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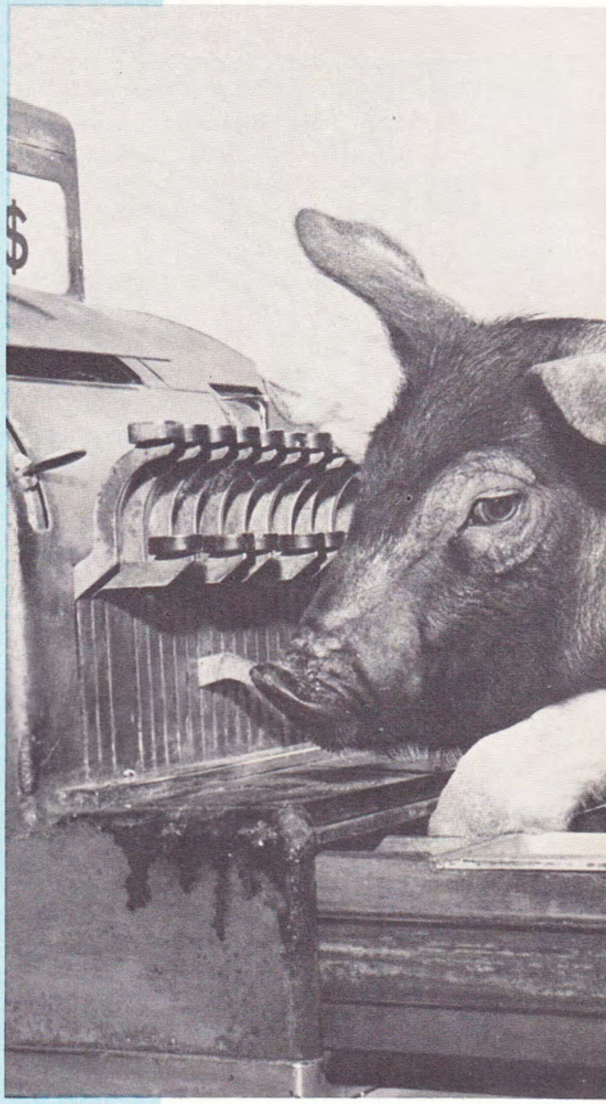

- Breeding
- Disease Control
- Nutrition
- Economics
- Housing
- Meats

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

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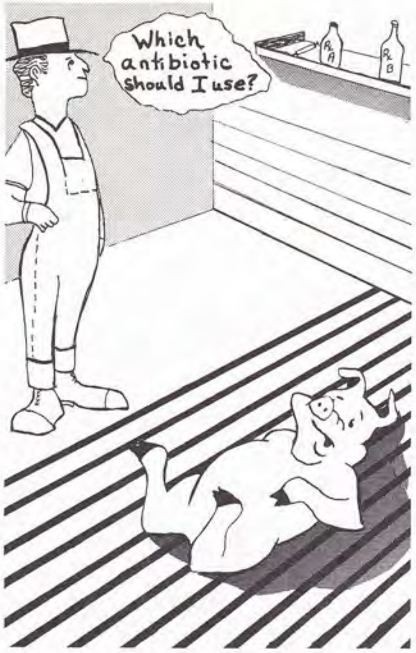

Problem for producers.

Antibiotics: Are They Losing Their Punch?

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

There is "growing concern" throughout the world that antibiotics are no longer beneficial, are losing their "punch" and because of their wide-spread use in animal feeds have caused the development of resistant microorganisms.

The recent rapid change in the swine industry from basically pasture or drylot programs to highly intensified confinement-rearing programs with slatted-floor manure disposal systems has also raised questions about the value of antibiotics for swine.

It is good to ask these questions because it calls attention to the need for continuous applied research on antibiotics for swine. The heyday of antibiotic research is behind us. Animal scientists have turned their attention to other (perhaps more glamorous) vitally needed areas of research. However, the "growing concern" means we must reevaluate kind, level of usage and allowable antibiotic combinations for swine because of their long-term use and in view of changes in production systems.

A recent experiment was conducted at the Nebraska Experiment Station to determine the value of chlortetracycline (Aureomycin) and bacitracin for growing-finishing swine raised on slatted floors. These two antibiotics have been used widely in swine feeds.

This is the first experiment we have conducted on the value of antibiotics for pigs raised in confinement on partially slatted floors. Pigs raised in the research units previously have been fed antibiotics. Results are shown in Table 1.

Pigs fed the diet containing 40 grams per ton of chlortetracycline gained faster, more efficiently and consumed more feed than those fed the basal diet without antibiotics. As indicated in the table (see footnote "a") the pigs were on test 102 days. The beneficial effects of chlortetracycline were even more apparent during the first half of the experiment. The pigs fed chlortetracycline were more uniform and "sleeker" in appearance than the untreated pigs.

Bacitracin fed at the level of 40 grams/ton resulted in a marked depression in average daily gain and feed consumption as compared to those fed no antibiotic or chlortetracycline. The depressing effects of bacitracin was obvious almost from the start of the test. Since feed intake was reduced (about ½ lb. per pig/day as compared to the controls), it is not known whether the bacitracin affected the palatability of the diet or had an adverse effect on the pigs themselves. Regardless, one must question the use of bacitracin in swine feeds at the moment.

Obviously, this single experiment has not answered many of the current questions about antibiotics for swine. It is apparent though, that chlortetracycline (Aureomycin), a broad spectrum antibiotic which has been used in swine feeds for 20 years is still producing a positive growth and feed conversion response in growing-finishing swine raised in a relatively "clean" environment.

Table 1. Value of antibiotics for G-F swine raised on partially-slatted floors.[a]

	Treatment		
	No antibiotic[b]	40 grams/ton Chlortetracycline[b]	40 grams/ton bacitracin[b]
No. pen/treatment	2	2	2
No. pigs/pen	10	10	10
Initial wt., lb.	55.8	55.4	56.0
Final wt., lb.	213.0	219.9	201.7
Av. daily gain, lb.	1.56	1.61	1.43
Av. Daily feed intake, lb.	5.20	5.25	4.73
Gain/feed ratio	0.30	0.31	0.30

[a] 50% slatted floor research unit. Hampshire & Yorkshire Crossbred pigs. Aug.-Dec. 1969. Duration of test, 102 days. Chlortetracycline graciously supplied by American Cyanamid Co.; Bacitracin by Dawes Laboratory, Inc.

[b] 14% Corn-Soybean meal diet.

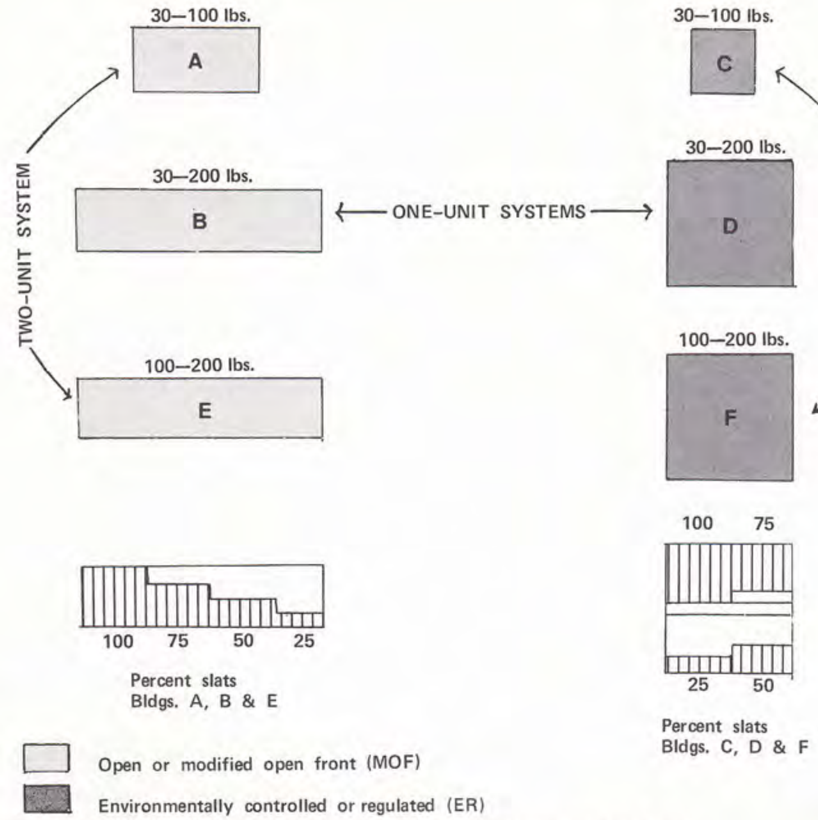

Fig. 1. Schematic diagram of housing management systems.

Confinement Housing Research

By R. D. Fritschen
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Research to meet the needs of a progressive pork industry in Nebraska and the Midwest must include intensive investigation in the area of confinement housing and management. Since the solution of one problem often creates another, research must be comprehensive in scope.

This report involves a study conducted from Aug. 18 to Dec. 13, 1969. A total of 480 growing-finishing pigs were used to:

1. Compare open versus enclosed housing in a one- and two-unit system.

2. Compare 100, 75, 50 and 25% slatted floors. Fig. 1 is a schematic diagram of the housing management systems.

[1] Appreciation is expressed to Dan Huwaldt and Paul Kerr for feeding and care of livestock.

Pigs were allotted 10 to a pen with a light, medium and heavy weight group for the three replicate pens of each slatted floor percent. Average initial weights were 17, 27 and 51 pounds for the light, medium and heavy groups respectively.

Buildings A and B are modified open units completely under roof but capable of being completely open or closed by raising or lowering panels. Building E is an open front unit that is only partially under roof. These three units, as well as the environmentally regulated units, have a door at the rear of each pen that can be opened for ventilation purposes. Units A, B and E are uninsulated and have no mechanical ventilation. No supplemental heat was provided in these three units for this study.

Buildings C, D and F are environmentally regulated units completely enclosed, heated, insulated and mechanically ventilated.

Units A and C provide four square feet per pig up to about 100 pounds. Pigs are then moved to units E and F which provide eight square feet per pig. This constitutes the two-unit production concept in both the open and closed system. Units B and D allow eight square feet per pig for the entire study. These two units represent the one-unit concept in the open (modified open-front) and enclosed systems. Average daily gain and feed efficiency were determined at two-week intervals. Other response criteria were lung lesions, gastric lesions and bone breaking strength.

Daily Gain, Feed Efficiency

Table 1 shows the relative performance of the two-unit modified open-front (MOF) and environmentally regulated (ER)

(continued on next page)

Table 1. Two-unit modified open front versus environmentally regulated system.

	Bldg. A & E				Bldg. C & F			
Percent slats	100	75	50	25	100	75	50	25
Av. initial wt., lb.	31.7	31.9	31.5	31.7	31.9	32.1	31.7	31.7
Av. final wt., lb.	187.0	193.8	206.6	198.0	204.4	206.8	197.6	203.7
Av. da. ga., lb.	1.45	1.50	1.61	1.54	1.61	1.63	1.54	1.61
Feed/Gain[a, b]	3.33	3.28	3.19	3.14	3.09	3.00	2.93	2.98

[a] ($P < .01$) Percent slat means different between systems.
[b] ($P < .01$) Linear slat effect within system.

Confinement Housing

(continued from page 3)

systems. There was a highly significant difference in gain and feed efficiency when comparing the two types of housing. Most of the difference between systems occurred after the pigs were moved from A to E and C to F.

Since unit E is only partially covered by a roof the slower gain and greater feed requirement per unit of gain appear to be negative responses to the colder environment. It should be noted, however, that all of the difference in performance cannot be converted to dollars. Since the C-F combination was environmentally controlled, a utility charge must be assessed. In addition, the initial cost of the C-F building combination was about one-third greater than the A-E system. The data also show that there was a highly significant linear slat effect within the system for feed efficiency. This means that as the amount of slatted floor increased, there was a significant increase in the amount of feed required per unit of gain.

