Force Plates Assessment

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Lameness in sows is one of the most important welfare issues, responsible for up to 25% of culling reasons in gilts (Tarres et al. 2006, Livest. Sci. 100:121). However, detection and evaluation of lameness in sows have not been studied extensively. Until now, qualitative visual scores of gait, standing posture, difficulty in lying down and locomotion are the main methods used to measure lameness in pigs. However, accuracy of these qualitative methods can vary among observers. Therefore, there is a need for more objective quantitative methods to assess lameness in pigs.

The use of force plates to analyze weight distribution on limbs of cows shows promise (Chapinal et al. 2009, J. Dairy Sci. 92:581) and may be applicable to sows. Use of this technology in sows could lead to better early detection, quantification and understanding of sow lameness and advance research into the relationship between housing, social factors, nutrition and lameness.

The objective of this project was to develop a quantitative method for the evaluation of lameness in breeding sows. The specific objectives of this project were to: 1) develop a scale to measure sow weight distribution on each limb; 2) validate this device (repeatability and relation to lameness), 3) study the impact of analgesics (short term pain control) on weight distribution in lame sows. Work related to the project was carried out at the AAFC Dairy and Swine R&D Centre (DSRDC) in Sherbrooke, Quebec and at the Prairie Swine Centre (PSC) in Saskatoon, Saskatchewan. The third study on impact of analgesics is still under analysis and results are not available yet.

Figure 1. Sow standing in the force plate

1) Development of the force plate scale:

A large crate (213 x 63.5 x 107 cm, inside) was built by Pacific Industrial Scale Co. Ltd (Richmond, British Columbia, Canada). The crate was large enough for the wider sows to move freely and the crate could be adjusted at the back for smaller sows. The scale platform was divided in 4 stainless steel individual quadrants (front: 101.6 x 30.5 cm, rear: 111.8 x 30.5 cm), with each quadrant lying on 4 single ended beam load cells. Each quadrant had a 500 kg weight capacity and was independent from the crate.

A removable middle line bar (203.2 x 1.3 x 15.2 cm) and transversal ridge (30.5 x 1.3 x 7.6 cm) were used to ensure that the sow had its feet in the corresponding quadrant. A feeder was installed within the crate frame in order to draw the attention of the sow in a standardised direction and to keep her static for a period of time during measurement. A digital indicator (GSE 665) recorded the total weight and weight applied on each separate quadrant, with an average collection rate of 14 data points per second.

Calculations were then carried out to determine: 1) the percentage of total body weight distributed on each leg; 2) the ratio between weights applied on opposite (left and right) legs; and 3) the weight shifting that occurs between two opposing limbs (frequency, amplitude, between left and right limbs).

2) Validation: repeatability of the measures

Five visually non-lame and five visually lame sows were assessed on the force plate (twice on two different days). The within-sow coefficients of variation for each measure was lower than 15%. Measures taken from the force plate are therefore considered to be repeatable (Pluym et al., 2013 Biosyst. Eng. 116:64-74).

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If this logic continues to be accepted and become the conventional thinking it will be more challenging for producers to use stalls in the future. So there is a lot going on here beyond the science that is driving the expectations.

From a scientific perspective, it's important to keep in mind that stall size compared to animal size changes over time, and research is ongoing to assess the factors of stall size and time spent in stalls as it relates to comfort and welfare. However with the bar rising on what is considered adequate freedom of movement, clearly there will be rising pressure to reduce time in conventional stalls and adopt greater use of group systems. What we know from science and will continue to learn from science can help producers transition to systems that better meet the new expectations.

Q: A big reason for stalls in the first place was to protect the animals and support their health through individual care. Aren't there real welfare drawbacks too with group systems?

