1987

EC87-219 1987 Nebraska Swine Report

William Ahlschwede
billahls@neb.rr.com

Donald G. Levis
University of Nebraska-Lincoln, donlevis@hotmail.com

Gerald Bodman
University of Nebraska-Lincoln

Murray Danielson
University of Nebraska-Lincoln

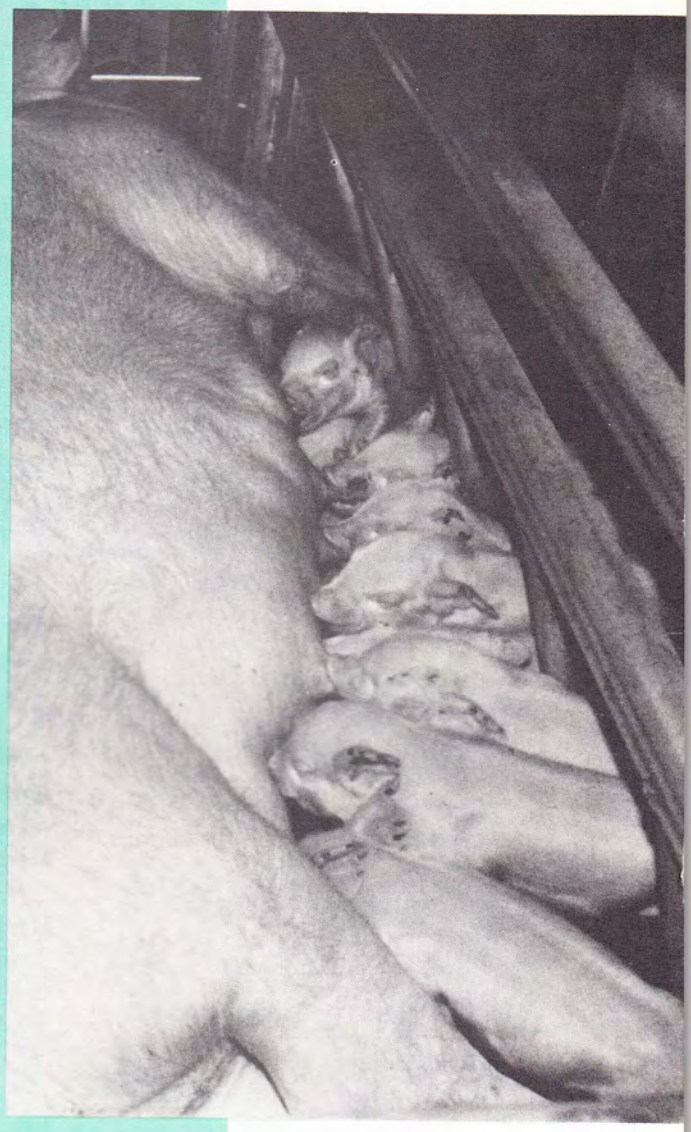
Fernando A. Osorio
University of Nebraska - Lincoln, fosorio1@unl.edu

See next page for additional authors

Nebraska Cooperative Extension Service EC 87-219
Nebraska Agricultural Research Division

1987

NEBRASKA SWINE REPORT



- Breeding
- Disease Control
- Nutrition
- Economics
- Housing

Prepared by the staff in Animal Science and cooperating Departments
For use in Extension, Teaching, and Research programs

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Leo E. Lucas, Director of Cooperative Extension Service, University of Nebraska, Institute of Agriculture and Natural Resources.

TEACHING RESEARCH IANR EXTENSION

Institute of Agriculture and Natural Resources

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Acknowledgments

A. H. Robins Co., Richmond, VA

A. L. Laboratories, Englewood Cliffs, NJ

Allflex Tag Company, Harbor City, CA

American Cyanamid Company, Princeton, NJ

Armour Food Company, Madison, NE

Bettcher Industries, Inc., Vermillion, OH

Borden's Inc., Elgin, IL

Chr Hansen's, Milwaukee, WI

Central Soya, Ft. Wayne, IN

Crows Hybrid Corn Co., Milford, IL

E. I. DuPont de Nemours Co., Wilmington, DE

Eli Lilly and Company, Indianapolis, IN

Fabral Co., Lancaster, PA

Farm Journal, Philadelphia, PA

Fats and Proteins Research Foundation, Inc., Des Plaines, IL

Feed Flavors, Inc., Wheeling, IL

Hoechst - Roussel AGRI-VET Company, Somerville, NJ

Geo. Hormel Packing Company, Fremont, NE

Hearhand Lysine, Inc., Chicago, IL

Hoffman-Laroche, Inc., Nutley, NJ

IMC, Inc., Terre Haute, IN

J. M. Huber Corp., Quincy, IL

Merch & Co., Inc., Rahway, NJ

John Morrell Packing Company, Sioux Falls, SD

National Pork Producers Council, Des Moines, IA

National Soybean Processors Association, Washington, DC

Nebraska Farmer, Lincoln, NE

Nebraska Pork Producers Association

Nebraska SPF Accrediting Agency, Lincoln, NE

Nebraska Soybean Utilization and Marketing Board, Lincoln, NE

Nebraska Sorghum Utilization and Marketing Board, Lincoln, NE

Nebraska State Energy Office, Lincoln, NE

Norden Laboratories, Lincoln, NE

Nutrition Specialties, West Point, NE

Pfizer, Inc., Terre Haute, IN

The Upjohn Co., Kalamazoo, MI

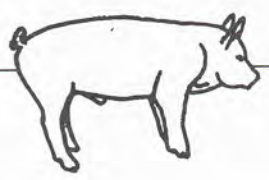
Urschel Laboratories, Inc., Valpariso, IN

U.S. Meat Animal Research Center, Clay Center, NE

Waldo Farms, DeWitt, NE

Wimmer Meat Products, Inc., West Point, NE

Zin-Pro, Corp., Chaska, MN



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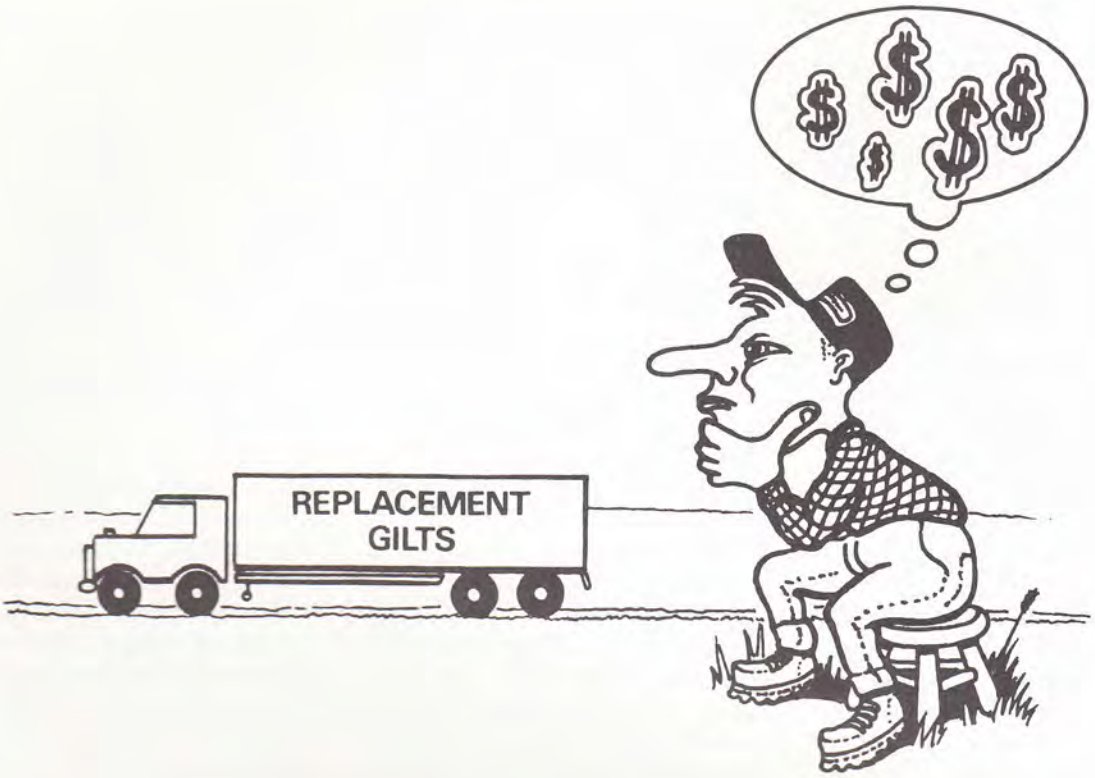
Issued January 1987, 7,000

The 1987 Nebraska Swine Report was compiled by William T. Ahlschwede, Extension Swine Specialist, Department of Animal Science.



BUY REPLACEMENT GILTS?

William T. Ahlschwede[1]

Pork producers who farrow have traditionally raised their own replacement gilts. One of the attributes of rotational crossbreeding systems is that replacement females are saved from the market crosses. Rotational crosses are being replaced by terminal crosses which use more productive "white sows". These producers are confronted with a choice of either buying replacement gilts or committing production space to specialized matings to produce gilts.

Health, Cost

Health risk and cost have been the primary deterrents to purchasing replacement gilts. This evaluation will deal with the costs and economic benefits of purchasing replacement gilts. While the health aspect remains important, gilts are available today from sources which represent little disease risk. Improved procedures for introducing gilts further minimize the risk of serious disease problems due to purchased breeding stock.

This evaluation considers costs and benefits of purchasing Landrace-Yorkshire replacement gilts relative to systems which produce their own gilts. Crossbreeding Systems Analysis procedures have been used to predict, through computer modeling, the production levels and anticipated financial returns of the crossbreeding systems considered. Three breeding systems have been considered, the traditional three breed rotation, a four breed terminal system using F1 Landrace-Yorkshire females for commercial production, and a Landrace-Yorkshire based rotaterminal, designed to produce home-raised Landrace-Yorkshire crossbred females for terminal crossing.

General results from the Crossbreeding Systems Analysis of these three systems are in Table 1. These projections were based upon current estimates of average breed performance, Table 2, and heterosis values. The economic evaluation assigned costs typical of the 1980's, with added costs for lower conception rates, larger litters, slower gains, and poorer feed efficiency. Pigs were sold at 220 pounds on a $0.45 per pound base price with premiums for reduced fat based on the NPPC Pork Value system. Charges for extra feed for sows with larger litters were included in the cost structure. With this cost structure, purebred production with the four breeds used here averaged less than a dollar a litter profit. The dollar return reported in Table 1 is the expected profit on 100 litters.

In each system shown in Table 1, the matings are arranged so that gilts produced in one line are the females for the matings in the following line. In the rotation, gilts from the matings in the third line are the sows in the first line. In the rotaterminal,

Table 1. Expected production and profit from 100 litters with three crossbreeding systems.

Sire	Dam	% in system	Offspring Heterosis	Pigs raised	Net per 100 litters
Three breed rotation					
Hamp	Y,D,H..	33.3	85.7	8.56	$ 7909.51
Duroc	H,Y,D...	33.4	85.7	7.96	5438.58
York	D,H.Y...	33.3	85.7	8.02	5379.93
Weighted average					6241.87
Four breed terminal					
York	York	2	0	7.78	2396.78
Land	York	8	100	8.08	5566.58
H x D	L x Y	90	100	9.55	11167.50
Weighted average					10544.01
Rotaterminal					
York	L,Y,L...	5	66.7	9.10	7642.21
H x D	Y,L,Y...	45	100	9.08	9524.07
Landrace	Y,L,Y...	5	66.7	9.34	8135.52
H x D	L,Y,L...	45	100	9.11	9429.20
Weighted average					9317.86

the Yorkshire sired replacement gilts produced in the first line are mated for terminal production in the second line, or mated to a Landrace boar in the third line for production of replacement gilts. Similarly, the Landrace sired gilts in the third line of the system are bred for terminal production as shown in the fourth line, or for replacement gilt production in the first line.

The superior productivity and profit of the terminal cross is apparent from Table 1. The $43 per litter advantage of the four breed terminal system over the rotation has been a strong force in the adoption of these specialized breeding systems. In the four breed terminal system, the terminal matings (line 3) produce at a $49 advantage over the rotation. The gilt producing matings reduce this advantage by $6 per litter. This system is one of the most common when purchased gilts are involved. It is not a functional system for producing home-raised replacement gilts, unless the commercial unit has 400 or more sows and a keen interest in gilt production. With 400 sows, the smallest breeding group would be 8 Yorkshire sows mated to a Yorkshire boar, which is barely large enough to be functional.

Table 3 shows expected returns from 100 litters produced by the purchased F1 Landrace-Yorkshire females. Returns were calculated for four prices of replacement gilts and eight replacement rates. The gilt cost, designated as "Premium per gilt over market hog value" is gilt purchase price less the value of one 220 lb market hog. Since most gilt suppliers gaurantee that the gilts will breed, excess gilts are not included in the gilt cost. "Gilts needed" is the number of replacements to be purchased for each 100 litters farrowed. It is the same as percent gilt litters or composite replacement rate. Annual replacement rate would be about twice as large, depending upon the average litters per sow per year. Farm practices determine, through culling, the number of gilts needed. If 30% of the sows are culled after each farrowing, and sows are not culled for old age, a 30% replacement rate is realized. Culling 15% of the sows after each litter and allowing no more than 10 litters for a sow requires a replacement rate of about 20%. A 10% culling rate with a 10 litter limit per sow requires about 16% gilt litters. A culling rate of 10% and allowing sows to farrow up to 15 litters requires a 14% replacement rate. Lower replacement rates are almost impossible to achieve.

As might be expected, Table 3 shows that as the percent replacement rate goes up or gilt price rises, profits are reduced. With this background, we turn to comparisons with Table 1. The first comparison is with the three breed rotation. At all of the replacement rates and gilt purchase prices considered, production using purchased F1 Landrace-Yorkshire sows was more profitable. And with the intermediate gilt prices and 18-20% replacement rates, profits were increased $24-$30 per litter over the rotation.

Comparison of Table 3 and the rotaterminal (third system in Table 1) is the functional comparison. The rotaterminal is designed to allow commercial pork producers to produce their own replacement gilts for terminal crossing. The two breed rotation between Yorkshire and Landrace produces the specialized sows needed for terminal crossing. Since a two breed rotation expresses 66.7% of the heterosis (100% in F1), these sows are not quite as productive as are the Landrace-Yorkshire F1's. But because all sows in the herd are Yorkshire, Landrace crosses, any sow can be bred to produce replacement gilts or market hogs. Since the matings producing the replacement gilts are nearly as productive as the terminal crosses, there is little cost in making too many matings producing replacement gilts. Although three types of boars are required in this system, enough flexibility exists to make it functional on many farms. Hence this is the system of choice for terminal crossbreeding with home raised gilts.

Table 2. Performance averages assigned to breeds used in crossbreeding systems analysis procedures.

Breed	Conception rate %	Litter size no.	Piglet survival %	Days to 220 lb	Fat inches	F/G
Hampshire	85	9.0	66	183	1.0	3.30
Duroc	85	9.6	66	172	1.2	3.33
Yorkshire	72	10.8	72	177	1.2	3.35
Landrace	69	10.0	84	180	1.3	3.40

Table values refer to purebred performance.

Table 3. Expected profit after deducting gilt purchase costs.

Gilts needed	Expected net on 100 litters			
	Premium per gilt over market hog value			
	$75	$100	$125	$150
30	8917.50	8167.50	7417.50	$6667.60
25	9292.50	8667.50	8042.50	7417.50
20	9667.50	9167.50	8667.50	8167.50
18	9817.50	9367.50	8917.50	8467.50
16	9967.50	9567.50	9167.50	8767.50
15	10042.50	9667.50	9292.50	8917.50
14	10117.50	9767.50	9417.50	9067.50
13	10192.50	9867.50	9542.50	9217.50

The expected profit from terminal production with purchased Landrace-Yorkshire F1 females is similar to that expected with the Yorkshire-Landrace based rotaterminal. With $100 premium gilts and replacement rates of less than 20%, the two systems are equivalent. With $125 premium gilts, the systems are equivalent with a 15% replacement rate. For farms smaller than 200 sows, the purchased gilt program is competitive at higher replacement rates because of inefficient use of white boars or higher percentages of matings producing replacement gilts.

Two additional factors deserve consideration. One is the breeding value of the replacement gilts. Can you produce gilts as good as you can buy? An additional 0.1 pig raised per litter is worth about $4 per litter. Reducing finishing feed by 0.1 lb per pound of gain or reducing backfat by 0.1 in. is worth about $10 per litter.

The second factor is the operational simplicity of the terminal cross with purchased gilts. Only one kind of boar is needed. All sows are bred to the same boars. There is no time spent finding and selecting the boars to sire gilts. The breed of the sow does not have to be recorded to be checked for the proper mating for gilt production. It is a simplified system. Breeding management costs are reduced.

The terminal crossbreeding systems considered here have both used Landrace-Yorkshire crossbred sows. Other types of sows are being used in terminal crosses. Not everyone has had "good luck" with the Landrace-Yorkshire crosses. They are not recommended for extensive production systems with outside farrowing. The evaluation reported here has application to the systems studied.

Crossbreeding systems which use home-raised gilts offer greater opportunity for selection of replacements. Selection was not considered in this evaluation. It is not certain that the benefits from selection among replacement gilts would be cost effective in the systems considered. Previous analyses of the benefits of gilt selection indicated a maximum return of $5 per litter. When costs of collecting the data needed for the selection were considered, little advantage remained. The benefits of selection in the terminal system would likely not make up for the increased number of less productive gilt producing matings required for selection.

