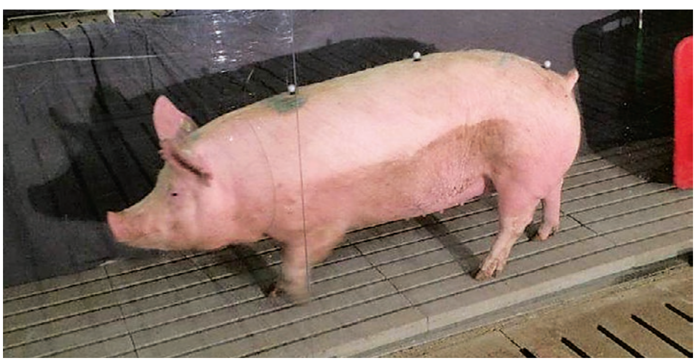
Optimizing concrete slat and gap widths for group-housed gestating sows

Submitted by Laurie Connor[1], Nicolas Devillers[2] and Qiang Zhang[1]

[1]University of Manitoba, Winnipeg, MB and [2]Agriculture and Agri-Food Canada, Sherbrooke, QC.

Why floor slat and gap widths are important

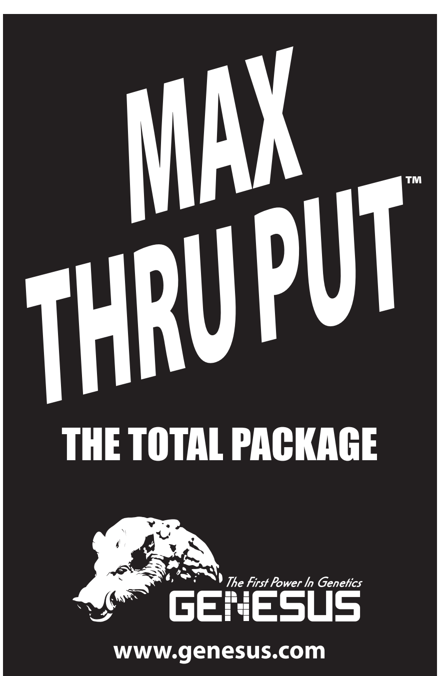
The transition to sow group housing recommended by the Code of Practice for Care and Handling of Pigs (2014) requires sound information about housing systems options and sow management. One critical area of impact is the type of pen flooring. Concrete slatted floors are commonly used in sow barns for effective drainage of manure to achieve cleaner and more hygienic floors, better in-barn air quality and decrease the total pen space needed; however, considerations must be given to other aspects of sow health and well-being. Slat design can affect the permeability and thermic properties of the floor which, in interaction with ambient temperature, can modify the location of lying, resting and dunging behaviours. Leg and hoof/claw injuries and lameness are major reasons for culling sows, particularly in group housing. Sows housed on slatted floors show more claw injuries than ones housed on solid floors. Moreover, gap width between slats can be responsible for foot injuries in sows and more likely in gilts which have smaller feet. On the other hand, a narrower gap width may decrease manure passage and can increase risks of infection of claw lesions. However, scientific information on the most suitable slatted flooring for sows is lacking. With these factors in mind, we set out to determine the most effective concrete floor slat and gap width combinations for comfort and wellbeing of sows as well as ease of manure management.



Sow outfitted with fluorescent markers and walking the pre-test kinematics corridor on parallel oriented slats.

How the research was done

Before any in-barn tests could be conducted, the slat and gap widths and orientation that caused the least change to sow gait needed to be determined. For this pre-test, slats of three pre-determined widths were cast in concrete (85, 105 and 125 mm). Each slat width was tested with three defined gap widths (19, 22 and 25 mm), in both horizontal and longitudinal orientation in a test corridor where each sows' walking gait could be video recorded. (PIC) Twelve small non-lame sows/gilts and 12 large lame sows were video recorded walking on each of the nine pre-test floor combinations accord-



ing to a Lattice design. Their gait was analysed from video recordings using kinematics.

