

1980

## EC80-219 Nebraska Swine Report

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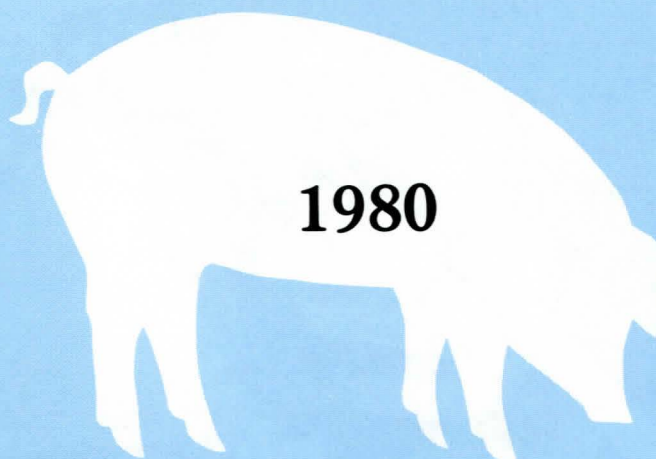
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# NEBRASKA SWINE REPORT

- Breeding
- Disease Control
- Nutrition
- Economics
- Housing

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

Extension work in "Agriculture, Home Economics and subjects relating thereto," The Cooperative Extension Service, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, Cooperating with the Counties and the U.S. Department of Agriculture  
Leo E. Lucas, Director



*Institute of Agriculture  
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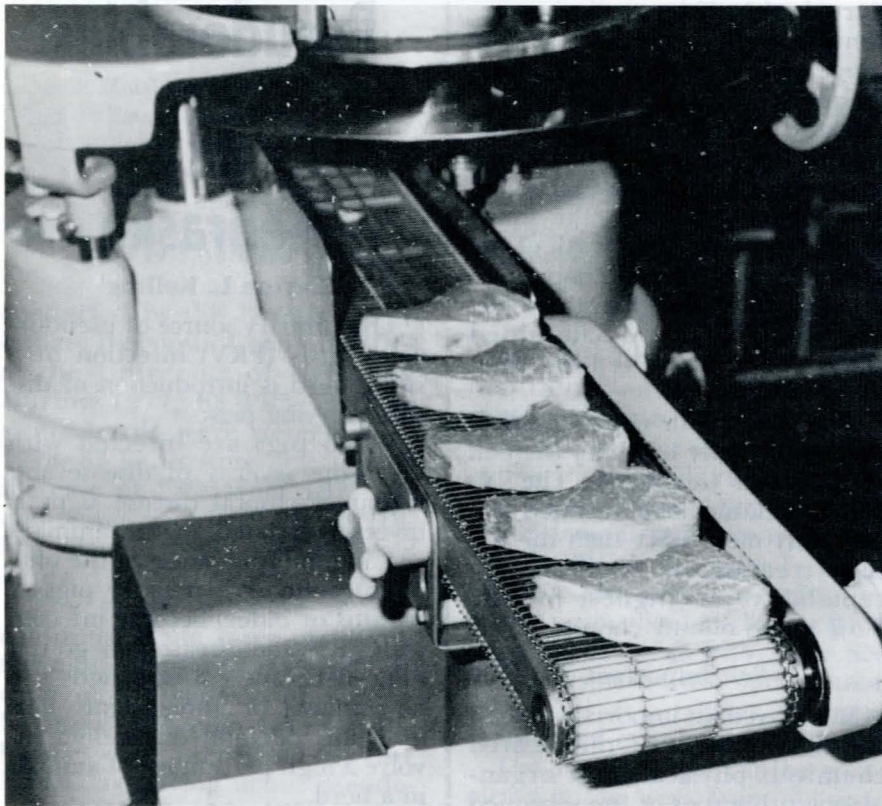
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Production line for big chops.

## Big Chops From Little Pieces

**Roger W. Mandigo,  
Louise M. Dalton,  
Dennis G. Olson<sup>1</sup>**

Not easily sold. That's how the meat industry describes some pork cuts. In particular, the picnic shoulder and shoulder butt are not accepted as well by consumers as the ham, loin, or belly. These products, picnic shoulder and shoulder butt, are considered to be both highly nutritious and an excellent high quality protein source. Due to product variation in size, lean to fat ratio, and amount of bone consumers are reluctant to buy and serve these pork cuts. The Hotel, Restaurant and Institutional Trade (HRI) has been faced with similar problems. Meat demands for the HRI business are portion control oriented and these picnic shoulders and shoulder butts do not readily meet those needs.

Due to the lower demand for picnic shoulders and shoulder

butts, prices are generally much lower than for fresh hams. Some are cured, smoked and merchandised similar to ham. A small percentage are marketed fresh. Most are processed into meat products such as sausage. Increasing the value and demand for these less merchandisable cuts demands a new marketing concept.

### New Marketing Concept

New technology and processing equipment was combined with the search for methods to restructure meat pieces to simulate intact muscle. Flaked and formed products were developed (see 1976 and 1977 Nebraska Swine Reports). These techniques made it possible to produce a lower cost product made to practically any composition specification. This product could be easily formed into shapes similar to the more popular cuts of pork. The texture of this product resembled an intermediate be-

tween intact muscle and ground meat. The product texture was actually closer to that of ground meat particles. The need for a restructured product much closer in texture to intact muscle was apparent.

The main objective of this study was to produce a fresh, chunked and formed, muscle-bonded pork chop which had the chemical, physical, and organoleptic properties of an intact muscle. The product was formed utilizing the principles of protein extraction through physical abrasion of muscle chunks in a mixer. The chemical, physical, and organoleptic properties of the chunked and formed fresh pork chops were evaluated and compared to boneless pork loin chops. The final study involved comparing two levels of salt and two levels of mixing time. Salt levels of 0 (control) and 0.5% salt were selected. Mixing times of 8 and 16 minutes were used.

### Meat Processing

The meat used in the manufacture of the chunked and formed fresh pork chops was obtained from hogs processed at the University. The cut used in this study was the pork shoulder butt. Shoulder butts were trimmed of excess fat and frozen before use. The intact pork loin chop was made from fresh Canadian backs and used as the control.

The meat was removed from the freezer in 200 lb (90.7 kg) batches and tempered to 35°F (1.7°C). Once the meat had been tempered to this temperature, all bones and excess fat were removed. The meat was tenderized through a mechanical tenderizing machine (Bettcher Industries, Inc., Vermillion, Ohio, TR-2 machine). The meat was chunked into approximately 1 inch (2.54 cm) cubes and mixed. Mixing times of 8 and 16 minutes were used.

During mixing, the extraction of protein could be observed as the pieces of meat began to accumulate a sticky exudate. After mixing, the products were stuffed into

*(continued on next page)*



## Big Chops From Little Pieces

(continued from page 3)

plastic bags, flattened to the approximate shape desired, frozen, tempered to 24°F (-4.4°C) before pressing. The logs were pressed in a hydraulic press into the shape of pork chops (Bettcher Model 70 Hydraulic Press) and then sliced in an upright power cleaver (Bettcher Power Cleaver Model 81). The one inch (2.54 cm) thick chops were vacuum packaged before cooking and taste panel evaluation.

Chemical analysis of the four treatments and the two replications indicate that mixing and the presence of salt had no major influence on the composition of the chops. The use of salt and increased mixing times resulted in better sectioned and formed pork chops. Cooking losses were lower in the 0.5% sodium chloride added treatment. The lowest cooking loss was found with the 0% salt and 16 minute mixing time. There were no significant differences in cooking losses between either the 0% salt treatment and the intact loin, which was used as the control.

The most important part of this study was the production of a muscle-bonded product. The bonds between the pieces of meat simulated the adhesive forces between intact muscle fibers. This factor was closely evaluated. Significantly higher Kramer Shear and adhesion or tensile strength values were exhibited in the intact control chop. Increased mixing time and salt increased the tensile strength between the muscle bonds. The 0.5% salt treatment exhibited significantly stronger tensile strength values than did the 0% salt treatment. Those values were still lower than the tensile strength of the control chop. The Kramer Shear force data indicated that the 0.5% salt and the 16 minute mixing time treatment produced a significantly more tender product than the other three sectioned and formed treatments or the control. Samples with salt were slightly darker in color than samples having no salt.

### Evaluation

Sensory evaluation was con-

ducted with 224 panelists representing both sexes and a wide range of age, education level, and frequency of eating pork. The salt-added treatments received significantly better flavor scores than either the 0% salt sectioned and formed chops or the intact control pork loin chops. All of the sectioned and formed chops were rated more tender than the intact loin control chop. Salt-added chops were more tender than those without salt.

The intact loin chop (control) was significantly less juicy than all of the other treatments. The salt added treatments were rated significantly more juicy than the no-salt treatments. Overall acceptability was highest for the 0.5% salt, 8 minute chops.

### Salt Important

Salt played an important role in the development of the desired chemical, physical, and organoleptic properties of the sectioned and formed pork chops. Lower cooking losses, more desirable acceptance-preference scores by consumers and greater tensile strength resulted from the incorporation of salt in the products. Increased mixing time in combination with salt caused an increase in tenderness of the product. Consumers could not detect the difference in tenderness between either of the salt added treatments.

This research has shown that it is possible to produce a sectioned and formed fresh pork chop that has similar chemical and physical characteristics to the intact loin muscle. The combination of added salt and mechanical mixing yielded a sectioned and formed pork chop that was rated higher in sensory characteristics than the intact control. The sectioned and formed pork chop is similar to intact pork loin chops.

<sup>1</sup>Roger W. Mandigo is Professor of Animal Science; Louise M. Dalton is currently Management Trainee, Oscar Mayer Inc., Madison, Wisconsin; Dennis G. Olson is Assistant Professor of Animal Science. Appreciation is expressed to Bettcher Industries, Inc., Vermillion, Ohio for equipment support for this project.

# Pseudorabies in Nebraska

Clayton L. Kelling<sup>1</sup>

The primary source of pseudorabies virus (PRV) infection of a swine herd is introduction of disease carrying pigs.

When pigs are infected with PRV, the severity of disease and extent of clinical disease signs is inversely related to the animal's age and immune status at the time of infection. When older pigs (2 months or older) become infected with PRV, the disease may go unnoticed because disease signs can be minimal or nonexistent. This infection can and often does involve a high percentage of animals in a herd.

Once PRV-infected pigs recover from an episode of pseudorabies in which classical disease signs are prevalent, the recovered animals continue to carry virus which can be shed when prevailing conditions (host stress) favor viral multiplication. The recovered animals are potential lifetime carriers of the virus.

The role of wildlife in transmission of PRV cannot be discounted. However, it appears that the part wildlife vectors play in establishing herd infections is minor.

Prevention is the key to control of pseudorabies. Prevention is best achieved by avoidance of infected pigs. Contact with infected animals is best avoided by purchasing herd replacements from herds participating in scheduled PRV-testing and/or by testing the animals at the time they are purchased. The replacement animals should be isolated for 30 days and retested before being added to the herd.

Pseudorabies appears to be spreading in Nebraska. This suggests that introductions are being made in Nebraska herds without the benefit of testing. Evidence for the disease spread comes from the results of laboratory tests



	1977	1978	(Nov. 15) 1979
Total No. PRV positive herds	68	87	111
Total No. herds PRV positive by virus isolation (herds with acute pseudorabies)	27	45	55
No. herds PRV positive by SN test	42	50	61

**Figure 1. Summary of Nebraska Veterinary Diagnostic Center pseudorabies test results for 1977, 1978 and 1979.**

conducted by the Nebraska Veterinary Diagnostic Center (NVDC) at the University of Nebraska. During 1977, 68 PRV-infected swine herds were detected. In 1978, 87 herds were detected, an increase of 28% from 1977. By mid-November, 1979, the NVDC had identified 111 PRV-infected herds.

The yearly increase in lab-confirmed acute cases of PRV is the most significant lab test indicator of the increase of PRV in Nebraska. Twenty-seven swine herds were identified by the NVDC as having acute pseudorabies in 1977, 45 in 1978, and in 1979, 55 by mid-November (Figure 1).

