1978

EC78-219 1978 Nebraska Swine Report

Dwane R. Zimmerman
University of Nebraska-Lincoln

Roger Kinsey
University of Nebraska-Lincoln

Roy Carlson
University of Nebraska-Lincoln

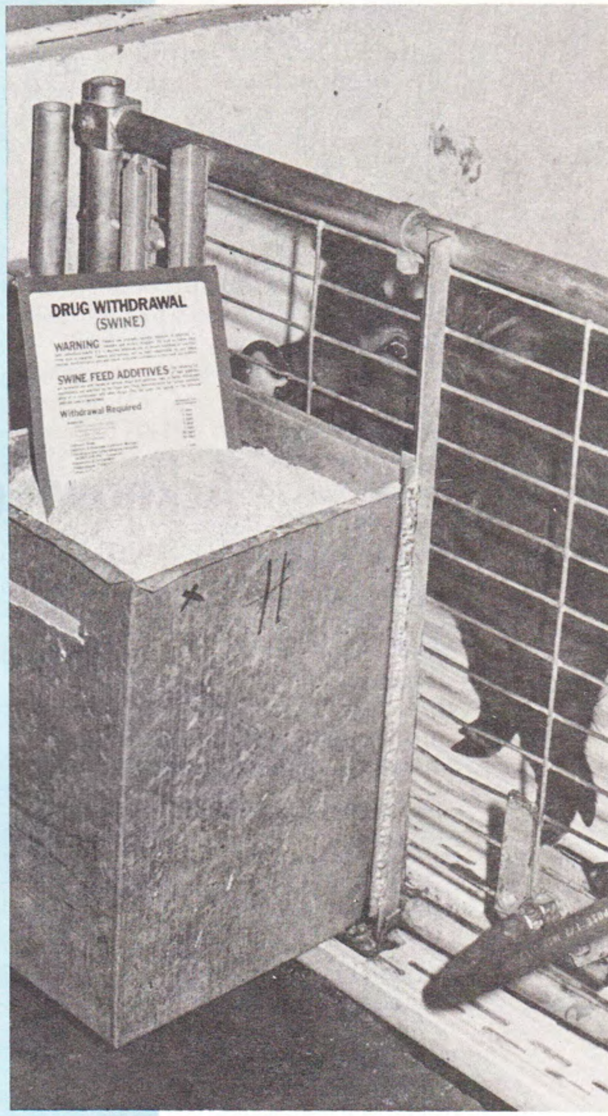
Bobby D. Moser
University of Nebraska-Lincoln

Dean Boyd
University of Nebraska-Lincoln

See next page for additional authors

E. C. 78-219

1978 NEBRASKA SWINE REPORT



- Breeding
- Disease Control
- Nutrition
- Economics
- Housing

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

University of Nebraska–Lincoln
Institute of Agriculture and Natural Resources

L. E. Lucas, Director, Extension Service
H. W. Ottoson, Director, Experiment Station
T. E. Hartung, Dean, College of Agriculture

Acknowledgments

The authors wish to express their appreciation to the following for grant or product support of Nebraska Research and Extension programs. The dedicated effort of the support personnel in the laboratories and research units is acknowledged and appreciated.

A. L. Laboratories
Englewood Cliffs, New Jersey
American Cyanamid Company, Princeton, New Jersey
Bayvet Division, Cutter Laboratories, Inc.
Shawnee, Kansas
Bettcher Industries, Inc., Vermillion, Ohio
Calcium Carbonate Company
Quincy, Illinois
Commercial Solvents Corporation, Terre Haute, Indiana
Dawes Laboratories, Inc., Chicago, Illinois
Diamond Shamrock Chemical Co., Newark, New Jersey
Eli Lilly and Company, Indianapolis, Indiana
Farmland Industries
Kansas City, Missouri
Fats and Protein Research Foundation, Inc., Desplaines, Illinois
George A. Hormel Packing Company, Fremont, Nebraska
Hoffman-LaRoche, Inc.
Nutley, New Jersey
Merck and Company
Rahway, New Jersey
National Pork Producers Council, Des Moines, Iowa
National ByProducts, Omaha, Nebraska
Nebraska Farmer, Lincoln, Nebraska
Nebraska Pork Producers Association
Nebraska SPF Accrediting Agency
Lincoln, Nebraska
Pfizer, Inc., Terre Haute, Indiana
Pioneer Hi-Bred International, Inc., Des Moines, Iowa
Rhodia, Inc. (Hess and Clark Div.), Ashland, Ohio
Sargent Calcium Products Company, Weeping Water, Nebraska
S. B. Penick and Company, New York, New York
Shell Chemical Company, Agricultural Division, San Ramon, California
Townsend Engineering
Des Moines, Iowa
Urschel Laboratories, Inc., Valparaiso, Indiana
U.S.D.A., ARS, WRRL, Berkeley, California
Waldo Farms, DeWitt, Nebraska

Contents

Issued January 1978, 10,000

Confinement Influence

Puberty in Gilts

Dwane R. Zimmerman
Professor (Swine Physiology)

Roger Kinsey
Graduate Student

Roy Carlson
Research Technician

Successful introduction of gilts into the breeding herd is an important aspect of breeding herd efficiency. Efficiency depends on ability of gilts to reach puberty (exhibit first estrus), continue regular estrous cycles and conceive at first breeding. Delayed puberty decreases the potential for litter size and increases production costs. Ovulation rate and litter size increase with advancing sexual age (number of heat periods experienced before breeding).

Total confinement has caused increased management problems in breeding gilts. Producers have attempted to circumvent the problems by removing gilts from confinement (usually relocating them to outside lots) before breeding. Studies conducted in Nebraska (University of Nebraska Agricultural Experiment Station and U.S. Meat Animal Research Center) suggest that the main reproductive difficulty is lack of heat (anestrus) in gilts of normal breeding age (7-8 months and older). Depending on the age of the gilts involved, the failure of gilts to express estrus during the breeding period may be caused by delayed puberty or by an increased incidence of quiet ovulations (ovulations unaccompanied by standing heat).

Recent studies at the University of Nebraska have attempted to assess the influence of intensive confinement on two aspects of reproductive development in gilts. First, to evaluate to what extent development and maintenance of gilts under intensive confinement conditions delays puberty compared to removing gilts from these conditions at various stages of development. Second, to determine whether the ability of confinement developed gilts to respond to stimuli proven effective for triggering puberty in gilts developed outside is normal or impaired.

Intensive Confinement Delays Puberty

Gilts were developed in large groups (50-60 per group) in close confinement (gilts were initially allowed 2 sq. ft. or .19 sq. m/pig with pens enlarged thereafter to accommodate growth) from weaning at 4-5 weeks without contact with a boar or any other known stimuli. At 70 and 120 days of age, groups of 12 or 13 gilts were removed at random from the large group situation and moved to smaller pens in the same room (moved inside, MI-70 & MI-120 groups) but with a comparable allocation of floor space per pig or were relocated in large outside pens (moved outside, MO-70 & MO-120 groups). The remaining gilts were kept in their

original pens and served as controls. The only change in the control group other than the loss of penmates and a reduction in the group size was the decrease in pen size required to keep the floor space comparable (7-8 sq. ft. or .65-.74 sq. m/gilt after 120 days) among treatment groups maintained inside. All gilts were observed once daily for symptoms of first estrus without the aid of a boar and were laparoscoped to confirm that ovulation accompanied the estrous observations.

Removing gilts from intensive confinement conditions appeared to benefit pubertal development. None (0%) of the control gilts expressed first estrus between 170 and 190 days of age as compared to 15% and 33% of the MI-120 and MI-70 day groups. Removal, regrouping and relocation outside produced similar estrous responses between 170 and 190 days (15% and 33% estrous responses for the MO-70 and MO-120 groups, respectively) as removal and regrouping inside.

Benefits of removing and regrouping gilts inside, however, were not maintained beyond 190 days; no further first estrous activity (0%) was observed in the MI-70 and MI-120 groups between 190 days and end of the experiment at about 230 days of age. This compared to a 50% pubertal response in the control group and 100% first estrous responses in the M0-70 and M0-120 day groups by 230 days of age.

The earlier gilts were relieved from intensive confinement, the better the estrous response between 170-190 days. However, the age at removal had little influence on the percentage of gilts expressing estrus by 230 days of age. The most important overall benefit to pubertal development was produced in response to removal and relocation outside, regardless of whether it occurred at 70 or 120 days of age.

Ability To Respond To Stimuli Impaired

A second phase of the study described above was to evaluate whether development in confinement impairs ability of gilts to respond to regrouping, relocation and boar exposure stimuli. Part of the gilts on each development regimen (control, MI-70, MI-120, M0-70 and M0-120 groups) were subjected to a combination of regrouping (gilts from different pens mixed together), relocation (moved to a different room or pen location) and boar exposure (once daily introduction of an intact boar into the pen with the gilts for approximately 10 minutes each day) stimuli at 170 days of age.

Regrouping, relocation and boar exposure (R, R and BE) markedly stimulated onset of first estrus in all development groups as compared to controls. The overall estrous response between 170 and 190 days was 80% for R, R and BE vs 16% for controls. The magnitude of the response to the R, R

(continued on next page)

Puberty in Gilts

(Continued from page 3)

and BE stimuli was affected, however, by the development conditions imposed on the gilts.

Gilts reared in close confinement until 170 days (control) or 120 days (MI-120) of age were less responsive (50-62% estrous response) to R,R and BE stimuli than gilts removed from the intensive confinement conditions at 70 days, regardless of whether the gilts were developed outside (M0-70, 92% estrous response) or inside (MI-70, 100% estrous response) and compared to gilts developed outside after 120 days (M0-120, 83%).

Unstimulated gilts maintained inside (control, MI-70, MI-120) that had not expressed estrus by 190 days were observed to respond readily to R,R and BE stimuli at 190 days of age. Overall, 90% of these gilts expressed estrus between 190 and 230 days of age as compared to 35% of the unstimulated control gilts.

Summary

Removing gilts from intensive confinement conditions involving large numbers of pigs per pen (50-60) before 120 days of age benefited pubertal development. The estrous response before 190 days was similar whether gilts were moved to outside pens with little space restriction or were left inside in smaller groups but with the same floor space per pig as the control gilts maintained continuously in a large group.

The earlier the gilts were relieved from intensive confinement (70 vs 120 days), the better the pubertal response observed between 170 and 190 days.

Regrouping, relocation and boar exposure was an effective stimulus for induction of puberty at both 170 and 190 days of age but was the least effective at 170 days in gilts maintained continuously in the same pens in large groups. Regrouping, relocation and boar exposure at 170 days effectively hastened puberty by more than 20 days as compared to unstimulated controls.

Nutrition, Temperature

Piglet Survival

Bobby D. Moser
Associate Professor
(Swine Nutrition)

Dean Boyd
Graduate Student

Wayne R. Cast
Graduate Student

Piglet survival is of utmost importance in swine production. Twenty-five percent of all pigs born die before weaning. The majority of these losses occur during the first few days after birth. The first 12 hours of life are most critical. It is apparent that preweaning mortality is a major cause of loss to the swine industry. Efficiency of production would be greatly enhanced if this mortality were reduced.

There are several causes of piglet mortality. The major causes are overlay by the sow and congenital weakness. These major causes may be brought about by chilling, starvation and dehydration. The newborn piglet is vulnerable to cold stress because of his sparse hair coat, thin hide and small amount of body fat. The newborn pig is not able to control body temperature efficiently. This is a handicap to survival when exposed to a stressful environment or limited milk supply.

Reactions of the piglet to changes in the environment are a signal to the herdsman that he is either comfortable or uncomfortable. In cold conditions, the pig crouches lying on his knees, shivering violently, sometimes with the forelimbs thrust between the hindlimbs and with its sparse coat of hair erected. When pigs are chilled, they huddle close to the sow and thus the opportunity for crushing increases. In warm conditions the limbs are extended and the pig lies relaxed on its side, signaling that he is comfortable.

Temperature Critical

The critical temperature of the newborn pig is about 86° F (26.7° C) and gradually declines as the pig grows. The newborn pig is attracted to artificial heat sources such as heat lamps, catalytic heaters, heat in the floor etc., and seems to prefer an air temperature of about 90° F (32.2° C). After the first week and until six weeks of age, the preferred temperature is somewhat less —about 80 (26.7° C) to 85 (29.4° C). Therefore, for maximum baby pig survival, supplemental heat that will give a floor temperature of 90° F (32.2° C) must be available for the newborn pig. It is important that he find the heat source as well as nurse within a few minutes after birth.

As the pig grows, gradually reduce the temperature to about 70° F (21.1° C) by the time the pig is six weeks of age. This creates a dilemma in that the temperature for the sow during this period (lactation) should be about 60° F (15.5° C). Thus, two different heating systems are needed in the farrowing house—one for the baby pig and one for the sow.

