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I am submitting herewith a thesis written by Leland C. Thompson entitled "A Comparison of Six Farrowing House Slat Materials." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

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A COMPARISON OF SIX FARROWING HOUSE SLAT MATERIALS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Leland C. Thompson

December 1979

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ABSTRACT

There were 410 crossbred Duroc, Hampshire, Landrace and Yorkshire sows and their litters used in this study to compare the self-cleaning properties of six different slat types and to relate slat cleanliness to pig performance. Each litter was raised to weaning (about 5 weeks of age) in a 24-crate environment controlled confinement farrowing house. Each partially slatted farrowing crate utilized one of six different slat types in the rear 30 inches of the crate. The slat materials, #9 expanded metal, Behlen stainless steel, round rods, flat steel, plastic and aluminum, were evaluated for cleanliness by objective numeric scoring of the slatted area at weekly intervals. Slat cleanliness was primarily related to percent void (slot) space in the slat section. Expanded metal, Behlen stainless steel and round rod slats had a greater percent void space and scored significantly cleaner than flat steel, aluminum and plastic slats. The slats constructed of materials more readily available for on-farm construction such as expanded metal, round rods and flat steel self-cleaned more effectively than the specialty slat materials such as stainless steel, plastic and aluminum. The age and number of pigs in the litter had little influence on slat cleanliness. Year and season of year differences affected the cleanliness of all slat types but did not affect the differences among slat types. Slat cleanliness had little influence on the percentage of pigs weaned of those born alive; however, the slat material itself significantly affected the percentage weaned. Expanded metal, round rods, Behlen stainless steel and flat steel slat materials were those associated with

the lower weaning percentages of 74.3 and 69.5, respectively. There were no significant differences in adjusted 35-day pig weaning weight.

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CHAPTER I

INTRODUCTION

The number of pigs a sow raises, not the number she farrows, determines her economic value to the breeding herd and provides whatever profit she is to contribute to the operation. A major goal of the commercial swine producer is to maximize the number and weight of pigs weaned per sow per year. The number and quality of pigs she weans is a combination of the number of pigs farrowed alive, heredity, death losses, environment and quality of management.

As the swine industry orients toward highly mechanized confinement operations, the production of large uniform litters which are ready for market at the same age is of material economic importance. A partial solution to this problem in crate-type farrowing houses lies in the type and design of slat material used in the farrowing house.

Farrowing environment has received much attention in recent years as total confinement farrowing systems are being utilized to avoid the problems of pasture farrowing. Confinement farrowing places the sow and pigs in a somewhat foreign biological environment. Density of population in confinement farrowing modifies behavior patterns and creates managerial and labor difficulties (Jensen, 1971).

Confinement crate-type farrowing necessitates control over the environment of the sow and litter. The introduction of slatted or partially slatted floors in swine farrowing houses has proven to be an unprecedented stimulus for complete confinement swine systems (Jensen, 1964). Slatted floors are desirable because of their self-cleaning

aspects since the use of partially or completely slatted floors markedly reduces cleaning chores and handling of waste (Conrad and Mayrose, 1971).

Slatted floors have been effectively used in farrowing units for several years. Labor is reduced, bedding can be eliminated and the sow and pigs remain relatively clean and dry (Jensen, 1964). Lucas and Thomson (1953) conducted experiments which showed that the type of flooring can markedly effect performance of small pigs. With the use of slatted floors, waste material is forced through the slots, thus reducing the pig's exposure to material possibly carrying pathogenic organisms, parasites, etc.

It is reasonable to assume that some types of flooring material self-clean better than others. Jensen (1971) found that various materials, sizes and designs of slats are used successfully. Overall, an ideal waste disposal system permits maximum pig comfort and performance, reduces odor and pollution, is relatively automatic and should be economical to operate (Conrad and Mayrose, 1971).

The objectives of this study were two-fold. First was to evaluate the self-cleaning properties of six different types of slat material in confinement crate farrowing and, secondly, to relate litter and pig performance to the design of the slat material.

CHAPTER II

LITERATURE REVIEW

I. Litter Environment

Beginning at birth, the baby pig must adjust to its new environment to survive. The role of the environment in pig survival is thought to be most important before the pig is weaned.

Baker et al. (1943) reported that the relative importance of litter environment in determining pig growth decreased regularly from 49 percent at birth to 24 percent at 168 days of age. Studies by Nordskog et al. (1944) indicate that environmental effects common to litters are greatest before weaning and decrease from 30.7 percent at weaning. Because the baby pig is especially vulnerable to environmental factors such as cold, dampness and unsanitary conditions, it becomes important that swine herdsmen recognize that piglets require a warm and dry environment if they are to have the best chances for survival (Curtis, 1970).

Thermal Environment

The newborn pig is essentially unable to regulate its own body temperature. This is especially true of the weak and smaller pigs. According to Krider and Carrol (1960) small and weak pigs are not only disadvantaged in competing for food but also are more susceptible to the adverse effects of poor environment.

Studies by Curtis (1970) to evaluate the environmental-thermoregulatory interaction and survival of the young pig concluded that

the direct effects of pig chilling were highest on the first day. In this study, 25 percent of pig deaths on day one were attributable to pig hypothermia or chilling. Jensen (1972) agrees, reporting that pig deaths the first day are largely related to pig chilling.

In addition to the direct effects of pig chilling, subsequent death losses may occur as a result of the indirect effects of chilling. Curtis (1970) reports that chilled pigs are slower moving and more susceptible to sow overlay. Chilled pigs are more predisposed to diseases and chilling may worsen in many cases.

A special feature of farrowing crate environment which may influence pig comfort is the type of floor used. Jensen (1971) reports that type and material used as farrowing crate floor significantly effects the conductive heat loss of the pigs' environment and thus effects pig comfort. Lucas and Thompson (1953), investigating the effects of flooring upon pigs reared in an otherwise cold environment, found that temperature and type of flooring can markedly effect the performance of small pigs.

In environmentally controlled farrowing houses, flooring is a factor in pig comfort. Stephens (1971) studied the metabolic rates of newborn pigs in relation to floor insulation and ambient temperature and found that type of flooring and its insulating properties can markedly affect heat loss of piglets at various environmental temperatures.