The comparison of the one-unit MOF versus ER system (Table 2) indicates that the difference in growth rate was significant and in favor of the MOF unit. The difference in feed efficiency was highly significant but favored the ER system.

The difference in building response to feed utilization can best be explained as a function of temperature difference. The temperature in all ER units was maintained as close to 72° F. as possible. The temperature in Unit B varied directly as the outside temperature; however, the panels on Unit B were lowered on Nov. 6 and remained down for the duration of the study. Figure 2 indicates the average maximum and minimum temperature by month for the test period and the average maximum and minimum temperature in Bldg. B for the period that the fiber glass panels were lowered.

The effect of lowering the panels from Nov. 6 to Dec. 13 was to maintain the temperature at a level 12 to 18 degrees warmer as well as to prevent drafts. This management practice enhanced rate of gain but appeared less effective upon efficiency of gain.

Thus, the principal difference in feed efficiency or utilization among hogs reared in the two units may be due to the fuel source—Bldg. B using feed as fuel and Bldg. D using electricity and propane gas. Again, there is a difference in initial building cost as Unit B cost nearly $2 per square foot less than Unit D. The highly significant linear slatted floor effect upon feed utilization within systems was again evident in this comparison.

The comparison of the one versus two unit MOF buildings in Table 3 reveals a highly significant difference in gain and feed efficiency in favor of Bldg. B. This response was again believed due primarily to a difference in environment. The two systems compared quite closely during the first phase when the pigs were in Unit A. However, when the pigs were moved to Bldg. E during a colder period of the year performance went down. Again, there was a highly significant linear response for feed efficiency due to slatted area within system or building.

The comparison between the one- versus two-unit ER system is summarized in Table 4. There

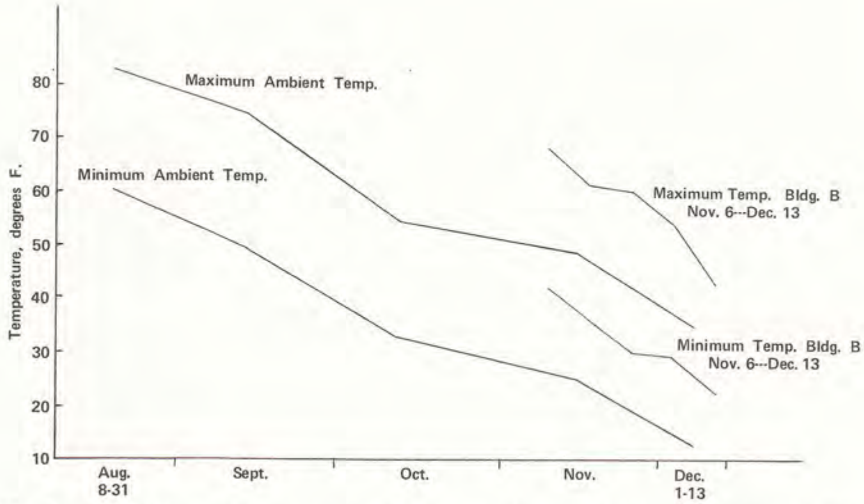

Fig. 2. Average maximum and minimum temperatures for test period Aug. 8-Dec. 13 and average maximum and minimum temperatures in Bldg B (MOE) during period when panels were lowered (Nov. 6-Dec. 13).

Table 2. One-unit modified open front versus environmentally regulated system.

	Bldg. B				Bldg. D			
Percent slats	100	75	50	25	100	75	50	25
Av. initial wt., lb.	31.7	31.7	31.7	31.7	31.7	31.7	31.7	31.9
Av. final wt., lb.	210.8	213.8	206.8	215.6	203.7	204.6	211.0	206.4
Av. da. ga., lb.[a]	1.67	1.70	1.63	1.72	1.61	1.61	1.63	1.63
Feed/gain[b, c]	3.14	3.10	2.97	3.01	3.03	2.84	2.89	2.77

[a] ($P < .05$) Percent slat means different between systems.
[b] ($P < .01$) Percent slat means different between systems.
[c] ($P < .01$) Linear slat effect within system.

Table 3. One- versus two-unit modified open front system.

Percent slats	Bldg. B				Bldg. A-E			
	100	75	50	25	100	75	50	25
Av. initial wt., lb.	31.7	31.7	31.7	31.7	31.7	31.9	31.5	31.7
Av. final wt., lb.	210.8	213.4	206.8	215.6	187.0	193.8	206.6	198.0
Av. da. ga., lb.[a]	1.67	1.69	1.63	1.72	1.45	1.50	1.61	1.54
Feed/gain[a, b]	3.14	3.10	2.97	3.01	3.33	3.28	3.19	3.14

[a] ($P < .01$) Percent slat means different between systems.
[b] ($P < .01$) Linear slat effect within system.

Table 4. One- versus two-unit environmentally regulated system.

Percent slats	Bldg. D				Bldg. C-F			
	100	75	50	25	100	75	50	25
Av. initial wt., lb.	31.7	31.7	31.7	31.9	31.9	32.1	31.7	31.7
Av. final wt., lb	203.7	204.6	211.0	206.4	204.6	206.8	197.6	203.7
Av. da. ga., lb.	1.61	1.61	1.63	1.63	1.61	1.63	1.54	1.61
Feed/gain[a, b]	3.03	2.84	2.89	2.77	3.09	3.00	2.93	2.98

[a] ($P < .01$) Percent slat means different between systems.
[b] ($P < .01$) Linear slat effect within system.

was no significant difference in gain between systems. There was however, a significant system response to feed efficiency in favor of the one-unit system, Bldg. D. There was, again, a highly significant linear slat effect upon feed efficiency. Apparently the two-unit system in both the open and enclosed system causes stress that inhibits performance. This stress is more clearly defined in the respiratory study.

Respiratory Problems

Since all pigs were allotted, based upon weight, sex and litter, any pigs that may have been pneumonia carriers would have been equally distributed between buildings. All lungs were examined at slaughter for evidence of pneumonia. Samples were collected from lungs with pneumonic lesions for histopathology. Table 5 summarizes the results of this phase.

Pigs from the one-unit systems had a much lower percent of total pneumonia as well as VPP (mycoplasmal pneumonia). Likewise the open or MOF in the one- or two-unit systems had a lower pneumonia incidence than their controlled environment counterparts. The reason for the increased number of pigs with lung lesions grown in environmentally controlled housing is not clear. However, it is logical to assume that the gas/odor level associated with environment may predispose to respiratory problems. The factors responsible for the marked increase of total as well as mycoplasmal pneumonia in the two-unit systems is somewhat speculative.

However, it is quite likely that the reduced pig area and closer contact in unit A and C during the first phase of the study or until the pigs averaged 100 pounds may have been a factor. The fact that the pigs in the two-unit systems had to be moved once could also be a contributory factor. The percent of slatted area did not influence the incidence of total pneumonia except on the 75% slatted floor where there was a slight increase. Other data not included in the table reveal that the incidence of pneumonia was also higher in the light weight groups reared on the higher percentage of slatted floors.

Gastric Involvement

Past evidence at other universities indicates that at least two factors may be involved in ulcers in swine, namely, fineness of grind, relating to the diet, and intensity of confinement. Five different visual classifications of gastric involvement were used to measure the response of this tissue to housing systems and amount of slatted floor. Table 6 summarizes the gastric response to percent slats.

While some variation is evident the most revealing statistic is the low percent of normal

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Table 5. Pneumonic involvement by system and percent slat.

Percent slats	MOF or open bldgs.		Enclosed bldgs.		Total percent pneumonia
	B	A-E	D	C-F	
100	0/0[a]	30/70	3/0	44/67	20/65
75	10/0	70/71	20/33	62/78	40/65
50	3/0	14/83	8/0	57/71	23/65
25	3/0	30/44	14/75	43/62	23/56
	4/0	39/67	11/38	52/70	

[a] Percent total pneumonia/percent of total pneumonia with VPP-like lesions.

Confinement Housing

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stomachs. The highest incidence of any classification was for slightly inflamed stomachs.

This could be described perhaps as an intermediate stage of gastric disorder. To be classified as "ulcer" the stomach had to have one or more typical gastric lesions. It should be noted that while gastric abnormalities represent a potential threat to performance and profit, gain did not appear to be unduly influenced among pigs that had ulcers at slaughter.

Since feed efficiency was on a pen basis it is not known what effect ulcers had on this important economic trait. The influence of housing systems upon gastric disorders has not received much research attention except that reports indicate confinement tends to predispose to the problem. Table 7 summarizes the effect of confinement housing systems upon gastric involvement.

While Unit B had a relatively low percentage (10%) of normal stomachs, this building and system also supported the best total average daily gain. This may suggest that type of confinement is no more ulcergenic than fast gain. This theory could be supported by comparing the performance of Unit B with Unit D (Table 2) and then relating it to the gastric involvement in Table 7. However, this comparison could also be influenced by the respiratory situation (Table 5).

Again, an important statistic is the 13.1% normal stomachs. Abnormal stomachs, regardless of classification, represent a stress commensurate with the abnormality. When this stress among this many pigs is added to other stress factors, known or unknown, the effect can only be additive with poor performance or death the likely result.

Bone Breaking Strength

Concrete and slatted floors have been incriminated as causes of leg problems in swine. In this study the variation in bone breaking strength among pigs reared on different percent slatted floor was not significantly different. This is in agreement with earlier work from this Station. Bone breaking strength differences by weight replicate are shown in Table 8.

While some difference in bone strength between buildings or systems occurred, no trend of significance was detected. The variation in bone breaking strength by beginning weight replicates was highly significant.

The relationship between bone strength, days on test and rate of gain suggests that rapid growth apparently constitutes a stress on bone tissue. It also suggests that when selecting animals for fast growth we may also be selecting animals that may have a lower bone strength. And finally, it suggests that when modern pigs, selected and

Table 7. Gastric classification—percent by system.

Classification	Two-unit MOF A-E	Two-unit ER C-F	One-unit MOF B	One-unit ER D	Av.
Ulcer	26.5	27.2	27.0	20.7	24.8
Inflamed	23.0	21.8	22.0	22.6	22.4
Slightly inflamed	33.6	32.7	33.0	37.6	34.2
Brown	8.0	3.6	8.0	1.8	5.6
Normal	8.8	15.5	10.0	17.8	13.1

Table 8. Bone breaking strength by replicate.[a]

Bldg. type or system	Heavy	Medium	Light	Average
A-E	306	313	307	309
C-F	299	316	326	314
B	311	314	337	321
D	305	317	326	316
Average[b]	305	315	324	
Days on test	86	114	125	
Av. da. gain	1.80	1.60	1.43	

[a] Force required to break right metatarsal bones.
[b] Rep weight means significantly different ($P < .01$).

Table 6. Gastric classification—percent by floor type.

Classification	Percent slat 100	75	50	25
Ulcer	26.5	23.0	28.2	23.6
Inflamed	18.6	24.8	23.3	21.8
Slightly inflamed	33.3	38.1	28.2	37.3
Brown	7.8	5.3	6.8	1.8
Normal	13.7	8.8	13.6	15.4

bred for fast growth, are reared in confinement, emphasis should be placed upon diets that conform to the pigs' total daily needs with particular emphasis given to vitamin fortification and mineral level and balance.

Summary

Swine housing and management research at the Northeast Station has shown that:

1. As you increase the amount of slatted floor you increase the feed requirement per unit of gain. For best total performance it appears that somewhere between 25 and 50% slatted floor may be optimum.

2. Gain, feed efficiency and respiratory involvement appear adversely affected by the two-unit production system. The factors responsible may well be increased animal density during the first phase and/or physical movement from the smaller to the larger building.

3. On a total performance basis swine can perform as well in a modified open-front unit as in an environmentally regulated system.

4. Ulcers and other gastric disorders appear common in the systems described. While the incidence of gastric involvement appeared epidemic in proportion, the net effect of this involvement is not known.