Thus, keep the thermostat at eye level in the farrowing house at about 60° F, while increasing the floor temperature by supplemental heat to meet the needs of the baby pig. Also, the newborn pig should be kept in a draft free location. If any draft is present, the effect is almost as great as if a large draft is present. Drafts have the same effect as lowering the environmental temperatures and certainly determine how cold a pig really feels (wind-chill factor).

Nutrition Important

The nutritional status of the pig at birth and during the first few hours is also important. Overlay by the sow and congenital weakness are considered to be major causes of death in the newborn piglet, but both may be brought about by starvation and dehydration.

The piglet has a source of readily available energy stored as glycogen in his liver, and a lesser amount in the heart and muscle. Since the newborn piglet relies totally upon milk from the sow to provide his nutrition, it is critical that he nurse as soon after birth as possible to replenish his rapidly depleting energy stores. Research at the University of Nebraska indicates that only 14.3% of the liver glycogen at birth is present 24 hours after birth in normally suckled piglets (Table 1).

As glycogen is depleted, the level of circulating blood glucose falls dramatically. When the blood glucose drops to a critical level, the piglet develops a condition called hypoglycemia (low blood sugar), which leads to weakness and a predisposition to overlay. Because the piglet lacks insulative protection, low environmental temperatures during such conditions will speed up the rate of decline of the blood glucose which dramatizes the pig's condition.

If newborn pigs are allowed to nurse, not only will they receive needed nutrients, but the heat generated by the process of digestion will aid in keeping them warm. Research from Illinois reported that non-suckled pigs in a warm comfortable environment lived 56 hours longer than non-suckled pigs in a cold environment. Thus, pigs born into a cold environment and not allowed to nurse immediately are doomed and will probably die within a few hours after birth.

Frequent nursing has a sparing effect on the piglet's energy stores and helps him to maintain his blood sugar level. Adequate energy nutrition is difficult to guarantee for every piglet. The size of the litter and the body weight of the piglet will determine how much milk he receives. Larger, more vigorous piglets usually receive larger shares.

The newborn piglet is very dependent not only upon stored energy, but also upon energy acquired by suckling. To improve his ability to survive it would appear beneficial to increase his energy stores. In an experiment conducted in Nebraska, tallow added to the sow's diet at the rate of 20% and fed from day 100 of pregnancy to parturition, produced a slight increase in piglet liver glycogen at birth, and this difference was maintained through 12 hours after birth (Table 2). Cornstarch fed at the same energy intake as tallow maintained a high glycogen level at 6 hours but not at 12 hours. This extra energy after

(continued on next page)

Table 1. Rate of liver glycogen disappearance in piglets from birth through 24 hours of age (Nebraska experiment 75416).[a]

Hour of sacrifice	No. of piglets	Glycogen concentration, mg/g	% of 0 Hour
0 (birth)	12	177.87	----
6	12	87.25	49.1
12	12	73.04	41.1
24	12	25.39	14.3

[a]Boyd, M.S. Thesis 1977 University of Nebraska.

Table 2. Effect of dam's dietary treatment prior to parturition on the rate of liver glycogen disappearance in the piglet from birth through 24 hours (Nebraska experiment 75412).[a,b]

Hour of sacrifice	No. pigs per treatment	Control[c]	Control + tallow[d]	Control + cornstarch[e]	SE
		(mg glycogen/g wet liver tissue)			
0 (birth)	4	174.9	188.7	170.0	9.55
6	4	77.8	93.9	90.0	24.64
12	4	62.7	95.6	60.8	14.13
24	4	20.2	22.6	33.4	7.02

[a]Boyd, M.S. Thesis 1977 University of Nebraska.
[b]Diets fed from day 100 of pregnancy to parturition.
[c]Corn-SBM 14% protein, feeding rate 4 lb/hd/day (1.82 kg).
[d]Tallow added at 20% of the diet.
[e]Fed to the same energy intake as the tallow diet.

Table 3. Effect of high energy diets on fat composition of milk (Nebraska experiment 75413).[a,b]

Treatment	Control[c]	Tallow 15%	15% Tallow + Choline Chloride
Milk fat, %			
at farrowing	6.1	8.1	8.9
at 1 week	7.0	10.1	11.2
at 2 weeks	7.4	9.5	8.6
Avg	6.8	9.2	9.6

[a]Cast, M.S. Thesis 1977 University of Nebraska.
[b]All diets fed from day 109 of gestation through 2 weeks of lactation.
[c]Corn-SBM, 16%, 0% added tallow, 200 gm/ton (220 mg/kg) choline chloride.

Piglet Survival

(Continued from page 5)

birth should be beneficial to sustain the piglet until he has nursed.

The next consideration would be to improve the piglet's energy acquired by suckling. For many years herdsmen have equalized litter size by fostering pigs from one sow to another to reduce competition in large litters and equalize milk intake. Another way would be to assure adequate energy intake for each piglet. In an attempt to improve the energy content of sow's milk and subsequent survival rate of piglets, an experiment was designed to study the effects of tallow and choline additions to the diets of sows. Treatments were initiated on day 109 of gestation and continued through two weeks of lactation (Table 3). Tallow added (15%) to the diet of the sow increased the fat content of the milk (6.8% vs 9.2%) when compared to the control diet which contained no added tallow.

Table 6. Effect of tallow and Choline fed during late gestation (day 109) and lactation (2 weeks) on piglet survival of the smaller piglets in the litter at birth (2.2 or 2.4 lb, 1.0 or 1.1 kg) (Nebraska experiment 75412, 13, 16).

	Control[a]	Tallow 15 or 20%	15% Tallow + Choline Chloride
Trial[b,c]	% Survival, Piglets (no. of piglets)		
1	28.0 (42)	34.5 (43)	---
2	53.8 (15)	92.6 (20)	---
3	42.9 (7)	20.0 (5)	50.0 (10)
4	47.8 (21)	45.5 (11)	63.0 (47)
5	42.1 (19)	68.0 (25)	80.0 (40)
6	13.9 (10)	66.7 (6)	48.0 (16.0)
7	29.5 (22)	75.0 (8)	53.8 (4)
8	66.7 (9)	62.5 (8)	60.6 (10)
9	87.1 (14)	100.0 (8)	60.0 (10)
Weighted avg (Trials 1-9)	42.1 (159)	59.2 (134)	
Weighted avg (Trials 3-9)	46.2 (102)	64.8 (71)	60.9 (137)

[a]Corn-SBM, 16%, 0% added tallow, 200 gm/kg) Choline Chloride.
[b]Trials 1 and 2, 20% added tallow, piglet < 2.2 lb (1 kg), treatments started at farrowing.
[c]Trials 3-9, 15% added tallow, treatments started day 109 of gestation.

Choline, (a B-vitamin) is involved in the transport of lipids in the blood. Therefore, choline chloride (990 gm/ton) was added to the high energy diet in an attempt to increase lipid transport and thereby increase even further the fat content of the milk. The addition of fat plus choline resulted in the highest milk fat levels at farrowing and at one week, which is the most critical period for the piglet. The increase, observed in the colostrum, indicates how rapidly dietary fat is transported to the milk, since the treatment diets were fed for only four days before farrowing.

Table 4. Effect of high energy diets on blood glucose (Nebraska experiment 75413)[a]

Treatment	Control[b]	Tallow 15%	15% Tallow + Choline Chloride
Blood glucose			
0 hr mg.%[c]	35.7	55.0	47.1
6 hr mg.%[d]	71.2	87.0	77.6
24 hr mg.%[d]	72.7	80.0	83.2

[a]Cast, M.S. Thesis 1977 University of Nebraska.
[b]Corn-SBM, 16%, 0% added tallow, 200 gm/ton (220 mg/kg) choline chloride.
[c]($P<.10$) 1 vs 2, 3.
[d]($P<.05$) 1 vs 2, 3.

Blood glucose levels of the piglet responded to the treatments in a manner similar to that of milk fat. The high energy diets produced a higher blood glucose level than the control (Table 4). This suggests a better nutritional status for the piglet when sows were fed the high energy diets.

The validity of these measurements could be substantiated if piglet survival increased. The response of piglet survival to high energy diets fed to sows just before farrowing and through two weeks of lactation for nine different trials are presented in Tables 5 and 6. Overall piglet survival (trials 1-9) was improved (80.6% vs 83.3%) in those piglet that were nursing sows fed tallow (Table 5). A larger difference (83.6% vs 88.2%) was observed when tallow and choline were added to the sows diet. When looking at the response within each trial, it appeared that the

Table 5. Effect of tallow and Choline fed during late gestation (day 109) and lactation on piglet survival (%) at two weeks of age (Nebraska Experiments 75412, 13, 16).

	Control[a]	Tallow 15 or 20%.	15% Tallow + Choline Chloride
Trial[b,c]	% Survival (no. of litters)		
1[1]	69.2 (20)	73.2 (19)	---
2	85.9 (18)	87.7 (17)	---
3	87.5 (5)	79.6 (5)	87.5 (11)
4	84.4 (12)	85.4 (10)	88.7 (20)
5	79.8 (9)	87.3 (8)	93.7 (19)
6	92.9 (6)	96.4 (5)	76.8 (6)
7	55.6 (4)	86.9 (4)	77.7 (3)
8	85.8 (3)	78.0 (4)	85.8 (3)
9	94.3 (5)	90.9 (3)	88.7 (4)
Weighted avg (Trials 1-9)	80.6 (82)	83.3 (75)	
Weighted avg (Trials 3-9)	83.6 (44)	86.3 (39)	88.2 (66)

[a]Corn-SBM, 16% protein, 0% added tallow, 200 gm/ton (220 mg/kg) choline chloride.
[b]Trials 1 and 2, 20% added tallow, treatments started at farrowing.
[c]Trials 3-9, 15% added tallow piglets treatments started day 109 of gestation.

greatest improvement by the tallow treatments was when piglet survival of the control diet was less than 85%. Also, the variation among the trials for piglet survival was greater for the control diets than for those diets that contained fat. This indicated that the fat may have been acting as a buffer against the environment.

Research involving 1948 litters at Iowa State University showed a direct correlation between birth weight and survival rate. The smaller pigs at birth had a lower survival rate. Thus, the greatest opportunity for improved survival is with the smaller piglets in the litter. In the trials reported here the tallow additions had a greater effect on the smaller pigs (Table 6). Among pigs weighing less than 2.4 pounds (1.1 kg) at birth, tallow increased survival approximately 18% compared to those from sows fed the control which contained no added tallow.

Conclusion

The above data indicate that increasing the energy density (15% added tallow) of the sows diet will increase the fat content of the milk, blood glucose levels of the piglet and subsequent piglet survivability. It also appears the combination of fat and choline maximizes this improvement. It should be pointed out that the levels of added tallow used in these experiments (15% and 20%) are difficult to work with and are probably not practical. At present we do not know if a similar improvement would be obtained at lower levels. Because of the response that has been observed so far, we are encouraged to continue working in this area to determine the optimum diet and environment for maximum piglet survival.

Many factors contribute to the high mortality rate of newborn piglets. This high mortality rate could be reduced considerably if piglets were provided a warm, dry environment and were assured some colostrum the first few hours of their life. This improvement may be enhanced if the sow's milk contained a higher energy level.

Effect of Housing

High Energy Diets Fed to G-F Swine

Bobby D. Moser
Associate Professor
(Swine Nutrition)

R. D. Fritschen
District Extension Specialist
Animal Science

Research at the University of Nebraska and other experiment stations indicates that fat (tallow) added to the diet of growing-finishing swine will improve average daily gain and feed conversion. The amount of improvement will depend upon the amount of tallow added to the diet.

Experiments at Nebraska indicate that a significant increase in average daily gain may not be observed until the added tallow level is about 5% of the diet. Adding tallow at low levels (2 to 3%) had little, if any, effect on backfat thickness. Levels higher than this (4% and up) will probably slightly increase backfat thickness. The amount of increase appears to depend upon the type of pig and the level of tallow added. The fat-type pig has a tendency to respond to high tallow diets by increasing backfat thickness more than the lean-type pig.

One response evident in our experiments is improved feed conversion with the high tallow diets. This improvement in feed conversion begins with the first level of added tallow and increases with additional increments of tallow until the 8-10% added tallow level is reached. The physical handling problems associated with these high levels (8% or more) as well as the price relationship between tallow and energy from grain suggest low levels of added fat (5% or less). At the 5% level of added tallow, a significant improvement in both average daily gain and feed conversion with little effect on backfat thickness can be expected.