The use of a bedding material (straw, shavings, etc.) has been shown to be effective in providing young pigs with a warm, dry and clean surface. Sainsberry (1972) indicated that in environmentally controlled farrowing houses the need for bedding may be eliminated if the floor in

the rear part of the crate is slatted. Pigs will keep the sleeping area clean and use the slatted area for their dunging activity.

Sanitation

If the system of husbandry permits, the pig will most likely be the cleanest and most orderly of all farm animals. According to Baldwin (1969), studies of pig behavior indicate that pigs will use the warmer areas for sleeping, and defecate and urinate in other areas of the pen or crate. He reports that proper eliminative habits are a learned response taught by the dam since pigs raised without a nurse-dam exhibit indiscriminate dunging habits and may retain this behavior as an adult. In addition to pigs learning poor sanitary habits, it has been established that environmental overcrowding severely disrupts the pig's normal behavior possibly resulting in cannibalism and dunging indiscretion according to Baldwin (1969) and Kratzer (1971).

The introduction of slatted floors in farrowing houses greatly accelerated the trend toward the use of total confinement facilities. Labor is reduced and pigs have less contact with manure. Jensen (1971) reports that the use of slats in farrowing crates improves sanitation compared to conventional floors and helps to reduce the concentration and variety of microbes to which the pig is exposed. He further states that on slatted floors cophraphagy will be minimal, reducing the reinfection by internal parasites.

Slatted floors in farrowing facilities have proven to be quite advantageous in providing a healthy environment. A major step in controlling disease problems in confinement facilities has been the use

of slatted floors (Jensen, 1966). The various slat designs and arrangements available to the swine producer differ in their effectiveness but generally reduce labor, eliminates the need for bedding and keeps the sow and pigs clean and dry (Jensen, 1964).

II. Factors Influencing the Self-Cleaning of Slats

In order for slatted floors to aid in sanitation they must allow manure to pass through the floor out of possible contact with the pig. Several factors such as number of pigs, slat design, material used and slot spacing effect the self-cleaning property of slats. Jensen (1966) cites that farrowing crates and pens with slatted floors work best when they contain the maximum number of pigs space will allow or the sow can rear. If the excreta does not drop through the slats, it is trampled by the sow and pigs and forced through the slot spaces (Muehling, 1976).

Specific aspects of slat design are important for self-cleaning. The materials used for slats and the slot width are basic considerations. Studies by Muehling (1976) and Jensen (1972) show that in farrowing facilities the slot space width should be 7/16 inch (11mm). This width allows the manure to be worked through the floor without injury to the piglets feet and legs. They also report that the kind of slatted material may influence the pig's walking ease and desire to use the slatted area. The width of the slat material surface, itself, determines what proportion of the total slatted area will be void space because slot width is normally fixed for a specific size animal, but materials used for slats varies.

III. Farrowing House Slat Comparison Studies

Research reports comparing the self-cleaning properties of different slatting materials in farrowing crates are limited. A great variety of design and type of slat materials have been used by producers. Most slats are of the same basic design, consisting of materials with openings through which manure may drop to a pit or flush alley below. Jensen et al. (1972) report that slats in farrowing houses have received much attention and materials such as expanded metal, concrete, wood, steel, aluminum and plastic are available to producers.

Hubly et al. (1974) compared number 9 flattened expanded metal floors to 3-inch flat steel slats in farrowing crates and found the cleanliness of the pigs and the floor to be superior on the expanded metal floors.

Jensen et al. (1962) made 14 comparisons of number 9 expanded metal versus solid concrete floors. Results indicate that the pigs on test from 2 weeks to 6 weeks of age gained about 19 percent faster when confined to the expanded metal floors.

England (1967) investigated the performance of pigs reared on slatted floors in farrowing crates. He cites the fact that 4-inch wood slats spaced 3/8 inch apart were not suitable for baby pigs. The slats were too wide and spaced too close together resulting in poor cleaning because of clogged slot spaces.

Kite (1967) compared number 9 expanded metal and metal T-bar slatting materials in partially slatted farrowing crates. His results showed that the expanded metal and metal T-bar slats were similar in

self-cleaning aspects. Jensen (1972) found small pigs to be less efficient at working waste material through the slats and he therefore reasoned that narrow width slats with more total slot area should be used for best results.

CHAPTER III

EXPERIMENTAL PROCEDURE

Data for this study was collected from January 1976 to August 1978 from the swine research herd at Ames Plantation, Grand Junction, Tennessee.*

I. Experimental Animals

Approximately 24 gilts and sows were bred to farrow in each of 18 farrowings from January 1976 to August 1978 in the confinement unit at Ames Plantation. A total of 410 litters were farrowed producing 4151 live pig births.

II. Materials

The confinement unit included a 24-crate farrowing barn, 12-pen nursery and two finishing barns equipped with 12 partial slatted pens each. Sows were bred and gestated on pasture.

The 24-crate farrowing barn was an environment controlled building with an office and feedroom. There were 12 farrowing crates on each side of the building with access alleys both in front and behind the crates. Farrowing crates measured 5 x 7 feet equipped with a cup waterer, feed bowl and an electrically heated concrete floor section for pig comfort. All crates were equipped in front with a 12-inch wide

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*The University of Tennessee is a beneficiary of a perpetual trust under the terms of the will of the late Julia C. Ames.

section of flat steel slat over a collection pit (Figure 1). The rear slat section of each crate was 30 inches in width and covered a manure collection pit.

Six different types and designs of slat material were employed behind the sow consisting of expanded metal, Behlen stainless steel, round rods, flat steel, plastic and aluminum. Slat types and design utilized in this study were:

1. # 9 flattened expanded metal. The slat material was a purchased commercially produced number nine gauge galvanized expanded metal material with diamond-shape voids (Figure 2).

2. Behlen stainless steel slat. This slatting material was a name brand product made of 13 gauge stainless steel. The steel panel was formed into a 12-inch wide channel and perforated on the top surface to create slots 3/8-inch wide oriented across the long dimension of the slat (Figure 3).

3. Round rods. The round rod slatting material was constructed with 1/2-inch galvanized aluminized steel tube rods. The rods were welded to form a grate with slots 3/8-inch wide running across the long dimension of the crate (Figure 4).