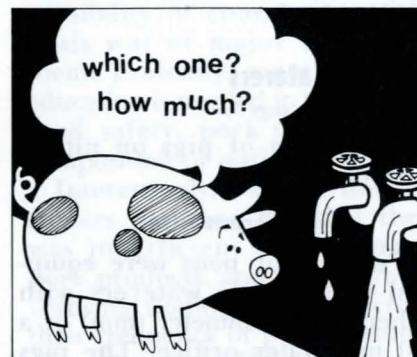
PRV is found most often where hogs are found in high numbers. Fifty-three percent of Nebraska counties have had one or more laboratory-confirmed cases of PRV. Within the last three years, most cases have been identified in northeastern Nebraska where the concentration of hogs is greatest (Figure 2).

### Test Takes One Week

A blood test, the serum-virus neutralization (SN) test, is the routine test used to determine if pigs have been exposed to PRV and are potential PRV carriers. The SN test is based on the principle of demonstration of antibodies against PRV in the animal's blood serum. Antibodies develop in blood serum about 10 days or later after exposure to PRV. The SN test is a specific test and is used extensively as a reliable indicator of infection or previous exposure.

The PRV SN test can be completed in one week from the time the serum sample is received in the laboratory. If the sample is received early in the week, tests can be completed in a few days. Producers should anticipate deadlines when possible and contact the local veterinarian for bleeding dates well in advance of sale or show deadlines.

<sup>1</sup>Clayton L. Kelling is Assistant Professor-Virology, Department of Veterinary Science.



**Nipple Waterers...**

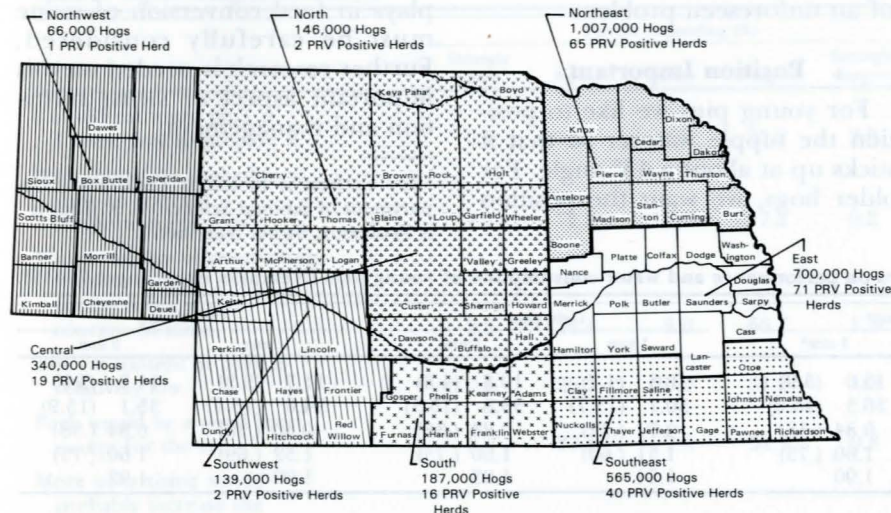
## Opening Size May Be Important

**Roy Carlson,  
E. R. Peo, Jr.<sup>1</sup>**

Last year we reported that pigs on cup-type waterers used 72% more water than pigs on nipple waterers. However, pigs on cup waterers tended to be more efficient in feed conversion. This latter observation suggested that water may have been limiting with nipple waterers. Savings in water use is important but the savings might be offset or partially offset by reduced pig performance. Varying the orifice (water inlet) size in nipple waterers might allow for more available water for the pigs and still maintain the reduction in water compared to those on cup waterers.

Two experiments were conducted with young pigs to determine the effect of orifice size on gains, feed conversion, and water

*(continued on next page)*



**Figure 2. Regional distribution of swine population and of 216 PRV positive swine herds (1977-1979).**



**Table 1. Effect of orifice size in nipple waterers on performance and water consumption of young pigs (Nebraska Experiment 79407).**

Criterion	Orifice size	Heavy pigs <sup>a</sup>		Light pigs <sup>a</sup>		Overall Avg.	
		1 mm <sup>b</sup>	3 mm <sup>b</sup>	1 mm	3 mm	1 mm	3 mm
Initial wt, lb (kg)		18.5 (8.4)	18.4 (8.4)	13.8 (6.3)	13.8 (6.3)	16.2 (7.4)	16.1 (7.3)
Final wt, lb (kg)		39.7 (18.0)	40.9 (18.5)	34.1 (15.5)	34.0 (15.4)	36.9 (16.8)	37.4 (17.0)
ADG, lb (kg) <sup>c</sup>		0.75 (.34)	0.80 (.36)	0.72 (.33)	0.72 (.33)	0.74 (.34)	0.76 (.35)
ADFI, lb (kg) <sup>c</sup>		1.42 (.64)	1.44 (.65)	1.38 (.63)	1.29 (.59)	1.40 (.64)	1.36 (.62)
F/G ratio <sup>c</sup>		1.89	1.81	1.91	1.79	1.90	1.80
H <sub>2</sub> O intake/hd/day, gal (L) <sup>d</sup>		.75 (2.8)	.97 (3.7)	0.83 (3.1)	1.28 (4.8)	0.79 (3.0)	1.12 (4.2)

<sup>a</sup>Six pens of 4 pigs/pen on each treatment.<sup>b</sup>mm = millimeters.<sup>c</sup>ADG = average daily gain; ADFI = average daily feed intake; F/G = feed required per unit of gain.<sup>d</sup>gal (L) = gallons (liters).

## Nipple Waterers

*(continued from page 5)*

consumption of pigs on nipple waterers.

### Different Sizes

Twenty-four pens were equipped with nipple waterers with either a 1.0 millimeter (mm) or a 3.0 mm water orifice. The pigs were divided into two weight groups with heavy and light weight groups on each orifice size. Pigs were maintained in an environmentally regulated research unit and water usage was measured with TRISEAL meters with one meter for each set of six pens. Results of the first experiment are shown in Table 1. As expected, the heavyweight pigs gained faster and more efficiently than the lightweight pigs. Surprisingly, the lightweight pigs used more water regardless of orifice size than the heavyweight pigs. The lightweight pigs may have "played" with the waterers more than the heavyweights.

Water consumption and feed conversion were reduced with both groups of pigs on nipple waterers with a 1 mm orifice. The pigs on nipple waterers with the 3 mm orifice were 6% more efficient

in feed conversion but used 42% more water. While gains also tended to be higher with pigs on the 3 mm orifice, the most significant observation seems to be the effect an adequate supply of water had on feed conversion. This observation was not as clear in the second experiment (Table 2), but again, the heavyweight pigs showed an improvement in feed conversion (8%) when drinking from nipple waterers with a 3 mm orifice. The reverse was true for the lightweight pigs. However, they gained 15% faster on the 3 mm orifice as compared to their counterparts on the 1 mm orifice but were 5% less efficient. One might expect this reduction in feed efficiency since the pigs on the 3 mm orifice were gaining faster, eating 22% more feed and thus were maintaining a larger body size at the end of the trial than the lightweight pigs on the 1 mm orifice. Water consumption was not recorded in this trial because of an unforeseen problem.

### Position Important

For young pigs we like to position the nipple waterer so that it sticks up at about a 45° angle. For older hogs, we want the position

reversed—stick down at 45°. We may change our mind with the younger pig. In the second experiment, we had problems with small grain particles lodging between the side of the waterer and the valve causing excessive wastage of water unrelated to the treatment comparisons we were trying to make. Reversing the positioning of the waterers from an upward direction to downward may correct the problems. Pressure and gravity flow will prevent grain particles from holding the valve open. Different style nipple waterers than the ones we are using or more finely ground grain would probably eliminate the problem too, if one wished to continue having nipple waterers tilted upward for young pigs.

Water is an important nutrient for swine. Our research indicates that we may need to pay more attention to water and watering devices. We want to conserve water, but the role the amount of water plays in feed conversion of swine must be carefully considered. Further research is needed on this important aspect of swine nutrition and management.

<sup>1</sup>Roy Carlson is Research Technician, Department of Animal Science. E. R. Peo, Jr., is Professor, Swine Nutrition.

**Table 2. Effect of orifice size in nipple waterers on performance and water consumption of young pigs (Nebraska experiment 79419).**

Criterion	Orifice size	Heavy pigs <sup>a</sup>		Light pigs <sup>a</sup>		Overall Avg	
		1 mm <sup>b</sup>	3 mm <sup>b</sup>	1 mm	3mm	1 mm	3 mm
Initial wt, lb (kg)		13.0 (5.9)	13.0 (5.9)	10.3 (4.7)	10.8 (4.8)	11.7 (5.3)	11.7 (5.3)
Final wt, lb (kg)		37.9 (17.2)	36.5 (16.6)	30.1 (13.7)	33.8 (15.3)	34.0 (15.4)	35.1 (15.9)
ADG, lb (kg) <sup>c</sup>		0.89 (.40)	0.84 (.38)	0.71 (.32)	0.83 (.38)	0.80 (.36)	0.84 (.38)
ADFI, lb (kg) <sup>c</sup>		1.74 (.79)	1.60 (.73)	1.31 (.60)	1.60 (.73)	1.52 (.69)	1.60 (.73)
F/G <sup>c</sup>		1.96	1.90	1.84	1.93	1.90	1.92

<sup>a</sup>Six pens of 4 pigs/pen on each treatment.<sup>b</sup>mm = millimeters.<sup>c</sup>ADG = average daily gain; ADFI = average daily feed intake; F/G = feed required per unit of gain.



## Consumers, Physicians

# Attitudes Toward Pork

T. J. Janssen,  
D. G. Olson,  
F. Caporaso,  
R. W. Mandigo<sup>1</sup>

Per capita consumption of pork has remained fairly constant over the last 35 years, while beef consumption has increased markedly. Many factors influence the demand for pork. Factors such as price, availability, desirability, preparation techniques, digestibility, fear of trichinosis, fat content, and advertising affect pork consumption.

Four hundred Nebraska consumers throughout the state were surveyed by phone for their responses to 55 questions. The survey was directed to the person doing the grocery shopping for the family. The majority of the respondents were females (90.7%) of which 50% were housewives.

## Knowledge and Attitudes

The knowledge and attitudes of the surveyed consumers were determined by answers to questions. Some of these questions are shown in Table 1. The answers to these questions represent many of the findings from this study.

Almost all consumers felt pork was readily available and a desirable food. Ninety-six percent of the respondents said they liked the flavor of pork, 87% liked the aroma during cooking, and 91% said their family liked pork.

In terms of cooking and preparation, 87% of the respondents said they knew how to properly cook pork; however, 75% said that pork should be cooked to at least 185°F (85°C). Recommendation for cooking fresh pork is 170°F (77°C). This temperature provides maximum flavor and juiciness and more than adequate protection against trichinosis. (Trichinosis is destroyed at temperatures above 140°F (60°C). With fat-type hogs, generally found years ago, high cooking temperatures were needed to melt away the fat. Improper cooking could result in a less than desirable product (dry and tough).

A majority of the consumers (53%) did not feel that the fat content of pork was relatively low. It would appear that the image of pork is still that it is a very fat type of meat, even though the lean con-

sumable portion of fresh pork is as lean or leaner than other red meat. Thirty-nine percent of those surveyed felt that pork is a good food product but expressed reservation about fat content.

There is also some concern about contracting trichinosis from consuming pork. Even though the incidence of trichinosis is extremely low in Nebraska, 27% of the respondents agreed that the possibility of contracting trichinosis was of major concern to them. Evidently, more consumer education is needed in the areas of food safety, pork cookery, and composition of pork products.

Interestingly, 32% of the consumers surveyed felt that there was insufficient advertising of pork products, and that more advertising would probably increase their frequency of pork consumption. However, 36% of the consumers felt that pork was too high priced and that they would eat more if it cost less.

