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# Predicting Carcass Composition and Individual Feed Requirement in Live Cattle Widely Varying in Body Size<sup>1</sup>

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**ABSTRACT:** A total of 192 feeder steers of five breed types and body sizes commonly found in the United States cattle population were fed high-energy diets to three endpoints (275-, 300-, and 360-kg carcass weights) to determine their carcass composition. Before slaughter, ultrasound was used to predict fat thickness, longissimus muscle area, and marbling. Individual steer data were used for developing prediction equations, which were validated with three independent data sets. These data were used to develop and validate equations to predict carcass composition and DM requirements for individuals fed in pens and varying in breed type, body weight and size, and ADG. Equations to predict carcass weight during growth accounted for 84, 83, and 88% of the

variation in the three data sets with 0, 1, and 3% bias. An equation to predict percentage of carcass fat from fat thickness and equivalent shrunk weight accounted for 96% of the variation in the percentage of carcass fat. An equation to predict yield grade from longissimus muscle area per 100 kg, fat thickness, and equivalent shrunk weight accounted for 93% of the variation. Dry matter requirement predicted by the system for individuals accounted for 48% of the variation in actual DMI with a 3% overprediction bias. The equations allow the user to allocate feed to individual animals in group-feeding environments along with marketing cattle on an individual basis at optimum endpoints given cattle types, feeding costs, and market prices.

Key Words: Growth, Carcass Composition, Nutrient Requirements

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## Introduction

The beef industry is developing programs to minimize carcass fat and identify superior feedlot performance. The major stumbling block has been the lack of a system for sorting cattle into optimum feeding and marketing groups, which requires comingling of cattle from different owners in a pen and marketing them as individuals. Sorting and tracking systems are now being tested that can overcome this problem (Fox and Perry, 1996). These systems require an ability to predict carcass compositional changes during growth so that cattle can be marketed at the optimum time. In order for cattle to be slaughtered at the optimum endpoint, a system for individual allocation of feed consumption and carcass prediction must be available. Fox et al. (1992) and Tylutki et al. (1994) presented a system for predict-

ing energy requirements that has been adopted by the NRC (1996). The objectives of this study were 1) to develop a system of equations to predict carcass fat percentage and yield grade in live cattle to allow prediction of optimum sale points; 2) to develop a system for predicting final empty body fat from carcass measurements and use this equation to predict energy and feed requirements for individuals in a pen to account for differences in body size, stage of growth, and days on feed; and 3) to evaluate the ability of ultrasound to predict fat thickness, longissimus muscle area, and marbling.

## Materials and Methods

A glossary of terms used in the text is presented in Table 1. Feeder steers (192) of five breed types and body sizes selected to represent types commonly found in the United States cattle population were fed high-energy diets to three endpoints to determine their carcass composition. Included at each carcass endpoint (275, 300, and 360 kg of carcass weight) were 10 each of Angus, Hereford, Simmental, and Holstein group-fed steers and six each of Angus, Simmental, Simmental × Angus, and Holstein individually fed steers. At

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Table 1. Glossary of terms

ADG	Shrunk weight average daily gain, kg/d
AFBW	Final shrunk body weight adjusted to 28% fat
BRY	Boneless retail yield
BW	Body weight
CF	Carcass fat
CW	Carcass weight
CWP	Predicted carcass weight proportion
EBF	Empty body fat
EBG	Empty body gain, and is .956 ADG
EBW	Empty body weight, and is .891 SBW
EQSW	Equivalent shrunk weight
EQCW	Equivalent carcass weight
EQEBW	Equivalent empty body weight
FFG	Feed for gain
FFM	Feed for maintenance
FSBW	Final shrunk body weight
FT	Fat thickness, cm
FTU	FT predicted with ultrasound
LM	Longissimus muscle
LMA	Longissimus muscle area, cm <sup>2</sup>
LMAKG	Longissimus muscle area/(FSBW/100)
LMAU	LMA predicted with ultrasound
NEg	Net energy for gain
NEm	Net energy for maintenance
NEFG	Net energy available for gain
RE	Retained energy, Mcal/d
SBW	Shrunk body weight, and is .96 full BW
YG	Yield grade

each carcass weight endpoint, complete carcass measurements were taken and the right side of the carcass was separated into wholesale boneless cuts, fat, trim, and bone. The 9 to 11 rib section from the left side was removed to determine carcass chemical composition.