Conclusion

It appears from this evaluation that purchasing replacement gilts is a practice which merits consideration. It appears that for farms with more than 200 sows, terminal cross production based on home-raised Landrace-Yorkshire crossbred sows (rotaterminal system) offers profit opportunities similar to terminal production based on purchased F1 Landrace-Yorkshire sows. As farm size gets smaller, the purchased gilt option becomes more favorable. On farms with more than 400 sows, it may be possible, with superior management and organization, to increase profits by producing home-raised F1 replacement gilts.

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[1]William T. Ahlschwede is Extension Swine Specialist, Department of Animal Science.

CHECKING SOWS AND GILTS FOR ESTRUS

Donald G. Levis[1]

The best housing and management procedure for stimulating and detecting estrus (heat) in weaned sows and replacement gilts has not been completely resolved. Many confinement and nonconfinement breeding systems have been designed which did not take into consideration the "physiological mechanism" of estrous expression. These systems have led to human frustration which results in poor management and subsequent reduced reproductive performance of the breeding herd.

Obtaining a better understanding of the physiological mechanisms and behavior involved in expression of estrus may contribute to a more efficient operation by having a labor-efficient breeding area, increasing litters per sow per year decreasing number of empty days, increasing litter size by breeding weaned sows at the proper time and decreasing feed cost for nonproductive sows.

Estrus Expression

The onset of estrus is gradual in the pig (Figure 1). Changes which may be observed are restlessness, loss of appetite, change in coloration of vulva, swelling of the vulva, cloudy mucous discharge from vulva, frequent sniffing of genitals of pen mates, often emitting a peculiar growling or roaring sound like a boar, adopting male-like sexual behavior by pursuing, nosing flanks, and mounting other females, an arched back, rigid immovable receptive stance, "ear-popping", where the ears will repeatedly move toward an erect position, and listening with her head cocked slightly to the side with her ears pricked. It is unlikely that all

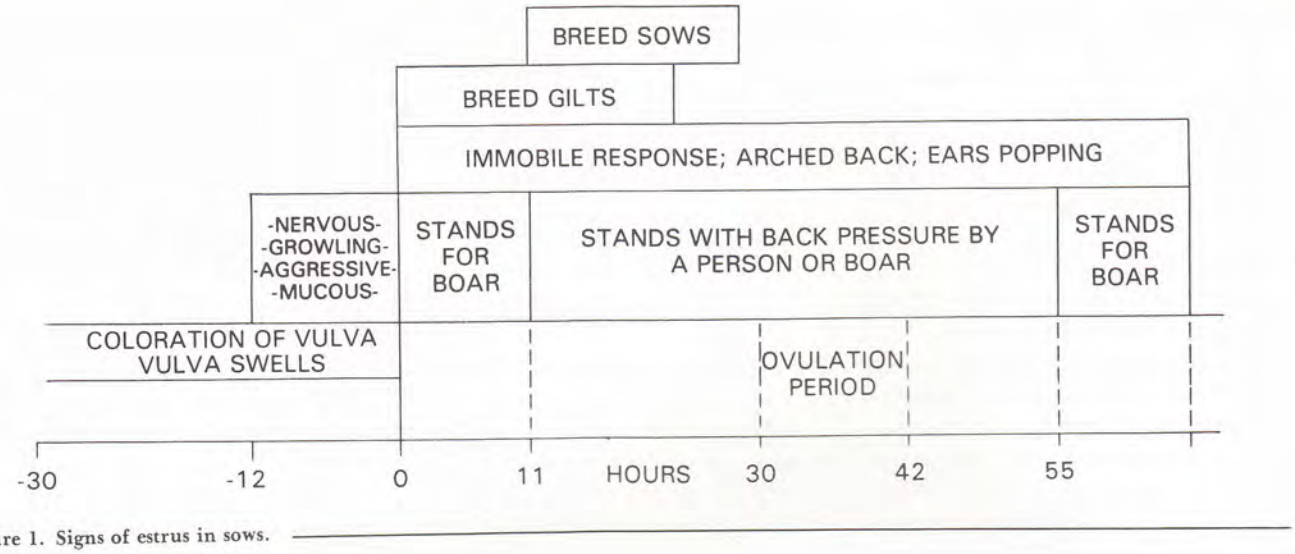

Figure 1. Signs of estrus in sows.

of these signs would be observed on every female.

Of the previously mentioned signs of estrus, the best indicator is the immobilization response (mating stance). However, an intense immobilization response is often not observed because of improper stimulation procedures. With continuous boar exposure, the female may become refractory to the sight, sound, and smell of the boar. This occurs frequently when sows have continuous contact with boars. Generally, sows in estrus will not maintain a rigid stance for more than 10 to 15 minutes. Therefore, the key to a good estrous detection procedure is to prevent boar exposure stimulation of estrus sows until the individual supervising the breeding is present to observe the rapid immobilization response.

Estrous Detection Procedure

The key to a successful estrous detection procedure is ease of operation combined with efficiency in detecting estrus. If the task of estrous detection becomes laborious, it will not be done effectively. For example, it is very frustrating to push an immobilized sow several feet to a breeding pen, and then have her reject the boar. Or to move several sows which give visual signs of estrus through a heat checking pen, yet they will not allow the boar to copulate.

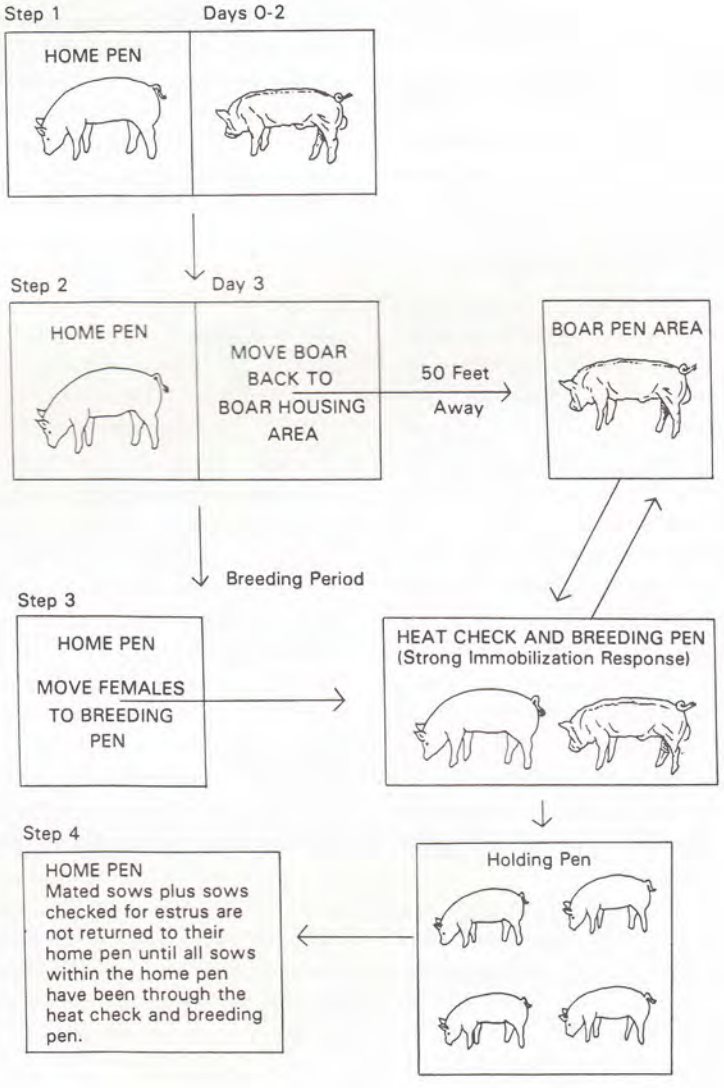

Figure 2. Estrus detection procedure, post weaning.

In Figure 2 an efficient and effective procedure to detect estrus in weaned sows is schematically illustrated. The procedure is divided into four steps.

The first step provides an environment for close boar-sow contact during the first two days after weaning. This can be provided by penning a boar in an adjacent pen for a 24-hour basis, or for several hours in an alleyway next to weaned sows. Another effective method is to place a boar with low sexual activity in the weaned sow pen.

The second step requires continuous separation of sows and boars except during the time of heat checking. The exact distance required for separation varies with type of facility employed. The main objective is to provide an environment which prevents weaned sows from receiving sexual stimuli from boars until the time of heat checking. While the immobilization response in the sow is released by tactile stimulation, it is the sight, sound, and smell of the boar that facilitates immobilization.

The actual mating process occurs during step 3. With this procedure the weaned sows are taken to a specific heat checking and breeding pen for estrous detection and mating. If the sows are in estrus, a rapid, strong immobilization response will be observed. The boar is not taken to the sow area because he may stimulate all estrous sows into the mating stance. If this occurs, some sows will not stand very well, if at all, when a second boar is taken to their pen 15-20 minutes later for breeding previously detected sows. Remember, a more intense and immediate estrous response will occur if the sows have not had boar contact 1 to 2 hours before heat detection and mating.

During step 4 sows are returned to their home pen. Do not return sows to their home pen until the whole pen has been through the heat check and breeding pen. This step helps prevent other estrous sows from receiving boar stimuli until entering the breeding area.

Breeding Facility

Figure 3 shows the floor plan for a handmating breeding facility in a remodeled barn. Basically, the remodeling involved moving an inside wall, installing a ventilation system, and constructing boar stalls and breeding pens. This floor plan incorporated the previously mentioned factors for detecting estrus. Weaned sows and replacement gilts are separated from

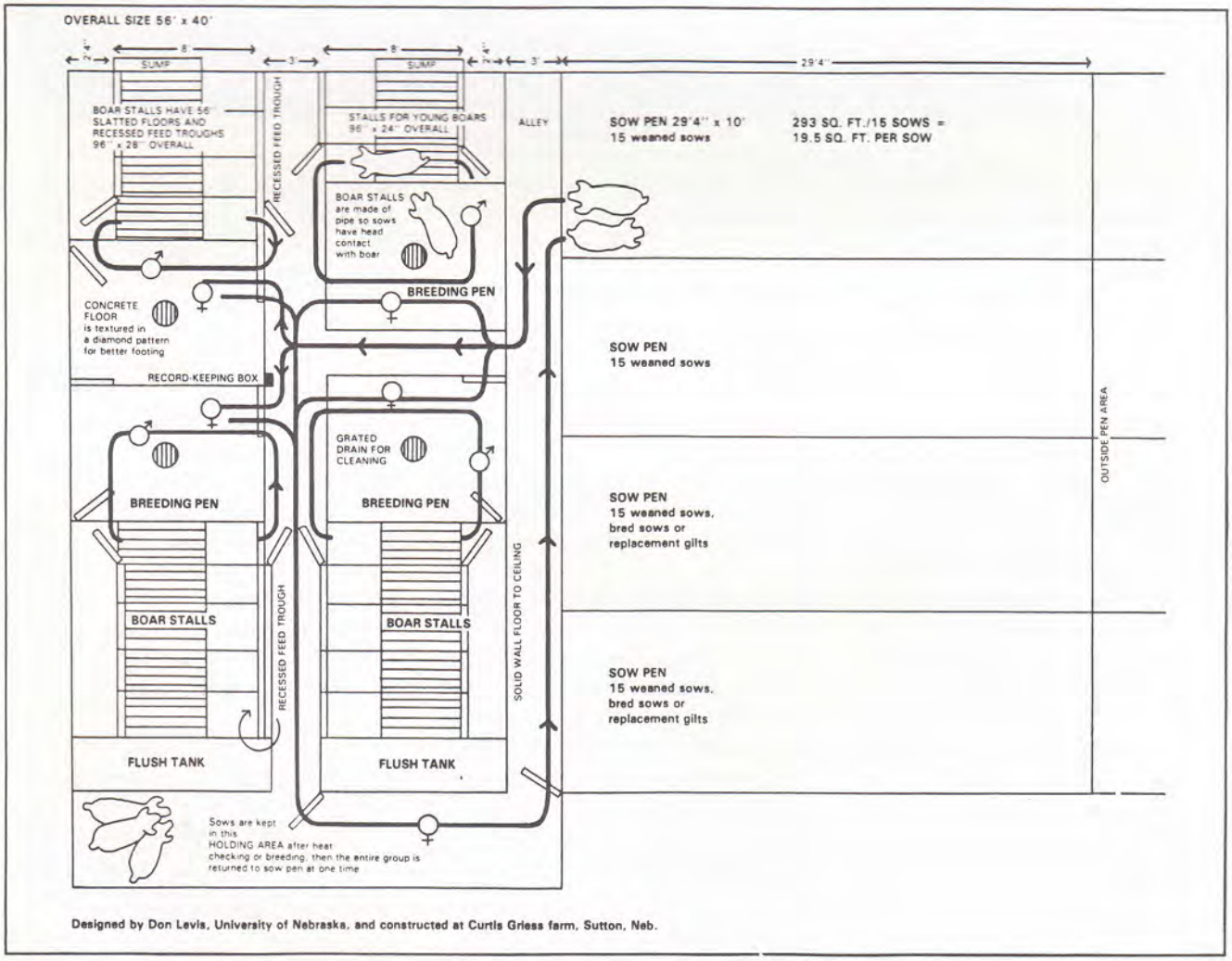

Figure 3. Breeding facility designed for estrous detection. Drawing courtesy of Pork '86 Magazine.

the boars by a solid wall from the floor to the ceiling. Boar contact after weaning can easily be accomplished by placing the boar in the sow pen or allowing him to roam the alleyway. A note of caution—do not put an aggressive boar in the sow pen at weaning because he may injure himself when pursuing nonestrous sows.

When sows and gilts are being heat checked, they are moved into a breeding pen which has a mature boar housed adjacently. When a large number of weaned sows are expected to be in estrus (4 to 6 days after weaning), only 1 sow is taken to each heat checking and breeding pen. On days when less estrous activity is expected, 2 to 3 sows can be taken to each pen for heat checking and breeding.

A beneficial feature of this floor plan is that when sows enter the breeding pens they do not pass mature boars. This helps prevent estrous sows from becoming immobilized in front of a boar and then having to be pushed to the breeding pen. Sows that are in estrus move to the boar and quickly become immobilized. This procedure helps to keep the sow in the breeding pen while the gate is open for bringing the boar into the pen. Breeding pen gates swing both directions which increases ease of animal movement. After copulation the boar is returned to his stall and the sow is then moved to a holding area until all sows in the pen have been through the heat check and breeding pens. After all the females in the pen have been heat checked and matings completed, the entire group is removed from the holding pen and returned to their pen at one time.

This procedure is very effective in detecting estrous sows. If a weaned sow has not exhibited an immobilization response within 5-7 minutes, remove her and move the next sow into heat check and breeding pen. Replacement gilts may require 10-12 minutes to exhibit a mating stance.

This facility can be managed by one individual and has performed exceptionally well since being constructed.

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[1]Donald G. Levis is Extension Swine Specialist, South Central Research and Extension Center, Clay Center, Nebraska.

MOF FARROWING

Gerald R. Bodman[1]

Modified-open-front (MOF) has been used for housing growing-finishing pigs since the early 1960s. The first Nebraska MOF Solar Nursery was put in use in 1979. Several designs for MOF breeding and gestation facilities are also in use. The need for more precise control of temperatures in farrowing units to prevent chilling of newborn pigs slowed development of designs of MOF buildings suitable for farrowing use.

Experience with other MOF buildings and a desire to keep construction costs and expenditures for external energy sources as low as feasible led two Nebraska pork producers to try MOFs for farrowing. In August 1984, two MOF farrowing units were put into use. The design goals were to control production costs by reducing the need for fossil fuel and electrical energy by at least 50% compared to a conventional farrowing house, keep construction costs at least equal (or less) than a conventional unit, and develop a system which would not adversely affect animal performance.

Solar MOF Farrowing Unit I

Unit I made use of some of the design principles from the successful MOF nursery located on this farm. To meet the desired farrowing schedule, capacity for 36 sows was required. The owners wanted to help assure sow comfort with their anticipated 4 to 4 1/2 week weaning program. The result was a 2-room, 36-sow farrowing unit with pens, front creep boxes with an in-floor warm-air solar heating system and an auxiliary warm-water heating system, under-pen fresh water flushing for removal of manure, woven wire floors in the sow area of the pens, and non-mechanical ventilation. Figure 1 shows the completed facility. Figure 2 shows some details of the unit.

Walls are constructed from insulated cast-in-place concrete sandwich panels (R 10-12) and 2 x 6 insulated frame (R 19). The 3:12 roof/ceiling is insulated with six inches of fiberglass insulation (R 19). Both the insulated walls and ceiling have a polyethylene (plastic) vapor barrier between the insulation and the painted chipboard used as the interior finish.

The 50" x 7' sow pens have 4" concrete partitions, 'open' metal rod front and rear gates and pig guards made of pipe on three sides. Front plywood creeps are 50" x 24" x 24". Pigs access the creep boxes through two 8" x 10" openings. Heat lamps (125W for first 3 days) or conventional light bulbs (75W and 60W) in the creep boxes are used as necessary to provide additional heat for the pigs.