At the conclusion of the interview, respondents were asked to make comments on pork that were not covered in the questionnaire. Eighteen percent said they couldn't eat much pork because of the fat or cholesterol content, which they felt were bad for their health. Also, some individuals contacted by phone declined to participate in the survey because pork was restricted from their diets. Many different reasons were given for these dietary restrictions.

Table 1. Agree-disagree statements.

	Percent responding (%)				
	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
I would eat more pork if I knew how to prepare it.	0.7	10.7	1.2	85.2	2.0
Pork should be cooked to at least an internal temperature of 185°F.	2.7	72.5	17.2	7.2	0.2
The possibility of contracting trichinosis from pork products is a major concern of mine.	2.2	24.5	5.0	66.7	1.5
The fat content of pork is relatively low.	0.5	26.7	20.0	51.2	1.5
Pork would be a good meat except for the fat.	0.8	37.8	7.8	52.9	0.8
More advertising would probably increase the frequency with which I would use pork.	2.3	30.0	6.3	61.5	0

## Restricting Pork in Diets

To pursue the medical or health reasons for restricting pork in the diet, physicians attitudes and knowledge toward pork were determined. A written questionnaire was sent to physicians and medical students. Responding to the questionnaire were 296 physicians and 181 medical students.

Table 2 shows the percentage responses of physicians and medical students to opinion statements. The statements were "either/or" type statements to prevent selecting a noncommittal choice. Because no intermediate choice was given,

(continued on next page)



## Attitudes Toward Pork

(continued from page 7)

several individuals did not respond to these statements. Thus, the total percentage in this table is less than 100. In general, the majority of the respondents felt that pork was easy to digest, high in protein, appropriately priced, of good quality, high in vitamins and minerals, and not tiresome to patients. Eighty-five percent did not consider trichinosis a major problem.

Less favorable responses were made regarding fat and cholesterol content. Both physicians and consumers share the impression that pork is fatter and has higher cholesterol even though the lean tissue is compositionally similar to other red meats.

Table 3 shows percentages of physicians and medical students who limit or eliminate meat products, fresh pork and cured pork in diets of patients with 15 selected conditions. In all 15 conditions, fresh pork and cured pork would

**Table 3. Percentage of physicians and medical students limiting or eliminating meat products.**

Conditions	Percent <sup>a</sup>					
	All meat products		Fresh pork		Cured pork	
	Limit	Eliminate	Limit	Eliminate	Limit	Eliminate
Anemia	4.1	.07	4.3	1.7	5.2	1.5
Choleystitis	25.6	6.3	34.5	27.5	30.6	27.1
Cholelithiasis	24.3	3.5	31.9	23.2	30.8	21.7
Cirrhosis	30.2	4.3	33.0	11.3	30.6	14.5
Congestive heart failure	18.4	1.3	21.5	7.4	22.1	29.3
Diabetes mellitus	16.3	0.4	20.4	2.0	19.5	3.9
Gout	38.8	4.8	38.8	10.0	38.2	11.1
High blood pressure	19.7	1.5	22.8	8.0	25.4	27.8
Hyperlipoproteinemia	50.5	5.6	52.7	19.1	50.1	20.0
Inborn errors of metabolism	15.4	6.5	16.7	7.8	16.1	8.0
Obesity	47.1	2.8	53.8	11.7	49.0	15.2
Pregnancy	8.5	0.7	13.7	2.0	16.9	4.1
Psoriasis	6.5	0.9	7.4	1.7	7.6	2.0
Renal failure	41.4	7.6	39.7	11.9	33.4	25.8
Ulcers	14.5	1.7	15.4	5.2	15.0	8.5

N = 461.

<sup>a</sup>Percent of total sample. It was concluded that those not responding had no restrictions.

be restricted (limited or eliminated) by a larger percentage of physicians and medical students than would restrict meat products in general. Nutritionally, fresh pork is very similar to other meats. It is doubtful that the higher percentage restrictions for pork over all meat products in general is based on any compositional differ-

ences. This could reflect a belief held by physicians and medical students that pork is inferior to other meats. Because of its salt content, cured pork would be restricted in low-sodium diets, but few other nutritional reasons exist for restricting cured pork for other conditions. Since medical doctors influence the diets of many people, attitudes of consumers towards pork may be less favorable than their attitudes for other meats.

In summary, pork is generally perceived by consumers and physicians to be a desirable meat. Consumers indicate price and advertising have a considerable impact on consumption. However, a significant number of consumers are unclear about proper preparation techniques, digestibility, incidence and prevention of trichinosis, and fat content of pork products.

Physicians also indicated that they felt pork was fatter and higher in cholesterol than other red meats. They also tended to restrict pork from the diet more than other red meats for treatment of specific conditions. In general, the image of pork is inferior to the image of other red meats.

<sup>1</sup>T. J. Janssen is a Graduate Student, Department of Animal Science. D. G. Olson is Assistant Professor. F. Caporaso is former Assistant Professor, now Research Scientist, McGaw Labs. R. W. Mandigo is Professor, Meats.

**Table 2. Percent response of physicians and medical students to opinion statements.**

Percent <sup>a</sup>	Opinion statement
62.5	Easy to digest
31.5	Hard to digest
94.4	High in protein
3.7	Low in protein
30.4	Too expensive
63.6	Appropriately priced
66.8	Fatter than other red meats
30.8	The same fat content as other red meats
31.2	Good for people who are watching their weight
60.1	Not good for people watching their weight
61.4	High in cholesterol compared to other red meats
19.1	Low in cholesterol compared to other red meats
43.0	Keeps well before cooking compared to other meats
41.2	Does not keep well before cooking compared to other meats
62.0	Sure of good quality
29.5	Not sure of good quality
47.5	Not much waste
44.9	Too much waste
63.6	High in vitamins and minerals
22.1	Low in vitamins and minerals
29.3	Patients get tired of it easily
54.2	Patients do not get tired of it easily
11.9	Greatly increases the possibility of contracting trichinosis
85.2	Trichinosis is not a major problem
80.7	High in cholesterol compared to other foods in general
9.5	Low in cholesterol compared to other foods in general

<sup>a</sup>N = Percent of total sample.



# Summer Breeding Management

Donald G. Levis<sup>1</sup>

The effects of climate (temperature, humidity, radiation, air movement, photoperiod) on swine reproduction during the summer months is not thoroughly understood. Limited research data have shown that during periods of high temperature sows may have a delay in postweaning estrus, extended periods of anestrus, reduced litter sizes, delay in return to estrus after mating, and a reduced farrowing rate.

Scientific studies have shown that temperature stress on boars causes a reduction in sperm concentration, number of sperm per ejaculate, sperm motility, and an increase in sperm abnormalities.

Heat stress does not reduce fertility level to the same extent in all boars. Some boars may have sperm production completely inhibited by heat stress and others only slightly reduced in sperm production. Since each boar is involved with many matings, a management system must be designed to maintain maximum fertility in all boars.

## Keep It Cool

Boars need to be maintained in a cool environment (less than 86°F, 30°C) 24 hours per day and 7 days per week. Depending on the boar, severity, duration, and the time of year of heat stress, it can take from 4 to 15 weeks for a boar to regain normal fertility (Figure 1).

Procedures that have been used as cooling methods are evaporative coolers, air conditioners, concrete wallows, and shade in combination with sprinklers and fans. These methods have worked well in adequately designed confinement buildings, but they do require management.

A large number of sows in Nebraska are pen mated. For producers operating with a pen breeding system, it may be advantageous to work boars only in the cooler periods of the day (from 7:00 p.m. to 7:00 a.m.). The logic behind this is that aggressive boars may become overheated during the day when trying to breed a sow or gilt that is not in good standing estrus. The combination of increased body heat production

caused by physical activity and high environmental temperatures can result in an increase in body and testicular temperatures of the boar.

Producers hand breeding sows in confinement may also want to consider working boars during the cooler period of the day. Some producers have indicated that high temperature reduces a boar's mating activity (libido); if so, using boars during the cooler periods of the day may increase the percentage which actively pursue the sows. Producers should not over-use aggressive boars during the summer months. If heat stress effects (reduced sperm numbers and motility) are coupled with over-use effects (reduced sperm numbers and volume) the end result is a decreased farrowing rate and litter size.

A major concern of the swine producer is that a high percentage of the weaned sows do not recycle on schedule during the summer months. However, there is no scientific data available that have partitioned the main effects of temperature, humidity, radiation, and photoperiod on anestrus in sows. Part of the anestrus problem can be attributed to the fact that first litter sows do not rebreed as quickly as sows that have had more than two litters (Table 1). The question is how does one operate a farrowing facility at capacity with a high percentage of sows not showing normal return to estrus after weaning.

The present solution is to maintain a large gilt pool. However, maintaining a large gilt pool in confinement operations results in a "plugging" effect on facilities and reduces reproductive efficiency of the breeding herd due to maintaining the large gilt pool. An additional problem which has not been extensively investigated is the influence of season on gilts reaching puberty. This is an important aspect of trying to breed an adequate number of sows to keep a full farrowing facility. When a high percentage of weaned sows are not recycling on schedule, the

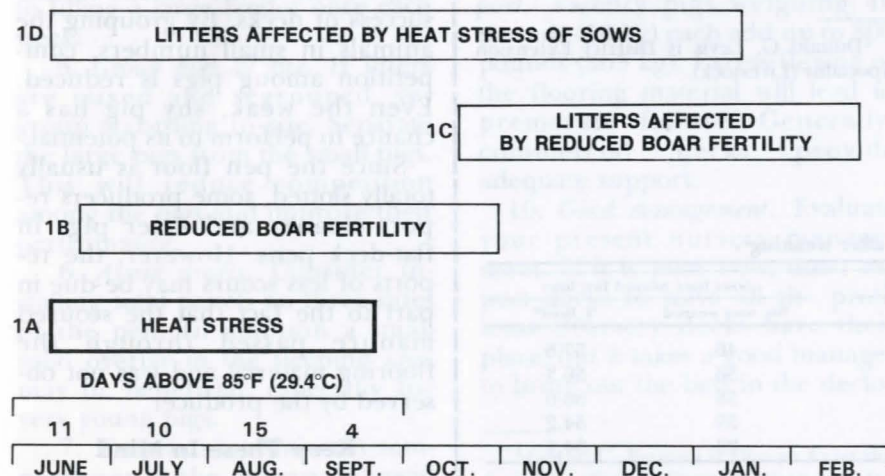


Figure 1. Influence of heat stress on reproductive performance.

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## Breeding Management

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gilt replacement pool is called upon. Preliminary evidence suggests that season also influences the estrous activity of gilts and a substantial number of gilts are needed in the gilt pool.

### Plan Ahead

Summer breeding herd management should be planned months ahead of the actual time the detrimental effects are going to take place. It is difficult to estimate how many replacement gilts to retain because at present it is not exactly known what effect age of gilt has on the percentage of gilts showing regular estrous cycles during summer months. In other words, it may be advantageous to enter the summer months with older, known cyclic gilts.

Most of the scientific data indicate that to maintain pregnancy after breeding during the summer months, sows should be kept cool for the first 30 days of gestation (decrease embryonic death) and the last 14 days of gestation (decrease stillborn rate). Most recommendations are as follows: when the temperature reaches 85°F (29.4°C) cooling should be considered.

If temperature is a cause of anestrus in weaned sows, it seems logical that a high temperature (90°F, 32.2°C) in the farrowing facility may be a contributing factor. To my knowledge, there has not been any controlled experiments to look at the effects of high temperature conditions while the sow is in the farrowing house.

Since heat stress causes an increase in respiration rate and rectal temperature, it may be advantageous for producers to monitor these two factors at various times. A range of values for each factor does exist which means a producer should establish what is normal for his breeding herd at various times during the year.

Based on weather data collected at the South Central Station, Clay Center, Nebraska, the first heat stress for 1979 occurred on June 11 and the last heat stress day on September 22 (Figure 1A). The period of time that a boar could have reduced fertility was from June 18 through October 31 (Figure 1B). The reason for reduced fertility after the last heat stress day is because at least 40 days are required for new sperm cells to be produced.

