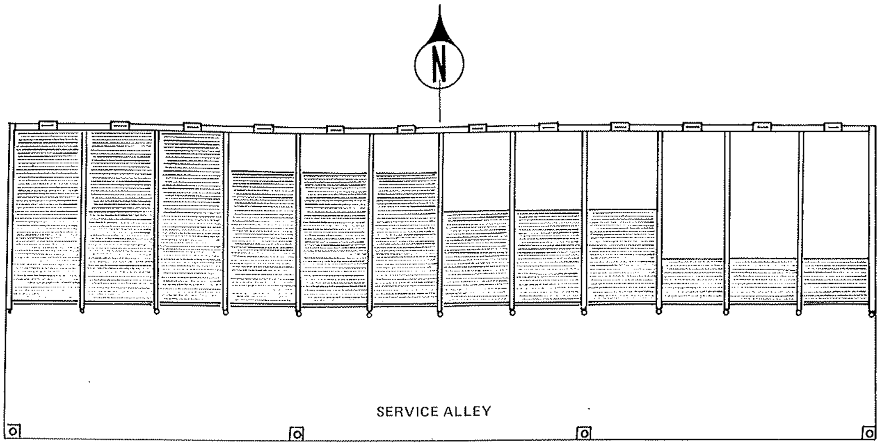

Figure 1. Floor plan of Building A. Floor types are 100, 75, 50 and 25 percent slatted. Pens are 4 x 12 feet, sloping 3/8 inch per foot from back to front including slatted area. A small door at the back of each pen provides additional ventilation capability.

Confinement Pork Production

Swine Finishing Facilities

By **R. D. Fritschen**
Area Extension Specialist, Animal Science
Northeast Station, Concord[1]

Adoption of confinement pork production is no longer a trend but an economic necessity for many. Factors involved in the shift to confinement were described by this author in the *1968 Nebraska Swine Report.*

In the *1969 Nebraska Swine Report* the first data collected at the Northeast Station's Swine Center was published. That first test revealed no real difference in gain or feed efficiency between pigs reared on 25, 50, 75 or 100 percent slatted floors. In addition, the unheated, uninsulated modified open front building (Bldg. A) supported gain and feed efficiency commensurate with that in the heated, environmentally regulated building (Bldg. C).

In Review

The initial test (Feb. 6–Apr. 30, 1968) to measure the influence of housing and management on growing-finishing pigs did not reveal significant differences in gain or feed conversion when comparing an unheated, uninsulated, naturally ventilated, modified open-front unit with a heated, mechanically ventilated environmentally regulated building.

In addition, while there was some variation in gain and feed efficiency between 25, 50, 75 and 100 percent slatted floors, there was no distinct trend. There was, however, a significant ($P>.05$) building X slatted area interaction for feed efficiency.

Based upon the labor required to scrape the manure over the slats in the 25 percent slatted pens, it was suggested that other slat to solid ratios be considered when planning a new unit. Metatarsal bones of the lower rear leg were collected and the relative breaking strength measured. Results indicated that bone strength is not reduced when pigs are reared on totally slatted floors as compared to the other three slat to solid ratios.

More Evidence

A second test was begun on September 19 and ended on December 12, 1968. The procedure was identical to that reported in the 1969 report. Building A, as previouslv described, is uninsulated, unheated and naturally ventilated. Pens are completely under roof and the south side of the unit is open. There is a service alley along the south side (Figure 1).

In this unit, hinged plywood panels along the south side were lowered or raised in accordance with an appraisal of the pigs' comfort and ambient weather conditions. Air movement was facilitated by louvers in the gable ends and by a four-inch wide slot under the eave on the north side of the building. This slot could be opened or closed in increments of six feet. To distinguish this type of building from other open-front units that do not have the capability of being enclosed completely, we refer to it as a modified *open-front building.*

Building C is an insulated, mechanically ventilated, heated building (Figure 2). An 80,000 B.T.U. hanging furnace is used to maintain temperature at 70 degrees F.

Since the inside environment of most units of this type are at least partially influenced by outside conditions we refer to Building C as an *environmentally regulated* structure rather than environmentally controlled.

A change in feeders was made in both buildings. The new feeders have a lower profile offering less resistance to air movement. The new feeders also greatly simplify feed efficiency determination.

Buildings A and C contain 12 four-by-eight-foot pens. Floor types include three pens that are 25, 50, 75 or 100 percent slatted. Sixty pigs averaging 43 pounds were allotted five per pen based on weight and sex to each building. Results are shown in Table 1.

Differences in gain were not significant at the one or five percent probability levels. However, the reduction in gain for the 25 percent slatted floor in Building C was significantly different at the 10 percent probability level. This was a 14.8 percent reduction in gain compared to the 50 or 100 percent slatted floor and 11.4 percent less than the 75 percent slatted floor.

In Building A the variation in gain between pens with different slot to solid ratios was very minor. A clear cut explanation is lacking for the marked reduction in gain among the pigs on 25 percent slatted floor in Building C. It was noted that these pens were consistently more dirty than pens with the

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[1] Appreciation is expressed to Dan Huwaldt, Swine Technician, for feeding and care of animals.

Swine Facilities

(continued from page 17)

Table 1. Comparison, modified open front and environmentally regulated swine facilities.

	Bldg. A Modified open-front				Bldg. C Environmentally regulated			
Percent slot	100	75	50	25	100	75	50	25
No. pigs	15	15	15	15	15	15	15	15
Av. initial wt., lbs.	31.9	31.9	31.9	31.9	32.1	32.1	31.9	32.1
Av. final wt., lbs.	174.1	181.9	173.5	174.4	184.9	180.2	183.7	168.5
Av. daily gain, lbs.	1.69	1.78	1.69	1.69	1.83	1.76	1.83	1.56
Feed/gain ratio	3.01	2.92	2.80	2.82	2.82	2.95	2.86	2.85

Test Period = Sept. 19–Dec. 12, 1968.

other three floor types. However, it is suggested that degree of filth may be a poor indicator of performance, particularly in an environmentally regulated building.

Variation in feed efficiency was nominal with no significant differences. It should be noted that when totally slatted floors are used that feed wastage is difficult to determine. In addition, when feed wastage does occur there is no opportunity for salvage. This may have been the case in Building A on totally slatted floors where a slight increase in feed per pound of gain was registered.

When housing effects alone are studied it appears that the pigs in Unit A were able to adjust to the colder environment quite readily as indicated in Table 2. Not measured but certainly a factor in production cost is the fuel used to heat Unit C. No supplemental heat was used in Unit A.

Pigs were removed from test on December 12 but remained in their respective buildings until marketed. On December 18 the first of numerous snow storms broke over the area. Subsequent weather provided a critical test for the two units and the animals in them. The only equipment failure was in Unit C, the environmentally regulated building, where during one storm eight waterers were frozen and the mechanical ventilation system was temporarily out of order. The wind-chill index was reported at a negative 62. During this same storm, considered the worst of the season, Building A remained problem free.

Leg Strength

The *1969 Nebraska Swine Report* reported the problem of feet and leg failure on concrete (Feet, Leg Problems in Swine; E. R. Peo, Jr., p. 9). Because of these problems, as well as other problems experienced by producers, it is highly desirable to measure the influence of different amounts of slatted floor on bone strength. The metatarsal bones of the right rear leg were collected at slaughter. The amount of force required to break them is reported in Table 3.

