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USING BEEF MORPHOLOGY TO PREDICT CARCASS WEIGHT WHICH CUTTING IN THAI-ISAAN STYLE

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ABSTRACT: The trading of the beef cattle market in Thailand is based on the price satisfaction agreement between sellers and buyers. The rancher, the middlemen and the butcher shop have been predicted the return from visual assessment. The prediction of return from carcass composition depends on personal skill. The highest price of carcass cutting in Thai-Isaan style composes with all meat, liver, spleen, kidney, heart, tongue and gastric. The objective of this study was to determine the best-fitted regression model for predicting the weight of carcass composition using body measurements. Data on carcass composition cutting in Thai-Isaan style and linear body measurements recorded form 100 crossbred male beef in Northeastern (Isaan) region were used for this study. The simple and multiple regression models were fitted with carcass composition as the dependent variable and heart grit, body height, body length, hip width and hip length as independent variables. The correlation coefficients between carcass composition and body measurements were strongly and significantly ($P<0.01$). Body length was best fit to simple regression model for predict carcass composition weight ($R^2=0.712$). A stepwise method was used to fitting the regression model. The recommended model was the 3 factors left in the model (heart girth, body length and hip length) with $R^2=08101$. The study concludes that linear body measurements can predict carcass composition weight and their return. The rancher, the middlemen and the butcher shop can use this equation to predict the return and set the beef price for trading.

Keywords: Carcass, Estimate the return, Total trimmed meat, Morphology, cattle

1. INTRODUCTION

Number of beef cattle in Thailand in 2017 was around 4,876,000. Forty-seven percent of all were in the Northeastern region of Thailand (Isaan) [1]. With extensive areas and Isaan people prefer to consume meat from beef and they have a culture about consumption beef, so there are a lot of beef cattle in the Isaan region.

In many areas of the trade, cattle cannot use scales for cattle trading. Because the weighing scales are expensive and not proper to use at beef market. In addition, live weight is not more important than income from the carcass. The trading of beef is based on the price satisfaction agreement between sellers and buyers. The rancher, the middlemen and the butcher shop estimate the return from visual assessment. The estimation of the carcass derived from the appearance of cattle is unique skill expertise and the wisdom of beef buyer.

Carcass weight directly depends on body weight [2]. Forecasting the carcass weight of cattle should have information on live weight. Nevertheless, trading in the countryside, there is no scale is used to weight. As a reason, the linear type trait of a live animal is applied to estimate the live weight, the carcass weight and inference to the return.

Estimation from sight, there will be a lot of error if not expert. Body measurements taken on live animals have been used expansively for a variety of reasons both in experiments and in selection purpose [3]. The accuracy of prediction carcass weight from a live animal is a financial contribution of livestock enterprise. The producers and buyers can estimate revenue from the sale of live beef and access value-based trading systems.

The objective of this study was to predict the carcass weight from body measurement using simple and multiple linear regression in Crossbred Brahmans.

2. SLAUGHTER AND CUTTING THAI-ISAAN STYLE, THAILAND.

Several percentages of beef cattle in Thailand are cutting in a standard way. For Isaan, the cutting was suitable for the local cooking. The famous Isaan

dish made from meat is Laab, the main ingredient is mincemeat and mixes with some pieces of liver, rumen, reticulum. The people in Isaan mostly consume every part of the beef carcass except skin, bone, and horn. At the butcher shop, parts of beef will group according to the value and each group is a sale in the same price.

The slaughter method starts with stunning cattle by a hammer at the front of the beef skull, which marks as X crossing line between horn and eye. After cattle fall down, a sharp knife is used to pierce the jugular vein to bleed until the blood flow is negligible. Four legs are hung separately and clean body outside. Cutting the skin along with the middle line to the tail is made. Skin for 4 legs is removed except under knee to hoof. The horns are then removed and the head is skinned. The head is detached by cutting through the neck muscles and the occipital joint. Cutting along with a middle line to open a flam and removed internal organs such as stomach, intestine, liver, heart, etc. Front legs, from scapula to hoof, hind legs from the femur to hoof (round bottom) are separated out for the hanging shown in the butcher shop. All red meat remaining in the frame is trimmed out of the bone. Each part is weighted before sending to the butcher shop. Hot carcass weight cannot be done because the slaughterhouse does not have the instrument to pull the body up and that trait is less important for local trading.