The management of boars during the heat stress period can influence the number of litters and the size of litters farrowed from October 10 through February 22, 1980 (Figure 1C). The number of live pigs at birth during June through September could be reduced by heat stress during late pregnancy (Figure 1D). Litter size and farrowing rate from October 1 through January 14, 1980, could be influenced by the effectiveness of cooling sows during early pregnancy. As can be seen reproductive performance could be influenced from June 11, 1979 through February 22, 1980 (256 days).

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Table 1. Percentage of sows bred within 9 days after weaning<sup>a</sup>.

Month	Sows have weaned 2 or more litters		Sows have weaned first litter	
	No. sows weaned	% Bred <sup>b</sup>	No. sows weaned	% Bred <sup>b</sup>
April	117	91.2	46	57.6
May	87	94.7	56	56.3
June	147	85.8	58	56.0
July	117	87.4	39	54.2
August	124	81.1	23	34.1

<sup>a</sup>Four week weaning schedule

<sup>b</sup>Monthly average

Are They for You?

## Deck Nurseries

Michael C. Brumm,  
David P. Shelton<sup>1</sup>

Nursery decks—flat, double, or even triple—are increasing in popularity for both new and remodeled facilities. This popularity may be due in part to reports of improved pig performance by producers who have installed deck systems. However, the improved management which often is started with a new deck nursery may be responsible for the better performance rather than the deck itself.

In the flat-deck arrangement, weaned pigs are confined in a pen having a slotted or perforated floor that is raised 12 to 24 inches (30 to 60 cm) above the building floor. Generally, these pens are 4 feet (1.2 m) wide and 4 to 10 feet (1.2 to 3.0 m) long, holding from 10 to 25 pigs.

The low number of pigs per pen may be one of the reasons for the success of decks. By grouping the animals in small numbers, competition among pigs is reduced. Even the weak, shy pig has a chance to perform to its potential.

Since the pen floor is usually totally slotted, some producers report cleaner and drier pigs in flat-deck pens. However, the reports of less scours may be due in part to the fact that the scoured manure passed through the flooring material and was not observed by the producer.

### Keep These In Mind

Producers considering a flat-deck nursery should keep the fol-





Weaned pigs confined in flat deck pen.

lowing items in mind:

1. *Heating and ventilation.* The system should be properly designed for the number and size of pigs to be confined. A common mistake is adding additional pigs to a building with an already inadequate ventilation system.

2. *Manure handling system.* Simply elevating the animals above the manure does not remove the problem. If manure is allowed to build up under the decks, large amounts of water, ammonia and other gases will be released into the building, resulting in poor environmental conditions.

3. *Space.* Allow 1.6 sq. ft. (.15 sq. m) per pig up to 25 lb (11 kg) and 2 sq. ft. (0.2 sq. m) per pig up to 40 lb (18 kg).

4. *Feeder space.* Allow one feeder hole for each 2 to 3 pigs. Keep fresh feed in the feeder by frequent additions of small amounts of feed. This is preferred to filling a large feeder once each week.

5. *Group pigs by size.* If litters are mixed and regrouped, regroup according to size. Separate the large pigs from the small pigs. This will reduce competition among the pigs and improve their performance.

6. *Avoid drafts.* Consider installing solid panels on three sides of the pen. In addition a small solid overlay in the sleeping area may be beneficial, especially for very young pigs.

7. *Temperature.* Maintain temperatures in the nursery to avoid stress on the young pig. Larger

pigs have lower thermo-neutral temperatures and can tolerate more temperature fluctuations than smaller pigs. Appropriate management practices and equipment alterations may allow energy saving by allowing some reduction in room temperature. Hovers and zone heating in the pig sleeping area will allow some energy conservation. The solid pen dividers and solid wood floor in the sleeping area will make the deck comfortable at a slightly lower temperature. Twelve pound (5.5 kg) pigs require 85° F (29° C). Forty pound (18 kg) pigs require 75° F (24° C).

8. *Use nipple waterers.* Nipple waterers assure a supply of fresh, clean water for the weaned pigs. Often, cup or bowl type waterers in cages are not cleaned as often as necessary, contributing to health problems.

9. *Provide adequate flooring support.* Twenty pigs weighing 40 pounds (18 kg) each add up to 800 pounds (363 kg). Excess flexing of the flooring material will lead to premature failure. Generally, commercial decks provide adequate support.

10. *Good management.* Evaluate your present nursery management. If it is poor now, don't expect decks to solve all the problems. Nursery decks have their place, but it takes a good manager to bring out the best in the decks.

<sup>1</sup>Michael C. Brumm is District Extension Specialist (Swine). David P. Shelton is District Extension Specialist (Ag Engineering).

## Antibiotics in the Pen Nursery

D. M. Danielson<sup>1</sup>

The popularity of cages and flat decks for weaning pigs is growing. This does not mean that our conventional pig nursery is going out of style or becoming old-fashioned. However, the producer should consider the new types of equipment for remodeling or new construction. Type of equipment chosen must fit the individual operation.

Because of the interest in and questions about cage rearing of pigs, the North Platte Station conducted studies using commercial, flat deck nursery pens. The decks used were 5' x 7' (1.52 m x 2.13 m) steel frame pens. The sides and ends are 1/4" (.635 cm) steel mesh welded to the frame. One end contains a 2' x 2' (.61 m x .61 m) steel frame and mesh gate. The other end contains a 4-bushel self-feeder. A stainless steel nipple waterer is located on one of the side frames. The floor consists of one piece of steel mesh covered with plastisol compound. The pen rests on a tubular steel frame which elevates the unit one foot (.31 m) above the room floor. A one foot (.31 m) wide grated pit equipped with a sump pump permitted proper cleaning and waste disposal from beneath the nursery pen floor. The room temperature was adequately controlled in accordance to the age and weight of the pigs.

### Does an Antibiotic Help?

This study was conducted to

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## Antibiotics in the Nursery

(continued from page 11)

determine if adding an antibiotic would help the performance of pigs reared in the nursery pens. A second phase of the study was to record the performance of the pigs after they were moved from the decks to conventional growing-finishing pens.

Fifty-six pigs from the station herd were weaned at about 21 days of age and allotted to one of four nursery pens. They were separated into either a light or heavy group. The light and heavy groups were each further divided into two groups. One light and one heavy group received a 16.5% protein grower diet fortified with an antibiotic (AB). The other groups re-

ceived the grower diet devoid of antibiotic. The AB used in this study was CSP-250 fed at the level recommended by the manufacturer. Equal sex distribution prevailed in all pens. All pigs were maintained in the nursery pens for 42 days. Feed (meal) and water were supplied *ad libitum*.

The initial pig weight of the light and heavy groups was 13 lb (5.9 kg) and 16 lb (7.3 kg) respectively. The first few days following weaning are frequently critical for the young pig because of numerous stresses. Many producers are content if the body weight doesn't increase during this period but the pig remains alive and healthy.

Table 1 reports pig performance from 1-6 weeks and also from 2-6 weeks to emphasize the



Antibiotics help in multiple deck pens.

rather meager performance expected during the first week following weaning. In this study, pig gain for the first 7 days ranged from -0.02 lb (-0.009 kg) to +0.43 lb (0.20 kg). Presence of the antibiotic during the first week appeared to reduce the gain compared to the pigs that did not receive an antibiotic. However, this trend was reversed during subsequent weeks. The results (Table 1) for average daily gain (ADG) and feed conversion (FC) from 2-6 weeks indicate improved performance when the antibiotic was present. The response in ADG of the heavier pigs [0.12 lb/day (.054 kg/day)] was twice that of the pigs in the lighter group [0.06 lb/day (.027 kg/day)]. Feed conversion didn't appear to be influenced by adding an antibiotic. During the initial 42-day phase it would appear the more significant factor was the death loss of one pig from each of the groups (heavy and light) that received the grower diet without added antibiotic.

Table 1. Pig performance when fed with and without antibiotic in grower diet reared in nursery pens (deck).

Criterion	Pigs			
	Light		Heavy	
	+ <sup>a</sup>	- <sup>b</sup>	+	-
No. of pigs	14	14 <sup>c</sup>	14	14 <sup>c</sup>
Initial wt, lb (kg)	13 (5.9)	13 (5.90)	16 (7.26)	16.2 (7.35)
ADG, lb (kg)				
1-6 weeks	.47 (.21)	.43 (.20)	.54 (.24)	.45 (.20)
2-6 weeks	.57 (.26)	.51 (.23)	.65 (.29)	.54 (.24)
F/G				
1-6 weeks	2.32	2.31	2.33	2.25
2-6 weeks	2.23	2.25	2.26	2.22
Termination wt, lb (kg)	32.8 (14.9)	31.2 (14.1)	38.9 (17.6)	35.2 (16.0)

<sup>a</sup>16.5% protein grower diet including CSP-250, 5 lb (2.27 kg) per ton of complete diet.

<sup>b</sup>Grower diet with no antibiotic.

<sup>c</sup>One pig succumbed during 5th week on study.

Table 2. Subsequent pig performance in growing-finishing unit, 7-12 weeks.

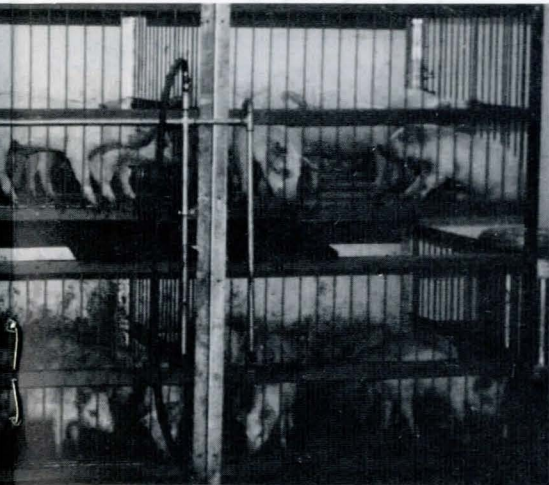
Criterion	Treatments <sup>a</sup>			
	++	+-	-+	--
No. of pigs				
Light	6	6	6	6
Heavy	6	6	6	6
Initial wt, lb (kg)				
Light	34.6 (15.7)	34.6 (15.7)	31.8 (14.4)	31.3 (14.2)
Heavy	40.7 (18.5)	41.3 (18.7)	35.8 (16.2)	35.8 (16.2)
Average	37.7 (17.1)	38. (17.2)	33.8 (15.3)	33.6 (15.2)
ADG				
Light	1.35 (.61)	1.28 (.58)	1.17 (.53)	1.07 (.49)
Heavy	1.44 (.65)	1.34 (.61)	1.11 (.50)	1.22 (.55)
Average	1.40 (.63)	1.31 (.59)	1.14 (.52)	1.15 (.52)
F/G				
Light	2.52	2.39	2.22	2.61
Heavy	2.46	2.65	2.41	2.41
Average	2.49	2.52	2.32	2.51
Termination wt., lb (kg)				
Light	91.2 (41.1)	88.3 (40.)	81. (36.7)	76.2 (34.6)
Heavy	101.3 (45.9)	97.5 (44.2)	82.3 (37.3)	87. (39.5)
Average	96.3 (43.7)	92.9 (42.1)	81.7 (37.1)	81.6 (37.)

<sup>a</sup>Phase 1 and 2 with or without antibiotic (+ or -).

### Growing-Finishing Phase

When the pigs were removed from the nursery pens and placed in a growing-finishing unit each original nursery pen was further divided into two groups. One group was continued on the same diet as before. The other group received the diet they had not received during the first phase. Thus, the four treatments for phase 2 were AB + AB(++), AB-AB(+-), -AB+AB(-+) and -AB-AB(--). To equalize the





number of pigs per pen the 12 heavier pigs from each of the original nursery pens were used in the second phase of this study. There were 6 pigs per pen and two replications for a total of 48 pigs. The duration of the second phase was 42 days. Feed and water were supplied *ad libitum*.

