VALIDATION OF FLANK-TO-FLANK ALLOMETRIC EQUATIONS IN PREDICTING WEIGHT OF LACTATING SOWS AND LACTATION WEIGHT CHANGE

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Summary

The objectives of this study were to validate the use of flank-to-flank measurement in predicting weight of lactating sows and to determine the accuracy of the developed models in estimating lactation weight change. A total of 70 lactating sows (PIC Line 1050) were used in this study. Flank-to-flank measurement and body weight were measured on each individual sow after farrowing and at weaning. Flank-to-flank measurement and weight of lactating sows was positively correlated (R^2 = 0.61; *P*<.0001) with the following equation: $BW^{0.33}$, kg = 0.0371 x Flank-to-flank (cm) + 2.161. Weights of sows post-farrowing and at weaning were lower (*P*<0.03) when predicted with the previous allometric model developed from growing pigs and sows than their actual weights or weights predicted using the lactating sow model. Likewise, absolute residuals for post-farrowing and weaning weights using a previous allometric model developed from growing pigs and gestating sows were greater (*P*<0.02) than those of the lactating sow model. There were no differences (*P*<0.89) between the predicted weights using the lactating sow model and their actual weights. There also were no differences between the actual average weight loss (*P*<0.14) and the predicted loss using the lactating sow model. Using the model previously developed with growing pigs and gestating sows resulted in 15.5 lb (*P*<0.007) greater than the actual average weight loss. In conclusion, flank-to-flank measurement can be used as a predictor of weight of lactating sows, with the relationship having less accuracy than those used for growing-finishing pigs, gestating sows, and boars. The pig allometric equation cannot be used to estimate weights of lactating sows and lactation weight change. The developed lactating sow model was more appropriate in estimating weights and weight loss at the herd level, but needs to be validated on other sows before use can be recommended.

(Key words: lactating sows, flank-to-flank, allometric equations, weight.)

Introduction

Kansas State University researchers have developed an allometric equation that uses flank-to-flank measurement as a valid predictor of pig body weight (Figure 1). This model encompassed a wide range of weights (150 to 800 lb) and was developed in numerous genetic lines and both sexes of pigs. The ability to predict pig body weight accurately within the weight range provides numerous potential applications. In sows, this provided a simple yet more accurate method of categorizing sows into weight categories that can be useful in developing feeding programs, especially during gestation. Some pig producers have

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also applied this model in estimating weight of lactating sows and used these estimates to determine weight change during lactation. However, the model has not been tested in lactating sows for its validity in estimating changes in weight. Therefore, the objective of this study was to validate the use of flank-to-flank measurement in predicting weight of lactating sows in different physiological stages and to determine the accuracy of the sow models in estimating lactation weight change.

Procedures

A total of 70 lactating sows (PIC Line 1050) at the Kansas State University Swine Research and Teaching Center were used in this study. Sows were weighed using a platform scale after farrowing and at weaning. Then using a cloth tape measure, flank-to-flank measurement was taken immediately in front of the hind legs of the sow. Measurement was from the bottom of the flank on one side to the bottom of the flank on the other side, with the cloth tape being placed over the top of the hip. The date of measurement, sow ID, parity, body weight (BW), and flank-to-flank measurement were recorded.

The weights of the sows post-farrowing and at weaning were estimated using two equations: Equation 1 – the original growing pig and gestating sow allometric model, and Equation 2 – the lactating sow model with BW expressed as $BW^{0.33}$ developed from the sows in this experiment. The model to predict weight of lactating sows using flank-to-flank measurement was developed using PROC REG of SAS. To improve the accuracy of the developed model, all observations were analyzed for influential outliers using multiple criteria, including studentized residuals, h value, DFITTS, DFBETAS, Cook's D, and CovRatio. Observations with values from the SAS output that exceeded the calculated critical value for three of the six criteria were removed from the model. A total of four sows were considered influential outliers and were excluded in the analysis. Residuals were used to estimate the accuracy of the equations in estimating post-farrowing and weaning weights. The residuals were calculated as the absolute value of the difference between predicted weight using the two allometric equations and actual weight measured. Lactation weight change was measured as the difference between the weight of the sow at weaning and its post-farrowing weight. Differences between the actual and predicted values for post-farrowing weight, weaning weight, absolute residuals, and lactation weight change were compared and analyzed using PROC GLM of SAS with the individual sow as the experimental unit.