Results compare closely with those from experiment one, where it was reported that "leg strength does not appear to be adversely affected by increasing slot to solid ratio." Relative bone strength was less in experiment one than in the second test. In addition, several pigs in experiment one were lost due to leg fractures while none were lost in experiment two. The pigs were from different sources and on the same nutrition program, thus suggesting a genetic association.

Moving Ahead

More extensive studies are underway. These studies involve many more animals and a total of six buildings. However, based on the data to date we suggest that:

1. When comparing data from this or any other Station, special attention be given to the particular type of buildings used. Other states report inferior results from open front units. These units are generally completely open with an outside apron. A *modified open front* unit has the pens completely under roof and has the capability of being totally enclosed.

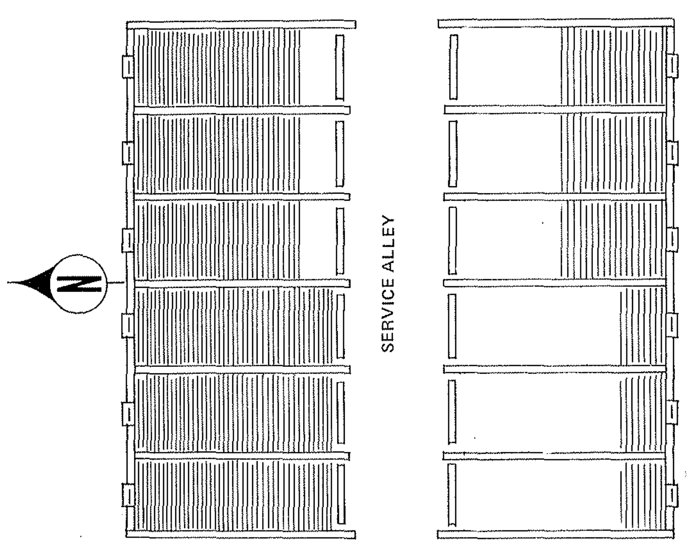

Figure 2. Floor plan of Building C. Floor types are, left, bottom to top, 100 and 75 percent slatted; right, bottom to top, 25 and 50 percent slatted. Pens are the same size as Figure 1 and small doors at back of each pen provide additional ventilation.

Table 2. Housing effects on gain and feed efficiency.

	Bldg. A	Bldg. C
Av. daily gain, lb.	1.72 (1.62)[a]	1.78 (1.68)
Feed/gain	2.89 (2.74)	2.87 (2.80)

[a] Values in parenthesis are from initial test Feb. 6–Apr. 30, 1968.

Table 3. Bone breaking strength.[a]

Percent slat	Bldg. A				Bldg. C			
	100	75	50	25	100	75	50	25
Rep. 1	246.0	231.5	251.5	220.5	281.5	260.0	234.5	240.0
Rep. 2	249.0	239.0	234.5	290.0	272.0	282.0	260.0	249.0
Rep. 3	266.0	247.5	276.0	240.6	215.5	190.5	254.5	240.5
Av.[b]	253.67	239.33	254.0	250.37	256.33	244.17	249.67	243.17

[a] Values are force required to break metatarsal bones.

[b] Average of two metatarsal bones per pig, five pigs per rep.

2. Pigs can perform well under several different confined production systems. Refinement and sophistication of design is not a substitute for management.

3. Modified open-front buildings properly designed and managed will allow performance commensurate with environmentally regulated buildings with no additional labor requirement.

4. Floors that are one-fourth slatted may not provide the most desirable balance between performance and labor. Thus other slot to solid ratios should be considered. It also should be noted that small pigs appear to be uncomfortable when forced to sleep on slatted floors. Thus, total slats may not be the best choice, particularly in a modified open-front unit.

5. While concrete surfaces are undoubtedly a leg stress, total slats apparently *do not* add to this stress.

Management Observations

1. *Tailbiting*—Prevention is the best cure. Remove tails no later than one week after farrowing. Tail biting may cause as much as 25% reduction in gain even under good management. When buying feeder pigs locate the producer early so you can have him remove the tails before the pigs are one week old.

2. *Dunging Pattern*—Wetting the desired dunging area immediately after the pigs are put in the pen has the effect of "training" the pig. In cool or cold weather use a heat lamp(s) to warm the desired sleeping area. Heat lamps may be turned off in 36 to 48 hours if not otherwise needed.

3. *Deteriorization*—Galvanized metal panels appear to rust at a rate 2 to 3 times as fast over partially slatted floors as totally slatted floors.

4. *Light Intensity*—Little or no light is necessary in total confinement. Light has the effect of encouraging activity, and thereby reducing efficiency. Light, in abundance, in confinement, almost certainly encourages tail biting. More research in the area of effect of light intensity on confinement pork production is needed.

5. *Shipping Hogs*—Experience indicates that it just doesn't pay to load the whole truck at once. Putting 6 to 8 pigs in the loading alley at a time makes for easier loading.

6. *Ventilation*—Almost daily adjustment of the ventilation system should be considered as weather, wind velocity and ambient temperature changes.

7. *Modified open-front units*—During winter months remove the liquid manure from the pit immediately after the building becomes empty. This will prevent freezing of manure which would limit the pit area and possibly cause damage to the facility.

Midwest Plan Service plan number 72673-R1 provides drawings and details for an open-front swine finishing facility. A building such as this can easily be modified so that it can be enclosed during cold weather.

The author suggests considering fiber glass, reinforced with wood, when modifying such an open-front unit. Fiber glass is competitive with other materials in cost and provides solar heating in the daytime. Midwest Plan Service provides plans on many other structures. Contact your County Extension Agent or the Agricultural Engineering Department, University of Nebraska.

Non-Protein Nitrogen for Swine

By P. E. Vipperman, Jr.
Assistant Professor Swine Nutrition

The price of protein may increase sharply over the next several years. The supply, primarily from soybean, may become limited. We get this indication from predictions of a rapidly expanding population and the ever-increasing amounts of "synthetic" meat products made from soybean proteins appearing on the grocery shelf. This places the pig in direct competition with man for the available supply of high quality edible protein.

We are preparing for this potential problem by looking for new sources of protein for swine and at the same time trying to improve the efficiency of use of the protein that is available.

Protein is composed of hundreds of smaller units called amino acids; so called because they are organic acids which contain an amino radical composed of nitrogen and hydrogen ($-NH_2$). The animal must first break the protein down into amino acids (during digestion) before it can be utilized in the formation of animal protein. Therefore, when we speak of protein "requirement," we are really concerned with the amount and kinds of amino acids in the diet.

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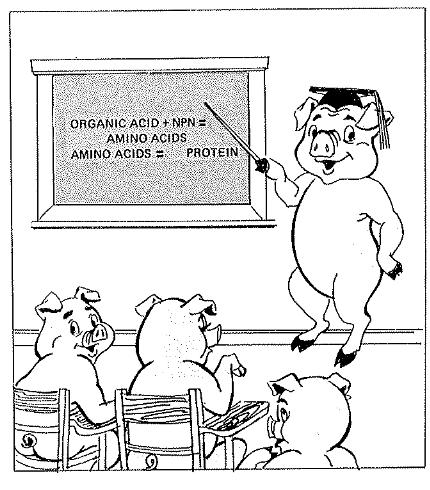

Non-Protein Nitrogen

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There are 22 known amino acids, 10 of which are "essential" to swine. By "essential" we mean that the animal cannot synthesize them in sufficient amounts to meet body needs, therefore, they must be included in the diet. The remaining or "non-essential" amino acids can be synthesized by the animal provided there is a nitrogen source available.

