Productivity and Behavior of Sows in Level vs. Sloped Farrowing Pens and Crates

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PRODUCTIVITY AND BEHAVIOR OF SOWS IN LEVEL VS SLOPED FARROWING PENS AND CRATES[1]

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ABSTRACT

Forty crossbred sows were used in 10 blocks to determine the effects of farrowing pen type and degree of slope on sow-litter performance and behavior. The two pen types were a farrowing pen (2.15 m^2 sow area plus 2.15 × .55 m creep area) and a farrowing crate (1.5 × 2.15 m). The two slopes evaluated were level (0% slope) and 8% slope. To collect behavioral data, a sample of litters was videotaped using time-lapse recorders for 24 h at 10 d of age. An interaction between slope and pen type was detected for number of pigs weaned ($P = .02$), percentage preweaning mortality ($P = .01$) and number of pig deaths due to crushing ($P = .01$). More pigs were crushed and fewer pigs were weaned when pens were level or when crates were sloped. Sows on sloped floors lay on their sternums more often ($P = .04$) than sows on level floors. Time sows were sitting was correlated with number of pigs crushed ($r = .54$, $P = .05$). Providing more room for the sow in a pen did not increase sow activity. The reduced piglet mortality in sloped pens may be attributed to changes in sow resting postures rather than to providing sows more freedom of movement. (Key Words: Farrowing Pens, Sows, Pigs, Behavior, Animal Welfare.)

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Introduction

The U.S. swine industry moved from farrowing pens to farrowing crates in the 1960s through 1970s. Farrowing pens were abandoned in favor of crates because the farrowing crate reduced crushing of piglets by the sow (Robertson et al., 1966) and because crates generally required less space per sow-litter. Today the farrowing crate is the most common housing system for lactating sows.

In the past few years, a new design of farrowing pen has been adopted by some American and Canadian pork producers. This new pen has a sloped floor but allows the sow greater freedom to move about and turn around in her environment. Certain producers feel that the sows perform better in this environment than in the traditional farrowing crate. However, the only published report on this subject found that sows and litters in sloped pens had performance equal to litters in level crates (Collins et al., 1987). Because these authors did not include a level pen in their study, the observed effects could not be attributed to slope of floor or to the additional space associated with the pen.

The objective of this study was to determine productivity and behavior while sows and litters were in level or sloped pens or crates. Including pen type and degree of slope in a factorial arrangement allowed us to determine whether the observed effects were due to slope of floor or to providing more space (pens vs crates).

Experimental Procedures

Forty mixed-parity sows were used in 10 blocks collected over time. Sows were obtained from a four-breed rotational-cross system using Landrace, Yorkshire, Hampshire and Duroc breeds. During lactation sows had ad

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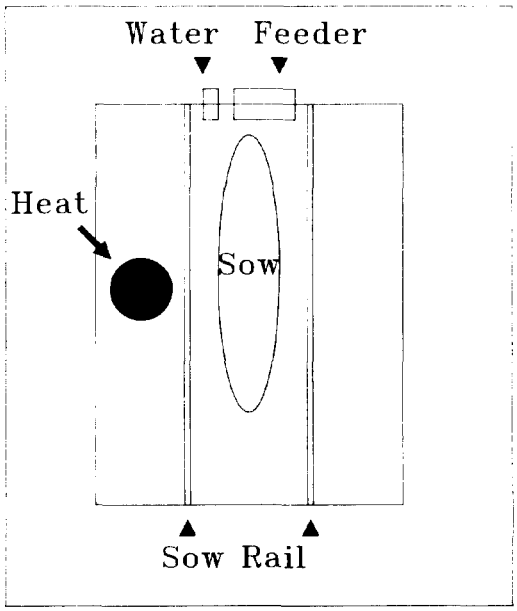

Figure 1. Diagram of farrowing crate used in the study. Outside dimension was 2.15 × 1.5 m with a sow area of .6 × 2.15 m. Heat source was an infrared bulb.