Dr. Jennifer Brown: There is no one perfect system. We recognize that welfare can also be a problem in groups, that's something that we are working on to assist producers to develop systems with new management ideas.. If you simply put sows in a group environment without taking certain management precautions there is going to be aggression issues, injuries and other problems. But as the review shows, there are things we know we can do to reduce aggression. Certainly in many group housing systems, , it's really not a serious issue, and we also see that European producers are regularly achieving equal or higher production levels in groups.

Q: Clearly animal welfare is in the spotlight more than ever before. How is this driving the agenda both at Prairie Swine Centre and at level of your industry stakeholders?

Lee Whittington: Pork producers and industry have always been interested in the welfare of their animals. That really hasn't changed. What's become different is the welfare of the animals is now a social topic that other parts of society are engaging in. That has changed the whole perspective just in terms of who is involved in this discussion. Certainly, this has heightened the awareness of producers and that's why producers like to see practical research that not only looks into welfare questions but helps provide new tools and new system designs that allow the pork producer to be successful.

To the credit of our producer stakeholders, animal welfare and behavior were among the priorities for research when Prairie Swine Centre was started two decades ago and that remains the case today. I think producers understand whatever challenge they face, they are better off the more knowledge they have that looks at solutions in the context of the overall swine enterprise. Obviously the health and welfare of the animals is critical to all aspects of profitable and sustainable production.

Regular improvements in areas such as early identification of potential issues that can be improved through research (such as lameness, system designs that improve the group environment) can all add up and make a big difference. We're always interested in finding those opportunities.

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3) Validation: relation with lameness

Sixty sows from AAFC and PSC were weighed on the force plate. Among them, 24 sows were visibly sound, 19 sows mildly lame and 17 sows lame using subjective gait scoring (gait scores 0 – sound even strides, 4 – the sow does not move; Main et al., 2000). Using force plate measures, only the weight shifting (WS) frequency and ratio of body weight (BW) applied between opposite legs differed among lameness scores. Indeed, WS frequency per minute for front legs (score 0: 22.5 ± 1.64, score 1: 24.77 ± 1.86, score 2: 33.3 ± 1.94, $P<0.001$) and hind legs (score 0: 20.4 ± 1.80, score 1: 21.89 ± 2.04, score 2: 31.3 ± 2.13, $P<0.001$) increased significantly with lameness. In this experiment, the ratio of BW applied between rear legs decreased with increasing lameness score (score 0: 0.72 [0.67-0.76], score 1: 0.71 [0.66-0.75], score 2: 0.62 [0.57-0.68], $P<0.05$). Different results were found at the two sites. This could be due to various environmental and animal factors, such as housing system, floor type, herd management, parity or genetics (Pluym et al., 2011 Vet. Med. 56:101-109).

Overall, the results show that lame sows had more variation in the weight applied on their limbs and did more weight shifting. This was also observed in studies on dairy cows (Pastell et al., 2010, J. Dairy Sci. 93: 954-960) and weight shifting is suggested as a means of reducing pressure on a painful limb, by transferring weight to the opposite limb. The force plate scale thus proved to be efficient at discriminating lame sows from non-lame sows, with lame sows characterized by greater weight shifting between opposing limbs.

> "Lame sows showed more variation in weight being applied to their limbs, in addition to more weight shifting"

4) Pros and cons

Since the force plate scale is a quantitative method, it is a more objective method than visual measurement. This eliminates the need to train individual assessors and eliminates problems related to inter-observer assessment. Currently the system is expensive, but the force plate has the potential to be included into an ESF feeder or other automated technologies. However, the force plate only provides information of weight bearing and thus provides no specific information related to gait disorder. A combination of static and dynamic observations (e.g. Force plate analysis followed by visual scoring) is recommended to provide a better assessment of lame sows.

The Bottom Line

Further research is required to increase the precision of measurement, to find threshold values that indicate lameness, and to develop associations between force plate measures and specific gait problems. The ultimate aim will be to develop systems that allow the early detection and diagnosis of lameness, and to make them an efficient and effective evaluation tool for the swine industry.