Results and Discussion

The relationship between flank-to-flank measurement and weight of lactating sows expressed on an allometric basis ($BW^{0.33}$) is shown in Figure 2. Flank-to-flank measurement and weight of lactating sows was positively correlated ($R^2 = 0.61$; $P<.0001$) with the following equation: $BW^{0.33}$, kg = 0.0371 × flank-to-flank (cm) + 2.161. This result agrees with previous work on growing-finishing pigs, gestating sows, and boars and indicates that flank-to-flank measurement can also be used to estimate weight of lactating sows. However, the developed lactating sow model only explains 61% of the variation in sow weights, which is considerably lower than the original pig and gestating sow model (96%) and the boar model (86%).

Using the pig model, the predicted weights of sows post-farrowing and at weaning were 24 ($P<0.03$) and 40 lb ($P<0.0001$) lower than their actual weights, respectively (Figure 3). These estimates were also lower ($P<0.01$) than the predicted weights using the lactating sow model. Likewise, absolute residuals for post-farrowing and weaning weights using the pig allometric equation were 9.2 ($P<0.02$) and 16 lb ($P<0.0008$) greater than those of the lactating sow model (Figure 4). There were no differences (P<0.89) between the predicted weights using the lactating sow model and their actual weights. This is expected as the lactating sow model was developed from the same group of sows as used to test the accuracy; however, the growing pig and gestating sow model did not accurately predict the weight of lactating sows at any physiological stage. This did not conform with previous work on adult, working boars, where the growing pig and gestation sow allometric equation fit the boar data as well as the developed boar equation. This suggests that there are more variations in body shape or differences in body volume of lactating sows that cannot be explained solely by linear body dimensions. The underestimation of weights may also be partially explained by the unaccounted contribution of mammary gland growth throughout lactation. University of Illinois researchers previously determined the compositional changes of suckled mammary glands from d 5 to 28 of lactation. Wet weights of a suckled mammary gland increased linearly from 0.84 lb/suckled gland at d 5 to 1.30 lb/suckled gland at d 21 of lactation. If the sow is suckling at least 10 pigs, then the unaccounted weight will be 8.4 and 13.1 lb at d 5 and 21, respectively. Changes in other mammary tissues and body stores throughout lactation may also contribute to the underestimation.

At the individual sow level, the predicted weight change using the pig model and the lactating sow model with the actual lactation weight change was highly variable. For example, both models predicted a positive weight gain in only one out of six sows that actually gained weight during lactation. There were also two sows that were predicted to have had a positive weight gain, when both actually lost weight. At the herd level, the predicted weight loss using the pig model was 15.5 lb (P<0.007) greater than the actual average weight loss, and the predicted weight loss using the lactating sow model was intermediate (Figure 5). There were no differences between the actual average weight loss (P<0.14) and the predicted loss using the lactating sow model. These illustrate the inability of either model to accurately estimate lactation weight change at the individual sow level. However, the lactating sow model was more accurate in estimating lactation weight loss than the pig model at the herd level. These results negate the potential usefulness of this method in estimating weight loss of individual lactating sows. The potential application of this model may be in performing experiments that will create differences and require the determination of weights and weight changes of groups of sows during lactation. The model measures the average sow weight loss of a group of sows more accurately than the loss of a particular sow. However, the validity of the lactating sow model on other data sets needs to be verified.

In conclusion, flank-to-flank measurement can be used as a predictor of weight of lactating sows, with the relationship having less accuracy than those in growing-finishing pigs, gestating sows, and boars. The allometric equation developed from growing pigs and gestating sows cannot be used to estimate weights of lactating sows and lactation weight change. The developed lactating sow model was more appropriate in estimating weights and weight loss at the herd level.

