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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**

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Issued January 1981, 8,000	

On the cover: Solar MOF Nursery on the Alvin Paus and Sons farm near Fairfield (nearing completion). See article on page 12.

The 1981 Nebraska Swine Report was compiled by William T. Ahlschwede, Extension Swine Specialist, Department of Animal Science.

Farm Mixing of Feed

Donald B. Hudman¹

Pork producers have many options in supplying nutrients to their swine herd:

1. Purchasing complete commercial diets.
2. Purchasing commercial protein supplements to be mixed or fed free-choice with grain.
3. Furnishing grain to a local feed dealer or elevator for grinding and incorporating with protein, minerals and vitamins into complete diets.
4. Purchasing base mixes that contain macro minerals (salt, calcium and phosphorus), trace minerals and vitamins to be mixed with grain and protein (usually soybean meal).

5. Purchasing protein, pre-mixes of vitamins, trace minerals and macro minerals for mixing with grain for complete diets.

The pork producer also has choices in equipment for farm mixing. These choices are portable grinder-mixers, stationary mills, and electric metering mills.

Delivery systems for transporting mixed feed will vary from farm to farm and include portable mixers, auger wagons, augering, or pneumatic delivery systems and equipment for bulk or bag delivery.

With the above options, the decision to mix on the farm or purchase commercial diets deserves careful consideration to determine which gives the most economical diets. However, price of diet is not the only factor to consider. On-the-farm mixing requires pork producers to accept responsibilities of diet formulation, ingredient purchasing and storage, ingredient preparation (grinding and premixing), purchase and maintenance of all grinding, mixing, weighing and delivery

equipment, and storage of complete diets. Economic analyses from several sources indicate that a minimum of 200 to 400 tons of feed per year is needed to justify farm mixing. Personal preference and other extenuating circumstances will cause this feed volume to vary from farm to farm.

Upon deciding to mix diets on the farm, other factors must be considered.

Swine Feeding Program

This program should include nutrient specifications and levels for all swine classes. Suggested feeding programs and sample diets are available at all Nebraska County Extension Offices in the publication EC 80-210, Swine Diet Suggestions. Suggested substitutions and variations in these diets are discussed. In addition, swine diet checks for costs and premix analysis can be made with the AGNET computer program, also available at Nebraska County Extension Offices.

Swine Diets

Swine diets are no better than the accuracy with which they are prepared. Accurate weighing of ingredients is necessary. The weight of individual ingredients may vary considerably in their weight by volume. This can be illustrated by comparing light versus heavy oats. The weight standard per bushel of oats (light oats) is 32 pounds (14.5 kg), yet many oats will weigh 40 pounds (18.1 kg) or more (heavy oats) per bushel.

However, volumetric measure can be utilized in diet formulation if each ingredient is measured in a specified volume (such as bushel), weighed accurately and the volume converted to weight for a designated diet. Each change in



Mixing rations on the farm.

source of ingredient will require a new weighing plus conversion. Volumetric measurements are less accurate than actual weight determined by a set of good scales. Accuracy of scales should be checked at regular intervals.

Another factor affecting the accuracy of diet formulation is the sampling and determination of nutrients by chemical analysis. An analysis to include crude protein and dry matter is the minimum needed for accurate diet calculations. Swine diets usually contain about 87% dry matter and any large variation in the dry matter content of ingredients should be considered during formulation. In addition to the major ingredients, it is imperative that vitamin and mineral content of the pre-mixes or base mixes be known before diet calculations. In the future, analysis for amino acids, calcium and phos-

(continued on next page)

Farm Mixing of Feed

(continued from page 3)

phorus is likely to become important for farm mixing.

Ingredient Preparation

Farm mixing operations require grain to be ground before mixing. The method of grinding (or rolling) seems to have little influence on pig performance. However, the fineness of grind should be comparable in particle size to other diet ingredients for optimum mixing. It is recommended that grain be ground with a $\frac{3}{8}$ " to $\frac{1}{2}$ " (9.5 mm-12.7 mm) screen. The speed at which a grinder is run will affect the fineness of grind, therefore, when a desired grind has been determined, the speed of the grinder should be recorded and utilized for future grinding. Fine grinding tends to increase feed wastage and may increase the incidence of gastric ulcers.

Mixing Procedures

The function of a mixer is to distribute feed ingredients uniformly throughout the formula. Uniformity of the mix is affected by particle size, shape, and density of the ingredients. With the use of several ingredients, it is impossible to have all ingredients with the same physical specifications. With this in mind, ingredients added at less than 2.5% of the diet will need to be combined (premixed) with one of the major ingredients as a carrier (usually ground grain or protein) to enhance mixing uniformity. This premixing is best achieved with a tumbler or horizontal type premixer. The premixer should be considered as a part of the mixing process and purchased along with other mixing equipment. Ingredients requiring premixing should represent at least 2.5% of the diet after premixing.

Incomplete mixing of diets is primarily caused by the lack of mixing time, sequence the ingredients are added to the mixer, agitator design and adjustment, speed of the agitation and the level of feed in the mixer.

Recommendations for Farm Mixing Batch Mixers

1. Check accuracy of scales before mixing. If feed is measured volumetrically, weigh a specific volume then estimate weights.
2. Obtain chemical analysis of major ingredients (grain and protein sources). Minimum analysis-crude protein and moisture.
3. Obtain accurate analysis of premixes from manufacturer. Level of vitamins, macro and trace minerals required for U. of N. diets should be available and displayed at mixer.
4. Premix ingredients required in small amounts with grain or protein to a minimum level of 2.5% of diet before adding to the mixer.
5. Grind or roll all diet ingredients to about the same size shape if possible. Avoid fine grinding.
6. Place major feed ingredient(s) in mixer first. Grain or protein ingredients are best for initial charge. (Initial amount should represent 25 to 50 percent of batch by weight.)
7. Place ingredients that are added at less than 2.5% and liquid ingredients in center of batch, then remainder of major ingredients last.
8. Add ingredients with mixer running, if possible.
9. Don't overfill mixer. Mixing efficiency is drastically reduced if recommended capacity is exceeded.
10. Follow the mixing time recommended by the manufacturer. Allow a *minimum of 10 minutes* mixing after adding last ingredient. A good mixer is designed for mixing, and if operated at recommended speed, an extended mixing time will not unmix feed. Use a dustproof timer to check mixing time.
11. Clean mixers after each batch or when changing diets. If feed additives are used, flush the mixer with $\frac{1}{4}$ to $\frac{1}{2}$ of mixer capacity with grain. Use this grain for mixing with subsequent diets for the same class of swine.
12. Periodically check accuracy of mixing by sampling and analysis of a single mix.

Meter Mills

1. Calibrations for proportioners are designed to function at a specific speed. Operate mill at speed recommended by manufacturer.
2. Fill all ingredient compartments and drops to mill so that ingredient flow into mixing compartment is consistent and continuous.
3. A weighing container and scales are necessary for determining accuracy of calibrations.
4. Calibrate mill each time a new source of ingredients is used for mixing. Determine ingredient flow by density of that ingredient. Density can change with source of ingredient and can affect accuracy of diet mixed.
5. Schedule recalibration at time intervals or based on amount of feed mixed to maintain accuracy of diets mixed.
6. Periodically check accuracy of mixing by sampling and analysis of a single mix.

Fill the batch mixer with the mixer running, if this can be done safely. Add major feed ingredients, such as grain and protein, to the mixer first to represent 25 to 50 percent of the diet. All premixed ingredients and liquid in-

redients should follow in sequence. The last ingredient should be the remainder of the major feed ingredients and represent 10 to 25% of the diet. Avoid overfilling to allow space for proper agitation. Follow the manufacturer's re-

commendation for mixing time—or, if not prescribed, mix a minimum of 10 minutes after adding the last ingredient. A dustproof clock with an alarm is recommended for timing of the mix. If a mixer is properly designed, operated and maintained, mixing longer than prescribed by manufacturer will not cause feed ingredients to separate. However, poor mixing can occur when mixing ribbons of the mixer are worn or out of adjustment. The mixing action should sweep the walls and floor of the mixer to prevent the settling of high density ingredients.

Clean the mixer between mixes to prevent drug contamination. Remove all feed material from the walls, ribbons, or augers. To lower the chances of drug contamination, flush the mixer by adding grain or similar materials to represent 25 to 40 percent of the mixer capacity and run a complete mixing cycle. Remove the flushed grain and reserve it for the next diet that contains the same drug.

Segregation and Unmixing

Segregation (separation) of individual ingredients is not a problem in the mixing procedure. However, segregation can occur during the transport of the feed after mixing. If the feed is transported in bulk across rough roads or long distances, the small, dense particles tend to settle to the bottom and the large, light particles tend to move to the top. Minimize travel by locating the mixing facility near the feeding facility.

Also, conveying equipment such as bucket elevators, augering devices and pneumatic equipment can cause segregation if not properly installed and maintained. Avoid vibration, moving feed at sharp angles, funneling during discharge, and electrostatic hang-up of fine particles in feed transport.

The most serious problem causing segregation or unmixing occurs when mixed feed is allowed to free-fall into a bulk bin or self-feeder. The shortest free-fall possible is needed to prevent segregation. Feed manufacturers

overcome this problem with pelleting and the incorporation of liquid ingredients such as molasses or fat to bind the ingredients together.

Testing Mixing Accuracy

Poor mixing may reduce rate and efficiency of pig gains, sow reproduction, and lactation. Mixing accuracy is needed. Mixing accuracy can be evaluated by sampling throughout a mix and analyzing for a specific substance. When a diet is sampled uniformly throughout the mixture there should be no more than a 10% variation between samples. As an example, if the average salt analysis of 10 samples was 0.3%, the lowest and highest level of salt would fall between 0.285% and 0.315% ($\pm 5\%$).

One procedure used by feed manufacturers employs micro-titration of salt by a chloride titrator in a capillary column. This simple method requires an accurate micro-scale, capillary columns, hot water, filter paper, stirring rods, and hot water containers. Capillary tubes for this analysis are available commercially from Quantab, Ames Company, Division of Miles Laboratories, Inc., Elkhart, Indiana 46514.

Our recommended diets for growing-finishing swine are formulated with 2.5% dehydrated alfalfa meal. It was anticipated that the distribution of the green color from the alfalfa would give an indication of the uniformity of the mix. This is a crude measure of mixing uniformity, but may be helpful.

Another method of evaluating the efficiency of the mix includes pulling at least $\frac{1}{2}$ pound (227 grams) samples from three or more locations in the mix and analyzing for one or more of the following: crude protein, fat, calcium, phosphorus, or salt. No more than a 10% variation between samples should be allowed.

Check on the uniformity of the mix at a minimum of one to three month intervals for best results.

¹Donald B. Hudman is District Extension Specialist (Swine), Panhandle Station.

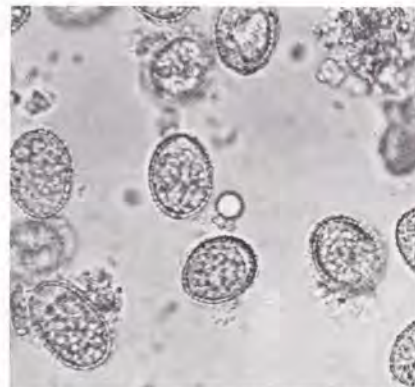


Figure 1. Oocysts are deposited within manure on hog lots. They are covered by a protective shell resistant to physical, chemical, and bacterial action.

Coccidiosis: Preventable

Donald L. Ferguson¹
Professor, Veterinary Science

A marked increase in the number of confirmed cases of coccidiosis in newborn pigs has been observed in the midwest. Coccidiosis in swine is caused by microscopic, one-celled parasites, chiefly of the genera *Eimeria* or *Isospora*. Nine species of coccidia have been identified in swine. *Isospora suis*, seems to be the species associated with diarrhea in newborn pigs.

Life Cycle

Isospora suis has a complex life cycle. The stage found in the manure is the oocyst. It is covered by a protective shell, resistant to physical, chemical, and bacterial action (Figure 1).

Oocysts freshly discharged in the manure must undergo a developmental process called sporulation before they become infective to pigs. This process, occurring outside of the animal, requires about four days under ideal conditions of temperature 86°F (30°C) and humidity (80-85%). It results in the formation within each oocyst of eight infective sporozoites.

When a baby pig swallows infective oocysts, the sporozoites are re-

(continued on next page)

Coccidiosis

(continued from page 5)

leased, penetrate the epithelial cells lining the intestine, and begin to divide into many intermediate stages. These continue to divide, and each division produces stages that cause damage to the host cells.

Male and female parasites unite to produce oocysts, which are passed out of the pig's body in the manure. This occurs about five days after the pig ingests the sporulated oocysts. The pig will shed oocysts in the manure for five to eight days (Figure 2).

Because of the multiplication of parasite stages within the epithelial cells of the intestine of the baby pig, the potential for destruction of large numbers of intestinal cells exists. If this potential is fully realized, then the ingestion of only 1,000 sporulated oocysts could result in the destruction of 24 billion intestinal cells.

Clinical Signs

In baby pigs 3 to 10 days old, a profuse yellow diarrhea occurs about 72 hours after ingestion of the sporulated oocysts. This is usually accompanied by dehydration, weight loss, lethargy, and possibly death (Figure 3). The severity of the disease is determined by the number of oocysts ingested by each pig.

Diagnosis

Diagnosis of clinical coccidiosis can be made from a combination of herd history, clinical signs, gross lesions at necropsy, microscopic examination of scrapings of the intestinal mucosa, presence of oo-

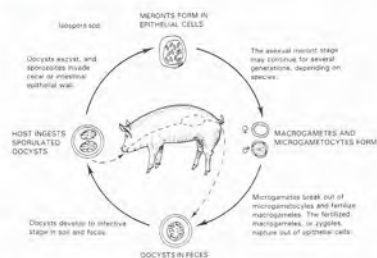


Figure 2. Adapted from Ivens, V.R.; Mark, D. L.; Levine, N. D.: Principle parasites of domestic animals in the United States (with permission of authors).



Figure 3. Coccidiosis can affect baby pigs 3 to 10 days old.

cysts in the manure, and histopathology.

Usually, diarrhea precedes the heavy discharge of oocysts by a day or two, and the diarrhea may continue after the oocyst discharge has returned to low levels. Therefore, it is not always possible to confirm a clinical diagnosis of coccidiosis by finding oocysts in the manure.

The most accurate way to diagnose coccidiosis is to examine materials from suspicious areas in the small intestine or colon under the microscope. To accomplish this, swine producers should submit fresh tissues or live pigs to their veterinarians. Diagnosis is based on histologic examination of the stained tissue sections for the life cycle stages of the coccidia.

It is advisable to consult your veterinarian in suspected outbreaks of coccidiosis as other disease entities sometimes manifest similar signs. Transmissible gastroenteritis (TGE), rotavirus, *Strongyloides ransomi*, and colibacillosis can cause diarrhea in baby pigs—thus confusing a correct diagnosis.

Treatment

Treatment of coccidiosis is difficult, because clinical signs do not become noticeable until the disease is advanced. At this time, the portion of the life cycle within the baby pig has been nearly or entirely completed, and much of the invasion of intestinal mucosa has already occurred. Thus, treatment administered at this time can at best result in a lessening of the

signs of coccidiosis. However, if drugs are given at an earlier stage of the disease, the clinical signs of infection can be largely or entirely prevented.

At present, a federally licensed coccidiostat for swine is not available. Amprolium, a drug that has been highly effective against avian and bovine coccidiosis, has been found to be of value in controlling and preventing coccidiosis in swine. Workers in Georgia report encouraging results have been obtained by giving amprolium to baby pigs with scours. In addition, preliminary studies suggest that amprolium may prevent scours associated with coccidiosis when it is given to three-day-old pigs for five days or to sows before they farrow. Sulfas and furazolidone have also been used with success.

Control and Prevention

Management practices play a critical role in establishment of effective parasite control programs. As in many diseases, it is easier to prevent coccidiosis than it is to treat it. Because several days are required for sporulation, the oocyst stage in the manure is the weakest link. Separating a sow and baby pigs from manure containing sporulated oocysts interrupts the life cycle and helps control the disease. This can be accomplished by washing of sows before farrowing and prompt removal of manure that accumulates in the farrowing stall or house.

