VALIDATION OF FLANK-TO-FLANK MEASUREMENTS FOR PREDICTING BOAR WEIGHT

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Summary

Allometric relationships, in which linear body dimensions are expressed as a function of body weight, are commonly used in growth studies. Previous work at Kansas State University showed a positive correlation between flank-to-flank measurement and sow body weight. Prediction equations were developed to estimate sow weight, but it is not known if the same equation will be valid in estimating body weight among other groups of pigs, such as boars. The objective of this study was to validate the use of flank-to-flank measurement in predicting boar weight, and to determine if the allometric equation for gestating sows can also be used for adult boars. A total of 100 adult working boars in a commercial A.I. stud were selected for this study. Flank-to-flank measurement and body weight were measured on each individual boar. Flank-to-flank measurement was positively correlated to boar body weight (R^2 = 0.84, $P<0.01$). The fit of the model improved slightly (R^2 = 0.86, $P<0.01$) when body weight was expressed as $BW^{0.333}$. The boar equation was: $BW^{0.333}$, kg = 0.0458 × flank-to-flank, cm + 1.1838. The comparison of residuals indicated that all three equations accurately predicted boar weight. The sow equation was also shown to be as accurate as the boar equations in estimating boar weight. Therefore, the sow allometric equation can be used as the final model to predict both sow and boar body weight.

(Key Words: Boars, Flank-to-flank, Allometry, Prediction Equations, Weight.)

Introduction

Allometry, which relates physical measurements such as body dimensions of an animal to its overall body size or weight, is frequently used in studies of animal growth. Assuming that the form of small and large pigs remains the same and that specific gravity of the body changes remain constant, then volume (or body weight) increases as the cube of linear dimensions. Linear body dimensions can then be expressed as $L = k\text{BW}^{0.333,}$ where L = linear dimension, k = appropriate coefficient, and BW = body weight. Kansas State University researchers previously developed a simple allometric equation to estimate sow weight by using flank-to-flank measurements. This provided a simple, yet more accurate, method of categorizing sows into weight categories, which can be useful in developing feeding programs, especially during gestation. It is unknown, however, if the same method is valid for other groups of pigs, such as adult working boars. Therefore, the objective of this study was to validate the use of flank-to-flank measurement in predicting boar weight and to

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determine if the allometric equation for gestating sows can also be used for working boars.

Procedures

A total of 100 adult working boars from two genetic lines (83 TR4, 17 PIC 380) in a commercial A.I. stud were used in the study. Boars were selected specifically to obtain the widest possible range in weights. A cloth tape measure was used to take a flank-to-flank measurement immediately in front of the hind legs of the boar (Figure 1). 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. Boars were then removed from the stall and weighed on a platform scale. The date of measurement, boar ID, age, body weight (BW), and flank-to-flank measurement were recorded.

Regression equations to predict boar weight using flank-to-flank measurement were developed by using PROC REG of SAS. Three equations were compared in the study: Equation 1 – boar model with BW having no scaling factor, Equation 2 – boar model with BW expressed as $BW^{0.333}$, Equation 3 – sow model with BW expressed as $BW^{0.333}$. Residuals were used to estimate the accuracy of the equations. The residuals were calculated as the absolute value of the difference between predicted weight by using the developed allometric equations and actual weight measured with the scale. Median residuals and sample quartiles were determined by using PROC UNIVARIATE of SAS.

Results and Discussion

The relationship between flank-to-flank measurement and boar weight is shown in Figure 2. Flank-to-flank measurement and boar body weight was positively correlated (R^2 = 0.84; P<0.01) with the equation:

$$\mathbf{BW, kg = 5.1793 \times flank\text{-}to\text{-}flank, cm - 322.87} \quad \text{(Eq. 1)}$$

When boar weight was expressed as $BW^{0.333}$, a similar relationship was observed (Figure 3). The second boar equation was:

$$\mathbf{BW^{0.333}, kg = 0.0458 \times flank\text{-}to\text{-}flank, cm + 1.1838} \quad \text{(Eq. 2)}$$

This allometric equation fit the weight data better than the first model (R^2 = 0.86; P<0.01). This result agrees with previous work on gestating sows, and indicates that flank-to-flank measurement can also be used to estimate boar body weight. Moreover, a better fit is obtained when boar BW is expressed in the model as $BW^{0.333}$.