Except for passive solar heat entering through the translucent south-wall ventilation panels, the only heat in the building is that added through the creep boxes. Floor temperatures are maintained at 95°F to 105°F. During the first two years of operation, interior ambient temperatures—measured 5' above the

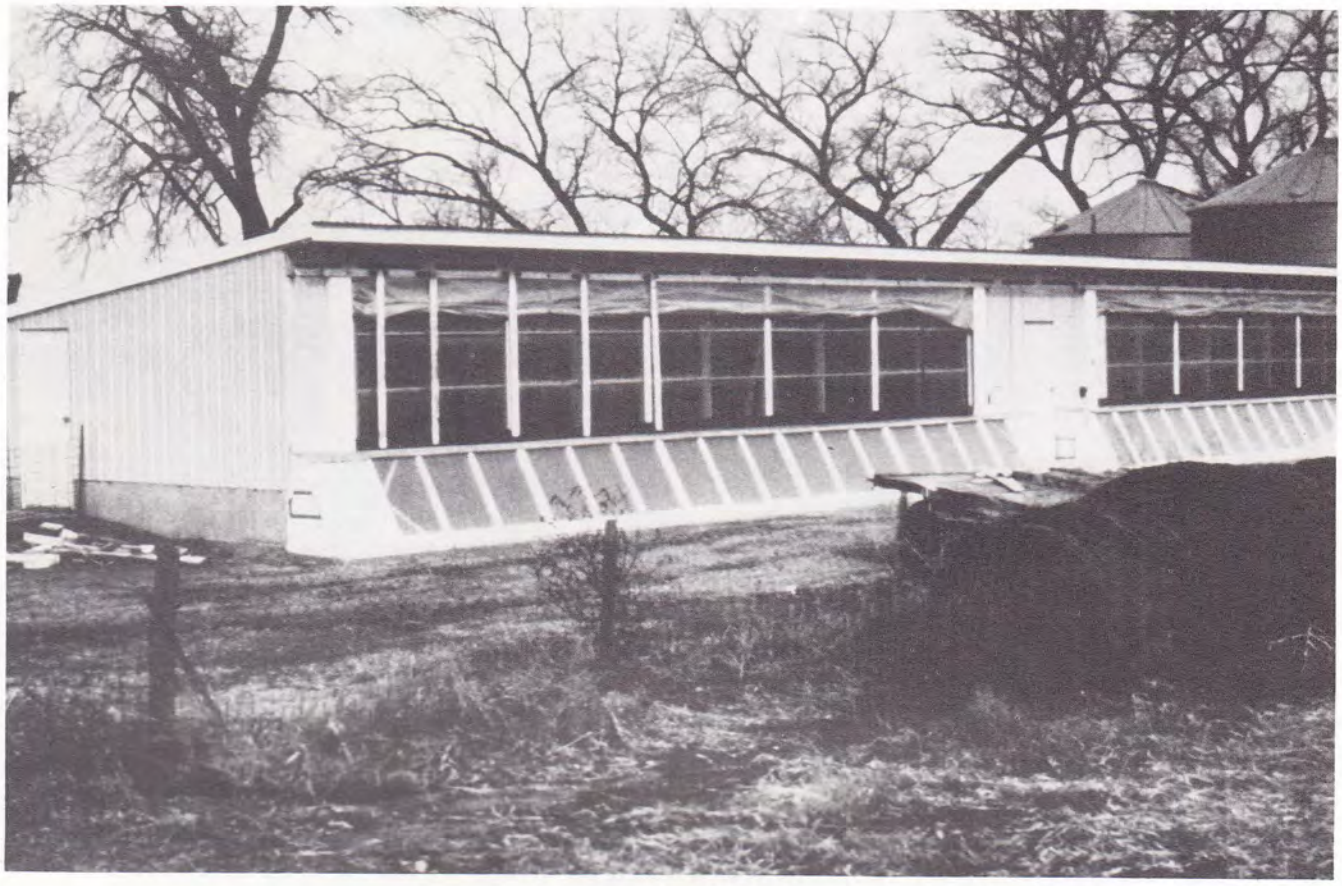

Figure 1. Completed solar heated farrowing house.

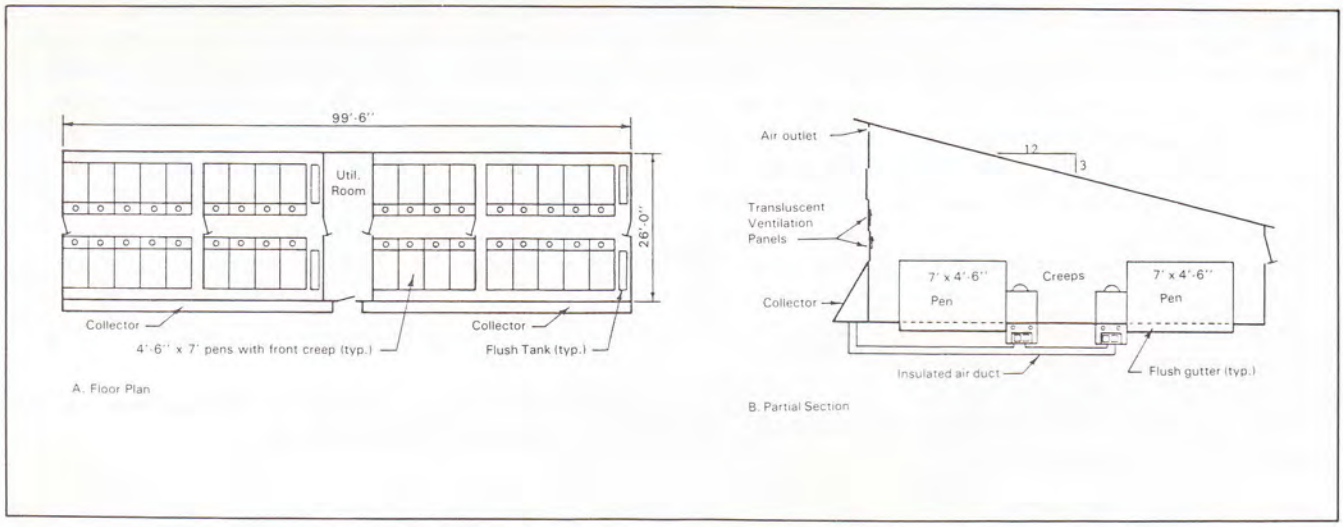

Figure 2. Unit I solar heated modified-open-front 36-sow farrowing house.

sows—ranged from 50°F to 101°F. Outdoor temperatures ranged from -8°F to +111°F. Drip coolers are used to provide additional sow comfort during hot weather.

Ventilation is controlled by manually adjusting the vertically sliding panels on the front of the building and insulated panels along the north wall. A 3" slot along the top of the south wall serves as an outlet for the ventilation air. An external curtain is used to help control air infiltration between the ventilation panels during windy weather and to control nighttime heat losses through the panels. Construction costs, including the in-floor heating system and allowance for the owners' time, were $1,111 per sow space. The solar fea-

tures accounted for 15% of the total cost.

MOF Farrowing Unit II

Unit II, a 14-sow MOF farrowing house, was built to complement two existing 14-sow farrowing rooms. The unit is combined with an MOF breeding and pen gestation facility which forms the west part of the building. The building has 2 x 6 insulated frame walls (R 21), perimeter insulation (R 11-12), and an insulated (R 31) 3:12 roof/ceiling. High density fiberglass reinforced plastic was used as the interior finish. Figure 3 shows the completed facility. Figure 4 shows some details of the unit.

Features in Unit II include raised crates with woven wire floors, an under-crate fresh water flush system and side creep boxes. Heat is provided by a propane-fired unit heater and 100W or 60W light bulbs in the creep boxes. During the first two years of operation interior temperatures varied from 60°F to 100°F while outdoor temperatures ranged from -9°F to +113°F. Creep box temperatures are maintained in the range of 80°F to 85°F. Drip coolers are used to enhance sow comfort during hot weather.

Ventilation is provided through two rows of openable panels along the south side and one row of panels along the north side. All panels are adjusted with thermostatically-controlled air cylinders.

Total system costs were $1,240 per sow space. This includes a pro-rated allowance for components (such as the flush tanks and the air compressor to operate ventilation panels) which are part of both the farrowing and breeding and gestation unit.

Energy Use

For comparison purposes, propane and electric meters were also installed on the conventional farrowing house at Unit II which contains 28 raised crates equipped with creep boxes. A mechanical ventilation system is used to control the interior environment. Table 1 lists the energy costs from mid-January through mid-April 1986. Costs were calculated based on propane at 60¢ per gallon and electricity at 7¢ per kilowatt-hour.

The table reflects energy use reductions of 40.7% and 29.9% in Unit I and Unit II MOF's, respectively, compared to the Unit II conventional house. Differences between Unit I and Unit II MOF costs are attributed to the solar system on Unit I. While these numbers do not equal the design goal of a 50% reduction, the Unit II conventional system had been recently remodeled and is better insulated than the typical Nebraska farrowing house. Further, the use of creep boxes helped reduce energy use in the conventional unit by an estimated 30-35% compared to farrowing houses without creep boxes.

Intensive monitoring of building performance was discontinued in April 1986. However, to obtain additional energy use data, propane and electric meters were left in place on both Unit II units during the summer of 1986. From April 22, 1986 through September 24, 1986 energy use in the MOF averaged 7.8¢/crate/day while in the conventional unit average costs were 16.3¢/crate/day, based on propane at 60¢/gallon and electricity at 7¢/kWh. These rates represent reductions of 52.1% in favor of the MOF.

Cost/crate/day is a convenient way to compare operating costs. However, production costs and sales prices are usually on a "per pig" basis. If a new group of pigs is weaned every six weeks (8-9 farrowings per year) and 8.5 pigs are weaned per litter, each 1¢/crate/day represents a cost of 5.6¢/pig weaned. Thus, a savings of 8.7¢/crate/day (Unit I MOF vs. Unit II conventional, Table 1) is a reduced production cost per pig of nearly 49¢.

Table 1. Energy use in MOF farrowing houses and the conventional farrowing house at Unit II. Costs are given in cents (¢)/crate/day.

Fuel	Unit I MOF	Unit II MOF	Unit II Conventional
Propane	4.1	3.8	6.5
Electricity	8.6	11.2	14.9
Total	12.7	15.0	21.4

Pig Performance

The "true" test of any energy use reduction system is the ability to reduce energy and production costs without adversely affecting pig health and performance. Because of differences in their record keeping systems pig performance at the two farms are shown separately in Tables 2 and 3.

The difference in "pigs weaned per litter" is due to the smaller number of pigs born alive by the sows in the MOF. Piglet survival was the same. Although a problem with boar fertility is suspected as the cause of the lower number of pigs born alive, the exact reason is unknown.

Table 3 summarizes results in Unit I. These data represent the performance of 143 litters from gilts and 40 litters from second parity sows far-

Table 2 Pig performance in Unit II MOF and conventional farrowing buildings, January-November 1985 (both units equipped with creep boxes).

MOF	No. litters	Pigs weaned/ litter	21-day pig weight (lbs)	Survival rate (%)
MOF	80	8.84	13.1	90.0
Conventional	65	9.69	12.9	90.4

Table 3. Pig performance in Unit I MOF.

No. litters	Pigs weaned/ litter	Age (days)	Weight (lbs)	Survival rate (%)
183	8.72	28.7	18.7	89.6

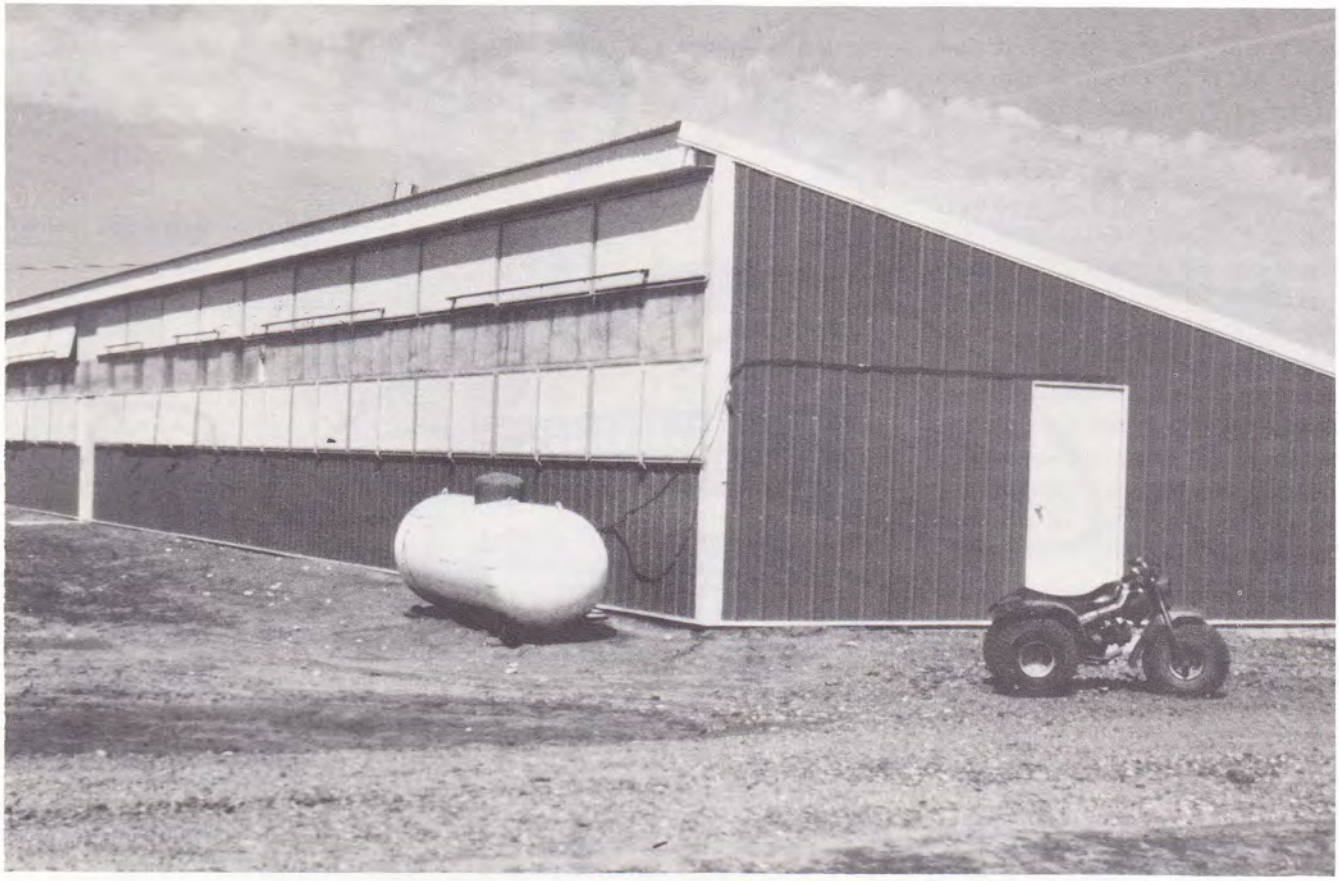

Figure 3. Completed modified open-front farrowing house.

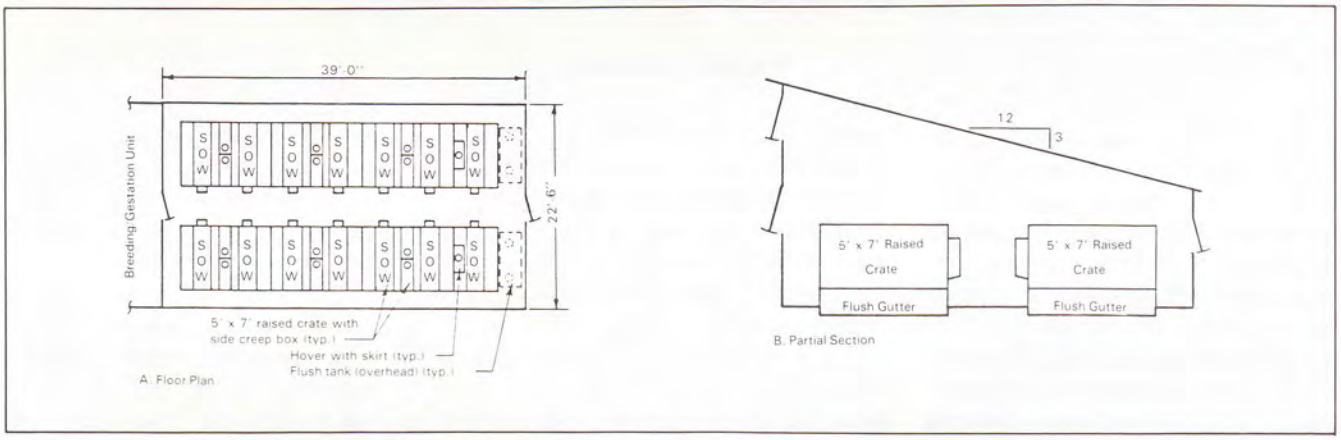

Figure 4. Unit II 14-sow modified-open-front farrowing house.

rowed December 1984 through June 1985 and in February 1986. With the exception of survivability (89.6%), all performance criteria exceed those identified as "excellent" in Pork Industry Handbook fact sheet No. PIH-100. A group of 19 sows farrowed in April and May of 1986 weaned an average of 10.2 pigs/litter with a survival rate of 95.1%. The 21-day weights averaged 14.2 lbs.

Summary

Building and pig performance have demonstrated that non-mechanically ventilated MOF buildings can be used for farrowing. Construction and energy costs can be reduced compared to many conventional facilities. Pig performance is similar to that achieved in many conventional farrowing units. As with all pork producing enterprises, good management is required.