4. Flat steel slats. The flat steel slats used were constructed of 1/4 x 1 inch galvanized flat steel strips. The steel strips were welded into a grate with slot void spaces 3/8 inch wide (Figure 5).

5. Plastic slats. The plastic slatting material was a purchased commercial slatting farmstead product. The slats were 5-5/8 inch wide, hard plastic channel with oval perforations 3/8 x 2 inch wide on the top surface. The slats were situated across the long dimension of the crate 3/8 inch apart (Figure 6).

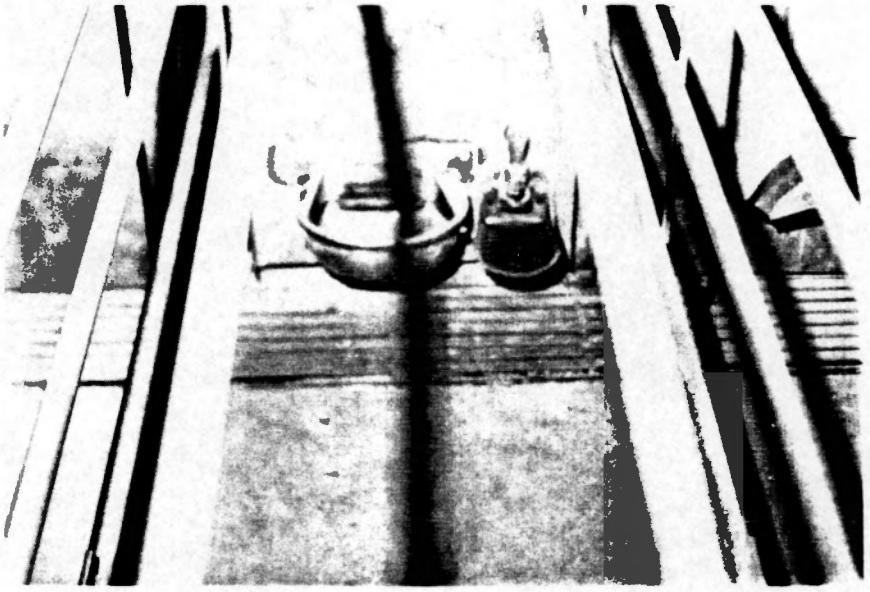

Figure 1. Farrowing crate equipped with a feed and water bowl and 12-inch wide front slatted area of 1/4 x 1 inch flat steel slat.

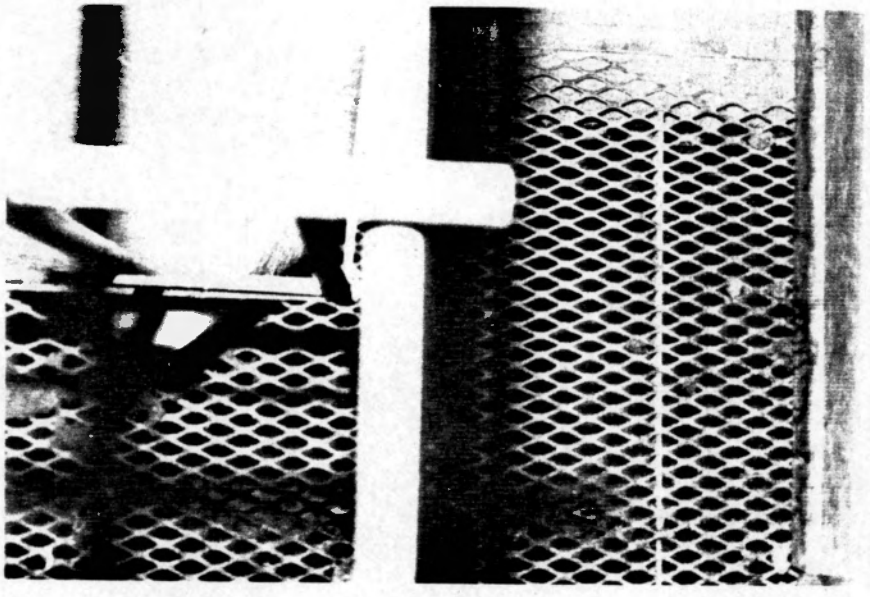

Figure 2. Farrowing crate equipped with galvanized #9 expanded metal.

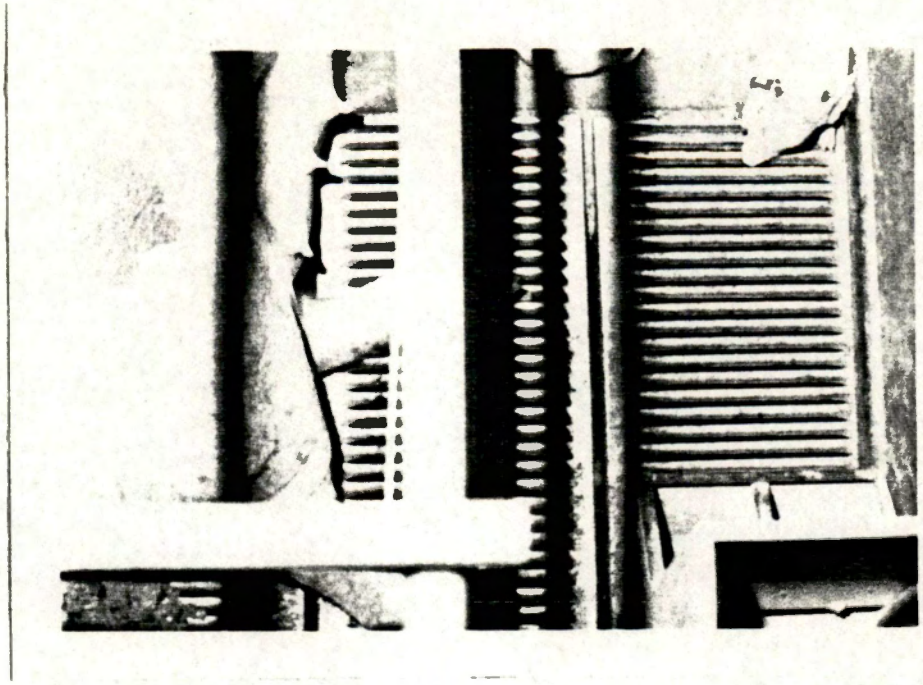

Figure 3. Farrowing crate equipped with Behlen stainless steel slats.