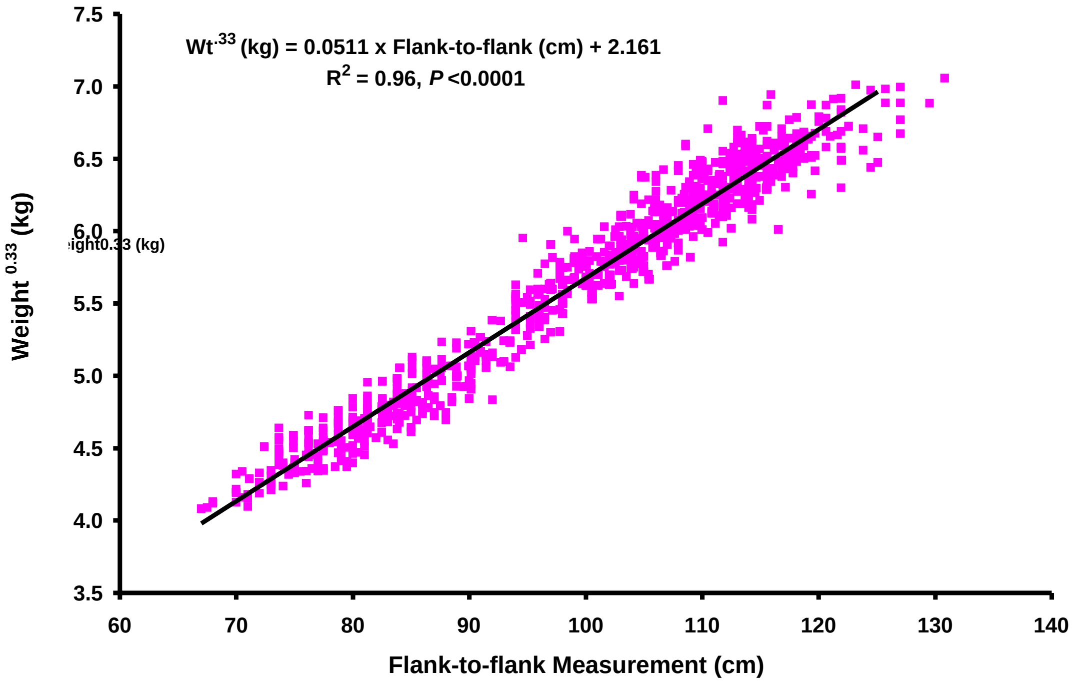

Figure 1. Relationship Between Flank-to-flank Measurement and Pig Body Weight Expressed on an Allometric Basis. This equation was developed in previous experiments (Sulabo et al., 2007).