Balanced Diet

A diet "balanced" with respect to amino acids would contain the proper level and ratio of the 10 essential amino acids required by the pig. Corn and other cereal grains are low in total protein and deficient in 3 of the 10 essential amino acids—lysine, methionine and tryptophan. Protein supplements are used to increase the level of protein and to correct the amino acid deficiencies in cereal grains.

It is assumed that if the diet does not supply an adequate quantity of the "non-essential" amino acids, they will have to be synthesized by the animal. The amino radicals necessary to form the "non-essential" acids must come either from the excess "essential" acids present or from some other nitrogen source. Thus, provision in the diet for adequate quantities of "nonessential" nitrogen allows us to use minimal quantities of the essential acids in ration formulation.

Research was started at the University of Nebraska to determine if, and to what extent, the protein deficiency of cereal grains could be corrected by furnishing enough nitrogen as non-protein nitrogen (NPN) for the animal to make the needed "non-essential" amino acids. An effort was also made to determine if the utilization of NPN could be increased by adding the individual "essential" amino acids found deficient in cereal grain.

A summary of the data from experiment 67404 is shown in Table 1. While daily gain decreased slightly, when either 5 or 10 percent of the dietary protein was replaced by NPN from a mixture of diammonium phosphate and diammonium citrate, there was some improvement in feed efficiency, backfat thickness and percent ham and loin. However, daily gains decreased sharply when the 20 percent NPN diets were fed.

The addition of lysine, methionine and tryptophan to Diet 5 improved the performance of all criteria measured, but these pigs still did not perform as well as those fed the corn SBM (Diet 1). The reduced performance of pigs on Diet 5 may have resulted from an imbalance of the essential amino acids or it may have been largely due to lack of palatability, since feed intake was about one-half pound per day less than group 1.

Table 2 is a summary of Experiment 69407 in which the NPN was supplied by urea and ammonium phosphate. The levels of supplemental lysine and methionine were varied in an attempt to find the most effective levels of these amino acids. Again, we saw some improvement in performance when amino acids were added to the NPN diets (Treatment 4 and 5 vs. 3). However, as the level of supplemental amino acids were further increased (Treatments 6 and 7), performance was reduced. This indicates the possibility that one or more additional amino acids must be supplied in the diet. Feed intake was also reduced when the higher levels of amino acids were employed.

Summary

These experiments do not show conclusively that NPN can be efficiently used as a large part of the supplemental protein for swine. However, they do give us hope that this can be accomplished, provided the proper levels and ratios of the essential amino acids can be established and the problem of feed intake can be solved.

In addition to the value of these experiments in determining if NPN can be utilized by swine, they also help answer one question of concern to many producers. That is, what happens to a pig when it consumes a supplement which contains urea? Our work to date indicates no harmful effect when urea is fed at levels which supply up to 10 percent of the total crude protein.

Table 2. Experiment No. 69407. Ammonium phosphate and urea as NPN source for G-F swine.

Treatment number		1	2	3	4	5	6	7
Protein equivalent NPN	(%)	0	0	3.8	3.8	3.8	3.8	3.8
Protein from corn + SBM	(%)	14.0	11.2	11.2	11.2	11.2	11.2	11.2
Total crude protein	(%)	14.0	11.2	14.0	14.0	14.0	14.0	14.0
Supplemental methionine	(%)	0	0	0	0.050	0.100	0.150	0.200
Supplemental lysine	(%)	0	0	0	0.085	0.170	0.255	0.340
Number pigs treatment	...	12	12	12	12	12	12	12
Initial weight	(lb)	57.9	55.5	54.1	57.0	56.5	55.5	56.0
84-day weight	(lb)	195.5	163.9	154.2	167.0	170.0	164.8	155.2
Gain per day	(lb)	1.64	1.29	1.19	1.31	1.35	1.30	1.18
Feed per day	(lb)	5.52	4.98	5.00	5.13	4.77	4.54	4.01
Gain/feed	(lb)	.30	.26	.24	.26	.28	.29	.29

Table 1. Experiment 67404. Diammonium phosphate and diammonium citrate as NPN sources for G-F swine.

	Dietary treatment				
	1	2	3	4	5
NPN (% of total protein)[a]	0	5	10	20	20+aa[b]
No. pigs treatment	12	12	12	12	12
Initial Wt (lb.)	59.6	60.0	60.3	60.0	60.0
Final Wt. (lb.)	210.3	207.5	204.2	188.3	196.9
Av. daily gain (lb.)	1.87	1.83	1.78	1.58	1.69
Av. daily feed intake (lb.)	6.42	6.09	6.00	5.65	5.94
Gain/feed (lb.)	0.64	0.66	0.66	0.62	0.62
Backfat thickness (in.)	1.5	1.3	1.4	1.4	1.4
Percent ham and loin	36.4	37.0	36.9	37.1	38.0

[a] All diets contained 16% protein until the pigs weighed approximately 110 lbs. at which time all diets were adjusted to 14% crude protein.

[b] The amino acids, methionine, lysine and tryptophan were added to approximately the level that would be found in Diet I.

Gestation Diets For Swine

By D. M. Danielson
Associate Professor, Animal Science
North Platte Station

The formulation of gestation diets and the management necessary in feeding these diets still need answers which are not fully known.

The gestation phase of pork production plays its role as the yardstick in measuring the degree of success in a good swine program.

For several decades alfalfa in its various forms has been used extensively in the formulation of swine diets. It has acted as a crutch in providing several of the necessary or essential ingredients in swine diets.

Alfalfa is readily available in many of the swine production areas as it is in the area surrounding the North Platte Station. Because of its availability, the equipment available to process alfalfa hay and the economics involved, sun-cured alfalfa has received the greater emphasis in swine diet studies at the North Platte Station.

Table 2. Performance data of gestating gilts (crossbred) fed different levels of alfalfa hay.

Item	Treatment		
	0%–4.2 lb.[a]	33%–5 lb.[a]	66%–6 lb.[a]
No. bred gilts	20	20	20
No. litters farrowed	14	17	19
Initial gilt wt., lb.	357	340	354
Gestation gain, lb.	84.9	87.8	80.4
Litter size at birth, live, no.	11.14	11.12	11.63
Birth wt., lb.	3.06	2.88	2.75
Litter size, 42 da., no.	9.21	7.82	7.68
Pig. wt., 42 da., lb.	24	24.7	24.2

[a] Percent alfalfa hay in diet and total feed allowed per animal per day.

Table 3. Performance data of gestating gilts (crossbred) fed different levels of alfalfa or prairie hay.

Item	Treatment			
	0%–4.2 lb.[a]	33%–5 lb.[a]	66%–6 lb.[a]	66%–6 lb.[b]
No. bred gilts	20	20	20	20
No. litters farrowed	12	17	18	17
Initial gilt wt., lb.	354	346	345	344
Gestation gain, lb.	64.8	76.1	79.7	54.5
Litter size at birth live, no.	9.67	9.41	9.78	10.18
Birth wt., lb.	2.74	2.55	2.58	2.63
Litter size, 42 da., no.	8.58	7.76	8.77	9.12
Pig wt., 42 da., lb.	27.15	26.07	26.65	26.28

[a] Percent alfalfa hay in diet and total feed allowed per animal per day.
[b] Percent prairie hay in diet and total feed allowed per animal per day.