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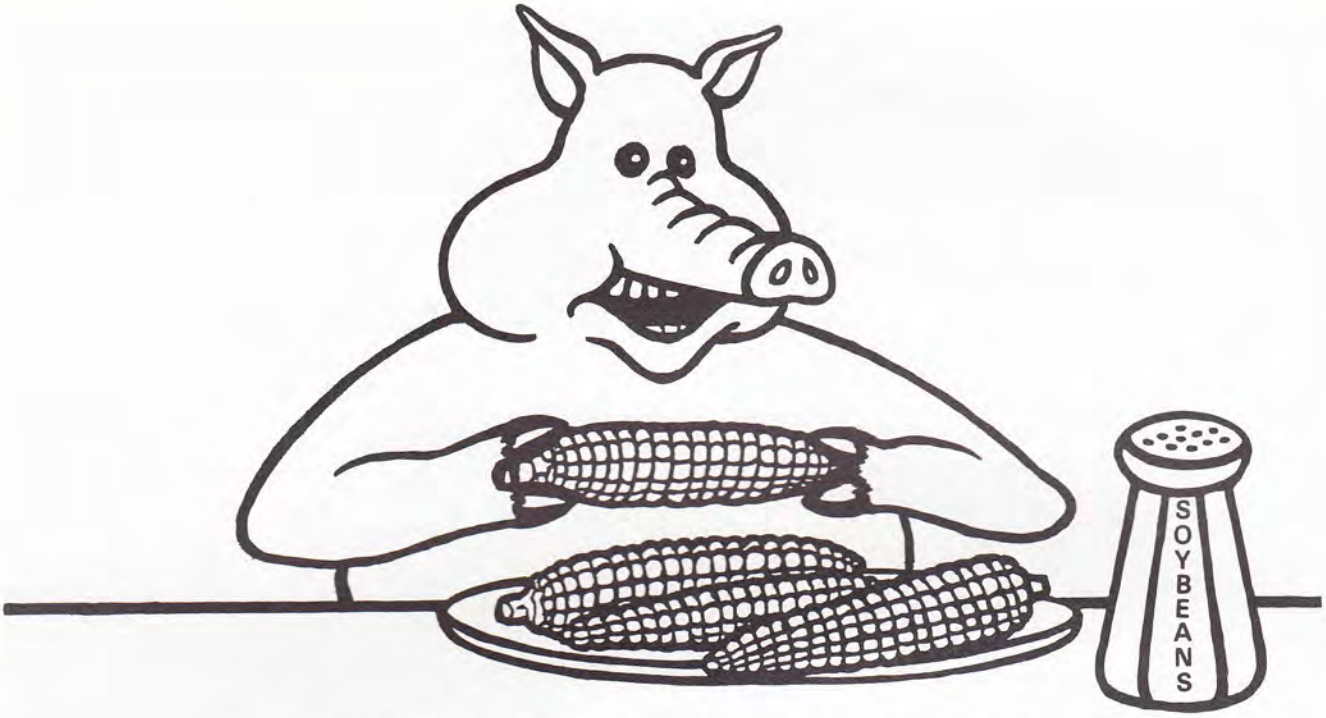
[1]Gerald R. Bodman is Extension Agricultural Engineer—Livestock Systems, Department of Agricultural Engineering. Special thanks is extended to Art and Doug Paus, Fairfield, NE., and Sid and Tim Burkey, Dorchester, NE., for their role in this study and their willingness to share their facilities and records.



SUPPLEMENTING GROWING-FINISHING DIETS WITH ROASTED SOYBEANS

Murray Danielson[1]

Pork producers continue to search for new ideas that will improve profitability and productivity of their operations. Many supplement selected diets with roasted soybeans. The oil in the whole soybean provides an increase in diet energy content. However, the protein content of roasted soybeans under normal conditions is about 37%. Soybean meal contains 44 or 49% protein. As a consequence there are several methods of replacing soybean meal with roasted soybeans. The objective of these studies was to evaluate the effect of several replacement methods when the diets were fed in meal and pelleted form.

Experiments

Two studies were conducted to compare three methods of replacing soybean meal with roasted soybeans in growing-finishing diets. The two studies differed only in that the diets in study A were fed in meal form and the diets in study B were fed in pellet form. Diets for each of the studies were: 1) basal, corn-soybean meal; 2) corn-roasted soybeans (roasted soybeans replaced soybean meal on equal weight basis); 3) corn-roasted soybeans as in diet 2 plus added lysine (L-lysine HCl) to level contained in diet 1; and 4) corn-roasted soybeans (roasted soybeans added at level to make diet equal in protein to diet 1). Diet formulations are in Table 1. The soybeans used in these studies were cooked and roasted using a Mix-Mill Roast-A-Tron. One hundred ninety two 40-50 lb crossbred pigs (96 in each of studies A and B) were used. The study was started with a 16% protein base diet until the pigs weighed 120-130 lb (phase 1) followed with a 14% protein base diet which was fed until end of the studies (220-240 lb (phase 2)).

Pigs in each study were allotted by weight outcome groups with six pigs per pen (three male, three female) and four pens per treatment.

Animals were housed in a semi-confinement facility (shelter for each pen with adjoining concrete platform for exercise, feeder and waterer). Animal weight and feed consumed were recorded at two-week intervals for study duration.

Study A (pigs fed meal diets) was conducted during September-December. Study B (pigs fed pelleted diets) was conducted during March-June. Table 2 indicates performance observed for each study.

Results and Discussion

Study A—As indicated during phase 1 (Table 2) average daily gain (ADG) of pigs fed diets containing

roasted soybeans was significantly reduced as compared to pigs fed the basal diet. The average daily feed intake (ADFI) was lower, which may account for the reduction in ADG. During phase 2 there was no significant difference due to treatment in ADG, ADFI or feed per pound of gain (F/G). There was enough compensatory improvement in phase 2 to offset the decreased performance in phase 1 such that for the complete study there were no significant differences between treatments for ADG, ADFI or F/G.

Study B—ADG of the pigs was not significantly different for the treatments used. There was a significant difference in F/G for each growth phase as well as for the overall study. Overall, whenever roasted soybeans replaced meal there was a significant improvement in F/G. The greatest improvement was shown by pigs fed treatment 4, the equal protein or isonitrogenous diet. ADFI was not significantly altered due to treatment. However, when roasted soybeans were fed intake was reduced as compared with the basal diet intake.

Table 1. Diet composition, studies A and B.

	Diet							
	1		2		3		4	
	Basal		GRS[a] lb/lb		GRS lb/lb + L-lysine		GRS isonitro-genous	
Ingredients	16	14	16	14	16	14	16	14
Corn	72	77.8	72	77.8	72	77.8	67.8	75.3
Soybean meal, 44%	22.3	16.5	—	—	—	—	—	—
Ground roasted soybeans	—	—	22.3	16.5	22.3	16.5	26.5	19
Base mix[b,c]	5.7	5.7	5.7	5.7	5.7[d]	5.7[e]	5.7	5.7

[a]GRS - Ground roasted soybeans.

[b]Base mix includes (% of total 16% diet) - alfalfa hay, 2.5; calcium carbonate, 0.9; dicalcium phosphate, 1.25; iodized salt, 0.5; trace minerals, 0.00075 (Calcium Carbonate Company, Swine, 15% Zn); and vitamins with carrier (finely ground corn) 0.54925; vitamins provided the following per pound of complete diet: vitamin A, 1500 IU; vitamin D, 252 IU; riboflavin, 1 mg; niacin, 8.5 mg; calcium pantothenate, 4.5 mg; choline chloride, 100 mg; vitamin B_{12}, 10 mcg.

[c]Base mix includes (% of total 14% diet) - alfalfa hay, 2.5; calcium carbonate, 0.85; dicalcium phosphate, 0.95; iodized salt, 0.5; trace minerals, 0.00075; and vitamins with carrier, 0.89925; vitamins provided the following per pound of complete diet: vitamin A, 100 IU; vitamin D, 252 IU; riboflavin, 1 mg; niacin, 8.5 mg; calcium pantothenate, 4.5 mg; choline chloride, 100 mg; vitamin B_{12}, 5 mcg.

[d]1298 g of L-lysine was added per ton of complete diet.

[e]958 g of L-lysine was added per ton of complete diet.

Table 2. Performance of animals fed diets supplemented with roasted soybeans.

	Study A - Meal				Study B - Pelleted			
Criteria	1[a]	2[b]	3[c]	4[d]	1[a]	2[b]	3[c]	4[d]
Phase 1 - 16%								
ADG	1.65	1.47	1.41	1.55	1.82	1.84	1.89	1.87
F/G	2.67	2.74	2.74	2.64	2.53	2.48	2.37	2.32
ADFI	4.39	4.02	3.91	4.10	4.61	4.62	4.57	4.41
Phase 2 - 14%								
ADG	1.84	1.83	1.92	1.92	2.12	2.09	2.05	2.11
F/G	3.79	3.63	3.43	3.52	3.36	3.39	3.07	3.05
ADFI	6.95	6.61	6.57	6.76	7.12	6.73	6.59	6.47
Phase 1 and 2								
ADG	1.74	1.64	1.66	1.73	1.97	1.97	1.97	1.99
F/G	3.23	3.21	3.10	3.11	2.96	2.86	2.79	2.70
ADFI	5.61	5.24	5.13	5.37	5.83	5.60	5.05	5.37

[a]Basal corn-soybean meal.

[b]Corn-roasted soybeans (replaced soybean meal on equal weight basis).

[c]Corn-roasted soybeans plus added lysine to level equivalent to diet 1.

[d]Corn-roasted soybeans, isonitrogenous to diet 1.

Conclusions

Overall, the diet treatments used in these two studies provided comparable pig performance within each study. Diet 3 in each study, where lysine was added, provided no increase in performance indicating lysine was not the limiting amino acid.

The difference in overall pig performance between Study A and B can be attributed to several factors. Genetic background and season of year can have much influence on pig performance. The pelleted diets used in Study B all provided for excellent pig performance with regard to average daily gain and feed conversion.

From results of these two studies it would appear replacing soybean meal on the isonitrogenous or equal protein basis to be the recommended method to utilize roasted soybeans in growing-finishing swine when fed in either meal or pellet form.

[1]Murray Danielson is Professor, Swine Nutrition, West Central Research and Extension Center, North Platte.

RAPID DIAGNOSIS OF PSEUDO-RABIES

F.A. Osorio
A.R. Doster[1]

The classical diagnosis of pseudorabies infections has been based on virus isolation and the detection of a significant rise in the level of circulating antibodies in infected animals. Unfortunately, both processes are time consuming and may allow spread of the infection in the herd before a definitive diagnosis can be made. More rapid methods of diagnosis would be helpful.

Rapid viral diagnosis methods are available today which give results quickly. This helps control the disease in a given herd. Ideally, rapid viral diagnosis would be based on the direct detection of components of the virus (proteins or nucleic acids) in the clinical sample in order to provide "same day" disease diagnosis. Biotechnology has provided high affinity reagents e.g., monoclonal antibodies and genetic probes, which permit direct accurate detection of the agent. However, these methods have lower sensitivity than laboratory techniques used for the isolation of the infectious virus. Virus isolation is still the ideal standard of sensitivity because a positive result can be obtained with a single infectious virus particle. The multiplication of this virus particle in cultured cells markedly amplifies the sensitivity of the assay.

This article describes the methodology developed at the Veterinary Diagnostic Center for rapid isolation of psuedorabies virus. We also present data that support the potential applicability of a commercial serologic test for rapid diagnosis of pseudorabies.

Isolation of Pseudorabies Virus

To combine speed and sensitivity for isolation of pseudorabies virus from field samples, we have designed a protocol based on centrifugation enhancement of infectivity. This method consists of applying virus-infected specimens (inoculum) to monolayers of cell cultures by means of a centrifugal field. We have combined this technique with the immunofluorescent detection of inoculated virus using fluorescent monoclonal antibodies specific for pseudorabies virus.

Initially, "detector" cell cultures of swine origin are grown on round glass coverslips in cell culture vials. Tissues from animals suspected of being infected with pseudorabies virus are collected at necropsy, homogenized, clarified, and used for the inoculum. Brain, tonsil, and spleen are the tissues of choice as they often contain the highest concentration of virus. The inoculum is added directly onto the cell monolayers in the vials and centrifuged at a relatively low speed (1500 x g) for 40-60 minutes at room temperature. After centrifugation the inoculum is discarded and fresh cell nutrient medium is added. Following overnight incubation at 98.5°F, the coverslips are removed and the cells are fixed and stained with fluorescent

Table 1. Rate of isolation of pseudorabies virus from field samples.

Time required for detection	Using rotary tubes[a]	Using centrifugal enhancement[b]
12 hours	ND	68
16 hours	26	13
1 day	15	
2 days	24	
3 days	10	
4 days	1	
5 days	4	
6 days	1	
Total no. of positive samples detected	81	81
Total no. of samples assayed	220	220

[a]No. of samples which were positive for pseudorabies virus cytopathic effect.

[b]No. of samples which were positive for pseudorabies virus monoclonal antibody staining or cytopathic effect.

monoclonal antibodies. A positive detection of pseudorabies virus will consist in one or more bright fluorescent groups or "foci" of infected cells when the coverslip is examined under a fluorescence microscope.

Table 1 shows a comparison of isolation rate of pseudorabies virus from field samples collected throughout Nebraska. The samples were tested using both the centrifugal enhancement protocol and a conventional virus isolation test which uses cell cultures grown in rotatory tubes. The centrifugal enhancement method allows the detection of all positive samples (n = 81/220) within 16 hours of inoculation. The conventional test required six days of incubation to reach the same level of sensitivity.

Serology for Rapid Viral Diagnosis

Serology, the demonstration of specific antibodies in sera, is the basis for the detection of animals that are positive reactors for pseudorabies. This methodology is widely used in eradication campaigns. It is anticipated that a wide range of test kits for pseudorabies serology will soon be available for use under field conditions. Different technologies have been applied in the development of these tests. Most of them are based on colorimetric or other "easy-to-read" reactions that avoid the use of sophisticated laboratory equipment. In general, these tests give qualitative evidence that the reactor has been exposed to pseudorabies virus sometime in life, either through infection or vaccination. They do not discriminate between antibodies produced as a result of acute or chronic infections.

We have tested the sensitivity and specificity of one of these new kits, which is based on latex agglutination (Viral Antigens, Inc. Memphis, Tenn.). The active reagent is a suspension of latex beads which have been coated with pseudorabies virus antigen. When mixed with serum or plasma containing pseudorabies antibodies, the latex will agglutinate and form visible clumps. The whole reaction, which only takes eight minutes, is conducted at room temperature.

A group of 531 swine serum samples was tested using the latex agglutination test, the ELISA test and the serum-neutralization (SN) tests. (ELISA and SN are the two official tests carried out at diagnostic laboratories.) The latex agglutination test was slightly more sensitive than the SN test. Apparently the latex technique was able to detect lower levels of circulating antibodies. This makes the sensitivity of the latex assay comparable to that of ELISA test.

Table 2 shows that the latex agglutination test was more sensitive than the other two techniques in detecting the earliest period of anti-

Table 2. Time period (expressed in number of days post-infection) required to detect pseudorabies antibodies in sera of experimentally infected pigs.

Animal ID[a]	Latex agglutin.	SN test	ELISA test
1	6	10	7
2	4	7	6
3	5	7	5
4	5	8	5
5	6	8	7
6	7	8	7
7	4	9	6
8	5	8	7
9	6	8	6
10	6	8	7
11	4	7	5
12	7	8	7

[a]Animals (>70 lb) were inoculated at 0 days post-infection with 1000 Infectious Doses - 50% (ID_{50}) of pseudorabies virus.

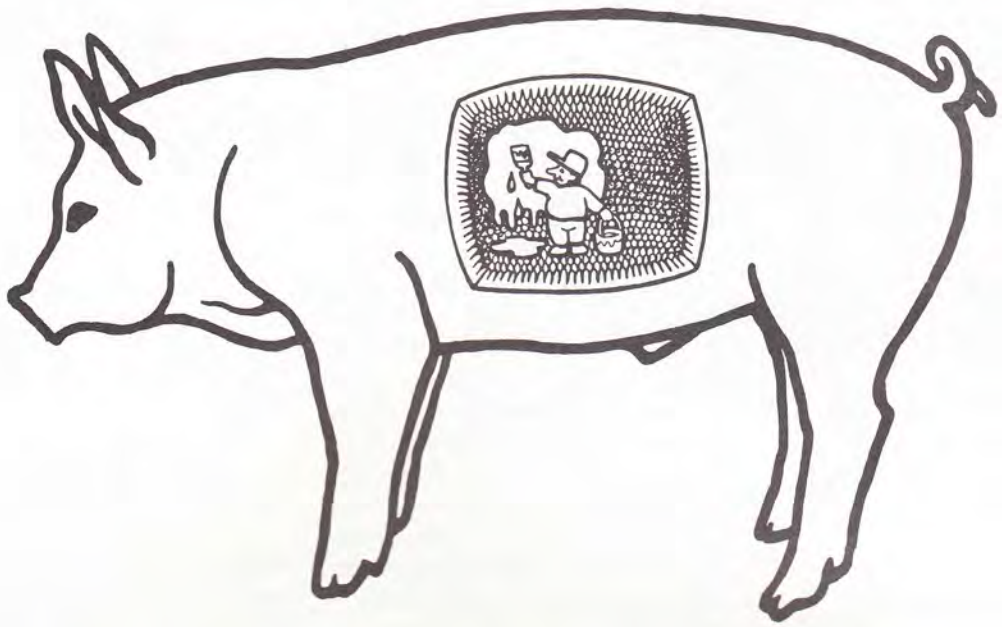
body response that follows experimental infection of pigs with pseudorabies virus. In some cases antibodies were detected by the latex test as soon as four days post-inoculation which is about when clinical signs appear. This greater sensitivity is probably based on the fact that the earliest type of antibody to appear after infection is immunoglobulin M. Immunoglobulin M has a high ability to produce reactions of agglutination.

ting immunoglobulin M. This is specifically useful for the detection and isolation of animals that have been in contact with pseudorabies infected pigs and which may be now incubating the disease. Both alter-

Conclusions

With the advent of new technology it is now possible to shorten the turnaround time of cases involving pseudorabies to less than 24 hours. The enhancement of infectivity through centrifugation combined with the detection of pseudorabies virus with monoclonal antibodies decreases the reporting time without reducing sensitivity. At the same time it is possible to apply serologic tests to the rapid diagnosis of pseudorabies by detecnatives are useful when facing a pseudorabies outbreak in the herd.