5. The modified open-front one-unit system had the lowest level of lung lesions, indicating that a dry, draft-free building subject to temperature fluctuations can represent thrifty environment. Since incidence of pneumonia was greater in the enclosed environmentally regulated systems it appears that some component of this environment enhances respiratory problems.

6. Bone breaking strength is not affected by amount of slatted floor. However, rapid gain does appear to predispose to weaker bones.

Colibacillosis Infections "Explosive"

By N. R. Underdahl
Professor, Swine Diseases
C. A. Mebus
Professor, Pathology

Baby pig scours, white scours, coliform enteritis and colibacillosis are common names used to describe *Escherichia coli* infections in very young pigs. *E. coli* is a bacterium which normally inhabits the intestinal tract of all warm- and cold-blooded animals. However, there are many different strains of the organism and many of these will cause disease when they become the dominant organism in the intestine.

1. *Septicemia*, the presence of *E. coli* in the blood, is followed by generalized infection with the organism multiplying in all the tissues. This generalized infection is normally found in newborn pigs and death occurs in 2-3 days (Fig. 1).

On necropsy there are frequently found fluid and fibrin in the abdominal and thoracic cavities, edema (fluids) in the lungs and edema surrounding the kidneys. With highly virulent strains, the bacteria can be cultured from all organs including the brain. The whole litter or only part of a litter may be affected; however, the death rate among younger pigs infected with these virulent strains will be nearly 100%.

2. *Diarrhea*, the most common form, occurs in pigs infected with a strain of *E. coli* which produces a toxin (poison). The first signs observed are diarrhea, listlessness, rough haircoat and dehydration. Pigs that are necropsied generally have a stomach full of milk, indicating they have been eating regularly.

Because of the pig's reaction

Fig. 1. Many pigs die with colibacillosis when they become infected shortly after birth.

to the toxins liberated by the bacteria, body fluid is poured into the intestine. This fluid, plus the milk, moves so rapidly through the intestine that little digestion or absorption takes place. The fluids lost into the intestine are drawn from the tissues of the body and consequently the pig loses weight and becomes dehydrated. In many cases there is no evidence of gross change in the other organs.

Death rate depends on the age of the pigs when first infected. Mortality approaches 70% when pigs are infected before the third day of life and is less than 40% when infected after two weeks of age. This diarrheal form is also common among weanling pigs but here the death rate is much lower and the loss of weight and condition are of greater economic importance.

3. *The third form* of *E. coli* infection is the edema disease syndrome. This form is caused by toxins released by the bacteria and absorbed from the intestine. Edema disease is most frequently seen shortly after weaning but can also be found in older pigs.

The disease is characterized by sudden deaths within the herd. The first pigs to die are frequent-

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Colibacillosis

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ly the largest, best performing animals. Following these, there may be other pigs with staggering gait, muscular tremors, spasms and paralysis. Edema of the eyelids and face is common.

On necropsy there may be edema of the stomach wall, coil of the large intestine, lungs and tissues around the kidneys; excessive fluids in the body cavities (abdominal, chest and heart sac) and hemorrhage in the intestines. Both diarrhea and constipation have been reported.

Recovery is not uncommon for less severely affected pigs. The number of pigs affected within a herd may range from 10-35% with a death rate of those affected ranging from 20 to 100%.

Signs of infection with a virulent strain of *E. coli* in the young pigs usually follow a period of stress. Stress factors include dampness, chilling, variations in temperature, feed changes for both the sow and pigs, weaning, moving, crowding, infection with other disease organisms or parasites and other drastic changes in management.

Disease 'Explosive'

Pigs born in a farrowing house with a large population of baby pigs are generally exposed and must adjust to massive numbers of bacteria. If the predominating organisms are virulent *E. coli*, then these bacteria may become established before the pig has acquired sufficient colostral antibody to be protected. Also the strain of coli may be new to the farrowing house, thus the sow not having been exposed to this new strain will not have the specific antibody in her colostrum to protect her pigs.

Diagnosis of colibacillosis is frequently confused with transmissible gastroenteritis (TGE). When TGE is causing diarrhea, the disease is more explosive, and all age groups of pigs in the farrowing house are generally

Fig. 2. Inverted intestines from baby pigs. Top intestine is from a normal pig. Note the "brush-like" villi covering. The other three intestines have varying degrees of villous atrophy (shortening or destruction of villi) caused by TGE infection. The intestine at the bottom of the picture has been completely denuded of villi by the TGE virus.

affected.

In TGE there is usually more vomiting. The sows as well as the pigs vomit and develop severe diarrhea. In colibacillosis the other pigs on the farm and the sows are not affected. The death rate is generally higher with TGE and on necropsy the stomach is filled with a hard milk curd. In TGE the intestinal villi are usually destroyed (Figure 2.).

Prevention and Control

Several methods for the prevention or control of colibacillosis have been attempted. Immunization of the sow with a vaccine or bacterin made from the *E. coli* isolated from the herd has been used but results have not been very satisfactory. Due to the large number of strains of *E. coli*, the bacterin should be a composite of several strains. Unfortunately, a new strain of *E. coli* which is not in the bacterin may enter the farrowing house and then the bacterin made from the older strains is not effective. Also, the sows must be vaccinated 1-2 months before farrowing in order to develop adequate colostral antibody.

Treating infected pigs with antibiotics, chemical therapeutic agents or antitoxins would be a logical method for control. However, the coli organism has the ability to develop resistance to commonly used antibiotics and drugs, thus making many of these treatments ineffective.

A producer having problems with colibacillosis can either use several broad spectrum antibiotics concurrently or have cultures made and antibiotic sensitivity (Figure 3) determined before treatment. Antibiotic sensitivity studies take several days so information gained is more applicable to litters yet to be farrowed.

No Cats, Dogs, Etc.

Through management of the swine herd many problems with disease can be prevented. Problems of colibacillosis can also be prevented or minimized by improved practices of swine husbandry. New additions to the breeding herd should not be made after the breeding season. Visitors, buyers, cats, dogs, birds and other animals should not be allowed in the farrowing house.

If it can be arranged, sows should be bred so that they will farrow in as short a period as

Fig. 3. Sensitivity test to determine the effect of antibiotics in controlling *E. coli* infection. The discs are (clockwise from 12): SSS—triple sulfa, C—Chloromycetin, FD—furadantin, DS — dihydrostreptomycin, B—Bacitracin, N—Neomycin, PB—polymyxin B, E—erythromycin, and, center, NA — Nalidixic acid. The clear area does not mean the drug is more effective, only that it diffuses through the medium more rapidly.

possible. The farrowing house should be thoroughly cleaned and disinfected and the sows put into the crates several days before farrowing. Pigs farrowed into a clean farrowing house usually have a lower mortality rate than those farrowed later. Pigs farrowed later must adjust to "bacterial build-up" in the farrowing house and therefore get a poorer start.

Keeping the pens clean, using disinfectant solutions on boots and equipment and routinely caring for the younger pigs first can all help in preventing the spread of coli infection.

When colibacillosis is first observed in the farrowing house, the disease can be slowed by eliminating drafts and lowering the humidity. Many producers have improved environmental conditions and reduced the incidence of colibacillosis by raising the building temperature to 75-85° F.

Don't Change Feed

The feeds used should come from the same source so that the bacterial contamination is constant and no new strains of *E. coli* are introduced. Also the feed should not be changed during periods of stress such as weaning or moving. It has been observed that pigs raised on clean soil have fewer problems with diarrhea and that clean sod given to pigs has reduced the incidence of scours.

In summary, colibacillosis is the most common disease of young pigs. The causative organism is a natural inhabitant of the intestinal tract. The treatment available may not always control the strain of coli causing the problem, therefore, determining antibiotic resistance before treatment or the use of multiple broad spectrum antibiotics are indicated.

Prevention and control through sound management before and following farrowing will do much to lessen the losses from colibacillosis.

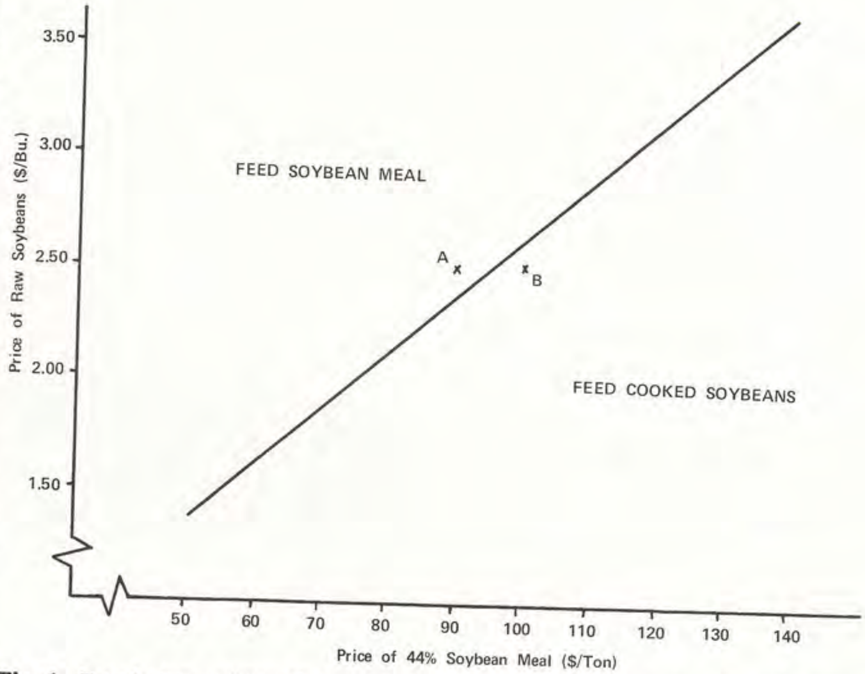

Fig. 1. Breakeven prices of soybean mean and soybeans in a 14% swine finishing ration (based on a corn price of $1.25 per bushel, a soybean cooking cost of $20 per ton and a 6% reduction in lb. of feed required per lb. gain with ration using cooked soybeans).

Soybeans for Swine — An Update

By L. L. Bitney
Extension Economist
(Farm Management)
E. R. Peo, Jr.
Professor, Swine Nutrition

Last year we reported on the value of whole soybeans for growing-finishing swine. At that time research was meager, but quite conclusive that properly cooked soybeans are nutritionally equal or superior to soybean meal for swine.

Since then several Stations have issued reports on the feeding value of whole soybeans which give additional support to the observation that cooked soybeans are good feed. Results of a recent study on the value of whole soybeans for G-F swine at the South Dakota Station are summarized in Table 1.

Table 1. Roasted soybeans for G-F swine.[a]

	Soybean meal	Roasted[b] Soy-beans
No. pigs/treatment[c]	18	18
Initial wt., lb.	65.3	64.8
Avg. daily gain, lb.	1.85	1.88
Feed/gain ratio	3.36	3.15
% Ham and loin	37.3	38.1

[a] Wahlstrom, Libal and Berns. 1970. S. Dakota Exp. Sta. A.S. Series 70-35.
[b] Processed in a "Roast-a-tron" cooker.
[c] Fed 15% protein diets to 115 lb.; 12% protein to 205 lb.

Average daily gains were increased slightly and feed conversion was improved about six percent when pigs were fed a diet containing whole soybeans as the source of supplemental protein. Ham and loin percentage was also slightly greater for pigs fed whole soybeans as compared with those fed soybeans. It is obvious from these data that properly cooked whole soybeans are a good source of protein for growing-finishing swine.

What About Cost?

What about the economic feasibility of cooked soybeans for swine?

If cooked soybeans produce normal gains in pigs, and do not result in price discounts at mar-

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Soybeans for Swine

(continued from page 9)

ket time, the decision to feed cooked soybeans boils down to a question of which diet will produce gains cheaper—one using soybean meal, or one using cooked soybeans?

Figure 1 can serve as a guide to the producer in selecting the cheaper protein source—cooked soybeans or soybean meal. A 14% finishing ration was formulated with each protein source, and is the basis for the comparison given in Figure 1.