Diet Studies

The first of several studies reported here consisted of 60 crossbred gilts placed in groups of 20 gilts each with each group receiving one of three gestation diets. Each of the diets differed in the percent alfalfa hay it contained. One group received a diet containing no alfalfa hay, another group received a diet containing 33 percent alfalfa hay and a third group received a diet containing 66 percent alfalfa hay (Table 1). All alfalfa was first cutting. The pelleted diets were fed by use of individual gestation stalls.

Table 1. Composition of gestation diets containing different levels of hay.

Ingredients	Treatment[a]			
	0%	33%	66%	66%
Corn	12	12	12	12
Oats	65	32.5	...	...
44% soybean oil meal	18.5	18	17.5	17.5
Alfalfa	...	33	66	...
Prairie hay	...	...	...	66
Bone meal	3.02	1.51	...	2.0
Salt	0.5	0.5	0.5	0.5
Monosodium phosphate	0.4	1.3	1.9	1.16
Trace minerals	0.1	0.1	0.1	0.1
Vitamin premix[b]	0.48	1.09	2.0	0.74
Total	100.00	100.00	100.00	100.00
Protein %[c]	17.02	17.19	17.36	12.74
Calcium %[c]	0.84	0.84	0.84	0.74
Phosphorus %[c]	0.81	0.79	0.70	0.72

[a] Indicates percentage of alfalfa or prairie hay in complete diet.
[b] Supplied the following per pound of complete diet: Vitamin A, 1,500 I.U.; Vitamin D_3, 112.5 I.U.; riboflavin, 1.0 mg.; calcium pantothenate, 1.8 mg.; niacin, 4.5 mg.; choline chloride, 5.0 mg.; and Vitamin B_{12}, 5.0 mcg.
[c] Calculated.

The quantity of daily diet allowance per animal increased as the percentage alfalfa hay increased in the respective diets (Table 1). This allowed for about the same gross energy intake per animal per day regardless of diet they received. Exposure of the animals on this study to these diets was from the day the animal was bred until shortly after farrowing. The lactation diet was the same formulation for all animals represented in this study regardless of gestation diet. The three groups were maintained at the same level of feeding for the duration of the study. Performance of the animals included in this study is shown in Table 2.

A second study was a replicate of the study described above with two exceptions, third cutting alfalfa hay was replaced by first cutting and a fourth diet was added. This diet differed only in that prairie hay

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Gestation Diets

(continued from page 21)

replaced alfalfa hay in the diet that originally contained 66% alfalfa hay (Table 1).

Comparable management of these animals was maintained as in the previously described study. Performance of the animals in this study is shown in Table 3.

A third study consisted of four diets equally assigned to 64 crossbred gilts, 16 animals per diet treatment). They differed in composition (Table 4) in that the first one did not contain alfalfa, the second contained 25 percent dehydrated alfalfa meal, the third 25 percent alfalfa hay and the fourth essentially 100 percent alfalfa hay. All alfalfa was fourth cutting.

Each of these diets, fed at a level of five pounds per head per day, was in pelleted form and fed to the assigned gilts in gestational feeding stalls. The gilts were exposed to their respective diet assignments the day they were bred and maintained on the same feeding regime throughout gestation. All animals were allowed the same lactation diet following parturation until their offspring was weaned.

Performance of the gilts and their offspring is shown in Table 5.

Table 5. Performance data of gestating gilts (crossbred) fed diets containing different levels and/or forms of alfalfa.

Item	Treatment			
	0%	25%[a]	25%[b]	100%[a]
No. bred gilts	16	16	16	16
No. litters farrowed	13	10	11	15
Gestation gain, lb. 110 da.	100	92	65	35
Litter size at birth, no. pigs recorded	10.08	9.1	10.82	10.4
Birth wt., lb.	2.69	3.01	2.86	2.59
Litter size, 42 da., no.	7.85	8.3	9.73	8.67
Pig wt., 42 da., lb.	24	26	23.3	25.1

[a] Indicates alfalfa hay in diet.
[b] Indicates dehydrated alfalfa meal in diet.

Results

In the studies reported, alfalfa levels as high as essentially 100 percent were used in gestation diets. All of these were fed at a constant level throughout the entire gestation period.

There appears to be a beneficial effect in obtaining a greater number of litters when adding alfalfa to these diets, and as a result wean a greater number of pigs from a given number of supposedly bred gilts.

There was no evidence of inflammation of the breast, inflammation of the uterus or impairment in the secretion of milk. Thus far, none of the studies at the North Platte Station with gestation diets including various levels of alfalfa hay and prairie hay have indicated an association of alfalfa hay or prairie hay with the mastitis-metritis-agalactia complex.

Although the number of animals involved in these studies are relatively small, a definite trend seems to exist. It appears alfalfa hay or prairie hay does provide some of the essential micro-nutrients that not all of the all-concentrate diets do. Alfalfa hay or prairie hay in themselves can play the role of a fairly complete supplement.

Pens available for research work.

Table 4. Composition of gestation diets containing different levels and/or forms of alfalfa.

Ingredients	Treatment			
	0%	25%[a]	25%[b]	100%[a]
Corn	12	40	40	...
Oats	65	17.5	17.5	...
Wheat bran	...	2.5	2.5	...
44% soybean meal	18.5	12.5	12.5	...
Dehydrated alfalfa meal	...	25	...	...
Alfalfa hay	...	...	25	96.75
Iodized salt	0.5	0.5	0.5	0.5
Bone meal	3.02	...	...	...
Sodium tripoly phosphate	0.4	1.5	1.5	2.4
Trace minerals	0.1	0.1	0.1	0.1
Vitamin premix	0.48[c]	0.4[d]	0.4[d]	0.25[d]
Total	100.00	100.00	100.00	100.00
Protein %, analysis	18.56	17.75	16.75	17.31
Calcium %, analysis	1.19	0.76	0.74	1.72
Phosphorus %, analysis	0.89	0.71	0.74	0.86

[a] Indicates alfalfa hay in diet.
[b] Indicates dehydrated alfalfa meal in diet.
[c] Supplied the following per pound of complete diet: Vitamin A, 1500 I.U.; Vitamin D_3, 112.5 I.U.; riboflavin, 1.0 mg.; calcium pantothenate, 1.8 mg.; niacin, 4.5 mg.; choline chloride, 5.0 mg.; and Vitamin B_{12}, 5.0 mcg.
[d] Supplied the following per pound of complete diet: Vitamin D_3, 112.5 I.U.; riboflavin, 1.0 mg.; calcium pantothenate, 1.8 mg.; niacin, 4.5 mg.; choline chloride, 5.0 mg.; and Vitamin B_{12}, 5.0 mcg.

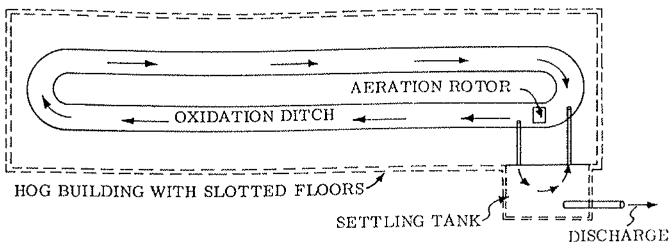

Figure 1. General layout of oxidation ditch systems.