3. MATERIALS AND METHODS

Crossbred Brahmans were purchased from many provinces around the region sent to municipality slaughterhouse in Kalasin province, Thailand. About 8-10 heads per week of beef were slaughtered, in total 100 male crossbred Brahman beef were used in this study. Before the slaughter process, beef was taken into restraint box for body measurement. The parameters compose with heart girth (HG): the body circumference posterior to the front legs, body length (BL): the distance between the point of shoulder to the outer and central tuberosity of left humerus to left tuber ischii, body height (BH): the vertical distance from ground to scapular of the withers, hip width (HW): the widest point at the center of the stifles, and hip length (HL): the distance between pin bone to the stifle.

Several kinds of beef were a slaughter in a day, one by one for tracking and recording each part of the body. Beef carcasses were trimmed in the style of Isaan. Carcass compositions were grouped by price value. The weight of the first price group (W1) was a high-value group composed of total trimmed meat such as shanks, chuck, sirloin, rump, round, loin, brisket, etc. The internal organ was also in the high-value group (W1_1) composed of tongue, heart, liver, spleen and kidney. The weight of the second price group was intermediate price (W2) composed of rib, meat scraps, fat, and intestine. The weight of the third price group was the lowest price (W3) composed of lung, trachea, bladder, cartilage, rumen, reticulum, omasum abomasum and their ligament. Each group was weighed after trimming. Whole legs with bone-in were weighted before selling and weighed only bone again after meat sold out to calculate meat.

Simple correlation coefficients between body measurements and weight of each carcass group were calculated and tested for significance. To predict carcass weight, the stepwise procedure was used to select the variable of body measurements for fitting prediction equations. The coefficient of determination (R^2) was assessed the accuracy of the equations.

4. RESULTS AND DISCUSSION

The mean, standard deviation, minimum and maximum of the body measurements and carcass weights were shown in Table 1. All observations were normally distributed. The high correlation between body measurements was found for hip width and hip length (0.926), Hip width and heart girth (0.824). The balance and relationships of the animal body part are stable when they rise in near management. [4]. Correlation between all body measurements and carcass weight group were significantly correlated (Table 2). Body length was reported to have the highest correlation with W1 (0.8453), heart grid was the highest correlation with W1_1 (0.4727), body height was the highest correlation with W2 (0.4742) and hip length was the highest correlation with W3 (0.6357).

Table 1 Descriptive value of body measurement and carcass weight groups

Variable	N	Mean	Std Dev	Min	Max
Body measurement					
Heart grid (cm)	100	177.08	11.461	155	220
Body height (cm)	100	131.60	11.347	112	170
Body length (cm)	100	133.20	13.505	102	165
Hip width (cm)	100	45.08	6.552	30	59

Hip length (cm)	100	52.21	6.392	37	67
The weight of the carcass group					
W1 (kg)	100	170.00	23.680	118	230
W1_1 (kg)	100	17.82	1.493	15	24
W2 (kg)	100	25.25	3.955	17	39
W3 (kg)	100	25.06	3.348	17	36

Note W1 = weight of first price group composted with total trimmed meat.; W1_1 = weight of internal organ high-value group composted tongue, heart, liver, spleen and kidney; W2= weight of second price group composted with rib, meat scraps, fat, colon, and intestine.; W3 = weight of third price group composted with lung, trachea, bladder, cartilage, rumen, reticulum, omasum abomasum and their ligament.