Most of the studies referred to were conducted under the same basic environmental conditions. Because there is a lower heat increment (heat that is lost in diges-

(continued on next page)

Table 1. High energy diets fed to G-F swine in different housing facilities.

	Experimental diets, % composition			
	Growing		Finishing	
Fat addition	0%	5%	0%	5%
Corn	75.5	69.2	81.1	74.8
Tallow	——	5.0	——	5.0
Soybean Meal (44%)	20.9	22.2	15.2	15.5
Dicalcium phosphate	1.4	1.5	1.5	1.6
Limestone	.64	.59	.61	.56
Salt	.5	.5	.5	.5
Trace mineral mix	.05	.05	.05	1.05
Vitamin premix	1.0	1.0	1.0	1.0
Calculated analysis				
Protein	16	16	14	14
Calcium	.65	.65	.65	.65
Phosphorus	.60	.60	.60	.60

High Energy Diets

(Continued from page 7)

tion) in fat metabolism, pigs should respond to high fat diets better in a warmer environment than in a colder environment. This has been demonstrated by the Georgia Experiment Station. It was found that feed efficiency improved more with the addition of fat during a summer trial (2.65 vs 3.11 feed/gain) than when fat was added during a winter trial (3.28 vs 3.48 feed/gain).

Swine production is moving rapidly toward confinement. The types of finishing facilities that exist today include open-front units with an outside apron, modified-open-front with partially slotted floor units and completely enclosed environmentally regulated units. Maximizing feed efficiency as well as energy efficiency is critical to the total economics of every swine enterprise. With this in mind, we felt it important to learn how pigs respond to certain diets under different environmental conditions.

An experiment was conducted at the Northeast Station to determine the effects of high energy diets fed to growing-finishing pigs in two different housing facilities during the winter (December-March). One hundred and sixty crossbred pigs weighing 30 lb (13.3 kg) were assigned to two dietary treatments (0 vs 5% tallow) and two housing facilities [environmentally regulated (ER) vs Modified-Open-Front (MOF)].

The control diets used in this experiment were basic corn-soybean meal diets fortified with minerals and vitamins and balanced to 16% protein for the growing phase and 14% protein for the finishing phase (Table 1). The 5% tallow was added to the treatment diets in place of corn. Protein percent of the diets was maintained by increasing the level of soybean meal. The environmental condition inside the two buildings can be characterized by the average daily temperature measured at a central point inside each building (Table 2). The temperature inside the ER building was warmer throughout the test than the temperature inside the MOF.

Table 2. Average daily extreme air temperature measured at central point inside the buildings.

	Environmentally Regulated (ER)		Modified-open-front (MOF)	
	F°	C°	F°	C°
High	70.7	21.5	64.0	17.8
Low	66.0	18.9	46.8	8.2

Even though the temperature was colder and more variable in the MOF, there were no differences in pig performance between the two buildings (Table 3). Pigs in the MOF gained 1.54 lb (.70 kg) per day compared to 1.58 lb (.72 kg) per day in the ER building. Average daily gain [1.58 lb (.72 kg) vs 1.54 lb (.70 kg)] and feed conversion (2.64 vs 2.65) was similar for both types of facilities. However, pigs in the MOF tended to be leaner as indicated by the lower backfat thickness [(1.43 in. (3.62 cm) vs 1.39 in. (3.53 cm)] and higher percent lean (53.0 vs 53.6). Since the MOF environment was slightly colder and more variable than in the ER building, the pigs apparently were utilizing all of the feed energy for growth with little deposited as excess backfat.

Table 3. Effect of level of tallow and type of house on performance of G-F swine.

	Level of tallow		Type of house	
	0%	5%	ER	MOF
ADG, lb (kg)[a]	1.52 (.69)	1.61 (.73)	1.58 (.72)	1.54 (.70)
ADFI, lb (kg)	4.14 (1.88)	4.06 (1.84)	4.16 (1.89)	4.07 (1.84)
F/G[a]	2.76	2.54	2.65	2.64
Backfat, in (cm)[a]	1.37 (3.48)	1.43 (3.62)	1.43 (3.63)	1.39 (3.53)
% Lean[b]	53.3	53.3	53.0	53.6

[a] 0 vs 5% Tallow (P<.05)

[b] % Lean = 21.3 + .055 (lb hot carcass wt) − 17.75 (in. average carcass backfat)

Table 4. High energy diets fed to G-F swine in different housing facilities.

Tallow addition	ER		MOF	
	0%	5%	0%	5%
ADG, lb (kg)				
30- 75 (13.6-34)	1.16 (.53)	1.23 (.56)	1.14 (.52)	1.18 (.53)
75-200 (34-91)	1.71 (.79)	1.88 (.85)	1.75 (.79)	1.81 (.82)
30-200 (13.6-91)	1.53 (.69)	1.64 (.74)	1.52 (.69)	1.58 (.72)
ADFI, lb (kg)				
30- 75 (13.6-34)	2.48 (1.12)	2.30 (1.04)	2.29 (1.04)	2.44 (1.01)
75-200 (34-91)	5.22 (2.37)	5.19 (2.35)	5.24 (2.38)	4.85 (2.20)
30-200 (13.6-91)	4.19 (1.90)	4.12 (1.87)	4.12 (1.87)	4.01 (1.82)
F/G				
30- 75 (13.6-34)	2.16	1.88	2.08	2.07
75-200 (34-91)	3.04	2.76	2.97	2.80
30-200 (13.6-91)[a]	2.80	2.51	2.72	2.56
Backfat, in (cm)	1.41 (3.59)	1.46 (3.72)	1.34 (3.41)	1.44 (3.66)
% Lean [b,c]	52.70	53.30	54.00	53.20

[a] Tallow addition x type of house (p<.10)

[b] Tallow addition x type of house (p<.05)

[c] % Lean = 21.3 x .055 (lb hot carcass) − 17.75 (in. aver. carcass backfat)

Adding 5% tallow to the diet increased average daily gain 5.6%, improved feed conversion 8%, increased backfat thickness 4% with no effect on percent lean. This improvement in performance with the high energy diet is consistent with the earlier work with 5% fat added to the diet of growing-finishing swine.

The primary purpose of this study was to determine if the effect of added tallow was the same in the two types of buildings. The trait averages for each building-diet treatment group are given in Table 4. The effect of the added tallow on average daily gain was similar in both buildings. Pigs fed the tallow added diets grew faster in both buildings. There is indication, however, that the tallow improved feed efficiency more in the ER building than in the MOF. This greater improvement in the warmer ER building (2.80 vs 2.51) than in the MOF (2.76 vs 2.56) is consistent with results from Georgia. Also, the response to added tallow was different in the two buildings for percent carcass lean. The added tallow increased lean percent in the ER building (52.7 vs 53.3) but decreased percent lean (54.0 vs 53.2) in the MOF. These differences are small and need further research.

As indicated by the averages in Table 4, the response to the added tallow seemed to be larger during the finishing phase than during the growing phase. While the fat improved gain and feed conversion during both periods, the response was greater during the finishing period. The pigs apparently made better use of the high energy diets from 75 to 200 lb (34 to 91 kg) than from 30 to 75 lb (13.6 to 34 kg).

Summary

Data from this experiment indicate that the addition of 5% tallow to the diet of growing-finishing swine fed during the winter months will improve average daily gain and feed conversion in either an environmentally regulated building or a modified-open-front building. The improvement in performance due to the high energy diets was greater during the finishing phase than in the growing phase.

The study also indicated that the MOF building supports performance during winter on a basis equal to the more expensive, utility-dependent ER building. Even though the initial weight of the pigs in this study was 30 lb (13.6 kg) it should be noted that the MOF is designed to accommodate pigs from 40 lb (18.1 kg) to market. Starting pigs under 40 lb (18.1 kg) in the MOF during winter requires careful consideration.

At present, an improvement in both gain and feed conversion can be expected from the addition of 5% tallow to the diets of growing-finishing pigs in both environmentally regulated or modified-open-front buildings.

Newer Dewormers for Swine

Donald L. Ferguson
Professor, Parasitology

In Nebraska, the most common internal parasites of pigs are the large intestinal roundworm — *Ascaris suum,* the whipworm — *Trichuris suis,* and the lungworms — *Metastrongylus spp.* You will find these worms in almost every swine herd in Nebraska, and it is not unusual to find several hundred worms in one pig. In a wormer trial conducted at the North Platte Station, we recovered 532 ascarids from the small intestine of 140-day-old pig.

Certain swine dewormers are highly effective against only one species of worms. If the herd problem involves only one parasite, then the product is worthy of consideration. However, if several different parasites are present in the herd, then a dewormer is desired that will effectively remove as many species as possible.

Piperazines

The piperazine compounds were introduced in 1947, but it was not until the mid-1950's that they were critically assessed and used extensively. Five forms of piperazine are usually available, namely piperazine citrate, dihydrochloride sulphate, a mixture of mono- and dihydrochlorides and piperazine-I-carbodithioic acid. Piperazines are the most popular swine dewormers.

Mode of Action: Piperazines act by blocking the neuromuscular junction so that the worms become paralyzed and pass out in the feces. They are effective against the large roundworm — *Ascaris suum* and nodular worm — *Oesophagostomum spp.*

Mode of Administration: Piperazines are supplied in liquid and powder formulations. They can be administered in ready-mixed piperazine feeds, by adding piperazine liquid solution to drinking water, or by mixing soluble piperazine powder in either feed or water.

Piperazines should be administered over a 24-hour period. The dosage prescribed on the package, or recommended by our veterinarian, should be mixed with that amount of feed or water which will be consumed in 24 hours. No more feed or water should be put out until the medicated material has been consumed.

Safety and Toxicity: The most outstanding feature of the piperazines are their great margin of safety. They are relatively nontoxic and, when given at the recommended therapeutic levels, are quite safe. No serious forms of intoxication have been reported with doses which are in excess of therapeutic doses by 4 to 10 times. If administered properly, piperazines can be given safely to sows within one month of parturition. In addition, they can be fed to gilts, boars, and young breeding stock.

Cost: It costs about 3¢ to deworm a 50-pound pig.

Hygromycin B

Hygromycin B, a fermentation product of the mold *Streptomyces hygroscopicus,* is an antibiotic that effectively removes large roundworms — *Ascaris suum,* whipworms — *Trichuris suis,* and nodular worms — *Oesophagostomum spp.* from pigs.

Mode of Action: The initial action

(continued on next page)

The large intestinal roundworm of swine, *Ascaris suum*.

Dewormers for Swine

(Continued from page 9)

of hygromycin against internal parasites evidently is directed at reducing the capacity of the females to produce worm eggs. The antibiotic apparently is fatal to the worms, but its action seems to be a cumulative one. Rapid expulsion of mature ascarids, so common following piperazine therapy, is not characteristic of hygromycin.

Mode of Administration: Ease of administering hygromycin B is its greatest advantage. It is added to a complete feed or protein supplement. When administered as a farm-mixed supplement, care should be used since 6,000 units/lb. is near borderline for effectiveness and in a farm-mixed ration, this could easily be reduced.

Safety and Toxicity: Hygromycin B has a wide margin of safety, but since it is a streptomycin-like substance, it also has some toxic effects. The incidence of deafness increases as pigs are left on medication for long periods. For this reason, it is suggested that medication be removed after the pigs reach 125 pounds. This allows for recovery of some of the hearing damage produced early in treatment.

Cost: Feeding hygromycin B to a pig from 30 to 125 pounds costs about 22¢ per pig. The advantage is continuous freedom from egg-laying worms.

Atgard (Dichlorvos)

Atgard is a highly effective anthelmintic which removes sexually mature (adult), sexually immature and/or fourth stage larvae of the whipworm — *Trichuris suis,* nodular worm — *Oesophagostomum spp.*, large roundworm — Ascaris suum, and the mature, thick stomach worm — *Ascarops strongylina* occurring in the lumen of the gastrointestinal tract of pigs.

Mode of Action: Worms expelled from pigs following treatment with Atgard are dead. The cholinesterase levels of the worms are suppressed sufficiently to result in the death of the parasites.

Mode of Administration: The preparation should be added to the indicated amount of feed and mixed thoroughly. Do not allow pigs access to feed other than that containing the dewormer until treatment is complete. Resume normal feeding schedule afterwards. Preconditioning or fasting pigs overnight is not necessary or recommended. Do not store the medicated feed as prolonged exposure lowers the anthelmintic efficiency.

Safety and Toxicity: Atgard (dichlorvos) is a cholinesterase inhibitor. Do not use this product on pigs simultaneously or within a few days before or after treatment with or exposure to cholinesterase-inhibiting drugs, pesticides, or chemicals. Swine showing signs of increased intestinal peristalsis such as that caused by bacterial or viral enteritis, or certain feeds such as new alfalfa, should not be dewormed until these signs subside or are brought under control by proper therapy.