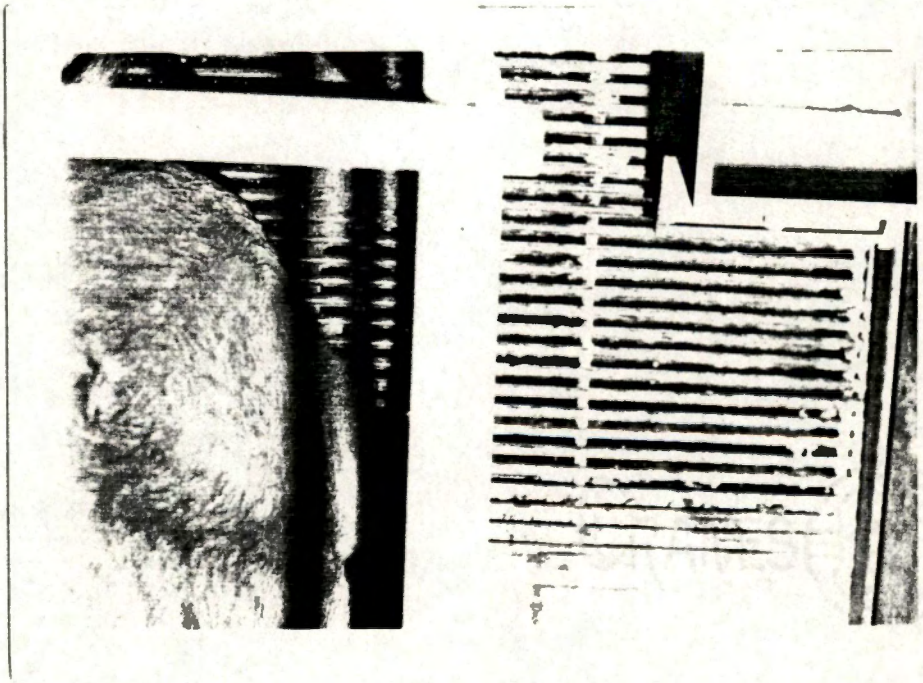

Figure 4. Farrowing crate equipped with round aluminized steel rods.

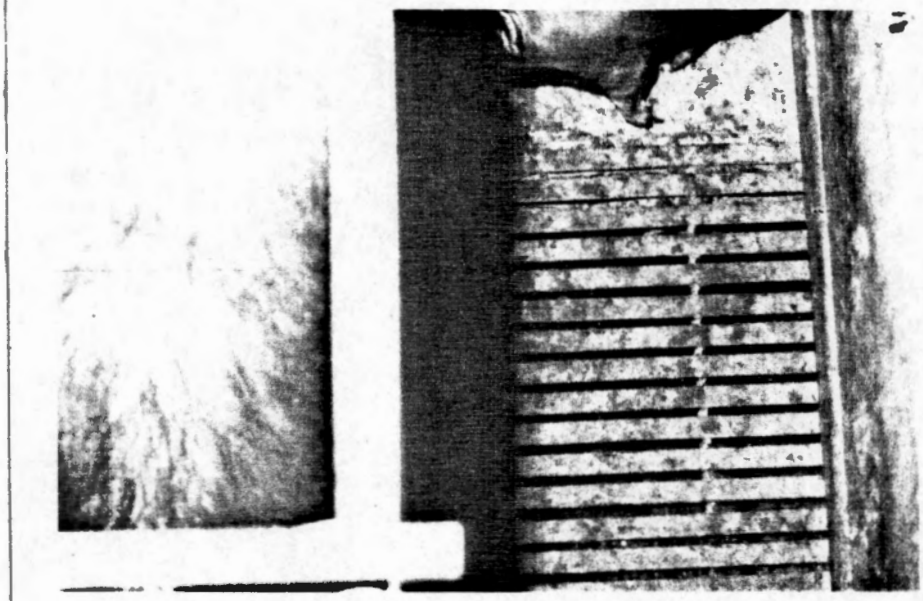

Figure 5. Farrowing crate equipped with galvanized flat steel slats.

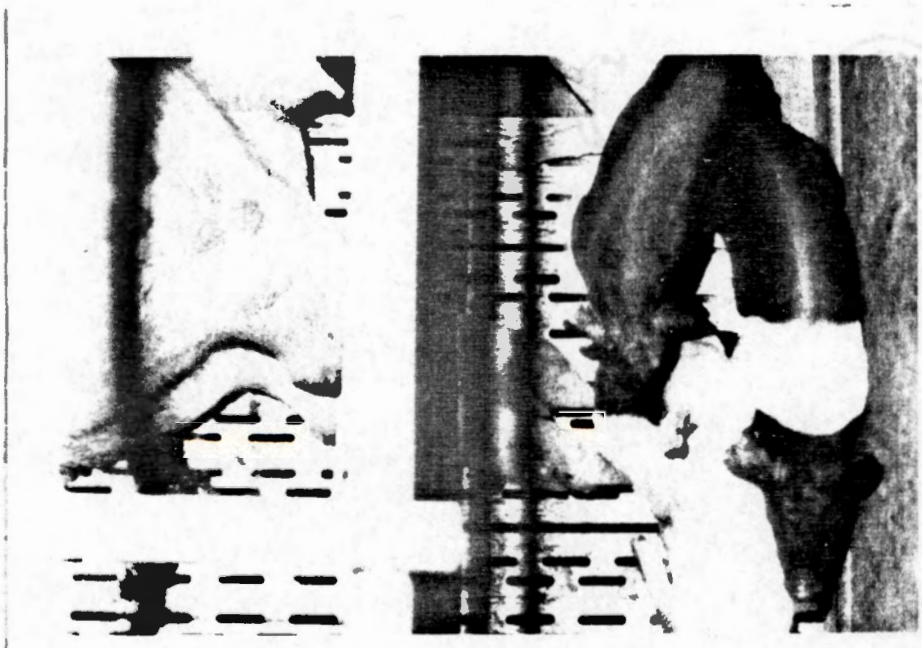

Figure 6. Farrowing crate equipped with plastic slats.