In last year's Swine Report (E.C. 70-219), we presented a similar Figure — with two lines on it. One line represented equal rates of feed conversion between the two rations, and the other line represented a 6% reduction in feed required per lb. of gain with the ration using cooked soybeans.

After reviewing results of feeding trials during the past year, we have removed the line which represented equal feed conversion, as several feeding trials have shown about a 6% reduction in feed required per pound of gain with cooked soybean rations.

How to Use Chart

To use Figure 1, select a price for raw soybeans on the vertical axis and a soybean meal price on the horizontal axis. These should be on-the-farm prices—the local soybean price less trucking and a delivered price for soybean meal. Draw a line upward from the meal price and one to the right from the soybean price. The point where these lines meet indicates which protein source is cheaper.

For example: **Point A**—results from a soybean price of $2.50 per bushel and a soybean meal price of $90 per ton. This point lies above the "break-even" line, indicating that soybean meal is the cheaper protein source.

Point B—results from a soybean price of $2.50 per bushel and a soybean meal price of $100 per ton. This point lies below the "break-even" line, indicating that cooked soybeans are the cheaper protein source.

You may use Figure 1 in another way—to determine what a bushel of soybeans is worth in the hog finishing ration. And, using it this way, you can adjust the soybean value for variation in corn prices, cooking costs, and moisture losses.

First, determine cost of soybean meal. For example, if soybean meal will cost you $90 per ton, draw a line upward from $90 on the horizontal axis until it meets the "break-even" line. Then draw a line to the left from this point to the vertical axis. This comes to about $2.37 per bushel for raw soybeans. We can conclude that if soybean meal costs $90 per ton, raw soybeans are worth $2.37 per bushel in a finishing ration. This soybean price may be adjusted as follows:

1. **Corn price**—A corn price of $1.25 per bushel was used in computing Figure 1. Since cooked soybeans furnish energy as well as protein, a ton of finishing ration formulated with cooked soybeans requires less corn than does one formulated with soybean meal.

Thus, as corn prices change, the break-even price between soybeans and soybean meal changes. A 10¢ per bushel increase in corn prices will make soybeans 5¢ per bushel more valuable in the 14% finishing ration.

If your corn price is $1.35 per bushel instead of the $1.25 assumed in Figure 1, soybeans would be worth 5¢ per bushel more than $2.37 as calculated in the above example, or $2.42 per bushel.

2. **Cooking cost** — A cooking cost of $20 per ton was used in preparing Figure 1. In last year's report, we showed that the cooking cost could range from $24.30 per ton to $1.97 per ton, depending on how many tons were processed by a cooker in one year. Also, within the last year, we have received reports of producers paying in the neighborhood of $20 per ton to have their soybeans cooked.

The amount that soybeans are worth in a hog finishing ration is directly influenced by the cooking cost. In fact, a $1 per ton increase in the cooking cost decreases the value of raw soybeans shown in Figure 1 by 3¢ per bushel.

For example, if the cooking cost were $22 per ton instead of $20, raw soybeans would not be worth $2.37 but 6¢ less (2 x 3), or $2.31.

3. **Moisture loss** — The moisture content in soybeans may be decreased by as much as 10%, depending on the cooking process. No moisture loss was assumed in Figure 1. To adjust for a 10% moisture loss, multiply the soybean price obtained from Figure 1 by 0.9.

In our example, which resulted in a soybean price of $2.37, a price of $2.13 would result if a 10% moisture loss occurred ($2.37 x .9=$2.13), or the raw soybeans would then only be worth $2.13 per bushel in the hog finishing ration.

These adjustments can be cumulative, that is, you can adjust the raw soybean price for a change in corn price, a change in cooking cost and for moisture loss. The adjustment for corn price or cooking cost may be made in either direction.

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

Don't Overlook Transportation

Another factor which should not be overlooked in the evaluation of cooked soybeans for swine rations is transportation cost. If you must haul your soybeans to a cooker and haul them home again for processing, this cost should be included as a part of the cost of obtaining cooked soybeans. It is possible, however, that you would have to travel a similar distance to obtain soybean meal. Thus, it is important when comparing prices of soybeans and soybean meal to consider the costs which would be incurred in obtaining all ingredients for each type of ration.

Many questions have been raised about the effect of whole soybeans on carcass quality. Most of the studies indicated that pigs fed whole soybeans have "softer" carcasses. However, the softer carcass is not a reflection in lack of quality (may actually indicate better nutritional quality) and should pose no major problem for the packer.

Properly cooked whole soybeans are a good feed for swine. Your decision on the use of whole soybeans is best based on the economics of which source of supplemental protein is the better buy — soybean meal or whole cooked soybeans. Too, depending upon your own feed processing situation, you cannot afford to overlook commercial protein supplements as an economic competitive source of supplemental protein for swine.

Managing Swine Wastes

By E. A. Olson
Extension Engineer (Farm Building)

Management of swine wastes to keep them from polluting our streams is one of the new problems facing the swine producer. The National Pork Producers Council has recently prepared "Guidelines for Pork Producers for Use to Preserve Environmental Quality." As the first livestock industry to take this leadership, the Council is to be commended. This action shows that this group has assumed the responsibility for the safe management of swine wastes.

Site Selection

The most vital step in controlling swine wastes is the selection of a site for locating a swine operation and the placement of buildings on the site. In making a decision, such factors as convenience, economy, water supply and access to feed sources need consideration.

While air pollution regulations have not been developed at this time, the Legislature passed the Nebraska Air Quality Act of 1969 which provides authority for an Air Pollution Council to set policies and to develop regulations on air pollution.

To avoid problems with odors, it is desirable to locate a site that will be remote from neighbors' residences or commercial operations. Odors from swine in confinement buildings have been detected a half mile down wind and as far away as 1½ miles. A number of lawsuits have been reported in Midwest newspapers where operators were sued because they were "creating a nuisance."

In odor control, the direction of the odor from the area of concern is important. Prevailing winds are of particular importance along with the terrain of the land on which the operation is located. In most areas of Nebraska, swine operations should be located northeast to east of your residence, your neighbor or commercial establishments. However, local conditions such as windbreaks and land slope could alter these conditions.

When selecting a site, sufficient additional space must be provided for waste handling facilities such as manure storage tanks, debris basins and holding ponds. If the swine waste will be returned to the land, sufficient land area must be provided for this purpose. Ten finishing animals will produce sufficient nitrogen to add about 200 pounds of nitrogen to one acre of cropland per year. This statement is based on the assumption that a portion of the nitrogen contained in the manure will volatilize and not be available for crop use.

Controlling Pen Runoff

To prevent stream pollution, it is necessary to keep swine wastes out of water courses. The system used will depend on the type and size of swine production facilities.

When swine have access to open lots, preventive measures may include:

1. A diversion.
2. A settling pond or debris basin.
3. A holding pond.
4. A method for spreading materials stored in the holding pond on the cropland.

A diversion terrace above hog lots will divert any water that does not fall directly on the pens, keeping this water from contacting the waste covering the surface of the lots. Another step is to divert any roof drainage out of the lots. These two steps will decrease the amount of runoff water from the lots carrying swine wastes.

Runoff from lots should be collected in a settling (debris) basin and carried to a holding pond. The use of a debris basin provides a place for solids to settle out so they will not accumulate in the holding pond. Difficult and expensive removal problems will develop if solids collect in the holding pond. Furthermore, the accumulation of solids reduces the storage capacity of the holding pond.

The facilities just discussed must be designed or tailored for each individual production site. Annual rainfall, land slopes, soil types and land area all must be considered. By using soil and water conservation practices with slight modifications, the requirements for a site can be deter-

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Swine Wastes

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mined. You will need engineering help from either your local SCS personnel or a consulting engineer to help assure a satisfactory system. Cost-sharing through your local ASCS offices is available in many counties if your facilities are built according to SCS design standards.

Manure From Buildings

Most confinement buildings are equipped with slotted floors which allow manure to drop directly into the manure storage pit. Manure accumulates in the pit until it is pumped out and spread on cropland or removed to a separate manure storage tank.

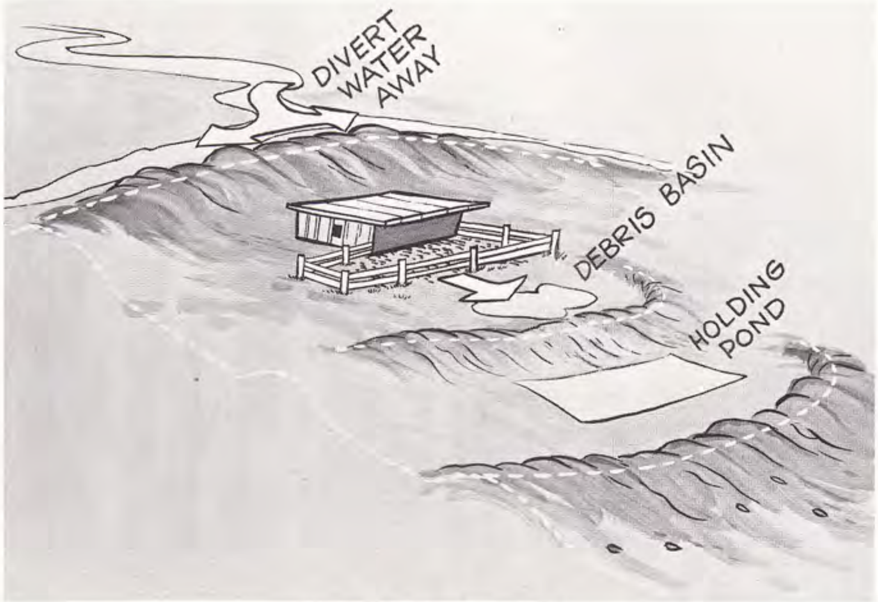
Manure pits below slotted floors can be built with a six-week storage capacity. If manure is allowed to accumulate, removal will be more difficult. Bacterial decomposition of manure starts to take place, frequently causing objectionable odors in the buildings.

Oxidation Ditches

Because of manure odors and difficulties of getting manure out of pits, more interest has been developing in the oxidation ditch. This is a low odor method of liquid manure handling.

In this system, a race track shaped pit is built under the partial or totally slotted floor. Waste accumulates in the pit and a rotor is used to keep the material in continuous circulation. The rotor adds oxygen which helps prevent anaerobic decomposition. The net result is odor reduction and also a reduction of up to 50% in the organic solids contained in the wastes. Thus, handling is more convenient and less objectionable.

The overflow liquid from an oxidation ditch system is generally collected in a storage tank or pit provided for this purpose. The effluent or liquid from this system is not suitable for discharge into a stream and should be spread on cropland.



Site selection important.

Success with this system requires a high degree of management. It may be particularly useful in an area where odor control is important and justifies the cost. A recent report from Scotland, where this system has been under study for several years, indicates that they are still battling with mounds of foam. Further information on design and operational suggestions are given in EC 70-789, "Oxidation Ditch for Swine Wastes." This publication is available from your local county Extension agent or directly from the Agricultural Engineering Department, College of Agriculture, University of Nebraska, Lincoln.

"Odorless" Lagoons

To reduce odor to a moderate level, lagoons must be provided with plenty of volume. For aerobic lagoons that produce little or no odor, provide a storage volume of 2 cu. feet for each pound of hog. Thus, a lagoon serving a 150-pound hog would need to provide 300 cu. feet for each animal. Even then, odors are likely to develop, particularly in the spring when waste begins to thaw.

When higher odor levels can be tolerated, lagoons for swine waste may be built with a storage volume of 1 cu. ft. per pound of animal. Since these lagoons will be anaerobic, high odor levels can be expected. Since Nebraska now has an air pollution law passed by the 1969 Legislature, the use of this type of facility should not be considered except in remote areas. It is too early to predict how these laws will affect the producer but *caution* is in order.

The writer is of the opinion that the lagoon should be considered only as a stopgap measure until other facilities can be arranged. Potential odor problems, plus the loss of the fertility value of animal waste, need to be given more consideration.