Whipworms attached to the lining of the large intestine.

Cost: It costs about 15¢ to deworm a 50-pound pig.

Tramisol (levamisole hydrochloride)

Tramisol is effective against the following nematode infections in swine: Large roundworm — *Ascaris suum,* nodular worms — *Oesophagostomum spp.,* lungworms — *Metastrongylus spp.,* and intestinal threadworm — *Strongyloids ransomi.*

Mode of Action: After administration, Tramisol is rapidly absorbed into the bloodstream and carried to all parts of the body, including the lungs, and the whole gastrointestinal tract. Peak levels in the blood are reached within 30 minutes.

Tramisol inhibits succinate dehydrogenase activity in worms producing muscular paralysis. Practically all of the gastrointestinal and pulmonary worms are expelled within 24 hours of Tramisol treatment.

Mode of Administration: Tramisol can be administered in the drinking water or feed. Before treating, withhold the water from pigs overnight. No other source of water should be offered. As soon as the pigs have consumed all of the medicated water, you should resume use of regular water. When using the premix or medicated feed, withhold the regular feed from the pigs overnight and then administer the medicated feed the following morning. To ensure the most effective deworming, the medicated feed should be consumed rapidly. Have sufficient

Lungworms in the bronchioles of the lungs.

trough space to allow all of the pigs to eat at the same time. When the medicated feed is consumed, resume normal feed.

Safety and Toxicity: Salivation or muzzle foam may be observed following treatment. This reaction is occasionally seen and will disappear in a short time. If pigs are infected with mature lungworms, coughing and vomiting may be observed soon after the medicated water is consumed. This reaction is due to the expulsion of worms from the lungs and will be over in several hours. Follow the recommended dosage carefully to assure removal of the worms and avoid an overdose of Tramisol. Do not administer Tramisol within 72 hours of slaughter.

Cost: It costs about 10¢ to deworm a 50-pound pig.

Banminth (pyrantel tartrate)

Banminth is recommended for the removal and control of the large roundworm, *Ascaris suum,* and the nodular worm, *Oesophagostomum spp.* In addition, it aids in the prevention of migration and establishment of ascarid infection and in the prevention of establishment of nodular worm infection.

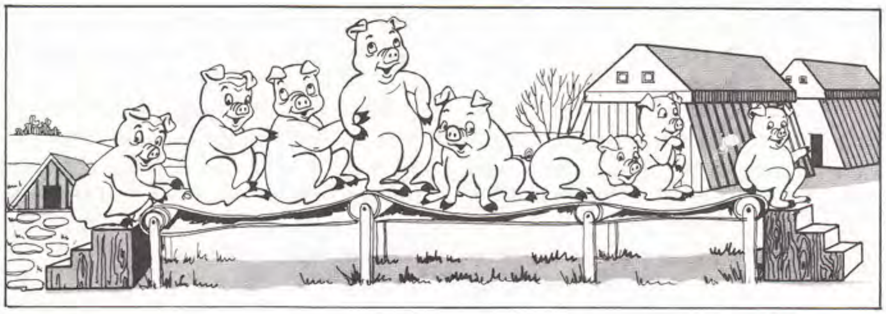
Mode of Action: Banminth kills the young worms (larvae) as they hatch from the eggs in the intestine, and it kills the adult worms which spread worm problems by seeding the environment with eggs.

Mode of Administration: Banminth is recommended for use in swine feeds. It shows excellent stability in both meal and pelleted feeds and in the premix and bulk forms. For example: In the premix, Banminth retained 100 percent of its original activity after 12 months of storage at room temperature and after 6 months at 113° F (45° C) and 140° F (60° C).

Safety and Toxicity: Banminth is safe for use in swine when fed at levels of 96 g/ton continuously and at 800 g/ton as directed. No evidence of toxicity was observed when Banminth was administered to pigs at the level of 1,000 g/ton of feed continuously for 119 days. In addition, Banminth showed no adverse effects on reproductive performance of swine when administered during the growing phase or during pregnancy.

Consult your veterinarian before using Banminth in severely debilitated animals. Do not mix it in feeds containing bentonite. Do not store medicated feed. Withdraw Banminth from the feed 24 hours before slaughter.

Cost: It costs about 5¢ to deworm a 50-pound pig. When placed in the feed for 60 days to prevent larval migration, it costs about 70¢.



Building and Space

Effect on Growing Pigs

R. D. Fritschen
District Extension Specialist (Animal Science)

Jerry Jensen
Livestock Research Technician

Increased building construction costs are concerning pork producers about more efficient utilization of floor space. Two common methods employed are regrouping and utilizing different size pens.

Space requirements depend on pig size. Since pig size changes daily during the weaning, growing, or finishing period, providing the "optimum" space is a management challenge of the first magnitude.

If pens are stocked with enough 40 pound (18.1 kg) pigs to allow eight square feet at market weight, the pigs will be utilizing only 50 percent of the space efficiently until they reach about 100 pounds (45.4 kg). Producers with the same size pens throughout a growing-finishing unit must choose between this understocking and regrouping.

The study reported here investigated effects of understocking in two types of buildings. Equal sized pens in a single slope roofed modified open-front (MOF) building and an environmentally regulated (ER) building were stocked with 10 or 20 pigs per pen during the growing phase. The experimental design and results are shown in Table 1.

Overall, the pigs in the MOF gained faster and were slightly more efficient than those in the ER building. When the pens with 10 pigs are compared between buildings the pigs in the MOF gained significantly faster ($P<.01$) than those in the ER building. The same trend (6 percent advantage) occurred for the pens with 20 pigs although the difference was not statistically significant.

In looking at the differences in 10 versus 20 pigs per pen within and between buildings, pens in the MOF with 10 pigs gained faster (1.32 lb (.6 kg) *vs* 1.26 lb (.57 kg)) and more efficiently (2.42 vs 2.53) than pens with 20 pigs. This same space effect was not expressed in the ER building as pens with 10 or

(continued on next page)

Table 1. Effect of building type and pen occupancy rate on gain and feed:gain.

Bldg.	E (MOF)				D (ER)			
No. of reps	4		4		4		4	
No. per pen	10		20		10		20	
Free space per pig, ft² (m²)	9.0	(.84)	4.3	(.38)	9.0	(.84)	4.3	(.38)
Avg. bg. wt., lb (kg)	28.7	(13)	28.9	(13.1)	28.4	(12.9)	28.8	(13.1)
Avg. final wt., lb (kg)	102.9	(46.8)	99.6	(45.3)	94.8	(43.1)	95.2	(43.3)
Avg. da. ga., lb (kg)	1.32[a]	(.6)[a]	1.26	(.57)	1.18[a]	(.54)[a]	1.18	(.54)
Feed:gain	2.42		2.53		2.54		2.56	

[a]Means differ significantly ($P<.01$).

Growing Pigs

(Continued from page 11)

20 pigs gained at the same rate for the period (ADG = 1.18 lb (.54 kg)) with F:G being nearly equal (2.54 vs 2.56 for the pens with 10 and 20 pigs, respectively).

The pig's need for additional space is expressed very subtly as the pig increases in size. Ambient temperature also plays a role. The size-temperature and number per pen effect on gain is shown in Figure 1.

For the gravity ventilated MOF building there was essentially no difference in gain between pens with 10 or 20 pigs until the pigs reached a weight of about 60 pounds (27.2 kg). However, from 60 pounds (27.2 kg) until the study was ended the difference in gain increased steadily in favor of pigs with more space. Compared to the ER building, temperature did not appear to interfere with gain in the MOF even though the mean temperature did fluctuate upward from the second two week weigh period on.

In the ER building the 20-pig pens gained more rapidly than the pens with 10 pigs during the two initial weigh periods. After the pigs weighed 58 pounds (26.3 kg), but before they weighed 78 pounds (35.4 kg), the pens with 10 pigs began to gain more rapidly than pens with 20 pigs.

These results suggest that 4.3 square feet (.38 sq. m) per pig up to about 58 pounds (26.3 kg) may be more beneficial than 9 square feet (.84 sq. m). But when pigs reach about 58 pounds (26.3 kg) their space needs as expressed by growth rate changed so that pens with 10 pigs were gaining more rapidly during the last two weigh periods. It also appears that in the ER building high temperatures depressed gain while this was not the case in the MOF building. Figure 2 graphically shows the relationship between F:G at two week weigh intervals or pig size and ambient temperature.

Pens with 10 pigs in the MOF were slightly more efficient at the start than pens with 20 pigs. The relative differences in efficiency became greater during the second and third weigh period. In this regard the F:G curve was similar to the ADG curve. Again mean temperature did not appear to affect F:G in the MOF.

The F:G pattern in the ER building favored pens with 20 pigs during the two initial weigh periods and reversed during the second and third weigh period. The pens with 10 pigs were more efficient during the last two weigh periods. As with the gain comparisons F:G also appeared adversely affected by higher ambient temperatures in the ER building.

Conclusions

Because pens with 20 pigs in the MOF building gained over 6 percent faster than pens with 10 or 20

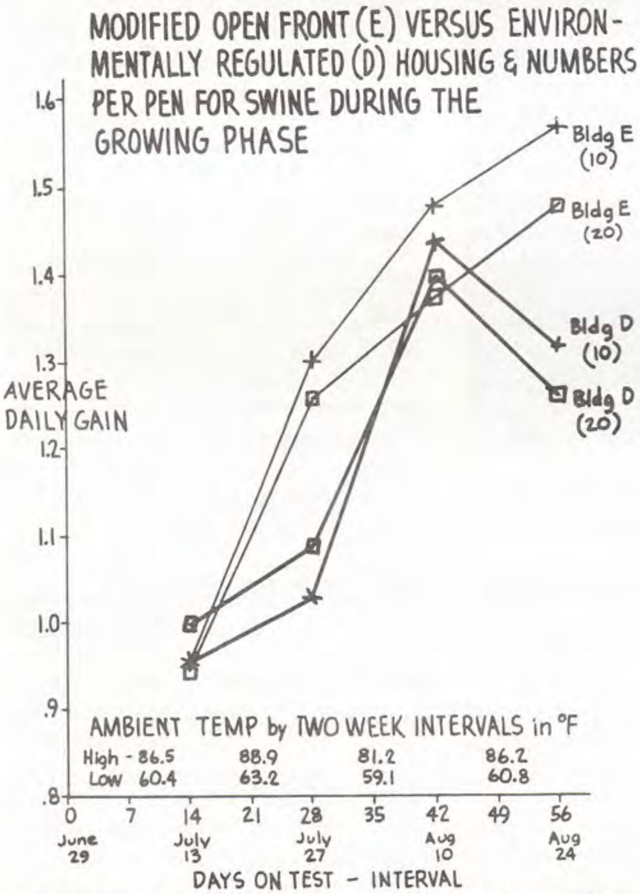


Figure 1. Effect of size-temperature and number of pigs per pen on gain.

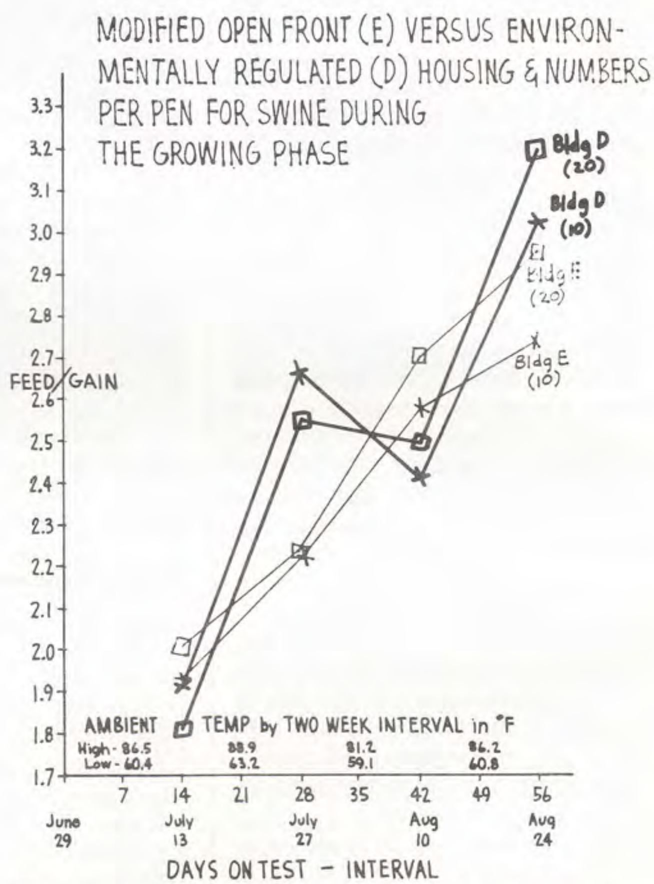


Figure 2. Effect of size-temperature and number of pigs per pen on feed/gain.

pigs in the ER building it appears that space requirements for the MOF may not be the same as for the ER building.

