RESEARCH REPORT
ANIMAL WELFARE

Title: Effect of a softer floor surface in the farrowing crate on the expression of lameness and subsequent sow performance - **NPB#08-153**

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Introduction

Lameness is both an economic and welfare concern in swine breeding herds. Producers are in a difficult situation to take a decision to treat, cull or euthanize a lame sow as there exists little information on the benefits and costs of these decisions. Nonetheless, lameness is identified as a major concern and flooring as a major factor. Further, when pain is suspected there are limited alternatives for analgesia for breeding swine. If we follow the dairy industry, one of the first steps in addressing sow lameness is through identifying factors affecting sow comfort. The use of alternative flooring, particularly in the farrowing room should be of benefit to the sow and also to the producer through a reduction of a painful condition, an increase in subsequent productivity and an increase in value if slaughtered. This study is expected to improve the competitiveness and sustainability of US pork industry both within the US and in export markets in the light of heightened welfare concerns, while addressing the need for logical and detailed management decisions.

Objective

To assess the effect of rubber mats in farrowing crates on welfare and performance of lame sows

Materials and Methods

Animals, housing and feeding – The study was performed at the University of Minnesota, Southern Research and Outreach Center, Waseca, Minnesota. All protocols were approved by the Institutional Animal Care and Use Committee of the University of Minnesota. This study involved 70 lame and 70 non-lame gestating sows (Genetically Advanced Pigs, GAP Genetics, Winnipeg, Manitoba, Canada) of parities 0 to 8 and weighing 402 to 738 lb at 109 days of gestation. Gestating sows were housed either in pens (12.75 m x 6.75 m) with one electronic sow feeder (ESF) per pen (TEAM electronic sow feeder; Osborne Industries, Osborne, Kansas) (n=77) or in stalls (Crystal Spring Hog Equipment Ltd, St Agathe, Manitoba, Canada; length 200 cm, width 60 cm wide, height 97 cm) (n=63). Pens and stalls had fully slatted flooring (solid portion 12.7 cm wide and 12.7 cm deep; slots 2.54 cm wide). Thirty nine parity one or two sows, 19 sows of parities three to five, and 10 sows of parities > five were housed in pens. Twenty one parity one or two sows, 32 sows of parities three to five, and 10 sows of parities > five were housed in stalls. The distributions of parities in pens and stall-housed sows did not differ (chi-square test; $P>0.05$). During gestation (until day 109) sows were fed 2.5 to 3 kg of feed daily. Sows while in the farrowing crates were offered 3 kg of feed per day until farrowing, and ad libitum feed during lactation. Equal numbers of sows were randomly allocated to farrowing crates (214 cm x 66 cm, excluding a creep area for the piglets) with cast iron floor or to crates with the cast iron floor covered with rubber mats (3cm thickness) on the posterior half. Sows were weaned at an average of 18.4 days of lactation (SD, 1.4 day).

<u>Data collection</u>

Lameness scores – The sows were observed by a single observer while moving them from their gestation housing to the farrowing crates. Lame sows were identified based on unequal weight bearing on all limbs. Sows

were categorized for lameness was assessed as lame or non-lame. A subjective lameness score of severity of lameness from 0 (not-lame) to 3 (severe lame) was also recorded for data description.

Claw lesions scores – Claw lesions were assessed prior to farrowing (day 110 of gestation) after the sows were moved into farrowing crates. Lesions included erosions, cracks, and overgrowths. The lesions were examined on a severity scale of 0 (no lesions noted) to 3 (severe). Claw lesion locations were classified as side wall, heel, sole, junction between heel and sole, white line, dew claws or toe. A total claw lesion score was calculated as the sum of all individual lesion scores for the claw.

Behavior variables - The behaviors of the sows were recorded and scored using cameras and a time-lapse video recording for 24 h on days 3, 9 and 15 post-farrowing. Events and postures evaluated included frequency of getting up, drinking water, dog sitting, and eating. A sow was considered to be eating or drinking from the time her head was observed in the feeder or at the nipples, respectively. A subsample of sows (n=108) was randomly selected to calculate the time that the sows were in lateral recumbency on day 9 post farrowing. The longest uninterrupted lying period observed during day 9 post-farrowing (T-max) was also determined for each sow (Rolandsdotter, et. al., 2009).

Performance variables – Data were obtained from the PigCHAMP database (PigCHAMP, Ames, Iowa) of the research unit to evaluate the farrowing performance of sows. Variables evaluated were numbers of born alive piglets, mummies, and stillborn; need for farrowing assistance; preweaning piglet mortality and recorded reasons; litter birth weight and litter weaning weight; parity; lactation length; disease and treatment events in the farrowing crates; and sow removal events. The litter from each sow was weighed at birth and at weaning using a weighing cart (Ag Alliance) with an electronic scale (Model TI500; Transcell Technology, Inc, Wheeling, Illinois; accurate to 1 lb).