Oxidation Ditches

Swine Waste Treatment

By **O. E. Cross**
Associate Professor, Farmstead Engineering
E. A. Olson
Extension Engineer (Farm Building)

Swine housing has changed drastically during the past 10 years. The advent of slotted floors with liquid manure, environmental control with insulation, ventilation, and heating, and the use of mechanized equipment have prompted a trend toward total confinement of the animals.

This concentration of large numbers of animals confined in a small space results in large quantities of wastes which are accumulated at one location. The handling, management, and disposal of the wastes becomes a problem.

When researchers and producers looked for methods of treating swine wastes, they naturally considered adapting the processes used for the treatment and disposal of municipal wastes—anerobic and aerobic decomposition. Many of the first attempts at treating swine wastes proved unsuccessful because of failure to understand the true characteristics of hog wastes.

Municipal sewage is composed of large quantities of water polluted relatively lightly with waste organic matter. Hog manure, in contrast, contains very large amounts of organic matter—often containing barely enough water to keep the wastes in a fluid form for handling.

Anaerobic decomposition is one of the most common processes used in treating hog wastes. The anaerobic process takes place in organic matter when dissolved oxygen is not available. The oxygen required by the anaerobic bacteria is taken from the breakdown of the organic solids. The anaerobic process is usually associated with undesirable odors.

The major benefit of anaerobic treatment is its ability to break down organic matter. The purpose is the destruction and stabilization of organic matter, not water purification. The liquid from an anaerobic system is not purified enough to be released into a natural watercourse without further treatment.

Aerobic decomposition is the process in which oxygen is supplied to the waste, making free oxygen available for the growth of aerobic bacteria. The aerobic system is essentially odorless. Unfortunately, aerobic bacteria are not 100% efficient in decomposing organic matter, and there is usually only 40% to 50% degradation of volatile solids.

Several methods are available for the disposal of swine wastes:

1. Return the wastes to the soil.
2. Aerobic and/or anaerobic lagoons.
3. Dehydration.
4. Incineration.
5. Composting.
6. Oxidation ditch.

Advantages and disadvantages are inherent with each of these systems. This article discusses the oxidation ditch disposal method.

The Oxidation Ditch

A properly operated oxidation ditch promotes aerobic decomposition and therefore is essentially odor-free.

The oxidation ditch has a continuous open channel shaped like a racetrack which holds the liquid waste (Figure 1). An aeration rotor churns the liquid wastes, mixing in air which supplies the necessary oxygen for the aerobic bacteria. The action of the rotor also keeps the ditch contents circulating so that the solids will be kept in suspension. The rotor must turn continually.

Aerobic bacteria use the organic matter in the wastes as food, thus reducing the biologically degradable organic matter to stable minerals, with carbon dioxide and water as byproducts.

In time, non-degradable organic solids and salts will build up in the ditch to the point where they will interfere with the biological process. Then the solids can be settled out in a settling tank and disposed

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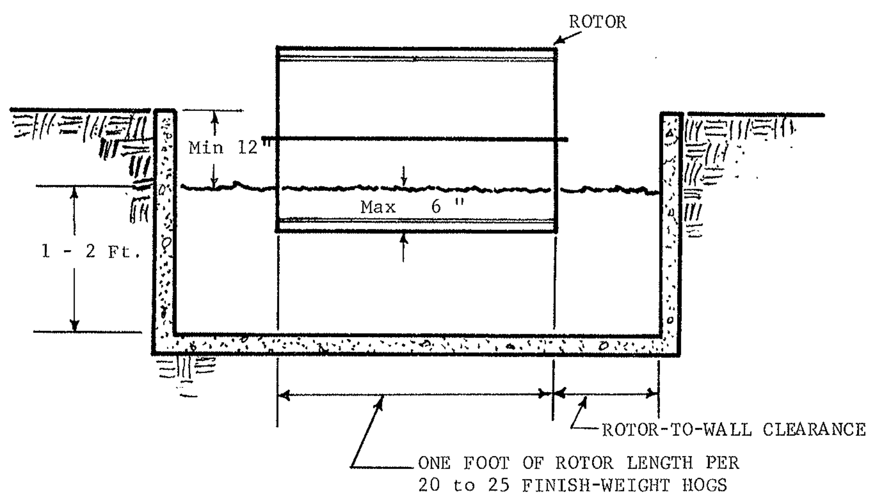


Figure 2. Typical cross-section of oxidation ditch.

Oxidation Ditches

(continued from page 23)

of separately. The salt concentrations can be diluted by emptying part of the ditch and refilling with water.

The effluent from the ditch must still receive further treatment in a lagoon or other waste-treatment facility before it can be allowed to drain into a stream. Otherwise haul or spread it on the land.

Ditch Capacity and Loading

Allow at least 1 cubic foot of ditch volume per 15 to 20 pounds of animal weight to provide adequate waste dilution. This allows for about 50 days of detention time.

Always design the ditch for the maximum pounds of pigs per building, which is probably at finish weight for the pigs. Designing for only the average weight of the pigs will not be adequate when the ditch is loaded at a maximum.

A typical cross-section of an oxidation ditch is shown in Figure 2. The width of the channel depends upon the length of the rotor which in turn depends upon the number of animals for which the system is designed.

Rotor

The major role of the aeration rotor (Figure 3) is to inject air into the liquid wastes as a means of adding oxygen. The recommended oxygen that must be supplied is two times the 5-day BOD[1] of swine wastes, or 0.64 lb. of oxygen per 100-pound pig per day.

A general guide for good treatment is that a foot of length of rotor be provided for each 20 to 25 finish-weight hogs with a 6-inch immersion and turning at 100 rpm. If you desire only aerobic storage without much treatment, you may operate with a few more hogs per foot of rotor.

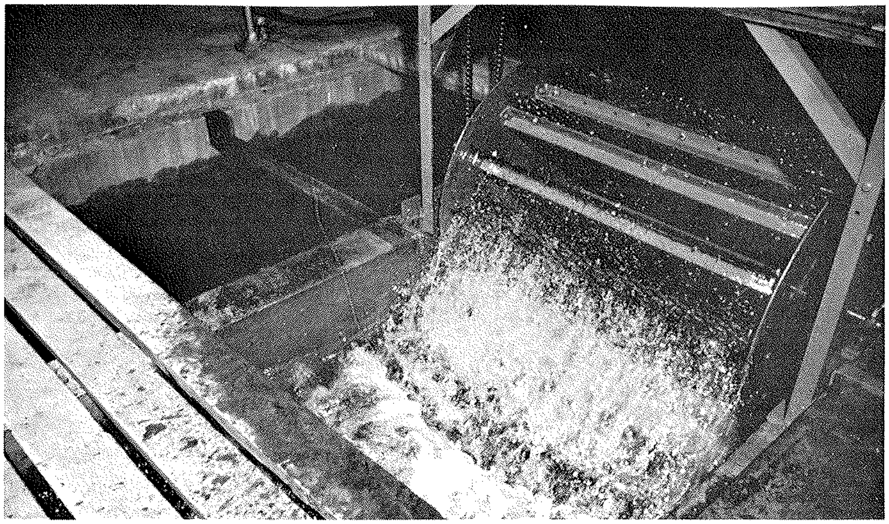


Figure 3. Aeration rotor in operation.

