THE EFFECT OF MATS ON THE WELFARE OF SOWS AND PIGLETS IN THE FARROWING HOUSE

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The objective of this study was to assess the effect of providing mats in the farrowing pen on behaviour and lesions in sows (n = 38) and piglets. Nineteen of the sows and their litters housed in farrowing crates with metal slatted floors were provided with mats, the remaining 19 acting as controls. Sow skin was inspected pre-farrowing and at weaning: the skin and feet of piglets were examined when they were 6 days old. Skin lesions were scored (on a scale of 0 to 6) according to severity. Total lesion scores per sow and median total lesion scores per litter were calculated. Sow behaviour was recorded by direct observation at feeding. Usage of a heat pad for lying in the presence or absence of mats was assessed over a 2hr observation period. Median skin lesion scores of sows did not differ between treatments. Litters from the control treatment had lower skin lesion scores (median [range] 8 [2–12] vs *10 [5–21]; P < 0.05). Median lesion scores of the front legs tended to be higher for piglets on mats (median [range] 8 [1.5–13]* vs *4 [1.5–8]; ns). Sows on metal flooring went from kneeling to lowering their hindquarters faster (median [range] 15 [2–45] s) than sows on mats (23 [11–54] s) (P < 0.05). Furthermore, they slipped more on their front (median [range] 2.7 [0–8.7]* vs *0 [0–1.3] slips min^{-1}; P < 0.001) and hind (median [range] 5.3 [0.3–31.7]* vs *1.9 [0–33.3] slips min^{-1}; P < 0.05) feet while standing, than sows on mats. More piglets lay on the heat pad when it was covered by a mat (mean ± SEM 45.97 ± 4.49 %) than when no mat was provided (29.29 ± 4.47 %) (P < 0.05). Mats improve sow comfort and reduce slipping. They encourage piglets to lie on the heat pad but cause damage to the skin of the front legs. Providing pigs with mats in the farrowing house could greatly improve welfare on slatted floors, but further research is needed to identify materials that are less abrasive.*

Keywords: *animal welfare, behaviour, lesions, pigs*

Introduction

Flooring in the farrowing house has changed dramatically over the years from straw bedding on concrete to metal, cast iron or plastic slats. Slatted floors offer many advantages for management as they are hygienic and require less labour to maintain but they offer little comfort to sows and their piglets since the requirements of a durable, clean floor are not compatible with the requirements of a soft lying area.

Studies have shown that slatted floors have an adverse effect on the skin and feet of suckling piglets (Vellenga *et al* 1983; Furniss *et al* 1986). Cases of damage to the skin of sows are less well documented, but Edwards and Lightfoot (1986) reported a higher incidence of leg and teat abrasions on fully slatted metal or plastic-covered woven wire floors compared to partially slatted or solid-bedded floors. In a survey of 25 farms, 30 per cent of sows housed on slatted floors in the farrowing house had lesions on their hind limbs, with the lateral accessory digit being most commonly affected (Boyle 1997).

Phillips *et al* (1996) demonstrated that sows strongly avoid slatted floors during and immediately after farrowing and O'Connell *et al* (1996) found that sows slip considerably more when manoeuvring on metal floors compared to plastic slats. However, plastic floors have a ridged profile to reduce slipping which causes other problems as these ridges appear to be uncomfortable for sows to kneel on when trying to lie down. The behaviour of the sow has important implications for piglet welfare. Piglets are strongly motivated to stay close to the udder and, therefore, risk being crushed as the sow changes posture (Cronin & Cropley 1991). If floors do not provide sows with an adequate foothold and disrupt the sow's lying behaviour there is an increased chance of piglets being crushed.

The use of mats in cubicle housing for dairy cows has become common and there is evidence that providing sows and piglets with a cushioning material may improve their welfare (Gravas 1979; Phillips & Pawluczuk 1995). The aim of the current experiment was to compare fully slatted metal floors with and without mats, in terms of sow and piglet welfare using behaviour, skin and foot lesions as welfare indicators.