Body weight and condition - At 109 days of gestation and on the day of weaning (15 to 24 days post farrowing), all sows were weighed on an electronic scale (Ag Alliance, Altoona, Iowa), and backfat was measured at the

last rib (5 cm from the midline of the back on both left and right sides) with a Lean-O-Meater ultrasound unit (Renco, Minneapolis, Minnesota). Body condition was also evaluated following the 5 point scale (1=thin, 5=fat) described by Straw and Meuten (1992).

Feed intake - Sows in farrowing crates were hand-fed twice daily weighed amount of feed which was recorded on the sow cards. Feed consumed was assumed to be equal to that fed if the feeder was empty. The average lactation feed intake (LFI) for each sow was calculated by dividing the total quantity of feed consumed from day 2 of lactation until weaning by the number of lactation days for that sow. The average feed intake for week-1 and week-2 post-farrowing were also calculated. The frequency of the number of lactation days that the sows were consuming $\leq$ 5 lbs (2.27 kg) was also calculated for all sows using daily feed intake (day 2 to 14 of lactation) .

Shoulder ulcers – Shoulders of sows were examined for shoulder ulcers on day109 of gestation and at weaning. Lesions were scored following a 4 point grade scale according to severity and size (Zubrigg, 2006).

Other variables - Longevity of sows in terms of culling, euthanasia and death with reason thereof prior to subsequent farrowing was recorded (up to 200 days). Wean to estrus interval, number of services to consumption, pregnancy status 45 d-post-breeding and subsequent farrowing rate were also recorded from the PigCHAMP database.

Statistical analysis

Behavior, performance productivity, body condition and feed intake variables – Two way ANOVA was employed to determine the effects of lameness and floor type (rubber mat vs. cast iron) on the behavior, performance, average feed intake and body condition variables of the sows. In all the analyses, the interactions between lameness and floor type were included. Means were compared with the use of Tukey's pairwise

comparison with the SAS probability-difference option (SAS-PDIFF). The feed intake (category of 0 to 5 lbs (2.27 kg) of lame and non-lame sows and flooring type (rubber mat vs. cast iron) on days 2 to 14 of lactation were compared, controlling for the effect of housing system (Proc Genmod, SAS v 9.2).

Shoulder ulcers – A logistic regression model was used to analyze the associations of the floor type (rubber mat vs. cast iron) and the presence of lameness and other covariates (parity, weight and back fat at 109 days of gestation) with the presence of shoulder ulcers.

Survival analysis – Univariate analyses were performed for treatment groups (Kaplan-Meier curves and a log-rank test of equality) to identify associations with sow longevity during the period ≤ 200 days after weaning. Kaplan-Meier curves were used (along with the log-rank test) to verify whether survival functions were approximately parallel among strata.

A *P* value of 0.05 or less was considered significant in all comparisons. All statistical analyses were performed with SAS System for Windows, version 9.2 (SAS Institute, Cary, North Carolina, USA).

Results

Animals and baseline information **–** Mean backfat thickness for sows housed in pens (18.13 mm; SD, 4.44) and sows housed in stalls (17.08 mm; SD, 4.50) did not differ (two-sample T-test; P>0.05). Mean weight for sows housed in pens (545.38 lb; SD, 68.65) and sows housed in stalls (550.30 lb; SD, 70.73) did not differ (two-sample T-test; P>0.05). A total of 108 sows (score 1=89 sows; score 2=15sows; score 3=4 sows) out of 240 sows evaluated were identified as lame animals. The lameness scores of the sows are presented on table 1. The proportions of sows that were identified as lame did not differ significantly between sows housed in stalls (41.4%) compared to sows housed in pens (48.4%) during gestation.

The mean total claw lesion scores of sows housed in pens (53.8; range, 20 to 126) was higher than in sows housed in stalls (32.2; range, 6 to 63) (two-sample T-test; $P<0.05$).