Since pigs in the 20 per pen groups gained as fast and as efficiently as those in the 10 per pen groups in the ER building, additional space beyond 4.3 square feet (.38 sq. m) per pig in this style building appears wasteful until after about 75 pounds (34 kg) and before 100 pounds (45.4 kg).

In the MOF building pigs with 9 square feet (.84 sq. m) gained more rapidly and more efficiently up to 100 pounds (45.4 kg) than pigs receiving 4.3 square feet (.38 sq. m). Since factors in addition to gain and F:G are involved in total economic returns from a building in a fixed period of time, it is difficult to conclude that 9 square feet (.84 sq. m) supports better total building efficiency than 4.3 square feet (.38 sq. m).

And finally, it can be concluded that the MOF supported improved gain and F:G when compared to the ER building.

Grain Handling Critical in Swine Feeding

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

Proper harvesting, drying and storage of grain for use in swine feeds is absolutely necessary to avoid swine production problems. Low quality grain can result in reduced gains, poor feed conversion, poor reproduction, and possibly heavy death loss.

Current grain production methods allow us to harvest high moisture grain, dry it and store it in the fall before bad weather and winter set in. Previously, grain was harvested when field-dried to a moisture level considered low enough for long-term storage. The grain producer, always at the mercy of the weather, cannot afford to take this risk today.

Grain Drying Problems

Mechanical grain drying is not without problems. First, fuel energy required to dry grain is costly and may be in short supply. Second, if not dried properly (temperature too high or moisture level not lowered enough) the feeding value of the grain will be affected.

Corn dried at too high a temperature will result in reduced gains and feed efficiency. It probably will have little effect on reproductive performance and should not result in death of the pigs consuming it.

Grain not dried to a moisture level low enough for long term storage (12-14%) will cause a great number of problems when the weather warms up in the spring. Grain normally goes through "the sweats" around seeding time and air and/or heat must be put on the grain to keep it from becoming moldy. Pigs fed moldy grain will often show reduced gains and feed conversion, abortions and other reproductive problems and even heavy death loss. Proper handling of grain at harvest and during storage can help avoid problems.

Drying Factors

Local elevators are currently drying grain at 180° to 220° F (82° to 104° C). Generally, the higher temperature is used for milo and the lower one for corn. Some discoloration will occur in corn dried in this range. What is the best temperature to dry corn? The answer is not clear-cut. Consider, for example, some factors important in the drying of corn:

1. *Temperature* — in most situations the drying temperature is the temperature of the air off the burner — not the temperature of the grain, which is a function of air flow.

2. *Efficiency of drying equipment* — it could be misleading to read that one researcher found it beneficial to dry grain at 400° F (204° C) when another reported that quality of grain dropped at 212° F (100° C). The higher temperature could have been for a continuous-flow dryer requiring only a few minutes to complete the process, while the 212° F (100° C) temperature may have been for an inefficient system that required a longer time to reach the same final moisture level than the continuous flow system.

3. *Relative Humidity* — more time is required to dry grain on a humid day.

4. *Initial moisture of grain* — a higher initial moisture of the grain prolongs time of drying. This can result in a deleterious effect on grain protein quality.

Research in the early 1950s by Hathaway and associates at the Nebraska Station showed that nutritive value of corn as an energy or protein source for rats decreased as drying temperature increased from 80° F (27° C) to about 194° F (90° C). Protein seemed to be more affected than energy (Table 1). Later, Hudman and Peo found that pigs fed corn dried at 130° F (54° C), 160° F (71° C), or 190° F (81° C) gained less than those fed corn purchased on the open market but more than those fed air-dried corn (Table 2). The

(continued on next page)

Table 1. Effect of drying temperature on nutritive value of corn (rat test).[a]

Drying temperature °F	°C	% Relative gain (8 wks) Corn used as source of energy	Corn used as source of protein
81	27 (control)	100	100
118	48	97	103
140	60	93	101
160	71	92	82
180	82	92	68
200	93	91	80
240	116	91	80

[a]From Hathaway *et al.* (1952) JAS 11:430.

Grain Handling Critical

(Continued from page 13)

pigs' response to corn dried at the various temperatures was similar to that found with rats by Hathaway.

Recently, Rivera at the Nebraska Station dried normal and opaque-2 (high lysine) corn at temperatures from 77° F (25° C) to 257° F (125° C) and fed it to rats. Results are shown in Table 3. Gain was markedly reduced in rats fed corn dried at 257° F (125° C). Also, digestible nitrogen (crude protein digestibility) and availability of lysine were adversely affected by the high temperature. Surprisingly, drying corn at 122° F (50° C) for 42 hours down to 7% moisture was nearly as bad as drying corn at 257° F (125° C). Low temperature drying might have economic advantages but it should not be prolonged. Drying corn at 122° F (50° C) for a short time (down to 12% moisture) resulted in a corn that gave an animal performance similar to the best treatment, where corn was dried at 77° F (25° C) to 12% moisture.

Illinois workers showed that pigs preferred corn roasted at 212° F (100° C) about 3 to 1 over corn roasted at lower or higher temperatures (Table 4). In fact, pigs preferred the 212° F (100° C) roasted corn 1.7 to 1 over non-roasted corn. However, roasting had little influence on gains or feed conversion as shown by the data in Tables 4 and 5.

Occasionally, you might be forced to harvest and dry corn before it has reached maturity. Obviously, yields will be affected severely by early harvest, but the feeding value of the grain is not affected much.

Table 2. Effect of drying temperature on nutritive value of corn.[a]

	Open market	Air dried	Drying temperature, °F (°C) 130 (54)	160 (71)	190 (88)
ADG, lb (kg)	1.29 (0.59)	1.17 (0.53)	1.24 (0.56)	1.23 (0.56)	1.19 (0.54)
F/G	2.6	2.6	2.6	2.5	2.7

[a]from Hudman and Peo (1958) Swine Progress Report 364. Neb. Agr. Exp. Sta.

Table 3. Effect of drying temperature on nutritive value of corn (rat test).[a]

	Drying Temperature °F / °C: 77 / 25[b]	122-L / 50-L[c]	122-S / 50-S[b]	167 / 75[b]	212 / 100[b]	257 / 125[b]
	normal corn					
Total gain, g	45	28	40	38	29	9
F/G	6.8	8.0	6.5	7.2	8.7	20.8
Digestible N, %	94	91	93	90	91	89
Available lysine, %	102	78	91	89	91	79
	opaque-2 corn					
Total gain, g	89	70	94	85	71	53
F/G	4.4	4.5	3.9	4.1	4.7	5.1
Digestible N, %	91	89	91	93	91	89
Available lysine, %	97	93	96	94	91	89

[a]from Rivera (1977), Ph.D. dissertation. Neb. Agr. Exp. Sta.
[b]Dried to 12% moisture.
[c]Dried at this temperature for 42 hours, final moisture level was 7%.

Results of research on the effects of stage of maturity when harvested and drying temperature of normal and opaque-2 corn fed to rats and swine are shown in Tables 6 and 7. As expected, rats and pigs fed opaque-2 corn gained faster and more efficiently than those fed normal corn. This is due undoubtedly to the better quality protein in opaque-2 corn. In the rat study (Table 6) corn harvested 45 days after pollination generally produced lower gains and poorer feed conversion than corn harvested at later dates. This was particularly true for opaque-2 corn.

There was essentially no difference in gains or feed conversion of pigs fed either normal or opaque-2 corn harvested at 52 or 80 days after pollination (Table 7). However, drying temperature of the corns at the two harvest dates was important. It was more advantageous, as measured by animal performance, to dry corn harvested at 52 days post-pollination at 104° F (40° C). A higher drying temperature 140° F (60° C) produced a "better" corn based on digestible nitrogen and available lysine, for corn harvested at 80 days. The reason for the difference is unknown at this time, but the response was the same with both corn varieties.

Storage Management Important

While proper drying temperature is important to assure a high quality feeding grain, proper management of the grain during storage is even more important. Grain coming out of the bin must be of the same high quality that it was when first stored. If the grain is not dried down to 12-15% moisture, mold growth will occur. Also, if the storage bin leaks, enough moisture will get into the grain to cause mold growth. And, as indicated earlier, grain seems to go through "the sweats" around planting time in the spring, and if air and/or heat are not circulated through the grain, severe mold will result. Although a large portion of the mold develops only on the surface, when the grain is pulled from the bin the top collapses into the middle, and soon the whole bin is contaminated with molds. Some molds are extremely toxic to swine while others cause chronic problems.

Fungi are microscopic organisms which cause mold in grain. The "seeds" of fungi are always present on grain and develop when environmental conditions are right. There are many different fungi, but two that cause problems for swine are *Gibberella zea* and *Aspergillus flavus*, the fungus which produces aflatoxin.

Aflatoxin is a powerful carcinogen (cancer-causing agent) and is often acutely toxic and lethal to swine. Research is currently underway to determine if pigs will accept and utilize corn treated with ammonia, a chemical that will reduce or eliminate aflatoxin in contaminated corn. Data shown in Table 8 clearly indicate that pigs will perform well on ammonia-treated corn. The procedures and clearance for treating corn with ammonia are still being negotiated.

In addition to the toxins produced, molds also produce substances (which may also be toxins) which interfere with normal coagulation of blood. In 1970, Fritschen at the Northeast Nebraska Experiment Station reported on a bleeding pig disease thought to be caused by moldy

(continued on next page)

Table 4. Acceptability of corn roasted at different temperatures to swine.[a]

Roasting temperature[b]		% of each corn chosen by pigs	Diet protien %: 9[c] ADG, lb, (kg)	9[c] F/G	19 ADG, lb, (kg)	19 F/G
°F	°C					
176	80	12.1	0.18 (.08)	6.7	1.00 (.46)	2.1
212	100	34.1				
248	120	10.1				
284	140	12.6				
320	160	11.1				
	REG	20.2	0.20 (.09)	7.1	0.97 (.44)	2.1

[a]From Costa *et al.* (1976) JAS 42:365.

[b]Roasted in a Roastatron. Corn temperature at discharge. Flow rate 30-35 seconds.

[c]All corn diet.

Table 5. Effect of roasting temperature on nutritive value of corn for swine.[a]

	Roasting temperature °F (°C)[b]: REG	180 (82)	219 (104)	261 (127)	284 (140)
Growing swine					
ADG, lb (kg)	1.41 (0.64)	1.41 (0.64)	1.39 (0.63)	1.45 (0.66)	1.36 (0.62)
F/G	1.69	1.69	1.72	1.72	1.69
Finishing swine					
ADG, kg	1.85 (0.84)	1.85 (0.84)	1.85 (0.84)	1.72 (0.78)	--
F/G	2.70	2.56	2.56	2.70	--

[a]From Costa *et al.* (1977) JAS 44:234.

[b]Exit temperature of corn from Roastatron. Initial moisture level of corn going in was 23%, coming out 20% and final 13%

Table 6. Effect of stage of maturity on nutritive value of corn (rat test).[a]

	Days after pollination: 45	51	58	65	72	79
Normal corn						
ADG, g	2.2	2.6	2.5	2.0	2.5	2.7
F/G	4.5	4.2	4.5	4.8	4.2	4.2
Opaque-2 corn						
ADG, g	4.4	5.7	6.4	6.0	6.9	5.5
F/G	2.8	2.3	2.2	2.2	2.1	2.4

[a]From Rivera (1977), Ph. D. dissertation. Neb. Agr. Exp. Sta.

Table 7. Effect of stage of maturity and drying temperature on nutritive value of corn for baby pigs.[a]

	Normal corn				Opaque-2 corn			
Maturity (days after pollination)	52		80		52		80	
°F	104	140	104	140	104	140	104	140
Drying temp., °C	40	60	40	60	40	60	40	60
Total gain, lb	14.1	14.5	13.9	13.4	22.2	21.1	21.6	20.0
(kg)	(6.4)	(6.6)	(6.3)	(6.1)	(10.1)	(9.6)	(9.8)	(9.1)
F/G	2.9	2.8	2.8	2.7	2.4	2.3	2.3	2.5
Digestible N, %	94	88	88	90	94	90	92	93
Available lysine, %	92	85	81	88	94	87	90	94

[a]From Rivera (1977), Ph.D. dissertation. Neb. Agr. Exp. Sta.

