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Effects of Season, Floor Type, Air Temperature and Snout Coolers on Sow and Litter Performance

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EFFECTS OF SEASON, FLOOR TYPE, AIR TEMPERATURE AND SNOUT COOLERS ON SOW AND LITTER PERFORMANCE[1]

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ABSTRACT

An evaluation of 341 sow and litter records over a 2-yr period was made to determine the effects of floor type and season on sow and litter productivity. Floor types were plastic-coated, expanded metal (PL) or concrete (CO) slatted flooring. Litters raised on PL had lower (P<.001) mortality (10.3 ± .85 vs 15.4 ± .83%), fewer splay-legged pigs/litter (.20 ± .06 vs .48 ± .06) and heavier weaning weights (61.0 ± .8 vs 54.2 ± .8 kg) than litters on CO. Sows ate less feed in the spring (P<.05) than during other times of the year. A second study was conducted with 88 litters to determine the effects of farrowing house temperature, floor type and snout coolers (SC) on sow and litter productivity. Farrowing house air temperature were 18, 25 or 30 C, with sows on PL or CO floors and with SC either on (910 cm/s) or off. At 18 and 25 C, average daily sow feed intake was higher (6.46 ± .21, 6.13 ± .19 and 4.20 ± .19 kg) and litter weaning weights were heavier (63 ± 2.8, 61 ± 2.5 and 52 ± 2.5 kg) than at 30 C. Litter mortality at 18 and 30 C was higher (P<.05) than for litters raised at 25 C (20.4 ± 2.6, 18.8 ± 2.3 and 12.0 ± 2.3%, respectively). Litters raised on PL at 18 C were 15 ± 3.4 kg heavier at weaning than litters raised on CO (P<.05). Providing SC increased sow feed intake at all air temperature (P<.05). However, SC sows held at 30 C ate less feed (P<.05) than sows held at 18 or 25 C. Snout coolers showed little benefit for litter performance while PL flooring, especially at 18 C, was beneficial to litter performance.

(Key Words: Air Temperature, Floor Types, Sows, Pigs, Season.)

Introduction

Snout coolers (SC) and different floor types have been utilized by pork producers to improve sow and piglet performance and comfort in warm environments. Snout coolers decrease the negative impact of heat stress on sows in farrowing crates by increasing convective (and perhaps evaporative-respiratory tract) heat loss, which decreases surface and core temperature and respiration rate (Taylor, 1958; Lipper and McGinty, 1961). Concrete (CO) flooring may increase conductive heat loss during heat stress.

Preference studies by Farmer and Christison (1982) indicated that pigs prefer plastic-coated, expanded metal flooring (PL) over other perforated flooring. Weaning weights (Washam, 1981; Mabry et al., 1982), survival rates (Jensen and Warren, 1981; Washam, 1981; Mabry et al., 1982) and knee and claw injuries (Washam, 1981; Mabry et al., 1982; Kornegay and Lindemann, 1984) were improved when litters were raised on PL instead of CO or solid flooring.

The objectives of these studies were to determine the effects of season, air temperature, SC, floor type and possible interactions on sow and piglet performance.

Materials and Methods

General. During gestation and the weaning-to-estrus interval, sows were fed 2 kg of a 13% crude protein sorghum-soybean meal ration in meal form each day. Before breeding, sows and gilts were vaccinated for leptospirosis. Four weeks before farrowing, bred sows and gilts were vaccinated for erysipelas, atrophic rhinitis and pasteurella. Before sows were due to farrow, and until weaning, sows were fed a 14% crude protein sorghum-soybean meal ration in meal form and water ad libitum. Within 1 d after parturition, piglets' tail and teeth were clipped, ears were notched, body weight was recorded and piglets received 1-ml (100 mg/ml) intramuscular injections of iron dextran and antibiotic. Fourteen days later boars were castrated and creep feed was offered. Sows in each farrowing group were weaned at an average age of 28 d in an all-in/all-out manage-

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ment scheme, with litters ranging from 21 to 35 d. Rooms were cleaned, disinfected and left vacant for a few days before pregnant sows entered. A four-breed rotational cross (Hampshire, Landrace, Yorkshire and Duroc) was used with crossbred sows and purebred boars.