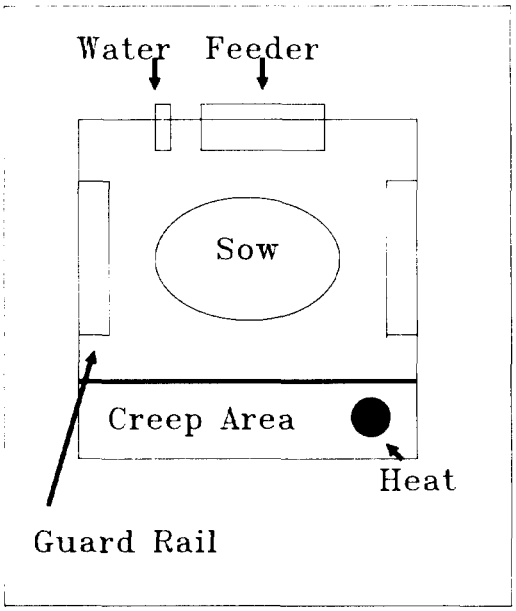

Figure 2. Diagram of farrowing pen used in the study. Outside dimension was 2.15 m^2. Creep area was 2.15 × .55 m and was not available to the sow. Sows could lie on or against the guard rails. Heat source was an infrared bulb.

libitum access to a fortified sorghum-soybean meal diet that contained 13% crude protein. One unit of each pen type (four pen types total) was constructed and one complete block was evaluated each 6 to 9 wk over about a 24-mo period.

Four treatments were examined: level crate, level pen, sloped crate and sloped pen. Two identical crates (Figure 1) and pens (Figure 2) were constructed, then one of each pen type was sloped by elevating one end. Slope was either 0 or 8% and the slope for the crate was from anterior to posterior (sow's head was uphill). The feeder and water were at the top of the slope. Crates measured 1.5 × 2.15 m with a .6 × 2.15 m sow area. Sow area in pens measured 2.15 m^2 with an additional 2.5 × .55 m creep area. An infrared heat lamp was used in the creep area of each type of pen. Floors were woven wire.

Performance measures were taken on sows and piglets. Sows were weighed upon entry to pen type (d 109 to 111 postmating) and at 21 d of lactation. While sows were in each type of pen, weight change was determined and sow lactation feed intake was recorded during lactation. Sows were fed 2 kg/d during gestation and had ad libitum access to feed during lactation. The study ended when piglets were 21 d old, but piglets remained with their sows for a variable time period after 21 d of age.

Piglets were weighed and counted at birth and at 21 d of age. Stillbirths include fully formed pigs born dead or those that were found dead at litter processing (within 12 h or parturition). Some piglets designated as stillborn may have been very early postpartum deaths. Piglets were considered crushed if their bodies were flattened and(or) severely bruised and if they were found dead under or near the sow. Preweaning mortality (%) was calculated as 100 times the number of pigs that died between litter processing and weaning divided by the number alive at litter processing. Creep feed was given from 2 wk of age until weaning and creep feed consumption was recorded (over 21 d). Male piglets were castrated at 11 to 14 d of age.

A sample of five sows and litters per treatment were videotaped at 10 d of age. Time-lapse recordings were recorded at .8

frames/s over 24 h. From these video records, behavioral measures were collected. Nursing frequency was the number of times per 24 h each litter went through a complete nursing cycle. Nursing interval was the average time between successive nursing bouts. Video recordings did not allow for quantification of the nursing bout duration. Both duration (min/24 h) and frequency (number of times/24 h) of all other behaviors were recorded. Standing was defined as the sow fully erect on all four legs. Sows were considered to be sitting when they assumed the dog-sitting posture. Lying on the side and belly (sternum) also were measured. When one-half or more of the pigs in a litter were lying under the heat lamp, heat lamp use was recorded.

The statistical design was a randomized complete block with a factorial arrangement of treatments (SAS, 1985). Ten blocks for performance measures and five blocks for behavioral measures were used in the data analysis. Litter size at birth (alive at 12 h) was used as a covariate for all litter performance and behavioral measures (except litter size at birth), because litter size (and the correlated effect of parity) is known to influence litter performance. A correlation coefficient was calculated between each pair of measures. Of primary interest were potential correlations among measures of behavior and productivity that might help explain observed differences in performance.

Results

The interaction between slope and pen type was significant for number of pigs crushed, number weaned and preweaning mortality (Table 1). Litters had fewer pigs crushed and fewer pigs weaned when the crate was level (compared with sloped crate) or when the pen was sloped (compared with level pen). The sloped floor prevented the elevated preweaning mortality found in the level pen.

The main effect of slope was significant for total litter weaning weight (Table 1). Litters were 27% heavier at weaning when in a sloped environment than when in a level environment.

Litters farrowed in sloped environments tended to have more pigs born live ($P = .08$) than those farrowed in level environments (10 vs 8.7 pigs). This small difference was not reflected in a significant effect of slope on the stillbirth rate (Table 1). Housing systems did not influence sow feed intake or sow lactation weight loss. Piglet creep feed intake and average pig weaning weights were not influenced by treatments.

In no cases did the pen type × slope interaction influence pig behavior ($P > .10$; Table 2). Sows in the sloped environments lay on their sternums more ($P = .04$) often than did sows in the level environments. There was a trend for sows housed in the sloped systems to lie more often on their sides as well ($P = .09$). There were no differences between farrowing environments for amount of time sitting due to the large amount of variation among sows.