Pig performance shown in Table 2 indicated that ADG was improved for the heavier group when they received the diet with added antibiotic. Pigs in the lighter group essentially showed no response in ADG when fed the diet fortified with an antibiotic. Feed conversion for the heavier pigs was essentially the same with or without the antibiotic. The lighter pigs indicated a FC trend toward improved conversion in the absence of antibiotic in their feed.

This study indicates addition of an antibiotic to the grower diet may have prevented a pig death loss during the initial phase. The benefits in ADG and FC from antibiotic supplementation must be weighed against the cost. Was their addition cost effective? Another antibiotic, pigs of different origin, facilities, management, etc., could definitely alter the results of this type of study. Overall, pig performance in this type of nursery system was quite satisfactory.

<sup>1</sup>D. M. Danielson is Professor, Swine Nutrition. Acknowledgment is made to Larry Solomon, Mark Crenshaw, Operations Managers and Dave Hagemeyer, Student Assistant, in the conduct of this study.

## A Management Aid...

# Sow Records

William T. Ahlschwede<sup>1</sup>

Recent attention to sow productivity has touched all segments of the pork producing industry. As this attention has matured, the realization has come that good sow performance requires a good support system. Superior support systems, particularly facilities for year-round breeding and farrowing, increase facility costs. However, production practices which fully use the facilities (every week, every year) spread the fixed costs over sufficient numbers of pigs to make the sophisticated facilities cost effective.

Achieving full use of farrowing houses places much greater emphasis on breeding performance, both pregnancy rates and timeliness of breeding. Producers cannot afford to find out about breeding failures at the time of expected farrowing. Management at breeding time is receiving added emphasis. Techniques to assure that timely mating occurs are being adopted. Heat checking, hand mating and pregnancy checking are being used to assure

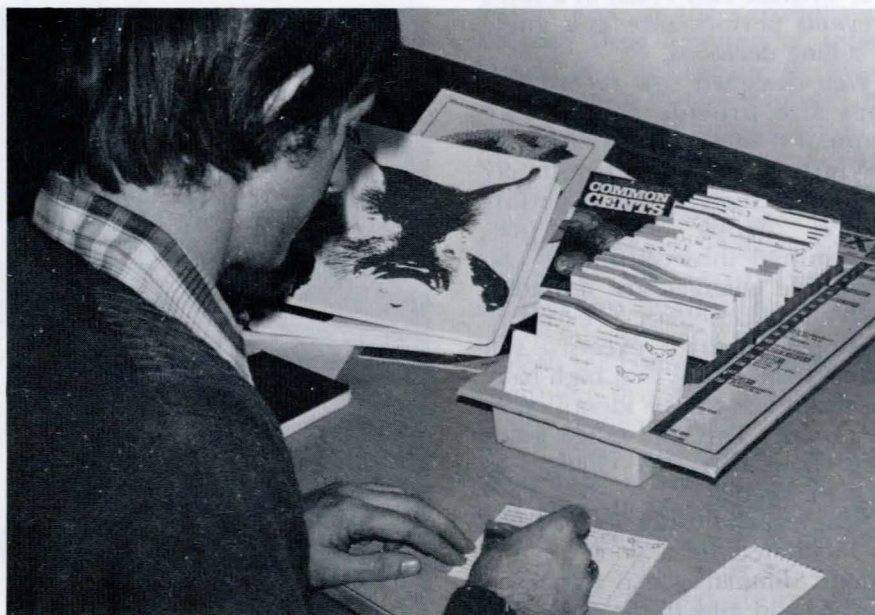
high levels of reproduction. These activities are most effectively performed when coupled with a functional sow-record system.

## Record Keeping Systems

Considerable attention has been focused on record keeping systems for sows. Often the emphasis of these systems has been to provide summary data for sow performance. Pigs per sow per year, production per sow month, and other summary statistics are interesting historical records which provide some diagnostic aid. However, sow record keeping systems which provide daily management help are available. Such record systems facilitate efforts to effectively heat check, hand mate, and pregnancy check. These systems can provide the historical summaries needed for planning production adjustments and financial records.

Sow record keeping systems have little value as daily or weekly management aids unless hand mating is practiced. Nearly all of the short range benefits of the

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Card system for sow management.



## Sow Records

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systems depend upon identifying the day of mating. Without a breeding date, time dependent management functions cannot be accurately identified.

### Management Aids

Well designed sow record keeping systems can provide the following decision making information on a daily or weekly basis.

1. Identify breed composition of sows at breeding time to allow proper boar breed selection.

2. Show days open for unbred females in the open sow pool. This information on a daily or weekly basis identifies anestrus or non-mating sows at breeding time. It allows identification of sows for culling based on excessive days open.

3. Facilitates separation of pregnant sows from those bred but not pregnant by identifying sows to be heat checked at the normal recycling time and identifying sows for pregnancy testing.

4. Identifies sows for timely husbandry activity such as deworming, immunization, feed changes during gestation and moving sows to the farrowing house.

5. Provide easy recall of a sow's previous performance as a guide in culling decisions.

Well designed sow record systems also provide short range summary material to identify production problems for timely corrective changes. When performance drops below predetermined intervention levels, corrective changes are initiated. Such costly problems as excessive days open, anestrus, excessive still births, small litters, and high baby pig death loss can be identified as they occur. This mid-range guidance allows corrective changes as they are needed.

Near term adjustments may also be facilitated by a good record system. Summaries may signal the need to add gilts to the open sow pool to compensate for reduced

mating activity. Summaries may indicate the need for an early move of sows and pigs from the farrowing house and nursery to make room for a larger than normal farrowing group.

Well designed sow record systems also provide the summary information needed for long range planning. Financial planning, matching facilities to production characteristics and the production documentation needed for tax and collateral purposes can be facilitated by these systems.

### Systems Basics

There are three necessary attributes of sow record keeping systems. The first is a calendar or clock mechanism. Since the practices which the record keeping system supports are primarily timed according to weaning or breeding date, the system must have a calendar built in. The second necessary attribute is a sow identification system. At a minimum, the identification system must allow sows to be identified with the calendar mechanism. Preferably, the identification would be sufficient to tie each sow to pedigree and lifetime production records. The third prerequisite is that the information is readily accessible.

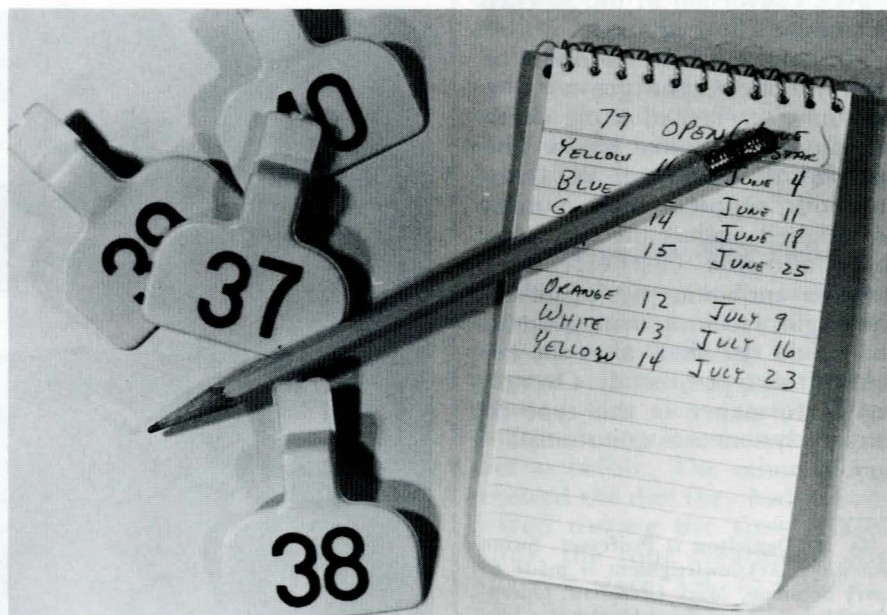
A wide range of sow record sys-

tems can be developed. Computer assisted systems represent the most complex. Color coded ear tags, function pens, and a seed corn book represent a simple but useful system. Three specific systems will be described. Each is functional. Each has advantages. Each has limitations. Each can be a valuable management aid.

### Ear Tag, Function Pen and Notebook System

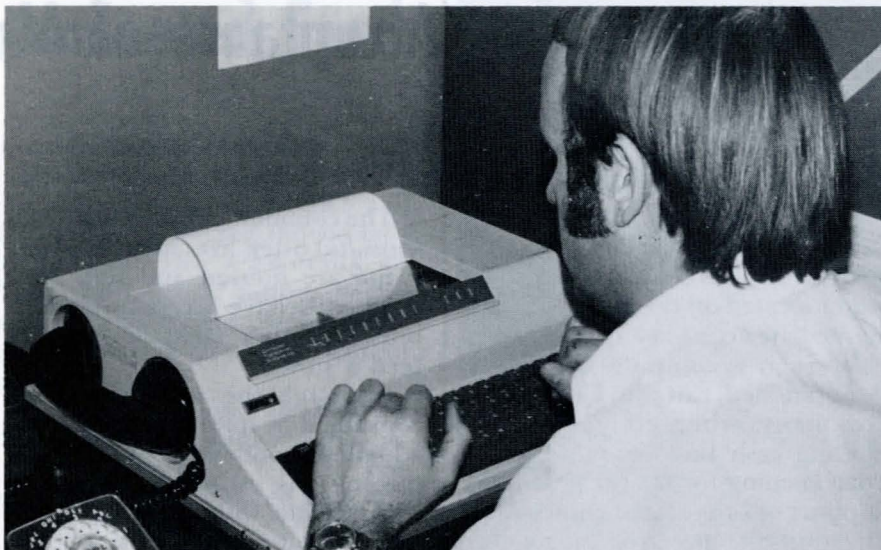
Many simple but functional systems can be designed which use only ear tags, several pens, and a small notebook. Two such systems will be described. The first uses color coded ear tags to perform the calendar and identification function. Four function pens are required—heat checking, breeding, pregnancy checking, and gestation. A small notebook is needed to record breeding dates of groups of sows.

Sows are given color coded ear tags when placed in the heat checking or open sow pen. The color of the ear tag identifies the week or month the sows were placed in the open sow pen. When the sows come into heat, they are moved to the breeding pen. When they have been bred, they are moved to the pregnancy checking pen and given a new color of ear tag corresponding to the week



Ear tag management system.





**Computer assisted management system.**

when they were bred. Six weeks later, the sows with the proper color ear tag are pregnancy tested. If they are pregnant, they move to the gestation area, carrying the color of tag which corresponds to the week in which they were bred. The small notebook is used to record the number of sows moved from pen to pen each week and to note the correspondence of ear tag color to the date. The color code of the ear tag allows an easy check on sows which are open an excessive number of days. The function pens allow an easy separation of sows according to their reproductive status. Only sows or gilts in heat are moved out of the open pen. Only sows which take the boar move into the pregnancy check pen. Only pregnant sows move to the gestation area.

A second ear tag system uses the ear tag itself for record keeping. Sows start with blank tags. As events happen they are recorded on the ear tag with ear tag marking ink. The sow's number, breed and date would be recorded when the sow or gilt enters the open pool. The date and service sire number would be recorded at breeding. The ear tag carries the information needed to spot sows with excess days open and for timely management practices. Since large tags would be required this system is best suited for operations using gestation stalls.

The ear tag systems described here provide the information and identification needed to perform the most important management procedures. Their usefulness is limited by the amount of information recorded.

### **Card Systems**

The various card systems available commercially or made by producers offer a wider range of information storage and retrieval. The wheel and tray systems have built in calendar mechanisms. The card for each sow is placed in the system at breeding. It then moves through the system in a manner which mirrors the sow's progress through the reproductive cycle.