Farrowing and gestation facilities were totally enclosed and environmentally controlled. The farrowing houses were two separate rooms which accommodated 16 sows each. Farrowing crates measured 1.5 × 2.1 m with a 56-cm center area for each sow. Crates in each room had eighter CO or PL flooring. The dimensions of the slots in the CO flooring consisted of ten 1.3- × 46-cm openings at the front of the crate and six 1.3- × 76-cm and four 2.5 × 76-cm openings at the back of the crate. The four 2.5-cm openings were directly behind the sow. A steel grate was inserted between concrete slats before and up to 48 h after farrowing to prevent injury to baby pigs' feet. In the center of the CO crates were 90 cm of solid concrete. The PL flooring encompassed the total area of the farrowing crate and contained about 1,300 perforations/m^2. All flooring was ground level (that is, not raised). Localized cooling devices (SC), connected to an evaporative cooling pad, were located at the front of each farrowing crate over the sow's head. Snout coolers could be independently turned on or off. Two gas heaters were located at opposite ends of each farrowing room and a 250-W heat lamp was located in the middle of the creep area in each farrowing crate. Fluorescent lights were on for 1 to 2 h/d in all buildings during feeding and animal care.

Exp. 1. An evaluation of 341 farrowing records, collected over a 2-yr period (1983 to 1985), was conducted to determine the effects of flooring materials and season on sow and piglet productivity. Flooring materials in the farrowing barn consisted of either CO or PL flooring. Month was determined where the greatest amount of the lactation period occurred. The following months were combined to give four seasons for analysis: December, January and February = winter; March, April and May = spring; June, July and August = summer; September, October and November = fall. All litters were from crossbred sows. Of the 341 litters, 262 litters were from multiparous females and 79 litters were from primiparous females. Cross-fostering occurred when litter size was extremely large or when a sow died or was injured. Records included: average piglet and total litter weight at 1 d of age and at weaning, number of piglets born alive and dead, number of piglets at weaning, sire-breed of piglets, weight of sow when entering the farrowing house and at weaning, and sow feed intake. Mortality (%) was calculated for each litter as follows: [1 - (number pigs weaned/ number live pigs after transfer)] × 100. An arcsin square root transformation was used in the analysis of percentage data.

Analysis of variance with a factorial arrangement of treatments was applied. The model included main effects of season and floor type, parity and the interactions among main effects. Number of live pigs nursing each sow at 1 d of age served as a covariate for all factors except number of piglets born. This factor equalizes effects of litter size and, to some degree, parity across treatments. Means were separated by t-tests, using error mean square as the source of variance (predicted difference procedure within SAS, 1982).

Exp. 2—Temperature × SC × Floor Type. Eighty-eight litters were utilized from January to March 1985 to determine the effect of farrowing house temperature, SC and floor type on sow productivity. Temperature and relative humidity were recorded by a calibrated 24 h/d hygrothermograph. Thermostats were set in the farrowing house for target temperature settings of 18, 25 or 30 C. The actual temperatures were 18.0 ± .5, 24.7 ± .2 and 29.9 ± .3 C for the target temperatures of 18, 25 and 30 C, respectively. Relative humidity could not be recorded for the 25 C temperature setting. Relative humidity was 59.3 ± 2.4% in the 18 C environment and 27 ± 1.3% in the 30 C environment. Floor types were the same as described in the sow survey section. Snout coolers were set to direct air on the sow's head and neck at a velocity of 910 cm/s. Air temperature exiting snout coolers was not measured, but was always cooler than inside air temperature. Sows and gilts were randomly assigned to floor type or SC (on/off) treatments within each temperature setting. Measurements evaluated in this study were the same as in the sow survey except sow weight 24 h after farrowing and creep feed intake (CFI) also were recorded.