In areas of porous soil, the bottom of the lagoon may need to be sealed to prevent wastes from polluting ground water. The cost of sealing will be an additional cost that should not be overlooked in planning.

Swine producers who irrigate can frequently modify their irrigation system so that liquid swine wastes can be distributed on cropland. This technique handles waste with a minimum of labor, reduces odor problems and takes advantage of the value of animal wastes.

According to Nebraska law, when animal waste runs off the property of the owner or operator or enters a water course, steps must be taken to control the wastes. The waste control facilities described earlier may be used. The method or system will vary for each producer.

When waste control facilities are required, the plans for the waste system must be approved by the Nebraska Water Pollution Control Council before construction. Cost sharing through your local ASCS office is available for helping with construction when facilities are built according to design standards of the Soil Conservation Service.

Assistance for the preparation of plans is available through your local SCS office. For large producers it may be necessary to use a consulting engineer. Either of these can help you prepare plans and information on a waste control facility so they can be sent to the Water Pollution Control Council for approval.

Plans for waste control facilities should be approved before construction. When an individual creates a pollution problem, the Water Pollution Council will call the producer to a hearing if investigation shows he is polluting.

The state law specifies that all waste systems are to be complete by Dec. 31, 1972. If we are to reach this goal, the cooperation and action on the part of all parties involved will be needed.

Additional information on this problem is available in EC 69-784, "Handling Swine Manure." Copies are available from your local county Extension office.

There is a growing feeling that we need to consider agricultural zoning. This could provide specified areas for livestock production, probably with buffer zones. Zoning can restrict the location of residences in areas zoned for agricultural production. Agricultural interests will need to take the lead in such a program through local county government.

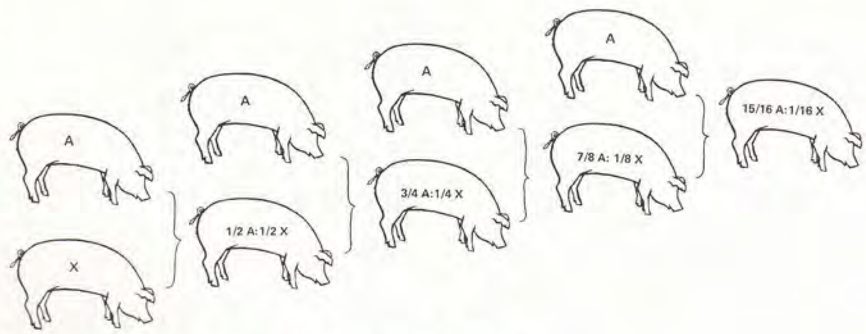


Fig. 1. Accumulating genetic influence of sires.

Do Your Boars Pay?

By P. J. Cunningham
Assistant Professor, Swine Breeding
W. T. Ahlschwede
Extension Livestock Specialist

The choice or selection of seed stock by pork producers can be a moneymaking decision. The choice of the boar to be used determines the genetic merit of the next pig crop and ultimately the level of performance for the herd in years to come. This article will deal with the importance of boar selection as it relates to the genetic merit of the herd, the worth of progeny and the responsibilities of purebred seed stock producers.

The genetic merit of a herd is the biological ability of the pigs in that herd to perform in a desirable way as compared to all other groups of pigs. This ability is based upon the average genetic potential of the herd. The largest contribution to the herd's genetic potential comes from the boars used. At any given time, half of the genes in the herd come from sires and half from dams. This is one of the basic principles of genetics.

However, since fewer males than females are used, each boar makes a larger contribution than each female. If one male is mated to 25 females, the male contributes 50% of the genes while each female contributes only 2% of the genes in the resulting pig crop.

In cases where replacement females are kept from within the herd, previous sires also contribute to the herd genetic merit in a large way. The maternal grandsire contributes 25% of the genes to the pig crop. Fig. 1 illustrates that 88% of the genes in a pig crop can be traced to the last three boar selections. It is apparent that sires chosen to be used in a herd are the major contributors to the herd's genetic merit.

More Male Latitude

The opportunity for selection among males is considerably higher than among females. With annual replacement of females, about 30% are required to go into the herd. With males, the replacement rate is about 1%. That is, of males born, only one per 100 is required for breeding purposes. Potentially, then, we have much more latitude for selection among males. With males we can use the very best. With females we use the good as well as the best.

Being able to choose only the best males means that the superiority of the chosen males, or the selection differential, is much greater than the average superiority of the females. Since the magnitude of the selection differential determines the improvement of the offspring, we can see that most of the potential improvement from selection comes from boar selection. Nearly 70% of the average selection differential (S.D.) can be attributed to male selection.

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Do Your Boars Pay?

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S.D. = (½) × (Male S.D. + Female S.D.)

For feed efficiency, selecting one boar from 100 and 30 females from 100 would give a selection differential of .375 lb. feed/lb. gain, of which .26 lb. feed/lb. gain (69%) is due to male selection.

S.D. = ½ (.52 + .23) = .375

Since only genes are transmitted from one generation to the next, care must be taken to assure that the superiority selected is not just environmental superiority. Comparisons of records of boars in two herds are not reliable indicators of the individual's genetic superiority because herd differences may be largely environmental, or due to procedures used to obtain records. Differences between boars within a herd are genetically reliable for traits with moderate to large heritabilities. If boars from more than one herd must be compared, deviations from herd average would be more useful than individual weights or measurements. Central test stations offer opportunities to evaluate on an equal basis boars produced in different herds.

Poor Boars Costly

Good boars pay producers dividends whereas poor boars may cost the producer each time he is mated. As an example, if we were able to pick the best boar out of 100 for rate of gain, we would expect each of his offspring to use 20 pounds less feed between weaning and market than the offspring of an average boar from the same group. This considers only the differences in feed for maintenance. This is about a 3% difference in feed costs. A similar selection (the best of 100) for backfat thickness would change the offspring average for backfat thickness by nearly .1 inch. Changing the herd average by .1 inch could increase the number of hogs grading No. 1 and reduce the number grading No. 3, (Table 1).

The worth of a boar depends upon how much better his offspring will be than an average boar and upon the number of offspring a boar has. If a boar produces offspring which use less feed or grade better, the boar pays dividends each time he is used. If his offspring use more feed or grade poorer, he costs money every time he is used. Per pig dividends may not seem large, but in times of narrow margins they are an important factor in determining profit levels.

Better Boars a Must

The examples indicate the importance of choosing between "best" boars and average boars. In addition to the benefit gained by selecting a "best" boar, commercial producers would like to buy boars which will do better than the boars bought the previous year. This year's "best" boar must be better than last year's "best" boar. For annual commercial improvement, each year's average boar must be better than the last year's average boar. This can be realized only if the seed stock herds are improving year by year.

Figure 2 shows how the commercial average follows the purebred average. Purebred herd A is improving performance but Purebred herd B is not improving. The performance of Commercial herd C, whose boars come from herd A, increases as Herd A's performance increases. Commercial herd D, whose boars come from herd B, soon reaches the level of herd B and does not improve performance.

It is the responsibility of purebred breeders to insure the continued improvement of commercial performance by following selection procedures which improve in the purebred herds those traits which are economically critical to commercial producers. To protect the future of the industry, purebred producers must test boars so that buyers may choose wisely among them. They must also use these test results to increase the genetic merit of their herds as well.

Table 1. A change in backfat thickness of .1 inch results in change in grading of hogs.

Grade	"Average" Sire	"Best of 100" Sire
No. 1	27%	50%
No. 2	63%	47%
No. 3	10%	3%
Average backfat	1.4	1.3

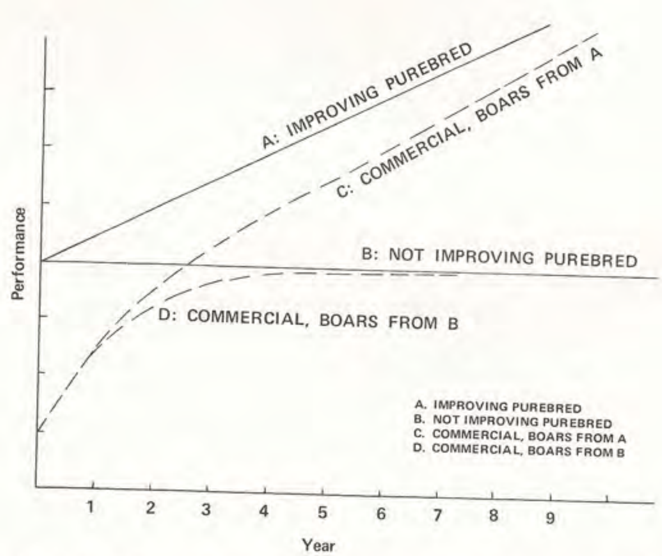

Fig. 2. Commercial herd performance approaches purebred herd performance.

Coconut ration.

Safflower oil ration.

Ration fed individually to pigs.

Effect of Diet Fats on Pork Carcasses

By D. E. Stilwell
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Professor, Swine Nutrition

There is considerable controversy about the effect on health of animal fat in man's diet. Experimental work to determine physiological responses, as affected by diet, in various species, has been conducted. The species studied have ranged from mouse to man and much has been learned.

It has long been known that the type of fat in the diet of the pig will profoundly change the ultimate characteristics of the lean and fat tissues of the pork carcass. Swine fed a soft or unsaturated fat such as safflower or peanut oil will have a soft carcass. Swine fed a hard or saturated fat such as coconut oil will have a firm or hard carcass.

There has been a lack of scientific evidence regarding these dietary changes on pork carcass acceptability and those changes at the tissue level which contribute to that acceptability.

Nutrition Studies

A few years ago, nutrition studies were begun at the Nebraska Station to study growth and other physiological responses in swine when different types of fat were added to the diet. The swine were then slaughtered at the Loeffel Meat Laboratory where carcass and meat characteristics were studied.

Pigs on basal, corn-soybean meal, diets have been compared to pigs fed the basal diet with 10 or 20% of the diet as either safflower or coconut oil. The results have been most interesting and may have important implications to the entire meat industry.

Results of a trial where 20% of the diet was either coconut or safflower oil individually fed to four crossbred barrows per treatment are shown in Table 1.

Although live and carcass weights were not statistically different, there was a tendency for pigs fed the fat-added diets to have an increased response for these traits. This is probably due

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Table 1. Physical and chemical carcass measurements from swine fed coconut or safflower oil.

Trait measured	Treatment: A Corn-Soy basal	B Basal + 20% safflower	C Basal + 20% coconut
Live wt., lb.	207	227	213
Cold carcass wt., lb.	148	167	154
Carcass length, in.	29.1	29.1	28.8
Av. B.F., in.	1.3[a]	1.9[b]	1.6[c]
Ham & loin, %	38.4[a]	34.5[b]	37.0[a, b]
Marbling score[1]	1.5	1.3	1.5
Color score[2]	1.8	1.0	1.8
LEA, sq. in.	5.0	5.5	4.8
Tenderness[3]	9.3	10.1	8.9
Firmness[4]	5.5[a]	6.0[a]	4.6[b]
Cooking loss, %	24.7	22.3	25.4

a, b, c Means with unlike superscripts are statistically different ($P < .05$).
1 Based on visual score of 1-5; 1 = slight, 5 = abundant.
2 Based on visual score of 1-5; 1 = very pale, 5 = dark.
3 Pounds of pressure required to shear ¾" diameter meat core from rib eye.
4 mm. penetration of steel ball on penetrometer.

Effect of Diet Fats

(continued from page 15)

to the increased energy intake due to the fat. Fat is considered to contain 2.25 times as much energy as does starch on a pound for pound basis. This is further emphasized in the increased backfat thickness and corresponding decrease in trimmed ham and loin percent for those pigs fed the fat-added diets.

No differences were noted in carcass length or loin eye area. Upon evaluation of the loin eye section at the 9th and 10th rib, there were no differences in marbling or color score, tenderness, or percent cooking loss. However, the pigs fed coconut oil had a more firm muscle than the control or safflower oil diet pigs.