¹Donald L. Ferguson is Professor, Parasitology, Department of Veterinary Science.

Influence of Lysine in Growing-Finishing Rations

D. M. Danielson¹

The addition of synthetic lysine to growing-finishing diets as reported by some researchers improved daily gain and feed efficiency. Other studies have indicated no response in pig performance with diets fortified with lysine while still other studies reveal a decrease in daily gains.

Due to the variation in responses reported, a study was con-

Table 2. Feed efficiencies (feed/gain) of G-F pigs fed diets with lysine additions

Item	-----Lysine, %-----			
1 - 9 wk	0.79	0.84	0.89	0.94
10 - 16 wk	0.64	0.69	0.74	0.79
Gilts	3.12	3.16	3.11	3.02
Barrows	3.30	3.37	3.36	3.36
Avg. for sexes combined	3.21	3.27	3.24	3.19

ducted to evaluate pig performance when additional levels of 0.05, 0.10 and 0.15% L-lysine monohydrochloride were added to corn-soy growing-finishing diets routinely used at the North Platte Station.

Four Different Levels

A total of 128 crossbred pigs (64 gilts and 64 barrows) averaging 33.8 lb (15.3 kg) were fed diets containing four different levels of lysine. Housing and pen accommodations provided separate eight-animal units. Sixteen animals of each sex group, divided into two pens of eight gilts and two pens of eight barrows, were assigned to one of four levels of supplementary L-lysine monohydrochloride—0, 0.05, 0.10 and 0.15%.

Initially, a 16% basal corn-soy diet calculated to contain 0.79% lysine was considered the control diet. The remaining three diet treatments thus contained 0.84, 0.89 and 0.94% lysine, respectively, after the addition of the synthetic lysine as previously mentioned. At the beginning of the tenth week on test the pigs were allowed a 14% corn-soy diet with the calculated lysine value of the four diets being 0.64, 0.69, 0.74 and 0.79, respectively. The lysine content of the 16 and 14% crude protein basal corn-soy diets used in this study is sufficient to meet the present National Research Council (NRC)

recommendations for swine in the respective weight ranges. As previously mentioned the initial weight of the animals on this study was 33.8 lb (15.3 kg). At the end of the 16-week study the termination weight was approximately 203 lb (92 kg). All diets were ad libitum fed in pellet form.

Observed Biweekly

Performance of the animals on each of the diet treatments was observed biweekly, recording individual pig weights along with total pen feed consumption for each period (Tables 1 and 2). Weight gain in gilts was decreased on diets with 0.05 and 0.15% lysine additions. A slight increase in performance at the 0.15% level was observed for the barrows. However, when combining the weight performance of gilts and barrows there was a decrease, although not significant, at all levels of added lysine.

Feed required per unit of live weight gain was slightly reduced for the 0.15% added lysine diet for the gilts. The barrows required slightly more feed per unit of gain for each of the levels of added lysine. When the feed efficiencies of the gilts and barrows were combined, there were no significant differences among levels of lysine.

In this study, no significant differences were found in daily gain and feed efficiency due to level of supplemental lysine in the diets. It would appear that the basal diets used in this study were sufficient to obtain optimum performance of the animals. This study offers no evidence that added lysine improved or depressed performance.

¹D. M. Danielson is Professor, Animal Science (Swine), North Platte Station.

Table 1. Daily gains in lb/day (kg/day) of G-F pigs fed with lysine additions.

Item	-----Lysine, %-----			
1 - 9 wk	0.79	0.84	0.89	0.94
10 - 16 wk	0.64	0.69	0.74	0.79
Gilts	1.52 (0.69)	1.44 (0.65)	1.53 (0.69)	1.41 (0.64)
Barrows	1.57 (0.71)	1.51 (0.68)	1.54 (0.70)	1.59 (0.72)
Avg. for sexes combined	1.55 (0.70)	1.48 (0.67)	1.54 (0.70)	1.50 (0.68)

How to STOP Rat Losses

Robert M. Timm¹

Two species of rodents, the Norway rat (common brown rat) and the house mouse, are commonly found living in or around swine production facilities in Nebraska. These pests cause economic losses to pork producers.

Rats and mice eat livestock feed and contaminate it with their urine and droppings. In doing so, they may be responsible for spreading some diseases among herds.

In addition, the rodents' gnawing and nest-building activities result in structural damage to livestock facilities. Rats may gnaw holes in walls or water pipes, and they may gnaw into insulated electrical wiring, causing fire hazards. House mice often live in insulated walls. Where present, they destroy the insulation by their tunneling, gnawing, and nesting (Figure 1). Rodents can damage most types of building insulation, but the rigid foam materials are particularly susceptible.

IPM Recommended

We recommend a program of Integrated Pest Management (IPM). This involves (1) using the damage control techniques best suited for the particular situation, (2) taking action as soon as a prob-



Figure 1. Fiberglass batt insulation within walls of a hog finishing house was destroyed by house mice in less than three years.

lem or potential problem is noticed, so as to prevent damage before it occurs and (3) when necessary, using rodenticides (rodent poisons) in a safe and correct manner. A combination of control techniques is generally more effective than any single technique used alone.

To prevent or control rat and mouse damage, we urge producers to take these five steps:

Step 1: Clean Up. If rats or mice are present, it is because they are able to find food, water (in the case of rats), places to hide, and places to nest and rear their young.

Clean, orderly facilities cannot support large numbers of rodents. Remove weeds from around buildings or keep them mowed. Remove all stored building materials or debris from around livestock facilities. Shelter is an invitation for a rodent problem (especially when the shelter is near a food source). Where possible, prevent rodents from getting into feed bins, feeders, or buildings where feed is stored. Although it may be difficult to prevent rodents from using livestock feed, it is possible to achieve good rodent control by taking away their shelter. If rats and mice are unable to hide and to nest, they cannot remain in any location for long. Cleaning up also

puts rodents under stress. This makes it more likely that they will accept and eat poisoned bait materials if these are used in the control program.

Where rat burrows are found in the soil, they can be fumigated with gas cartridges. These devices burn and produce carbon monoxide and other gases which suffocate the rodents. They can be purchased from various retail suppliers and from the U.S. Fish and Wildlife Service - Division of Animal Damage Control (see below).

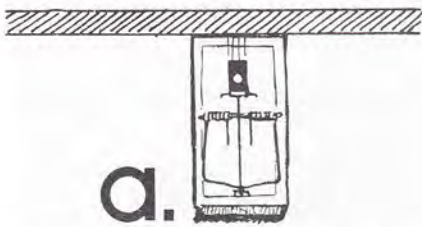
Step 2: Single-dose Poison. This step may be necessary if large numbers of rodents are present and quick control is needed. If only a few rodents are present, go to Step 3.

Single-dose poisons can be hazardous to pets, livestock, desirable wildlife, and humans, if incorrectly used. Care must be taken in their use to avoid hazards and to get good results. If it is necessary to use a single-dose poison, we recommend getting help from a professional pest control operator (exterminator), from the U.S. Fish and Wildlife Service - Division of Animal Damage Control, or from the Cooperative Extension Service.

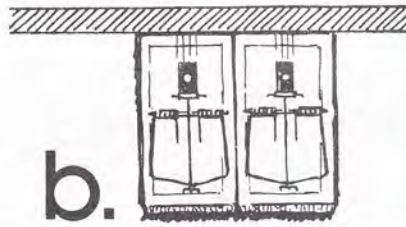
The most common single-dose poison used to control both Norway rats and house mice is zinc phosphide. It is available at cost to Certified Pesticide Applicators through the U.S. Fish and Wildlife Service - Division of Animal Damage Control. Contact your local District Field Assistant or call their main office in Lincoln, telephone (402) 471-5097.

Single-dose poisons should not be used by persons unfamiliar with their use. To control rats around swine facilities, it is necessary to use a bait material more attractive than the hog feed they are accustomed to eating. In addition, to get good results rats must be pre-baited with clean (non-poisonous) bait for three to five days before the poisoned bait is applied.

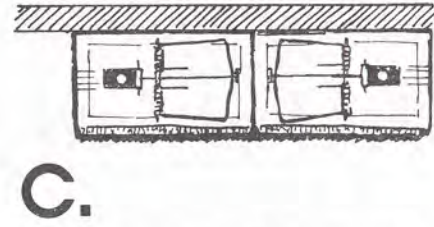
Step 3: Multiple-dose (Anti-coagulant) Poison. This step should follow any application of a



a. Single trap set with trigger next to wall.



b. The double set increases your success.



c. Double set placed parallel to the wall with triggers to the outside.

Figure 2. Proper placement of snap traps to catch rats and mice.

single-dose poison in order to kill surviving rodents. Use of multiple-dose poison is also an efficient way of controlling small to moderate numbers of rats or mice. These products also are useful for maintaining rodent numbers at a low level on a permanent basis.

Multiple-dose (anticoagulant) poisons damage the rodents' circulatory system by interfering with blood's normal clotting ability. Poisoned rodents die of internal bleeding. Rodents must feed on the bait over a period of several days in order to get a lethal dose.

Active ingredients used in multiple-dose baits include warfarin, chlorophacinone, diphacinone, fumarin, pival, and others. These baits may be purchased at retail outlets in a variety of forms. Loose grain mixtures containing the anticoagulant commonly are available. These baits are handy to apply when packaged in cellophane or paper packets. Baits formulated as paraffin-grain blocks are useful in damp locations where loose grain baits would spoil or mold quickly. Various types of anticoagulant concentrates are available to be dissolved in water to make a liquid bait or to be mixed into grain to make a loose grain bait.

Proper placement of bait materials is essential for good control. Place baits in locations where rodents are active, such as along walls or building foundations. To control house mice, bait stations should be placed no further than 10 feet (3 m) apart in areas of mouse activity. Use of bait boxes or bait stations protects bait from the weather and provides a safeguard for people, pets, and livestock. When using multiple-dose baits, it is important that an adequate

supply of fresh, high-quality bait be made available as long as feeding continues.

When using any rodent poison, be sure to pick up and dispose of any dead or dying rodents. Livestock or pets which might feed on them could be poisoned as a result of eating the carcasses.

Step 4: Traps. Trapping is a very effective control method, particularly for mice. It is generally more time-consuming than other methods but is a practical technique where low to moderate numbers of rodents are present.

The simple, inexpensive wood-based snap trap can be purchased in most hardware and farm supply stores. Bait traps with a mixture of peanut butter and rolled oats, a nutmeat, or a small piece of raw meat tied to the trigger.

Set traps close to walls, behind objects, and in other places where fresh rodent activity is seen. It is best to place traps with the narrow side against a wall, the trigger pointing at the wall (Figure 2).

Multiple-capture live traps for mice are available in some hardware and farm supply stores.

When using traps, use enough traps to make the control campaign short and decisive.

An alternative to traps are glue boards, which catch and hold rodents attempting to cross them in much the same way flypaper catches flies. Place glue boards along walls or in other areas where rodents travel. Do not use them where pets, children, or desirable wildlife would contact them. Glue boards are messy, and they lose their effectiveness in dusty areas or under extremes of temperature.

Step 5: Rodent-proof Buildings. The most successful and permanent form of rodent control is to "build them out" by closing all openings through which they can enter a structure. Although it may not be economically feasible to remodel older buildings to make them rodent proof, it is a wise investment to modify newer buildings, particularly insulated confinement facilities.

Seal any opening larger than $\frac{1}{4}$ " (0.6 cm) to exclude both rats and mice. Mice can squeeze through an opening less than $\frac{1}{2}$ -inch (1.2 cm) across, and both rodents can quickly enlarge holes or gaps by gnawing. Cracks and openings around building foundations should be sealed tightly with galvanized steel sheeting or concrete mortar. Steel wool is a good material to temporarily plug openings. Doors, windows, and screens should fit tightly. It is wise to cover with metal any edges where rodents might gnaw.

Corrugated metal siding often gives mice an opportunity to enter wall spaces through the open corrugations at the panel edge. Mice can quickly gnaw through a rubber or vinyl vapor barrier. Such openings should be sealed or blocked with metal or mortar.

For Additional Information— Extension NebGuides, G 79-461—Controlling Rats; G 79-470—Controlling House Mice; and G 80-516—Burrowing Rodent Control with Gas Cartridges; are available from Cooperative Extension Service offices throughout Nebraska.

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Want a Rapid Return to Estrus?

Full-feed Sows After Farrowing

Duane E. Reese,
Bobby D. Moser¹

A rapid return to estrus (heat) following weaning is important for profitable and efficient swine production. Sows that do not exhibit estrus within a normal time period following weaning reduce production efficiency by increasing the interval between farrowings.

Ideally, most sows should return to estrus within six days following weaning. However, some sows, particularly first litter sows, require nine days or longer to return to estrus. In a North Carolina study involving 800 sows only 57% of first litter sows were in estrus within nine days after weaning as compared to 87% of sows that had farrowed two or more litters. A subsequent study with 3,119 records showed that only 48% of first litter sows were in estrus within seven days postweaning as compared to 75% of sows that had farrowed two or more litters. Also, the percentage of all sows in estrus within seven days postweaning was lower (66%) during the warmer months of June through September than during the cooler months of April, May or October (88%). Another study from Canada with 700 first litter sows indicated that only 37% were in estrus by 10 days after weaning. No reasons for the delayed return to estrus were given in these studies.

Separate Gilt Pool

To compensate for this, some producers maintain a separate gilt pool to replace females that do not return to estrus within a normal time period. However, this increases the cost of production. For example, a 100-sow herd with 35% gilts, farrowing twice per year would give a total of 70 (35 × 2) possible farrowings from first litter sows. If we assume that only 50% of 70 gilts will return to estrus within a normal time period after

weaning, then a gilt pool of about 35 gilts must be maintained (70 × 50%) to substitute for the first litter sows that did not return to estrus on schedule. The cost to maintain 35 additional gilts for 90 days at \$.50 per day amounts to \$1,575 per year (\$.50 × 35 × 90) or \$15.75 per sow in the herd.

Several factors may be involved with delayed return to estrus following weaning. The amount of energy consumed during lactation may be one contributing factor.

Five trials involving 164 first and second litter crossbred sows were conducted at the Nebraska station from January to November (1980), to determine the effect of energy intake during a four week lactation on the interval between weaning and first estrus. Sows were fed either a low energy diet (8,000 kcal of metabolizable energy

Table 1. Daily nutrient intake.^{a,b}

	Treatment	
	Low energy	High energy
Energy, kcal of ME	8,000	16,000
Protein, gm	620	620
Calcium, gm	36	36
Phosphorus, gm	24	24

^aCalculated daily intake.

^bIntake of other nutrients equivalent except kcal of energy.

per day) or a high energy diet (16,000 kcal of metabolizable energy per day) during lactation. Both diets contained the same ingredients and the intake of all nutrients except energy was equivalent and were adequate according to current recommendations (Table 1). Litter size was standardized between treatment groups within three days after farrowing and the pigs did not receive creep feed. Following weaning, all sows were confined to gestation crates and fed 4 lb (1.8 kg)/hd/day of a corn-soybean meal diet (14% protein), and were heat checked once daily in pens with the aid of boars.