Table 8. Acceptance and utilization of aflatoxin-contaminated corn treated with aqueous or gaseous ammonia.[a]

	% in Diet			Free Choice	
Regular corn[b]	78	39	--	100	--
NH_3-treated corn[c]	--	39	78	--	100
ADG, lb (kg)	1.58 (.72)	1.58 (.72)	1.50 (.68)	1.58 (.72)	1.45 (.66)
ADFI, lb (kg)	4.51 (2.05)	4.05 (1.84)	4.09 (1.86)	4.36 (1.98)[d]	4.16 (1.89)[e]
F/G	2.85	2.56	2.74	2.75	2.87

[a]From Jensen *et al.* (1977) JAS 45:8.

[b]Yellow dent corn.

[c]White dent corn. Initially 100 ppb total aflatoxin when treated with anhydrous NH_3 gas. When fed the corn had no detectable aflatoxins.

[d]Pigs selected 2.3 pts corn to 1 pt supplement.

[e]Pigs selected 1.17 pts corn to 1 pt supplement.

Grain Handling Critical

(Continued from page 15)

feed. Symptoms seen from feeding moldy grain are:

All classes of swine

- Feed refusal
- Vomiting
- Dysentery
- Spontaneous hemorrhages throughout the body

Reproducing Swine

- Enlarged vulvas
- Lowered ovulation rate
- Abortions
- Fewer live pigs farrowed
- Greater number of mummified pigs

Antibiotics are not effective against mold toxicity.

Obviously, if you have or suspect you have moldy grain, the safest solution is to discard it. However, throwing the grain away could mean a sizable economic loss. Dead or poor performing swine are also quite an economic loss. There are a few things that can be done to check whether or not moldy grain is toxic (not all molds are toxic to swine) and possibly offset some of the effects:

1. Have grain sample checked by a laboratory for aflatoxin.
2. Mix suspect grain in no more than a 50:50 ratio and feed to a few young pigs before feeding to entire swine herd.
3. Include 2 to 4 grams of menadione sodium bisulfite (vitamin K) per ton of complete feed to prevent spontaneous hemorrhages.
4. **Do not** feed moldy grain to bred animals.
5. Test feed moldy grain to non-bred, non-lactating cattle since microorganisms in the rumen tend to destroy some of the mold toxins.

Fortunately, no aflatoxin has been found in Nebraska corn this fall (1977). The real question is whether or not aflatoxin or some other mold toxin will be present when grain comes out of the bin for feeding next spring. Careful attention to harvesting, drying and storage of grain can do much to reduce this major problem in swine feeding.

Energy— Are You Using It Wisely?

James A. DeShazer
Professor, Agricultural Engineering

David P. Shelton
Research Associate

Energy is work and heat. How fast we work or add heat to our farm buildings is power. Power is energy used per unit time. Units for power are horsepower, British Thermal Units (BTU) per hour and watts. Watts is the accepted international unit for power. Energy can be expressed as watt-sec which equals a joule or as you normally see it on your electric bill, kilowatt-hour (kW-hr). A kilowatt-hour equals 3413 BTU.

Energy Sources

Solar energy is the major source of energy. The rate at which solar energy reaches the earth's atmosphere is 1.4 kilowatts per square meter ($1.4kW/m^2$). A square meter equals 10.7 square feet. The rate of solar energy striking a surface normal to the sun's rays at noon on a farmstead in Nebraska is $0.9kW/m^2$.

Solar energy can be stored in plants through the process of photosynthesis, by raising the temperature of a mass, or by changing phase, e.g. evaporation. Therefore, stored solar energy is disguised as fossil fuels, plants, wind and hydropower.

Energy doesn't have to come from the sun. Atomic reactions on the earth can occur just as they do on the sun. Also the forces of the universe such as tides caused by the moon can be a source of energy to be used to perform work.

Energy Values

A large number of energy sources are available to operate a swine enterprise. Table 1 presents the energy values for different sources. The values will help make cost comparisons among the sources.

One of the most convenient and overlooked sources of energy for heating a swine building is the pig. The heat produced by four sows and litter or by 10 growing-finishing pigs in one day is equivalent to the heat output of a gallon of propane. If propane costs 40¢ per gallon then each sow and litter would produce an equivalent of 10¢ of fuel per day, and each growing-finishing pig would produce an equivalent of 4¢ of fuel per day. For a 20 stall farrowing barn, this would amount to $2 per day or $84 per 6 weeks. For a 200 pig capacity growing-finishing building, this would amount to $8 per day or $1,000 per growing period of 120 days.

Other "farm grown" energy sources include wood, crop residue, livestock waste and methane. Wood is an excellent choice if available on the farm and you need to remove the dead wood from the grounds. If you have to buy wood, then you need to closely figure your cost and determine the dependability of supply. A cord of wood (128 cu. ft.) will produce about 3,500 kW-hr of energy. This is equivalent to the heating value of 150 gallons of propane. If propane costs 40¢ per gallon then the equivalent energy cost for a cord of wood is $60. The cost of wood delivered in some areas is $90 per cord.

Crop residue as an energy source might require more energy to retrieve from the field than what you would save by using it. Twenty-six pounds of dry crop residue is equivalent to one gallon of propane.

Methane generation from animal wastes is being studied. It has drawbacks because of surveilance requirements and equipment needs.

Solar energy is almost a perfect heating fuel. This energy is pollution free, will not be depleted and is available at the farmstead without delivery cost. On the average in Nebraska we have the potential of collecting 2.6 kW-hr/day/square meter. Eight square meters of collector will collect solar energy equal to a gallon of propane per day. Therefore, collector cost plays an important role in determining the feasibility of using solar energy in swine housing.

Table 1. Energy values for various sources.

Source	Energy[a]	Per Common Unit	Efficiency Heating	Efficiency Engines
Solar	3,100 W-hr	day per m^2 (10.7 sq ft)	70%	—
Swine				
Sow + litter	7,000 W-hr	day	100%	—
Growing Finishing Pig				
50 lb (23 kg)	1,700 W-hr	day @ 50F (10C)	100%	—
50 lb (23 kg)	1,006 W-hr	day @ 68F (20C)	100%	—
100 lb (45 kg)	2,470 W-hr	day @ 50F (10C)	100%	—
100 lb (45 kg)	1,400 W-hr	day @ 68F (20C)	100%	—
200 lb (91 kg)	3,660 W-hr	day @ 50F (10C)	100%	—
200 lb (91 kg)	2,260 W-hr	day @ 68F (20C)	100%	—
Sawdust	20,000 W-hr	cu. ft. (0.029 cu m)	50%	—
Wood	50,000 W-hr	cu. ft. (0.029 cu m)	50%	—
Crop residue (dry)	1,760 W-hr	lb. (.454 kg)	50%	—
Livestock waste (dry)	1,760 W-hr	lb. (.454 kg)	50%	—
Coal	3,660 W-hr	lb. (.454 kg)	65%	—
Methane	2,500 W-hr	cu. ft. (0.029 cu m)	80%	—
Natural gas	3,000 W-hr	cu. ft. (0.029 cu m)	80%	—
Propane	27,000 W-hr	gal. (3.785 liter)	80%	—
Electricity	750 W-hr	hp-hr	100%[b]	30-90%
Heating oil	41,000 W-hr	gallon (3.785 liter)	70%	—
Diesel	41,000 W-hr	gallon (3.785 liter)	70%	30%

[a] 3.41 BTU = 1 W-hr

[b] with a heat pump the heating efficiency will be above 100%.

Energy Uses

Work: Replacement of manual labor with equipment for the large time consuming jobs of feed handling and waste management is a good practice. The power output of a human is approximately 0.07 kW. Over a 10 hour period this equals 0.7 kW-hr. If an electric motor was used, then 1.0 kW-hr of electricity would be needed to complete the job at a cost of about 4¢ assuming an electric rate of 4¢ per kW-hr. With labor at $3 per hour the cost would be $30, or 750 times the cost for purchasing electricity. Of course, the amortization of the cost of the equipment to replace your labor must be considered.

Heating: Heating livestock buildings is done to provide an environment for efficient feed conversion or prevention of baby pig losses. With feed costing about 5¢ per pound and propane costing about 40¢ per gallon, feed costs twice as much as propane per unit of heating energy obtained.

Two major heating methods exist, air heating and surface heating. Heating the air is common practice in insulated swine buildings. The average heat loss of well insulated buildings is 2 watt-hours per 2° F (1° C) temperature difference. If the building is not well insulated, then surface infrared heating is a good alternative. Both will have about the same energy requirement. Other heating methods are being investigated. The University of Illinois has demonstrated that floor heating required less energy than infrared and space heating for the same growing-finishing hog performance.

Energy Conservation

Work: Regular maintenance of electric motors will conserve energy. Correctly sizing the motor to the job will allow for efficient usage of energy. Natural ventilation will also conserve the energy that would normally be required to operate the ventilation fans.

Heat: To conserve heat in swine buildings you need to insulate the building and maintain the minimum ventilation rate required for moisture control.

Increasing the heat loss resistance of a swine building has diminishing return. Therefore, economics determine how much insulation should be placed in the swine building. If a swine building has an R-value in the walls of 3, 6 or 12, then the watt-hours (W-hr) of energy passing through a square meter of wall per 2° F (1° C) difference between the inside and outside temperature every hour would be 2.0, 1.0 and 0.5, respectively. Therefore, for the first doubling of R-value, the heat loss was reduced by 50%. The second doubling of R-value reduced the heat loss by only an additional 25%.

Increasing the ventilation rate will cause an increase in the heat requirement of the building in order to maintain the same inside air temperature. For each 100 cfm (2.9 cu meters per minute) of ventilation air used in the building, 1.4 kW-hr of energy per 2° F (1° C) difference between inside and outside temperature is lost per day. Therefore, ventilation rates should be kept as low as possible while still maintaining proper moisture levels in the structure.

Effect on Average Daily Gain

Changing Grain Sources

D. M. Danielson
Professor, Animal Science

M. E. England
Research Assistant

D. S. Pollman
Research Assistant

Increased emphasis on least cost computer fed formulation raises the question of what effect changing grain sources in a growing-finishing diet has on pig performance. If the pig's performance does not suffer, the producer can afford to change diets in his program whenever it is economically feasible. This study was started to determine if changing the grain source in the diet at regular two week intervals had any effect on the average daily gain or feed conversion in growing-finishing swine.

Feeding Regime

Three single grain basal diets (Table 1) were formulated on the basis of average composition of components of a 16% diet. The milo and wheat were purchased at a local elevator and were better than average quality. The three diets were then combined to form eight diet regimes: C — corn diet fed continuously; M — milo diet fed continuously; W — wheat diet fed continuously; CM — corn and milo fed alternately, each for two weeks; CW — corn and wheat fed alternately, each for two weeks; MW — milo and wheat fed alternately, each for two weeks; CMW — corn, milo and wheat fed in sequence, each for two weeks; and CWM — corn, wheat and milo fed in sequence, each for two weeks. The last two treatments were included to see if the order of feeding would affect performance. These alternating routines were continued from the start of the study until the animals reached market weight.

One hundred ninety-two crossbred pigs averaging 51.6 lb (23.4 kg) were allotted to four replicates based on weight. Pigs were then randomly assigned to the eight diet regimes within each replicate. Sex was uniformly distributed within each pen of six animals. All pens had a shelter and a concrete apron. Feeding and watering was *ad libitum.* Pigs were weighed at 14 day intervals at which time intake was determined and the diet was changed as indicated by the experimental design. Each replication (48 pigs) was ended when the average weight of the pigs for the respective replication was 220 lb (100 kg).

Table 1. Diet formulations.

Ingredients	1	2	3
		% of diet	
Ground corn	73.6		
Ground milo		73.6	
Ground wheat			81.8
44% SBM	20.5	20.5	12.5
Alfalfa hay	2.5	2.5	2.5
Ground limestone	1.0	1.0	.6
Cyphos	1.0	1.0	1.2
Salt (iodized)	.5	.5	.5
Trace mineral	.1	.1	.1
Vitamin-Antibiotic premix	.8	.8	.8
% protein (as fed)	16.08	18.39	17.45
% fiber (Cell wall constituents)	10.36	9.56	13.40
Ca:P	1.5:1.0	1.4:1.0	1.6:1.0

Table 2. Pig performance.

Diet treatment	Average daily gain lb (kg)	Feed conversion
C	2.02 (.92)	3.06
M	1.96 (.89)	3.22
W	1.87 (.85)	3.20
CM	1.98 (.90)	3.20
CW	1.92 (.87)	3.15
MC	1.92 (.87)	3.20
CMW	1.96 (.89)	3.06
CWM	1.98 (.90)	3.06

Grain Source Performance

Average daily gain and feed conversion (units of feed per unit of gain) were the criteria used to determine response to the diet regimes. Performance is given in Table 2.