Analysis of covariance for a nested design was applied to the data. The model was a complete randomized design with floor type and SC nested within the main effect of air temperature. Number of live pigs on each sow after cross-fostering on d 1 served as the covariate.

TABLE 1. LEAST-SQUARES MEANS FOR SOW AND PIGLET PERFORMANCE BY PARITY AND SLOTTED FLOOR TYPE (EXP. 1)

	Primiparous sows		Multiparous sows			P-values		
Item	Concrete floors	Plastic floors	Concrete floors	Plastic floors	SE_p^a	Floor type	Parity	Interaction
Number of litters	52	31	122	136				
Litter weaning wt, kg	50.28	63.33[d]	55.16[c]	60.78[d]	1.16	.01	.44	.01
Weaning number	8.4	9.2	8.2	8.8	.13	.01	.05	.33
Pig weaning wt, kg	5.99[b]	6.87[cd]	6.71[c]	6.97[d]	.10	.01	.01	.02
Mortality, %	14.39	6.29	16.22	11.24	1.19	.01	.03	.30
Splay-legged/litter	.54	.18	.48	.22	.08	.01	.89	.61
Sow feed intake, kg/d	5.79	5.72	6.63	6.58	.12	.68	.01	.96
Sow wt loss, kg/lactation	18.98	24.09	17.46	22.35	1.54	.01	.41	.95
Weaning to estrus, d	6.3	7.0	5.2	4.8	.37	.76	.01	.31

[a]Pooled standard error of the mean, n = 85.

[b,c,d]Means in the same row without a common superscript differ (P<.05).

Results

Exp. 1–Survey. Treatment means and standard errors for litter and sow weights and measures as affected by floor type are presented in table 1. Litters raised on PL floors were larger (P<.02) and heavier at weaning than litters raised on CO floors (P<.001). Percent mortality and number of splay-legged pigs/litter were higher in litters raised on CO floors (P<.01). Floor type did not have a significant effect on most sow measures. Sows lost more weight on PL than CO floors (P<.01).

Two variables were directly affected by season, number of splay-legged pigs and daily sow feed intake (table 2). Litters contained fewer splay-legged pigs per litter during the summer (P<.05) than during the fall or winter; spring-time incidence was intermediate. Daily sow feed intake was lower in the spring than in any other season (P<.05). A trend was found for pigs to be heavier at weaning during the fall, summer and winter when raised on PL floors (P=.1; figure 1).

Exp. 2–Temperature × SC × Floor Type. Treatment means and standard errors of the means for litter and sow measures are presented

TABLE 2. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR SOW AND PIGLET PERFORMANCE BY SEASON (EXP. 1)

	Season					
Item	Fall	Spring	Summer	Winter	SE_p^a	P-value
Number of litters	75	83	95	88		
Litter weaning wt, kg	56.67	59.03	56.84	58.18	1.16	.44
Weaning number	8.6	8.7	8.6	8.5	.13	.48
Pig weaning wt, kg	6.64	6.80	6.60	6.92	.11	.11
Mortality, %	13.22	11.60	12.72	13.94	1.18	.83
Splay-legged/litter	.44[d]	.32[cd]	.17[c]	.45[d]	.08	.04
Sow feed intake, kg/d	6.48[d]	6.05[c]	6.56[d]	6.50[d]	.13	.02
Sow wt loss, kg/lactation[b]	21.36	23.05	19.98	18.15	1.55	.15
Weaning to estrus, d	6.1	4.9	5.6	4.8	.44	.13

[a]Pooled standard error of the mean, n=85.

[b]Weight change from entering farrowing barn (pre-farrowing) to end of 28-d lactation.

[c,d]Means in the same row without a common superscript differ (P<.05).