Selected correlation coefficients are presented in Table 3. Some significant correlations were not thought to be of general interest (for example, between nursing interval and nursing frequency) and are, therefore, not presented. Sows that weaned larger and heavier litters spent less time lying on their sides ($r = -.62$). Sows that crushed more pigs spent more time in the sitting position ($r = .54$). Larger sows had greater piglet mortality ($r = .38$). As expected, litters with greater mortality had smaller pig birth weights ($r = -.34$) and fewer pigs weaned ($r = -.47$). Other significant correlations were not readily interpreted (Table 3).

Discussion

The finding that litters in the level farrowing pen had more crushed pigs than litters in the level crate supports early work by Robertson et al. (1966) and more recent work by Svendsen et al. (1986) who found that the farrowing crate saves baby pigs by preventing crushing by the sow. However, some pigs were still crushed in a conventional crate (.51 per litter in this study). Farrowing accommodation design could be improved to prevent this significant economic loss.

Collins et al. (1987), evaluating sloped pens without guard rails found that sow and litter performance were similar between level crates and sloped pens. Our results agree completely. They further found that sows housed on a slope of 17% had fewer pigs born and weaned than sows on a 10% slope floor. The sows and litters in this study were on an 8% slope to avoid problems associated with too much floor slope.

Not all farrowing pens are similarly designed. A previous report of a turn-around pen

TABLE 1. LEAST SQUARES MEANS FOR SOW AND LITTER PERFORMANCE IN FOUR FARROWING ENVIRONMENTS

	Level floor		Sloped floor		Pooled	*P*-values		
Measure	Crate	Pen	Crate	Pen	SE	P	S	P × S[a]
No. of litters	10	10	10	10				
Sow measures								
Feed intake, kg/d	6.9	7.2	6.4	6.4	.48	.69	.20	.77
Lactation wt loss, kg	21.8	21.4	30.9	20.9	4.9	.32	.41	.36
Litter measures								
No. born live	8.3	9.1	10.4	9.6	.71	1.0	.08	.28
No. stillborn[b]	1.08	.64	.51	.96	.40	1.0	.76	.30
No. crushed	.51	1.53	1.29	.27	.38	1.0	.55	.01
No. weaned	8.2	6.6	7.6	8.4	.51	.38	.27	.02
Preweaning mortality, %	10.8	27.1	17.2	9.1	4.5	.84	.20	.01
Pig weaning wt, kg	4.5	5.2	5.1	4.9	.32	.48	.78	.19
Total litter weaning wt, kg	32.5	24.3	36.2	36.3	3.3	.25	.04	.22
Creep feed intake, kg	.51	.56	.59	.50	.06	.82	.87	.28

[a]P = pen type; S = degree of slope; P × S = pen type × slope interaction.

[b]Number of fully formed pigs found dead at 12 h of age.

showed that sows and litters in that environment had performance similar or superior to litters in a traditional crate (McGlone and Blecha, 1987). The turn-around pen allowed the sows to turn around, but it did not give as much freedom of movement as the pens used in this study. Providing too much room (in our pen, 2.15 m^2 apparently caused an increase in piglet deaths due to crushing (Table 1). However, the quality of space also was important, because when the pen was sloped, the rate of piglet crushing was reduced to the amount observed in the level crate.

The success of a farrowing pen depends not so much on the amount of space provided, but on the way in which the pen type influences sow postural adjustments. The sloped pen, like the turn-around pen reported by McGlone and Blecha (1987), changed the normal lying postures made by the sow. Sows in the sloped environments lay more often on their sternums and uphill (direction of lying not actually

TABLE 2. LEAST SQUARES MEANS FOR SOW AND PIGLET BEHAVIOR IN FOUR FARROWING ENVIRONMENTS

	Level floor		Sloped floor		Pooled	*P*-values		
Measure	Crate	Pen	Crate	Pen	SE	P	S	P × S[a]
No. of litters	5	5	5	5				
Standing, min/d	117.7	157.1	116.2	197.6	49.1	.22	.73	.67
Standing times/d	6.5	11.2	12.8	11.2	2.5	.56	.31	.22
Sitting, min/d	9.5	45.2	2.5	–4.1[b]	22.6	.51	.28	.35
Sitting, times/d	1.8	2.4	4.6	–.2[b]	1.9	.26	.96	.17
Lying-side, min/d	1,181.8	1,225.9	1,110.1	1,149.5	55.1	.25	.45	.96
Lying-side, times/d	7.1	14.9	17.6	16.8	3.1	.26	.09	.18
Lying-belly, min/d	38.4	26.5	71.2	49.1	16.1	.29	.14	.75
Lying-belly, times/d	2.7	4.1	14.0	8.0	3.0	.44	.04	.23
Nurse interval, min	48.0	49.0	46.5	45.7	1.7	.93	.23	.60
Nursing, times/d	30.3	29.1	30.4	31.2	1.2	.87	.42	.39
Heat use, min/d	179.9	305.7	222.2	389.4	85.4	.13	.56	.82
Heat use, times/d	9.3	11.6	9.0	16.1	3.0	.20	.60	.50