Results indicate that sows consuming the low energy diet during

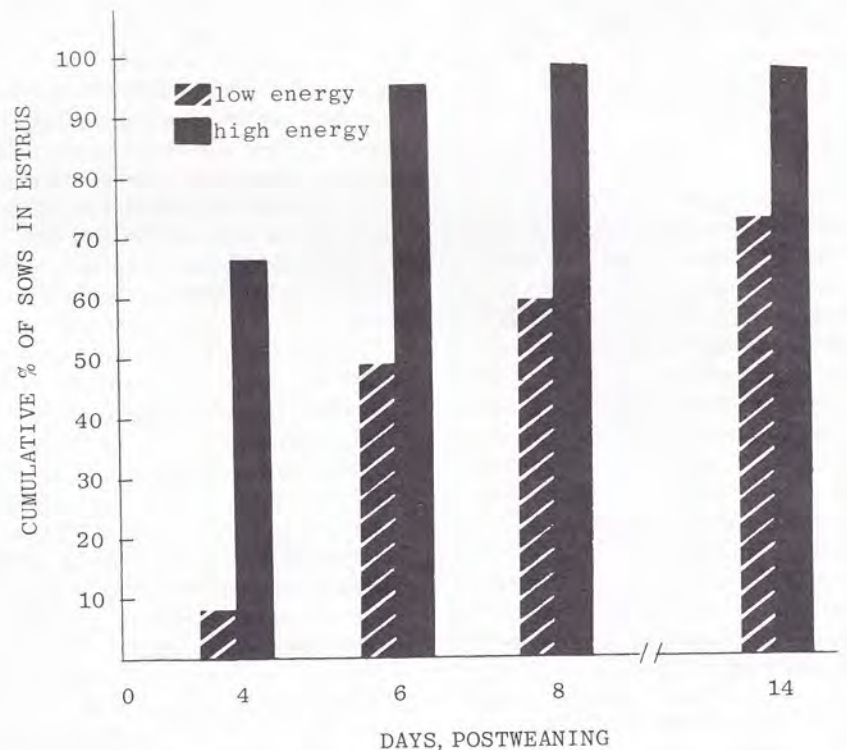


Figure 1. Cumulative percentage of sows in estrus at various days postweaning.

Swine Pneumonia Deadly

Alex Hogg¹

Swine pneumonia caused by the bacterium *Haemophilus pleuropneumoniae*, (H.p.p.) was first recognized in the U.S. in California in 1961. It has been incriminated as a cause of heavy economic losses in U.S. swine herds for the immediate past few years (Fig. 1). Some veterinarians think that the move to large confinement units has produced conditions favorable for the spread of this infection in U.S. swine herds. H.p.p. has been reported from swine-producing countries world-wide. The Scandinavian countries and Switzerland have experienced severe outbreaks in confined herds.

Pleuropneumonia of swine can vary from peracute to chronic. In a newly-infected herd clinical signs appear suddenly and include a body temperature up to 107°F (41.8°C), light to moderate coughing, but no great difficulty in breathing, with some pigs dying in less than 24 hours. Sometimes the skin of the ears or belly are blue because of lack of oxygen in the blood. There is often bloody froth on the nostrils of pigs that die peracutely. The disease spreads rapidly with 50 to 100% of the herd becoming infected. Death rate varies from 2 to 50% of the herd.

Six Days

A typical acute case flares up for six days at which time the heavy death losses decrease markedly. The disease then goes into a more chronic form. Abscesses form in the lungs which often cause decreased growth and poor feed conversion rates.

Some animals may completely recover, but in others the organ-

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lactation weighed less and had less backfat at weaning than sows fed the high energy diet (Table 2). Sows fed the low energy diet also weaned smaller and fewer pigs than sows fed the high energy diet. Pig survival rate from three days postfarrowing to weaning was greater than 90% for both treatments but slightly lower in litters of sows fed the low energy diet.

Significant Response

The most significant response was the effect of energy intake on the cumulative percentage of sows in estrus at various days following weaning, which can be seen in Figure 1 and Table 3. Through four days postweaning, 67% of sows fed the high energy diet were in estrus as compared to only 8% of sows fed the low energy diet during lactation. A higher percentage of sows fed the high energy diet were also in estrus through six (95% vs 49%) and eight (98% vs 60%) days following weaning. Through 14 days postweaning, 98% of sows fed the high energy diet were in estrus as compared to 73% of sows fed the low energy diet.

Results indicate that delayed estrus following weaning occurs more frequently with sows consuming 8,000 kcal of metabolizable energy per day as compared to sows consuming 16,000 kcal per day during the four-week lactation period. This has practical application in a situation where sows are consuming low amounts of energy (feed) during lactation. Sometimes sows are not fed at a high energy

Table 3. Cumulative percentage of sows in estrus at various days postweaning

Days, postweaning	Treatment	
	Low energy % in estrus	High energy % in estrus
4	8	67
6	49	95
8	60	98
14	73	98

level or they limit themselves by not eating enough feed. An example of when restricted feed intake might occur is during periods of hot weather.

Our general recommendation is to have sows on full-feed by four-five days after farrowing and to keep them on full-feed throughout the lactation period. It takes energy to produce milk and to keep sows in good condition. These data suggest that, if sows are kept in good condition (small weight loss) during lactation, they will return to estrus within a normal time period after weaning. Estrus after weaning was delayed in sows that were in poor condition (due to large weight loss during lactation) at weaning. Results from these preliminary trials appear very promising but further research is necessary before additional diet and management recommendations can be suggested.

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Table 2. Performance of sows fed various energy levels during lactation.^a

	Treatment	
	Low energy	High energy
No. of sows	80	84
Sow weight, lb (kg)		
at farrowing	314.6 (143.0)	320.7 (145.8)
at weaning (4 weeks)	274.4 (124.7)	320.8 (145.8)
Sow backfat, in. (mm)		
at farrowing	.88 (22.4)	.91 (23.1)
at weaning	.65 (16.5)	.88 (22.4)
Litter size ^b		
at 3 days postfarrowing	8.9	9.1
at weaning	8.0	8.6
Survival ^c , %	90	95
Pig weaning wt., lb (kg)	13.09 (6.0)	14.2 (6.4)

^a4 week lactation.

^bLitter size standardized within 3 days postfarrowing.

^cFrom 3 days postfarrowing to weaning.

Swine Pneumonia

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ism continues to live in the tonsils or lungs. These individuals become shedders and can be the source of infection for pigs in the next cycle of production.

Future generations of pigs are protected for some weeks by colostrum and milk antibodies. Consequently, the disease becomes a postweaning problem. Major losses then are from reduced performance. Death losses are much lower than when the disease first entered the herd.

Best Treatment

The best treatment in an acute outbreak of H.p.p. seems to be the intramuscular injection of large doses of penicillin-type antibiotics. Inject all pigs in affected pens and those in adjacent pens early in the outbreak. Follow-up injections of clinically ill pigs should be continued for two or three additional days.

Oral antibiotic treatment is usually recommended for a few weeks after the disease outbreak. Oral antibiotics have questionable value against H.p.p. but their use may be justified to help control secondary pneumonia caused by other organisms.

There are several H.p.p. vaccines (intrastate use) on the market. In addition, some veterinarians prepare autogenous vaccines from organisms isolated on the farm. These might be more effective than commercial vaccines



Figure 1. Pigs chronically affected by H.p.p. Note gaunt appearance, evidence of poor performance.

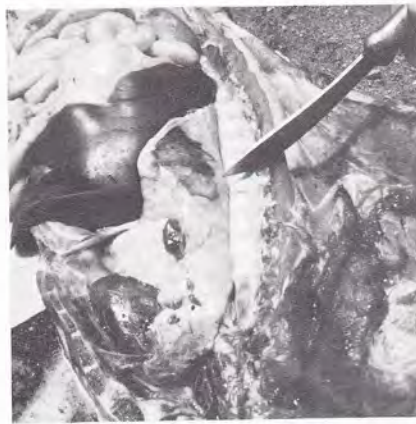


Figure 2. Pig lung with typical lesions of H.p.p. Note dark area of necrotic (dead) tissue at point of knife.

since there are at least three serotypes of H.p.p. found in this country.

Midwestern Spread

Recently H.p.p. is more frequently reported in midwestern swine herds. Diagnosis is by post-mortem lesions which include necrotic areas in the lungs and adhesions between the lungs and ribs (Figs. 2 and 3), and by isolating the organism.

Serologic tests, now in the developmental stages, offer a means for producers, purchasing replacement stock, to avoid buying carrier animals. Until these tests are widely available, buyers should know the health history of potential sources of replacements and avoid those that have had clinical signs of H.p.p.

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Figure 3. Chest of pig with H.p.p. being opened to demonstrate adhesion of lungs to ribs.

Solar Energy and

Michael F. Kocher,
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James A. DeShazer and
Dennis D. Schulte¹

Energy for maintenance of comfortable temperatures within the animal space represents a small but growing portion of the total cost of swine production in confinement systems. Currently, most of this energy comes from petroleum fuels. As supplies of these conventional fuels dwindle and prices rise, other energy sources may become more cost effective.

Solar energy is being used to replace the increasingly high priced fossil fuels and to reduce feed requirements in several Midwestern swine operations. The solar energy systems used in these operations are well-suited to confinement facility needs for in-floor heat or warm ventilation air. Ag engineers from UNL have designed and are researching these systems to aid in designing solar energy systems that can economically compete with conventionally fueled heating systems.

Solar collector systems can be separated into two groups: passive and active. Passive solar collectors are defined as collectors that do not use mechanical equipment (pumps, fans, blowers, etc.) to transport the heat from the collector to the heat storage to the area where the heat is needed. Passive systems are usually incorporated into buildings by using large glazed panels in the south wall, and massive concrete floors or associated materials such as sand, which function as heat storage. Active solar collectors use mechanical equipment to transport heat from the collector to the heat storage to the area where the heat is needed. Active systems can take a variety of shapes and sizes, and perform a variety of functions.

Research Beginnings

Research on solar energy use in

Swine Confinement Operations

swine buildings at the UNL Field Lab near Mead, Nebraska began in 1976. Results from the initial experiments indicated that active systems without heat storage consumed almost as much electrical energy as they saved, and therefore were not economical. The most effective solar energy systems incorporated both passive and active elements in their designs.

In 1977 a hybrid active-passive solar energy system was designed and constructed as an integral part of a 3840 ft² (357 m²) Modified Open Front (MOF) growing-finishing building on the Vennie Kavan farm near Wahoo, Nebraska. The building uses zone heating—heating primarily the floor and the air directly above it—to maintain a productive thermal micro-environment for the animals. Throughout the rest of this article, this building will be referred to as the Kavan design, or Kavan unit.

Kavan Design

Construction features of the building include single-glazed, fiberglass-reinforced plastic panels which act as passive collectors on the south side of the structure. During the winter, sunlight passing through the thirteen 10 × 8 ft (3.0 × 2.4 m) panels strikes the floor of the unit warming the floor and storing solar energy in the floor to help maintain a warm thermal environment. Additional in-floor heating is provided by the storage component of the active collector system. Concrete blocks placed with the hollow cores lengthwise, form an air passageway to allow the heated air from the active collector to flow through the cores. The blocks heated by contact with the heated air from the collector transmit heat to the soil under the floor, providing heat storage for the system.

Two 4 × 55 ft (1.2 × 16.8 m) roof-mounted double-pass air type collectors mounted perpendicular to the roof slope provide heated

air for the system. Under normal operating conditions the air is heated to 150°F (66°C). Air temperatures during stagnation (no airflow through the collector) may reach 350°F (177°C). These high temperatures dictate that the primary collector insulation must be a high temperature-rated mineral or glass-based product with low organic matter binding.

Operational evaluation of the collector performance has indicated that there is insignificant difference in performance between selective coatings applied to the absorber plate and dark colored pre-finished factory coatings on the metal used for the absorber plate. The difference in performance between aluminum and steel absorber plates in this collector has also been minimal.

Kavan Unit Economics

An economic analysis of the structure at the Kavan farm was performed to identify the costs of solar equipment and to permit an evaluation of the financial feasibility of active solar systems in growing-finishing operations. The analysis separated the cost of the base structure from the cost of the active solar collector system portion of the building. The cost of the base structure was estimated at \$38,332 or \$106.48 per pig space (1980 dollars). The cost of the active solar system was estimated at \$5,277 which includes material and labor costs for the collector, ducting, controls and storage. This represents \$12.69 per square foot (\$136.59 per m²) of collector area. Thus, the total investment in an active in-floor solar heating system represents an additional 15 percent cost over the base structure. A discounted cash flow for a 10-year investment period indicated that \$273 per year must be obtained from reduced costs or increased benefits to justify investment in the system.

In a growing-finishing unit, supplemental heat is not always

needed, and therefore, heating energy savings are not always realized. However, increased floor temperatures due to the solar system may improve feed efficiency and daily gain and produce a savings in this manner. A before-tax savings in feed consumption of one percent, based on a full building, would generate the required savings necessary to compensate for the increased investment cost. Aside from the investment costs, operating costs for electrical energy for the fans averaged 17 cents per day. Repair costs were estimated at 10 cents per square foot (\$1.08 per m²) of collector area per year, or \$43 per year.

Kansas State Research

Research and development work on the use of solar energy in swine housing has been conducted at Kansas State University (KSU). The collector that has been developed can be added to existing gableroof, mechanically ventilated, confinement buildings, whose long side faces south.

The solar collector is a concrete block wall with two glazing layers on the south side of the building. The block wall is not of typical construction, but consists of solid concrete blocks either 8 × 8 × 16 in. (200 × 200 × 400 mm) or 8 × 6 × 16 in. (200 × 150 × 400 mm) placed so that the long dimension is perpendicular to and several inches away from the south wall of the building. The blocks are dry-stacked (no mortar) with narrow vertical gaps left between adjacent blocks. These gaps allow airflow through the block wall. The south side of the block wall is painted flat black to increase the solar energy absorbed by the blocks.

The slots and gaps in the collector glazings and blocks are designed so that winter ventilation air enters the collector between the glazings, travels across the warm black surface of the block wall and gradually filters through the gaps between the blocks, and on into the building ventilation air inlet. Fans exhausting moisture and odors with ventilation air con-

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Solar Energy

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tinually pull ventilation air through the collector into the building. In this way, the building ventilation fans provide the power to move the air through the collector instead of having a separate fan perform this function. The concrete blocks act both as absorber plate and heat storage.

Kansas State Economics

Kansas State University has constructed several of these collectors on farrowing buildings both on the Kansas Agricultural Experiment Station and on cooperators' farms. Costs for the collector systems averaged \$140 per sow (1978 dollars), based on a two-pen wide building with 5 ft (1.5 m) wide farrowing pens. After monitoring temperature data and energy usage for these units, an economic analysis was performed to evaluate the financial feasibility of using the collectors. Results from the analysis indicated that using the collectors saved approximately 1½ gallons of propane per square foot (61 liters per m²) of collector area under Kansas climatic conditions. Assuming state income tax credits of 25%, federal income tax credits of 10 percent, propane costs of 50¢/gal, electricity costs of 2.5¢/kW hr, and a collector life of 10 years, the investment and operational costs for the collectors would equal the investment and operational costs for conventionally fueled heating systems.

Solar Demonstration Project

The University of Nebraska-Lincoln is presently cooperating with the U.S. Department of Agriculture (USDA) and U.S. Department of Energy (DOE) in developing 10 demonstration sites in Nebraska for solar heating livestock structures. One of these sites, at the Merlyn Lay farm near Glenvil, has a building with two 25-sow farrowing rooms and a gestation room. Along the 160 ft (48.8 m) south wall of the farrowing house is a new 140 × 7 ft (42.7 × 2.1 m) collector similar to the Kansas State University collectors (Figure 1). The collector is used to preheat winter ventilation air, cool summer ventilation air, and warm fall air for grain drying. The cost for this collector was \$186.49 per farrowing pen. A complete economic analysis has not been performed, but the collector payback period is estimated to be 10 to 12 years.

Nebraska Solar Wall

Two other collectors for the Solar Demonstration Project currently under construction will preheat winter ventilation air and heat water for in-floor heat in two farrowing houses. The collector designed for these purposes, called the Nebraska Solar Wall, uses a stack of concrete slats instead of concrete blocks for heat absorption and storage. The slats are stacked in a triangular pile along the south wall of the building with a 60° sloped front absorber surface. Horizontal gaps between each layer of slats in the stack are formed by using strips of flat metal bars to separate the slat layers. The sloped south

surface of the slats is painted flat black. Copper water lines are laid on top of the ledges formed by each layer of slats in the stack.

The collector operates similar to the KSU collector for winter ventilation air heating. During the summer a fan in the collector exhausts air from the collector to the outside to keep the collector from overheating. Water is circulated through the collector water lines and is heated by the hot air in the collector as well as by direct heat gain from solar radiation. This water is pumped to an insulated storage tank. The in-floor heat system uses the heated water from this storage tank as heat is required.