Behavior, performance, body condition and feed intake –The frequency of getting up and dog sitting on days 3, and 15 post-farrowing was not affected by lameness ($P>0.05$), but it was affected on day 9 post-farrowing ($P=0.029$). The frequency of drinking water on day 15 was not affected by lameness ($P>0.05$), but it was affected on days 3 and 9 post-farrowing ($P<0.05$). Lameness did not affect the frequency of eating on days 3, 9 and 15 post-farrowing ($P>0.05$). The presence of rubber mats did not affect the frequency of getting up and eating of the sows ($P>0.05$), but it did affect the frequency of dog sitting and drinking water on day 9 post-farrowing ($P=0.02$). The effect of lameness and rubber mats allocated on the posterior half of the sows on the behavior are shown in table 2. The frequency of getting up was significantly higher in the non-lame group with rubber mats than the lame group with rubber mats on days 3 and 9 post-farrowing ($P<0.05$). It was also significantly higher than the lame group without mats on day 15 post-farrowing ($P<0.05$). The frequency of dog sitting and drinking water were significantly higher in the non-lame group with rubber mats than the lame group with rubber mats on days 9 and 15 post-farrowing ($P<0.05$). There were no statistical differences in the frequency of dog sitting, drinking water and eating between all groups on day 3 post-farrowing. The frequency of eating was significantly higher in the non-lame group with rubber mats than the lame group without mats on day 9 post-farrowing ($P<0.05$). There were no statistical differences in the frequency of eating among all groups on day 15 post-farrowing. Table 3 presents the behavior of the four groups of sows. The proportion of time that the sows were in lateral recumbency on day 9 post farrowing (mean for all sows= 0.92 hours, SD=0.04) did not differ among groups ($P>0.05$). The T-max observed during day 9 post-farrowing (mean for all sows= 4.6 hours, SD=1.4) was also not different among groups ($P>0.05$).

There was no significant difference in farrowing performance and body condition among groups. There was no significant difference in LFI, total feed intake, feed intake on week -1 or week-2 post-farrowing. The number of days sows consumed less than 5 lbs (2.27 kg) was 42% higher in lame sows and 30% lower in stall housed sows

(P<0.05 for both). Use of rubber mats was not associated with feed intake in this study. Table 4 presents the productivity performance, body condition and feed intake variables of the four groups of sows.

Shoulder ulcers– A total of 52 sows developed shoulder lesions in this study. Table 5 presents the shoulder ulcer prevalence at weaning among all sows evaluated. Logistic regression analysis showed that back fat thickness at 109 d of gestation (odds ratio 0.832) was negatively associated with the likelihood of having shoulder ulcers at weaning. The odds of shoulder ulcers was also 3.0 (1.410-6.346) times higher in sows without mats than sows with rubber mats on hind limbs (P<0.05). Parity, housing system and lameness were not associates with the occurrence of shoulder ulcers. Table 6 shows the odds ratio and confidence intervals of the factors associated with shoulder ulcers at weaning.

Survival analysis – The reduction in survival function was proportional between lame and non-lame sows, and the Kaplan-Meier survival curves were approximately parallel (Figure 1). The 200 days survival rate for lame sows with cast iron was 79 percent, which was not different from the survival rate for lame sows with rubber mat (73 percent) (P >0.05). The 200 day survival rate for non-lame sows without mats cast iron was 75 percent, which was not different (P >0.05) from the survival rate for non-lame sows with rubber mat (78%). Mean survival time for lame sows with rubber mats was 169 days after weaning, whereas mean survival time for lame without rubber mats was 174 days (P>0.05). Mean survival time for non-lame sows with rubber mats was 177 days after weaning, whereas mean survival time for non-lame without rubber mats was 171days (P>0.05). The test of equality indicated that the survival time did not differ significantly among groups of sows (P>0.05) (Figures 2 and 3).

Discussion

The effect of lameness on the behavior of the sows on this study is indicative of the adverse effect of lameness on postural behaviors. This supports a previous study that found that lameness was related to alter lying down behaviors (Bonde, et al. 1987). If sows are lame they are more likely to spend more time on lying down and also have more difficulty on rising, leading to an altered frequency of those behaviors. In our study, 90% of the lame animals displayed only mild manifestations of lameness, which may explain the small differences observed overall in the frequencies of the behaviors among the groups of sows. Moreover, post-partum behavior of the sow and familiarity of stall-housed sows to postural changes in restricted space could have influenced the results of our study.

The high prevalence of shoulder lesion at weaning in this study (33%) was in accordance with previous research that had reported a high prevalence of shoulder lesions of up to 48% at 12 days post-farrowing (Davies, et al. 1997). Our data showed that shoulder lesions were negatively associated with back fat thickness at 109 d of gestation. For every unit (mm) that the back fat was increased at 109 days of gestation the likelihood of developing shoulder lesions was reduced by 17%. Christensen et al. (2002) also found an effect of back fat depth. That study reported that for each mm extra back fat depth, the risk of pressure ulcers is decreased by 16%. Davies et al. (1997) also reported that body condition score, back fat depth and tuber depth are risk factors for shoulder lesions. Their study considered that soft tissue overlying the tuber is a direct determinant for the risk of developing shoulder lesions in lactating sows. These findings may support the hypothesis that the shoulders of sows with good body condition have less pressure sores from the environment.