Materials and methods

Farrowing accommodation

The farrowing accommodation consisted of eight adjoining, thermostatically controlled rooms with ten farrowing pens per room. Room temperature was maintained at 24°C for the first week of lactation and was thereafter maintained at 20°C. Due to differences in floor types between the farrowing rooms, only four rooms were included in the study, each one being used successively as it became available. The time span between the first sow farrowing and the last piglet being weaned was 4 months. The farrowing pens (2.3x1.65 m) were fitted with centrally positioned farrowing crates measuring 2.3x0.5 m. Each pen had fully slatted metal floors (Tri-bar®, Nooyen, Deurne, The Netherlands) which consisted of 10mm wide slats placed 10mm apart and had a 'no slip' section consisting of special indentations in the metal in the area under the sow. A water-heated metal pad (1.2x0.45 m) for the piglets was located on either side of the farrowing crate. Only four crates per room could be used due to the position of the cameras: the treatments occurred equally in each room.

Sow and piglet mats

Productive Comfort® farrowing mats (R J Mooney & Son Ltd, Longmile Road, Dublin 12, Ireland) measuring 1.4x0.9 m and approximately 30mm thick were placed over the metal slats in the area of the sow and were secured to the slats using plastic ties. The posterior part of the mats was narrower than the anterior part and an elevated area of softer material ran in a narrow panel (approximately 0.4m) along the centre of the mat to improve the accessibility of the sows' udders. Piglet mats were about 6mm thick and could be cut to measure from a roll. These were secured over both heat pads using plastic ties. Both mats were made of

compression-moulded synthetic rubber. Figure 1 illustrates the positioning of the mats in the farrowing pen. The sow's mat overlapped the piglets' mats by about 70mm on either side.

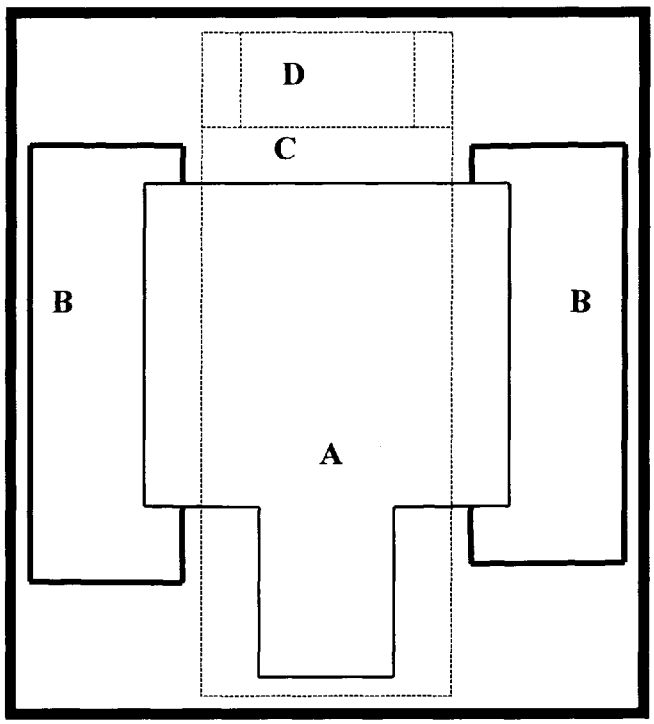

Figure 1 **Floor plan showing positioning of pig mats in farrowing pen.**
A: Sow mat. B: Piglet mats covering both metal heat pads. C: Farrowing crate. D: Trough

Animals

Thirty-eight multiparous Landrace x Large White sows from the minimal disease herd at Moorepark Research Centre were used for the study, with equal numbers being allocated to each treatment on the basis of parity. Sows were exposed to the two treatments from approximately 5 days before farrowing until weaning. Data were collected from 13 litters (133 piglets) on mats and 14 litters (145 piglets) without mats. Piglets were exposed to the treatments from birth to weaning. Sows were housed individually in basket crates during pregnancy.

Behavioural observations

Sows in the farrowing house were fed a home-mixed diet consisting of barley-wheat-soya bean meal (containing 165g protein, 57g fat, 32g fibre, 50g ash and 140MJ digestible energy kg^{-1}) diluted in 3.5kg water per kg feed, in two equal feeds, by an automatic, computerised, wet feeding system. Sows were allowed as much feed as they would consume up to a maximum of 8kg day^{-1}. Average intake was about 5.8kg feed day^{-1}. The times of feeding were the same every day (0900h and 1530h), and feeding time provided the best opportunity for observing standing up and lying down behaviour. Sow behaviour was recorded on three occasions 7–10 days post-farrowing and at least one morning and one evening feeding time

was included for each sow. Thus, some sows were observed twice in the morning and once in the evening while others were observed twice in the evening and once in the morning. Preliminary observations revealed no difference in sow behaviour between the morning and evening feeding times.