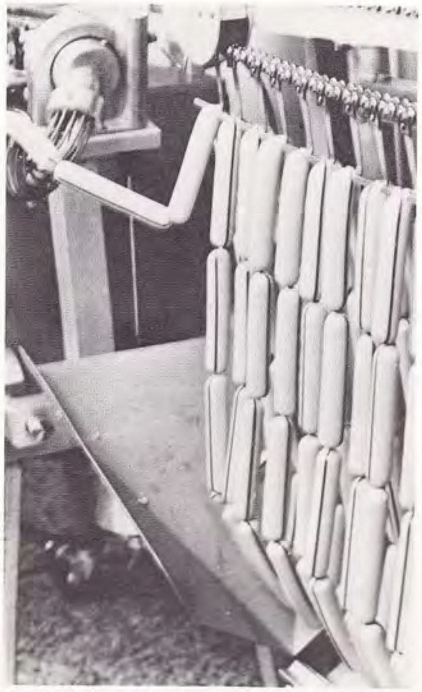
In addition to these conventional traits, emulsion and sausage manufacturing characteristics were also evaluated. Results are shown in Table 2.

Results in Table 2 indicate a trend toward an increase in emulsion stability of meat from pigs fed safflower oil and a decrease in stability of meat from pigs fed coconut oil. This trend is also noted in the percent cooking loss of rib chops as shown in Table 1, although these results were not statistically different.

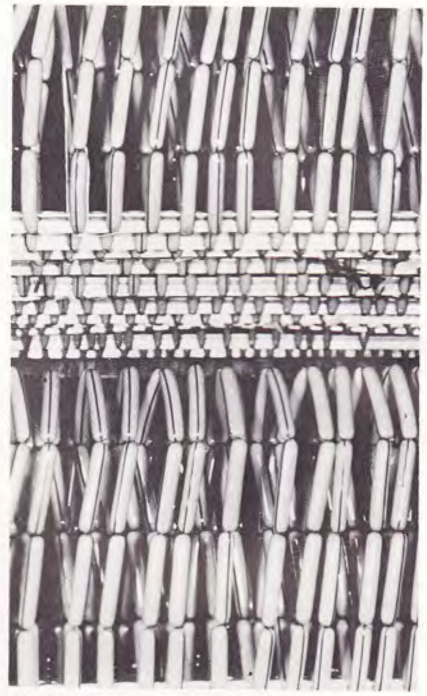
The results in Tables 1 and 2 closely follow results obtained from an earlier study which involved 48 barrows and gilts fed 10% of their diet as either safflower or coconut oil.

Consumer Evaluation

In addition to the criteria already discussed, a consumer evaluation study was conducted on smoked pork loin, sausage, bacon and frankfurters prepared from carcasses of the pigs fed the three diets. Essentially no difference in preference was found in the smoked chops or frankfurters from the three diets. Basal diet sausage and bacon were preferred over the safflower oil diet sausage and bacon.



Production for processed meat emulsions.



Finished franks coming out of smoke house.

Certainly, more data are required to help explain some of the differences and similarities in pork from pigs fed these types of diets and how the carcasses may fit into the industry picture of the future. A third, similar study is currently in progress to help accomplish this goal. Consumer demand will tell us the direction red meat production will take. Research today will prepare us to meet consumer demand tomorrow.

Table 2. Emulsion properties of pork from swine fed coconut or safflower oil.

	Treatment		
	A	B	C
Trait measured	Corn-soy basal	Basal + 20% safflower	Basal + 20% coconut
Normal cooking loss, %[1]	1.2[a]	0.2[a]	4.6[b]
Severe cooking loss, %[2]	6.3[a]	5.7[a]	24.4[b]
Emulsification capacity, ml. oil/g. meat[3]	41.9	40.3	40.9
Emulsion stability, total ml./100 g. emulsion[4]	5.7[a]	4.2[a]	10.1[b]
Fat, %	12.2[a]	9.8[a]	19.1[b]
Solids, %	11.3	16.3	12.9
Water, %	76.5	73.9	68.0

[a, b] Means with unlike superscripts are different ($P < .05$).

[1] Weight change of four franks placed in boiling water and removed when water reboiled.

[2] Weight change of four franks boiled for 30 minutes.

[3] Amount of corn oil emulsified per g. lean meat.

[4] ml. material cooked out of 100 g. emulsion when cooked to 170°F. with components of that total expressed as a percent.

Feed Performance and Cost

By Murray Danielson
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(Swine)
P. H. Grabouski
Assistant Professor, Agronomy
(Outstate Testing)
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(Farm Management)

Optimum performance with minimum cost is what the pork producer must strive for. He will not necessarily use the same feed formulations all of the time in his program to reach this goal.

Studies at the North Platte Station using various grains in growing-finishing diets provided results encouraging further investigation as to how these grains could best be altered in growing-finishing diets.

Growing-Finishing Study

To start this study a total of 128 pigs, 64 crossbred barrows and 64 crossbred gilts, averaging about 35 pounds were allotted to eight diet treatments.

There were two pens of eight pigs each (four barrows and four gilts) represented for each diet treatment. Each pen consisted of an 8 x 10 foot concrete floored shelter with a 10 x 10 foot concrete outside apron. Located on each concrete apron was a self-feeder and an automatic waterer.

The eight diet treatments and their respective composition are shown in Table 1. An attempt was made to balance each of the eight diets to contain 16% protein.

Proso millet and wheat contained a greater quantity of protein than did the corn. Thus, a lesser quantity of soybean meal was needed in the diets where Proso millet and/or wheat replaced the corn portion of the diet.

Diets 4, 5 and 6 were of the same composition as Diet 3 with the exception of added lysine at three different levels shown in the footnotes of Table 1. Proso millet for all practical purposes contains little lysine. Lysine, being an essential amino acid for swine, was added at the indicated levels to determine what response the various levels would be.

Lysine was also added to Diet 8 in that Proso millet was included as 50% of the corn replacement. The quantity of lysine added to Diet 8 brought the lysine content of the diet up to about the equivalent amount of that found in Diet 1, the basal corn-soy diet. Each of the 16% protein treatments was fed *ad libitum* in pellet form. All other managerial practices were comparable for each pen during the study.

Results

Results are presented in Table 2. Pigs fed Diet 7 yielded the least desirable performance with reference to average daily gain (1.58 lbs. per day) followed closely by the pigs fed Diet 2 (1.59 lb. per day). Both of these diets contributed like feed conversions of 3.16 lb. of feed required per pound gain.

Diet 8 was the most desirable for pig perfomance for the 98-day feeding interval. Diet 8 differed from Diet 7 in that it contained supplemental lysine. The lysine was very efficiently utilized both for increased daily gain and improved feed efficiency (3.01).

The remainder of the diet formulations were quite similar with indications of a slight linear response in average daily gain as the level of lysine was increased in the diets.

(continued on next page)

Table 1. Composition of 16% growing-finishing diets.

Ingredients	Diets, %							
	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]	7[g]	8[h]
Corn	75.75	——	——	——	——	——	——	——
Wheat	——	82.75	——	——	——	——	40.00	40.00
Millet (Proso)	——	——	79.00	79.00	79.00	79.00	40.00	40.00
Soybean meal (44%)	20.75	13.75	17.50	17.50	17.50	17.50	16.50	16.50
Ground limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dicalcium phosphate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sodium tripolyphosphate	0.60	0.60	0.65	0.65	0.65	0.65	0.60	0.60
Iodized salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Trace minerals (high zinc)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Vitamin Premix[i]	0.325	0.325	0.275	0.275	0.275	0.275	0.325	0.325
Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000

[a] Control (16% corn-soy diet).
[b] Wheat replacing corn with diet protein content adjusted to that found in basal diet.
[c] Millet replacing corn with diet protein content adjusted to that found in basal diet.
[d] 0.001% lysine added.
[e] 0.002% lysine added.
[f] 0.003% lysine added.
[g] Equal quantities of wheat and millet replacing corn with diet protein content adjusted to that found in basal diet.
[h] 0.00075% lysine added.
[i] Supplied the following per pound of complete diet: Vitamin A, 1200 I.U.; Vitamin D, 135 I.U.; riboflavin, 2.0 mg.; calcium pontothenate, 4.0 mg.; niacin, 9.0 mg.; choline chloride. 10.1 mg.; and Vitamin B12, 5mcg.

Feed Performance

(continued from page 17)

Economic Implications

At this point we might ask — "What do the results of this experiment mean in terms of dollars and cents?" or "At what prices do wheat and millet become competitive with corn in a growing-finishing swine diet?"

Data from Diets 1, 2, and 3 (corn, wheat, millet) were used to prepare Figure 1, which shows the value of wheat and millet in a 16% growing-finishing swine diet based on alternative corn prices.

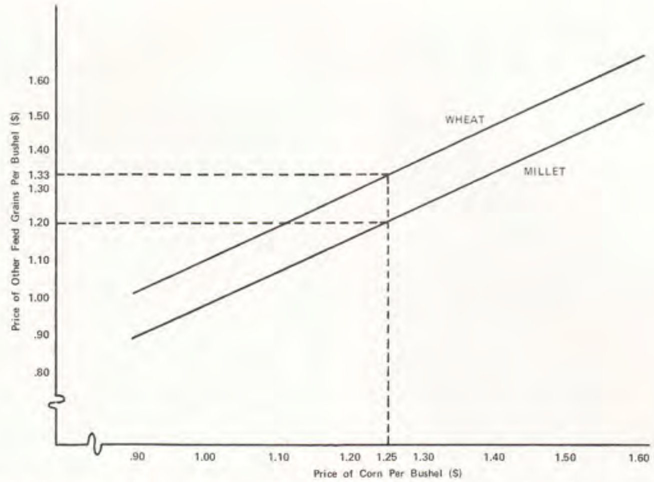


Fig. 1. Value of wheat and millet in a 16% growing-finishing diet at alternative prices of corn.

For example, if corn costs $1.25 per bushel, draw a line upward from the $1.25 point on the horizontal, or corn, axis of the graph. This line meets the "wheat line" at $1.33 and the "millet line" at $1.20. Thus, if corn costs $1.25 per bushel, it would pay to use wheat instead of corn as a feed grain up to a wheat price of $1.33 per bushel. Likewise, if corn costs $1.25 per bushel, millet would be cheaper than corn as a source of grain up to a millet price of $1.20 per bushel. Since millet is normally traded on a hundredweight basis, Table 3 may be used to convert this millet price of $1.20 per bushel to an equivalent price of $2.14 per hundredweight. Current prices of all other diet ingredients were used in preparing Figure 1. This included a price of $90 per ton for 44% soybean meal.

Table 2. Live animal performance (98-day duration).

Item	Treatments[a] 1	2	3	4	5	6	7	8
No. of pigs	16	16	16	16	16	16	16	16
Avg. initial wt., lb.	35.9	35.2	35.0	35.3	35.3	35.9	35.7	35.4
Avg. final wt., lb.	197.1	190.8	192.0	193.9	196.7	202.2	190.6	206.9
Avg. daily gain, lb.	1.65	1.59	1.60	1.62	1.65	1.70	1.58	1.76
Feed/lb. gain, lb.	2.97	3.16	3.11	3.25	3.04	3.13	3.16	3.01

[a] Treatment designation same as shown in Table 1.

Table 3. Equivalent prices per bushel and per hundred weight for corn, millet and wheat.

Price per bushel	Price per hundredweight: Corn or millet (56 lb.)	Wheat (60 lb.)
$ .70	$1.25	$1.17
.80	1.43	1.33
.90	1.61	1.50
1.00	1.79	1.67
1.10	1.96	1.83
1.20	2.14	2.00
1.30	2.32	2.17
1.40	2.50	2.33
1.50	2.68	2.50
1.60	2.86	2.67

Diets 4, 5, and 6 were not used in Figure 1, because they resulted in a higher cost per pound of pork produced than did Diet 3. As noted earlier, Diets 4, 5, and 6 were identical to Diet 3, except for the addition of lysine.