6. Aluminum slats. The aluminum slats were constructed of casted aluminum channel. The aluminum slats had a flat top surface 1-11/16 inch wide x 1/8 inch thick. These were fastened together side by side 7/16 inch apart to provide slot spaces (Figure 7).

These slatting materials were randomly distributed throughout the farrowing barn in pairs (Figure 8).

III. Feeding and Management

Gilts and sows were brought to the farrowing barn and placed in crates approximately one week before the expected farrowing date. Sows were limit fed until after farrowing. Beginning about one week past farrowing, nursing sows were fed a 14 percent fortified crude protein ration (Table I) at a rate of one pound for each suckling pig plus three to five pounds additional for the sow (depending upon sow condition). The pigs were weaned at about 5 weeks of age, weighed and moved to the pig nursery. The farrowing house temperature was maintained at 60-85°F depending upon season and outside temperature.

All pigs were identified (ear notched), weighed, and needle teeth clipped at birth (day one). Some crossfostering was accomplished as soon after birth as possible (day one) to even up liters. Iron shots were administered, tails docked and male pigs castrated during the first 7-10 days. Heat lamps were provided for 48-96 hours post-farrowing in addition to the electrically heated concrete to provide a warm dry surface for the pigs. At approximately 10 days of age, the pigs were administered the second iron shot and provided access to an 18 percent crude protein pelleted commercial creep feed.

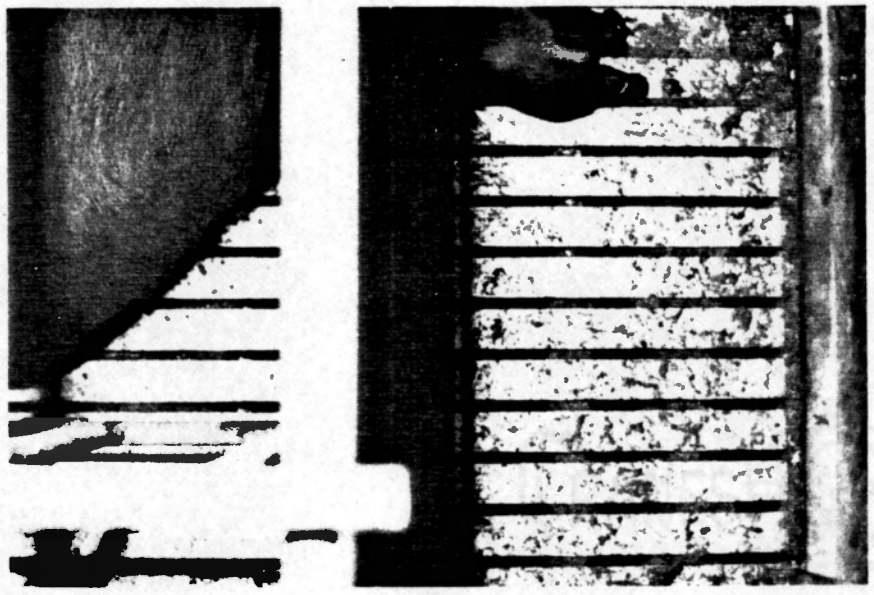

Figure 7. Farrowing crate equipped with aluminum slats.

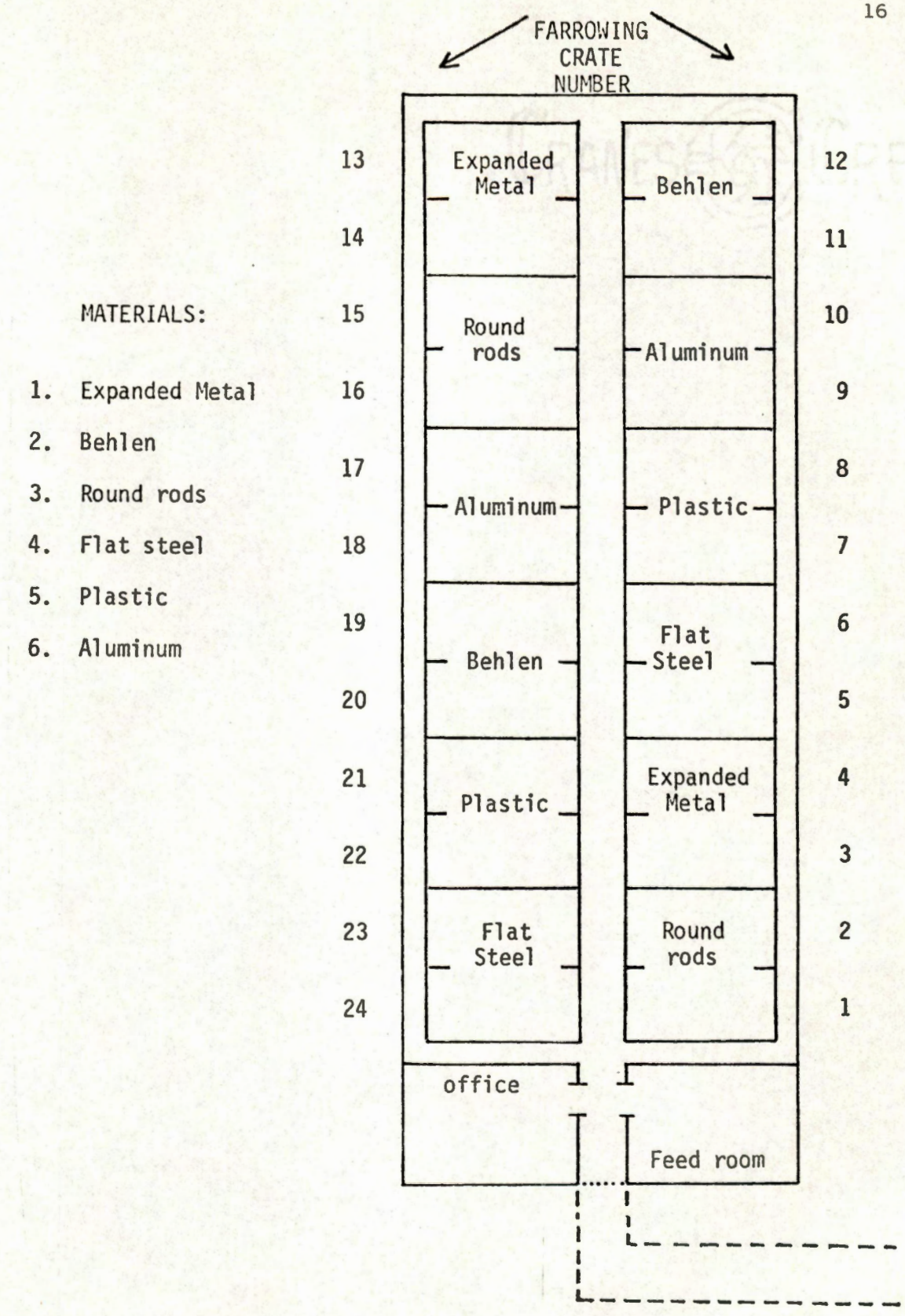

Figure 8. Farrowing house design.