Each observation period began approximately 10min before feeding was due to commence, while the sows were lying down and ended when the sow had finished feeding and had resumed a lying position. Sows were observed continuously and behaviour was recorded on a hand-held computer (Psion Organiser LZ64), using behavioural observational software (Noldus Information Technology 1993, 1994). The behaviours recorded included: number of rising attempts, number of weight shifts and slips min^{-1} on both front and hind feet while standing, feeding and rising; number of attempts at lying down; time taken to go from lowering knees to lowering hindquarters; and, finally, time taken from lowering hindquarters to lying laterally.

Sow behaviour was also recorded on video for a 48h period one week after farrowing using time-lapse recording. Recording started on Friday afternoon and ended on Sunday. Behavioural states were recorded using an event recorder (Noldus Information Technology 1993) which included duration and frequency of lying laterally, ventral lying, nursing, standing and frequency of rising attempts. When the piglets were 10 days old they were observed over a 2h observation period between 1900h and 2200h. Every 5min the number of piglets lying on the heat pad and elsewhere in the pen was noted. The number of piglets engaged in other activities was not recorded.

Skin and foot lesions

Sows were examined for skin lesions pre-farrowing (ie on entry to the farrowing house) and at weaning, approximately 4 weeks later. Piglet skin and feet were examined at 6 days of age.

Table 1 Classification and evaluation of skin lesions.

Classification	Score
Normal	0
Alopecia/callus	1
Redness/swelling	2
Wound	3
Callus + swelling	3
Severe wound	4
Severe swelling	4
Severe wound + severe swelling	6

Skin lesions were scored according to their severity, using a method adapted from de Koning (1985) (Table 1). The lesions were classified under the following categories: i) alopecia (hair loss) or callus (thickening of the epidermis and atrophy of glands); ii) redness, which may or may not be accompanied by subcutaneous swellings; iii) wounds (where the epidermis is interrupted but not ulcerated and there is no evidence of secondary infection); iv) callus plus subcutaneous swelling (caused by chronic pressure and most commonly found on the joints); v) decubitus (where pressure produces ischaemia, subsequent tissue damage and necrosis). These ulcerated lesions may or may not be accompanied by infection and were classified under the category 'severe wound' in the scoring system; and vi) severe swellings (characterized by redness and swelling accompanied by heat and pain). Figure 2 illustrates the locations on the body inspected for lesions. Addition of scores yielded a total score for

each sow. Because individuals within a litter cannot be regarded as independent observation units, median litter scores were calculated. Piglet foot lesions were categorized and recorded as described by Penny *et al* (1963) and scored according to severity (on a scale of 0 to 3).