We found no association of lameness, parity or housing system with the risk of shoulder lesions. Among these, the lack of association between parity and shoulder lesions was supported by Davies, et al. (1996). In contrast, others studies have reported an association between parity (Davies et al. 1997; Christensen et al, 2002; Zurbrigg, 2006) and lameness (Bonde, et al, 1987) with shoulder lesions.

Additional contributing factors may be associated with the development of shoulder lesions including floor type and activity level during parturition and lactation (Davies, et al 1997). Rolandsdotter, E. et al. (2009) showed an association between prolonged lateral recumbency and shoulder lesions in lactating sows. In contrast, our study did not show any significant difference between the time that sows that developed shoulder lesions spent in lateral recumbency compared with sows that did not develop shoulder lesions.

The presence of rubber mats under the hind limbs during lactation was associated with lower proportion of sows with shoulder lesions under the conditions of this study. Zubrigg (2006) reported that the presence of rubber mats during the lactation period reduced the time of the healing process of shoulder lesions by 7 days.

The overall performance of the sows in terms of productivity performance during the period of this study was not affected by lameness or the presence of the rubber mats on the posterior half. Although the rubber mats did not affect feed consumption, the number of day that lame sows consumed $\leq$ 5 lbs (2.27 kg) was 42 % higher when compared to non-lame sows under the conditions of this study. Previous studies have reported the adverse effect of consuming less than 3.5 kg of feed during the first two weeks of lactation, which leads to higher likelihood of being removed before a subsequent farrowing (Anil, et al. 2006). However, our study found no difference in the survival of lame and non-lame sows for up to 200 days after weaning.

Woven wire, cast iron and, triangular bar (*tri-bar*) are common flooring materials used for farrowing crates. It is logical that if a sow with a markedly altered gait on a slatted or wire floor walks with more or less normal gait on a soft floor, there are problems. A significant difference in the frequency of weight shifting when lame sows walked on concrete floor and on rubber mats has been reported (Anil et al., 2007). Higher odds of lameness (Heinonen et al., 2006) and a higher prevalence of claw lesions were found in sows housed on slatted floors than on concrete floors (Ehlorsson et al., 2002).

Rushen et al., (2004) suggested, based on studies in cattle, that the type of floor can influence the manifestation of lameness. The prevalence of footpad lesions in cows has been reported to be greater on rough concrete than on smooth concrete (Wood, 2001). Other bovine studies have also indicated the advantages of rubber flooring for lame animals compared to concrete surface in terms of gait (Flower et al., 2007), stride length (Telezhenko and Bergsten, 2005) and postural changes and duration (Rushen et al., 2007), and heel lesions (Vanegas et al., 2006). Brennan and Aherne (1987) observed a higher severity of foot lesions in starter pigs penned on woven wire flooring than in those penned on plastic coated expanded metal floors.

Lay Interpretation

The aim of this study was to explore the effect of providing rubber mats in farrowing crates on the impact of lameness on sow welfare and performance. The study was conducted at Southern Research and Outreach Center, Waseca and involved 70 lame and 70 non-lame sows. An equal number of lame and non-lame sows were randomly allocated to farrowing crates with bare cast iron floors or to identical crates provided with rubber mats of 3 cm thickness placed over those floors. The frequency of getting up and dog sitting was affected by lameness on day 9 post-farrowing (P= 0.029) but was not affected on days 3 or 15 post-farrowing (P>0.05). The frequency of drinking water was affected by lameness on days 3 and 9 post-farrowing (P<0.05) but not on day 15 (P>0.05). Lameness did not affect the frequency of eating on days 3, 9 or 15 post-farrowing (P>0.05). The presence of rubber mats did not affect the frequency of getting up and eating of the sows (P>0.05), but it did affect the frequency of dog sitting and drinking water on day 9 post-farrowing (P=0.02). There was no significant difference in farrowing performance, body condition, LFI, total feed intake, feed intake on week -1 and week-2 post-farrowing between the groups. Back fat measurement at 109 d of gestation (odds ratio 0.832; 95% CI: 0.741-0.933) was negatively associated with the likelihood of having shoulder ulcers at weaning. The likelihood of shoulder ulcers was 3.0 (95% CI: 1.410-6.346) times higher on cast iron when compared to rubber mats on hind limbs (P<0.05). Parity, housing system and lameness were not associated with shoulder ulcers in this study. The survival of sows at 200 days post-weaning did not differ among groups (P>0.05). In general,

the results indicate adverse effects of lameness on postural behavior and feed and water consumption during lactation.