Rotor Immersion and Liquid Depth

The depth of rotor immersion affects the rate of oxygenation, rate of liquid flow, and power consumption. The depth of liquid in the channel affects detention time and depth of immersion and rate of rotor rotation necessary to keep the solids in suspension. The simplest method of operation for a constant rotor immersion is to keep a constant liquid level in the ditch by using an overflow that discharges into a holding tank or lagoon.

As a rule of thumb for finishing hogs, the rotor immersion should equal about one-third the liquid depth of the ditch in order to prevent settling of the solids. A 6-inch immersion is about maximum since too many rotor operational problems occur at greater immersion depths. This would give a recommended ditch depth of between 1 and 2 feet.

Rate of Liquid Flow

The aeration rotor must circulate the liquid wastes fast enough to keep the solid particles in suspension. Liquid transport can be the limiting factor in the design of a rotor even when adequate oxygen is being added.

The liquid velocity required depends on the weight and size of waste particles in suspension circulating in the ditch. Normally, about 1 to 1.25 feet per second velocity of the liquid is recommended. At these velocities, the liquids should not travel over 300 to 350 feet without passing another rotor since air should be added to the wastes about every 5 minutes for most efficient treatment.

Operation

Fill the channel with water and start the rotor at the desired blade immersion. Never start with untreated (septic) manure in the ditch. Add the waste gradually at first to minimize foaming. Initial foaming can be reduced with antifoam agents such as vegetable oil, petroleum oil, various commercial products, or by a water spray.

Once the ditch establishes an adequate microflora, the start-up foaming should subside. This can take up to 2 to 3 weeks. A slight ammonia odor may be noticed during start-up. The start-up period can be reduced by initially seeding the ditch with activated sludge from a satisfactorily operating ditch or from a municipal sewage plant. Never drain the ditch completely unless absolutely necessary. Always leave at least one-third the volume for enough activated sludge to provide a seed when the ditch is refilled with water.

Problems—The major operational problem has been foaming—along with incomplete treatment. Provide at least a 12-inch freeboard depth to allow a reasonable foam

[1] The 5-day BOD (biochemical oxygen demand) is a test to determine the pollutional strength of organic wastes. This test measures the amount of oxygen required by the aerobic bacteria for the biological decomposition of organic matter at a standard time of 5 days. The average BOD per 100-pound hog is about 0.32 pound per day.

level without obstructing liquid circulation. Changes in appearance of foam can serve to alert the operator to imminent foaming problems. Odors can also alert the operator that something is wrong. Clinging odors are a sure sign of an improperly operating ditch, while the presence of an earthy smell generally is associated with a properly operating ditch.

Color of the liquid can also give an indication as to the aerobic condition of the waste. A greenish-black mixture indicates that it is mostly anaerobic and more oxygen is needed, while a dark rich brown indicates a properly operating ditch. If aerobic conditions are not maintained, anaerobic bacteria will predominate causing odors and foam.

Open up the house and turn on ventilation before starting a rotor which has not been operating for over 2 to 3 days. Pigs have been killed by gases released when a rotor was started after having been turned off for some time and the ditch contents had become septic. The rotor should never be off more than 2 to 3 days without draining part of the wastes and refilling with tap water before restarting.

Regular maintenance is required. Maintenance of the rotor bearings can be a major problem. Hog hair and other foreign materials seem to get into the bearings, so they should be located where they can be easily serviced and replaced. Also, belt drives seem to operate better than chain drives.

Sludge Removal—After a ditch has been in operation for several months it will be necessary to remove some sludge to keep from having excessive amounts of solids in the ditch. A properly operating ditch should stabilize the sludge adequately so it can be handled without causing objectionable odors.

Since the rotor creates an inch or so of hydraulic head, the inlet to the sludge trap can be placed in the ditch just after the flow passes the rotor. If the outlet is placed just behind the rotor, flow should occur just opposite the direction of flow in the ditch (Figure 1).

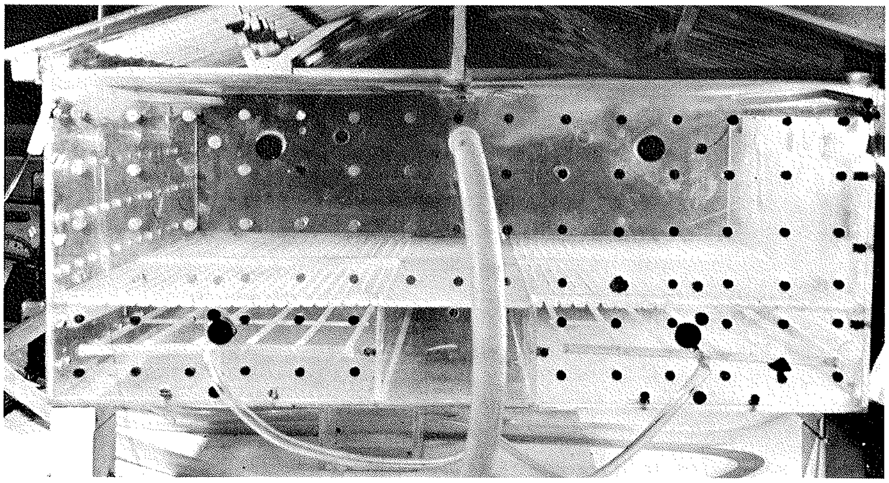
As the flow enters the sludge trap, the velocity will be reduced and the solids will be deposited in the trap. The sludge trap will need to be cleaned out periodically and can be pumped on to drying beds or hauled directly to the fields for fertilizer.

If no sludge trap is available, the solids content can be lowered by draining several inches of liquid in the ditch and diluting the remainder with tap water.

Final Disposal—Liquids from the oxidation ditch will not receive adequate treatment to allow disposal into a natural watercourse. Allow overflow to discharge into a lagoon after passing through a settling tank to settle out remaining solids. Irrigate from the lagoon if surplus water is a problem.

If it is not desirable or possible to have a lagoon, build a storage tank outside the building to store the overflow from the ditch. Haul with a tank wagon and spread on the fields when necessary.

Costs—The costs for an oxidation ditch will include first costs and operating costs. The cost of the rotor is about $250 per foot so a 7-foot rotor costs about $1,750. Operating costs at 2¢ per kilowatt-hour are about ½¢ per hog per day. The operating cost will depend somewhat on the degree of treatment desired and can run as high as 1¢ per hog per day.



Engineers use this model to evaluate ventilation systems.

Gas Removal from Swine Housing

By J. A. DeShazer
Associate Professor, Livestock Facilities
E. A. Olson
Extension Engineer (Farm Building)

Swine producers are concerned with how to decrease odors and noxious gases in completely enclosed animal production units with slotted floors.

This concern has probably been caused by public awareness of air pollution, respiratory discomfort of some humans while working in a swine housing environment and the reaction of pigs to gases produced in the storage pits.

Gas Production

The most important gases generated from stored manure during anaerobic decomposition are carbon dioxide (CO_2), ammonia (NH_3), methane (CH_4) and hydrogen sulfide (H_2S).