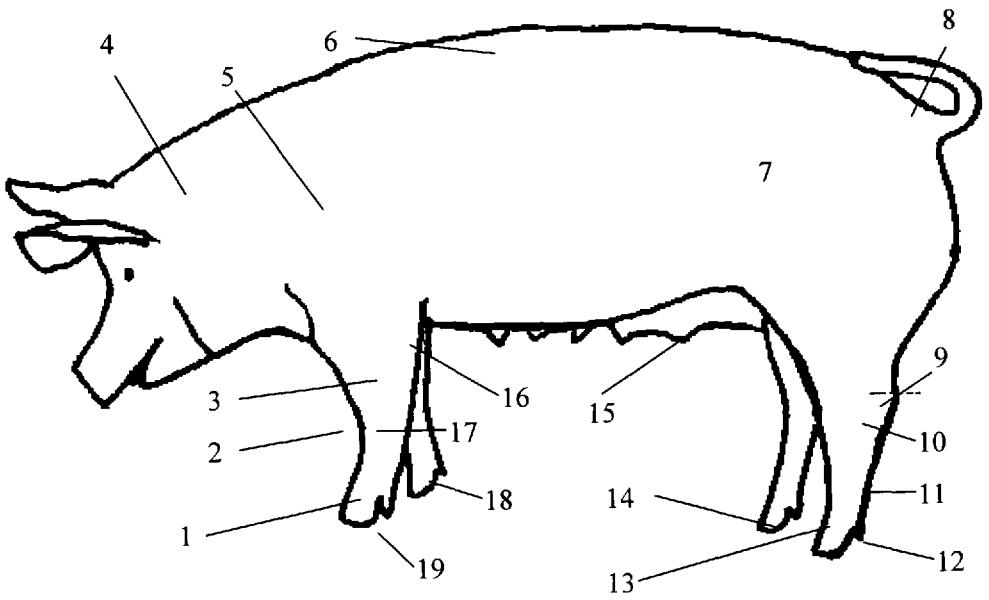

Figure 2 **Topographical representation of locations on right and left sides of sows and piglets inspected for lesions. 1 front fetlock; 2 carpal joint; 3 humerus; 4 neck; 5 scapula; 6 back; 7 point of hip; 8 tail; 9 hock; 10 tarsa – metatarsal joint; 11 metatarsus; 12 accessory digits – lateral aspect, hind limb; 13 hind fetlock; 14 accessory digits – medial aspect, hind limb; 15 mammary gland; 16 elbow; 17 carpus – lateral aspect; 18 accessory digits – medial aspect, fore limb; 19 accessory digit – lateral aspect, fore limb.**

Statistical analysis

The NPAR1WAY and frequency procedures of SAS (1989) were used to analyse the data. Skin lesion scores of sows and piglets, foot lesion scores of piglets and behaviour of sows and piglets were analysed using the non-parametric Mann-Whitney *U* test. The mean of the three direct observations on sow behaviour was used for the statistical analysis. Differences in skin and foot lesion scores of piglets between treatments were tested using median scores per litter. A 'severe skin lesion score' was calculated by addition of only those skin lesions scoring 3 or greater. Chi-square analyses were used to determine the differences in total number of piglets affected by severe skin lesions and each category of foot lesion between the two treatments.

Results

Behaviour

The video recordings did not reveal any significant differences in frequency or duration of nursing, standing, lateral lying, ventral lying or number of rising attempts between

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treatments. Sows in both treatments spent most of the 48h period in a lateral lying position. The findings from the direct observations are shown in Table 2. Sows on mats slipped significantly less on both their front and hind legs while standing and feeding. Furthermore, sows on mats slipped significantly less on their front feet while rising than sows on metal. Sows on mats tended to spend longer in the kneeling position (Table 2) although this was not significant. They also took significantly more time to go from kneeling to lowering their hindquarters when lying down after feeding ($P < 0.05$). The percentage of the observation time spent lying over the 2h observation period was similar for litters in both treatments. However, when mats were covering the heat pad, significantly more piglets lay on the heat pads (mean ± SEM; 45.97 ± 4.49 %) in comparison to piglets without a mat covering the heat pad (mean ± SEM; 29.29 ± 4.47 %) ($P < 0.05$).

Table 2 **Number of slips min^{-1} (median, range) on the front and hind feet, time taken to go from kneeling to lowering the hindquarters (s) and duration (s) spent kneeling by sows on mats and metal flooring.**

Behaviour	Mat			Metal			P
	Median	Min	Max	Median	Min	Max	
Slip front foot standing	0	0	1.3	2.7	0	8.7	0.001
Slip front feeding	0	0	0.7	0	0	7.3	0.05
Slip front rising	0	0	0	0	0	0.3	0.01
Slip hind foot standing	1.9	0	33.3	5.3	0.3	31.7	0.05
Slip hind feeding	0.2	0	8.3	2.0	0	24.3	0.01
Kneel to lower hind (s)	23.0	11.0	54.0	15.0	2.0	45.0	0.05
Kneeling position (s)	40.2	12.0	103.0	21.7	6.6	463.0	ns

Skin lesions

The median skin lesion scores of sows pre-farrowing and at weaning did not differ between treatments and skin lesion scores did not increase significantly from the pre-farrowing to the weaning inspections within treatments (Table 3).

Table 3 **Skin lesion scores (median, range) for sows on mats (n = 19) or metal (n = 19) flooring inspected pre-farrowing and at weaning.**

Lesion score	Mat			Metal			P
	Median	Min	Max	Median	Min	Max	
Pre-farrowing	29	22	49	28	22	45	ns
Weaning	28	20	41	29	25	45	ns

Mats had a negative effect on piglet skin (Table 4). Both the median total lesion score and the median severe lesion score were significantly higher for piglets on mats. There was also a tendency (ns) for the median total lesion score of the front limbs of litters on mats to be higher than that of litters without mats (Table 4). Furthermore, there were significantly more piglets in litters on mats affected with severe lesions to the front limbs (77% [102/133] *vs* 56% [81/145]; $P < 0.001$).