Table 1: Distribution of lameness severity scores in sows from stall or pen gestation

	Housing system		
Lameness Score*	**Pen (n=124)**	**STALL(n=116)**	**Total**
0	64	68	132
1	54	35	89
2	9	6	15
3	1	3	4

* Lameness score 0 (non-lame) to 3(severe lame)

Table 2: Mean frequency of observed behaviors among lactating sows at different days post-farrowing

Behavior	Day	Lame		Mat	
		Lame (n=70)	Not Lame (n=70)	No (n=70)	Yes (n=70)
		Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Getting up	3	6.64 (0.39)	7.83 (0.55)	6.89 (0.41)	7.59 (0.54)
	9	8.26 (0.39)[a]	9.47 (0.38)[b]	8.69 (0.41)	9.06 (0.38)
	15	9.99 (0.49)	11.33 (0.59)	10.19 (0.51)	11.13 (0.58)
		Lame		**No Lame**	
Dog sitting	3	9.89 (0.69)	11.83 (0.72)	10.60 (0.73)	11.11 (0.69)
	9	12.03 (0.61)[a]	13.91 (0.61)[b]	12.09 (0.59)[a]	13.88 (0.63)[b]
	15	18.71 (0.92)	20.77 (0.92)	18.81 (0.97)	20.67 (0.99)
Drinking water	3	9.26 (0.52)[a]	10.94 (0.61)[b]	9.87 (0.60)	10.33 (0.55)
	9	11.86 (0.57)[a]	13.60 (0.59)[b]	11.77 (0.55)[a]	13.71 (0.60)[b]
	15	17.16 (0.77)	19.10 (0.88)	17.30 (0.84)	18.96 (0.81)
Eating	3	6.20 (0.35)	6.91 (0.36)	6.41 (0.34)	6.70 (0.38)
	9	7.67 (0.36)	8.60 (0.32)	8.04 (0.34)	8.23 (0.34)
	15	9.00 (0.40)	10.03 (0.47)	9.27 (0.40)	9.76 (0.48)

[a,b] Within each row, within each category of lame or mat, the means with different superscripts differ significantly ($P<0.05$)

Table 3: Mean frequency of observed behaviors among lactating sows on days 3, 9 and 15 post-farrowing

[a,b] Within each row, the means with different superscripts differ significantly ($P<0.05$)

Behavior	Day	No Mat (n=35)	Mat (n=35)	No Mat (n=35)	Mat (n=35)
		Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Getting up	3	6.66 (0.49)[a]	6.63 (0.63)[a]	7.11 (0.66)[ab]	8.54 (0.86)[b]
	9	8.43 (0.63)[a]	8.09 (0.49)[a]	8.94 (0.53)[ab]	10.00 (0.53)[b]
	15	9.86 (0.68)[a]	10.11 (0.71)[ab]	10.51 (0.78)[ab]	12.14 (0.89)[b]
Dog sitting	3	9.57 (0.91)[a]	10.20 (6.23)[a]	11.62 (1.13)[a]	12.03 (0.89)[a]
	9	11.20 (0.79)[a]	12.88 (0.91)[ab]	12.97 (0.87)[ab]	14.86 (0.85)[b]
	15	17.66 (1.20)[a]	19.78 (1.39)[ab]	19.97 (1.51)[ab]	21.57 (1.41)[b]
Drinking water	3	9.06 (0.69)[a]	9.46 (0.79)[a]	10.69 (0.98)[a]	11.20 (0.73)[a]
	9	10.91 (0.73)[a]	12.82 (0.85)[ab]	12.63 (0.81)[ab]	14.57 (0.84)[b]
	15	16.00 (1.07)[a]	18.31 (1.08)[ab]	18.60 (1.28)[ab]	19.60 (1.22)[b]
Eating	3	6.37 (0.46)[a]	6.03 (0.54)[a]	6.46 (0.49)[a]	7.37 (0.51)[a]
	9	7.83 (0.55)[ab]	7.50 (0.45)[a]	8.26 (0.42)[ab]	8.94 (0.48)[b]
	15	9.00 (0.57)[a]	9.00 (0.58)[a]	9.54 (0.57)[a]	10.51 (0.75)[a]

Table 4: Reproductive and litter performance, body condition and feed intakes of sows by lameness status and floor treatment (mat or no mat)