This particular Nebraska Solar Wall is under construction and considered to be an experimental design. Complete costs and economic analyses have not been determined, although it is expected that costs and economic payback will be similar to the KSU unit.

Another of the solar heated confinement buildings in the Demonstration Project is a Solar MOF Nursery on the Alvin Paus and Sons farm near Fairfield, Nebraska. The structure is a 116 × 23 ft (35.4 × 7.0 m) 550-head nursery which uses heat conservation practices as well as solar heat to supply all the supplemental heat required for the nursery-age pigs. The heat conservation measures incorporated into the building include insulated concrete sandwich wall panels; 6 in. (152 mm) fiberglass insulation in the ceiling; in-floor zone heat; and the use of insulated hovers over the rear one-third portion of each pen to help keep the heat down in the animal zone. The MOF non-mechanically ventilated design provides further energy conservation compared to typical nurseries with fans to ventilate the building.

The solar components of the building include both passive and active systems. The passive collectors are 8 × 6 ft (2.4 × 1.8 m) windows that allow winter sunlight to warm the floor in the front two-thirds of each pen. Directly underneath the floor in the front two-



Figure 1. Merlyn Lay's solar system.

thirds of each pen is a layer of insulation to reduce heat loss through the floor. The active collector is a 39 in. (1.0 m) high by 108 ft (32.9 m) long single-pass air type collector mounted on the ground in front of the building at a 60° slope. Storage for the active collector system is located under the rear one-third of each pen. It functions both as storage and an in-floor heat distribution system. Concrete blocks with the cores lined up lengthwise provide channels for airflow through the storage to allow the heated air from the collector to store the heat in the concrete block, the 7 to 10 in. (178 to 254 mm) sand layer above the block, and the concrete floor above the sand layer. The concrete block and sand layer is insulated from the soil underneath the building to keep temperatures high enough for the nursery-age pigs. The infinite soil mass storage used in the Kavan design did not allow these high temperatures.

Solar MOF Nursery Economics

Although a complete economic analysis has not been performed on this structure, a few economic factors are known. The entire structure cost about \$30,000. Of that, \$6,945.92 was the cost for the materials and labor involved in the active collector, ductwork, storage, fan, controls, and the passive windows. The passive windows themselves cost \$2,739.80. The cost of the total active collector system alone was 16 percent of the base structure cost, or \$11.98 per square foot (\$128.99 per m²) of collector area. Operating costs to heat the building during the 79-80 winter came to \$10.00—just the cost to run the fan in the collector! Heating costs for similar structures without solar heat were estimated at between \$1000 and \$1100. From this data, the payback period for the solar system was estimated at 7 to 8 years.

Conclusions

If you are thinking of installing a solar energy system in your

swine confinement unit, consider:

1. Solar collectors should face south. This orientation will enable maximum collection of solar energy.

2. Solar collectors for swine confinement facilities require large areas. Combining this point with the previous point indicates that solar energy is best suited for use with buildings that have their length running in the east-west direction.

3. Vertical wall collectors such as the KSU collector can deliver an average of about 450 BTU's per square foot (5.1 MJ per m²) of collector area per day during the months of November through April. This translates to approximately 1.0 gal. of propane per square foot (40 liters per m²) of collector area saved per heating season under Nebraska climatic conditions.

4. Collectors with their absorber surface at a 60° angle from the horizontal can deliver an average of 600 BTU's per square foot (6.8 MJ per m²) of collector area per day during the months of November through April. This translates to approximately 1.3 gal. of propane per square foot (52 liters per m²) of collector area saved per heating season under Nebraska climatic conditions.

5. The Ag. Engineering Plan Service at UNL has several plans for solarized swine confinement facilities including:

Plan No.	Description	Price
NE 10.726-35	MOF With Passive Collector Only	\$2.00
NE 10.726-37	Solar MOF Nursery (Paus Building)	\$2.00
MWPS 81902	20-Sow Solar Farming House	\$2.00

For further information or help in planning a solar energy system for your swine confinement facility, consult your County Extension Agent or Extension Ag Engineers.

¹Michael F. Kocher is Extension Assistant; Eugene J. Veburg is Research Assistant; Gerald R. Bodman is Extension Engineer (Livestock Systems); James A. DeShazer is Professor (Livestock Environment); and Dennis D. Schulte is Associate Professor (Livestock, Processing) Department of Agricultural Engineering.

Fumaric Acid: Does It Improve Feed Efficiency?

Austin J. Lewis¹

Fumaric acid is a white crystalline substance with a pleasant, tangy taste. It is used in the food industry in such products as beverages and baking powders.

Several reports from Europe have indicated that the performance of baby pigs can be improved by adding fumaric acid to their diets. Fumaric acid is believed to reduce post weaning scours and, consequently, increase growth rate. In the United Kingdom and the Netherlands commercial feed containing fumaric acid is sold for pigs weaned when 17 to 21 days old. Fumaric acid is very attractive

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Fumaric Acid

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as a potential feed additive because it is already approved for use in human foods and also because it is produced by animals themselves. Thus, it should be relatively easy to obtain regulatory approval for fumaric acid as a feed additive as far as safety is concerned.

Fumaric Acid Tested

Two experiments were conducted to examine the effects of fumaric acid additions to baby pig diets on pig health and performance. In the first experiment 96 pigs with an initial weight of 12.1 lb (5.5 kg) were divided into six groups and fed one of six different diets. The composition of the basal diet is presented in Table 1. The other diets contained 0.6, 1.2, 1.8 or 2.4% fumaric acid with antibiotics (CSP-250) or 1.8% fumaric acid with no antibiotics.

Pigs were housed in 12 pens with 8 animals (4 barrows and 4 gilts) per pen. Two pens (16 pigs) were assigned to each dietary treatment. This experiment was conducted in a heated, mechanically ventilated nursery building with a partially slatted floor. The pigs were weighed, feed intake was measured, and feces were examined for scours weekly. The scoring scale used for feces was as follows: 1. constipated; 2. normal; 3. slight diarrhea; 4. definitely unformed and moderately fluid feces

Table 1. Composition of the basal diet.^a

Ingredient	%
Ground corn	53.08
Soybean meal	22.71
Ground oats	10.00
Dried whey	5.00
Dried fish solubles	2.50
Dried brewers yeast	1.00
Tallow	2.50
Dicalcium phosphate	1.38
Limestone	0.68
Trace mineral mix	0.10
Salt (iodized)	0.50
Vitamin premix	0.30
Antibiotic mix	0.25
	100.00

^aCalculated to contain 18% crude protein, 0.75% calcium and 0.65% phosphorus.

Table 2. Effect of fumaric acid and antibiotics on performance and scours scores of baby pigs.

Fumaric acid, %	0	0.6	1.2	1.8	2.4	1.8
Antibiotic ^a	+	+	+	+	+	-
Average daily gain, lb (kg)						
Experiment 1	0.37(0.17)	0.35(0.16)	0.37(0.17)	0.42(0.19)	0.50(0.23)	0.37(0.17)
Experiment 2	0.79(0.36)	0.85(0.38)	0.88(0.40)	0.80(0.37)	0.82(0.37)	0.76(0.34)
Average	0.58(0.26)	0.60(0.27)	0.63(0.29)	0.61(0.28)	0.66(0.30)	0.56(0.26)
Average daily feed intake, lb (kg)						
Experiment 1	0.75(0.34)	0.70(0.32)	0.71(0.32)	0.80(0.36)	0.86(0.39)	0.68(0.31)
Experiment 2	1.48(0.67)	1.67(0.76)	1.74(0.79)	1.56(0.71)	1.52(0.69)	1.32(0.60)
Average	1.11(0.50)	1.18(0.54)	1.23(0.56)	1.18(0.54)	1.19(0.54)	1.00(0.45)
Feed efficiency, (feed/gain)						
Experiment 1	2.02	2.02	1.92	1.88	1.79	1.85
Experiment 2	1.86	1.97	1.97	1.94	1.86	1.74
Average	1.94	2.00	1.95	1.91	1.83	1.80
Scours score						
Experiment 1	2.4	2.4	2.3	2.6	2.4	2.6
Experiment 2	2.1	2.0	2.1	2.1	2.1	2.2
Average	2.25	2.20	2.20	2.35	2.25	2.40

^aCSP-250

and 5. very watery and/or frothy feces. The experiment lasted four weeks. The second experiment was similar to the first except that pigs were housed in groups of four in the baby pig room of Marvel Baker Hall. This laboratory has a partially slatted floor, excellent environmental control, and minimal disease exposure. Initial weight of the pigs in the second experiment was 11.7 lb (5.3 kg). In this experiment the feces were scored for scours daily for the first 14 days of the experiment.

Results of the two experiments are presented in Table 2. It is clear that the performance of pigs in the second experiment was much better than those in the first experiment. As the diets were identical, the pigs were of similar genetic makeup, and the average initial weights were similar, most of the difference in performance must have been due to environmental factors. These results show clearly the very profound effect that environment in the nursery can have on the performance of pigs during the first four weeks after weaning.

Pigs fed the diet without antibiotics tended to perform less well than the other pigs. Their feed consumption and weight gains tended to be lower, and although there was little difference in the scours score for any treatment, the score was slightly higher for the

pigs fed no antibiotics. Somewhat surprisingly, the pigs fed no antibiotics did have the best feed efficiency overall. There was a tendency for this in both experiments.

Some Improvement in Gains

The effects of fumaric acid appeared to be different in the two experiments. In the first experiment, feed intake and weight gain were increased when 1.8 and 2.4% fumaric acid were added. In the second experiment, these two items were maximized at 1.2% fumaric acid. Overall it seems that the 1.2% level gave the best response. There was no consistent effect of fumaric acid on feed efficiency. Similarly, the addition of fumaric acid did not influence scours scores in this experiment.

These results demonstrate that there may be some improvement in weight gains of baby pigs from adding fumaric acid to their diets. The optimum level of addition appears to be dependent on the environmental conditions in the nursery and, consequently, the overall level of performance. In these studies the increase in growth rate that was observed did not appear to be due to a reduction in the incidence of diarrhea.

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Feeding Processed Soybeans

Larry L. Bitney,
E. R. Peo, Jr.¹

At certain times it may be more economical to use whole soybeans as a protein supplement for swine than soybean meal. Whole soybeans can be fed to swine but they must be heat-processed before feeding. Raw soybeans contain antigrowth factors which are destroyed when the beans are heated in the presence of moisture.

Considerable research has been conducted on the feeding value of cooked soybeans for swine. We discussed the research in our 1970 and 1971 Nebraska Swine Reports. The feeding value picture has not changed since then. What has changed, of course, is the price relationship between corn, soybeans, and soybean meal. Too, we know more about the value of fat in the swine diet. Whole soybeans add a considerable amount of fat. Fat additions will improve feed conversion in swine.

Formulas containing 16% and 14% protein using either soybean meal or whole soybeans are given in Table 1. Note that it takes more soybeans to make 16% and 14% protein diets than it does soybean meal. But, the diets with whole processed soybeans contain more fat and thus are higher in energy.

Table 1. Sample 16% and 14% protein swine diets formulated with whole processed soybeans or soybean meal.^a

	Diets and amounts			
	16%		14%	
	Soybean meal	Soybeans	Soybean meal	Soybeans
Ground corn	1507	1407	1619	1544
44% soybean meal ^b	420	---	308	---
Whole processed soybeans ^{b,c}	---	520	---	382
Dicalcium phosphate (18.5% P)	18	17	22	19
Ground limestone	24	25	20	24
Salt	10	10	10	10
Trace minerals mix	1	1	1	1
Vitamin-antibiotic mix	20	20	20	20

^aAs fed basis

^bTotal fat, %

^cAdded fat

from soybeans, %

2.98	7.45	3.16	6.44
---	4.68	---	3.44

According to Moser (1975 Nebraska Swine Report) adding 5% fat to the diet could improve feed conversion as much as 13%. From a conservative point of view, you can expect at least a 10% reduction in feed required per unit of gain with the fat added from use of whole processed soybeans.

Economic Feasibility

The economic feasibility of feeding processed soybeans to swine is affected by the relationship between the price of soybeans, soybean oil, soybean meal, and corn. The price situation in the fall of 1980 favored the feeding of processed soybeans. The price of soybean oil remained relatively low, while the price of soybean meal increased. The price of corn was also increasing. Thus, substituting soybean oil (in the processed beans) for some of the energy provided by the corn, and producing the same amount of gain with less total feed, was an attractive alternative.

The break-even chart in Figure 1 was developed for use by hog producers to determine the economic feasibility of feeding processed soybeans, given an individual producer's price of soybeans and soybean meal.



The appropriate prices for a producer to use in Figure 1 are the on-farm price of soybeans (elevator price, less the cost of hauling them to the elevator) and the on-farm price of soybean meal (delivered price). To use the chart, let's assume that the price of soybean meal is \$280 per ton, and that soybeans are \$8 per bushel. The dotted lines drawn from these prices intersect at point "A". This point is in the region of the chart which indicates that it would be economically advantageous to feed processed soybeans. If the soybean price increased to \$10/bu., we would be at point "B", which indicates that we should sell our soybeans and buy soybean meal. If the soybean price is \$9/bu., we are at point "C", which is in the "grey area" of the chart. The upper break-even line represents a 10% reduction in feed per unit of gain with the processed soybean ration, while the lower line reflects a 6% reduction. Results of feeding trials indicate that we can expect at least a 6% reduction in feed required per unit of gain with a high degree of certainty. There is also evidence that a 10% reduction may be achieved. Thus, at point "B" our decision as to what to feed depends upon our personal optimism or pessimism regarding the potential results of feeding a ration containing processed soybeans.

A cooking cost of 60/bu., or \$20/ton, was used in calculating the break-even lines in Figure 1. If your cooking cost is different from 60¢ you can still use Figure 1. For example, if your cooking cost is 80¢

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Processed Soybeans

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per bushel, merely add 20¢/bu. to the soybean price used in Figure 1. Thus, if your actual soybean price is \$8.00/bu., you would use \$8.20 in Figure 1 to reflect the higher cooking cost.

A corn price of \$3.10 per bushel was used in calculating the break-even lines in Figure 1. To adjust for different corn prices, lower the soybean price 6¢/bu. for each 10¢/bu. increase in the corn price. For example, if soybeans are \$8/bu., and the corn price is \$3.30/bu., subtract 12¢ from the soybean price used in Figure 1. The appropriate price would then be \$7.88. Conversely, decreases in the corn price would result in an increase in the soybean price to be used in Figure 1.

Processing Costs

A processing cost of \$20 per ton was used in calculating the break-even lines in Figure 1. But, soybean processing costs may vary considerably among producers, depending upon the volume of beans processed and the type of processing equipment used.

The costs of two processing machines, a roaster and an extruder,

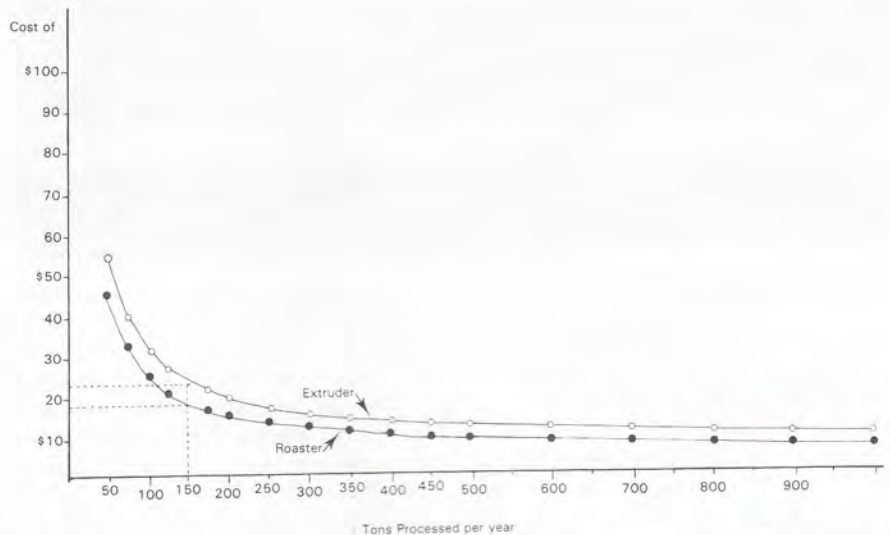


Figure 2. Estimated total cost per ton of processing soybeans according to method of processing and tons processed per year.

er, were calculated and the resulting cost curves are presented in Figure 2. Two types of costs are incurred when a hog producer buys and operates a soybean processing machine—fixed costs and variable costs. The fixed costs include depreciation (10 year life), interest (12%), repairs due to time, and insurance. These costs are fixed, and do not change with the amount of annual use. Thus, the fixed cost per ton processed decreases as the

processing volume increases. The initial investment in the roaster was \$11,400, and the annual fixed cost was \$1,995. This machine had a capacity of 1200 lb. per hour. The extruder cost \$13,000, had an annual fixed cost of \$2,275, and had a capacity of 900 lb. per hour.