The card systems require that sows be permanently identified. Each sow has a card which carries the sow's information. Generally, a notebook is used to record herd activity. This information is recorded daily onto the sow cards and entered into the system. The wheel system has pockets or slots for cards for each day in the cycle. The wheel is advanced one space each day. The tray system has weekly boxes. The weekly boxes are advanced once a week through the calendar system. With both the wheel and tray card systems, the cards for the open sows and gilts are in compartments outside the calendar system. As females are bred, their card is placed in the slot

or box corresponding to the day or week. As the wheel or boxes are advanced, indicators on the frame show groups of sows due for heat checking, pregnancy checking, moving to the farrowing house and other timely practices. The wheel systems contain daily slots corresponding to the length of the sow cycle. For three to four week weaning, 150 daily slots would be desirable. For weaning at older ages, more slots would be needed. With the tray system, 22 boxes would be a comfortable minimum.

The card is the information holder in these systems. They can be quite complete. A basic card should include the sow's identification, breed composition and life-time breeding, farrowing, and weaning information. Production information should be dated. Pig counts at birth are important. Some indication of mothering ability would be desirable. Summary statistics and intervention indicators are hand calculated with the card systems. Cards representing sows in the open pool are also manually sorted and checked for excess days open.

### **Computer Assisted Programs**

A third level of sophistication in sow record keeping systems is the computer assisted system. Computers give us the capability of keeping large amounts of information in a small space, performing functions instantaneously and automatically summarizing performance records. The computer system has more equipment (hardware) costs associated with it. Good programs (software) for computer sow record keeping systems are not widely available today, but are being developed.

With the computer systems, the computer program provides the calendar mechanism. The computer maintains, usually on electronic tape or disc the sow records and current reproductive status. Herd activity is entered into the computer on a daily or weekly basis. All breedings are recorded. Heat check, pregnancy check, far-

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## Sow Records

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rowing, and weaning information are also entered on a regular basis. With this data in storage, as well as the sow's lifetime performance, the computer will on command provide desired lists and performance summaries. Helpful lists include a list of open sows including days open, a list of sows to be heat checked for return to estrus, a list of sows due to be pregnancy checked, a list of sows to be moved to the farrowing house, a list of sows due to farrow and a list of sows due to be weaned. In addition, the computer can be programmed to give a variety of other lists which would be helpful in management of the sowherd. The computer can be programmed to print daily work schedules.

In addition to work lists, the programs can be designed to provide periodic summaries of critical performance indicators. The number of sows bred per week, average days open, late returns to estrus, litter size born, death losses, litter size weaned and boar use can be provided on command. To make good use of the computer systems, careful and regular attention must be given to entering the necessary information into the computer. Since the computers have such broad capabilities, there is a tendency to develop systems which require more inputs than common with the card systems. Typically, daily activity would be recorded on work sheets or in a small notebook to be entered into the computer at the end of the day or week.

Several types of computer support arrangements are available and practical. Time share arrangements on large computers such as Nebraska's AgNet system are available. These arrangements usually require a remote terminal and a telephone hook up. The terminals, which can be used for other programs on a time share basis, cost \$1500-\$2000 and are the size and configuration of a typewriter. Such time share arrangements often require long distance telephone calls. There

may be time restrictions on when the central computer can be used.

An attractive arrangement for computer support for a sow record keeping system is a micro-computer. It appears that for an investment of \$3000-\$5000 one can purchase a small computer with adequate capability to handle a large sow herd. An owned computer located on the farm provides immediate access at any time of the day. Such a computer, properly programmed, can provide support for many other endeavors, including cash flow accounting, record keeping for tax purposes and support of other farm enterprises. In addition, many of the micro-computers can be used as remote terminals for time sharing on large computers. It appears that many of the small computers (\$3000-\$5000) can operate the sow record keeping system. However, some producers have chosen to move up to larger computers (\$15-\$20,000) to gain more programming flexibility and capacity.

Sow records and systems for using them can be useful management aids. To be of benefit, they must provide timely information which is helpful in decision making, work scheduling, and planning. Any of the systems outlined above can be beneficial if they are properly used. Such help, however, does not come free. All systems require time and care to enter information into the system. Record keeping takes time. Properly designed, the system will provide lots of output for a small amount of input. But someone must keep the records updated. The costs on the simpler systems come as increased time to write out record forms, manipulate cards by hand and calculate summary statistics. The computer assisted systems simplify and expedite the record keeping system, but require a greater capital commitment to the equipment for the system.

<sup>1</sup>William T. Ahlschwede is Extension Swine Specialist.

## Acceptance of Mouse-

Robert M. Timm,  
Bobby D. Moser<sup>1</sup>

The common house mouse (*Mus musculus*) often lives in areas where swine are housed and fed. Mice frequently have access to feeders, bins, or other structures where feed is stored.

Although the amount of feed consumed by mice constitutes only a limited economic loss to the producer, it is estimated that mice contaminate with their feces and urine about ten times the amount of feed actually eaten. This study attempts to measure the effect of this contamination on swine.

### Preference Testing

Contaminated feed was obtained by placing house mice into containers in which clean feed (corn-soybean meal, 18% protein) had been placed, and allowing them to live there for about six weeks. At the end of the contamination period, mice were removed and the feed thoroughly mixed. Five subsamples of contaminated feed were sifted for mouse droppings, which averaged 394 per liter of feed.

Control (clean) feed was from the same batch and was stored in

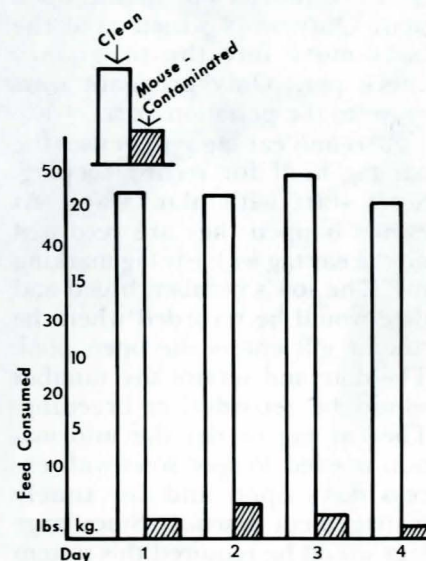


Figure 1. Total feed consumed by 12 pigs during a free-choice test.



# Contaminated Feed

its original sacks until use.

Six barrows and six gilts weighing between 21 and 41 lb (9.5 and 18.5 kg) were housed individually in pens at the University of Nebraska-Lincoln. Before beginning the experiment, the pigs were given a five-day adjustment period.

Over the first four days of the trial, each pig could choose between two identical feeders, one containing contaminated feed and the other clean (control) feed. The feeders were rotated daily to avoid any position preference. Feeders were weighed daily and refilled as necessary. Feeders were never allowed to become empty. The pigs preferred clean feed (Figure 1).

## Effects of Eating Contaminated Feed

Following the preference test, the feeder containing clean feed was removed from each pen, forcing the pigs to eat contaminated feed on days five through eight. In this no-choice situation, pigs ate the contaminated feed, but the total food consumption on days five and six was lower than at any other time. One pig ate no measurable amount of contaminated feed on days five and six and ate only one pound (.45 kg) of feed on day seven. Even so, the total feed consumption by all pigs during days five through eight was not significantly different from consumption during the free-choice

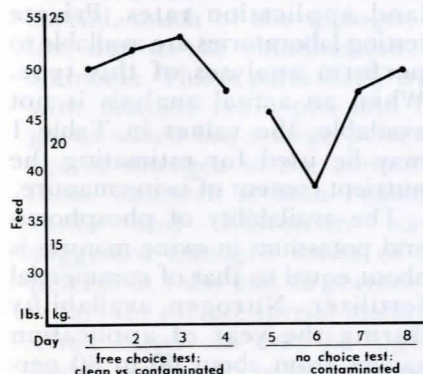


Figure 2. Total feed consumed by 12 pigs.



Mouse-contaminated, crusted feed.

testing (Figure 2).

Pigs were weighed on days one, five, and eight. Weight gain during the four-day free-choice test was not significantly different from gain during the four-day test in which pigs ate only contaminated feed.

## Summary

This pilot study demonstrates that when given a choice, pigs will eat clean feed rather than feed heavily contaminated by house mice. When given no choice, pigs will eat contaminated feed and show no apparent short-term reduction in weight gain.

Contamination of hog feed by rodents increases the potential for spread of disease. Other studies have shown that house mice can carry *Salmonella* bacteria and may be involved in spreading organisms responsible for baby pig scours.

Other studies being conducted at the University of Nebraska indicate that rodents can cause significant damage to confinement structures (particularly to insulation). For these reasons, we recommend a continuous program of rodent control:

- Store feed in rodent-proof containers or buildings.
- When feeders are not in use, empty them.

- Clean up spilled feed and eliminate shelter rodents can use for nesting.

- Rodent-proof buildings when possible.

- Where mice or rats are present, the most successful control programs are those using a combination of methods including removal of food and shelter, use of traps, and the proper use of rodenticides.

<sup>1</sup>Robert M. Timm is Extension Vertebrate Pest Specialist. Bobby D. Moser is Associate Professor (Swine Nutrition).



Contaminated feed can carry disease.





The picture is old, but the practice of spreading manure is still good.

## Fertilize Crops With Swine Manure

Elbert C. Dickey  
Gerald R. Bodman<sup>1</sup>

Application of manure to farmland is an appropriate and environmentally sound management practice for most swine producers. Land application returns nutrients from manure to the soil and helps build and maintain soil fertility. Manure also improves soil tilth, increases water-holding capacity, lessens wind and water erosion and improves aeration. Application of manure should be viewed as a means to utilize crop nutrients present in the manure rather than utilizing the land as a means of disposal.

In addition to containing nitrogen, phosphorus and potassium, manure contains trace elements such as calcium, magnesium, iron, and zinc. However, the economic value of swine manure as fertilizer is usually calculated on the basis of its N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O content. Manures containing significant amounts of runoff or dilution water may also serve as a source of irrigation water. Although the nutrient content of this water is usually low, it should be regarded as a fertilizer source. In such cases, calculation of the value of the manure and wastewater for crop

production must include both the nutrient and water value.

A number of factors must be considered when determining the amount of manure each soil is capable of handling without damage to the soil and to the surrounding environment. These factors include soil type, topography of the land, cropping system, and the nutrient and salt content of the manure.

The rate of manure application depends upon whether one wants to maximize the recovery of plant nutrients or the amount of manure that can be applied per unit of land area. Where an adequate land base exists, all attempts

**Table 1. Approximate nutrient content of liquid swine manure at time applied to land.**

Nutrient	Maure handling system	
	lb/1000 gal (kg/m <sup>3</sup> )	
	Pit	Lagoon
Total nitrogen	50 (6.0)	4 (0.48)
Ammonia nitrogen	38 (4.6)	3 (0.36)
Phosphorus (P <sub>2</sub> O <sub>5</sub> ) <sup>a</sup>	27 (3.2)	2 (0.24)
Potassium (K <sub>2</sub> O) <sup>b</sup>	19 (2.3)	4 (0.48)
Dry Matter (Percent)	4	1

<sup>a</sup>To convert to elemental P, multiply by 0.44

<sup>b</sup>To convert to elemental K, multiply by 0.83

should be made to maximize nutrient recovery by application rates consistent with crop utilization rates. However, where a large concentration of swine is maintained on a relatively small land base, manure application rates may be designed to maximize the application rate while avoiding any deleterious effects on the land.

### Nutrient Content of Manure

The nutrient content of manure varies depending on type of ration, animal age, manure handling method, and other factors. Analyze samples of manure immediately before land application to determine the level of plant nutrients, and thereby provide a basis for determining appropriate land application rates. Private testing laboratories are available to perform analyses of this type. When an actual analysis is not available, the values in Table 1 may be used for estimating the nutrient content of swine manure.