From this pre-test phase it was determined that, compared to walking on solid concrete, sows' gaits were least affected when slats were 105 mm wide with gaps of 19 mm. Two newly manufactured slatted floors were installed into identical test rooms at the Glenlea Research Station, University of Manitoba. In-barn trials were then conducted by following two groups of 25 nulliparous gilts over two consecutive gestations. One group was housed on concrete slatted test floor (Test; 105 mm slats, 19 mm gaps) and compared to a cohort in an identical room/pen but with conventional concrete slatted flooring (Control; 125 mm slats, 25 mm gaps).

Sows were grouped in the pens with a space allowance of 2.04 m2 per sow, from approximately five to 15 weeks of each gestation and were individually fed with an electronic sow feeder. Each animal was evaluated for lameness (visual gait score, hoof lesions scores for heel overgrowth and erosion, wall cracks, heel cracks and toe length, and limb weight distribution using a force-plate scale), postural behaviour using accelerometers (time budget of standing, lying, sitting and frequency of posture changes), and overall behaviour within the pen (video recordings to assess time budget of activities) during the two successive gestations.

Lameness, hoof lesions, weight distribution and postural behaviour were assessed twice per gestation, and behaviour was video recorded three times per gestation. Performance was recorded in terms of body weight and back fat across gestation and reproductive performance (number of piglets: total born, born alive, stillborn, weaned, and piglets weight at birth and weaning). Performances, lameness and behaviour variables were analysed for the effects of the treatment, time and gestation number.

Assessment of pen cleanliness and air quality were conducted to provide information on floor porosity (slat-gap ratio) for effectiveness of manure removal. Ammonia concentration was measured continuously in each room. Temperature and relative humidity were recorded on data loggers at five minute intervals in three locations in each room. Pen cleanliness was assessed weekly from time lapse photographs taken hourly during the 12 h of 'lights-on' (0700 h -1900 h) on the day preceding floors being scraped to remove any manure build-up. The time-lapse pictures were analyzed using MIPAR image processing software. The floor was divided into four areas for analysis according to the observations of sow activities ¬–sleeping, low traffic, high traffic and dunging areas.

Animal cleanliness (percentage of body stained by manure), which reflects pen cleanliness, air quality, temperature and humidity, was also analyzed from time-lapse photographs using the MIPAR image processing software.

CONTINUED ON PAGE 26

Force plate scale measures individual limb weight distribution while sow is standing still eating.

Friction of the slat surfaces was measured throughout the test periods to quantify the slipperiness (slip resistance) of the slatted concrete floors. A surface tester was designed and constructed to measure surface friction and roughness.

Outcomes

The pre-test slat-gap assessment in the kinematics corridor offered a unique opportunity to see how slatted flooring dimensions and orientation can influence sow locomotion. Most of the observed effects on sow gait were on the front limbs which bear 60% of the body weight. More gait parameters in small non-lame sows were affected by floor design than in large lame sows; and for perpendicular than in the parallel slat orientation. Therefore, small non-lame sows were more sensitive to the variation of the configuration of the slatted floors and variations in slat or gap width was more likely to be perceived by sows when walking perpendicularly to the slats orientation.

Comparisons between combinations of different slat and gap widths showed that more gait parameters were significantly altered by larger gap widths (stride length, stance time, foot height, joints angles, back angle, walking speed) and the smallest and the largest slat widths (swing time, foot height, joints angles). Comparisons of the different combinations of slat and gap widths revealed that slat width of 105 mm and gap width of 19 mm were the best floor design according to gait characteristics on the solid control floor. These results provide the first evaluation of the impact of slat and gap widths of concrete floor on locomotion of sows. Longer term in-barn tests were needed to fully validate the pre-test results and investigate the impact on postural behaviour, lameness occurrence, foot health and pen environment.

Overall, there were minimal differences between sow groups on the test and control floors in most measures including per-

formance, gait score, lameness and behaviour (Table 1). However, sows on the control floor had higher feet lesion scores and indicators of greater hind-limb discomfort than sows on the narrower slat/gap widths of the Test floor.