[1]F.A. Osorio is Assistant Professor/Virologist, and A.R. Dosteris, Associate Professor/Director of Veterinary Diagnostic Center, both in the Department of Veterinary Science.



PASSIVE IMMUNITY WITH SPRAY DRIED IMMUNOGLOBULINS

W. Leonard Staudinger
Gary Anderson[1]

The importance of feeding colostrum to the newborn was first documented in 1905 when Jensen demonstrated that calves fed boiled colostrum died with an enteritis; whereas, those fed non-boiled colostrum survived. Subsequently, numerous studies have demonstrated that both circulating and intestinal immunoglobulins from fresh colostrum are necessary to protect the new born mammal from numerous diseases.

In the cow, horse, sheep, goat and pig, immunoglobulins are absent in the serum of the newborn. Under normal conditions, antibodies are present in the serum of these animals only after the young have ingested the colostrum. However, the period of time that absorption of colostral antibodies can occur is up to 24 hours after birth, at which time there is closure to further absorption.

It is now known that immunoglobulins in circulation are required to protect against septicemia. However, these circulating antibodies do not necessarily prevent enteric infections. Animals over 24 hours old fed colostrum can be protected from enteric infections, whether or not circulating antibodies are present. Transmissible gastroenteritis (TGEV) and rotavirus are two viruses that replicate in villous or crypt epithelial cells of pig intestines. These viruses usually are not effected by circulating antibodies. Consequently, the primary method used to prevent infections of baby pigs by TGEV and rotavirus is to make sure that the sow has specific antibodies in her colostrum and milk. This confers what is termed lactogenic immunity and depends upon a constant supply of antibodies in the baby pig intestine.

To control infections by TGEV and rotaviruses, sows can be immunized so that neutralizing antibodies appear in the colostrum and milk. If sows do not have these specific immunoglobulins or if pigs have recently been weaned, an outbreak may occur with high morbidity and mortality of pigs. Even in the presence of milk immunoglobulins, infections may occur if concentrations of passive milk antibodies have decreased below protective levels.

Recent work has focused on increasing lactogenic immunity of pigs by feeding spray dried immunoglobulins in colostrum. The approach has been to include these spray dried antibodies in the pig's feed so that high levels of neutralizing antibodies will bathe the intestinal lumen. To be economically feasible, specific neutralizing immunoglobulins

should be in the form of a dried powder so there will be a long shelf life. Additionally, these dried immunoglobulins may be used to "fortify" milk replacers or included in dry feeds such as starters.

Studies Conducted

Temperatures in excess of 160°F denature proteins; thus, freeze drying has been the standard drying practice to maintain immunoglobulin structural and functional viability. Unfortunately, this process is relatively slow and requires large amounts of energy. Spray drying immunoglobulins, however, is a relatively inexpensive method of obtaining a dried product. Although temperatures during the drying procedure can vary from 285 to 390°C, far higher than temperatures that typically denature the protein, we have found that homogenizing immunoglobulins in bovine colostrum before spray drying protects them from denaturation. For example, Table 1 shows the effect of pasteurization and spray drying on TGEV neutralizing titers of a mixture of bovine colostrum and pig serva carrying a high level of anti-TGEV immunoglobulin. It appeared that TGEV specific immunoglobulins did survive the high temperatures encountered during spray drying. The next step was to see if spray dried colostrum would protect baby pigs from virus-induced diarrhea.

Colostrum from 14 dairy cows was used in the study. Half had received multiple vaccinations with Norden's Scour Guard3. The vaccination procedure was designed to produce high levels of rotavirus immunity. Bovine rotavirus immunoglobulins cross react with porcine rotavirus. After parturition the first three milkings from each animal (both immunized and control) were frozen and stored appropriately for future pooling and processing. The colostrum from immunized and control groups each were pooled and spray dried at 356°F inlet and 149°F outlet temperature. These pools provided "test colostrum" and the "control colostrum" for studies in piglets.

Table 1. The effects of spray drying on neutralizing capacity of immunoglobulins.

Neutralization titers		Spray dryer temperature	
Before S.D.[a]	After S.D.	In	Out
128	128	284 F	140 F
256	256	329 F	149 F
256	512	374 F	158 F
256	512	410 F	176 F

[a]S.D. = Spray Drying

Eight piglets were derived by C-section and housed in a sterile environment throughout the study. All pigs (gnotobiotes) were fed SPF-Lac spiked with either the spray dried "test colostrum", the spray dried "control colostrum", or SPF-Lac without any colostrum for 13 days. When the piglets were three days old (day 3), they were inoculated with 1 ml of feces known to be infected with virulent porcine rotavirus. For three days before rotavirus challenge, the consistency of fecal samples was either normal or pasty in all pigs. By day one following the first challenge, all control pigs demonstrated watery feces. The pigs that ingested reconstituted dried "test" and "control" colostrum had normal, or in a few cases, pasty fecal consistency three days after the first challenge, indicating complete protection.

After the second challenge, control pigs showed very watery fecal consistency or projectile diarrhea, whereas only one pig receiving "test colostrum" had feces classified as slightly watery. One pig from the "control" colostrum treatment also had feces classified as a little watery the first day after the second challenge.

In addition to clinical observations, rotazyme tests were performed on fecal samples collected before and after challenge. A positive test indicated shedding of virus by an infected pig. In a few cases, the rotazyme results were checked by electron microscopic examination of the fecal sample. The "control" and "test colostrum" treated pigs all showed a negative reaction, indicating no viral particles were being shed before challenge. After challenge, control pigs had feces that tested positive for the presence of virus by both the rotazyme test and by electron microscopy. Two of the four pigs fed "test" colostrum had viral particles in their feces one day following the second challenge and two pigs in this group also developed a positive rotazyme test four days after the second challenge. The pigs receiving spray dried "control" colostrum had delayed shedding of viral particles in their feces.

Summary

Laboratory serum neutralization tests indicate that immunoglobulins homogenized in bovine colostrum and spray dried retain their viability to the extent that they prevent infections of cells in culture. In addition, feeding spray dried colostrum to gnotobiotic piglets completely protected them against a single challenge of rotavirus. This was true of colostrum from the non-immunized as well as the immunized animals. It is likely that even the non-immunized heifers and cows had antibodies in their colostrum from previous infections. In addition, a second challenge with rotavirus resulted in essentially no clinical signs in the colostrum fed piglets but virus was shed.

It yet has to be determined whether using spray dried colostrum to enhance lactogenic immunity will prevent or ameliorate infections under field conditions. The stress encountered by baby pigs in a laboratory are appreciably different from the conditions encountered in typical feeder pig operations. The practicality of using spray dried preparations to enhance protection from enteric infections remains to be determined; however, the potential of increasing survivability during disease outbreaks is promising.

[1]W. Leonard Staudinger is Visiting Associate Professor, and Gary Anderson an Associate Professor, both in the Department of Veterinary Science.

TEXTURE OF PREBLENDED COARSE GROUND SAUSAGE IN CASINGS

James W. Lamkey
Roger W. Mandigo
Chris R. Calkins[1]

Preblending is a method of processing sausages that allows for storage of the raw material with reduced microbial growth. Preblending also allows time for analysis of the raw material so that the processor can get a more consistent product. Preblended meats contain water, salt, nitrite, and sometimes spices and are stored in a cooler until made into sausage. The extended time of contact between salt and meat allows for increased penetration of salt into the meat and results in greater extraction of proteins required to give texture to the final product.

The processing of meat into sausage is accomplished by reduction in particle size (grinding) and mixing for incorporation of the ingredients required for flavor. Although preblending increases the protein extraction, the physical manipulation of the batter (mixing, grinding) after storage may actually reduce the advantages. This experiment was designed to study the effect of physical manipulation on the textural properties of a coarse ground sausage product.

Materials and Methods

Pork and beef were ground to 1/2 inch and mixed eight minutes with water, salt, nitrite, and spices. Sausage batches were made every 4 hours for a 24-hour period. After mixing, batches were divided in half and each half was either ground to 1/8 inch and stuffed into casings or placed in plastic bags without grinding. Both halves were stored in a cooler for 24, 20, 16, 12, 8, 4, or 0 hours. The time of mixing of batches was designed so that all treatments could be processed in the smokehouse simultaneously. Preblends stored in plastic bags were ground to 1/8 inch and stuffed into casings after the storage period. Raw preblends were analyzed for pH, water-holding capacity, and Instron extrusion. Textural analyses of the final product was accomplished with Lee-Kramer shear and compression attachments on the Instron Universal Testing Machine.

Results and Discussion

Analyses of the raw preblends revealed that pH and moisture retention were not affected by either storage method or storage time. Smokehouse yield revealed that the stuffed sausage exhibited about 2% less yield when compared to their unstuffed counterparts.

Extrusion is a measure of the force required to push the batter through small openings. A greater force indicates increased resistance to flow (increased viscosity). Figure 1 indicates increasingly greater force was required to extrude the stuffed preblend overtime while the extrusion force of preblend that was not stuffed remained relatively constant. This increase in viscosity suggests that bonds formed during the storage period are destroyed upon grinding.

To determine if the loss in bonding due to grinding affects the texture of the final product, two tests were performed. Lee-Kramer shear measures the force required to shear the sausage with nine metal plates in a holding device. The interpretation of the results for this grind size is a combination of bond formation and tenderness of particles. Tenderness increases (indicated by a decrease in the amount of force) with an increase in protein extraction. Bind, on the other hand, will increase as the amount of extracted protein increases. Figure 2 is a graph of mea-

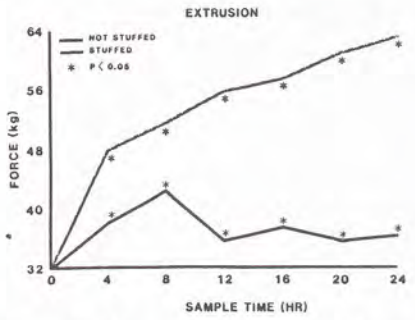


Figure 1. Mean extrusion forces of raw preblends as influenced by storage time.

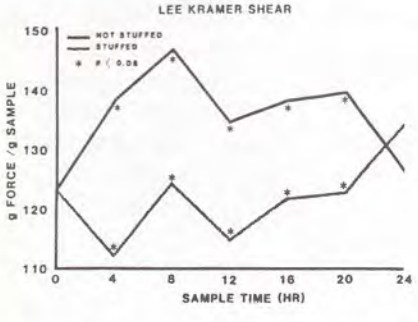


Figure 2. Mean Lee-Kramer shear peak forces as influenced by storage time.

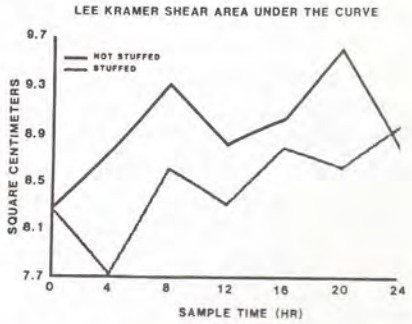


Figure 3. Mean Lee-Kramer area under the curve as influenced by storage time.

surements indicating the greatest force required to shear sausages from each holding method. There was some variation within each method, but throughout the storage period there were no significant changes. Preblends that were not stuffed during the storage period required a greater amount of force to be sheared than did the stuffed counterparts. This indicates that there was an increased tenderness in the stuffed samples.

Where peak force is a measure of the greatest amount of force required to shear the samples, area under the curve is an indication of total force required. Total force is also defined as work. Figure 3 indicates that sausages not stuffed during storage had a tendency to require more work. However, no significant differences were found for storage method or time. One point to note is that both methods did increase in the amount of total force over the entire storage period. This increase in work over time is another indication of the increase in bond formation.

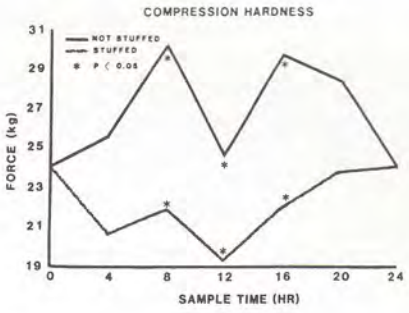


Figure 4. Mean compression hardness values as indicated by storage time.

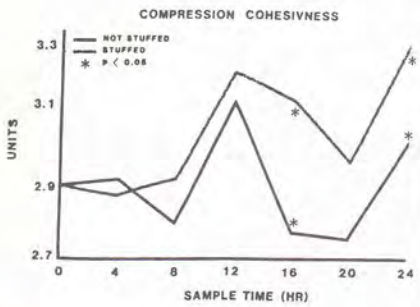


Figure 5. Mean compression cohesiveness values as indicated by storage time.

Compression is a test to determine the product's ability to resist deformation. Hardness is a measure of the force required to deform the product. Although Figure 4 indicates no difference over the storage period within each method, less force was required to deform the stuffed samples than the samples not stuffed. On the other hand cohesiveness (Figure 5) was greater for the stuffed samples than for the samples not stuffed. Cohesiveness is defined as the ratio of the amount of work required to deform the product when it is compressed the first time to the amount of work required when the sample is compressed a second time. As compression values increase, there is a strong indication that the resistance to the second compression force is greater. Data indicate that there was a greater number of bonds formed between particles in the stuffed samples but they were not as strong as the bonds in the samples not stuffed.

Summary

This study indicates that stuffing sausage products before storage increases the number of bonds formed. However, for sausages that are not ground after storage, the extracted protein does not get distributed evenly throughout the product. A more even distribution seems to give increased bond strength to the finished product.

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[1]James W. Lamkey is a graduate student, Roger W. Mandigo is Professor, Meats, and Chris R. Calkins is Associate Professor, Meats, Department of Animal Science.

EFFECTS OF TRANSPORT ON FEEDER PIG PERFORMANCE AND BLOOD CHEMISTRY

M. C. Brumm
B. D. Schultz
E. T. Clemens[1]

Feeder pigs (164) were used in an experiment to evaluate effects of extended transport on performance, health, and blood chemistry. Feeder pigs were purchased from a large farrowing complex, eartagged, weighed and assigned to one of two experimental transport distances. Beginning at 4:30 p.m. pigs were loaded and either taken 15 miles directly to the Nebraska Northeast Research and Extension Center, or transported overnight by commercial truck 603 miles before arriving at the Center. Both groups of pigs were withheld from feed and water for the same 19-hour transport period.

When the transport (603 miles) pigs arrived at the Center all were allotted to pens and limit-fed twice daily a receiving diet containing 10% alfalfa for seven days, then fed the diet *ad lib* for two additional weeks. Both groups of pigs were then fed a 16% crude protein grower diet until reaching 125 pounds body weight, following which a 14% finishing diet was fed. Pigs were housed in a partially slatted floor facility with 12 pens. There were 14 pigs per pen (6.4 sq. ft/pig) for 8 pens and 13 pigs per pen (6.8 sq ft/pig) for the remaining 4 pens.

Blood samples were collected by venus puncture from all pigs before transport and again at the time the transport pigs reached the Center (and before feed and water access). Additional blood samples were collected one week post-transport and at the end of the 84-day experimental period (12 weeks post-transport).

Results and Discussion

Transporting feeder pigs from a common source 603 miles versus 15

Table 1. Effects of transport on feeder pig performance.[a]

	Pre-transport value		Post-transport value		1 week post-transport		12 weeks post-transport	
	Trans.	Non-trans.	Trans.	Non-trans.	Trans.	Non-trans.	Trans.	Non-trans.
Body weight (lb)	50.6	50.8	45.5	46.2	53.9	55.0	196.7	194.5
Average daily gain (lb)	—	—	—	—	0.42	0.51	1.39	1.36
Average daily feed (lb)	—	—	—	—	1.94	2.00	4.93	4.82
Feed/gain ratio	—	—	—	—	4.66	4.15	3.57	3.56

[a] One pig in the non-transport group died during the experiment, three non-transport and two transport pigs were treated during the experiment.

miles, with no access to feed and water, had little effect on performance. Weight loss for the 19-hour transport period was similar, 5.1 lb from the transport pigs, 4.6 lb for the non-transport pig. One week after purchase and transport, the transport pigs were 1.1 pounds lighter in average weight than the non-transport pigs. There was, however, no significant effect of transport on animal weight gain or feed conversion at any time during the experimental period (Table 1). The transport pigs ate less feed during the first week post-transport. It is possible that any transport effect on performance occurred during the loading and initial transport, and thus was also experienced by those pigs taken the short 15 miles distance.