The availability of phosphorus and potassium in swine manure is about equal to that of commercial fertilizer. Nitrogen availability during the year of application ranges from about 60 to 80 percent for pit-stored liquid swine



**Table 2. Agronomic fertilization rates for various crops.**

Crop	Pounds of nutrient per bushel		
	Available N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Barley (1)	1.5	0.55	1.0
Corn for grain	1.3	0.55	0.28
Grain Sorghum	1.1	0.42	0.21
Oats (1)	1.1	0.40	1.5
Rye (1)	2.2	0.69	1.8
Soybeans	(2)	1.1	2.4
Wheat (1)	2.3	0.68	2.0
Pounds of Nutrient per ton			
Alfalfa	(2)	10	60
Corn Silage	7.5	3.1	9.4
Grain Sorghum for silage	7.5	3.1	9.4
Sorghum-Sudan	40	15	59
Tall Fescue	39	19	53
Kilograms of Nutrient per 100 kilograms yield			
Barley	3.1	1.1	2.1
Corn for grain	2.3	0.98	0.50
Grain Sorghum	2.0	0.75	0.38
Oats	3.4	1.3	4.7
Rye	3.9	1.2	3.2
Soybeans	(2)	1.8	4.0
Wheat	3.8	1.1	3.3
Alfalfa	(2)	0.5	3.0
Corn Silage	0.38	0.16	0.47
Grain Sorghum for silage	0.38	0.16	0.47
Sorghum-Sudan	2.0	0.75	3.0
Tall Fescue	2.0	1.0	2.7

(1) If straw is removed.

(2) Legumes can obtain most of their N from the air and are normally not fertilized with N. However, if included in a crop rotation with nitrogen using crops, they will use the available N in the soil and not fix N from the air. Therefore, it can be assumed that they will remove as much N as corn for grain would in the same rotation. This information is general in nature and may not reflect an accurate recommendation for all areas or soil types of the state. In order to obtain more accurate recommendations for phosphorus and potassium, soil testing should be done.

Source: Illinois Environmental Protection Agency, 1976.

Design Criteria for Field Application of Livestock Waste. WPC-2.

manure and anaerobic lagoon effluent. The availability of nitrogen for open swine lot manure is about 60 percent of that in mineral fertilizers during the first year of application. Where land receives manure on an annual basis, consideration for residual nitrogen from previous applications must be considered.

When swine manure is surface spread, much of the nitrogen is lost due to the volatilization of ammonia. This is particularly true with manure from pits and lagoons which has a large percentage of nitrogen in the ammonia form. Research at both Pennsylvania and Wisconsin have suggested nitrogen losses of 25 percent in 1 day and 45 percent in 4 days for surface spread manure. Those losses can even be higher under warm, dry weather conditions. Ammonia volatilization is a

disadvantage if efficient nitrogen utilization is the goal, but it can be beneficial if there is concern about excessive nitrogen application and potential leaching of nitrate nitrogen into the groundwater. To retain the nitrogen, surface applied manure should be incorporated into the soil immediately. In addition to reducing the nitrogen loss, incorporation also reduces the possibilities of odor, surface water pollution, and insect breeding.

#### Land Application Rates

Manure is beneficial to most crops. Silage crops (corn or sorghum) recycle nutrients well because they produce more plant material and harvesting the silage removes more nutrients from the land application area than other crops. Annually cultivated crops are well adapted to manure application because the manure can be

incorporated into the soil before planting or after harvest.

To make efficient use of the crop nutrients in swine manure, application rates should not exceed the agronomic nitrogen rate, which is defined as the annual application rate of available nitrogen required for a reasonable anticipated crop yield. In most cases the phosphorus applied will exceed the crop requirements if the agronomic nitrogen rate is met. Thus, to make the best use of phosphorus resources it may be advisable to apply manure at the agronomic phosphorus rate. In the event that phosphorus rates are used, supplemental nitrogen from commercial fertilizer will generally be needed to meet the agronomic nitrogen requirement. Agronomic fertilization rates for various crops are given in Table 2.

The land application rate of swine manure depends primarily on these factors:

1. Agronomic fertilization requirement of the crop to be grown.
2. Nitrogen content of the manure.
3. Availability of the nitrogen.

These factors can be used to estimate the annual manure nitrogen requirement of the crop and application rate as follows:

1. Manure nitrogen requirement of crop = estimated yield  $\times$  agronomic fertilization rate
2. Application rate =  

$$\frac{\text{Manure nitrogen requirement}}{\times 100 \text{ divided by}} \frac{\text{Nitrogen content (\%)}}{\times \text{nitrogen availability (\%)}}$$

To convert this application rate to tons per acre divide by 2000. To obtain gallons per acre divide by 8.3. Application rates for liquid swine manure were calculated from equations 1 and 2 and are given in Table 3. Swine producers can use these rates as a guide in scheduling land application operations so that sufficient land is available at the times needed and to judge the adequacy of a tract of

(continued on next page)



**Table 3. Annual application rates for liquid swine manure.**

Nitrogen concentration <sup>a</sup>		Nitrogen requirement of crop, lb N/acre		
		50	100	150
Pounds per 1000 gallons	Percent (Wet Basis)	Application Rates (gallons/acre/year)		
7.5	0.1	7,500	15,000	23,000
15	0.2	3,800	7,500	11,000
22.5	0.3	2,500	5,000	7,500
30	0.4	1,900	3,800	5,600
37.5	0.5	1,500	3,000	4,500
45	0.6	1,300	2,500	3,800
60	0.8	940	1,900	2,800
75	1.0	750	1,500	2,300

Nitrogen Concentration <sup>a</sup>		Nitrogen requirement of crop Kg N/ha		
		56	112	168
Kilograms/ Cubic Meter	Percent (Wet Basis)	Application Rates (cubic meter/hectare/year)		
0.9	0.1	70	140	215
1.8	0.2	35	70	103
2.7	0.3	23.4	46.7	70
3.6	0.4	17.8	35	52.4
4.5	0.5	14.0	28	42.1
5.4	0.6	12.2	23.4	35
7.2	0.8	8.8	17.8	26.1
9.0	1.0	7.0	14	21.5

<sup>a</sup>1% = 10,000 ppm

## Fertilize With Swine Manure

(continued from page 19)

land for a feeding operation of a given size.

### Figuring the Value of Manure

Calculate the value of the manure giving consideration to the plant nutrients supplied plus allowances for improving soil properties such as tilth and water intake rate. Thus, the value of manure varies with its nutrient content and the land need. Assuming unit price for nitrogen, phosphate and potash of 19, 19 and 7 cents per pound (0.45 kg), respectively, liquid pit manure having average N-P-K concentrations listed in Table 1 worth about \$18 per 1000 gallons (3.79 m<sup>3</sup>). However, many soils in Nebraska derive practically no benefit from phosphorus and potassium additions. If phosphorus and potassium are not needed then the value of liquid pit manure is approximately \$9.50 per 1000 gallons (3.79 m<sup>3</sup>).

### Precautions

As swine manure undergoes microbial decomposition, many types of salts are released. Some are absorbed by the soil while others remain in the soil solution. Salt accumulation from high ap-

plication rates can adversely affect seed germination and plant growth by reducing the plant's capacity to utilize soil water. Applications of manure at agronomic rates generally will not create salinity problems.

Weed infestations have frequently been credited to manure use. The number of viable weed seeds in manure is greatly reduced by the heating and cracking processes involved in grain ration processing. However, roughages and bedding materials may contain weed seeds that could eventually be carried to the fields in viable condition.

### Summary

Land application of swine manure at agronomic rates generally results in high utilization of crop nutrients while at the same time minimizing potential environmental problems. Manure analyses in addition to soil analyses are recommended for determining correct application rates. Other variables which influence the manure application rate are percentage of available nitrogen, manure incorporation practices, and type of manure handling system.

<sup>1</sup>Elbert C. Dickey and Gerald R. Bodman are Extension Agricultural Engineers.

## During Stress...

# Fiber Sources in Starter Diets

**Bobby D. Moser<sup>1</sup>**

Weaning is a critical time for the young pig. At weaning the pig is subjected to many stressful factors that could affect his ability to survive, consume feed, and grow normally without developing severe scours. Reducing stress helps keep the pig from going through the "post-weaning slump".

Stress is a term often used as a "catch all" for anything that might happen to the pig. However, there are certain stressful events that a pig must go through:

1. Being removed from the security of the sow.
2. Being placed in a new pen, which in many cases has a lower environmental temperature and increased drafts.
3. Being mixed with other strange pigs.
4. Competing with 20-30 pigs in the pen from different litters.
5. Being exposed to a different diet and a different waterer.
6. Being castrated and vaccinated.

The pig must go through all of the events listed above at some time in its life. However, the question is, "does he have to go through all of them on the same day (at weaning)?" Getting the pig accustomed to the new environment, new diet and new waterer is important. Also, not allowing the pig to be exposed to all of these events at the same time and providing him with a buffer against this stress may help to make weaning more successful.

The marketing of feeder pigs often includes exposure to similar kinds of "stressful" events. Nebraska research shows that adding oats (25%) to the diet of purchased feeder pigs may act as a buffer



**Table 1. Experimental starter diets containing various fiber sources (Nebraska exp. 79407)**

Ingredients	Experimental diets <sup>a</sup>					
	1	2	3	4	5	6
	%	%	%	%	%	%
Corn (9%)	61.8	48.2	57.2	47.5	60.2	60.2
Soybean meal (44%)	23.1	21.9	21.8	20.1	23.5	23.5
Oats (ground)	—	15.0	—	—	—	—
Dehydrated alfalfa	—	—	6.3	—	—	—
Wheat bran	—	—	—	17.8	—	—
Solka floc	—	—	—	—	1.3	—
Oil dri	—	—	—	—	—	1.3
Dried whey	5.0	5.0	5.0	5.0	5.0	5.0
Dried fish solubles	2.5	2.5	2.5	2.5	2.5	2.5
Dried brewer's yeast	1.0	1.0	1.0	1.0	1.0	1.0
Lard	2.5	2.5	2.5	2.5	2.5	2.5
Dicalcium phosphate	1.4	1.3	1.4	.6	1.4	1.4
Limestone	.6	.6	.4	1.1	.6	.6
Salt (iodized)	.5	.5	.5	.5	.5	.5
Trace mineral mix	.1	.1	.1	.1	.1	.1
Vitamin premix A	1.5	1.5	1.5	1.5	1.5	1.5
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

<sup>a</sup>Calculated analysis for all diets: Protein 18%, calcium .75%, phosphorus .65%.

against a stressful condition by reducing the incidence of severe scours. A similar result has been observed when 20% oats was added to the diet of early weaned pigs (3-4 weeks of age). However, a diet containing 10% oats appears to produce a faster and more efficient gain than diets containing 0 or 20% oats.

The reason oats are producing this kind of response is not known. Is it something unique about the oats or is it just the increased fiber content of the diet which naturally occurs when oats are added? If it is just the increased fiber content, other fiber sources could be used.

#### Effect of Fiber in Diet

An experiment was designed to study the effect of several fiber sources on pig performance and the incidence of scours. A corn-soybean meal diet (with no added fiber) was used as a control (Table 1). The control diet was compared to diets containing added fiber. The fiber sources were oats, dehy-alfalfa, wheat bran, solka floc and oil dri (an inert product). The fiber content of the control diet was 3.2% compared to 4.5% for those diets that contained an added fiber source.

Pigs were weaned at 4 weeks of age. They were sorted by weight and placed in pens of four pigs each. To expose the pigs to some

stress, the pens were washed but not steam cleaned or disinfected, the room temperature was maintained at 70°F (21.1°C) and no antibiotic was added to the diet or water. Normally, pens are steam cleaned, disinfected, allowed to set idle for a least one week. Room temperature is maintained at 80-85°F (27-29°C) for one week and then gradually reduced as the pig gets older, and antibiotic is added to the feed. Daily scour scores were given to each pen. A one to five scoring system was used, where 1 was firm and 5 was very loose.

Adding fiber to the diet of early

weaned pigs had little effect on daily gain or feed conversion (Table 2). Pigs fed the control diet gained .73 lb/day (.33 kg/day) with a feed conversion of 1.78, while the combined respective daily gain and feed conversion of the fiber sources were .75 lb/day (.34 kg/day) and 1.81. The fastest gain was observed with the diet containing the oil dri (an inert product) and the most efficient gain was obtained with the diet containing the solka floc (a pure fiber source), .82 lb (.37 kg) and 1.71, respectively.