Variable costs include propane (65¢/gallon), electricity (6¢/kwh), labor (\$5.00/hour), and repairs due to use. The variable costs were \$5.52 per ton for the roaster and \$8.73 per ton for the extruder.

The total processing costs per ton for each machine at various levels of annual use are presented in Figure 2. The annual fixed costs cause the curves to slope downward, resulting in lower processing costs per ton as larger tonnages are roasted per year.

The dotted line drawn upward at the 150-ton level indicates that the processing cost per ton would be \$18 with the roaster, and \$24 with the extruder. Using a 14% finishing ration, a ton of beans would go into the ration required to feed 16 hogs from 40 to 220 pounds (18 to 100 kg). Thus, at the 150 ton level, a producer would be finishing 2,400 head of hogs per year.

If a producer were to process 500 tons per year, which would result in processing costs of \$9 to \$13 per ton, he would be finishing 8,000 head per year. Thus, the

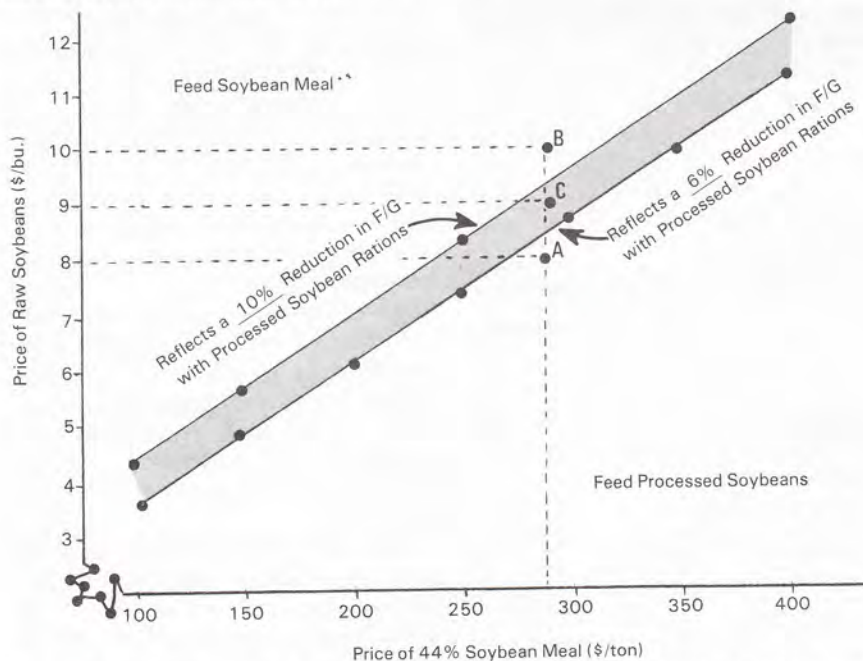


Figure 1. Breakeven prices of soybean meal and soybeans in a 14% swine finishing ration (corn at \$3.00/bu., soybean processing at \$20/ton or .60/bu.).

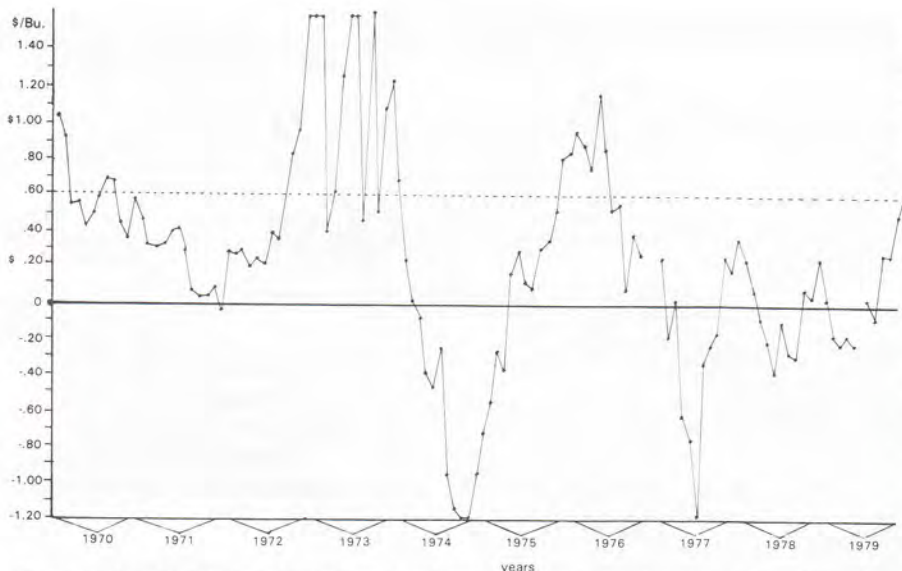


Figure 3. The feed value of processed soybeans minus the market price of soybeans, by months, 1970-79.

purchase of a processing machine would be feasible only for a large producer. A smaller producer would either need to have his beans processed on a custom basis, or do custom processing for other producers to keep his costs at a reasonable level.

Consider the Long Run

The costs calculated in Figure 2 were based on a 10-year life of each machine. Thus, a producer should be concerned with the profitability of feeding processed soybeans over an extended period of time, not just during periods when soybean meal is expensive. To explore the long-run feasibility of an investment in soybean processing equipment, monthly prices for soybeans, soybean meal, and corn were tabulated for a ten-year period (1970-79). An 8% reduction in feed required per unit of gain with the processed soybean ration was assumed. The feed value of processed soybeans was calculated and compared to the market price of soybeans for each month over the 10-year period. The price differences (the feed value of the processed beans minus the market price) appear in Figure 3. As you can see, the differences have been positive, as well as negative. Since the feed value of processed soybeans was used in this comparison, the difference between their feed value and the

market price must exceed the processing cost in order for processing to be feasible. The dotted line was drawn across Figure 3 at the 60¢ level to indicate a 60¢ per bushel (\$20 per ton) processing cost. The proportion of the time during the 10-year period that feeding of processed soybeans would have been feasible is represented by the proportion of the time that the price differential line is above the dotted 60¢ line.

A quick glance at Figure 3 shows us that an investment in a soybean processing machine (with a 60¢/bushel processing cost) would have been profitable only part of the time during the last 10 years. The data which Figure 3 was developed from indicate that feeding processed beans would have been feasible (with the 60¢ cooking cost) in only 24 months, or 20% of the time during the ten-year period.

Figure 3 gives us a historic view. The next 10 years could be different from the last 10, although it is not likely that the price relationships which affect the feasibility of feeding processed soybeans will change drastically.

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Add Fat (Dry) to Increase Daily Gains

Kelly Keaschall,
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Adding fat to swine diets gained much attention in the 1970's. With the cost of conventional energy sources increasing, other sources such as inedible fat become economically competitive. Research at UNL has shown that adding fat to swine growing-finishing diets will improve feed efficiency and average daily gain. A 5% addition of fat can improve gain by about 5% and feed efficiency 10% with little effect on backfat. Fat added to the prefarrowing and farrowing diet has shown an improvement of about 3% in baby pig survival. A low level of fat (2%) added to the diet can also be used as a management tool to control dust in confinement buildings.

One factor limiting use of fat in swine diets is the physical handling problems associated with adding liquid fat. Animal fat, such as inedible tallow and greases, is generally the more economical feed-

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Add Fat (Dry) to Diet

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grade fat available. It commonly comes as a semi-solid at room temperature. To be properly mixed in the diet, it must first be melted and then added slowly to prevent the fat from "balling up" in the mixing process. Too, diets containing high levels of fat have a tendency to bridge in the feeders. If these problems could be eliminated, adding fat to swine diets could become more practical.

"Dried-Fat"

So called "dried-fat" products may eliminate the handling difficulties associated with liquid fat. "Dried-fat" products use carriers to absorb and hold the fat. These products are relatively free flowing and can be added to the diet in the same manner as a conventional supplement. The amount of fat in some of these products ranges from 20-70% depending on the carrier used.

Nine treatments were used in an experiment to determine if pigs utilize the fat from "dried-fat" products as well as liquid fat (Table 1). Pigs were fed the 18% protein diets to 80 pounds (36 kg) then switched to 16% protein. The treatments containing the carrier with no added fat were used to determine if the carrier had any affect on performance. Fat (liquid or dry) was added to the diet at the rate of 5%.

Table 1. Diet composition.*

% ingredient	Treatment								
	1	2	3	4	5	6	7	8	9
Corn	69.6	63.3	63.3	66.7	60.8	66.9	60.6	63.5	57.2
Soybean meal	26.7	28.0	28.0	26.4	27.2	27.2	28.5	25.4	26.7
Tallow	-	5.0	-	-	-	-	-	-	-
Lard	-	-	5.0	-	-	-	-	-	-
Whey	-	-	-	3.3	-	-	-	-	-
Whey + fat	-	-	-	-	8.3	-	-	-	-
Verxite	-	-	-	-	-	2.1	-	-	-
Verxite + fat	-	-	-	-	-	-	7.1	-	-
Wheat bran	-	-	-	-	-	-	-	7.5	-
Bran + fat	-	-	-	-	-	-	-	-	12.5
Minerals & Vitamins	2.7	2.7	2.7	2.6	2.7	2.8	2.8	2.6	2.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Calculated analysis 18% protein, .75% Ca, .65% P.

Table 2. Performance of pigs fed various forms of fat.

Item	Treatment								
	Control 1	Tallow 2	Lard 3	Whey 4	Whey + Fat 5	Verxite 6	Verxite + Fat 7	Bran 8	Bran + Fat 9
ADG, lb (kg) ^{bf}	1.57 (.71)	1.60 (.93)	1.69 (.77)	1.58 (.72)	1.61 (.73)	1.52 (.70)	1.64 (.74)	1.56 (.71)	1.63 (.71)
ADFI, lb. (kg) ^{bcd}	4.44 (2.01)	4.09 (1.86)	3.93 (1.78)	4.45 (2.02)	3.97 (1.80)	4.47 (2.03)	4.50 (2.04)	4.55 (2.06)	4.09 (1.86)
F/G ^{bde}	2.81	2.56	2.32	2.82	2.47	2.95	2.75	2.92	2.51
Backfat, in. (cm)	1.04 (2.64)	1.10 (2.79)	1.02 (2.59)	1.11 (2.82)	1.08 (2.74)	.92 (2.34)	1.01 (2.57)	.99 (2.51)	1.05 (2.67)

^aInitial wt. 20 lb. (9.1 kg). Final wt. 200 lb. (91 kg).

^b1, 4, 6, 8 vs 2, 3, 5, 7, 9 (P<.001).

^c2, 3, vs 5, 7, 9 (P<.025).

^d5 vs 7, 9 (P<.01).

^e7 vs 9 (P<.01).

^f2 vs 3 (P<.025).

Adding fat to the diets at this rate produced faster and more efficient gains than their non-fat counterparts (Table 2). This is consistent with earlier research at Nebraska and at other experiment stations. Diets containing the fat carriers produced an average daily gain and feed/gain similar to that of the control diet. This suggests that adding the carriers at the levels used in this experiment (whey, bran and verxite) should not have an adverse effect on performance. Two of the "dried-fat" products (bran + fat and whey + fat) produced a daily gain and feed/gain equivalent to the diets containing liquid fat and better than the diet containing the verxite + fat. The verxite is an inert material and makes an excellent carrier for liquid fat. The verxite + fat product was free flowing and easy to add to the diets. Pigs apparently were not able to utilize the fat from the verxite carrier as well as from other sources, as indi-

cated by the reduced feed efficiency.

Backfat No Problem

High levels of added fat increase backfat. However, small additions have not had an adverse effect on backfat. There was no difference in backfat thickness of pigs fed the nine dietary treatments. This suggests that adding fat at the rate of 5% does not adversely effect backfat when added in the liquid or dry form to swine diets.

All of the "dried-fat" products were easy to add to the diets. They also seemed to reduce the dust even in the "dry" state. The wheat bran product tended to set up in the cold winter months which caused some problems. The verxite was the easiest to handle and was free flowing, but it resulted in the poorest performance of any of the diets with added fat. The whey product eliminated the handling problems and gave performance equal to that of the tallow and lard. These data indicate that some "dried-fat" products are capable of producing performance equal to diets containing liquid fat. Adding fat in the dry form would be more practical for home mixing operations. The cost of "dried-fat" products is usually higher than feed grade tallow or lard. Thus, economic comparisons as well as physical handling characteristics should be considered when choosing between "dried-fat" and liquid fat additions to swine diets.

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Will Consumers Accept Low Sodium Pork?

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M. L. Lesiak and
D. G. Olson¹

There is much concern about health and how it is affected by food intake. Salt (more specifically sodium) is part of that health concern. While it is only suspected that sodium is directly related to high blood pressure and hypertension, many individuals are typically placed on low sodium diets. Processed meats are considered high in sodium and are recommended to be avoided in low sodium diets.

Salt is added to processed meats for flavor, to act as a preservative, and to solubilize proteins in the formation of emulsions. These soluble proteins act like "glue" to bind and hold the very fine particles of meat tissue together. Emulsion products, such as frankfurters and bologna, would be virtually impossible to make without salt.

Table 1. Treatments for low sodium bologna, polish sausage, fresh pork sausage and bacon

Treatment	Ingredient percent of formulation		
	NaCl	KCl	Na ₄ P ₂ O ₇
Bologna			
1	2.25	-	-
2	0.75	1.0	0.15
3	0.75	1.0	-
4	0.75	1.25	-
5	0.75	1.50	-
Polish Sausage			
1	2.0	-	-
2	0.75	0.75	-
3	0.75	1.0	-
4	0.75	1.25	-
Fresh Pork Sausage			
1	1.25	-	-
2	0.45	0.45	-
3	0.45	0.60	-
4	0.45	0.75	-
Bacon			
1	2.0	-	-
2	0.75	0.75	-
3	0.75	1.25	-

Table 2. low sodium bologna treatments.

Treatment	Ingredient percent of formulation				
	NaCl	KCl	MgCO ₃	Yeast	Na ₄ P ₂ O ₇
1	2.25	---	---	---	---
2	0.75	1.0	0.6	---	---
3	0.75	1.0	---	0.25	---
4	0.75	1.0	---	---	0.1
5	0.75	1.0	---	---	---

Table 3. Effects of NaCl, KCl, MgCO₃, yeast and Na₄P₂O₇ on bologna sensory evaluation scores.

	Treatment means ^{1,2,3}					S.E.
	Na2.25	NaK-MgCO ₃	NaK-yeast	NaK-P ₂ O ₇	NaK	
Flavor	4.9 ^a	3.4 ^a	4.5 ^a	4.3 ^a	4.3 ^a	0.12
Texture	4.9	4.2	4.7	4.1	4.5	0.16
Acceptability	5.0 ^a	3.4 ^a	4.5 ^a	4.2 ^a	4.3 ^a	0.13
Aftertaste	4.5 ^a	3.5 ^a	4.2 ^a	4.0 ^a	4.1 ^a	0.07

¹Scoring scale: 1 = extremely dislike, 4 = neutral, 7 = extremely like

²Means with different superscripts in each row are significantly different (P < .01).

³n = One hundred six observations per treatment mean.

Therefore, the challenge to the meat industry is to produce low sodium meat products without sacrificing quality or desirability of processed meats.