Productivity measure	Lame		No Lame		
	No Mat (n=35)	Mat (n=35)	No Mat (n=35)	Mat (n=35)	
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	*P*
Total born	12.00 (0.57)	11.97 (0.52)	11.77 (0.55)	11.86 (0.60)	NS

Table 5: Shoulder ulcer at weaning among all evaluated sows

Born alive	10.94 (0.55)	10.97 (0.52)	10.74 (0.49)	10.63 (0.56)	NS
Stillborn	0.89 (1.05)	0.83 (1.12)	0.77 (1.09)	0.97 (1.34)	NS
Mummies/litter	0.17 (0.08)	0.17 (0.08)	0.26 (0.11)	0.56 (0.09)	NS
Litter birth weight (lb)	37.89 (1.61)	37.78 (1.51)	37.6 (1.64)	37.04 (1.64)	NS
Piglet birth weight (lb)	3.61 (0.11)	3.55 (0.10)	3.54 (0.08)	3.59 (0.09)	NS
Piglets weaned	9.29 (0.33)	9.46 (0.29)	9.66 (0.19)	9.66 (0.20)	NS
Litter wean weight (lb)	134.88 (5.62)	130.19 (4.76)	136.18 (3.96)	136.13 (4.03)	NS
Piglet wean weight (lb)	14.46 (0.32)	13.76 (0.28)	14.09 (0.29)	13.97 (0.29)	NS
Sow weight at 109d (lb)	545.57 (10.56)	557.29 (12.09)	534.06 (11.99)	553.46 (12.31)	NS
Sow weight At weaning (lb)	500.86 (11.42)	508.26 (11.93)	492.91 (12.63)	509.60 (13.32)	NS
Weight difference (109d–weaning) (lb)	-44.71 (6.22)	-49.03 (4.44)	-41.14 (5.77)	-43.86 (4.13)	NS
Sow back fat at 109d (mm)	17.31 (0.65)	16.91 (0.81)	18.09 (0.84)	18.31 (0.73)	NS
Sow back fat At weaning (mm)	14.54 (0.55)	14.60 (0.64)	15.57 (0.69)	15.29 (0.59)	NS
Back fat difference (109d-weaning) (mm)	-2.77 (0.32)	-2.31 (0.33)	-2.51 (0.33)	-3.03 (0.33)	NS
Total feed intake (lb)	224.14 (9.84)	218.51 (9.79)	234.74 (11.19)	220.26 (9.46)	NS
Daily feed intake (lb)	11.99 (0.52)	11.71 (0.53)	12.45 (0.52)	11.81 (0.48)	NS
Daily feed intake (week-1) (lb)	9.64 (0.53)	9.06 (0.54)	10.11 (0.51)	9.73 (0.52)	NS
Daily feed intake (week-2) (lb)	13.43 (0.59)	13.43 (0.59)	13.99 (0.61)	13.38 (0.53)	NS

	Flooring system		
Shoulder ulcer	**No mat (n=79)**	**Mat (n=78)**	**Total**
No ulcer	44	61	105
Ulcer	35	17	52
Shoulder ulcer (%)	44.3[a]	21.8[b]	33.12

[a,b] Within shoulder ulcer incidence row, the means with different superscripts differ significantly ($P<0.05$)

Table 6 Factors associated with shoulder ulcers at weaning

Explanatory variables	**Odds ratio (CI)**	***P****
Sow back fat at 109 d (mm)	0.832 (0.741-0.933)	0.0019
Sow weight at 109 d (lb)	1.004 (0.996-1.013)	0.3227
Parity (1 vs. 3 to 9)	0.879 (0.201-3.843)	0.6481
Parity (2 vs. 3 to 9)	1.380 (0.429-4.433)	0.4340
Housing system (stall vs. ESF)	1.393 (0.596-3.254)	0.4442
Flooring system (cast iron vs. rubber mat)	2.991 (1.410-6.346)	0.0043
Lameness (no lame vs. lame)	1.225 (0.563-2.667)	0.6090

* Based on multivariate logistic regression analysis

Figure 1: Kaplan-Meier graph of the time to removal from the herd for lame (dotted line) and non-lame (solid line) sows after lameness assessment.

Day 0 is the day of weaning following treatment.