TABLE I. COMPOSITION OF SOW-NURSING RATION

	Lactation
Corn, lbs	1250
SBM, lbs	350
Alfalfa meal, lbs	100
Wheat Bran, lbs	200
Pre-mix,[a] lbs	100
Total	2000

[a]Pre-mix contains vitamins, minerals and varying levels of antibiotics.

IV. Scoring Slat Materials for Cleanliness

Scoring of each slat material was based on the subjective appearance (cleanliness) of the pen and especially the slatted area behind the sow. A scoring system was employed to rank the appearance of the slat material from clean to dirty, employing numeric scores.

Numeric values and description used to score the slat material ranged from 1-5 as follows:

1. A score of "1" indicated clean and dry conditions over the slats.

2. A score of "2" indicated the slats were slightly dirty having very little manure present.

3. A score of "3" indicated a moderate amount of manure not being thoroughly worked through slot spaces.

4. A score of "4" indicated that slat material was not allowing manure to be worked through slot spaces resulting in some caking of manure on top of slats and some dampness.

5. A score of "5" indicated extremely dirty conditions where manure remained piled and caked on slat surface giving an overall damp and dirty appearance.

Scoring technique was consistent throughout the study. The slats were scored on Friday of each week at 7:00 A.M. in the same crate sequence. The herdsman at Ames Plantation did the scoring except for about two weeks vacation each year. During these times, an assistant scored with the herdsman for two weeks prior to his being away; thus, accomplishing consistency in the scoring process. Scores were collected

on each slat material weekly from birth to weaning. Only scores of slat materials where both sow and pigs were present were used in the analysis of this study.

V. Methods of Analysis

An analysis of variance procedure was used to test the hypothesis that slat design and slat material did not influence the average cleanliness of the slatted section behind the sow. Mean squares and F values derived from type I sums of squares were employed to evaluate the effects due to percent voids (slots) and slat material after allowing for effects due to year, season, year-season interaction, breed of dam and parity (number of previous litters) of sow. The underlying ordered model describes the dependent variable: average cleanliness score for each litter (score average).

Model I

Score average = μ + year + season + year x season + breed of dam + parity + percent voids + material + error

The same model and methods were used to evaluate the effects due to slat material irrespective of the percent voids in the slat section.

To determine the effects of pig age on slat self-cleaning, a regression analysis was used to produce least square estimates of coefficients of the underlying linear model. The dependent variable is the weekly cleanliness score.

Model II

$$Score = A + b(age)$$

The linear coefficients of regression (b) produced by this model represents the change in slat cleanliness over time.

The coefficients were then used as dependent variables in the model below. This model tests the hypothesis that slat materials did not differ with respect to the relationship between slat cleanliness and pig age.

Model III

$$b = \mu + year + season + season \times year + breed\ of\ dam + parity\ of\ sow + material + error.$$

Analysis of variance was employed to test the hypothesis that slat cleanliness had no influence on the percent of live pigs weaned. The underlying model describes the dependent variable (percent of live pigs weaned).

Model IV

$$Percentage\ weaned = \mu + year + season + year \times season + breed\ of\ dam + parity\ of\ sow + material + mean\ cleanliness\ score + error.$$

Mean squares and F values derived from the sequential sums of square of the above ordered model were used to evaluate the variation in percent of live pigs weaned due to slat cleanliness after allowing for influences due to year, season, breed of dam, parity of sow and slat material.

The next hypothesis to be tested states that slat material had no influence on percent of live pigs weaned irregardless of slat cleanliness.

The underlying ordered model was used to describe the dependent variable: percentage weaned.

Model V

Percentage weaned = μ + year + season + year x season + breed of dam + parity of sow + mean slat cleanliness + slat material + error.

Mean squares and F values derived from type I sums of squares were used to evaluate the influence of slat material after removing variation due to mean slat cleanliness, year and season differences, breed of dam and parity of sow.

The Duncan's Multiple Range Test was used to separate means according to significant differences. Specific orthogonal contrasts were used to separate means of dependent variables according to specific grouping of levels within an effect.

A least square means procedure was used to produce least square means of the dependent variables: average cleanliness score, b, percent of live pigs weaned.

CHAPTER IV

RESULTS AND DISCUSSION

Data from 18 farrowing groups of crossbred Duroc, Hampshire, Landrace and Yorkshire gilts and sows bred to farrow in the confinement facility (System 3) between 1976 and 1978 formed the basis for this study. A total of 4,151 live pigs born in 410 litters were reared in confinement farrowing crates each having one of six different types of slat material behind the sow. The slat material in each crate was scored for cleanliness weekly on Friday. The mean of the cleanliness scores (score average) for the period from birth to weaning (age of about five weeks) served as a measure of the self-cleaning properties of each slat type. Pigs were weighed at birth and at weaning and the percentage of live pigs weaned of those born alive was calculated.

I. Effects of Slat Types

Score Average

The slat material and the design of the slat significantly affected the mean score for slat cleanliness ($P<.05$). The ratio of solid area to void space in each slat design was the major determinant of the slat's self-cleaning properties. The slat material itself had a significant influence on cleanliness score.