Diets 7 and 8 were not used in Figure 1 because they use a blend of wheat and millet, and could not be shown on a graph of this type. The addition of lysine to the wheat and millet blend was profitable, and Diet 8 appears to be a good diet. It produced the most rapid daily gain and was similar to corn (Diet 1) in rate of feed conversion.

Other Considerations

Rate of Gain—In addition to feed conversion or pounds of feed required per pound of gain, the rate of gain is important in comparing diets. A diet which produces gain slower than "normal" lengthens the feeding period required to reach a specific market weight.

A longer feeding period means additional labor, more wear and tear on facilities, additional out-of-pocket costs, and may cause a producer to miss his desired marketing day. In addition, in a multiple farrowing system, a slow-gaining group may not be through before another group of pigs are ready for the facility.

These problems would probably not appear with any of the diets used in this test. The slowest gaining group (Diet 7) would only take four days longer than the corn ration group (Diet 1) to achieve a 160 pound gain. And, the fastest gaining group (Diet 8) would achieve that gain in six days less than the corn ration group.

Quality of Product—Millet and wheat apparently produce carcasses similar to those produced with corn. None of the pigs produced on the diets in this experiment received a price discount at market time.

Processing and Feeding—The wheat and millet diets may be processed and fed with the same equipment used for the conventional corn diet.

Summary

Wheat and/or millet appear to be realistic alternatives to corn in properly balanced growing-finishing diets.

Additional lysine supplementation used in this study, even though producing more rapid growing pigs, was not feasible from an economic standpoint. However, if the lysine cost remains constant and the selling price of pigs becomes higher there is a point where the extra cost of the supplemental lysine would be justified.

Pork producers should check their local prices when buying feed grains to see if they can save feed dollars by feeding grains other than corn.

Removing corn from bunker storage.

High Moisture Corn for Swine

By Harold H. Hodson, Jr.
Extension Swine Specialist
Iowa State University

Interest in storing corn in the high moisture form has been increasing. This has followed the shift toward field shelling of corn at harvest time. In 1969, 75% of Nebraska's corn crop was shelled in the field. Five years earlier, only 33% was field shelled. The primary advantages of early corn harvest are reduced field losses and the chance to harvest the stalks as silage or pasture when they have greater nutritive value. Early harvest may also facilitate fall plowing.

Since a large portion of the corn crop is fed to swine, there has also been increased interest in feeding high moisture corn to swine. Although it is generally accepted that high moisture corn can be successfully used in a swine feeding program, special considerations may be required to obtain maximum performance.

Work at Iowa State University in the late 1950's (Hunt *et al.*, 1960) indicated that high moisture corn was of equal feeding value to dry corn when included in a complete ground and mixed ration or mixed with a pelleted supplement. In Illinois studies, Jensen and Becker (1961) reported that high moisture corn produced approximately the same rate of gain and was utilized as well as dry corn when mixed into the ration on an equivalent dry matter basis.

In the series of Iowa State studies, more feed was required per pound of gain when high moisture corn was fed free-choice with supplement in comparison to free-choice dry corn and supplement although the gains were approximately the same. Feed required per pound of gain increased because the pigs ate a higher proportion of the high moisture corn resulting in a lower protein content in the ration. This same observation of more total feed required per pound of gain for high moisture corn was made by Conrad *et al.* (1969) from Purdue University studies in which the corn and supplement were also offered free-choice. In the Purdue studies slightly less protein supple-

(continued on next page)

High Moisture Corn

(continued from page 19)

ment was required per pound of gain with the high moisture corn.

On the other hand, in University of Illinois (Becker and Jensen, 1961) and Michigan State University (Harmon *et al.*, 1959) studies, pigs fed high moisture corn and supplement free-choice consumed more protein supplement than pigs fed dry corn and supplement free-choice. As a result of the increased protein supplement consumption, 32 to 51% more supplement was required per pound of gain with the high moisture corn in the Michigan State studies. Gains were slightly slower on the free-choice high moisture corn than on the free-choice dry corn in both the Illinois and Michigan State studies.

Since results conflict concerning the free-choice feeding of high moisture corn and protein supplement to growing and finishing pigs, Iowa State University conducted a field trial during the winter of 1969-70.

Experimental Procedures

Free-choice high moisture corn (either whole shelled or cracked) and supplement was compared to a complete ground and mixed 14% protein ration utilizing dry corn (12.6% moisture) and the same supplement as fed free-choice (Table 1). The complete ground and mixed ration was used as a control since it is the standard feeding method used by most producers today. The moisture content of the high moisture corn was 27.5 to 29%, except for the last six days of the trial, when another source analyzing 23% moisture was used.

The trial was conducted in a completely enclosed, environmentally controlled finishing unit with a total slotted floor. The high moisture corn was removed from an air-tight silo once or twice a week, stored in a small trailer near the finishing house and placed in the self-feeders as needed — daily or every other day. Although the storage in the small trailer was undesirable, the study was conducted from the last week of November through the first week of March when the outside temperature was low. The free-choice supplement and the complete ground and mixed ration were placed in the feeders approximately once per week as needed.

Two groups of pigs (one lightweight group averaging 48 pounds and one heavier group averaging 63 pounds) were randomly assigned to the six pens with 20 pigs per pen. Thus, two pens of pigs were placed on each treatment. The trial was terminated after 101 days because the original supply of high moisture corn was depleted and the labor necessary for weighing the feed into the feeder was becoming a problem for the producer with the approaching spring field work.

Table 1. Summary of the results of 101-day feeding trial with high moisture corn for growing-finishing pigs.[a]

	No. pigs	Av. initial wt.	Av. final wt.	Av. daily gain	Corn/lb. gain[c]	Supplement/lb. gain	Total feed/lb. gain[c]	% Protein in ration
Whole high moisture shelled corn and supplement—free choice[b]								
Pen N-3	20	48.7	157.6	1.05	2.78	0.68	3.46	14.1
Pen N-4	20	64.0	176.8	1.12	3.16	0.48	3.64	12.4
Average	20	56.4	167.2	1.09	2.97	0.58	3.55	13.2
Cracked high moisture shelled corn and supplement—free choice[b]								
Pen N-5	20	49.6	159.7	1.09	2.79	0.61	3.40	13.7
Pen N-6	20*	61.7	176.5	1.12	3.15	0.49	3.64	12.5
Average	20	55.7	168.1	1.11	2.97	0.55	3.52	13.1
Complete ground and mixed 14% protein ration[b]								
Pen N-7	20**	47.0	181.8	1.31	2.57	0.61	3.18	14.0
Pen N-8	20	62.4	197.7	1.34	2.71	0.64	3.35	14.0
Average	20	54.7	189.8	1.33	2.64	0.63	3.27	14.0

* One pig died during trial. ** Two pigs died during trial.

[a] Trial was conducted by the Animal Science Extension Section of Iowa State University in cooperation with A. O. Smith Harvestore Products, Inc., Arlington Heights, Illinois.

[b] The moisture content of the high moisture corn was 27.5 to 29 except for the last 6 days of the trial when it was 23 percent because a different source of high moisture corn was used since the original supply was depleted. Purina's 36 percent Hog Chow was used for both the free-choice and complete ground and mixed ration.

[c] The high moisture corn intake was adjusted to 87.6 percent D.M. (equivalent to the dry corn utilized in the complete ration) before the corn or total feed per lb. of gain was calculated.

Results and Discussion

The results are given in Table 1. The free-choice, high moisture shelled corn fed either whole or cracked resulted in a slower rate of gain and a higher feed requirement per pound of gain when compared on an equivalent dry matter basis with the complete ground and mixed ration containing dry corn. As was the case in the earlier Iowa State studies (Hunt *et. al.*, 1959,) the reduction in performance with the free-choice high moisture corn and supplement resulted because these pigs ate a higher proportion of corn. This resulted in a lower protein content in the ration compared to the 14% for the control complete ground and mixed ration.

Since most studies with free-choice, high moisture corn and supplement have indicated that under- or over-consumption of protein supplement is a problem, it is recommended that either the high moisture corn be mixed with a pelleted supplement or included in a complete ground and mixed ration. Spoilage may be a problem with a complete ground and mixed ration unless it is prepared daily which will increase the labor requirement. Therefore, an automated system which mixes high moisture shelled corn and a pelleted supplement is the most desirable method.

The free-choice system may be used successfully if precautions are taken to insure the proper intake of protein supplement in comparison to the corn intake. Certainly more research is needed on the type of supplement which should be used with free-choice high moisture corn. Most free-choice supplements contain meat and bone meal or other ingredients to reduce palatability and avoid over-consumption. It may be that all soybean meal or whole roasted soybean supplements balanced with minerals and vitamins would be better for feeding free-choice with high moisture corn because of their high palatability. But, as indicated earlier, over-consumption of the free-choice supplement has occurred in some cases even though the supplements contain meat and bone meal. Thus, to insure proper intake of the free-choice protein supplement when fed with high moisture corn, the palatability may have to be adjusted for each individual case, and this would be impractical.

In this field trial, the gains and efficiency of feed utilization were almost identical for the cracked and the whole shelled high moisture corn treatments (Table 1). Thus, it apparently isn't necessary to crack high moisture corn for growing and finishing pigs. In some cases it may be desirable to grind high moisture corn to insure proper mixing with the protein supplement and to prevent the pigs from selectively sorting out the corn or supplement.

Removing corn from upright storage.

The cost of gain was not calculated in this study since storage, drying and other costs will vary with each particular situation. As indicated earlier, the performance with high moisture corn is essentially identical to that with dry corn when it is mixed with the supplement. Thus, the possible use of high moisture corn in a swine feeding system is primarily an economic decision rather than a nutritional one. The possible harvesting advantages must be balanced against any disadvantages of special equipment and time required to properly prepare high moisture corn rations. Also, any discounts for high moisture content, if the corn is to be purchased or sold, must be balanced against possible higher storage cost (including interest, depreciation and taxes on investments) in comparison to the cost for drying and/or storing dry corn.

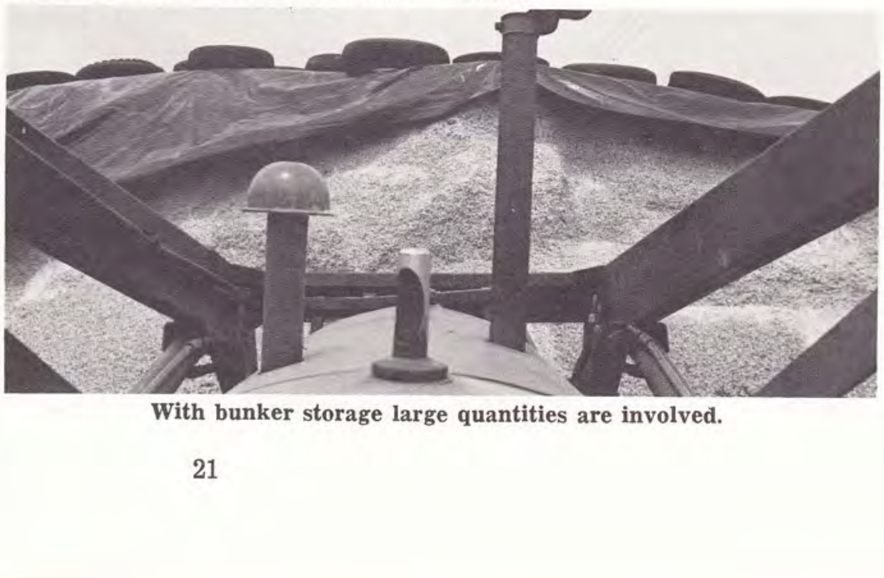
Summary

1. Studies conducted at Iowa State University, as well as other midwest universities, indicate that growing and finishing pigs may not properly balance their ration when high moisture corn and supplement are fed free-choice.

2. Rate of gain and feed efficiency, when compared on an equivalent dry matter basis, have been essentially the same for pigs fed high moisture or dry corn in studies where corn and supplement are mixed together rather than fed free-choice.