There was no advantage in average daily gain of feeding one grain source over rotating grain sources [1.96 lb, (.89 kg) for one grain source versus 1.96 lb, (.89 kg) for the rotating regimes]. The only significant difference was between those on corn or milo straight through versus those on wheat [2.01 lb (.91 kg) vs 1.87 lb (.85 kg)]. Similar results have been reported in other studies.

The feed conversion of pigs on a single source was similar to those on changing diets (3.16 vs 3.13). Pigs fed three different grains had a better feed conversion than those on the two grain regimes (3.06 vs 3.18). In line with other reports, those on corn for the entire period had an advantage over those on milo or wheat (3.06 vs 3.21).

Summary

Results of this study indicate that changing the grain source in a growing-finishing diet at regular two week intervals did not depress average daily gain or feed conversion. However, caution should be used in that if grain quality is altered the animal performance could also be significantly altered. Also, a shorter interval (less than two weeks) from that reported in this study might indicate greater differences in pig performance when utilizing different grain sources in a finishing diet.

Limited-Interval Feeding of Alfalfa

D. S. Pollmann
Research Assistant

D. M. Danielson
Professor, Animal Science

Hand feeding is the most common method of limiting energy intake of sows during gestation. However, there is much interest in self-feeding during gestation.

Self-feeding reduces labor to a minimum, but presents the problem of controlling feed intake. Two methods of control have been used: (1) adding some readily available bulky ingredient to the diet and (2) interval feeding (allowing sows access to feeders for only a limited time each day or every other day).

Studies under many different conditions have demonstrated the value of restricted feeding of the gestation herd. Restricted feeding not only reduces the feed cost, but also often improves litter size farrowed, increases pig birth weight, reduces farrowing problems, and improves sow longevity.

If a feeding method were developed that would have the intake control advantages of hand feeding and the low labor of self-feeding, it would help the producer.

Table 1. Composition of gestation diets.

	Treatment	
Ingredients, %	Dehy	Sun-cured
Alfalfa, sun-cured	—	25.00
Alfalfa, dehy, 17% protein	96.75	—
Corn, ground	—	37.37
Oats, ground	—	17.50
Wheat bran	—	2.50
Soybean meal, 44%	—	12.50
Salt	.50	.50
Monosodium phosphate	2.50	1.78
Limestone	—	2.25
Trace minerals	.10	.10
Vitamin mixture[a]	.15	.50

[a]Provided per pound of complete diet: Vitamin A, 1500 IU; Vitamin D_3, 112.5 IU; riboflavin, 1.0 mg; calcium pantothenate, 1.8 mg; niacin, 4.5 mg; choline chloride, 5.0 mg; and Vitamin B_{12}, 5 mcg.

Limited-Interval Feeding

In this study, the objective was to evaluate "limited-interval" feeding with sun-cured and dehydrated alfalfa. The pelleted experimental diets (Table 1) were fed so all gilts received comparable energy intake per day.

Forty crossbred gilts were bred to farrow between January and March 1977. There were four treatments: (1) 25% sun-cured alfalfa diet fed daily, (2) 25% sun-cured alfalfa diet fed biweekly, (3) 97% dehydrated alfalfa diet fed daily, and (4) 97% dehydrated alfalfa fed biweekly.

Daily hand-fed gilts received diets every morning in individual feeding stalls at the rate of 4.8 lb (2.18 kg) of sun-cured alfalfa (treatment 1) or 6.0 lb (2.73 kg) of dehydrated alfalfa (treatment 3).

Limited-interval fed gilts had feeders filled biweekly. On Monday morning and Thursday afternoon feed was added to supply the equivalent of 6.0 lb (2.73 kg) per head per day (treatment 4) and to supply 4.8 lb (2.18 kg) per head per day in a 10-hole self-feeder (treatment 2). At first the dehy-fed gilts were unable to consume the entire portion, but after two

(continued on next page)

Table 2. Effect of dehydrated alfalfa in limited interval feeding regime in gravid gilt diets on reproductive performance.

	Diets			
	25% Alfalfa		97% Dehy	
Criterion	Daily	Biweekly	Daily	Biweekly
No. bred	10	10	10	10
No. farrowed	10	10	8	10
Farrowing				
No. live/litter	11.50	11.10	10.88	10.33
No. stillborn	.40	.20	.63	.20
No. mummified fetus	.10	.10	.38	.20
Average weight, lb (kg)				
at birth	2.73 (1.24)	2.71 (1.23)	2.60 (1.18)	2.77 (1.26)
at 7 days	5.02 (2.28)	4.88 (2.22)	4.64 (2.11)	4.73 (2.15)
at 14 days	7.39 (3.36)	7.55 (3.43)	6.97 (3.17)	7.41 (3.37)
at 21 days	9.90 (4.50)	10.27 (4.67)	9.75 (4.43)	10.34 (4.70)
No. alive				
at 7 days[a]	9.70	9.10	8.38	7.60
at 14 days[b]	9.30	8.80	7.38	7.20
at 21 days[c]	9.10	8.70	7.00	6.80
Total weaning wt, lb (kg)[b]	90.2 (41.0)	89.3 (40.6)	68.2 (31.0)	70.4 (32.0)
Survival %	79.1	78.4	64.3	65.8
Average daily feed intake, lb (kg)[d]	13.82 (6.28)	11.70 (5.32)	13.66 (6.21)	12.74 (5.79)
Gestation gain, lb (kg)[a]	90.42 (41.1)	93.06 (42.3)	80.52 (36.6)	78.98 (35.9)
Lactation gain, lb (kg)	12.98 (5.9)	.22 (.1)	1.32 (.6)	1.76 (.8)

[a]Diet difference ($P<.10$)
[b]Diet difference ($P<.05$)
[c]Diet difference ($P<.01$)
[d]Method difference ($P<.01$)

Limited-Interval Feeding

(Continued from page 19)

weeks, consumption had increased to the full allotment.

Gilts were maintained in outside lots and allotted to treatments the day of breeding. All gilts were farrowed in a modern farrowing house, and consumed a 16% protein lactation diet *ad libitum*.

Differences between treatments for the number of pigs born, stillborn, and mummified fetuses were not significant. Individual birth weight of pigs from dehy-fed gilts was 2.69 lb (1.22 kg) compared with 2.73 lb (1.24 kg) for pigs from the sun-cured alfalfa group. The dehy-fed group had lower survival rates which accounted for lower total litter weaning weight.

Gestation gain was greater for gilts fed sun-cured alfalfa than for those fed dehy. Both groups were offered about 5800 kcal of metabolizable energy per day, but the dehy group had more acceptability problems.

The limited interval feeding system had no effect on sow performance compared to daily feeding. Average daily feed intake during lactation (ADFI) was the only parameter affected by limited-interval feeding. Gilts on the limited-interval feeding system during gestation consumed 11% less lactation feed than the daily fed gilts.

Summary

1. Using a limited-interval feeding system could reduce labor required with daily feeding. But it is important that the aminals are checked each day. The addition of dehydrated alfalfa affected reproductive performance by a decrease in number weaned and litter weaning weight.

2. Gestation gain was less for the dehy-fed group than for those on 25% sun-cured alfalfa.

3. Gilts fed biweekly consumed 11% less lactation feed than the daily fed group.

4. With the limited-interval feeding system, feed intake and gestation gain can be controlled without affecting reproductive performance in gilts.

Antibiotics and Reproduction

Bruce Treffer
Graduate Student
Bobby D. Moser
Associate Professor
(Swine Nutrition)

The purpose of feeding antibiotics to growing and finishing swine is to improve gains, feed efficiency, and health. What may be more important is the effect of antibiotics on reproductive performance. Conception rate and litter size are important economic traits in swine. Any increase or decrease in these traits can greatly affect the economic outcome of a particular operation.

An experiment was conducted to determine the effect of an antibiotic (Aureomycin) on reproductive performance when added to the flushing, gestation and lactation diets.

Performance Studied

In this experiment, 101 females were used. All were bred and gestated in outdoor dirt pens at the University of Nebraska Field Lab in Mead, Nebraska. The sows farrowed in farrowing crates in a partially slotted floor environmentally regulated farrowing house.

Ten days before start of breeding, half of the females were put on a control (corn-SBM; 14% crude protein, Table 1) flushing diet with no antibiotic and the

Table 1. Percentage composition of diets.

	Flushing	Gestation	Lactation
Protein level	14%	12%	14%
Corn	80.8	85.93	67.78
Soybean meal	14.5	9.7	13.18
Ground limestone	.6	2.22	.42
Dicalcium phosphate	2.55	.6	2.07
Salt (iodized)	.5	.5	.5
Trace minerals	.05	.05	.05
Vitamin premix (control or medicated)	1.00	1.00	1.0
Beet pulp	—	—	10.0
Wheat bran	—	—	2.5
Dehydrated alfalfa meal	—	—	2.5
Total	100.0	100.0	100.0

Table 2. Effect of antibiotic fed during the flushing, gestation and lactation phases.

	Flushing		Gestation		Lactation	
	Control no anti.	Antibiotic 1gm/hd/day	Control no anti.	Antibiotic .5gm/hd/day	Control no anti	Antibiotic 200gm/day
No. sows exposed	50	51				
No. sows pregnant	45	48				
No. of sows farrowed[a]	27	39	34	32	31	35
Pigs born/litter	10.74	10.54	10.41	10.84	10.74	10.51
Pigs born alive/litter	10.22	10.26	9.88	10.63	10.42	10.09
Stillborns/litter	.52	.33	.59	.22	.32	.49
Mummified fetus/litter	.48	.21	.44	.19	.26	.37
No. Pigs/litter						
Alive @ 1 wk	9.33	9.10	8.88	9.53	9.03	9.34
Alive @ 2 wks	9.07	8.82	8.56	9.31	8.77	9.06
Survival						
1 week	90.6	88.8	89.3	89.7	86.7	92.1
2 weeks	88.4	86.0	86.3	87.7	84.2	89.5
Pig weight, lb (kg)						
Birth weight	3.03 (1.38)	3.02 (1.37)	3.01 (1.37)	3.03 (1.38)	2.89 (1.31)	3.14 (1.43)
1 week	5.37 (2.44)	5.55 (2.52)	5.46 (2.48)	5.50 (2.50)	5.19 (2.36)	5.74 (2.61)
2 weeks	8.68 (3.94)	8.59 (3.90)	8.68 (3.94)	8.57 (3.89)	8.34 (3.79)	8.88 (4.03)
Lactation						
ADFI (sows)	10.67 (4.84)	10.14 (4.60)	9.99 (4.54)	10.75 (4.88)	10.14 (4.60)	10.55 (4.79)
Weight change	−6.19 (−2.81)	−6.13 (−2.78)	−9.18 (−4.17)	−2.94 (−1.33)	−1.65 (−.75)	−10.14 (−4.60)

[a] Pregnant sows in excess of farrowing house capacity were sold.

other half on the same diet but with 1 gram Aureomycin/head/day. After a 10-day flushing period, the females were fed a control gestation diet until bred and then switched to one of two gestation diets until farrowing. The two rations were the same (corn-SBM, 12% protein, Table 1) except that one contained Aureomycin at a level which supplied .5 grams/hd/day. After farrowing, the sows were again split into two groups with half put on a non-medicated control lactation ration (corn-SBM; 14% protein, Table 1) and the other half on a diet containing 200 grams of Aureomycin per ton. Sows were full fed during lactation and consumed about 10 pounds (4.54 kg) per head per day which provides one gram of the antibiotic per day.

A total of 101 females were bred and of these, eight did not conceive (Table 2). Since the number in each Auromycin treatment which failed to conceive was nearly the same, no real benefit from Aureomycin on conception can be assumed. Also, the conception rates of the females in this study were relatively high for both groups. In herds where conception is a problem, the use of an antibiotic in the flushing ration might prove more of an advantage.

Adding antibiotic to the flushing ration did not appear to have an effect on any of the other reproductive or pig performance traits studied. The number of pigs born alive was almost identical (10.22 vs 10.26) for both the control and antibiotic fed sows.

Fewer stillborns and mummified fetuses were observed for sows fed the antibiotic ration during gestation (.59/litter vs .22/litter) and (.44/litter vs .19/litter) respectively. Sows fed the antibiotic gestation ration tended to have more total pigs born alive (10.63/litter vs 9.88/litter). This increase was also present for number of pigs per litter alive at one and two weeks after farrowing (9.53 vs 8.88) and (9.31 vs 8.56), respectively. The gestation ration, however, had little effect on pig survival percentage (Table 2). The percent survival for the control and antibiotic fed sows was similar at both one (89.3% vs 89.7%) and two weeks (86.3% vs 87.7%), respectively. This suggests little carryover effect of the antiobiotic fed during gestation into the lactation phase.