These results do not support the suggestion that transport distance is by itself a contributing factor to reduced overall performance of purchased feeder pigs. Time off feed and water, which is a part of transportation, was equalized for the two treatments in this study. Reports of excess shrink and reduced performance of transported pigs may be due to time off food and water.

Effects of long distance transport on feeder pig hematology and blood chemistry is reported in Table 2. Several such blood values reflect disturbances in body fluid balance (i.e. colloids, osmolality and packed-cell volume), degree of stress (cortisol and triiodothyronine) and possible health status (white blood cell counts, primarily neutrophils and lymphocytes). Pretransport blood values appeared normal for both groups of pigs. However, 19 hours later when the transported pigs arrived at the Center and were compared to the non-transport pigs, several areas of statistical differences were noted. The greater increase in the packed-cell volume, percent neutrophils and neutrophil/lymphocyte ratio suggests the transport pigs were under some degree of stress. However, the changes in these values, relative to the pre-transport values, as well as the increase in cortisol and depressed triiodothyronine, suggest that the 19 hours of feed and water deprivation was of greater physiological significance than was the transport distance. The lower triiodothyronine value for the non-transport pigs would indicate their ability to further reduce metabolic process and conserve weight loss, as was evident in the post-transport performance data. Fluid losses of both groups, as reflected by the colloid and osmolality values, were similar.

It is important to note that, one week after transport, statistical differences in hematology, blood chemistry, or performance data were no longer apparent. The absence of statistical differences was also evident at the 12-week period. Thus, both the performance data and blood analysis suggest that long distance transport of feeder pigs has no lasting detrimental effect on the animal. And that the short-term (19-hour) feed and water deprivation and/or relocation of swine may be of more importance in the initial setback in performance of feeder pigs.

1/M. C. Brumm is Extension Swine Specialist, Northeast Research and Extension Center, Concord. B. D. Schultz is a former graduate student, and E. T. Clemens is Associate Professor, Physiology, Department of Veterinary Science.

Table 2. Effects of transport on feeder pig blood chemistry and hematologic examination.

	Pre-transport value		Post-transport value		1 week post-transport		12 weeks post-transport	
	Trans.	Non-trans.	Trans.	Non-trans.	Trans.	Non-trans.	Trans.	Non-trans.
Blood chemistry								
Colloid (mm Hg)	23.1	22.2	21.0	20.9	22.0	21.6	23.9	24.8
Osmolality (mOsm)	306	301	304	301	307	314	308	308
Cortisol (ug/dl)	4.1	3.6	5.5	7.3 [a]	4.8	3.4	4.9	6.9
Triidothyronine (ng/dl)	40.5	43.1	31.8	26.5	46.3	50.9	42.9	37.8
Hematology								
Packed-cell volume	32.2	33.1	36.3	34.9	36.2	35.0	41.5	40.4
Neutrophils (%)	37.3	37.5	48.6	43.8 [a]	35.4	32.2	33.3	32.8
Lymphocytes (%)	57.5	58.1	48.4	52.1 [a]	60.1	63.5	63.2	64.2
Monocytes (%)	2.4	2.2	2.0	2.7	2.4	2.4	1.8	1.2
Eosinophils (%)	2.3	1.8	0.5	1.1	1.5	1.7	1.7	1.8
Basophils (%)	0.5	0.4	0.0	0.2	0.4	0.5	0.2	0.0
Neut/Lymph ratio	0.64	0.65	1.00	0.84[a]	0.59	0.51	0.53	0.51

[a]Transport and non-transport values within the post-transport sampling period are statistically different at the $P \leq 0.05$ level of significance.

BUYING GOOD QUALITY SOYBEAN MEAL

Duane E. Reese[1]

The use of base mixes and vitamin and trace mineral premixes in feeds is increasingly common among Nebraska pork producers. In a recent survey, nearly 43% of Nebraska pork producers indicated that the majority of the feed they fed was made on the farm using grain, soybean meal, and premix.

Buying soybean meal and making diets on the farm does not insure that the feed quality will be as good as or better than that obtained by buying a complete feed or supplement. In fact, the quality may be worse if, for example, the soybean meal does not contain the level of protein it was assumed to have. Pig performance and profits could suffer as a result.

Pork producers who buy soybean meal should be knowledgeable about the steps they can take to be sure they are buying good quality soybean meal, and what to do if quality becomes a problem.

Important First Step

Pork producers who buy soybean meal directly from processors should ask if the meal is being sold under National Soybean Processors Association (NSPA) trading rules. If the processor and the producer agree to conduct the sale under NSPA rules, then the producer can follow the guidelines below to check quality and file claims with the processor if quality becomes a problem.

On the other hand, producers who buy soybean meal from dealers should ask the dealer if they (the dealer) purchased the meal under NSPA guidelines. Producers buying soybean meal from dealers who take physical possession of the meal are not able to use NSPA trading rules to identify quality problems and file claims with the dealer. There are no uniform trading rules published that a pork producer can use to file a claim when buying soybean meal from a dealer. Procedures for filing claims must be established between the producer and the dealer. Therefore, probably the best quality assurance measure that a pork producer has when buying soybean meal from a dealer is to establish whether the dealer bought the meal under NSPA guidelines.

Sampling and Chemical Analysis

Pork producers should not attempt to take their own samples and submit them for analyses because they are not considered "official" and cannot be used to settle claims under NSPA guidelines. An official sample of each load of soybean meal that leaves the processor is taken and is retained by the processor. Portions of this sample are used for chemical analyses.

If producers wish to check meal quality they can obtain a portion of the official sample for analysis by simply contacting the processor. Upon request the processor will do one of two things with the samples: (1) Send it to the producer to be analyzed at a laboratory of the producer's choice, or (2) send it directly to an NSPA certified laboratory acceptable to the processor. Processors usually have a list of NSPA certified laboratories.

In the event that a producer submits a portion of the official sample to a laboratory of the producer's choosing, the next step is to submit the results of the analysis and a claim

in writing to the processor. If settlement cannot be reached on the basis of the analysis conducted in the producer's and processor's laboratories, a third portion of the official sample will be sent to a mutually-agreeable referee laboratory if requested by the processor. Results of this analysis will be used to settle the claim. Expense for the third analysis will be borne by the producer or processor depending on the results.

If the producer's portion of the sample is sent directly to an NSPA certified laboratory, then the producer's analysis is considered valid unless the processor reports a different analysis of the official sample. In this case the processor can request that the certified laboratory, which conducted the buyer's analysis, send a retained portion of the official sample to a mutually-agreeable official referee laboratory. The results of this third analysis are binding upon both parties and are used to settle claims. Furthermore, the processor pays for the third analysis.

What To Analyze For

Under NSPA guidelines producers can receive payment if soybean meal does not meet moisture, crude fiber, and crude protein specifications. Thus, there is little justification for having the official sample analyzed for more than these three components.

Settling Claims

Producers have 40 days from the time the soybean meal arrives on the farm to file written claims with the processor or they will be waived. As stated earlier, NSPA guidelines call for monetary adjustments in the price of soybean meal if moisture, fiber and protein specifications agreed to at the time of sale are not met. In the case of a protein analysis less than specification, the processor will pay the producer the amount of two times the delivered invoice bulk price per unit of protein below specifications.

Protein is not considered to be below specification unless the soybean meal tests .5% of protein below specification adjusted to 12% moisture. Thus, 44% soybean meal would have to test below 43.5% protein (on a 12% moisture basis) before a deficiency payment would be paid. For example, if 44% soybean meal tested 43% protein, then the settlement for protein would amount to $3.60 a ton for soybean meal having a bulk price of $180 per ton (44% -43% = 1% x 2 x $180/ton).

Adjustments for excess fiber and moisture are calculated in a similar way. It is important to note that the adjustments for protein, etc., outlined in the guidelines can be modified by the producer and processor. For more details regarding the NSPA guidelines, producers can contact their soybean meal supplier or call the NSPA at 202-452-8040.

Summary

Good quality soybean meal is an essential component of a sound nutrition program. Producers who buy soybean meal are encouraged to check with their supplier to determine if the soybean meal is being sold under National Soybean Processors Association (NSPA) guidelines. If so, producers are better able to work with suppliers to resolve problems with the soybean meal quality.

[1]Duane E. Reese is Extension Swine Specialist, Department of Animal Science.

USE OF PORK SKIN PRE-EMULSIONS IN A LOW FAT PORK LOAF PRODUCT

Lawrence N. Quint
Roger W. Mandigo
Chris R. Calkins[1]

Current consumer demand for reduced fat in processed meats poses both a challenge and an opportunity to the meat industry. The challenge lies in finding a way to produce such products at a reasonable cost without loss of palatability or consumer acceptance. At the same time, production of these products may provide the opportunity to increase utilization of high collagen by-products such as pork skins.

In Europe, pig skins are often added to finely comminuted meats in the form of pre-emulsions to reduce formulation costs. The use of pork skin pre-emulsions to replace the more expensive lean at low levels would upgrade their value while making the final product more affordable without significant impact on its nutritional quality. This research was conducted to investigate the effects of reducing fat content and replacing 7.5% of the lean meat with pork skin pre-emulsions on product color, texture, and sensory properties.

Materials and Methods

Skin was removed from pork shoulders and bellies. Trimmed skin was frozen, tempered to 25°F, and comminuted. Comminuted skin was then used to produce two pre-emulsions, one with calcium caseinate and one without. This was done by hand mixing the skin and calcium caseinate (if called for) with an equal weight of ice. This mixture was run through an emulsion mill twice. The various pork loaf treatment formulations are listed in Table 1. The low

Table 1. Pork loaf treatment formulations.

	Treatments			
	High fat	Low fat	Low fat, pre-emulsion	Low fat, pre-emulsion, calcium caseinate
Lean pork (7.0% fat)	11.25 lb	15.35 lb	15.80 lb	15.80 lb
Regular pork (28.5% fat)	2.26 lb	4.65 lb	2.70 lb	2.70 lb
Fat pork (71% fat)	6.49 lb	— — —	— — —	— — —
Water/Ice	2.00 lb	2.00 lb	2.00 lb	2.00 lb
Pork skin (32% fat)	— — —	— — —	1.50 lb	1.50 lb
Salt	180.0 g	180.0 g	180.0 g	180.0 g
Calcium Caseinate	— — —	— — —	— — —	136.2 g
Seasonings	103.0 g	103.0 g	103.0 g	103.0 g
Sodium Phosphates	40.0 g	40.0 g	40.0 g	40.0 g
Sugar	28.0 g	28.0 g	28.0 g	28.0 g
Cure (6.25% Nitrite)	22.5 g	22.5 g	22.5 g	22.5 g
Sodium Erythorbate	5.0 g	5.0 g	5.0 g	5.0 g

and high fat treatments were formulated to contain 11% and 28% fat, respectively. Ground lean pork trim was combined with the remaining water (total water less any used in skin emulsion preparation), salt, sugar, seasonings, phosphate, cure (nitrite) and sodium erythorbate. After five minute mixing, fat pork trim and the pre-emulsion were added and mixing was resumed for an additional three minutes. The resulting batter was then run through an emulsion mill, stuffed into No. 9 fibrous casings and thermally processed to an internal temperature of 149°F. The experiment was repeated three times. Pork loaf color was evaluated using the Hunter colorimeter. Texture analyses were performed with the compression, Lee-Kramer shear, and bind-adhesion attachments on the Instron Universal Testing Machine. A consumer sensory panel of college students was used to evaluate the pork loaf treatments for juiciness, texture during chewing, and overall acceptability.

Results and Discussion

The effect of fat content and skin pre-emulsions on pork loaf color in terms of Hunter "L", "a" and "b" values are presented in Table 2. Hunter "L" values describe pork loaf lightness, with a larger value indicating a lighter color. Lightness appeared to be related to fat content, since the high fat loaves had higher Hunter "L" values than the low fat loaves. Among the low fat loaves, the addition of skin alone resulted in no increase in product lightness, while the inclusion of calcium caseinate increased lightness. Calcium caseinate is a white powder and its inclusion would be expected to result in a lighter product.

Hunter "a" values describe redness, with a larger value indicating a greater intensity of product redness. Reducing pork loaf fat content increased product redness. The addition of skin pre-emulsions resulted in an increase in redness over the other low fat treatment.

Hunter "b" values indicate pork loaf yellowness, with higher values indicating a greater yellow component in the product color. The high fat loaves were found to have the most intense yellow component. The use of skin pre-emulsions increased the intensity of the yellow color component of the pork loaf among the low fat treatments, and within the treatments containing pre-emulsions, the inclusion of caseinate further increased the intensity of the yellow component.

Compression hardness values for the various pork loaf treatments are presented in Table 3. Hardness values for the high fat treatment were lower than for the low fat treatments, indicating a less firm product. Among the low fat treatments, the addition of skin emulsions increased hardness values and the inclusion of caseinate with the pre-emulsion further increased loaf hardness.

Lee-Kramer peak shear force and total work values are shown in Table 3. It is seen that pork loaf firmness, as indicated by lower peak shear force and total work values, was lower for the high fat treatment than the low fat treatments. Also, within the low fat treatments, addition of pre-emulsions increased firmness. The pre-emulsion containing caseinate produced the firmest pork loaves. The firming effect of calcium caseinate on pork loaf texture should be expected since it in effect increased the protein content at the expense of moisture and fat.

The adhesion-bind test is used to estimate the relative bind between particles in finely comminuted meat products. Adhesion peak force values are shown in Table 3. The high fat treatment had lower bind than all the low fat treatments. A higher fat content would be expected to have this effect, since the fat dilutes the protein matrix which is responsible for product bind. Among the low fat

Table 2. Effect of reduced fat content and pork skin pre-emulsions on pork loaf Hunter color scores.

Treatment	Hunter L	Hunter a	Hunter b
High fat	59.97[a]	7.75[c]	10.12[a]
Low fat	52.39[c]	9.06[b]	8.83[d]
Low fat, pre-emulsion	52.87[c]	9.39[a]	9.20[c]
Low fat, pre-emulsion caseinate	54.27[b]	9.37[a]	9.54[b]

[abcd]Means in the same column but with different superscripts are significantly different ($p < .05$).

Table 3. Effect of reduced fat content and pork skin pre-emulsions on pork loaf compression hardness, Kramer shear and adhesion-bind values.

Treatment	Compression hardness (kg)	Peak shear force (kg/g)	Total work to shear (kg-mm/g)	Adhesion peak force (g)
High fat	82.4[d]	1.02[d]	22.17[d]	125.56[d]
Low fat	116.1[c]	1.20[c]	25.72[c]	201.33[c]
Low fat, pre-emulsion	127.3[b]	1.41[b]	27.43[b]	292.83[b]
Low fat, pre-emulsion, caseinate	148.8[a]	1.64[a]	31.00[a]	336.83[a]

[abcd]Means in the same column but with different superscripts are significantly different ($p < .05$).

treatments, the addition of pre-emulsions improved bind values and within the pre-emulsion treatments, the inclusion of caseinate further improved bind values.

Consumer sensory evaluation data are presented in Table 4. Pork loaf containing the higher fat content was rated highest for juiciness. This was significantly higher than the two treatments containing pre-emulsions. No significant treatment differences were seen for texture ratings despite the rather large differences measured instrumentally. This may be due to the lack of sensitivity associated with using an untrained consumer panel. No significant treatment differences were observed for overall acceptability. Scores for both texture and overall acceptability indicate that consumers displayed some liking for all treatments.

Summary

Results of this study indicate that reducing fat content of pork loaf formulations impacts on product color, increases product firmness and bind, and decreases product juiciness. All of these effects may be of importance to the meat processor. Replacement of 7.5% of the meat block in low fat pork loaf formulations with pork skin pre-emulsions further changes product color, causes a greater increase in product firmness and bind, and results in a greater decrease in product juiciness.

[1]Lawrence N. Quint is a graduate student, Roger W. Mandigo is Professor, Meats, and Chris R. Calkins is Associate Professor, Meats, Department of Animal Science.

Table 4. Effect of reduced fat content and pork skin pre-emulsions on pork loaf consumer sensory evaluation scores[a].

Treatment	Juiciness	Texture	Overall acceptability
High fat	5.26[b]	5.25	5.19
Low fat	5.19[bc]	5.08	5.26
Low fat, pre-emulsion	4.82[cd]	4.99	5.06
Low fat, pre-emulsion, caseinate	4.67[d]	4.71	4.75

[a]Sensory panel utilized a hedonic scale as follows: 1 = dislike extremely, 4 = neutral, 7 = like extremely.

[bcd]Means in the same column but with different superscripts are significantly different ($p < .05$).

NEW VARIETIES OF GRAIN SORGHUM – ARE THEY BETTER FOR SWINE?

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

Grain sorghum and corn are the leading grains fed to pigs in Nebraska. Both produce similar weight gains, but it has been known for years that pigs fed grain sorghum require more feed per pound of gain than pigs fed corn. Thus, when all performance factors are considered, the "rule of thumb" is that grain sorghum has a feeding value equal to 95% of corn. That is, if corn is selling for $4.00 per 100 lb, grain sorghum is worth $3.80. Anything less than the $3.80 used in this example offers an economic advantage to the feeder, assuming all other factors associated with the production, buying, selling, storage and availability of grain sorghum and corn are equal.

However, times change. New varieties of grain sorghum are constantly being developed by plant geneticists. Although most of the new varieties evolve because of their ability to produce grain and withstand the rigors of their growing environment, some have characteristics (large kernels; softer starch) that might improve their feeding value. With this in mind, two experiments were conducted to determine the feed value of three newer varieties of grain sorghum for nursery-age and growing-finishing pigs.