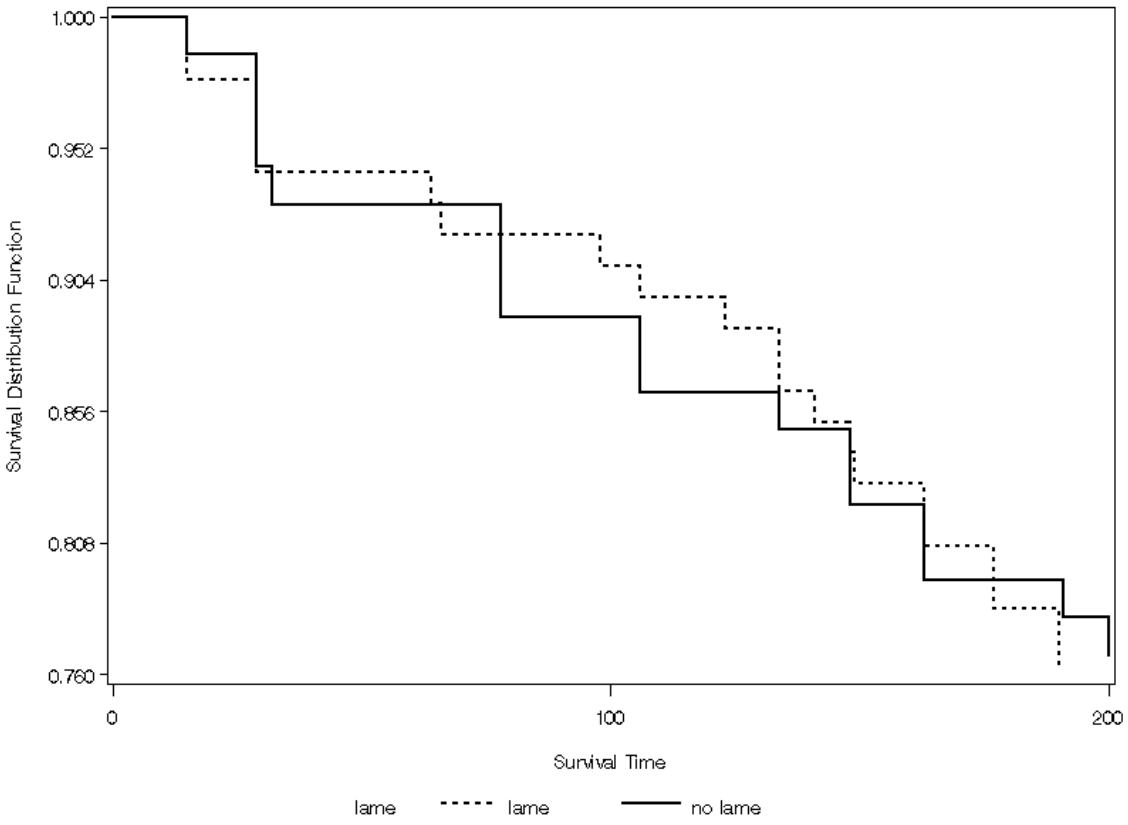


Figure 2: Kaplan-Meier graph of the time to removal from the herd for lame sows with no mats (solid line) and lame sows with rubber mat (doted line) after lameness assessment.

Day 0 is the day of weaning following treatment.