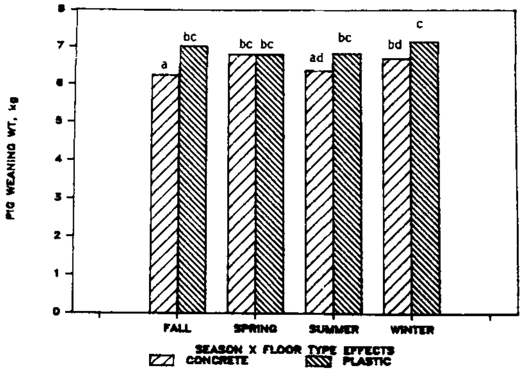

Figure 1. Interaction between season of the year and floor type on 28-d pig weaning weight. Means with different letters differ (P<.05; pooled SE=.15; n=341).

in table 3. Near the start of this study, three sows on PL floors with no cooling died before or during parturition. Therefore, farrowing room temperature was lowered to 28 C until all sows had farrowed, then thermostats were adjusted to 30 C. Total litter weaning weights were lighter in 30 C than in 18 or 25 C environments (P=.01). Average individual pig weaning weight was higher in the 18 C environment (P<.001) than in 25 or 30 environments. Litter mortality was 8 and 7% lower (P<.05) in the 25 C than in the 18 or 30 C environments, respectively. Daily sow feed intake was similar in 18 and 35 C environments but was reduced in 30 C air temperature (P<.001). Sow weight loss was greater in the 30 C environment (P<.001) than at other air temperatures. Sows in the 18 C environment took 2 to 3 d longer to come into estrus after weaning than sows in the warmer environments (P<.01).

The main effect of SC was significant for sow feed intake. Sows that had access to SC in the 30 C environment consumed 1.0 kg more feed than did sows without access to SC (figure 2). Although sow feed intake during 30 C heat stress was improved by SC, sow feed intake was still lower than in other air temperature treatments without SC. Piglet mortality was higher in the 30 C environment when SC were on and in the 18 C environment than in the 25 C environment when the SC were off (figure 3; P=.05). Litters raised on PL floors in the 18 C environment were over 15 kg heavier at weaning than litters raised either on CO at 18 C or than litters on both floor types in the 30 C environment (P<.05; figure 4).

Discussion

Baxter and Mitchell (1977) stated that floors should have certain characteristics: 1) not cause injury, 2) not contribute to infection, 3) not contribute to stress, 4) be maintenance-free, 5) be easy to clean and 6) have as reasonable cost. In the present study, only performance measures were considered, but inferences can be drawn from other studies that have considered the first three characteristics of floor types. In this study, floor type influenced primarily piglet measures. Compared with CO, PL resulted in

TABLE 3. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR SOW AND PIGLET PERFORMANCE IN DIFFERENT FARROWING HOURSE TEMPERATURES (EXP. 2)

	Temperature, C				
Item	18	25	30	SE_p^a	P-value
Number of litters	29	29	30		
Litter weaning wt, kg	63.23[c]	61.13[c]	52.38[d]	2.47	.01
Weaning number	8.1	8.9	8.3	.27	.13
Pig weaning wt, kg	7.82[c]	6.87[d]	6.40[d]	.20	.001
Mortality, %	20.35[c]	11.97[d]	18.79[c]	2.29	.04
Creep feed intake, kg/lactation	3.13	3.04	2.61	.74	.88
Sow feed intake, kg/d	6.46[c]	6.13[c]	4.20[d]	.19	.001
Sow wt loss, kg/lactation[b]	3.14[c]	7.86[c]	24.21[d]	2.25	.001
Weaning to estrus, d	7.3[c]	4.4[d]	5.3[d]	.62	.01

[a]Pooled standard error of the mean, n = 29.

[b]Weight change from farrowing to end of 28-d lactation.

[c,d]Means in the same row with different superscripts differ (P<.05).