Low Sodium Research

Earlier work at University of Nebraska-Lincoln found that low sodium bologna with low salt levels had stability problems. Bologna with high levels of potassium chloride had flavor problems. The current study was conducted to determine effects of potassium chloride (KCl) levels on characteristics and acceptability of low sodium bologna, polish sausage, fresh pork sausage, and bacon. The study also investigated the use of magnesium carbonate (MgCO₃), sodium pyrophosphate (Na₄P₂O₇), and autolyzed yeast on characteristics and flavor acceptability of a high potassium, low sodium bologna.

General formulations and processing steps were followed for the four meat products. Bologna was selected to study the effect of additional ingredients in the presence of low sodium and high potassium levels. The additional ingredients were magnesium carbonate (MgCO₃), yeast and sodium pyrophosphate (Na₄P₂O₇). The experimental treatments are shown in Tables 1 and 2. The control bologna contained NaCl at a level (2.25%) representative of com-

mercial bologna products. The bologna treatments were evaluated for emulsion stability, color, Instron compression, puncture probe, Kramer shear and by consumer sensory panel evaluation. Emulsion stability was tested on the day of processing. Color determination Instron tests and consumer panels were conducted six to eight days after processing.

NaCl and KCl were varied to establish treatments for polish sausage, fresh pork sausage, and bacon (Table 1). The polish sausage, fresh pork sausage, and bacon treatments were evaluated for proximate analysis, percentage chloride, potassium, sodium and consumer desirability. Emulsion stability and Instron compression tests were conducted on polish sausage products.

Consumer panels evaluated flavor, texture, overall acceptability and aftertaste for all products. Bacon was not evaluated for texture. Panelists were asked to check the box that corresponded to how much they liked or disliked a sample for each of the characteristics being evaluated.

Bologna

Table 3 shows the effects of the added ingredients on high potassium, low sodium bologna. Magnesium carbonate (MgCO₃) which was added to bologna to reduce

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Low Sodium Pork

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potassium chloride bitterness had other detrimental effects. The $MgCO_3$ reduced textural characteristics (Kramer shear), received undesirable sensory ratings and produced product discoloration. For these reasons it was eliminated from further study.

A yeast product by the commercial name of Z yeast-70 (Amoco Foods) was used to reduce bitterness and increase saltiness of a low sodium bologna with KCl added. The use of yeast did not have any effect on emulsion or texture characteristics. At the levels used, the yeast did not show any particular benefit as seen in sensory evaluation. In sufficient amounts yeast can add its own unique flavor to a product.

Sodium pyrophosphate (P_2O_7) was used to increase stability of the products. The (P_2O_7) compensated for the reduced sodium in emulsion stability testing. The (P_2O_7) increased texture (Kramer force) characteristics but did not have an effect on sensory evaluation. The (P_2O_7) used in combination with low levels of KCl in bologna did not show any significant benefit compared to higher KCl levels studied. However, (P_2O_7) as seen before tended to decrease cooking losses.

The effects of various KCl levels on characteristics of a reduced sodium bologna were minimal. Reduction of sodium tended to increase cooking losses. The addition of higher levels of KCl reduced the loss. No differences were found for textural measures or sensory panel texture. A difference was found for aftertaste

Table 5. Effects of KCl levels on fresh pork sausage sensory evaluation scores.

	Treatment means ^{1,2,3}				S.E.
	Na1.25	NaK.45	NaK.6	NaK.75	
Flavor	5.2	4.8	4.8	4.8	0.08
Texture	5.2 ^a	4.8 ^b	5.0 ^{ab}	5.0 ^{ab}	0.05
Acceptability	5.1 ^a	4.7 ^b	4.7 ^b	4.7 ^b	0.04
Aftertaste	4.9	4.7	4.7	4.5	0.11

¹Sensory scale: 1 = extremely dislike, 4 = neutral, 7 = extremely like.

²Means with different superscripts in each row are significantly different ($P < .05$).

³n = Ninety observations per treatment mean.

in sensory evaluation (Table 4). The control was rated significantly better than the sodium reduced treatments with KCl added. The highest level of KCl addition, 1.5%, was undesirable for aftertaste and represents an upper limit for KCl at this level of sodium reduction in bologna. All other treatments were rated in the neutral to like range of the rating scale.

Polish Sausage

Three levels of KCl were used to determine their effect on low sodium polish sausage. Reduction of sodium increased cooking losses. The higher levels of added KCl reduced the loss. There were no differences detected for texture measures. No differences were found for sensory evaluation scores which were all in the "neutral" to "like" range of the scale. The control NaCl treatment tended to be scored higher for all characteristics.

Fresh Pork Sausage

With fresh pork sausage cooking losses were reduced as KCl levels increased. No differences were found for textural measures, but a difference was found in sensory texture (Table 5). As salt levels increased texture ratings increased. This may be related to the effect of salt on cooking loss. Acceptability scores of the control

NaCl treatment were found significantly higher than the reduced sodium treatments. The sodium reduced treatments were not different for acceptability and were rated in the "neutral" to "like" range of the sensory scale.

Bacon

Production of low sodium bacon for sensory evaluation involved a number of variables. Variables were percent pump, product yield and cooking loss. The results of the sensory evaluation showed that there were no differences. All treatments were rated in the "neutral" to "like" range for flavor, acceptability, and aftertaste. The treatment containing low NaCl and a low level of KCl tended to be rated higher than other treatments. This may be due to a sweeter taste compared to the other treatments.

Conclusions

The overall results indicate that acceptable low sodium meat products can be produced. These products, however, may not be the same for all characteristics as products produced with normal levels of sodium chloride. Differences that were shown are small with characteristics of the low sodium products still being desirable. With proper seasonings these products may become as acceptable to consumers as the high sodium products available in the market today.

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Table 4. Effects of KCl levels on bologna sensory evaluation scores.

	Treatment means ^{1,2,3}					S.E.
	Na2.25	NaK-P ₂ O ₇	NaK1	NaK1.25	NaK1.5	
Flavor	5.2	4.4	4.4	4.3	4.1	0.23
Texture	5.2	4.4	4.8	4.7	4.4	0.15
Acceptability	5.3	4.3	4.4	4.2	4.0	0.21
Aftertaste	5.0 ^x	4.1 ^y	4.2 ^y	4.0 ^{yz}	3.8 ^z	0.04

¹Sensory scale: 1 = extremely dislike, 4 = neutral, 7 = extremely like.

²Means with different superscripts in each row are significantly different ($P < .01$).

³n = Ninety observations per treatment mean.

Buying, Caring For Feeder Pigs

M. C. Brumm
Concord, Nebr.

More than one-fourth of U.S. market hogs were purchased as feeder pigs. This percentage is probably higher in Nebraska due to the large concentration of farrowing cooperatives. While there are no definite numbers, it appears that in Nebraska over 35% of the pigs slaughtered are purchased as feeder pigs and transported to a finishing facility.

This shipment and mixing of pigs at a young age subjects the animal to a variety of stresses including hunger, fatigue, thirst, ration changes, social order changes, new pen mates, and temperature changes. An effective purchasing and receiving program will help reduce these stresses.

Following are guidelines for purchasing and starting feeder pigs.

Type of Pig to Purchase

Many problems with feeder pigs can be avoided by careful purchase of pigs. The ideal purchased feeder pig:

1. Weighs 35-40 lb(16-18 kg) at eight weeks of age.
2. Is castrated and healed.
3. Has internal and external parasites under control.
4. Is healthy, vigorous and alert.
5. Is purchased from a reliable source.

Beware of "cheap" pigs. It's unwise to pay too much but it's worse to pay too little. When you pay too much for good pigs you only stand to lose a little money. If you buy "cheap" pigs however you may lose the pigs also.

Management and Housing

Be prepared for the arriving pigs. Provide a clean, dry and draft-free sleeping area. In confinement, provide at least 4 sq. ft. (.38 sq. m) of floor area for 30-50 lb (14-22 kg) pigs and 5 sq. ft. (.47



sq. m) for 50-80 lb (22-36 kg) pigs. Prevent piling and prolapses by maintaining a warm, comfortable environment. Upon arrival, group pigs by size. If possible, put no more than 25-30 pigs per pen. More than 50 pigs per pen may result in reduced performance due to social interactions.

One waterer is required per 20 pigs. If nipple waterers are used, it may be necessary to let them drip for the first day or two until the pigs learn how to drink from this type waterer. Provision should be made to medicate pigs through the water, if needed. This can be done either with an inline medicator or a tank or barrel waterer. A 40-pound pig will consume about ½ gallon (2 l) of water per day.

Provide at least one feeder space for each 3-4 pigs. If feeders have lids, it may be necessary to tie them up for the first few days or until the pigs are eating properly. Floor feed for the first few days following arrival of the pigs. This promotes good dunging habits and allows the manager to spot a sick pig sooner.

Frequent observation is a must. Close scrutiny at least twice a day for the first few weeks may prevent a serious disease outbreak. Monitor feed and water consumption since reduced consumption of either is a symptom of a problem. Provide a separate pen for sick animals. It may pay to provide extra heat in this pen to assist the sick animal in overcoming stress.

Nutrition

A specially formulated receiving ration fed for the first two weeks may help reduce death losses. The ration should provide 16% protein with adequate vitamins and minerals.

The addition of 10-20% oats to the ration as a fiber source may aid in the reduction of scours and

death loss. Other fiber sources such as alfalfa or wheat bran may also be considered.

The use of a feed additive in this receiving ration is recommended. Selection of a feed additive and level of feeding depends on the individual situation on each farm. Producers are encouraged to consult their veterinarian, nutritionist, or extension specialist for help on this selection.

Health

The use of water medication may be indicated for newly arrived pigs. A sick pig will often drink but not eat. Many producers provide a sulfa product in the water for five days after arrival. If palatability is a problem, a flavoring agent such as Jello may increase consumption. However, water is more important than preventive medication. Avoid unpalatable treatments which depress water consumption.

If pigs have been trucked a long distance and are dehydrated, it may be advisable to also include an electrolyte in the water to aid in restoration of body water balance. With all medications, read and follow label instructions.

Plan on treating pigs for both internal and external parasites. Deworm the pigs shortly after arrival with a broad spectrum wormer such as levamisole phosphate or dichlorvos. If the internal parasite load is heavy, reworm the pigs in two to three weeks to remove any reinfestation.

Inspect the pigs on arrival for mange and lice. Treat as necessary using an approved insecticide following label instructions. Do not spray visibly sick pigs. Successful treatment requires breaking the life cycle. Since the recommended insecticides do not kill eggs, two or more sprayings at 10 days are required.

A post-mortum examination of any dead pigs will help in disease control. Giving pigs extra attention and care should keep death losses consistently under 2% from time of delivery until sale.

¹M. C. Brumm is District Extension Specialist (Swine), Northeast Station.

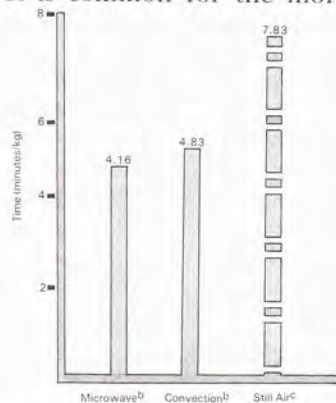
Low Energy Cooking of Pork

R. W. Mandigo,
T. S. Janssen and
M. P. McGinley¹

The United States faces serious energy problems. The food service industry is directly affected by the reduction in the supply of energy and by dramatically increasing energy costs. The food industry consumes nearly 17 percent of the nation's energy. Ovens in the food service industry are heavy energy consumers. Microwave and convection ovens have been described as energy savers. Preparing food in a microwave oven may save 50 to 75 percent of the energy required with an electric range. The microwave oven saves energy because it cooks faster and with no warm up time. The convection oven saves energy because it cooks the food at a lower cooking temperature with a shorter pre-heating time.

Little work has been done on standardizing pork cookery procedures for convection or microwave ovens. Many institutional food preparation manuals still suggest that pork be cooked to 185°F (85°C). The present recommended internal temperature of 170°F (77°C) provides maximum flavor and juiciness.

It is common for the morning



^an = 3 replications per treatment. Standard error = .03.
^{b,c} = Means with different superscripts are significantly different (P < .05).

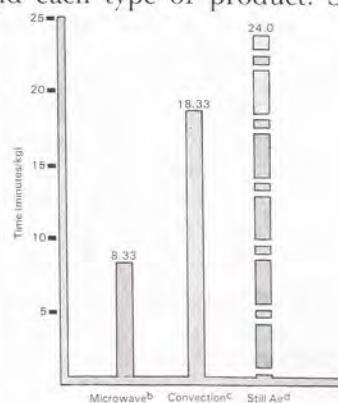
Figure 1. Comparison of cooking times for pork sausage links cooked by microwave, convection and still air ovens.

cook to have the main noon entrees cooked by 10:00 a.m., only to leave them in a steam table for several hours before serving. This, plus cooking pork 185°F (85°C) leads to a dry, tough and unmarketable product.

New Cooking Ovens and Practices

Preparation of acceptable pork products in microwave and convection ovens would aid the food service industry in adding menu variety and reducing energy expenditures. Suitable institutional cookery procedures were developed for fresh pork products using convection, microwave and still air ovens. This study investigated energy utilization of three ovens and the quality of fresh pork products cooked in them. Fresh pork roasts, sausage links and pork chops from each cooking method were compared.

Meat for the study was obtained from a commercial food service supplier (Geo. A. Hormel and Company, Fremont, NE) and is similar to the meat products customarily used in the University food service system. Standardized recipe forms were obtained from the University of Nebraska East Union and adapted for each type of oven and each type of product. Stan-



^an = 3 replications per treatment. Standard error = .04.
^{b,c,d} = Means with different superscripts are significantly different (P < .05).

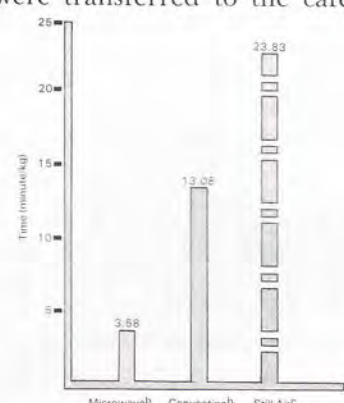
Figure 2. Comparison of cooking time for fresh pork roasts using microwave, convection and still air ovens.

ard institutional dial type, meat thermometers were used to monitor the internal temperature of the meat while in the convection (Blodgett "Zephaire", Burlington, VT) and still air (Blodgett "gas fired three deck") ovens. A Litton Micro-Temp microwave oven food thermometer was used to monitor the internal temperature of the meat while in the microwave oven (Litton "MenuMaster Systems 70/80", Minneapolis, MN). The pork roasts and chops were cooked to an internal temperature of 160°F (70°C). The sausage links were cooked to 165°F (74°C).

Cooking losses were measured on the samples being prepared for sensory evaluation. Weights were taken to obtain cooking loss due to evaporation in the oven and outside the oven, dripping inside and outside the oven, and total cooking loss. Cooking times were also recorded. Cooking losses were calculated as a percentage of the initial fresh meat weight.

The volts and amps of the three ovens were measured by a General Electric clip-on amp meter. The time variables were determined by timing the intermittent heating cycle with a stop watch. The power and energy of the three ovens was calculated from formulas.

The Nebraska East Union was used as the site for all sensory panels. The pork products were prepared as specified by the standardized recipes. After taking cooking loss weights, the products were transferred to the cafeteria



^an = 2 replications per treatment. Standard error = .26.
^{b,c} = Means with different superscripts are significantly different (P < .05).

Figure 3. Comparison of cooking time for pork chops using microwave, convection and still air ovens.

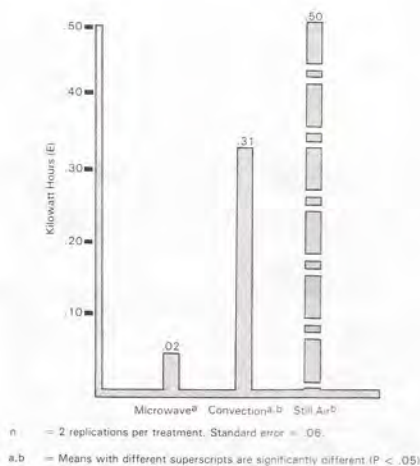


Figure 4. Comparison of energy required to cook fresh pork sausage links by microwave, convection and still air ovens.

steam table for serving. The sensory panel consisted largely of dormitory students. The consumers were allowed to choose freely if they wanted to be a participant. The pork samples were color coded according to their cooking method and the panelists were asked to rank the three pieces of coded pork according to their preference.