Although overt lameness, measured as gait scores, was similar between sows on the control and test floors, the severity of heel overgrowth and erosion and wall cracks was greater for both front and rear (P<0.001) feet in control sows compared to test sows in both gestations.

Sows on test floor during gestation. Coloured markings are individual identification for behaviour assessments from video and time-lapse records.

However, these effects were already evident as soon as one week after sows were moved to the gestation pens, so it is difficult to conclusively discern treatment effects from pre-existing conditions. But, feet lesion scores generally increased during gestation on both slatted floor types and decreased somewhat during lactation when sows were on different flooring. In terms of comfort indicators, analysis of weight distribution showed some effects on several variables measured on hind legs.

For example, control sows spent more time weight shifting in late gestation ((37 vs 32±1.6% of time, P=0.036, control vs test respectively), had a higher variability (SD) of the percentage of weight applied on hind limbs in early (SD = 4.3 vs 3.9±0.10, P=0.006) and late gestation (SD = 3.9 vs 3.4±0.12, P=0.003, for an average of 21% of body weight applied on each hind leg), and a higher amplitude of weight shifting on hind legs in late gestation (P=0.002)).

Higher weight shifting and variability of the weight applied on hind legs are signs of higher discomfort while standing still and possibly lameness in control sows. Therefore, as observed in previous studies, signs of lameness or discomfort

CONTINUED ON PAGE 28

CANADA BEST MANAGED COMPANIES

CANARM® AgSystems™

PUTTING INNOVATION TO WORK

SowChoice Systems™ By CANARM®

Producers demanded stainless steel, low cost per sow, high throughput and a design rugged enough to service commercial scale Canadian farms, built here in Canada. SowChoice delivers! Its modular construction frees producers from the "one design fits all" trap. Industrial rated controls that do not fail and the best warranty in the business to back it all up.

"The ability of the Canarm feeder to feed 80 sows day after day is outstanding. With stainless steel construction and knowledgeable tech support only a text message away 24/7, we made the right choice when replacing our original ESFs."

Keith Sensenig

Owner of 950 head sow barn - Memphis, Missouri

Visit www.sowchoicesystems.com or call 1-800-260-5314 for more information.

Table 1. Effects of floor treatment* and gestation number on performances, feet lesions and postural behaviour (least square means)

Measure	Week of gestation	Control floor		Test floor		SEM max	Effects (P-value)		
		1st gestation	2nd gestation	1st gestation	2nd gestation		Floor	Gestation	Interaction
Body weight (kg)	5	181	211	177	216	1.7	0.67	< 0.0001	0.002
	15	216	242	219	242	2.6	0.48	< 0.0001	0.5
Total number of piglets born		14.5	15	13.7	16.3	0.6	0.71	0.01	0.065
Number of piglets born alive		13.6	14.5	12.8	14.9	0.6	0.74	0.017	0.32
Number of piglets weaned		11.5	12.9	11.1	12	0.5	0.092	0.03	0.61
Litter weaning weight (kg)		82.8	86.6	74.8	80	3.1	0.015	0.12	0.81
Heel overgrowth and erosion score									
Front feet	6	1.96	1.86	1.58	1.83	0.12	0.072	0.45	0.081
	14	2.48	2.11	1.97	1.93	0.09	0.0003	0.062	0.19
Rear feet	6	2.22	2.28	1.76	2.13	0.1	0.003	0.007	0.051
	14	2.73	2.52	2.21	2.35	0.09	0.0003	0.73	0.066
Wall cracks score									
Rear feet	6	1.22	1.69	0.98	1.37	0.11	0.003	<0.0001	0.68
	14	1.54	1.68	1.3	1.52	0.12	0.069	0.084	0.65
Postural behaviour (% of time)									
Lying	6	78.3	75	83.3	72.6	1.9	0.47	<0.0001	0.009
	14	77.8	81.1	75.1	77.9	2.1	0.19	0.04	0.88
Sitting	6	5.4	4.9	4.5	5.1	0.8	0.66	0.9	0.42
	14	6.3	2.4	5.2	4.8	1.5	0.63	0.015	0.049
Standing	6	16.3	20	12.2	22.5	1.8	0.62	<0.0001	0.021
	14	15.8	16.3	19.6	17.1	1.9	0.26	0.49	0.29