The third model tested was the sow model:

$$\mathbf{BW^{0.333}, kg = 0.0511 \times flank\text{-}to\text{-}flank, cm + 0.5687} \quad \text{(Eq. 3)}$$

A comparison of the three models, on the basis of absolute residuals, is shown in Table 1. The average residual was 16.8 and 17.4 kg for Equations 1 and 2, respectively. When the sow model (Equation 3) was used to estimate boar weight, the average residual was 18.3 kg. The median residuals for Equations 1, 2, and 3 were 13.6, 13.8, and 14.5 kg, respectively. This indicates that the predicted weights of half of the boars were within 14 kg of their actual weights, whereas 75% of the boars were within 23 kg. On the other hand, predicted weights of 90% of the boars were within 35 and 40 kg of their actual weights when Equations 2 and 3 were used, respectively. Comparison of residuals indicates that all three equations accurately predicted boar weight. The prediction equation developed for gestating sows was also shown to be as accurate as the boar equations in estimating boar weight.

Although both the linear and allometric equations were suitable models for estimating pig weight, expressing BW as $BW^{0.333}$ in the model is preferred for a number of reasons. First, we are relating flank-to-flank measurement, which is a uni-dimensional concept, with a three-dimensional concept, body weight. The allometric coefficient (0.333), which describes the relationship between the two variables, is determined by dividing the dimensional exponent of flank-to-flank measurement (= 1) with the dimensional exponent of body weight (= 3). This means that flank-to-flank measurement increases at a lower rate than an increase in body weight. Second, previous data from sows and growing-finishing pigs suggest that the relationship between flank-to-flank measurement and body weight is non-linear in a lower weight range. With this, a linear model will not be appropriate for estimating a wider range of pig weights. The sow allometric equation can be used as the final model in estimating pig weights because it has been developed and tested on a larger database, a wide range of weights (50 – 350 kg), more genetic lines, and both sexes of pigs. The final model in estimating pig weights by using flank-to-flank measurement is the sow model (Equation 3).

Figure 1. Flank-to-flank Measurement.

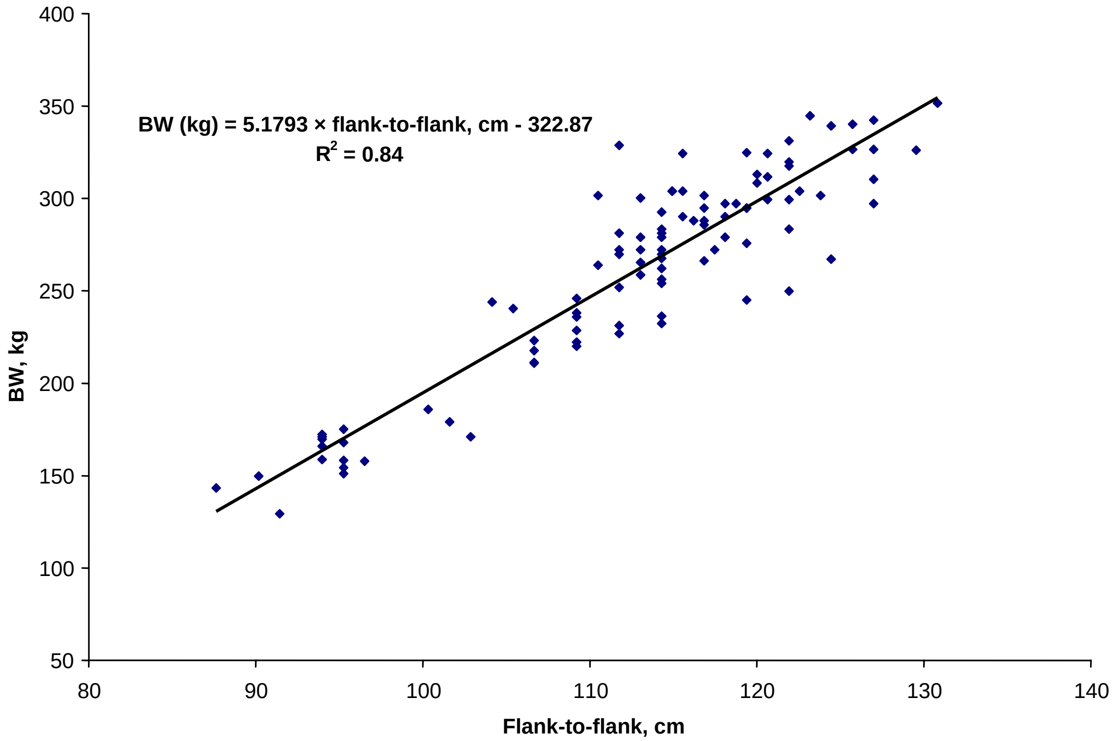

Figure 2. Relationship Between Flank-to-flank Measurement and Boar Weight (100 boars).