Table 2 Correlation between body measurements and carcass weight

Parameters	W1	W1_1	W2	W3
Heart grid	0.8054 ***	0.4727 ***	0.4066 ***	0.6037 ***
Body height	0.7196 ***	0.4540 ***	0.4742 ***	0.5762 ***
Body length	0.8453 ***	0.3316 ***	0.2359 ***	0.5115 ***
Hip width	0.7966 ***	0.3773 ***	0.3692 ***	0.6298 ***
Hip length	0.7403 ***	0.3987 ***	0.4546 ***	0.6357 ***

Note: W1 = weight of first price group composted with total trimmed meat; W1_1 = weight of internal organ high-value group composted tongue, heart, liver, spleen and kidney; W2 = weight of second price group composted with rib, meat scraps, fat, colon, and intestine; W3 = weight of third price group composted with lung, trachea, bladder, cartilage, rumen, reticulum, omasum abomasum and their ligament; *** $p<0.01$

4.1 Prediction equation for carcass weight group

All body measurements were included in models to predict weigh groups. Body measurement traits accounted for 81.6%, 35.1% and 46.2% of the variation observed in W1, W2 and W3 respectively.

Table 3 Regression equations for predicting three weight groups from body measurements

Variable	W1	W2	W3
Intercept	-106.30	-7.8	-3.34
Heart grid	0.52	0.07	0.05
Body height	0.20	0.15	0.06
Body length	0.92	0.04	0.001
Hip width	0.65	-0.47	0.06
Hip length	1.21	0.51	0.23
R^2	0.816	0.351	0.462
P-Value	0.0001	0.0001	0.0001

To make it easier to use one body measurement used for simple linear regression. Simple linear regression for prediction each weight group was calculated from their highest correlation with body measurement (Table 4). The highest correlation between W1, W1_1, W2 and W3 were body length, heart girth, body height and hip length, respectively. Body length explained 71.5% of the variation in W1. It was observed that one cm change in HG resulted in approximately 1.482 kg change in weight of the first price group.

Table 4 Simple linear regression equations for estimation of the weight of the first price group, the weight of second price group and weight of third price group

Dependent variables	Equations	R^2
W1	= -27.500+1.482BL	0.715
W1_1	= 6.872+0.06HG	0.223
W2	= 3.491+0.165BH	0.225
W3	= 7.676+0.333HL	0.404

Note: W1 = weight of first price group composed with total trimmed meat; W1_1 = weight of internal organ high value group composed of tongue, heart, liver, spleen and kidney; W2 = weight of second price group composed of rib, meat scraps, fat, colon, and intestine; W3 = weight of third price group composed of lung, trachea, bladder, cartilage, rumen, reticulum, omasum abomasum and their ligament.

The main return for the butcher from beef carcass was the W1, it made around 80.00%, of all income from the whole carcass, as a reason the prediction equations were focused on this trait.

In the prediction of W1, when only one parameter of body measurement included the model, the R^2 was highest for body length (Table 5). To make the equation easier, the non-intercept model was also calculated in the present study. In several studies, heart girth is the best body measurement for prediction of body weight in buffalo [5], Brahman crossbred [6], Bali cattle [7]; however, for the carcass weight, body length was better.

Table 5 Simple linear regression equations for estimation of the weight of the first price group from body measurements

Regression equations	R^2	P-Value
W1 = -125.86+1.66(HG)	0.6486	0.0001
W1 = -27.74+1.50(BH)	0.5178	0.0001
W1 = -27.49+1.48(BL)	0.7144	0.0001
W1 = 40.15+2.87(HW)	0.6345	0.0001
W1 = 26.76+2.74(HL)	0.5479	0.0001
Non-intercept model		
W1= 0.959(HG)	0.9912	0.0001

W1= 1.129(BH)	0.9906	0.0001
W1= 1.278(BL)	0.9943	0.0001
W1= 3.752(HW)	0.9919	0.0001
W1= 3.248(HL)	0.9910	0.0001

Note W1 = weight of first price group composted with total trimmed meat. HG=heart girth, BL= body length, HL= hip length

The R^2 was highest (0.816) for prediction equation using all body measurements in the model, according to previous prediction study [8, 9]. The model to predict the weight of first weight group was W1= -106.30 +0.52(HG) +0.20(BH) +0.92(BL) -0.65(HW) +1.21(HL) (table 3). However, when all parameters were in the model, it was not practical to use. To fitting regression equation, the stepwise procedure was used. Each variable is considered for addition to or subtraction from the set of variables based on the sequence of F-tests. In the final step, there were 3 parameters (BL, HG, HL with p-value <0.15) left in the equation with R^2=08101 (Table 6).