3. There is no apparent advantage to cracking high moisture corn for growing and finishing swine.

4. The possible use of high moisture corn in a swine feeding system is primarily an economic decision rather than a nutritional one. Thus, the various costs involved should be carefully studied for each individual case before a sound decision can be made.



With bunker storage large quantities are involved.

Figure 1. The massive subcutaneous hemorrhage caused by a slight bruise is one of the characteristic symptoms of the disease.

Bleeding Pig Disease

By R. D. Fritschen
Area Extension Specialist
(Animal Science)
O. D. Grace
Professor, Diagnostic Laboratory
E. R. Peo, Jr.
Professor, Swine Nutrition

Cornbelt swine producers for years have been reporting death losses in pigs due to uncontrolled bleeding. While the problem has never become epidemic in nature the loss to individual producers can be substantial.

The problem apparently results from some unknown factor interfering with the normal vitamin K utilization by the pig. Normally, vitamin K (K_2) is formed in the pig's gut to meet the functional needs of the animal. Since bile salts are necessary for absorption it is believed that this occurs in the upper part of the small intestine, where bile salts are present.

Interference with the synthesis or utilization of K_2 may cause uncontrolled bleeding or hemorrhages. More than 50 percent mortality has been reported, generally in younger pigs weighing about 40 pounds.

Since the compounds and mechanisms which interfere with vitamin K synthesis and/or utilization are not known, controlled research to determine causes, controls and symptoms is slow to evolve.

It is generally agreed however, that some component(s) of the diet undergoes a subtle change that may include the formation of certain molds or fungi that liberate mycotoxins. Thus, as this diet is eaten, the syndrome develops.

Other factors such as stress and certain drugs have been incriminated as being directly or indirectly associated with the problem.

Problem Becomes Opportunity

Two hundred sixty feeder pigs weighing 22-24 pounds were delivered to the University of Nebraska Northeast Station in late February 1970. The pigs were of the same genetic background, having been raised by a local producer.

Before delivery, the pigs were fed a medicated creep feed.

At the Northeast Station we put the pigs on a standard 18% protein diet fortified with antibiotics.

About one week after delivery a number of pigs became lame. We treated some of the lame pigs with injectable antibiotics.

It soon became apparent that a condition of epidemic proportion was developing since the severity and incidence of lameness increased with no noticeable response to antibiotic treatment.

Consultation with the local veterinarian and subsequent autopsy at the University Diagnostic Laboratory revealed the nature of the problem — bleeding pig disease!

Up to this time none of the pigs had died except those sacrificed for diagnosis. We immediately removed the ration and offered new feed which contained supplemental vitamin K as menadione sodium bisulfite. Since most of the pigs were too sick to eat or because the condition was too advanced, the feeding of vitamin K had little benefical effect.

We determined blood clotting time by capillary tube technique on several pigs by tapping an ear vein. Normal clotting time for pigs is from one to five minutes with most determinations falling in a range from two to four minutes. Of the pigs checked, clotting time was from eight to ten minutes. The tapped ear veins continued to bleed for several days until these pigs died.

The initial symptom, lameness, persisted. In addition, other symptoms developed. Of these, blood in the urine was common. We also observed massive hemorrhages under the skin and considered them a direct cause of death in many of the 40 pigs that ultimately died.

These hemorrhages were so gross that the site of leakage could not be determined. However, many of the pigs treated with injectable antibiotics via an 18 gauge needle subsequently died with massive hemorrhages centered around the needle site.

The fragility of veins was so intense that a slight rubbing under the pig's neck by contact with the feeder during normal eating was enough to start a hemorrhage such as shown in Figure 1, causing the pigs to actually bleed to death within their own tissue.

Complete and prompt syndrome remission was achieved with intramuscular vitamin K therapy. This was administered with a 26 gauge needle to reduce hemorrhaging at the injection site.

The period from diagnosis to control spanned a period of five days. During this period pig mortality was 15.4 percent.

The Opportunity

Since a quantity of the suspect

diet remained, we planned an experiment to attempt to reproduce the disease and at the same time establish controls. We used 36 pigs, unrelated to the first group but of a known genetic and nutritional background.

Biologically there are three general forms of vitamin K, namely: bacterially synthesized K or vitamin K_2, plant formed K or K_1 and commercially synthesized K (i. e. menadione sodium bisulfite or MSB), sometimes referred to as K_3.

We designed the experiment to measure the pigs' response to the three forms of vitamin K in the presence of an apparently potent hemorrhage causing or anti-K_2 factor.

We took two independent clotting times on each pig as it was weighed before starting on test and averaged them to establish a beginning clotting time. The pigs weighed 30 pounds.

Treatments were:

Suspect diet.

Suspect diet plus 2.5 percent dehydrated alfalfa meal (K_1).

Suspect diet plus 2 grams per ton of menadione sodium bisulfite (MSB or K_3).

On day six after starting on test, pigs on the suspect diet without either K_1 or K_3 began showing the bleeding pig syndrome. The initial symptom was blood in the urine. Lameness, loss of appetite, listlessness or depression, subcutaneous hemorrhages and ear and naval sucking were other symptoms observed.

One pig in this group also developed a massive eye abnormality characterized by protruding tissue around the eye socket. A cloudy condition developed on the eye itself. After the end of the study and injection of MSB the eye appeared to return to normal.

None of the pigs on diets containing either K_1 or K_3 developed visual syptoms of the syndrome as described.

On day nine following diet exposure one pig on the suspect diet without K_1 or K_3 died. Autopsy revealed a massive hemorrhage in the spleen area and tissue damage to the spleen itself suggestive of rupture. In addition, this animal had a bladder filled with blood tinged urine.

At this time we again took double clotting times on each pig and averaged them to establish a final clotting time. We then gave MSB injections to the 11 pigs remaining on the suspect diet.

No additional pigs died and the described symptoms appeared to disappear within several days.

The bar-graph in Figure 2 indicates the average beginning and final clotting time as well as the calculated "safe" and "danger" areas.

The final clotting time for pigs on MSB (K_3) treatment was well within normal and acceptable limits, although there was a slight delay. The pigs on dehydrated alfalfa meal (K_1), while not showing visual symptoms of the disease, did have a slightly greater delay in clotting time as compared to pigs receiving MSB.

Pigs challenged with the suspect diet without either vitamin K_1 or K_3 had a delayed clotting time more than three times greater than the initial clotting time.

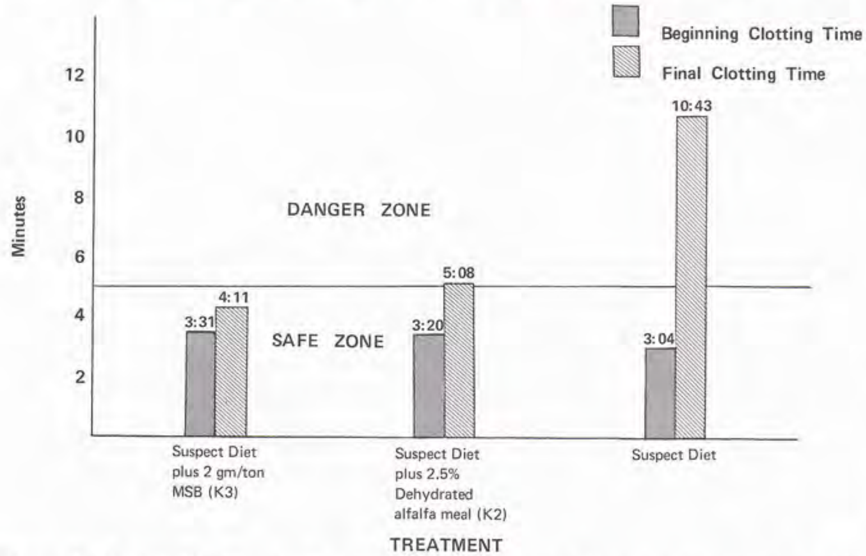


Figure 2. A graphic illustration of beginning and final clotting times for pigs fed the suspect diet with and without two sources of vitamin K.

An Opportunity and a Result

A significant aspect of this study is that a critical problem can often be converted into a research opportunity. The results indicate that menadione sodium bisulfite fed at a level of two grams per ton of complete feed prevented onset of the bleeding pig syndrome and maintained normal clotting time in the presence of an unknown but extremely potent hemorrhagic or antivitamin K factor.

Further, the study demonstrated that while dehydrated alfalfa meal fed at the 2.5% level prevented visual symptoms of the disease it was less effective in maintaining a normal blood clotting time.

Thus, even though "K" synthesis in the pig's gut generally provides the animal's need for the vitamin, it now appears that adding menadione sodium bisulfite to the pig's diet at the two gram per ton level should be considered routine because:

—We are not able to detect the presence of the hemorrhage causing or anti-K factor in feedstuffs and,

—Since MSB costs only 5 to 10 cents per gram this type of insurance fits everyone's budget.

The logic of this proposal is such that already most commercial feed companies are including Vitamin K in their starter rations.

Marvel Baker Hall, East Campus, University of Nebraska.

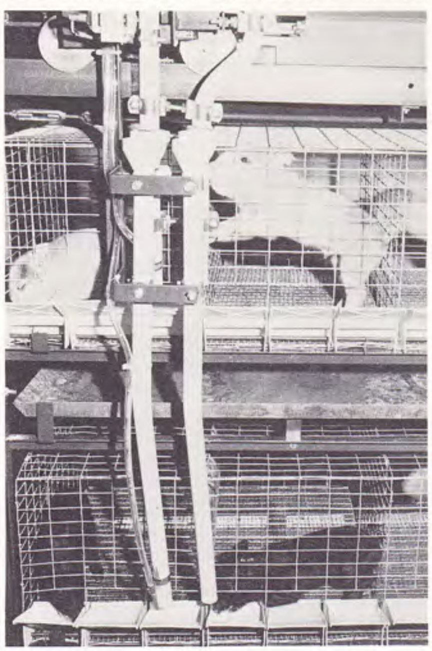
Swine Related Research

By James D. Heldt
Instructor, Animal Science

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

Northeast Station, Concord, Nebraska

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



Mechanized feeding of baby pigs at the North Platte Station.

North Platte Station

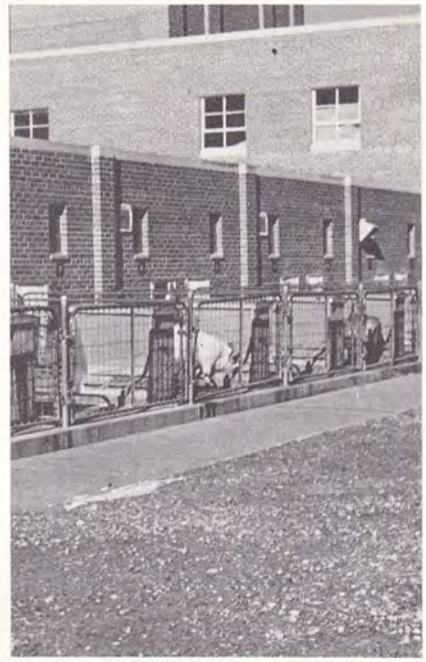
Nutrition and Management: Digestability, amino acid balance and relative value of feed grains; soybean cooking, baby pig management; calcium and phosphorus evaluation.

Lincoln and Mead

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

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

Animal Science—Genetics and Physiology: Selection for ovulation rate; genotype-environment interaction studies; hormone levels associated with reproductive status; control of estrus and ovulation with synthetic and natural hormones; management effects on sexual development. Nutrition: Effects of copper and vitamin E on growing-finishing swine; muscle development of baby pigs as influenced by protein sources, sex and genetic line; effects of saturated and non-saturated fats on carcass quality of growing-finishing pigs; zinc deficiencies; biotin supplementation of soybean meal and dried skim milk diets for baby pigs; utilization of non-protein nitrogen; value of alfalfa meals processed by different methods; chelated trace minerals.



Swine center on Adams Street in Lincoln.

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

Swine center at the Northeast Station, Concord.