Carbon dioxide: Carbon dioxide is a colorless, odorless gas about 1½ times as heavy as air and highly soluble in water. Normal atmosphere contains about 300 ppm (parts per million) (0.03%). In a ventilated swine confinement unit the concentration has been reported to be between 600 and 1,800

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Gas Removal

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ppm because of the CO_2 produced by the respiration of the pigs and from manure decomposition. This is well within the recommended safe limits of 5,000 ppm for man. Air containing 40,000 ppm causes the pig to have deep, fast breathing.

Ammonia: Ammonia is colorless, has a pungent odor, is lighter than air and is highly soluble in water. The problem of ammonia is less with slotted floors than with solid floors because of its high solubility in water.

Concentrations in confinement hog buildings have been measured as high as 35 ppm in a ventilated building and 176 ppm in an unventilated building. The upper recommended working limit for humans is 50 ppm. Because it is an irritant, ammonia tends to induce sneezing, salivation and loss of appetite of pigs at high concentrations of 100 to 200 ppm.

Methane: Methane is colorless, odorless, and about one-half as light as air. Pigs suffer no harmful effects from inhaling methane. Since it is considerably lighter than air, it will dissipate rapidly if there is adequate ventilation.

Hydrogen sulfide: Hydrogen sulfide is colorless, smells like rotten eggs, is somewhat heavier than air and is soluble in water. Hydrogen sulfide is one of the most toxic gases to humans and animals associated with liquid manure storage. It is both an irritant and an asphyxiant.

For humans, low concentrations of 20 to 150 ppm cause severe irritation to the eyes and respiratory tract, if inhaled for an hour. The eyes are affected after 6 to 8 minutes of exposure. Exposure to 500 ppm for 30 minutes will affect the nervous system and cause severe headaches, dizziness, excitement, and a staggering gait.

According to the American Conference of Governmental Industrial Hygienists, high concentrations of 800 to 1,000 ppm cause immediate unconsciousness and death through respiratory paralysis unless artificial respiration is immediately given.

Pigs are made uncomfortable by prolonged exposure to low concentrations of hydrogen sulfide. Pigs exposed continuously to at least 20 ppm develop fear of light, loss of appetite, and nervousness; 50 to 200 ppm cause vomiting, nausea, and diarrhea. In acute poisoning, hydrogen sulfide acts so rapidly that there are few symptoms of imminent danger. Sudden nausea and unconsciousness are followed by death at concentrations of 800 ppm and above. The pigs may recover completely from exposure to high concentrations, but they may be susceptible to pneumonia and other respiratory diseases.

A concentration of 0.09 ppm in a normal ventilated confinement building rose to 0.28 ppm after the ventilation was shut off for 6 hours. Dangerous concentrations can be released by vigorous agitation of stored liquid manure. Concentrations reaching 200 to 300 ppm have been reported a few minutes after pumping out a storage pit and as high as 800 during vigorous agitation.

A farmer can determine the presence of hydrogen sulfide by noting the black accumulations of copper sulfide that form on copper thermostats and electrical wiring, the white deposits of zinc sulfide on galvanized steel, and the black discolorations of lead-pigmented white paint.

Removal of Odors and Gases

One method of getting rid of odors and noxious gases is through the use of oxidation ditches which, when operating properly, give off an earthy smell.[1] For existing swine facilities it is difficult to implement the use of an oxidation ditch. For existing facilites, the use of the ventilation system to draw air from the pit area shows promise and is presently being studied.

Ventilation—In designing a ventilation system for the removal of gases from the pit area, the engineer needs to: 1. Determine the size of exhaust duct underneath the slotted floor to pick up the pit gases.

2. Determine the fan capacity so as to match the quantity of gases being produced by the amount of air being exhausted from the pit area.

3. Determine the amount and size of openings in the exhaust distribution duct.

The openings in the duct should be adjustable so as to allow regulation of the air pattern underneath the pit area. The air pattern can be evaluated with the use of smoke sticks.[2] The smoke sticks contain a chemical that reacts with the moisture in the air and forms a white smoke that allows you to follow the air circulation pattern.

With an exhaust ventilation system there appears to be some corrosion problems of exhaust fans underneath the pit area. A positive pressure system is being used by some companies with all the air going through the exhaust ports in the pit area. This decreases the corrosion of fans but might cause drafts to occur at the level of the animal if not properly designed.

Model Research Studies—Studies concerning the control of odors and noxious gases in swine confinement units have been conducted with a 1/12 plexiglass scale model of an existing swine environmental controlled building at the Northeast Station.

In this study, five different air flow distributions, four different inlet settings and four different outlet locations of fans were used. Ammonia gas was distributed below the slotted floor as would be found in a confinement unit. As more air was exhausted below the floor level, the concentration of ammonia gas above the floor decreased. However, there was no statistically significant difference between all the air exhausting below the floor and ⅔ of the total exhausted air being exhausted below the slotted floor.

It was found that the inlet settings influenced the concentration of ammonia above the floor. Field

[1] "Oxidation Ditches and Swine Waste Treatments by O. E. Cross and E. A. Olson in this *Nebraska Swine Report*.

[2] #15-049 Smoke Sticks; E. Vernon Hill Incorporated, P.O. Box 14248, San Francisco, California 94114.

studies are presently being conducted to substantiate some of the findings of the model research studies. Some systems also are in the construction process and formulative process to test different pit ventilation systems.