Table 6 The parameters left in the multiple linear regression for estimation of the weight of the first price group

Variable	Intercept	HG	BL	HL
Parameter Estimate	-89.782	0.547	0.898	0.820
C(p)		49.633	13.585	4.864
Partial R^2		0.715	0.075	0.021
Model R^2		0.715	0.789	0.810
p-value		0.0001	0.0001	0.0015

Note: HG=heart girth, BL= body length, HL= hip length

Due to economic profit, carcass weight is an important trait in animal husbandry. It might depend on many effects such as gender, age, breed, feeding condition etc. [10]. In this study, we used only male cattle and age approximately 18-36 months. Dressing percentage was not affected during this age of animal investigated [11]. Beef cattle in northeastern Thailand were usually Native-Brahman and raised in the small farming system. Management in the small farming system did not differ, cattle grazing in the pasture and was sometimes supplemented with concentrated feed sources and straw hay.

In previous studies, body measurement in beef cattle was focused on live weight for rural livestock enterprises or for selection purposes such as Brown Swiss [12] Kamphaengsaen beef [13], Sahiwal cattle [9] and Brahman crossbred [14]. This could be because the measurements of the part of the body were easier in live animal and the measurement can predict body weight when lacked a weighing scale, the prediction can be accepted in accuracy. Because the use of linear measurements to predict carcass composition in cattle was rare, there were some studies in sheep [15-16] and goat [17]. In this study, we calculated the predictive equation to estimate the total trimmed meat from the live appearance. It is very useful for predicting carcass weight without expensive instruments such as an ultrasound machine. Although the use of ultrasound technique could improve accuracy in predicting carcass weight [18] and could reduce the cost of collection estimates of carcass composition in live seedstock [19], it is not suitable for use in the rural situation. However, prediction of meat weight by live weight, stifle width, body height and hip width with higher R^2 (0.87) need more parameters [20].

The butchers in northeastern Thailand got mostly income of carcass from W1. The average income from each group was 79.77%, 8.38%, 7.63%, and 4.22% for W1, W1_1, W2 and W3, respectively. It can be clearly seen that economic weighting of W1, W1_1, W2 and W3 varied according to the quality of the carcass and the likelihood of consumption. Moreover, the price per kilogram of W1, W1_1, and W2 were 3.0, 3.0 and 1.8 times of W3, respectively (fluctuating in a narrow range of demand and supply).

The one composition of measurement could predict total trimmed meat from the body length. A prediction chart for determining total trimmed meat weight from various body lengths was prepared and shown in Fig 1.

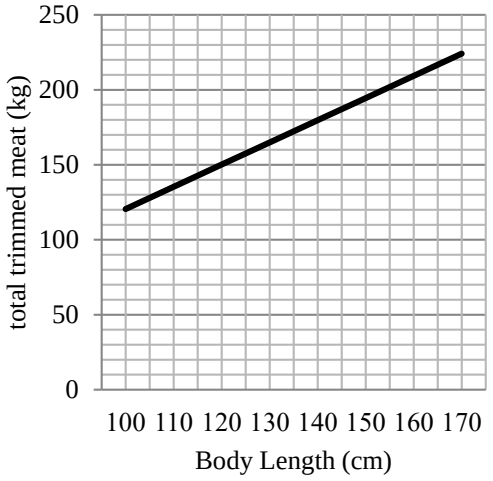

Fig. 1 Prediction chart for determining total trimmed meat weight (W1) from body length in male crossbred Brahmans.

5. CONCLUSIONS

Brahman can predict the carcass composition weight including their returning. The practical application of the result in those situations that weight measurements might not be feasible to set the price such as in small farmers or in a cattle market where do not have access to a weighbridge. Linear body measurements can help the rancher, the middlemen, and the butcher shop to forecast the return and set the beef price for trading. Therefore, this study is significant for the prediction of carcass weight and buyers can estimate revenue from the sale of live cattle and access value-based trading system. For fitting equation, prediction of total trimmed meat using three parameters was $W1 = -89.782 + 0.547(HG) + 0.898(BL) + 0.820(HL)$.

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