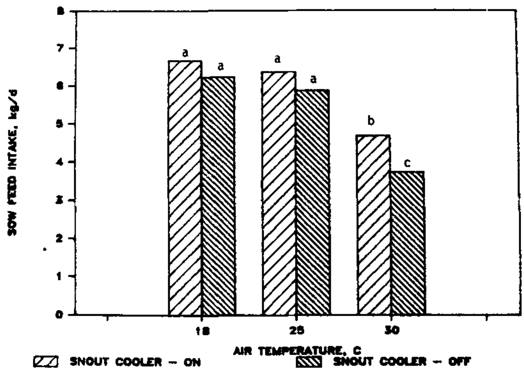

Figure 2. Interaction between environmental temperature and snout coolers on daily sow feed intake. Snout coolers had an air velocity of 910 cm/s. Means with different letters on bars differ (P<.05; pooled SE=.26; n=88).

greater numbers and weights of piglets at weaning and fewer splay-legged piglets. An increase in weaning weights, pen cleanliness and increase in mortality has been associated with an increase in floor perforation (Washam, 1981; Mabry et al., 1982).

Studies in which lesions on legs and feet of swine and preference of floor type by newborns have been observed may give some insight into differences observed in litter performance between the two floor types in this study. Jensen and Warren (1981) found that litters raised on PL floors had lower incidence of abrasions and lesions compared with concrete, metal and wood floors. Evidence of bleeding from knee abrasions were highest for CO flooring. Farmer and Christison (1982) observed that piglets preferred to spend time on PL floors compared with perforated metal, fiberglass slats and woven wire floors. Baardson et al. (1980) reported that piglets raised on totally slatter CO floors had a higher incidence of nipple necrosis than piglets raised on PL floors. Although researchers have reported little relationship between foot and leg injury and performance (Jensen and Warren, 1981; Kornegay and Lindemann, 1984), data from Exp. 1 show that PL floors support greater litter weaning weights, reduced piglet mortality and fewer splay-legged piglets. Thus, the floor type that piglets preferred also supported greater litter productivity.

In this study, a higher incidence of splay-legged pigs occurred on CO. Thurley et al. (1967) and Kohler et al. (1969) indicate that floor type and texture can influence incidence of splay-legged pigs. We observed that CO floors were wetter around the side and rear areas of sow. This observation may partly explain the higher incidence of mortality and splay-legged incidence on CO flooring.

Because facilities were completely enclosed and extremes in outside temperature were tempered by use of SC during warm weather, season of the year had a relatively minor effect on sow and litter performance in Exp. 1. The summertime delay in return to estrus reported by Clark et al. (1986) was not found in this study.

In Exp. 2, sows exposed to 30 C temperatures during lactation consumed less feed and lost more weight than sows exposed to continu-

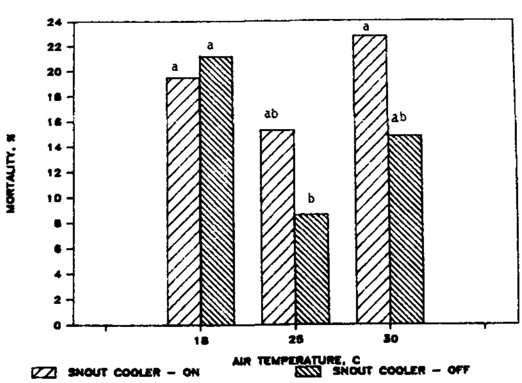

Figure 3. Interaction between air temperature and snout coolers on percent mortality. Means that do not have a common letter on bar differ (P<.05; pooled SE=3.19; n=88).