The three varieties studied were Pioneer 8333, considered a standard bronze sorghum; NC+271, a cream variety; and Funks G550, a yellow variety. These three were chosen because of their availability in Nebraska. The grain sorghums fed to nursery-age pigs were grown at the Agricultural Research and Development Center, Mead, NE and were

produced under the same agronomic conditions. Because greater quantities of grain were needed, the NC + 271 and Funks G550 varieties were purchased on the open market for the growing-finishing experiment.

Nursery-Age Pig Experiment

Two hundred and forty 18 lb pigs were assigned, 20 pigs per pen, 3 pens per treatment. The four dietary treatments were normal corn, Pioneer 8333 (bronze), NC + 271 (cream) and Funks G550 (yellow)—each fed in a typical pelleted starter diet containing some milk products. Each diet was formulated to contain 1.15% lysine since the grains varied in lysine content. Results of the 28-day experiment are shown in Table 1.

During the first 14 days, pigs fed the diets with corn gained 7.8% faster, consumed 6% more feed but were no more efficient in feed conversion than those fed the various grain sorghum diets. At the end of the 28-day experiment, pigs fed the diets with corn continued to maintain their gain (6.7%) and feed intake (5.9%) advantage over pigs fed the sorghum diets.

A somewhat surprising finding was that feed conversion of the pigs was the same regardless of the grain fed. The fact that the diets were balanced for lysine (1.15%) and were pelleted may have contributed to the lack of difference in feed conversion. Or, the availability of the nutrients in the newer varieties of grain sorghum may have been better. It would seem that all of the difference in gain between the pigs fed diets with corn and those fed diets with grain sorghum was due to the reduced feed intake of the grain sorghum diets.

Pigs fed the yellow and cream sorghums gained 7.8% faster, consumed 5.4% more feed and were 2.8% more efficient than those fed the bronze sorghum during the first 14 days. For the entire experiment pigs fed the yellow and cream sorghums gained 3% faster than pigs

Table 1. Value of grain sorghum varieties for nursery-age pigs[a] (Neb. Exp. 85416).

	Avg. daily gain, lb	Avg. daily feed intake lb	Feed/gain ratio
	0-14 days		
Corn	1.06	1.48	1.40
P-8333 (bronze)	0.93	1.35	1.44
NC + 271 (cream)	1.00	1.43	1.42
F-G550 (yellow)	1.01	1.40	1.39
	0-28 days		
Corn	1.23	2.00	1.62
P-8333 (bronze)	1.13	1.86	1.65
NC + 271 (cream)	1.17	1.91	1.63
F-G550 (yellow)	1.16	1.89	1.62

[a]Data based on 3 pens of 20 pigs/pen/trt. Int. wt. 18 lb.

Table 2. Effect of grain sorghum varieties on performance of G-F pigs[a] (Neb. Exp. 85416).

Grain	Diet balancing method: Lysine basis	Protein basis	Avg for grain
	Avg. daily gain, lb		
Corn	1.72	1.76	1.74
P-8333 (bronze)	1.69	1.65	1.67
NC + 271 (cream)	1.68	1.74	1.71
F-G550 (yellow	1.66	1.61	1.64
Avg. for balancing method	1.69	1.69	
	Feed/Gain ratio		
Corn	3.25	3.21	3.23
P-8333 (bronze)	3.38	3.44	3.41
NC + 271 (cream)	3.59	3.47	3.53
F-G550 (yellow)	3.40	3.34	3.37
Avg. for balancing method	3.40	3.37	

[a]3 pens of 10 pigs/pen/trt. Int. wt. 47.0 lb; final wt. 220 lb.

Table 3. Effect of grain sorghum varieties on carcass traits of G-F swine[a] (Neb. Exp. 85416).

Grain	Diet balancing method: Lysine basis	Protein basis	Avg for grain
	Dressing, %		
Corn	74.5	74.4	74.3
P-8333 (bronze)	72.7	73.8	73.2
NC + 271 (cream)	73.0	73.3	73.1
F-G550 (yellow)	73.6	74.6	74.1
Avg. for balancing method	73.4	74.0	
	Carcass length, inches		
Corn	31.35	31.63	31.49
P-8333 (bronze)	31.93	31.64	31.79
NC + 271 (cream)	31.27	31.76	31.51
F-G550 (yellow)	31.53	31.49	31.51
Avg. for balancing method	31.52	31.63	
	Avg. backfat inches		
Corn	1.32	1.27	1.29
P-8333 (bronze)	1.27	1.34	1.30
NC + 271 (cream)	1.34	1.27	1.31
F-G550 (yellow)	1.33	1.30	1.32
Avg. for balancing method	1.31	1.30	

[a]Data based on 18 pigs with 12 barrows and 6 gilts/trt.

fed bronze sorghum with intake and efficiency being similar. The differences between the bronze and the yellow and cream sorghums during the first two weeks were probably due to reduced feed intake associated perhaps with lower palatability of the bronze sorghums.

Growing-Finishing Pig Study

Two hundred-forty, 50 lb pigs were used to evaluate the effects of the three grain sorghum varieties on gains, feed conversion, and carcass traits of G-F pigs. Because the grains varied in both lysine and protein contents, the diets fed were compared on the basis of being balanced for lysine (.725%) or crude protein (15%). Results of the G-F study are shown in Tables 2 and 3. On the average, pigs fed corn gained 3.9% faster and were 6.2% more efficient in feed conversion than those fed grain sorghum. The results were similar regardless of whether the diets were balanced for lysine (.725%) or protein (15%). The cream sorghum supported 4.2% better gains, but 4.6% poorer efficiencies than the yellow sorghum. The reduced gains of the pigs fed yellow sorghum were caused by the fact that diets formulated with this variety were lower in protein and lysine than the other diets. The yellow sorghum (FG550) analyzed lower in protein and lysine than was estimated when the diets were first formulated.

The effects of grain sorghum varieties on carcass traits of G-F pigs are shown in Table 3. Pigs fed diets formulated with corn had a slightly higher carcass yield than those fed diets formulated with grain sorghum. Balancing the diets for protein also resulted in a higher dressing percentage. Pigs fed grain sorghum tended to have slightly longer carcasses and more backfat than those fed corn.

Results of the G-F study are consistent with earlier studies and reemphasize the fact that although corn and grain sorghum have similar energy values, it requires more feed per unit of gain with grain sorghum than with corn. Relative to corn, the newer varieties of grain sorghum do not appear to be utilized better by pigs than the old varieties. Our data suggest that there could be a slight advantage for the yellow or cream sorghums over the bronze varieties.

Thus, the choice of variety of grain sorghum to grow is one that yields well on your farm, is disease and drought resistant, and will not lodge easily. If purchasing grain sorghum, the pork producer may want to consider utilizing the newer yellow and cream varieties if available and if priced the same. We hope that the development of other new varieties and our research on modification of the kernel will help to make grain sorghum equal to corn in feeding value for pigs.

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[1]H.A. Grabouski is a graduate student, E.R. Peo, Jr., is Professor, Swine Nutrition, A.J. Lewis is Associate Professor, Swine Nutrition, and J.D. Hancock is Research Technician, Department of Animal Science.

HIGH LYSINE DIETS NO PROBLEM FOR WEANLING PIGS

Austin J. Lewis
E. R. Peo, Jr.
Joe D. Hancock[1]

The importance of lysine in swine nutrition is well recognized. Lysine is almost always the first limiting amino acid in swine diets when using feedstuffs commonly fed in Nebraska. Consequently, diets are now usually formulated to meet lysine requirements rather than crude protein requirements. This is particularly important when crystalline lysine is included in feed formulations.

The lysine requirement of weanling pigs has received a good deal of attention in recent years. Our research (Nebraska Swine Report 1980), and that of others has demonstrated that young pigs respond (increased growth rate and improved feed efficiency) to higher levels of lysine than we previously thought were needed. Today, many starter diets contain quite high levels of lysine, and questions have been raised about the possibilities of excess lysine—too much of a good thing. A recent experiment at the University of Nebraska was designed to help answer some of these questions.

A total of 288 pigs were weaned between three and four weeks of age. The pigs weighed 14 lb at the beginning of the experiment. They were kept, four pigs per pen, in an environmentally regulated room and fed diets with lysine contents that ranged from 1.00 to 1.75%. The basal diet was relatively simple, consisting primarily of corn and soybean meal, and was designed to meet all nutrient requirements. Additions of lysine were provided by supplements of crystalline lysine (L-lysine.HCl) or soybean meal. Pigs were allowed *ad libitum* access to feed and water, and weights and feed intakes were recorded weekly during the four weeks of the experiment.

Feed intakes of the pigs were not affected by the dietary treatments (Table 1). The addition of lysine, from either crystalline lysine or from supplemental soybean meal, neither increased nor decreased feed intake.

Weight gain (Table 2) was influenced by the treatments. Pigs fed diets containing additional lysine (total lysine from 1.15 to 1.75%)

gained faster than those fed the diet with 1.00% lysine. Weight gain appeared to reach a maximum when the dietary lysine content was between 1.15 and 1.30%. These results are similar to those of our previous research, and indicate a lysine requirement higher than the current National Research Council (NRC, 1979) recommendation of 0.95%. Weight gain of the pigs fed the additional lysine from soybean meal was higher than that of the pigs fed crystalline lysine. Lysine levels as high as 1.75% did not reduce weight gain.

The feed efficiency (feed/gain) results (Table 3) were similar to those for weight gain. Pigs fed diets containing supplemental lysine used feed more efficiently than those fed the diet containing 1.00% lysine. The optimum lysine level appeared to be between 1.15 and 1.30%. Feed efficiencies of the pigs fed supplemental lysine from soybean meal were superior to those of the pigs fed crystalline lysine. There was no reduction in feed efficiency from the high lysine levels.

This experiment demonstrates that it is safe to feed moderate excesses of lysine. Dietary lysine concentrations that were 40% higher than University of Nebraska recommendations and 85% higher than the NRC requirement did not produce any negative effects. However, supplementing dietary lysine to levels above 1.30% was of no benefit and obviously made the diets more costly.

Table 1. Feed intakes (lb per day) of weanling pigs fed diets containing various additions of lysine[a,b,c]

	Lysine, %					
Source of lysine	1.00	1.15	1.30	1.45	1.60	1.75
Basal diet	1.07					
Crystalline[d]		1.03	1.08	1.11	1.12	1.10
Soybean meal		1.05	1.17	1.07	1.02	1.04
Average	1.07	1.04	1.13	1.09	1.07	1.07

[a]Individual values represent the mean of 6 pens with 4 pigs/pen, except for the basal diet where there were 12 pens with 4 pigs/pen. The average initial weight of the pigs was 14 lb; the average final weight was 33 lb.

[b]No differences between treatments (P>.10).

[c]Coefficient of variation 11.77%.

[d]Supplied as L-lysine.HCl (78% L-lysine).

Table 2. Weight gains (lb per day) of weanling pigs fed diets containing various additions of lysine[a,b,c,d]

	Lysine, %					
Source of lysine	1.00	1.15	1.30	1.45	1.60	1.75
Basal diet	0.61					
Crystalline[e]		0.62	0.64	0.65	0.67	0.68
Soybean meal		0.64	0.76	0.69	0.69	0.70
Average	0.61	0.63	0.67	0.67	0.68	0.69

[a]Individual values represent the mean of 6 pens with 4 pigs/pen, except for the basal diet where there were 12 pens with 4 pigs/pen. The average initial weight of the pigs was 14 lb; the average final weight was 33 lb.

[b]Basal diet vs others (P<.042).

[c]Crystalline vs soybean meal (P<.028).

[d]Coefficient of variation 11.32%.

[e]Supplied as L-lysine.HCl (78% L-lysine).

Table 3. Feed efficiencies (feed/gain) of weanling pigs fed diets containing various additions of lysine[a,b,c,d,e]

	Lysine, %					
Source of lysine	1.00	1.15	1.30	1.45	1.60	1.75
Basal diet	1.77					
Crystalline[f]		1.65	1.67	1.71	1.68	1.62
Soybean meal		1.63	1.54	1.53	1.47	1.46
Average	1.77	1.64	1.60	1.61	1.56	1.54

[a]Individual values represent the mean of 6 pens with 4 pigs/pen, except for the basal diet where there were 12 pens with 4 pigs/pen. The average initial weight of the pigs was 14 lb; the average final weight was 33 lb.

[b]Basal diet vs others (P<.001).

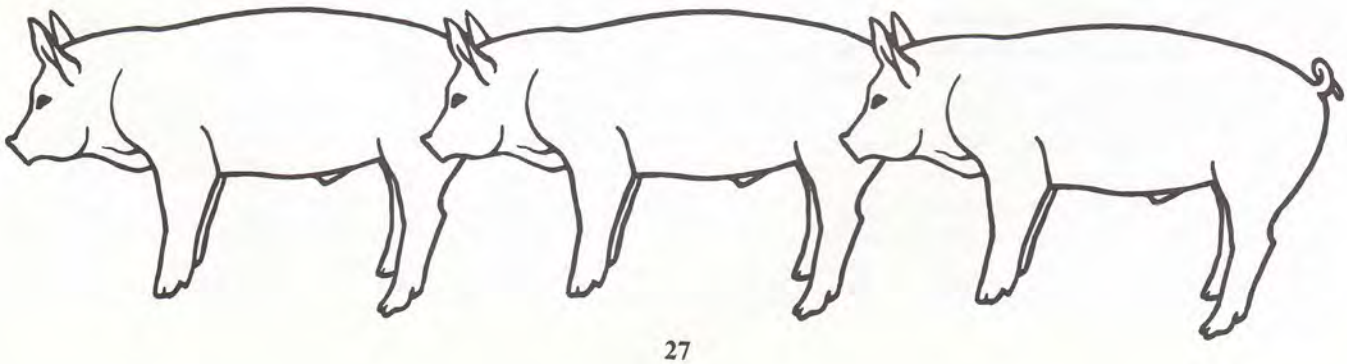
[c]Crystalline vs soybean meal (P<.001).

[d]Soybean meal linear (P<.002).

[e]Coefficient of variation 6.42%.

[f]Supplied as L-lysine.HCl (78% L-lysine).

[1]Austin J. Lewis and E. R. Peo., Jr. are Professors, and Joe D. Hancock is Research Technician, Department of Animal Science.



EXTRA VITAMINS AND MINERALS NOT NEEDED IN FEEDER PIG DIETS

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

Feeder pig finishers are often encouraged to add extra vitamins and trace minerals to receiving diets with the expectation of increasing pig performance. Benefits of vitamin and trace mineral additions in excess of those normally added to grower diets for newly arrived feeder pigs have not been critically tested. This experiment was designed to determine the effect of additions of vitamins and trace minerals beyond National Research Council (NRC) recommendations on performance and health.

Two trials were conducted. One hundred forty four commingled feeder pigs were purchased for each trial from auction markets in Southern Missouri. After assignment to the experimental receiving diets at arrival, the pigs were housed in partially slatted modified open front (MOF) facilities with 12 pigs per pen (8 ft^2/pig), four pens per experimental diet per trial.

The receiving diets were floor-fed twice daily for the first 7 days and then self-fed from a four-hole feeder for another 14 days. The receiving diets were formulated to contain one, two, or three times the NRC recommendations for vitamins and trace minerals for 44 pound pigs (Table 1). All receiving diets contained 16% crude protein, 0.78% lysine, 0.66% calcium, 0.50% phosphorus, 0.1% added selenium, and 20% ground oats.

After the three-week receiving period, all pigs were fed a common 16% grower diet to 120 pounds followed by a 14% finisher to market weight. The receiving diets and 16% grower diets contained ASP-250.

Results

There was no improvement in average daily gain or feed conversion

Table 1. Levels of vitamins and trace minerals added to feeder pig receiving diets.

		Diet		
Nutrient	Unit	1x	2x	3x
Vitamin A	IU/lb	591	1182	1773
Vitamin D	IU/lb	90	180	270
Vitamin E	IU/lb	5	10	15
Vitamin K	ppm	2	4	6
Vitamin B_{12}	ppm	11	22	33
Riboflavin	ppm	2.6	5.2	7.8
Pantothenic Acid	ppm	11	22	33
Choline	ppm	700	1400	2100
Niacin	ppm	14	28	42
Biotin	ppm	.1	.2	.3
Folic Acid	ppm	.6	1.2	1.8
Zinc	ppm	50	100	150
Iron	ppm	50	100	150
Manganese	ppm	2.0	4.0	6.0
Copper	ppm	3.0	6.0	9.0
Iodine	ppm	.14	.28	.42

from increasing the vitamins and trace minerals in receiving diets (Table 2). The depression in final weight and overall ADG for pigs fed the 3X receiving diet was not evident until eight weeks after arrival and was related to health problems in trial 2.

In trial 2, an outbreak of bloody scours confirmed by the Veterinary Diagnostic Laboratory as caused by *Treponema hyodysenteriae* occurred nine weeks after pig arrival. While it was controlled with water and feed medication, the broad nature of the outbreak prevented collection of information on the effect of the receiving diets on relative health and death loss.

These results do not support the recommendation of routine inclusions of elevated vitamins and trace minerals in feeder pig receiving diets beyond the levels normally present in corn-soybean meal based fortified diets. The feeder pig finisher does not routinely need to add to his production costs by increasing vitamins and trace minerals in receiving diets.