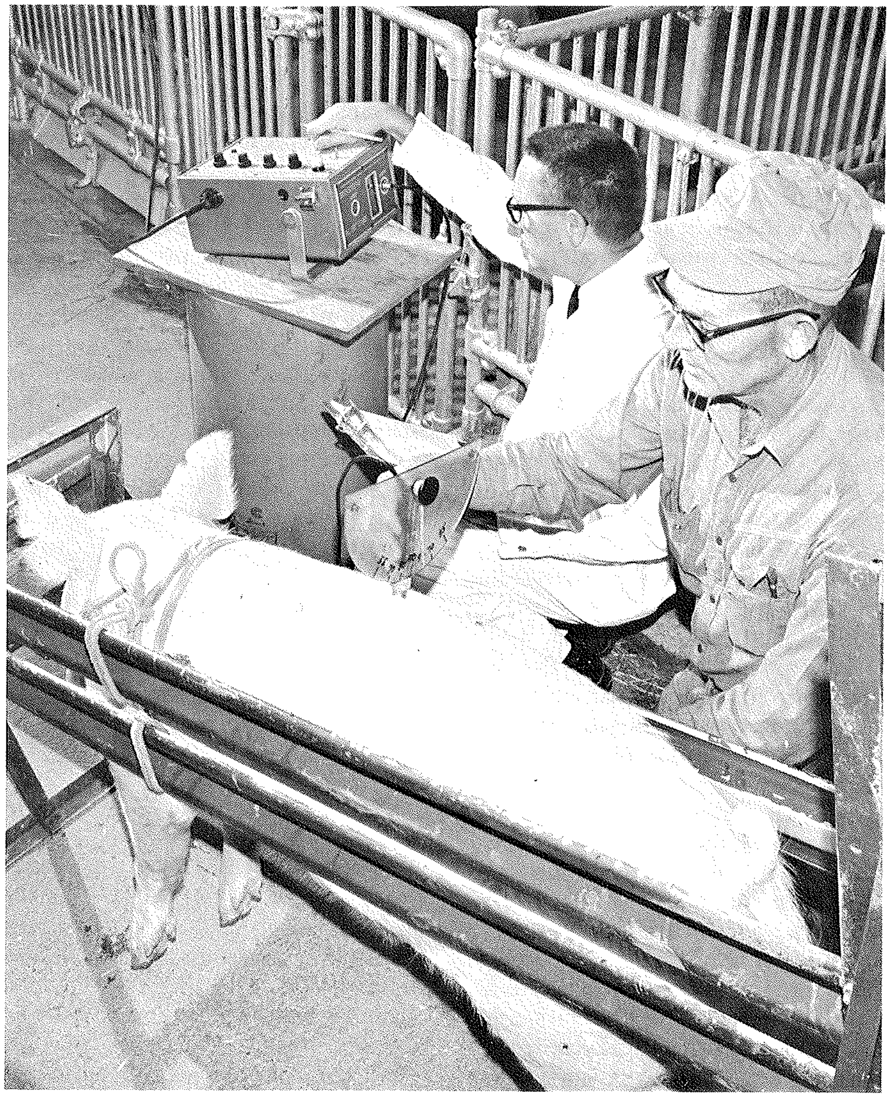
Management Cautions

1. When the ventilation system stops in a tightly constructed building full of pigs, the pigs may die from asphyxiation because of lack of oxygen and increased carbon dioxide, or from heat stress. Conditions become critical when the oxygen content drops from the normal 21% to 10% or below. A confinement unit should have some type of safety or warning device to notify the operator if the mechanical ventilation system fails.

2. Vigorous agitation of liquid manure stored for some time can release noxious gases and create dangerous or even lethal conditions. If manure stored under slotted floors is agitated while the pigs are allowed to stay inside the building, extreme care should be taken to ventilate the building and the pigs should be watched for any signs of ill effects. Instances have been reported of pigs dying during the agitation of manure, and an operator in Scotland was overcome during the emptying of a storage pit.

3. The air in a manure storage pit is not safe to enter without first ventilating the pit. Both hydrogen sulfide and carbon dioxide are heavier than air and will tend to accumulate in the pit. Several human deaths have been reported when operators entered a covered manure pit, were instantly overcome, and drowned in the remaining liquid waste. Never enter a manure storage pit unless it has been properly ventilated and you are equipped with a proper mask. Always have someone stand by with a rope attached to you to pull you out at the first signs of dizziness.

Portions of this material have been adapted from "Swine Housing and Waste Management" by Arthur J. Muehling, University of Illinois.



Ultrasonic measurement is one method of live animal evaluation.

Ultrasonics

Swine Selection Tool

By P. J. Cunningham
Assistant Professor, Swine Breeding

Swine producers, in recent years, have placed increased emphasis on the production of animals with superior carcass merit. Compared with other performance traits, carcass traits are affected to a larger extent by the genetic makeup of the animal. About 50 percent of the differences among individuals, with respect to carcass merit, are due to differences in the genetic makeup of the individuals. This indicates that selection for superiority in carcass merit should be effective in improving the carcass merit of a herd.

The problem which arises is the identification of replacement boars and gilts with superior carcass merit. To actually measure the various carcass traits of an individual requires slaughtering the animal. This is impossible if an animal is to be kept for breeding purposes.

Two alternatives are open to a breeder to circumvent this problem:

1. Obtain carcass information on relatives of prospective replacement animals.
2. Obtain a live animal measurement which is a good indicator of carcass merit.

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Ultrasonics

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The number of relatives required to obtain adequate carcass information for an accurate indicator of an individual's carcass merit is large enough that a search for accurate live animal measurements seems warranted.

Ultrasonic Measurement

Ultrasonic measurement is one method of live animal evaluation which has received attention in recent years. Ultrasonic measurements of fat and muscle thickness can be obtained from the live animal. These measurements are then used for predicting a particular carcass trait such as percent ham and loin.

It is possible to predict the performance for a particular trait from almost any measurement, but this does not mean that the value predicted is accurate. Perfect accuracy occurs if a measurement predicts the carcass measurement exactly. Therefore, before adopting any measurement as a selection criteria, a breeder should have some idea as to its accuracy. The statistic used to determine the accuracy of a prediction equation is the correlation between the actual and predicted values. The closer the correlation is to one, the greater the accuracy of the prediction equation.

Data obtained from the Swine Testing Station near Clarkson indicate the correlation between predicted and actual percent ham and loin to be slightly above 0.6 using slaughter weight, age at 200 pounds, fat thickness at the shoulder and last lumbar vertebrae and the muscle depth at the last rib. This is not an especially high correlation.

There are probably at least two reasons why the correlation is not higher: (1) the overall uniformity of the test station pigs and, (2) the small number of ultrasonic measurements taken. If a prediction equation involving ultrasonic measurements is to be a valuable aid in selection, it must be able to distinguish among uniform animals. Breeders can visually distinguish the poor from the good boars, but where they need help is in distinguishing the very good from the good. The answer in this particular situation might have been to include other ultrasonic measurements.

If a breeder must wait until market weight before measuring and selecting his replacements, live animal measurements lose some of their value because of the decreased market value of boars not kept for breeding.

The ideal situation would be to be able to accurately predict percent ham and loin from ultrasonic measurements taken earlier on the animal. Also, prediction equations involving ultrasonic measurements have historically been developed from barrows. Since there are differences between boars and barrows, the question arises as to whether or not prediction equations developed from barrows are applicable for use with boars.

To obtain some insight into these two questions, the Nebraska Station conducted an experiment involving both boars and barrows and took ultrasonic measurements at seven different times.

The correlations between the predicted and actual values, for percent ham and loin, for the equations used are given in Table 1. The actual value was the percent ham and loin obtained at slaughter at about 210 pounds.

Table 1. Correlations between actual and predicted percent ham and loin.

Reading	1	2	3	4	5	6	7
Avg. weight	88	111	128	145	163	188	199
Avg. age	85	99	107	116	126	140	149
Boars	0.80	0.74	0.83	0.59	0.52	0.75	0.79
Barrows	0.57	0.87	0.86	0.82	0.83	0.66	0.85

Results of this study indicate that barrows can be measured just as accurately at any time after reaching 110 pounds as they can at 200 pounds, but boars must be measured before reaching 130 pounds or not until 200 pounds. The accuracy of predicting percent ham and loin was generally higher for barrows than for boars.

The data also indicate that equations developed from barrows may be applied to boars with little loss in accuracy. Very limited numbers of animals were involved in this study (24 boars and 24 barrows), and thus, the results must be tempered somewhat. This study is presently being repeated to obtain more conclusive results.

The reason the correlations are higher for this study than the test station results is that greater variation existed among the animals, but probably more importantly because of an increase in the number of measurements used. Fat readings were taken at the shoulder, fourth rib, tenth rib, last rib, last lumbar vertebrae, rump and in the center of the ham. Muscle depth readings were taken at the tenth rib, last rib and the center of the ham.

In summary, it appears that ultrasonic measurement may be a valuable aid in selection if the proper readings are taken. It also appears possible to obtain measurements which will accurately predict percent ham and loin at lighter weights. Measurements taken at about 125 pounds appear to be the most useful.

Percent ham and loin may not be the most desirable trait for the breeder to use as a selection criteria. Pounds of ham and loin per day of age might be a more desirable trait since it requires rapid growth in addition to carcass merit. Accuracy in predicting pounds of ham and loin per day of age has not been determined at the present.