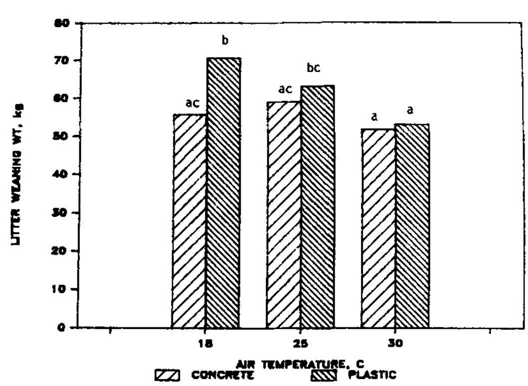

Figure 4. Interaction between environmental temperature and floor type in farrowing crates on litter weaning weight. Means that do not have a common letter on bars differ (P<.05; pooled SE=3.44; n=88).

ous temperatures of 18 and 25 C during lactation. Bond et al. (1952) reported that sows lost more weight as environmental temperature increased. Cox et al. (1964) indicated that a continuous temperature of 29 C had a greater detrimental effect on sow feed intake than fluctuating temperatures between 18 and 32 C. Studies in which sow feed intake was restricted during lactation (.45 kg/piglet or 2.32 kg plus .2 kg/piglet) showed that feed restriction increased sow weight loss with no effect on litter performance (Elsley et al., 1969; Hitchcock et al., 1971; Libal and Wahlstrom, 1975). Although sow feed intake in the 30 C environment was quite similar to the feed intakes of restricted-fed sows in other studies, litter weaning weights were adversely affected. Temperature may have had an indirect effect on piglet weaning weight, because the lower and higher critical temperatures for 5-kg piglets were thought to be 23 C and 31 C, respectively, on CO floors (Mount, 1968). Thus, piglets probably were not heat-stressed in the 30 C temperature. Therefore, reduced piglet weaning weights at 30 C must be attributable to reduced sow feed intake and subsequent reduced sow milk production. Sows held at 30 C had reduced feed intake and increased weight loss during lactation. Mortality was lowest at the intermediate temperature. Litters raised in cooler environments (10 to 20 C) experience higher mortality due to chilling (Taylor et al., 1952; Parker et al., 1980; McGinnis et al., 1981; Nienaber et al., 1985). Although piglets are able to increase heat production by increasing their metabolic rate at an air temperature of 20 C, the pig's lack of insulation, sparse pelage and a large surface area-to-body weight ratio handicaps the pig in maintaining homeostasis (Mount, 1968; McGinnis et al., 1981). Therefore, we speculate that increased mortality at 18 C may have been due to chilling of piglets (sow feed intake was normal), but at 30 C increased mortality may have been due to reduced sow feed intake and reduced milk production.

In the 30 C environments, SC increased daily sow feed intake but did not bring feed intake up to levels of sows in cooler temperatures (figure 2). Johnson and Taylor (1958) were among the first researchers to study the use of localized cooling devices for sows. Bond (1959) quoted Taylor (1958) as showing that cooling of the sow increased sow comfort and decreased rectal and surface temperatures and respiration rates. Also, Lipper and McGinty (1961) showed that in the temperature range from 26 to 33 C, cool air resulted in lower daily rectal temperatures and respiration rates for sows confined in crates but not for sows in pens. The tendency for litters raised at 25 and 30 C with SC on to have higher mortality that when the SC were off indicates that SC may increase piglet heat loss (figure 3). Piglets may not have been further chilled by SC at the cooler air temperature of 18 C.

Piglets raised on PL floors in the 18 C environment were heavier than piglets raised on CO floor in all three environments and on PL floors in the 30 C environment (figure 4). High piglet conductive and radiant heat losses on CO flooring may be responsible for the lower litter weaning weights on CO compared with PL floors at 18 C. However, thermal and physical properties of the floor seem less critical as air temperature increases (figure 4) to 30 C. However, the thermal property of the floor did apparently cause sow death on PL during heat stress.

Overall, SC had little overall beneficial effect on litter performance. In cool and warm environments, PL flooring had a positive benefit on litter weaning weight. Sows and litters held at 30 C showed evidence of heat stress, which was not observed at 25 C. Heat stress depressed sow feed intake, piglets weaning weights and increased piglet mortality and sow weight loss. Piglet mortality was increased and the weaning-to-estrus period lengthened at 18 C compared with sows held at 25 C. The range of air temperatures supporting optimal sow and litter performance is apparently narrow.

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