[a]P = pen type; S = degree of slope; P × S = pen type × slope interaction.

[b]Raw mean for this treatment was 1.8 min/d. One very large datum in the level pen treatment caused these least squares means to be negative.

TABLE 3.SELECTED SIMPLE CORRELATION COEFFICIENTS BETWEEN LITTER PERFORMANCE AND BEHAVIOR[a]

Item A (X)	Item B (Y)	r	b	SE_b	*P*
Pigs stillborn	Heat use (D)	.59	.004	.002	.02
Pigs stillborn	Heat use (F)	.71	.154	.042	.003
Pigs weaned	Sow lying-side (D)	−.62	−.010	.003	.003
Pigs crushed	Sow sitting (D)	.54	.008	.003	.01
Pigs weaning wt	Heat use (D)	−.55	−.003	.001	.03
Litter weaning wt	Sow lying-side (D)	−.72	−.064	.014	.0003
Mortality, %	Sow wt	.38	.003	.001	.02
Mortality, %	Pigs weaned	−.47	−.056	.017	.002
Mortality, %	Pig birth wt	−.34	−.452	.202	.03
Nursing (F)	Heat use (F)	.52	.222	.099	.04

[a]Only significant correlations are presented. D = duration, F = frequency of behavior, b = slope, SE_b= SE of slope, P = *P*-value for b and r.

recorded). Sows seemed to slide downhill more when they lay on their sides perpendicular to the slope.

Sow general level of movement was not influenced by the amount or quality of space provided (see data on standing duration and frequency, Table 2). Sows moved about as much in a crate as they did in a pen (note no pen type effects in behavioral data in Table 2). Therefore, the farrowing crate did not change the level of activity of sows below that observed in penned sows. Similar activity for crated and penned sows was observed by Hansen and Curtis (1980) for prepartum sows.

Sow sitting rates were highly variable. Only 6 of the 20 sows from which behavioral data were collected showed any sitting. These sows were in each of the four environments. The average rate of pig crushing was 1.0 ± .36 for those sows that showed any sitting vs .29 ± .12 for those sows that did not show any sitting ($P < .01$).

The correlation between sow sitting and pigs crushed (r = .54) was of interest. Edwards et al. (1986) analyzed video records from sows and found that the most common posture that sows assumed before crushing as pig was the sitting position. Thus, sows that spend more time sitting (and heavier sows) seem more likely to crush pigs. We do not know the genetic or environmental causes of sow sitting, but reducing this behavior might reduce rates of crushing in all sow environments.

Some behaviors correlated with performance measures (Table 3). Sows that spent less time lying on their sides weaned larger and heavier litters. Of course, litters with larger pig birth weights had lower piglet mortality. Litters that used the heat lamp more often tended to nurse more often, also. However, litters that used the heat lamp for longer durations had smaller pig weaning weights. Finally, litters that used the heat lamp more often and for longer durations came from sows that had more stillborn piglets. Paradoxically, greater heat lamp use was correlated with lower pig performance (more stillbirths and smaller weaning weights). Perhaps pigs that spent longer periods under the heat lamp were less vigorous.

Implications

This study has implications for swine management and for animal care. First, a return to conventional level pens of the past would result in more piglet deaths, lower economic returns and lower overall well-being (especially for crushed pigs). Second, sloping the conventional pen altered sow, and possibly piglet behavior and reduced the rate of crushing to within the range observed for crated sows. The additional barn space needed to house a given number of sloped pens compared with crates might preclude widespread adoption of this system because sow-litter performance was no better in sloped pen than in the crate. Third, farrowing crates should not be sloped (from anterior to posterior); this increased rates of crushing. Fourth, alterations in sow behavior are required to reduce the rate of crushing. At this point, we are not able to say which environment the sow might prefer, the restricted space of a crate or the sloped pen that is difficult to maneuver in. Finally, the causes of piglet crushing are

poorly understood, but further investigations into sow behavior and its genetic and environmental causes might reduce crushing rate, even in the conventional crate.

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