Composition

There were no significant differences among the cooking methods in the compositional values for moisture, protein and fat for any of the products—pork sausage links, pork roasts or pork chops.

No significant differences were detected on the pork sausage links or pork roasts samples cooked by the three different ovens on Instron compression or Instron Warner-Bratzler shear values. The pork chops cooked by the microwave oven had a significantly higher (P<.05) adhesion peak force value. No other significant adhesion or Warner-Bratzler shear values were detected for pork chops.

Cooking Losses

The still air oven had a significantly higher (P<.05) total cooking loss than the microwave or convection oven when preparing sausage links. Fresh pork roasts showed no significant differences in cooking losses for the three

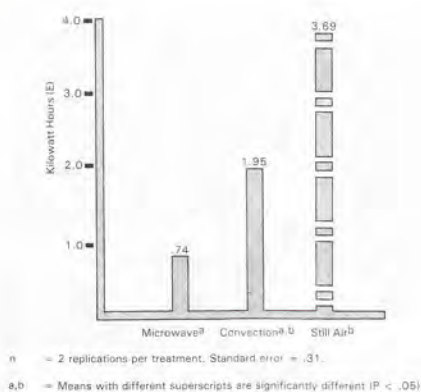


Figure 5. Comparison of energy required to cook fresh pork roasts by microwave, convection and still air ovens.

cooking methods. The three cooking methods were found to have significantly different total cooking losses for pork chops. The microwave oven had the lowest loss and the convection oven had the highest.

Energy Use

Figures 1, 2 and 3 show the time required to cook equal amounts of pork sausage links, roasts and chops. Cooking time is less in microwave ovens than in convection or still air ovens. Convection cooking took less time than still air. The time required to cook equal amounts of pork roast were significantly different (P<.05) for the three types of ovens. The still air oven required significantly more (P<.05) time to cook sausage links and pork chops than did the other two ovens. The microwave and convection ovens were similar in cooking time for sausage links or pork chops.

Related to cooking time is the amount of energy required to cook equal amounts of meat. As expected, the microwave oven had the lowest energy requirement, followed by the convection and still air oven. Convection and microwave ovens required less warm-up and cooking time than the still air oven. The convection oven required almost 15 times more energy than the microwave to cook an equal amount of pork sausage links, and the still air oven required about 25 times more energy. Energy requirements for cooking pork roasts and pork chops followed the same pattern as the

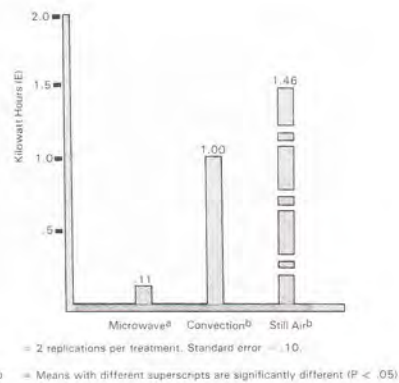


Figure 6. Comparison of energy required to cook pork chops by microwave, convection and still air ovens.

pork sausage links. The significant differences are shown in Figures 4, 5 and 6.

The microwave oven was a substantial energy and money saver compared to the still air oven. The convection oven also saved energy and money when compared to the conventional still air oven.

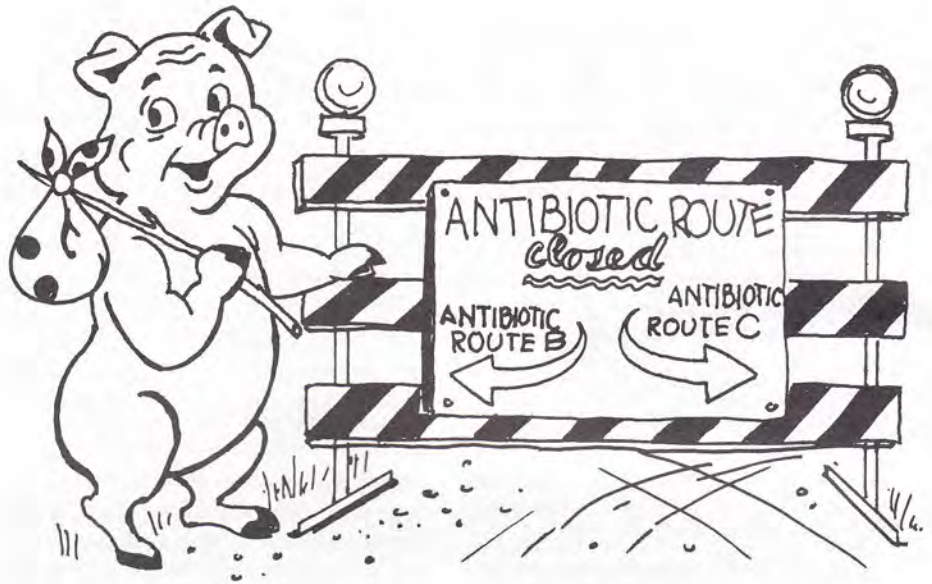
Sensory evaluation of the pork products showed that the preference of cooking method followed the same pattern of preference for all these products. The convection oven was the preferred method of preparation. The products cooked in the microwave oven were the least preferred. However, this does not mean that the microwaved products are unacceptable. They are simply preferred less than the products prepared in the convective or still air ovens.

Conclusion

Results indicate that the convection oven produces a more preferred pork product than the still air oven. Both the convection and microwave oven can be used in institutional kitchens to produce quality pork products with substantial savings in time and energy. Changes in cooking schedules and end point temperatures: 170°F (75°C) instead of 185°F (85°C) are important steps in improving the desirability of institutional pork products.

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What Antibiotic Should I Use?



E. R. Peo, Jr.¹

What antibiotic should I use in my swine feeding program? This is a question commonly asked by swine producers. It is also a question not easily answered.

Antibiotics are compounds produced by microorganisms that control other microorganisms. Chembiotics are synthesized chemical compounds that also control microorganisms. Penicillin and chlortetracycline are examples of antibiotics; carbadox (Mecadox) is an example of chembiotic. Although not correct, in practice we often refer to all drugs that control microorganisms as "antibiotics".

There are many different antibiotics and chembiotics that will improve growth rate and feed conversion of swine. Thus, singling out one antibiotic or antibiotic program to use might prove hazardous. What works in one situation might not work in another. While antibiotics are "expensive", they more than pay for themselves in improved pig performance if the "right" one(s) is fed to the "right" class of swine and in the "right" situation.

What is "Right"

Determining what is "right" has to be based on research findings from experiment stations and from the pharmaceutical industry.

Research to date clearly shows that the greatest response in terms of improved gains, feed conversion and survival rate is with the young pig from birth to about 75 pounds (34 kg) of body weight. Many studies indicate that there is little value in feeding antibiotics or chembiotics beyond 125 pounds (57 kg). However, recent research at the Nebraska Station indicates that pig response to antibiotics and chembiotics may depend upon the kind and level of drug being fed and conditions under which fed.

Two drugs commonly used in diets for young pigs are ASP-250 and Mecadox. ASP-250 is the trade name for a drug combination. It is fed at a level of 250 grams per ton of complete feed of which 100 grams is from chlortetracycline, 100 grams from sulfamethazine and 50 grams from penicillin. Mecadox is a trade name for the chemical compound carbadox. ASP-250 can be fed up to 15 days before marketing for slaughter; Mecadox must be withdrawn 10 weeks before slaughter.

Both drugs are effective in improving gains, feed efficiency and survival rate in young swine. In some studies ASP-250 has been superior to Mecadox. In others, the reverse is true. For example, as shown in Table 1, pigs fed Mecadox gained 12.5% faster on 7% less feed than those fed ASP-250

during the nursery phase. The difference between the two drugs was reduced to 4% for gain and 2% for feed efficiency at the end of the growth phase. No diet was fed without an antibiotic since past experience has clearly indicated a positive growth and feed efficiency response to the two.

In this study we were interested in the effect of previous drug treatment (ASP-250 or Mecadox) on response to different antibiotics during the finishing phase of growth. The pigs fed ASP-250 or Mecadox were subdivided and fed either Virginiamycin, Terramycin, or Tylan to market weight. The levels fed were those recommended by the manufacturer.

A Toss Up?

Pigs fed ASP-250 during the nursery and growth phase gained faster and more efficiently on each of the antibiotics fed during the finishing phase than those that had been fed Mecadox. The pigs fed ASP-250 tended to compensate during the finishing phase for the reduced performance (compared to Mecadox) during the nursery and growth phase. As a consequence, there was little difference in the overall performance of the pigs regardless of whether or not they had been fed ASP-250 or Mecadox during the nursery or growth phases. The reason for the

Table 1. Various antibiotics regimes for G-F pigs
(Neb Exp. 80406)

		Treatments					
		ASP-250			Mecadox (25 g/t)		
		ASP-250			Mecadox (25 g/t)		
Nursery Phase		Virg.	Terra.	Tylan	Virg.	Terra.	Tylan
Growth Phase		(10 g/t)	(20 g/t)	(20 g/t)	(10 g/t)	(20 g/t)	(20 g/t)
Finishing Phase							
Nursery phase (10/11-11/8)	No. animals ^a		120			119	
	Initial Wt, lb (kg)		19(9)			19(9)	
	Final wt, lb (kg)		44(20)			46(21)	
	ADG, lb (kg)		.87(.39)			.98(.44)	
	ADFI, lb (kg)		1.95(.88)			2.07(.94)	
	F/G		2.27			2.12	
Growth phase (11/8-12/4)	No. animals ^b		96			96	
	Initial Wt, lb (kg)		44(20)			46(21)	
	Final Wt, lb (kg)		82(37)			85(39)	
	ADG, lb (kg)		1.44(.65)			1.50(.68)	
	ADFI, lb (kg)		3.77(1.71)			3.83(1.74)	
	F/G		2.61			2.55	
Finishing phase (12/4-1/31;2/14)	No. animals ^c	32	32	32	32	32	32
	Initial wt, lb (kg)	81(37)	80	84	84	85	88
	Final wt, lb (kg)	203(92)	200(91)	209(95)	199(90)	204(93)	204(93)
	ADG, lb (kg)	1.88(.85)	1.86(.84)	1.92(.87)	1.78(.81)	1.85(.84)	1.78(.81)
	ADFI, lb (kg)	6.45(2.93)	6.32(2.87)	6.68(3.03)	6.28(2.85)	6.37(2.89)	6.38(2.89)
	F/G	3.45	3.41	3.48	3.54	3.45	3.60
Overall growing finishing (11/8-1/31;2/14)	No. animals ^d	32	32	32	32	32	32
	Initial wt, lb (kg)	44(20)	44(20)	46(21)	45(20)	47(21)	47(21)
	Final wt, lb (kg)	203(92)	200(91)	209(95)	199(90)	204(93)	204(93)
	ADG, lb (kg)	1.76(.80)	1.73(.78)	1.80(.82)	1.70(.77)	1.74(.79)	1.72(.78)
	ADFI, lb (kg)	5.71(2.59)	5.56(2.52)	5.86(2.66)	5.54(2.51)	5.64(2.56)	5.71(2.59)
	F/G	3.26	3.22	3.27	3.28	3.25	3.32

^aSix pens, 20 pigs/pen/trt.; Virg = virginiamycin; ASP = Chlortetracycline-sulfamethazine-penicillin; Terra = terramycin.

^b12 pens, 8 pigs/pen/trt.

^cTreatment effect (P<.10)

^d4 pens 8 pigs/pen/trt.

reduced performance during the finishing phase of the pigs previously fed Mecadox (as compared to those fed ASP-250) has not been determined.

ASP-250 (or a competitive product, CSP-250) as stated earlier contains sulfamethazine and must be withdrawn from swine diets 15 days before slaughter to prevent

violative levels of the sulfa drug from appearing in pork tissue. CSP-250 is similar but contains sulfathiazole rather than sulfamethazine. An advantage for sulfathiazole is that it can be fed up to 7 days before slaughter and does not pose as much of a sulfa residue problem as sulfamethazine. However, there is some question

as to whether or not sulfathiazole is as effective as sulfamethazine for combating chronic or acute diseases in swine. Sulfathiazole apparently is not absorbed as readily from the digestive tract as is sulfamethazine. There is little published information on the value of sulfathiazole as a replace-

(continued on next page)

Table 2. Effect of levels of Chlortetracycline and sulfa source on performance of G-F swine
(Neb. Exp. 80406)

	Treatments					
	No Antibiotic	CTC (50 g/t)	CTC (100 g/t)	CTC (200 g/t)	CTC Sulfamethazine Penicillin	CTC Sulfathiazole Penicillin
No. pigs/trt ^b	32	32	32	32	32	32
Int, wt., lb (kg)	43(20)	43(20)	42(19)	43(20)	42(19)	43(20)
Final wt., lb (kg)	200(91)	197(89)	200(91)	203(92)	200(91)	204(93)
Avg. daily gain, lb (kg)	1.73(.78)	1.69(.77)	1.73(.78)	1.76(.80)	1.73(.78)	1.77(.80)
Avg. daily feed intake, lb (kg) ^c	5.15(2.34)	4.89(2.22)	5.12(2.32)	5.17(2.34)	5.08(2.30)	5.09(2.31)
Feed/gain ratio	2.98	2.88	2.94	2.92	2.93	2.87

^aCTC = chlortetracycline; CTC, sulfa and penicillin fed at rate of 100, 100 and 50 gms/ton.

^bFour pens/trt; 8 pigs/pen. Conducted during March-June, 1980; length of test 91 days; housing, MOF units.

^cLinear effect of CTC levels sig .04.

What Antibiotic?

(continued from page 27)

ment for sulfamethazine in CSP-250 for swine. Too, one can ask if we need to use sulfa drugs in swine feeds when tissue residue is still a big problem. Or, can we obtain the same gain and feed conversion response by feeding a higher or comparable level (comparable to the 250 gram level of ASP-250) of a broad spectrum antibiotic such as chlortetracycline?" The results of Nebraska Experiment 80406 help answer this question (Table 2).

Feed Savings

Pigs fed the CSP-250 product containing sulfathiazole gained 2.3% faster on 2.1% less feed than those fed the product with sulfamethazine. Pigs fed a diet with no antibiotic made gains similar to those fed antibiotics but required 2.4% more feed per unit of gain. Thus, the only realized advantage for using antibiotics in this study was the savings in feed. The pigs used in the study were SPF. Thus, the expected improvement in response might be less with SPF swine than with swine from a conventional herd.

One other question that is often asked is "Are there any antibiotics that will improve gains and feed conversion of finishing swine?"

This is an important question. We know that most of the time antibiotics will improve gains and feed conversion of young pigs. If pigs are "doing well" producers are often reluctant to withdraw antibiotics from the diet. From an economic point of view it might be desirable to eliminate antibiotics from finishing swine feeds or switch to antibiotics that have been reported to improve gains and feed conversion of finishing swine. Two such antibiotics are Flavomycin (bambermycins) and Virginiamycin. We compared these antibiotics along with Aureomycin for finishing pigs starting at two different weights, 81 lbs (37 kg) and 118 lbs (54 kg). The pigs had been fed ASP-250 during the growing phase. The results of the experiment are shown in Table 3. Both the light and heavy weight pigs gained faster and more efficiently on the diets containing antibiotics than those on diets without antibiotics. There were no differences in gains or feed conversion between light weight pigs fed no antibiotic or Flavomycin. The light weight pigs fed Virginiamycin and Aureomycin gained faster and more efficiently than those not fed antibiotics. The greatest response was obtained with Aureomycin.