*Control floor: 125 mm (5 in) slats and 25 mm (1 in) gaps. Test floor: 105 mm (4 in) slats and 19 mm (0.75 in) gaps

are mainly observed on rear limbs and, in the present study, were higher in control sows than test sows.

Observation of how sows' budgeted their time (walking, passive, feeding, social interaction) showed that Control sows spent more time passive (5.7 vs 3.7±0.5%, P=0.006, respectively) and less time walking (3.6 vs 4.6%±0.4, P=0.08, respectively) than Test sows. Looking at postural behaviour, few interactive effects of treatment and gestation number were seen. At week six of first gestation, control sows spent more time standing (16.3 vs 12.2%±1.3, P=0.028, respectively) and less time lying (78.3 vs 83.3%±1.2, P=0.005, respectively) than Test sows. No

PARKS
LIVESTOCK
A Member of The Parks Companies

With over 30 years of experience in the livestock industry, we continue to provide today's producers with
The Best Full Service Marketing in North America

Feeder Pigs

S.E.W.s

Call today to talk to our team ~ Toll Free: 1-800-821-7418 ~ Email: jasonmills@parkslivestock.com

major effect of treatment was observed on the frequencies of posture changes. Overall, differences in sow behaviour between test and control were limited and do not reveal a consistent effect on sows' activity.

Photographs for lesion scoring of toes, dew claws, underside white line and heel-sole erosions were taken at the beginning and end of each gestation period on the test floors.

Evaluation of air quality, sow cleanliness and floor friction showed no significant differences between the test and control floors, thereby demonstrating that manure removal was not compromised by the narrower gaps and slats of the test floor. Specifically, no significant differences (P>0.05) were noted between the two test rooms in temperatures, relative humidity and ammonia concentrations during the trials. Floor cleanliness, as a percentage of manured floor area, was similar for both floors. Similarly, the percentage of sow body surface soiled by manure was similar (e.g. 27.1% and 26.9%, gestation 1, test and control, respectively; P>0.05). The surface friction, a measure of slip resistance, was similar for both test floors throughout the trial. Notably, the dynamic coefficient of friction (DCOF) decreased markedly within the first week of pig occupancy then remained relatively unchanged for the remainder of the trial. This was likely due to manure on the floor, even though the floors were scraped before friction measurements were taken. All-in-all, the narrower slat and gap widths of the Test floor did not have a detrimental effect on manure accumulation and air quality.

The bottom line

As a general conclusion, effects of treatment that were seen do not indicate a marked difference between the two types of floor tested. Nevertheless, Control floor (125/25mm) seems to lead to higher feet lesions scores and a higher discomfort while standing according to the measurements from the force plate. However, these differences did not result in significant differences of gait score and lameness during the two gestation periods. The effects on behaviour and reproductive performance were also limited. However, in terms of feet health and sow comfort, these results indicate a benefit of the narrower concrete slat (105 mm) and gap (19mm) flooring, at least for smaller or early parity sows which then impacts later performance and longevity.

Acknowledgements

We are grateful for the financial support for this research from Swine Innovation Porc, Manitoba Pork and Agriculture and Agri-Food Canada. In-kind support was generously provided by Genesus Inc and by Barkman Concrete. The assistance of our technicians, students and barn staff was invaluable, especially Lindsey Lippens, Lee-Anna Murray, Andrew Tefs, Heidi Pylypjuk, Marjolaine St-Louis, Xiaojie Yan, Rong Yue, Emmanuel Janvier, Aurélie Radiguet, Marion Coste, Steve Méthot, Don Chaput, Archie Isit and Gemmar Maramot. ■