Designing an Objective Static Force Plate to Measure Severity of Lameness in Multi-Parity Sows

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Summary and Implications

Lameness is a major reason for culling sows from the commercial breeding herds. Stalder reported that sows culled for feet, leg, and locomotion disorders ranged between 6 to 15 %. In the U. S., commercial sow farms evaluate lameness using subjective methods. An objective and standardize method for assigning lameness scores to a sow would likely be more accurate than subjective scoring measures and provide producers with a useful tool to assess lameness. Therefore, the objective of this study was to design and build a static force plate to measure weight distribution on four legs of a standing sow. Faculty and students in Animal Science, Agricultural and Biosystems Engineering, and Veterinary Diagnostic and Production Animal Medicine developed a static force plate system with automated characteristics to objectively detect lameness in sows. The static force plate system has many advantages over other alternative systems. The static force plate is made of durable materials, is accurate, fits gestation or farrowing stalls, and can measure the weight placed on each hoof independently. The static force plate is a practical application for the commercial swine industry and may allow for earlier detection of lameness problems when compared to subjective lameness evaluation. This in turn will allow for more timely treatment or culling of individual sows from the breeding herd.

Introduction

Lameness is a major reason for culling sows from the commercial breeding herds. Stalder reported that sows culled for feet, leg, and locomotion disorders ranged between 6 to 15 %. There are numerous methodologies that can be employed to subjectively and objectively measure the degree of lameness an individual animal is expressing at a given point in time. Subjective lameness scoring systems are designed to categorize the degree of lameness expressed while the animal is walking and have been developed for dairy cows, beef cows, dogs, sheep, horses, and broilers. These scoring systems for livestock have been implemented so that caretakers can quickly and affordably quantify the prevalence of lameness in the herd on any particular day. However, there can be disagreement between the lameness score assigned to an individual animal; so an objective and standardize method for assigning lameness scores to an animal would likely be more accurate than subjective scoring measures and provide producers with a useful tool to assess lameness. One such method that shows promise is the force plate measurement system. This device quantifies the amount of force each limb applies to the surface of the assessment tool. Force plate measurement systems can measure variables that have been associated with objectively classifying structural abnormalities into degrees of lameness. An animal will distribute less weight on the limb(s) that is painful or structurally unsound. The use of such equipment has been evaluated in other species such as dogs, chickens, dairy, and horses. Force plate measurements are typically obtained during locomotion for these species, which is acceptable because these animals spend a greater portion of their time moving. However, for breeding sows that housed where mobility is limited, a different objective tool for lameness needs to be considered. Therefore, the objective of this study was to design and build a static force plate to measure weight distribution on four hooves of a standing sow.

Materials and Methods

Concept: The static force plate is a unique system that has been designed to fit within gestation and farrowing stalls.

Static Force plate mechanical design: The force plate measures 152.4 length x 56.5 width x 10.6 cm height, with 0.64 cm thick aluminum plating comprising the top and bottom plate. A semi-flexible epoxy (FlexCoat, Vanberg Specialized Coatings, Lenexa, KS) was mixed with sand at the manufacturers recommendations and applied to the top plate at a desired thickness of 0.48 cm. This epoxy-sand composite provided concrete-like flooring and mimicked what the sow was used to standing on every day. The use of the flooring material attempted to reduce the variability that would have been a result of the sow standing on material that felt foreign to them. The force plate was designed so that the weight of each of the sow's four limbs would be independently measured. This was accomplished by dividing the top plate into quadrants; each having dimensions of 76.2 length x 27.9 cm width.