The heavy weight pigs responded differently to Flavomycin

than the light weights. The best gains and feed conversion were obtained with pigs fed Flavomycin whereas the light weight pigs showed no response to Flavomycin. Heavy weight pigs fed the various antibiotics gained 9.6% faster on 4.0% less feed than pigs fed diets without antibiotics. The findings are somewhat in contrast to previous reports that indicate it is difficult to economically justify the use of antibiotics in diets of finishing pigs. The improved gains and feed conversion observed in this experiment would more than pay for the cost of the antibiotics fed. Pigs used in this study were SPF. If one can obtain a response with SPF swine, it seems logical to assume that a similar or greater response would be observed with non-SPF swine.

A Boon to Producers

Antibiotics and chembiotics are a boon to the swine producer and ultimately to the consumer from efficiently produced pork. Antibiotics have been a part of swine feeding programs for 30 years. Alternate, well researched antibiotic programs, different perhaps from what is being used today, will keep antibiotics and chembiotics in swine diets for the next 30 years.

¹E. R. Peo, Jr., is Professor-Swine Nutrition, Department of Animal Science.

Table 3. Effect of pig weight on response to certain antibiotics (Neb. Exp. 80402)

	Treatments ^a							
	Light Weight				Heavy Weight			
	No Antibiotic	Flavo (2 g/t)	Virg (10 g/t)	Aureo (50 g/t)	No Antibiotic	Flavo (2 g/t)	Virg (10 g/t)	Aureo (50 g/t)
No. pigs/trt ^b	20	20	20	20	20	20	20	20
Int. wt., lb (kg)	81(37)	82(37)	81(37)	82(37)	119(54)	118(54)	114(51)	118(54)
Final wt., lb (kg)	178(81)	179(81)	183(83)	190(86)	214(97)	225(102)	210(95)	224(102)
Avg. daily gain, lb (kg) ^c	1.73(.78)	1.74(.79)	1.81(.82)	1.92(.87)	1.70(.77)	1.90(.86)	1.81(.82)	1.88(.85)
Avg. daily feed intake, lb (kg) ^d	5.60(2.54)	5.64(2.55)	5.55(2.52)	5.88(2.67)	6.05(2.74)	6.30(2.86)	6.16(2.79)	6.68(3.03)
Feed/gain ratio ^e	3.24	3.26	3.07	3.06	3.56	3.30	3.40	3.55

^aFlavo = flavomycin; virg = virginiamycin; aureo = aureomycin

^bTwo pens/trt; 10 pigs/pen. Conducted during Jan-Mar, 1980; length of test 56 days; housing, MOF unit.

^cNo antibiotic vs rest sig .10; virg vs aureo sig .02.

^dNo antibiotic vs rest sig .10; virg vs aureo sig .07.

^eNo antibiotic vs rest sig .05.

Nebraska's Growing Pork Industry

William T. Ahlschwede¹

Pork production in the 70's saw many ups and downs in numbers, prices, and producer attitudes. While the numbers and prices went up and down and up and down again, the timing of those changes did not follow the histor-

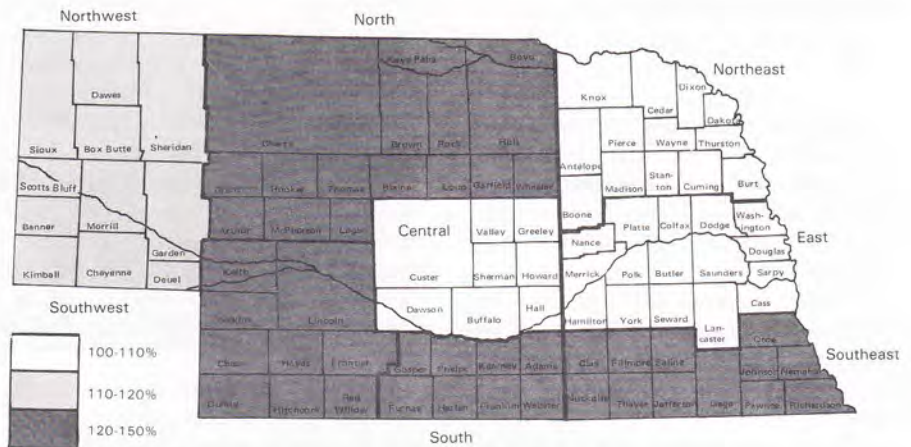


Figure 2. 1977-1979 pig crop as a percent of 1976-1969 pig crop.

ical hog cycle. The change in numbers seemed more exaggerated than has been typical of the hog cycle. The changes in price were more precipitous than pork producers had become accustomed to. Pork producers began the 1970's with a large inventory. They have begun the 80's with a similar high inventory.

Nebraska pork producers have enjoyed and suffered the alternate consequences of high and low numbers and high and low prices. However, during the 70's changes took place in Nebraska's pork producing industry that set it apart from the rest of the nation. The first and most apparent of these changes was the development, establishment and growth of the so called feeder pig cooperatives. In 1970 there were four in Nebraska.

In 1980 there were over 100. These units, collectively producing over 20 percent of Nebraska's pig crop, influenced the shape of Nebraska's pork producing industry.

A second distinguishing characteristic of pork production in Nebraska was its growth and relative strength. In 1970 Nebraska produced 5½% of the nation's pig crop. In 1979 Nebraska's share of the nation's pig crop had grown to 6½%. This increase in pork production in Nebraska took place outside of the traditional pork producing areas. This expansion into non-traditional geographic areas represents a new pioneering spirit. This spirit will shape the industry for years.

Changes Recognized

The changes in Nebraska's pork industry during the 70's were recognized by the agri-business communities supporting the pork production industry. Swine facilities and equipment manufacturers and suppliers have become much stronger based in Nebraska during the last decade. The feed industry has made substantial investments in new facilities serving the pork producing areas in Nebraska. The pork slaughter and packing industry in Nebraska has also made major changes. Of the major packing plants slaughtering hogs in Nebraska during the 60's, only two operate today. The plants lost have been replaced by new mod-

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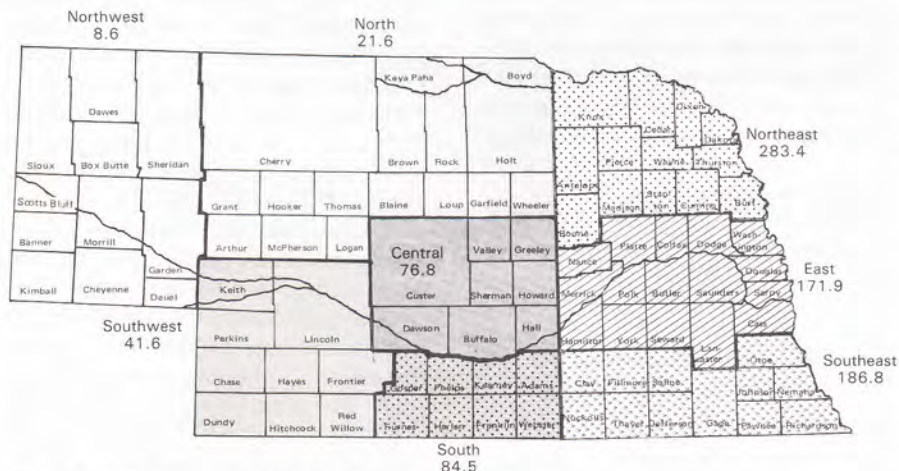


Figure 1. 1979 pig crop, pigs raised per square mile.

Growing Pork Industry

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ern packing facilities located nearer sources of production. The changes in Nebraska's pork producing industry have been recognized by others. Agri-business has responded.

Figure 1 shows the distribution of Nebraska's pig crop by crop reporting district in Nebraska. Northeast Nebraska has been and remains the most intense area of pork production in Nebraska. Cuming County remains Nebraska's most dense in terms of pigs raised per square mile. The area surrounding Cuming County in Northeast Nebraska is the next most dense area of pork production. The Southeast corner follows in production density. The next most dense area fills the remainder of the Eastern third of the state. In the Western two-thirds of the state pork production appears to be more dense in the South than the North, more dense in the East than the West and radiating up the river valleys where supplies of feed grains are more available.

Figure 2 shows the relative change in pig crop from the late 60's to the late 70's. The pig crop in 1977, 1978, and 1979 are given as a percentage of the pig crop by crop reporting district for 1967, 1968, and 1969. All areas of the state increased in numbers. Nebraska produced 14 percent more pigs in the late 70's than in the late 60's. However, essentially all of that increase in production occurred outside the most dense production area. While there is considerable county to county variation, the Northeast, East and Central Nebraska areas held their own in pork production. The Panhandle region increased pork production by 10 to 20 percent. The strongest expansion in numbers occurred in the southern part of the state—the Southeast, South, and Southwest crop reporting districts showed the strongest increases in numbers. The Northern crop reporting district also shows substantial increase. A large part

of that increase reflects changes in the eastern end of North crop reporting district. This movement of pork production into areas beyond the heavy Northeast production area appears to be continuing. The availability of feed grain in the southern and western river valleys certainly is an important factor. The establishment of slaughter plants away from the Missouri River has also been helpful.

Forces which seem to be at work in moving Nebraska pork production westward seem to be a part of a similar national trend. Pork production in the western corn belt has increased at the expense of production in the eastern corn belt. Those factors which have caused pork production to move westward in the country appear to continue. As we project into the next decade consideration of energy supply and transportation costs can be expected to reinforce this shift in production.

Westward Shift

The westward shift of pork production in Nebraska has not been without challenges. Many of those challenges remain. The viability and long term success of pork production in these "frontier" areas will depend upon the development of supplies and services needed to support that industry. Increased market capabilities and western slaughter capacity will be called for. The supplies of processed feeds, health products and health care services will need further development. As non-traditional production areas develop producers will need increased access to the specialized equipment used in pork produc-

tion. The local financial support needed by pork producers will necessarily cause changes in those financial institutions. Pork production in central and western Nebraska is in its adolescence. The various segments of that industry suffer growing pains. Those segments need to grow together.

Nebraska during the 70's drew the nation's attention. Nebraska's changing style of production caught their attention. While Nebraska producers suffered their fair share of losses during times of over production, they led the nation going into those changes in production. During the 70's Nebraska producers tended to expand ahead of the rest of the nation. They also reduced the farrowings and pig crops sooner than producers in other parts of the country. This slightly out-of-step change in numbers allowed Nebraska producers to minimize their losses during periods of unfavorable production levels.

Wide Production Base

The 1970's was a period of exaggerated fluctuations in hog production (Table 1) and in the prices paid for pigs. It is difficult to study the absolute levels of production and feel confident about production trends. While the ups and downs of the hog production cycle continued, Nebraska producers increased their share of the pig crop during the 70's.

Nebraska's pork industry is strongly based on feed grain supplies and skilled managers and operators. The production units represent a wide range of sizes, facilities and styles of operation. This wide base of production puts Nebraska's pork producing industry in a position of strength for the 1980's. It appears that the growth and development will continue across the state, particularly in the central and western areas. The strong foundation of the 70's will help assure a profitable industry in the 80's.

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Table 1. Nebraska pig crop.

Year	Pig crop	% of U.S.
1970	5,862,000	5.7
1971	5,652,000	5.7
1972	5,149,000	5.5
1973	4,896,000	5.6
1974	4,788,000	5.7
1975	3,986,000	5.6
1976	4,878,000	5.8
1977	4,970,000	5.8
1978	5,429,000	6.1
1979	6,719,000	6.5



Gilts during light period.

Confinement and Photoperiod

Dwane R. Zimmerman¹

Successful introduction of replacement gilts into the breeding herd is an important aspect of breeding herd efficiency. Gilts should reach puberty (exhibit first estrus and ovulate) at an early age, continue regular estrous cycles until bred, and conceive readily at first breeding.

Early puberty is necessary if replacement gilts are to be successfully bred during a limited breeding season and express their full potential for litter size at first breeding. Gilts should express one or more estrous periods before the usual breeding age (7-9 months) since fewer eggs and smaller litters are produced when gilts are bred at first estrus rather than at later estrous periods. Gilts that express first estrus at an early age can be bred at a younger than usual age as long as one or more estrous periods have been expressed before breeding. This practice will reduce feed and other overhead costs associated with gilt maintenance without detracting from reproductive performance.

Confinement Effects

Management of gilts in total confinement has caused increased breeding problems in gilts. Producers have attempted to circumvent the problems by removing gilts from confinement (usually relocating them to outside lots) before breeding. Although characterization of the problem is incomplete, the main reproductive diffi-

culty seems to be anestrus or lack of heat. The failure of gilts to express estrus during the breeding period may be caused by delayed puberty or by an increased incidence of quiet ovulations (ovulations unaccompanied by standing heat), depending on the age and breed of the gilts.

U.S. Meat Animal Research Center researchers compared the incidence of anestrus in confinement reared gilts representing five breeds (Duroc, Hampshire, Landrace, Large White and Yorkshire) and observed that the incidence of anestrus varied greatly among breeds. Landrace gilts were the least adversely affected (8% anestrus at 9 months) and Yorkshire gilts most adversely affected (38% anestrus at 9 months) by confinement rearing. Large White, Hampshire and Duroc gilts were intermediate with 11%, 18% and 25%, respectively, not expressing estrus by 9 months of age. Of the anestrus gilts at 9 months, 55% showed no evidence of ovulation (prepubertal) and 45% ovulated but did not express estrus (behavioral anestrus).

U.S. MARC researchers also evaluated the effect on estrous activity of rearing gilts in confinement and outside lots. This was

done in two different seasons (Oct.-March vs. April-Oct.) of the year. Breeds represented were Duroc, Yorkshire, Hampshire and Landrace-Large White crossbreeds. Gilts reared in outside lots showed greater estrous activity between 5 and 9 months in both seasons studied, but the advantage was much greater in the cooler season, October to March. Puberty was delayed in both confinement and nonconfinement groups reared from April to October. This delay was attributed to the detrimental influence of high summer temperature on onset of cycling activity.

Nebraska and Georgia researchers have evaluated the effect of relocation of gilts from confinement to outside lots during development (70 and 120 days, Nebraska; 100 days, Georgia) on the incidence of anestrus at 230 and 250 days of age, respectively. Relieving gilts from intensive confinement conditions by moving them outside markedly reduced the incidence of anestrus compared to controls maintained in confinement (0% vs. 50%, Nebraska study; 24% vs. 64%, Georgia study). Relocation in confinement also benefited pubertal development but proved less effective than relocation outside at these ages.

The factor or factors in confinement that are inhibitory have not been identified. Inadequate light may be a factor in some confinement situations, but the inhibitory effects of confinement were expressed in the Nebraska and U.S. MARC studies under controlled lighting regimes (about 12 hours artificial light daily).

Photoperiod Effects

Seasonal effects on age at puberty have been reported by a number of research groups. Most researchers have observed a similar seasonal pattern with fall-born

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Table 1. Photoperiod effects on age at puberty.

	Experiment 1		Experiment 2	
	12 hr. light	0 hr. light	18 hr. light	6 hr. light
Puberty, days	183	222	190	232
Ovulation rate	12.9	12.4	14.0	13.5

Confinement

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gilts attaining puberty at an earlier age than spring-born gilts. The factors responsible for the seasonal variation in puberty are not known but photoperiod (day length) and temperature are two major components that vary dramatically between seasons.

With the development of more and more breeding stock under confinement management, it becomes important to know whether photoperiod is important and, if so, what amounts (day length and light intensity) are needed to obtain early puberty in gilts.

Canadian scientists have recently reported that day length is important and should be controlled in confinement with artificial lighting. They observed that complete darkness and 6 hour daily photoperiods delayed puberty as compared to 12 hours or 18 hours of light each day (Table 1). Photoperiod did not affect the number of ova released.

Nebraska recently started research to evaluate the effect of light on puberty. In the initial study, no difference was observed in age at puberty in gilts subjected to 16 hours or 8 hours of light each day (Table 2).

More information is needed before sound recommendations can be made regarding the optimal photoperiod and lighting intensity needed for early pubertal development in gilts. Factors such as light intensity, wave length of the light, age at which gilts are subjected to different photoperiods, and perhaps breed will need to be considered by researchers when evaluating the influence of photoperiod on puberty in gilts.

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Table 2. Effect of 16 hours light vs. 8 hours light on age at puberty in gilts.

	16 hr. light	8 hr. light
No. gilts	78	80
Puberty, days	208.3	204.7

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