Mean cleanliness scores for each slat material are shown in Table II. The expanded metal (EM) slat material with the largest percent void area self-cleaned significantly better than the other designs and materials ($P<.05$). Round rods (RR) and Behlen stainless

TABLE II. LEAST SQUARE MEANS OF CLEANLINESS SCORE AND REGRESSION OF AGE ON WEEKLY SCORE

	Expanded Metal	Behlen Stainless Steel	Round Rods	Flat Steel	Plastic	Aluminum
Number of litters	70	70	67	65	69	70
Percent void area	60	43	38	27	23	21
Average cleanliness score	1.55 ± 14^{a}	$1.94 \pm .14^{b}$	$1.83 \pm .14^{b}$	$1.83 \pm .14^{c}$	$3.85 \pm .14^{e}$	$3.40 \pm .14^{d}$
Mean coefficient for regression of age on score	$-0.0004 \pm .004^{b}$	$0.0047 \pm .004^{a}$	$-0.0024 \pm .004^{b}$	$-0.0075 \pm .004^{b}$	$-0.0053 \pm .004^{b}$	$0.0049 \pm .004^{b}$

^{a,b,c,d,e}Means superscripted with different letters are significantly different ($P < .05$).

steel (BSS) slats were similar in self-cleaning properties ($P>.05$), but superior to the flat steel (FS), aluminum (AL) and plastic ($P<.05$) slats. The flat steel slats cleaned more effectively than aluminum ($P<.05$) which was significantly cleaner than the plastic (P) slat ($P<.05$).

The ranking of slat materials according to self-cleaning ability largely follows their differences in design. The slat design allowing for the greatest percentage of void area generally cleaned best, and slats with less void area cleaned less effectively.

The basic design of each slat material allowed them to be categorized as those having greater than 35 percent void space (slot space) and those with less than 30 percent void space. As a group, the slats with greater than 35 percent void space were expanded metal, round rods and Behlen stainless steel. The slats with less than 35 percent void space were flat steel, aluminum and plastic. The slat designs allowing for greater than 35 percent void space self-cleaned significantly better than those having less than 30 percent void area ($P<.05$). Overall, slat self-cleaning improved as the total percentage of void area increased. However, some point is reached where the proportion of total slatted area as void space is so large that the pigs and sow are uncomfortable because of feet and leg injuries and other problems.

Also, grouping the slat materials as "farm built" (EM, RR, FS) or "store bought" (BSS, AL, P) made another interesting comparison. Results indicate that the "store bought" slat materials were significantly less effective at self-cleaning than the "farm built" types ($P<.05$). The expanded metal, round rods and flat steel slats are those most easily constructed on the farm, while Behlen stainless steel, plastic and aluminum slats are commercially produced designs and types.

The herdsmen did not note differences in dunging habits of pigs between and among the six slat materials.

II. Relationship between Slat Cleanliness and Pig Age

Slat self-cleaning was not affected by age of the pigs. The hypothesis that pig age regressed on weekly cleanliness score might help to explain variation in cleanliness scores was rejected. Results indicated that a nonsignificant linear relationship existed ($P>.05$). This relationship differed, however, among slat materials both in magnitude and direction of slope. Table II presents the mean regression coefficients for each slat material. With the exception of Behlen stainless steel all other slat materials produced negative coefficients. Results show the positive coefficient for Behlen stainless steel to be significantly different from that of the other slat materials ($P<.05$). A negative regression coefficient implies that slat self-cleaning improved as the pigs got older while a positive coefficient (Behlen stainless steel) implies the opposite. This characteristic of Behlen slats may be related to the perforating process used to create the slot voids in the slat. This process results in a rough steel "lip" on the lower edge of each void space which may retard manure passage especially as older pigs produce larger droppings and a greater daily volume of manure.

III. Effect of Year and Season

The analysis showed that there were differences in the mean cleanliness scores due to year and season of year effects. These

differences resulted primarily because not all seven farrowing seasons occurred in each year of the study and because of uncontrollable environmental influences. However, within each farrowing season, the ranking of each slat material for cleanliness remained the same.

Each of the farrowings within a year were considered as representative of seven different farrowing seasons. The seven farrowings occurred 52 days apart in October, early December, late January, March, early May, July and late August. Mean cleanliness scores for all slat materials in each year and farrowing season are presented in Table III.

IV. Relationship Between Performance Traits, Slat Cleanliness and Slat Material

Percentage Weaned

The percentage of live pigs weaned of those born alive was not significantly affected by the cleanliness of the slat section behind the sow ($P>.05$). On the other hand, when influences due to slat cleanliness were held constant, analysis of variance revealed that percentage of live pigs weaned was significantly affected by slat material ($P<.05$). Table IV presents the least square means for the percentage of pigs weaned (Percentage Weaned). Orthogonal comparisons of the least square means for each material revealed that farrowing crates equipped with expanded metal, Behlen stainless steel, round rods, and flat steel slats resulted in litters with significantly higher percentage of live pigs weaned than did farrowing crates equipped with plastic or aluminum slats.

TABLE III. SIMPLE MEANS OF CLEANLINESS SCORES FOR EACH YEAR AND SEASON OF THE STUDY

	Litters	Average Scores
Year		
1976	137	2.01
1977	164	2.67
1978	109	2.70
Season		
October	48	2.75
December	68	2.46
January	71	2.18
March	65	2.32
May	67	2.17
July	45	2.60
August	46	3.00

TABLE IV. LEAST SQUARE MEANS FOR PERCENT OF LIVE PIGS WEANED, ADJUSTED 35-DAY WEIGHT, AVERAGE DAILY GAIN AND AVERAGE BIRTH WEIGHT

	Expanded Metal	Behlen Stainless Steel	Round Rods	Flat Steel	Plastic	Aluminum
Number of litters	70	70	67	65	69	69
Percent weaned	81.7[a]	81.8[a]	81.4[a]	83.2[a]	69.5[b]	74.3[b]
Adjusted 35-day weight	18.78 ± .88	19.30 ± .87	18.93 ± .89	19.40 ± .87	18.88 ± .88	19.19 ± .88
Average daily gain	.44 ± .02	.45 ± .02	.45 ± .02	.46 ± .02	.45 ± .02	.46 ± .02
Average birth weight	3.12 ± .1	3.26 ± .1	3.09 ± .1	3.16 ± .1	3.16 ± .1	3.09 ± .1

[a,b]Means superscripted with different letters are significantly different ($P < .05$).