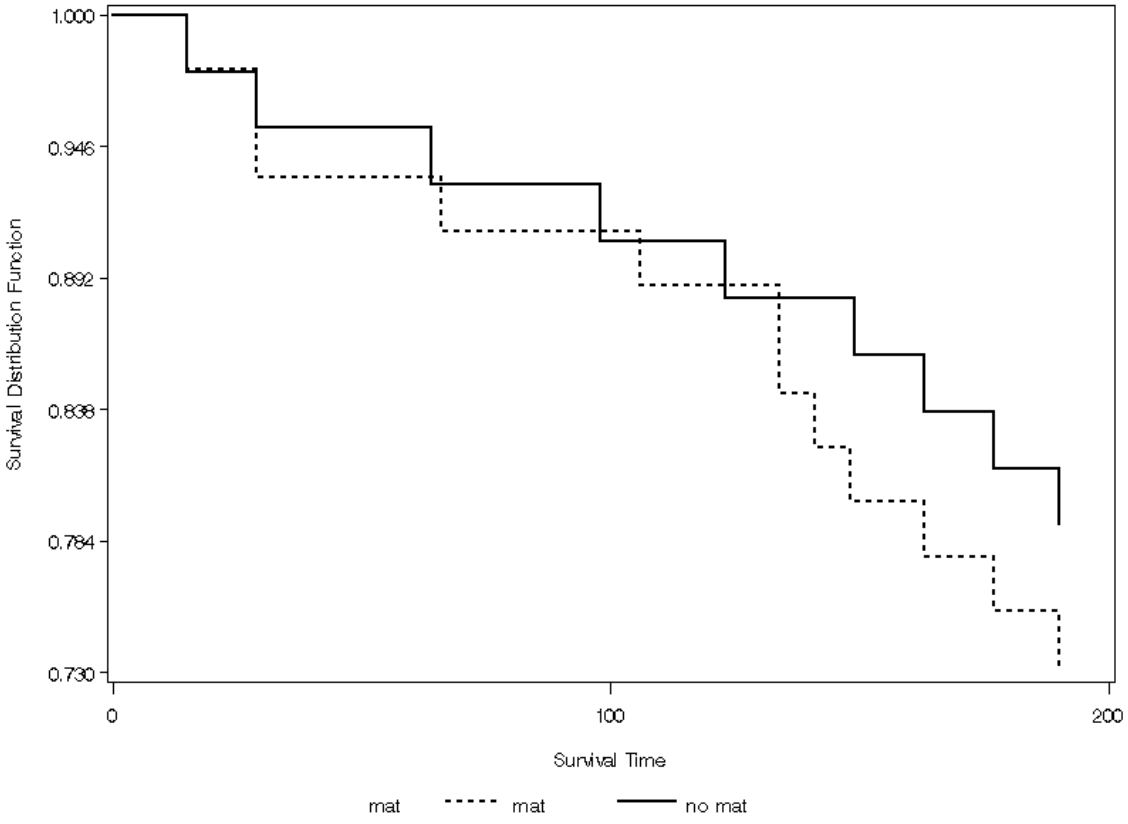
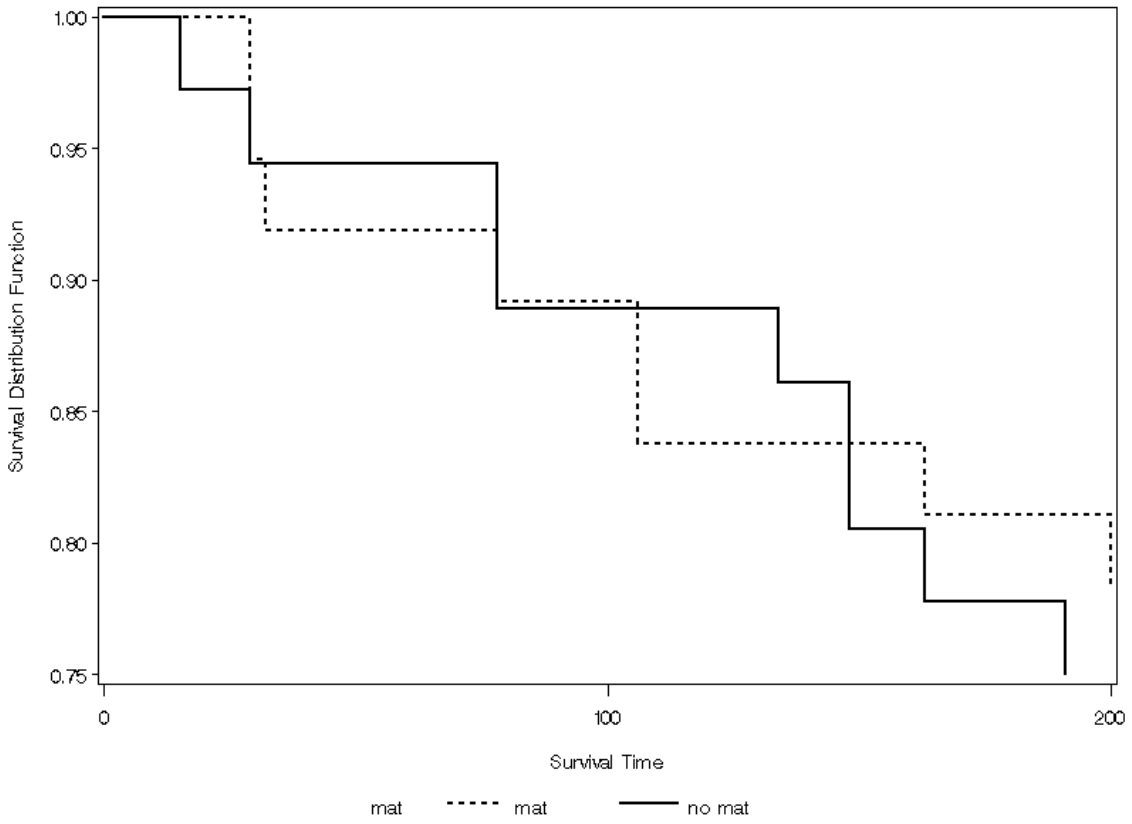


Figure 3: Kaplan-Meier graph of the time to removal from the herd for non-lame sows with no mats (solid line) and non-lame sows with rubber mat (doted line) after lameness assessment. Day 0 is the day of weaning following treatment.



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