[1]M. C. Brumm is Extension Swine Specialist, Northeast Research and Extension Center, Concord. E. R. Peo, Jr., is Professor, Swine Nutrition, Department of Animal Science.

Table 2. Effect of elevated vitamins and trace minerals in feeder pig receiving diets on pig performance.

Item	Vit-min level of fortification[a] 1x	2x	3x	SE[b]
Pig weight				
Initial	43.1	43.2	42.8	
Final	203.8 [c]	202.8 [c]	195.6[d]	2.3
ADG, lb				
0-3 wk	1.08	1.07	1.05	.03
0-8 wk	1.30	1.30	1.25	.03
0-Final	1.35[c]	1.35[c]	1.29[d]	.02
ADF, lb				
0-3 wk	2.63	2.65	2.60	.04
0-8 wk	3.69	3.69	3.65	.05
0-Final	4.71	4.71	4.62	.05
F:G				
0-3 wk	2.44	2.49	2.49	.05
0-8 wk	2.86	2.84	2.92	.04
0-Final	3.48	3.51	3.59	.04

[a]Levels were 1, 2 or 3 times those recommended by NRC.

[b]Standard error

[c]Means with different superscrips differ ($P < .05$).

IVOMEC® FOR SWINE PARASITE CONTROL

Donald L. Ferguson
Alex Hogg[1]

Ivomec® contains ivermectin, a new and highly active broad-spectrum antiparasitic agent, recently released for use in swine. Ivermectin is obtained from fermentation of the soil organism, *Streptomyces avermitilis*.

Mode of Action

Ivomec® inactivates parasitic nematodes, arachnids, and insects. In roundworms, it stimulates the release of gamma aminobutyric acid (GABA) from nerve endings and enhances its binding to special receptors at nerve junctions. Nerve impulses are interrupted, paralyzing and killing the parasites.

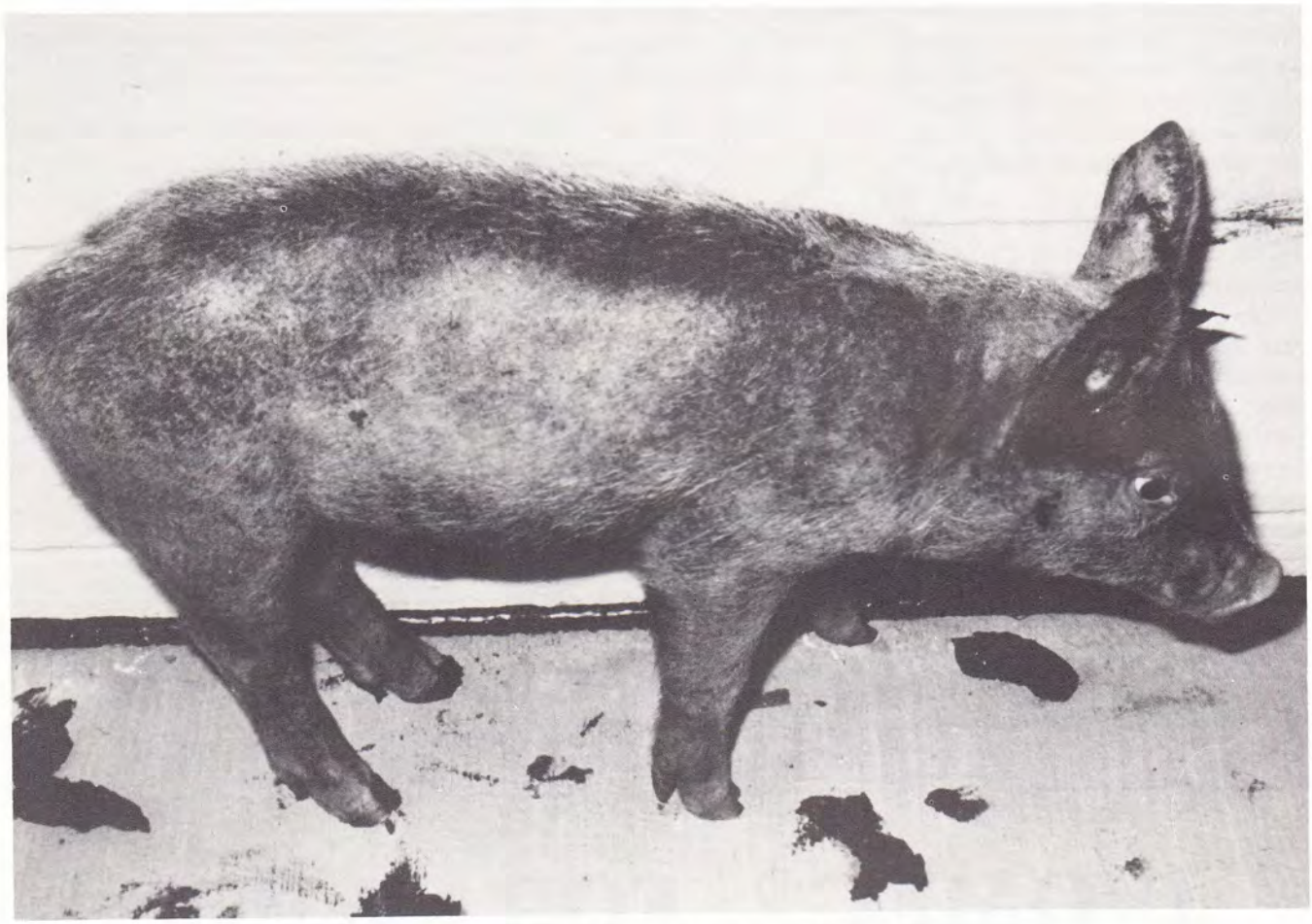
In arthropods, the GABA enhancement effect works similarly, except that nerve impulses are interrupted between the nerve ending and the muscle cell.

Ivomec® is unrelated structurally to any of the presently available parasiticides. Its unique mode of action is not shared by any other antiparasitic agent. Ivomec® is not a benzimidazole, so parasites that have developed a resistance to benzimidazole compounds should not be a problem with this product.

Ivomec® has no measurable effect against flukes or tapeworms, presumably because they do not have GABA as a nerve impulse transmitter.

Margin of Safety

Trials have demonstrated that Ivomec® has a wide margin of safety when administered at the recommended dosage level of 300 micrograms per kilogram body weight. Adverse reactions were not observed in pregnant sows or breeding boars. In Nebraska, Ivomex® has been given to newborn pigs, pregnant sows at all stages of gestation, breeding boars, and all other ages of pigs with no adverse reactions. In addition, our studies have produced no toxic signs in goats given up to 25 times the use level of 200 micrograms per kilogram body weight.



Pre-treatment—six-week-old piglet that weighed 17 lbs.

Efficacy Profile

Ivomec® in swine is dosed at 300 micrograms per kilogram body weight and is recommended for subcutaneous injection. This translates to 1 ml for 75 lbs body weight. It reaches peak plasma concentration two days following injection and maintains an effective blood level for 6-10 days.

Studies have demonstrated that Ivomec® is highly effective against the major worms that cause economic damage in swine. It will remove the immature (4th stage larvae) and mature forms of the large intestinal roundworm *Ascaris suum,* red stomach worm *Hyostrongylus rubidus,* and nodular worm *Oesophagostomum* spp. In addition, it is extremely effective against the adult forms of the intestinal threadworm *Strongyloides ransomi* and lungworm *Metastrongylus* spp. (see Table 1).

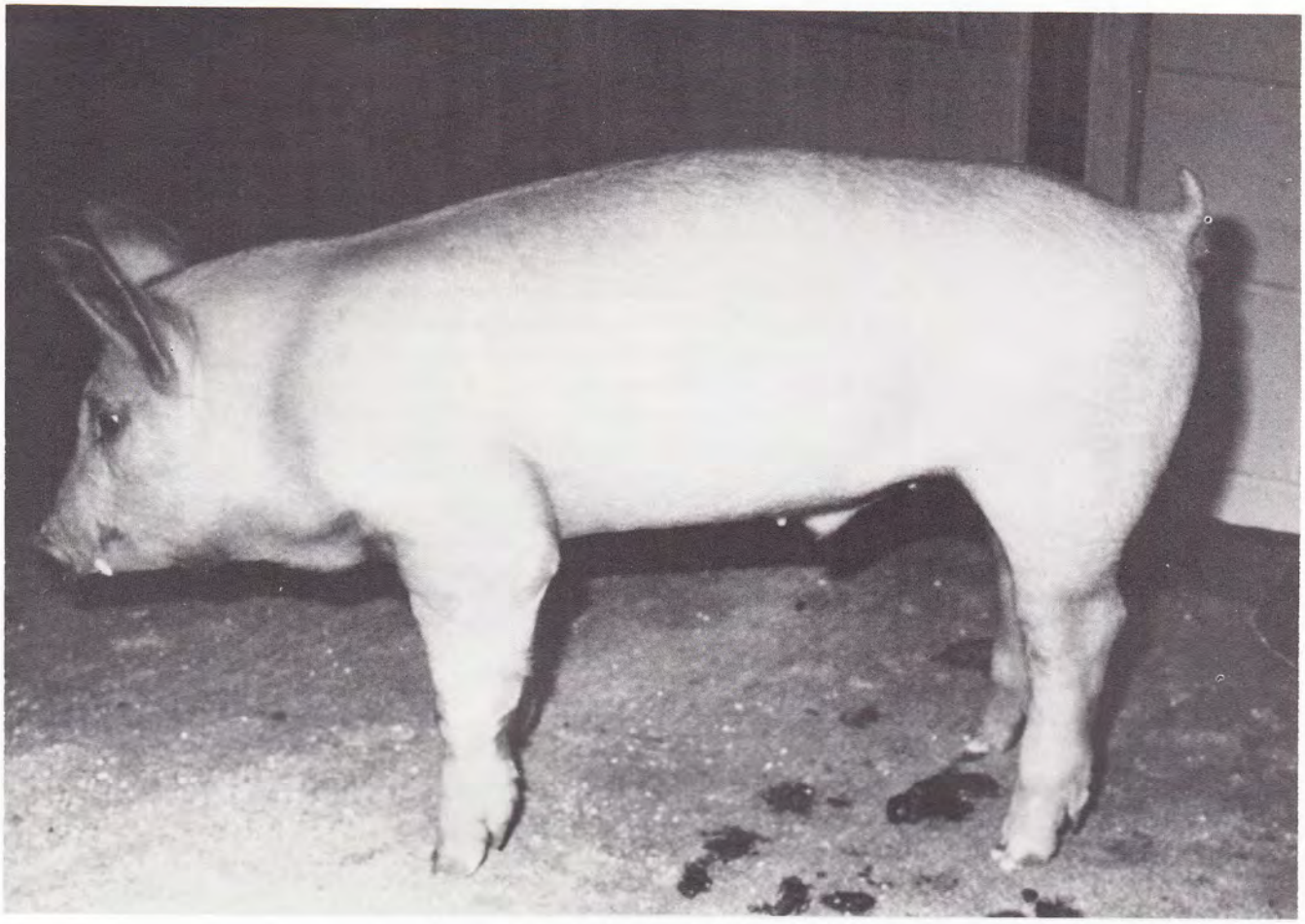
In swine, Ivomec® has exhibited excellent activity against the mange mite *Sarcoptes scabei* var. *suis* and sucking louse *Haematopinus suis.* Because Ivomec® is not ovicidal, reinfection is possible from hatching eggs of sucking lice *(H. suis)* that are attached to the hair.

Mange Control Programs

Program 1. Inject sows two weeks before farrowing. Keep the injected

Table 1. Efficacy profile.

Internal parasites	Percent efficacy	
	Adult worms	Immature worms (4th stage larvae)
Gastrointestinal Roundworms		
Large Roundworm *(Ascaris suum)*	100%	99.4%
Red Stomach Worm *(Hyostrongylus rubidus)*	98.2%	98.9%
Nodular Worm (*Oesophagosomum* spp.)	96.2%	94.7%
Threadworm *(Strongyloides ransomi)*	98.7%	
Lungworms (*Metastrongylus* spp.)	100%	
External parasites		
Sucking lice *(Haematopinus suis)*	Fully effective	
Mange mites *(Sarcoptes scabiei* var. *suis)*	Fully effective	



Post-treatment—twenty-eight days after treatment pig weighed 53 lbs (ADG 1.28 lbs).

sows well isolated from other pigs that have not been treated with Ivomec®. Pigs born to the treated sows should be free of sarcoptic mange and should stay free if kept separate from pigs infested with sarcoptic mange mites.

Program 2. Treat every pig on the farm on the same day. Don't dilute Ivomec®, simply use small syringes (1 ml plastic) for small pigs and small bore needles. Repeat the treatment 14 days later.

Program 3. Feeder pigs: Treat on arrival and isolate from pigs infested with sarcoptic mange.

Economic Considerations

Various studies have shown that controlling mange makes good economic sense. For instance, data from a Nebraska study showed an economic benefit of about $40 per litter farrowed or about $5 per pig finished to market. This study compared data from the same herd in which the pigs were untreated one year and treated for mange the subsequent year.

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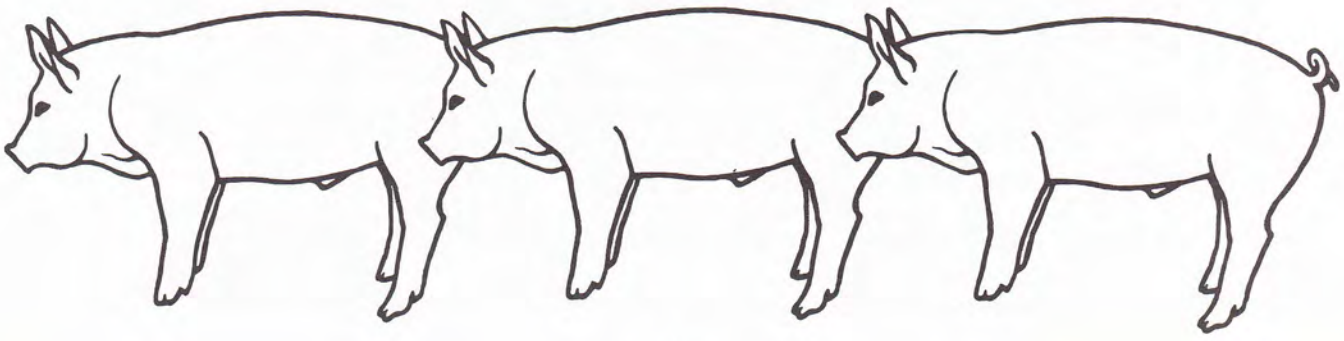
[1]Donald L. Ferguson is Professor, Parasitology, and Alex Hogg is Extension Veterinarian, both in the Department of Veterinary Science.



DEATH IN A PIT

Rollin D. Schnieder[1]

"It's what you can't see or smell that can kill you." Four tragic deaths in Nebraska in the past two years confirm this statement.

Two deaths in a manure storage tank a few years ago shocked a whole community. Why did it happen? The answer is that all conditions were right for this type of accident. Manure in storage undergoes bacterial action and gives off gases that have a suffocating or paralyzing effect.

The major gases given off by stored, decomposing manure are methane, carbon dioxide, ammonia, and hydrogen sulfide. Carbon dioxide is an odorless, colorless gas that can suffocate. It is a gas that all of us have in our lungs and exhale; however, an excess amount can kill. Ammonia is a pungent gas that can kill; however, the smell of it will encourage people to get out of an enclosure into fresh air. Hydrogen sulfide is an instant killer if the concentration is high enough. Even though it has a rotten egg odor, one breath of air with a hydrogn sulfide content of 1000 ppm can kill. It has a paralyzing effect on the respiratory system. It also has an effect on the sense of smell. The second breath would not have the rotten egg odor. Methane is odorless and will explode, like natural gas.

People suffering from exposure to manure gases can be given CPR. However, in the case of hydrogen sulfide poisoning, the respiratory procedure would have to continue until the effects of the gas were purged from the body.

No one should ever go into any manure storage unless the area has been ventilated with a fan for at least one hour. Even then, there might be gas which could cause lung irritation. Agitation of the manure will cause additional gas to be released. Visits with neighbors after accidents indicate that entering manure storages is a common practice. One producer who sent his wife and two children into a just emptied pit risked losing his family. Manure storage pits and tanks are not the only places on farms with these risks. Silos, grain bins, well pits, molasses tanks and elevator pits have been death traps. Any enclosure can become lethal if it has dead air space, decomposing organic material, and moisture. The gases which kill are normal decomposition products.

What's the answer? First, if it is necessary to go into a hazardous enclosure do so only with functional, self-contained breathing apparatus and have a safety lifeline, controlled by someone on the outside. This is costly equipment and probably would not be purchased by a farmer. Most rescue squads have this equipment and would probably assist rather than have to pull you out of a pit.

Second, if you empty a pit for repairs, ventilate the area with a powered blower for at least an hour before you enter.

Third, realize that most of the gases we have discussed are heavier than air and seek a lower level. This is why ventilation is important.

Design buildings so that gas release is to the outside atmosphere rather than inside the building.

Keep these thoughts in mind. The hydrogen sulfide that we see generated on farms is also a product of oil wells in some parts of the nation. This same gas was looked at as a poisonous gas in World War II. Due to it's corrosiveness, it would eat up the containers and was not used. The point is that it is not just a farm problem. It is a natural part of life around us.

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[1]Rollin D. Schnieder, Extension Safety Specialist, Department of Agricultural Engineering.