Table 4 **Skin lesion scores (median, range) of litters of 6-day-old piglets on mats (n = 13) or metal (n = 14) flooring.**

Lesion score	Mat			Metal			P
	Median	Min	Max	Median	Min	Max	
Total lesion score	10.0	5.0	21.0	8.0	2.0	12.0	0.05
Severe lesion score	8.0	3.0	15.0	4.5	0	8.0	0.001
Front legs score	8.0	1.5	13.0	4.0	1.5	8.0	ns

Piglet foot lesions

Of the 279 piglets inspected, 100 per cent had foot lesions. The median total foot lesion score did not differ between the mat or metal treatments (median [range] 12 [10–15] *vs* 13 [7–18]; ns). However, there were significantly fewer piglets affected by bruised soles (Table 5) on mats. Furthermore, piglets on mats tended to be less affected by bruised coronets, wounded heels, and wounded accessory digits but these differences were not significant (Table 5). A high proportion of piglets in both treatments were affected by bruised coronets and bruised heels. About 20 per cent of piglets in both treatments were affected by wounded coronets.

Table 5 Percentage of piglets affected by different foot lesions on mats (n=134) and metal (n=145) flooring.

Foot lesion	Mat	Metal	P
Bruised soles	3.0	10.0	0.05
Bruised coronets	89.5	94.0	ns
Bruised heels	100.0	98.0	ns
Wounded coronets	20.0	19.0	ns
Wounded heels	4.5	9.7	ns
Wounded accessory digits	6.7	11.0	ns

Discussion

Fully slatted metal flooring may be unsuitable for use in farrowing houses as sows show strong aversion to this type of flooring, possibly because it is slippery (Anonymous 1992, 1993; Phillips *et al* 1996). Despite the indentations in the floor used in this study, it still proved slippery for the sows, in contrast to the mat treatment where slipping on both the front and hind feet was significantly reduced.

There was no difference in the duration or frequency of behaviours such as standing or lying between treatments in contrast to the findings of Gravas (1979) where sows with rubber mats in the farrowing pen spent significantly more time lying down than sows on a concrete floor. Furthermore, a concrete floor covered with epoxy paint was found to be so slippery that sows avoided standing up when changing position. Although the metal floors in this study were slippery, no such effect was detected.

Considerable pressure is placed on the knees during the lying down manoeuvre and O'Connell *et al* (1996) found that kneeling on certain floor types can be a source of discomfort to sows. They suggested that it was painful for sows to kneel on plastic floors with a ridged profile as they had to make repeated attempts at lying down. In the present study, sows on mats tended to spend longer in the kneeling position and they also took significantly more time to go from the kneeling position to lowering their hindquarters. This suggests that mats were more comfortable for sows to kneel on and this enabled them to take more time lying down. Thus, mats appear to improve sow comfort but these findings also have important implications for piglet welfare. Edwards *et al* (1986) found that 40 per cent of piglet deaths were due to crushing, 22 per cent of which occurred when the sow lay down after standing. As most crushings occur beneath the hindquarters (especially when sows 'flop' down), anything that allows the sow to take more time lowering her hindquarters could reduce crushing, as this would give the piglets more time to get out of the sow's way (Svendsen *et al* 1986; Blackshaw & Hagelso 1990). A recent Dutch study (Vermeer & Binnendijk 1997) confirmed that providing sows and piglets with mats reduced crushing significantly but the authors were unsure as to how much of the reduction was attributable to the sow mats and how much to the piglet mats.

A higher proportion of piglets in litters on mats lay on the heat pads, in comparison to the control treatment where piglets were just as likely to lie in areas of the farrowing pen other than on the heat pads. The most likely explanation for this finding is that piglets that had mats covering the heat pads perceived this part of the pen to be a more comfortable place to lie. This is supported by the work of Farmer and Christison (1982) who demonstrated that piglets as young as 1 day old were able to show clear preferences for floor type. Providing piglets with mats could also play a part in reducing crushing. Piglets are strongly motivated to stay close to the udder, and providing them with a more comfortable lying place may be a simple means of encouraging them away from the dangerous zone around the sow (Cronin & Cropley 1991).