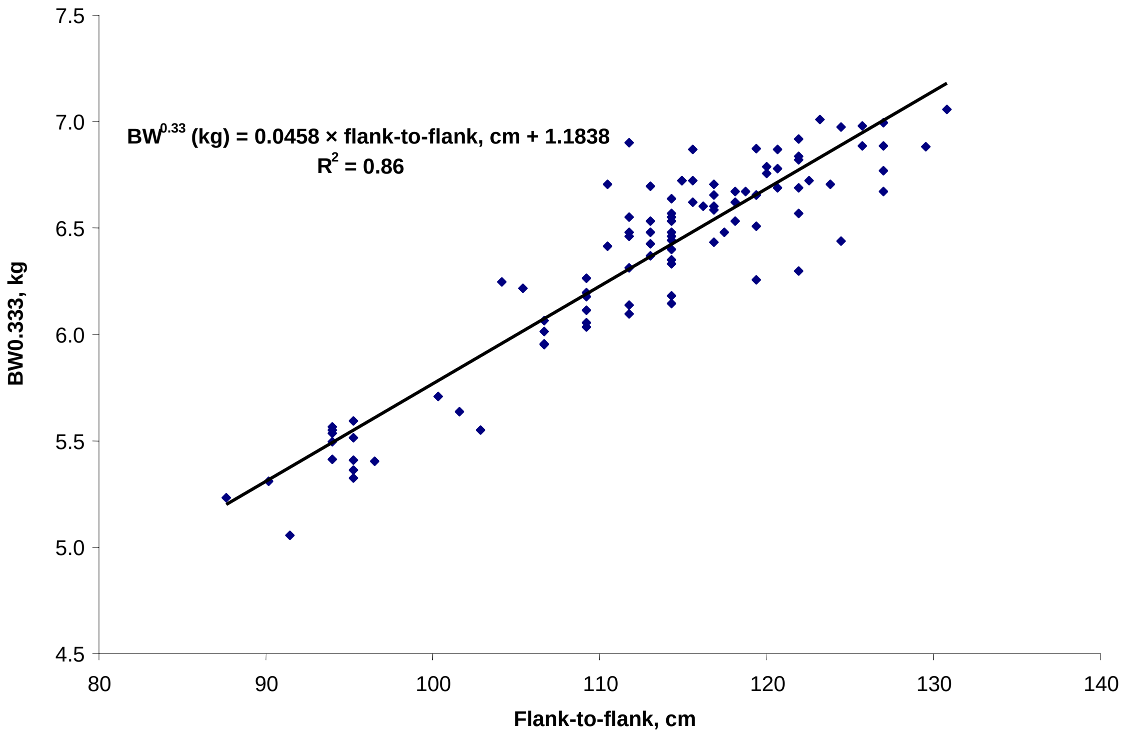

Figure 3. Relationship Between Flank-to-flank Measurement and Boar Weight Expressed on an Allometric Basis (kg $BW^{0.333}$).

Table 1. Comparison of Models Based on Absolute Residuals[a]

Percentile	Absolute Residual					
	Equation 1[b]		Equation 2[c]		Equation 3[d]	
	lb	kg	lb	kg	lb	kg
25th	15.0	6.8	15.0	6.8	15.0	6.8
50th	30.0	13.6	30.5	13.8	32.0	14.5
75th	50.0	22.7	50.5	22.9	54.5	24.7
90th	76.5	34.7	77.5	35.2	89.0	40.4

[a]Residuals = absolute difference between predicted and actual weight.
[b]Equation 1: BW, kg = 5.1793 × flank-to-flank, cm – 322.87.
[c]Equation 2: $BW^{0.333}$, kg = 0.0458 × flank-to-flank, cm + 1.1838 (boar equation).
[d]Equation 3: $BW^{0.333}$, kg = 0.0511 × flank-to-flank, cm + 0.5687 (sow equation).

Table 2. Predicted Pig Body Weight (lb) by Using Flank-to-flank Measurement

Flank-to-flank Measurement		Predicted BW
in	cm	lb
24	61	110
25	64	122
26	66	135
27	69	149
28	71	164
29	74	179
30	76	196
31	79	214
32	81	232
33	84	252
34	86	273
35	89	294
36	91	317
37	94	342
38	97	367
39	99	394
40	102	421
41	104	451
42	107	481
43	109	513
44	112	546
45	114	580
46	117	616
47	119	654
48	122	693
49	124	733
50	127	775