Severe scours was not a problem in this study as indicated by the relatively low scour scores observed. Apparently the stress applied to the pigs was not severe enough to cause a problem. Thus, the effect of fiber source on the incidence of scours could not be tested. It is interesting to note that the scour score for all pens increased from 1.4 on day one to 2.2 by day four of the test. This suggests that because of the stress at weaning, most pigs will develop some looseness within a few days after weaning until they become accustomed to their new environment. It is important at weaning to provide pigs with good environment and good feed to keep the looseness from becoming severe.

<sup>1</sup>Bobby D. Moser is Extension Swine Specialist.

**Table 2. Effect of various fiber sources on gain, feed/gain and scour score of starter pigs<sup>a</sup> (Nebraska exp. 79407)**

Treatments	Control	Added fiber sources <sup>b</sup>				
	Corn-SBM 1	Oats (15%) 2	Alfa-Dehy (6.25%) 3	Wheat bran (17.8%) 4	Solka floc (1.32%) 5	Oil dri (1.32%) 6
ADG, lb (kg) <sup>c,d</sup>	.73 (.33)	.75 (.34)	.72 (.33)	.72 (.33)	.76 (.34)	.82 (.37)
ADFI, lb (kg)	1.30 (.59)	1.42 (.64)	1.32 (.60)	1.34 (.61)	1.29 (.58)	1.46 (.66)
F/G	1.78	1.89	1.83	1.85	1.71	1.79
Scour score: (1-5)						
Day 1	1.3	1.3	1.1	1.3	1.9	1.3
2	1.4	1.3	1.6	1.4	1.4	1.4
3	1.6	2.0	1.9	2.0	1.7	1.6
4	2.1	2.5	1.9	2.0	2.4	2.3
5	2.1	2.5	2.1	2.0	2.7	2.4
6	2.7	2.6	2.5	2.1	2.6	2.2
7	2.6	2.3	2.1	2.0	2.9	2.3
Avg	2.0	2.1	1.9	1.9	2.2	1.9

<sup>a</sup>Environmental conditions:

—Pigs 4 wks of age (weaning); initial wt. 16.2 lb (7.3 kg); final wt. 37.2 lb (16.8 kg).

—4 pigs/pen, pen washed but not steam cleaned, no antibiotic in feed, room temperature 70°, (21.1°C), one heat lamp/pen.

<sup>b</sup>Crude fiber (4.5%).

<sup>c</sup>4 vs 5, 6 (P<.05).

<sup>d</sup>5 vs 6 (P<.05).





Ready for a quick start.

## High Lysine Starter Feeds

Austin J. Lewis<sup>1</sup>

Several commercial feed companies offer pig starter feeds that are fortified with synthetic lysine. The total lysine content of these feeds considerably exceeds the National Research Council (NRC) recommendations, but there are various claims that the high lysine diets are necessary to maximize rate of gain, feed conversion and cost of gain.

In addition, most feed com-

panies add at least some fat to their starter feeds. Adding fat to the diet increases feed efficiency and may improve certain physical factors, such as reducing dustiness, but most research with baby pigs has shown little advantage in terms of weight gain. It is possible, however, that fat and lysine added together may have some special advantage.

Do high lysine starter feeds, with or without added fat, significantly

improve the performance of baby pigs? If so, is the improvement likely to be enough to offset any increased cost that may be involved? These are important questions facing a pork producer who is choosing a starter feed program. A recent experiment at the University of Nebraska was designed to help answer some of these questions.

A total of 192 crossbred pigs, weaned when about 3 weeks old and weighing 12 lb (5.5 kg) were fed diets containing 0 or 5% added fat (lard) and six different levels of lysine. The diets were based on corn and soybean meal and contained 19% crude protein. Lysine levels ranged from 0.95% (the current NRC recommendation) to 1.45% as shown in Tables 1-3. Pigs were penned in groups of four in an environmentally controlled room and given continuous access to self feeders and waterers. The experiment was continued for four weeks, at which time the pigs weighed about 34 lb (15.5 kg).

Pigs fed the diets with added fat

Table 1. Feed intakes in lb/day (g/day) of weanling pigs fed diets with fat and lysine additions<sup>a,b</sup> (Nebraska Experiment 78417).

Added fat, %	Lysine, %						Avg for fat levels <sup>c</sup>
	0.95	1.05	1.15	1.25	1.35	1.45	
0	1.34 (608)	1.42 (644)	1.50 (679)	1.57 (710)	1.44 (651)	1.43 (646)	1.45 (657)
5	1.25 (566)	1.31 (596)	1.30 (590)	1.37 (620)	1.25 (566)	1.31 (593)	1.30 (589)
Avg for lys levels <sup>d</sup>	1.30 (587)	1.37 (620)	1.40 (634)	1.47 (665)	1.34 (609)	1.37 (620)	1.37 (623)

<sup>a</sup>Individual values represent the mean of 4 pens with 4 pigs/pen.

<sup>b</sup>Coefficient of variation 5.78%.

<sup>c</sup>Fat effect ( $P < 0.001$ ).

<sup>d</sup>Quadratic effect ( $P < 0.065$ ).

Table 2. Weight gains in lb/day (g/day) of weanling pigs fed diets with fat and lysine additions<sup>a,b</sup> (Nebraska Experiment 78417).

Added fat, %	Lysine, %						Avg for fat levels
	0.95	1.05	1.15	1.25	1.35	1.45	
0	0.71 (320)	0.77 (349)	0.81 (369)	0.88 (397)	0.79 (359)	0.79 (359)	0.79 (359)
5	0.71 (320)	0.76 (342)	0.82 (374)	0.82 (370)	0.77 (348)	0.78 (353)	0.77 (351)
Avg for lys levels <sup>c</sup>	0.71 (320)	0.76 (346)	0.82 (371)	0.85 (384)	0.78 (354)	0.79 (356)	0.78 (355)

<sup>a</sup>Individual values represent the mean of 4 pens with 4 pigs/pen.

<sup>b</sup>Coefficient of variation 8.95%.

<sup>c</sup>Linear effect ( $P < 0.039$ ); quadratic effect ( $P < 0.005$ ).



**Table 3. Feed efficiencies (feed/gain) of weanling pigs fed diets with fat and lysine additions<sup>a,b</sup> (Nebraska Experiment 78417).**

Added fat, %	Lysine, %						Avg for fat levels <sup>c</sup>
	.95	1.05	1.15	1.25	1.35	1.45	
0	1.96	1.86	1.83	1.79	1.86	1.82	1.85
5	1.79	1.74	1.58	1.67	1.69	1.74	1.70
Avg for lys levels <sup>d</sup>	1.87	1.80	1.70	1.73	1.77	1.78	1.78

<sup>a</sup>Individual values represent the mean of 4 pens with 4 pigs/pen.

<sup>b</sup>Coefficient of variation 7.67%.

<sup>c</sup>Fat effect ( $P < 0.001$ ).

<sup>d</sup>Linear effect ( $P < 0.020$ ); quadratic effect ( $P < 0.001$ ).

compensated for the greater energy density by consuming less feed than those without added fat (Table 1). This effect, which shows that baby pigs are able to adjust their feed intakes to meet their energy needs, was true for each of the lysine levels. Feed intakes tended to increase as lysine level was increased up to 1.25% of the diet.

The addition of 5% fat had no

effect on weight gain (Table 2). Previous work at Nebraska has shown an improvement in weight gain when 5% tallow has been added to diets for finishing pigs, but baby pigs do not respond in the same way. However, increasing the lysine level from 0.95% to 1.25% resulted in a substantial improvement in weight gain. Weight gains increased from 0.71 lb/day (320 g/day) to 0.85 lb/day (384 g/day), a 20% increase.

## Swine Research Projects in Progress

The 1980 Nebraska Swine report contains some of the pork production activities of the Institute of Agriculture and Natural Resources. Additional research and development projects are being conducted by staff members of the Animal Science Department. Some of these activities are described below.

### Lincoln Based Projects

#### Nutrition

*E. R. Peo, Jr., Bobby D. Moser and Austin Lewis*

The need for antibiotics, minerals, energy, fiber and amino acids by pigs of all classes are being studied.

- Antibiotic studies include the effectiveness of additives for growing pigs and withdrawal properties of sulfamethazine.
- Lifetime calcium phosphorous requirements for breeding females are being studied.
- Research has been started on the utilization of high moisture milo.
- The amino acid composition and utilization of various grains need more complete study to more accurately for-

mulate diets. Intensive amino acid studies with corn are under way.

- Sources of dry fat for inclusion in swine diets are being studied. A dry fat source would make fat an easier diet ingredient.
- A study of the effect of energy during lactation on later breeding performance has been started.

#### Physiology

*Dwayne Zimmerman and Roger Kittok*

The environmental control capabilities of the new swine unit at the Field Laboratory at Mead are particularly evident in the research in the physiology area.

- The effect of photoperiod on the development of boars and gilts is receiving attention. The influence of hours of light per day during the growing period upon puberty, sexual behavior, semen characteristics of boars and ovulation rate in gilts is being studied.
- The metabolism of progesterone by the uterus and its role in embryonic mortality is being studied.

As expected, feed efficiency was improved when fat was added, but the addition of lysine up to the 1.15% to 1.25% level also improved feed efficiency (Table 3). In fact, the improvement from the higher lysine level, about 10%, was equal to that achieved by the fat addition.

The results of this experiment demonstrate that increasing the lysine levels of starter diets up to 1.15% to 1.25% of the diet does increase both weight gain and feed efficiency. Adding 5% fat improves feed efficiency, but not weight gain. The presence of fat does not seem to affect the response to added lysine. Pork producers must weigh these advantages against any differences in the costs of various starter feeds.

<sup>1</sup>Austin J. Lewis is Assistant Professor, Swine Nutrition.

### Breeding and Genetics

*Rodger Johnson and William T. Ahlschwede*

Much of the emphasis in the swine breeding program is in understanding responses to selection.

- The high ovulation rate line and its control is being further characterized. Testicular response in boars is being studied relative to the changes which have occurred in the gilts.
- A selection study aimed at increasing litter size and reducing age at puberty has been initiated.
- The response of the lean growth selection line in energy utilization is being studied. Detailed composition and development techniques are being used.
- Development of breeding plans and management systems for improved sow productivity.

### Meats

*Roger Mandigo, Dennis Olson, Dwight Loveday*

Pork processing receives high priority by the department's meat



group. Since a high percentage of pork is merchandized as processed meat, research efforts are aimed at improving consumer and institutional acceptance of processed pork.

—The development of low sodium sausage and cured pork products is receiving attention.

—The effects of freezing rates and temperatures upon the emulsion properties of pork are being studied.

—A study of institution cooking methods for pork is in progress. Microwave, convection and conventional ovens are being compared.

—Techniques for producing restructured fresh pork products continue to be developed.

#### **Northeast Station**

*Michael Brumm*

Swine research at the Northeast Station has been started in the area of starting purchased feeder pigs. Various starting procedures will be investigated.

#### **South Central Station**

*Don Levis, in  
cooperation with USMARC*

Research is being started at the South Central Station on the mating behavior of boars. The influence of pen arrangements on the boar is being investigated.

#### **North Platte Station**

*Murray Danielson*

Nutritional studies with sows and growing pigs receive primary emphasis at the North Platte Station.

—Alfalfa—Energy relationships in gestation diets and their effect on sow performance is being studied.

—Gestation phosphorous levels for sows is being investigated.

—Studies of energy levels and sources for early weaned pigs reared in decks have been initiated.

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## **CURRICULUM OPTIONS**

Undergraduate programs for Animal Science majors and for other students in the College of Agriculture help develop the student's capability to cope with problems of Nebraska's livestock industry. Because of the size of this livestock industry—65% or more of Nebraska's agricultural income—all agriculturists who work in Nebraska must understand livestock production. Many options are available in the undergraduate Animal Science program. These include:

- |                                   |                   |
|-----------------------------------|-------------------|
| 1. Production—Beef, Sheep & Swine | 5. Business       |
| 2. Range Production               | 6. Education      |
| 3. Dairy                          | 7. Poultry        |
| 4. Science                        | 8. Communications |