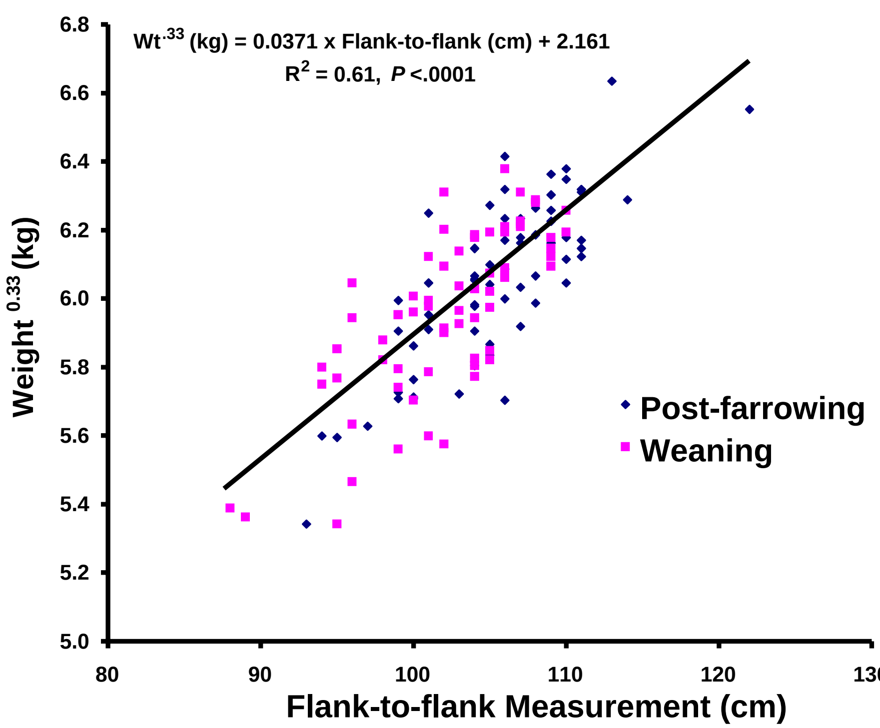

Figure 2. Relationship Between Flank-to-flank Measurement and Weight of Lactating Sows Expressed on an Allometric Basis (66 sows).

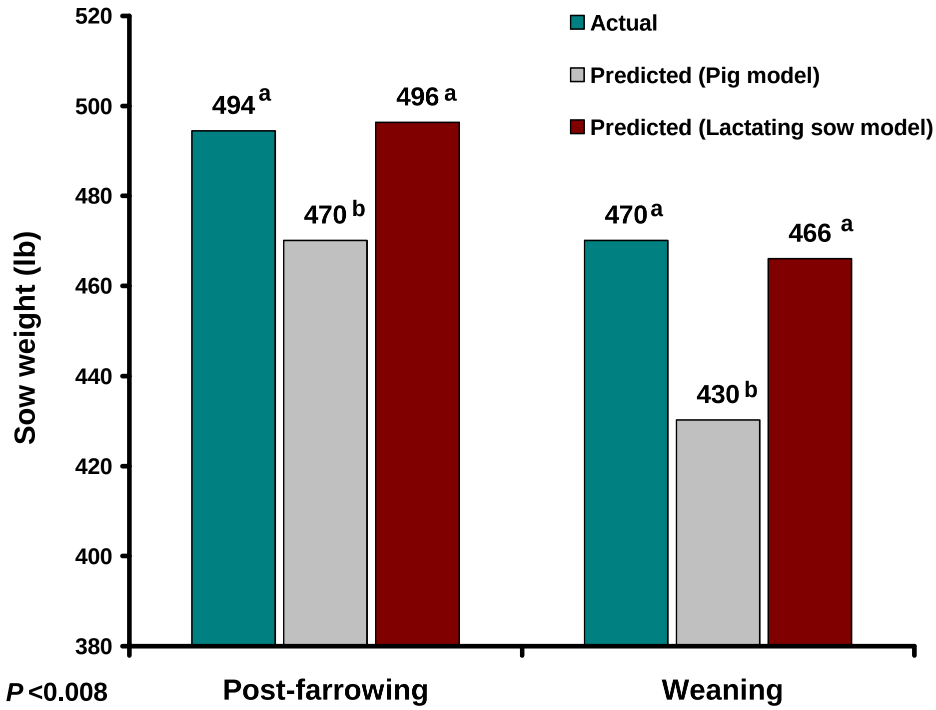

Figure 3. Actual and Predicted Weight of Lactating Sows at Post-farrowing and Weaning Using the Growing Pig and Gestating Sow Model and the Lactating Sow Model.