Sows on the antibiotic lactation diet did have more pigs alive per litter at one week after farrowing than those on the control diet (9.23 vs 9.03). The same was also true at two weeks (9.06 vs 8.77). The pigs nursing sows fed Aureomycin thus had a higher survival rate: 92.1% vs 86.7% at one week and 89.5% vs 84.2% at two weeks. Some of this greater survival capacity was probably due to a higher average birth weight. Heavier pigs at birth usually are stronger and more likely to live. The pigs from sows on the antibiotic lactation diet remained heavier at one and two weeks of age. The sows on this diet also tended to lose more weight during lactation. This weight loss could be due to a higher level milk production.

Summary

Due to the relatively small number of animals in this study and the lack of greater variations between treatments we cannot reach any solid conclusions on the merits of antibiotics in this phase of production.

There are, however, some interesting trends that suggest antibiotics might reduce stillborns and mummies. The antibiotic fed during gestation may result in more pigs born alive. Similarly, antibiotics fed during lactation may have a positive effect on baby pig survival. These results are worth considering and should warrant more research in this area. It should also be noted that the reproductive performance in the sows used in this study was relatively good. In a herd in which reproductive performance is a problem, the feeding of antibiotics may result in a greater advantage.

New Adjustment Factors For Performance Testing

W. T. Ahlschwede
Extension Livestock Specialist (Swine)

Larry W. Olson
Research Associate

T. E. Socha
Instructor, Veterinary Science

Nebraska pork producers are becoming increasingly aware of the value of breeding stock with "bred-in" ability to produce lean pork rapidly and efficiently.

The best assurances that breeding stock possess these abilities are objective performance test records. Breeding and improvement programs, which have the best chance for genetic improvement, are built upon comprehensive testing and selection procedures.

Most swine testing programs in Nebraska evaluate fat thickness and growth rate. Age and backfat probe at 220 lb (100 kg) are the traits most commonly measured. The logistics of testing large numbers of boars and gilts make it impractical to weigh and probe each pig on the day it reaches 220 lb (100 kg). Hence, procedures have been developed which allow producers to weigh and probe pigs at weights somewhere near the target weight and then adjust these records to the target weight. Experience has taught us that this is an acceptable procedure, provided the adjustments are reasonable and the weight discrepancy is not large.

The size of the weight discrepancy is a practical problem related to the timeliness of the weighing and probing as well as the frequency of weigh days. Adjustment factors are generally accepted by testing organizations for use by all of their cooperators. Factors attempt to describe the average growth and backfat deposition rates of the tested pigs. As new data become available, better adjustment factors can be developed.

Table 1. Number, age, and weight of boars and gilts analyzed.

	Boars	Gilts
Weight		
Number	19,522	34,653
Age, days	140.8	140.8
Weight, lb (kg)	175.0 (79.4)	162.7 (73.8)
Backfat Probe		
Number	12,586	25,441
Weight, lb (kg)	190.0 (86.2)	173.1 (78.5)
Backfat Probe, in (cm)	0.75 (1.90)	0.76 (1.94)

54,085 Pigs Evaluated

Performance records from 54,085 pigs produced by members of the Nebraska SPF Accrediting Agency in 1974 and 1975 were evaluated to establish patterns of growth and backfat deposition (average of three backfat probes). These patterns were used to develop new adjustment factors. The new factors were compared to adjustment factors currently in use to determine their feasibility and accuracy.

The performance records were divided by sex for the analysis of both growth and backfat thickness. The number of records, average age and average weight for the boars and gilts evaluated in this study are shown in Table 1. Only pigs weighing at least 150 lb (68 kg) were probed and included in the analysis for backfat thickness.

The relationships of weight and age and of backfat probe and weight were analyzed by regression techniques to determine the average rates of growth and backfat deposition. Second order regression analyses were performed to determine if nonlinearity was present in the relationships. With the large number of performance records in this study, slight deviations from linear growth and backfat deposition were noted. However, the deviations from linearity were sufficiently small that they could be ignored.

The average growth patterns for boars and gilts are shown in Figure 1. The solid portions of the lines represent the range of ages and weights found in this study. The dashed lines are the extensions of the linear growth lines to the points of zero weight. Growth lines indicate that as market weight is approached, the boars are heavier than gilts at a given age and are growing faster. The rate of gain for boars was 1.66 lb (.75 kg) per day and for gilts was 1.41 lb (.67 kg) per day.

Figure 2 shows the average backfat deposition curves for boars

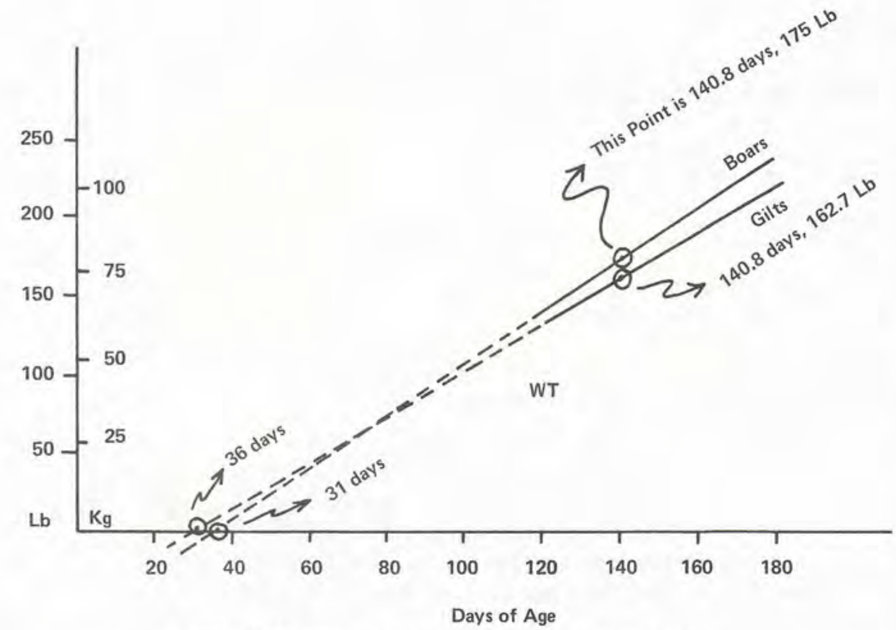


Figure 1. Average growth patterns for boars and gilts.

and gilts. On the average gilts deposited fat more rapidly than boars and were fatter at any given weight than were boars. Backfat deposition rates were 0.003 in/lb (.022 cm/kg) for boars and 0.0044 in/lb (.025 cm/kg) for gilts.

Adjustment Factors

Once the patterns of growth and backfat deposition are determined, several options are available in constructing adjustment factors. One type of adjustment scheme, which has been widely used, assumes the same rate of growth and backfat deposition for all pigs. As historically used, this scheme simply adds one day to the age of the pig for each 2 lb (.91 kg) that the pig weighs less than the target weight. Backfat is adjusted by adding 0.004 in (0.01 cm) for each pound (.454 kg) the pig weighs less than the target weight. These adjustment factors are appropriate if rates of gain and backfat deposition reflect those of the pigs being tested and if the rates are the same for all pigs. The average growth rate of the pigs in this study was about 20% less than the old standard. Backfat deposition for boars was essentially the same as found in this study, but gilts deposited fat about 10% faster. The real difficulty with this additive adjustment scheme is the fact that all pigs do not grow or deposit fat at the same rate. At a given age, a heavier pig had to have grown faster than a lighter pig. For one pig to be fatter at a given weight, he must have deposited fat more rapidly. Adjustment factors which use the pig's own growth rate and fat deposition rate in adjusting age or fat thickness at market usually are more accurate than those which do not.

Adjustment schemes which use a pig's own performance in adjusting the performance record have also been used. This method depends upon standard patterns of growth and backfat deposition, such as those in Figures 1 and 2. If a boar probed at 200 lb (91 kg) is 10% fatter than the standard at 200 lb (91 kg) his adjusted backfat probe at the target weight is taken to be 10% greater than the standard backfat thickness at the target weight. The boar's own backfat thickness at 200 lb (91 kg), i.e., 10% fatter than standard, determined the rate of adjustment and hence the adjusted backfat thickness. This scheme works well when the standard patterns of growth and fat deposition are either linear or curvilinear.

If the standard patterns of growth and backfat deposition are linear, the form of the adjustments can be changed. The following example indicates this method. From the extension of the standard growth pattern (Figure 1) we note that the boar line crosses zero weight at 36 days. Suppose a boar 136 days old weighed 205 pounds (93 kg) and we would like to know his age at 220 lb (100 kg). His rate of growth and his adjustment rate is taken to be

$$\frac{\text{Weight}}{\text{Age} - \text{age at zero wt.}} \text{ or } \frac{205 \text{ lb}}{136 \text{ days} - 36 \text{ days}} = 2.05 \text{ lb/day } \left(\frac{93 \text{ kg}}{136 \text{ days} - 36 \text{ days}} = .93 \text{ kg/day}\right).$$

The boar needs to grow 15 lb (7 kg) to reach the target weight. At this boar's rate of growth (2.05 lb/day (.93 kg/day)) it will take 15 ÷ 2.05 days (7 ÷ .93 days) = 7.3 days more to reach 220 lb (100 kg). His age at 220 lb (100 kg) is estimated to be 136 + 7.3 = 143.3 days. This adjustment scheme has the general form

$$\text{Age at Tw} = \text{Age} + (\text{Tw} - \text{Wt})(\text{Age} - a) \div \text{Wt}$$

Where Tw is the target weight, Age is the animal's age when weighed, Wt is his test weight and a is the standard age at zero weight.

(continued on next page)

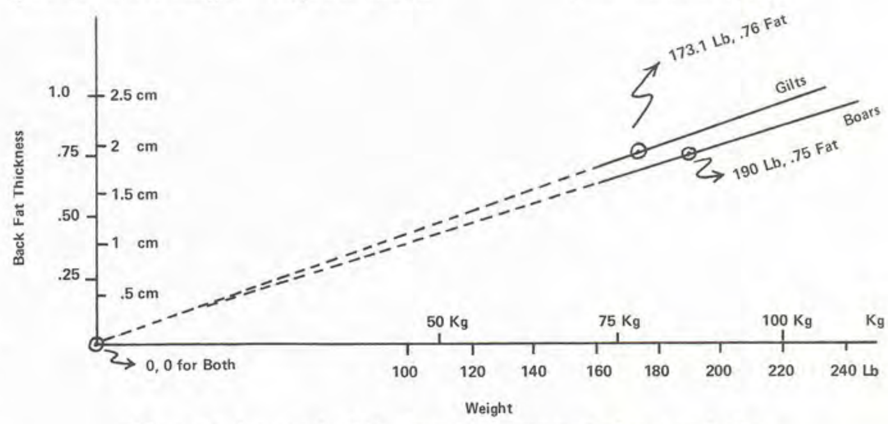


Figure 2. Average backfat deposition curves for boars and gilts.

New Adjustment Factors

(continued from page 23)

Table 2. Adjustment equations for age and backfat thickness at 220 lb (100 kg).

For Boars
Age at 220 lb = Age + (220-Wt) (Age-36) ÷ Wt
Age at 100 kg = Age + (100-Wt) (Age-36) ÷ Wt
For Gilts
Age at 220 lb = Age + (220-Wt) (Age-31) ÷ Wt
Age at 100 kg = Age + (100-Wt (Age-31) ÷ Wt
For Boars and Gilts
Backfat at 220 lb = Backfat + (220-Wt) (Wt-0) ÷ Backfat
Backfat at 100 kg = Backfat + (100-Wt) (Wt-0) ÷ Backfat
simplified to
Backfat at 220 lb = 220 × Backfat ÷ Wt
Backfat at 100 kg = 100 × Backfat ÷ Wt

For adjusted backfat the equation has the form

Backfat at Tw = Backfat + (Tw − Wt) (Wt − a) ÷ Backfat

Where Tw is target weight, Backfat is the average probe when weighed at weight Wt and a is the standard weight at zero backfat.

Using the standard growth and backfat deposition pattern found in this study, the adjustment equations in Table 2 were developed.

Based on this study separate age adjustment equations are given for boars and gilts. The standard equation indicates zero weight for boars at 36 days and zero weight for gilts at 31 days.

For backfat thickness the standard equations for both boars and gilts indicated zero fat at zero weight. This allows a much simplified form for the backfat adjustment. To calculate the adjusted backfat thickness, simply multiply the fat thickness by the target weight and divide by the pig's weight.

These adjustment factors (Table 2) were tested against the additive factors described earlier (2 lb per day (.92 kg per day) and 0.004 in per lb (.025 cm per kg)) with an independent set of performance records. The equations in Table 2 were found to be more effective in adjusting weight differences than were the additive factors. In addition, the variation in the adjusted records was closer to the expected variation using the new factors (Table 2) than when the additive factors were used.