Average Daily Gain

Average daily gain and adjusted 35-day weight of the pigs did not differ significantly among slat types. It should be noted, however, that pigs reared in crates equipped with flat steel slats not only produced the best liveability, but the pigs grew slightly faster resulting in higher adjusted 35-day weights and the greatest litter weight produced per sow.

CHAPTER V

SUMMARY

Data from 410 crossbred Duroc, Hampshire, Landrace and Yorkshire sows and litters was utilized in this study. The objective of the study was to evaluate the self-cleaning properties of six different slat types installed in the rear section of the farrowing crate and to then relate slat cleanliness to pig performance.

The slat types used included #9 expanded metal, Behlen stainless steel, 1/2-inch round rods, 1-inch flat steel, 5-5/8 inch plastic and 1-11/16 inch aluminum slats with 60, 43, 38, 27, 23 and 21 percent void (slot) space, respectively. The materials were assigned to pairs of farrowing crates in a random fashion. Objective scoring of the slat sections (each farrowing crate) for cleanliness was done by numeric ranking from 1 (clean) to 5 (dirty). Slats were scored the same day each week from pig birth to weaning at about five weeks. The average score for the period from birth to weaning served as a measure of overall slat cleanliness.

Analysis of this data collected at Ames Plantation during 1976-1978 centered around ascertaining the determinants of slat self-cleaning effectiveness, and to determine if slat type affected the percentage of pigs weaned of those born alive. Ordered models and sequential sums of squares were used to delineate variation in response variables due to slat design and slat material effects. Means of dependent variables were tested for significant differences by Duncan's Multiple Range Test and specific orthogonal comparisons of levels within an effect. A linear

regression procedure was used to determine the change in slat cleanliness over time from pig birth to weaning.

Beginning about one week after farrowing, nursing sows were fed daily 3-5 pounds of a 14 percent fortified crude protein ration plus 1 additional pound for each suckling pig. Some crossfostering among litters was done within 24 hours of farrowing. The pigs were weighed, ear notched, needle teeth clipped, tails docked, administered iron and male pigs castrated during the first 10 days. Pigs were given access to an 18 percent crude protein pelleted commercial creep feed and administered iron at approximately 10 days of age. Pigs were weaned at about 5 weeks of age, weighed and placed in the nursery.

The ranking of each slat type for self-cleaning effectiveness largely followed differences in percentage of void (slot) space. Expanded metal ranked best in cleaning effectiveness followed in order by round rods, Behlen stainless steel, flat steel, aluminum and plastic slats. In addition to design differences, the material itself influenced slat cleanliness. The Behlen stainless steel, aluminum and plastic materials are specialty materials, but as a group were not as effective as expanded metal, flat steel and round rod slats. The age of the pigs had very little influence on slat self-cleaning properties. However, while the other slat types self-cleaned better as the pigs grew older, Behlen stainless steel slats tended to get dirtier as the pigs aged. Year and seasonal differences affected slat cleanliness but in each year and season, the ranking of the slats for self-cleaning effectiveness did not change.

Results indicate that the cleanliness of the slat section by itself did not effect the number of pigs weaned of those born alive. On the other hand, the slat material and/or design itself did affect the percentage of pigs weaned of those born alive. The use of slat materials expanded metal, round rods, Behlen stainless steel and flat steel resulted in weaning percents of 81.7, 81.3, 81.8 and 83.2, respectively. Aluminum and plastic slat materials were associated with significantly lower weaning percents of 74.3 and 69.5, respectively.

BIBLIOGRAPHY

BIBLIOGRAPHY

Baldwin, B. A. 1969. The study of behavior of pigs. Br. Vet. Journal 125-281.

Baker, M. L., L. N. Haxel and C. F. Reinmiller. 1943. The relative importance of heredity and environment in the growth of pigs at different ages. J. Anim. Sci. 2:3.

Conrad, J. H. and V. B. Mayrose. 1971. Animal waste handling and disposal in confinement production of swine. J. Anim. Sci. 32:811.

Curtis, Staleny E. 1970. Environmental-thermoregulatory interaction and neonatal piglet survival. J. Anim. Sci. 31:576.

Hubly, E. C., G. R. Carlisle, V. D. Ladwig and A. H. Jenson. 1974. Effects of flattened expanded metal and steel slats in partially slotted floors on the feet and legs of suckling pigs. Ill. Coop. Ext. Service Publ. AS-667.

Jensen, A. H., D. E. Becker and R. C. Thatcher. 1962. Management of swine confined to slotted floors. J. Anim. Sci. (Abst.) 21:1039.

Jensen, A. H. 1964. Symposium on environment and facilities in swine production. J. Anim. Sci. 23:1185.

Jensen, A. H. 1966. Management problems in confinement units. In Progress in Swine Practice. 1st Ed. American Vet. Publ., p. 40.

Jensen, A. H. 1971. Biological implications of intense swine rearing systems. J. Anim. Sci. 32:560.

Jensen, A. H., B. G. Harmon, G. R. Carlisle and A. J. Muehling. 1972. Management and housing for confinement production. Ill. Agriculture Extension Service Circular #1064.

Kratzer, D. D. 1971. Learning in farm animals. J. Anim. Sci. 32:1268.

Krider, J. L. and W. E. Carrol. 1960. Swine Production. Revised 1971, 4th Ed. McGraw-Hill Book Co., New York.

Lucas, I. A. M. and W. Thompson. 1953. The effect of flooring upon pigs reared in an otherwise cold environment. J. Agric. Sci. 43:192.

Muehling, A. J. 1976. Slotted floors for swine production system. Int. Pig Vet. Soc. Proc. C.4.

Nordskog, A. W., R. E. Comstock and L. M. Winter. 1944. Heredity and environmental factors affecting growth rate of swine. J. Anim. Sci. 3:257.

Sainsberry, D. W. B. 1972. Pig housing trends and problems. Br. Vet. Jour. 125:259.

Stephens, D. B. 1971. The metabolic rates of newborn pigs in relation to floor insulation and ambient temperatures. Anim. Prod. 13:303.

England, D. C. 1976. Full-cycle performance of swine confined to slotted floors. Oreg. Agr. Expt. Sta. Rpt. 245, pp. 3-5.

Kite, G. D. 1967. Slotted floor swine farrowing and nursery buildings. ASAE paper 67-401.

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