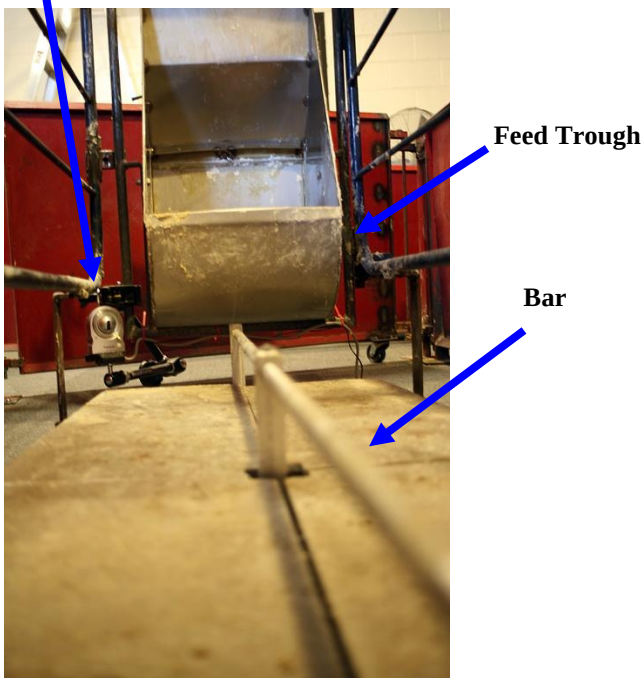
Static Force plate validation method: Each force plate load cell and the platform scale used to obtain the reference weight were validated using procedures outlined in Handbook 44 of the National Institute of Standards and Technology (NIST, U.S. Department of Commerce, Gaithersburg, MD). Four certified weights each weighing 22.68 kg (± 0.75 kg; Weights and Measures Bureau, Iowa Department of Agriculture and Land Stewardship, Ankeny, IA) were used in the validation procedures. The precision of each load cell was validated to ± 0.45 kg. Although each load cell was calibrated at the factory and the linear output mV per unit of force was provided, a total of 68.02 kg (using three 22.68 kg weights) was placed on each quadrant of the force plate before beginning the experiment so that the correct linear slope could be obtained and applied. The same 68.02 kg calibration weight was placed on each quadrant periodically to verify the accuracy of each corresponding load cell. If the value measured was outside the precision of the load cell (67.57 to 68.48 kg), then the data was discarded and the force plate was recalibrated until values were within tolerance.

Software and electronic specifics: Software is currently being developed for the identification of lameness. The goal will be to have a product commercially available within 12 and 18 months.

USDA calibration: The scale is calibrated using USDA low capacity scale test and calibration addendum form. It was officially certified on January 9th, 2009.

Figure 1. A sow standing on the static force plate.

Figure 2. The bar, located down the middle of the static force plate, helps to ensure each hoof is measured individually. A camera allows the researcher to validate the placement of each sow hoof on each quadrant. Each sow receives feed placed in the trough to keep the sows still while data is being collected.



Standard operating procedure for use of the static force plate: An individual sow is moved from her home pen and she enters the open end of the gestation stall. The back gate is closed once the sow is safely in the stall. The sow is trickle fed 0.45 kg (1 pound) over a specified period of data collection. Feeding the sow keeps her stationary and mimics the objective for practical use of this tool on farm (measure sows weight distribution / hoof at feeding events). Data points can be collected at one second interval if desired.

Discussion

The static force plate is a useful and practical way to detect lameness in sows. Most of the alternative force plates are composed of materials (i.e. felt, rubber, and plastic) that are not ideal for application to the commercial swine industry. The static force plate is composed of durable aluminum which provides the robustness needed to withstand many years of abuse by sow hooves and the harsh environment. Further, the available force plate systems typically require the sow to walk or move the entire distance of the force plate to collect locomotion data. This design allows the sow to stand on the force plate for extended periods of time (typically during feeding for 15 minutes to 1 hour) and collect weight distribution of each limb for lameness detection. This force plate also has many other

advantages in that it is highly accurate, fits already existing equipment, and that it measures the weight of each hoof individually. This facilitates easy tracking of the sow's hooves weight distribution throughout her productive life, which in turn, may prove helpful to producers in implementing environmental or genetic programs to their breeding sow herds to decrease the occurrence of lameness.