The skin lesion score of sows did not increase between the pre-farrowing and weaning inspections in either treatment in contrast to previous research in the same unit and on commercial farms (Boyle 1997; Boyle *et al* 1997). However, both of the 1997 studies involved greater numbers of sows and it is therefore probable that larger numbers of sows are needed to detect significant differences in sow lesion scores between pre-farrowing and weaning inspections.

Our results were similar to those reported in a study by Leonard *et al* (1996) where two floor types were compared in terms of sow skin lesions using 24 sows, with no differences in sow skin lesion scores between treatments being detected in either study. However, Vermeer and Binnendijk (1997) found that sows on the same mats as those used in the current study had fewer udder and teat injuries 7 and 21 days after farrowing compared to sows on a semi-slatted floor (concrete with metal slats under posterior part of sow). An explanation for this finding is that udder and teat injuries are uncommon in sows on the fully slatted Tri-bar® metal flooring used in the current study (Boyle 1997). Furthermore, the limbs of sows are more commonly affected by serious lesions than the body (Boyle *et al* 1997) and the limbs were not inspected for lesions in the study by Vermeer and Binnendijk (1997).

Vermeer and Binnendijk (1997) found that piglets on mats tended to have fewer 'open wounds' to the front legs (6.9% *vs* 15.7%) at 7 days of age whereas significantly more piglets on mats were found to be affected by severe lesions to the front legs in our study. It is possible that lesions seen on piglet skin in the mat treatment in the present study were partly caused by the sow mat. The sow mat, which was thicker and harder than the piglet mat, overlapped the piglet mat slightly and the front knees of the suckling piglets were in contact with it. The width of the sow mats should be reduced as it was unnecessary for them to overlap the piglet mats. Nevertheless, it appears that the piglet mat could still have potential for causing serious lesions as cushioning materials have higher coefficients of sliding friction than static friction. Gravas (1979) concluded that the type of lesions that developed on mats were more serious and Phillips *et al* (1995) showed that if cushioning combined with a lower coefficient of friction could be provided, as with closed-cell neoprene sponge impregnated with mineral oil, wounds were almost eliminated. In conclusion, the coefficient of sliding friction of the mats used in the present study may have been too high and this, combined with the vigorous thrusting actions with the front legs made by piglets fighting to maintain their positions at the udder, resulted in substantial injuries.

Foot lesions occurred in almost 100 per cent of piglets irrespective of treatment. Bruising was by far the most common lesion, as was found by Mitchell and Smith (1978). Most authors do not record bruising and record only more serious lesions such as abrasions and wounds (Quemere *et al* 1988; Navarotto *et al* 1994). It appears that the occurrence of bruising is so widespread as to be almost 'normal' for intensive production systems. Indeed,

Mitchell and Smith (1978) state that it is difficult to assess the clinical significance of bruising as it occurs even on the smoothest floors but they suggest that it causes tenderness in some piglets and may predispose them to abrasion of the foot. In accordance with Leonard *et al* (1996), a high proportion of piglets in both treatments had wounded coronets, probably due to their claws getting caught in the gaps between the slats. Although there was a tendency for slightly fewer piglets on mats to have wounds to the heels and dew claws, mats did not have an effect on piglet foot lesions apart from significantly reducing bruised soles. A possible explanation for these findings is that the mats did not cover the entire pen and piglets had access to a large area of slatted metal in both treatments. Covering a larger proportion of the pen with the mat for the first week of the piglets' life may significantly reduce the incidence of foot lesions.

Animal welfare implications

Used in combination, the sow and piglet mats could have potential for reducing the incidence of crushing. Mats improved sow welfare by providing sows with better footholds to stand and manoeuvre without slipping and by providing a cushioning effect for the knees. Although mats tended to reduce injury to the hooves of piglets, they had a detrimental effect on the skin of the knees which may partly have been due to the higher coefficient of sliding friction of mats compared to the metal floor. If this were the case, it is important that there is further research to identify materials with lower coefficients of sliding friction. However, as the sow mat overlapped the piglet mat and was therefore in direct contact with the knees of the suckling piglets, it is possible that the sow mat was at least partially responsible for the damage to the piglets' knees. As it is unnecessary for sow mats to overlap the piglet mats, the width of these mats could be reduced. The high proportion of piglets in both treatments with damaged feet at 6 days of age suggests a need for further studies into flooring materials for farrowing pens.

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