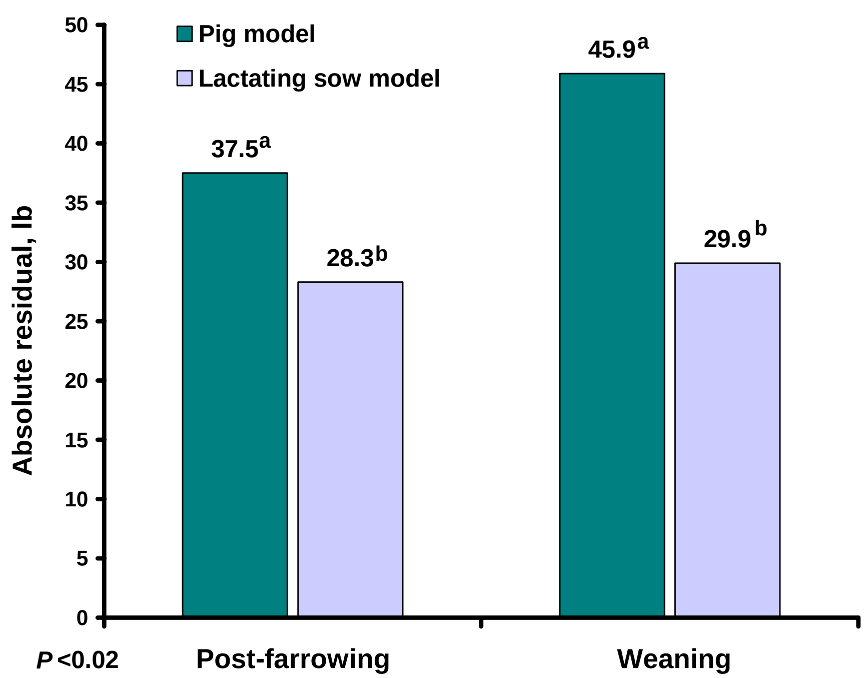

Figure 4. Absolute Residuals Using the Growing Pig and Gestating Sow Model and Lactating Sow Model for Estimating Post-farrowing and Weaning Weights.

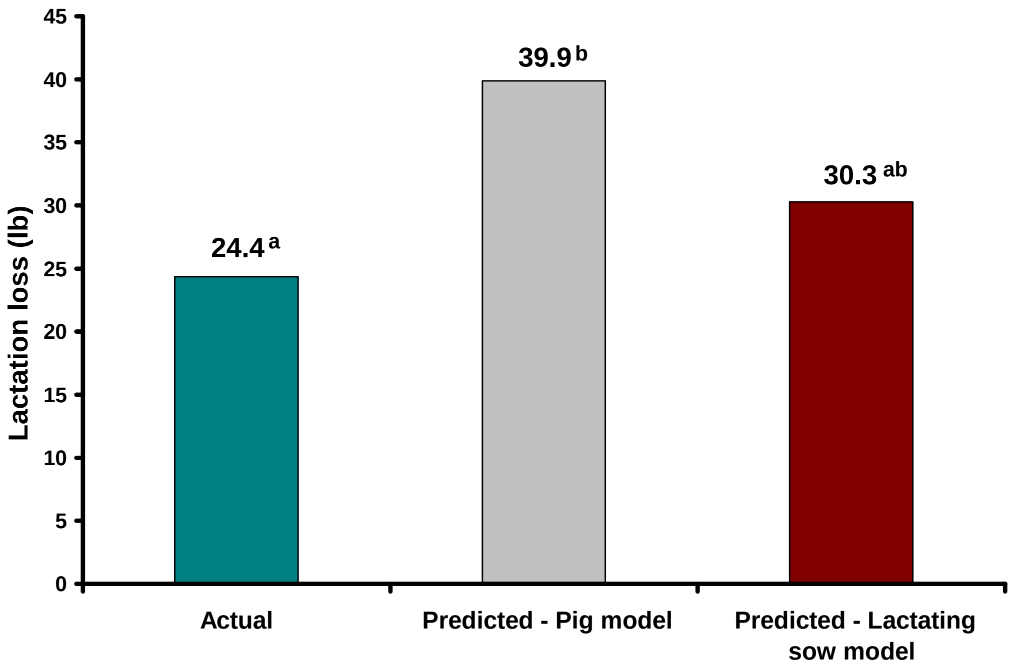

Figure 5. Actual and Predicted Values for Average Lactation Weight Loss Using the Pig Model and Lactating Sow Model.