All individual steer data were used for developing prediction equations, which were validated with three independent data sets. In the group-fed pens, Holstein, Angus, Hereford, and Simmental steers were allotted by breed to one of three carcass weight endpoints (275, 300, or 360 kg), resulting in 12 pens of 10 steers each. The Holstein calves were purchased at random at a few days of age from several weekly auctions in the northeast region of the United States and raised by a commercial Holstein feeder calf grower to approximately 16 wk of age, then placed on a diet at Cornell University similar to the diet used in this experiment until the beef-breed calves were purchased. The beef-breed calves were selected from graded feeder calf sales in Virginia and New York to be representative of Medium<sup>50</sup> to Large<sup>50</sup> feeder cattle grades (USDA, 1980). Steers were slaughtered when average estimated carcass weight of the pen reached the target endpoint.

In the individually fed pens, Holstein calves from the above source and Angus, Simmental, and Simmental × Angus calves (18 calves per breed) were selected from Cornell and New York herds to represent the Medium<sup>50</sup> to Large<sup>50</sup> grades. All steers were individually fed and removed from trial on an individual basis upon reaching the same endpoints as described for the

pen-fed steers. Steers in both trials were fed a high-energy whole shelled corn-based diet calculated to contain (DM basis) 15% corn silage, 14% CP, .6% Ca, .33% P, .8% K, 1.99 Mcal NEm and 1.34 Mcal NEg/kg to meet or exceed NRC (1984) requirements to allow maximum ADG. To avoid possible breed interactions with the various combinations available, no anabolic implants were used. Anabolic implant and breed interactions have been discussed by Perry et al. (1991).

All steers were slaughtered at Taylor Packing (Wyalusing, PA). At 24 h after slaughter, carcasses were graded by USDA and Cornell personnel for marbling score, quality grade (USDA, 1980), and conformation score (USDA, 1965); estimated KPH fat, carcass LMA, and FT measurements were taken. At 48 h after slaughter, the right side of each carcass was separated into wholesale boneless cuts, trim, fat, and bone by packing plant personnel according to Institutional Meat Purchase Specifications (USDA, 1975). Cuts from the rib and loin primals were trimmed to .64 cm, with the remaining cuts trimmed to 1.27 cm. Weights of each wholesale boneless cut, trim, fat, and bone were recorded by Cornell personnel. The 9–11 rib section was removed from the left side for dissection using the procedures of Hankins and Howe (1946), deboned, ground three times through 1/4" plate, and subsampled for Kjeldahl determination of N and chloroform-extractable lipid (AOAC, 1980). To compute daily protein and fat gain, initial composition was predicted from initial shrunk BW using the equations of Simpfordorfer (1974), as described by Perry et al. (1991). Before slaughter, fat thickness (**FT**), longissimus muscle area (**LMA**), and marbling score were predicted with ultrasound. Ultrasound measurements were collected in the live steer with a General Electric Datason (General Electric, Milwaukee, WI) diagnostic unit equipped with real-time linear array and sector transducers.

Each steer was restrained in a squeeze chute and allowed to calm down before measurements were collected. Subcutaneous FT over the LM and the LMA were collected between the 12th and 13th ribs as determined by physical palpation. A vegetable oil blend consisting of 10% olive oil and 90% corn oil (Gem Oil, Gem Products Corporation, Utica, NY) was used as a couplant after the measurement site was cleaned of loose hair, dirt, and manure, and a stand off pad (A-Plus Usound, Ithaca, NY) was used to ensure maximum resolution of ultrasound images.

Fat thickness and LMA scans were collected in duplicate with the linear transducer and measured with the internal calipers. Fat thickness measurements were quantified by placing the internal calipers at the internal edge of the hide and the external edge of the LM. Longissimus muscle area was quantified by tracing the LMA on the screen, and the area was calculated by an internal program. If the duplicate measurements were determined to have a greater

than 5% error, a second set of measurements were taken. Using the internal calipers to determine FT and LMA with less than 5% error increased the accuracy and precision of the measurements.

Carcass marbling was estimated by quantifying the attenuation or loss of signal in the LM as it passed from a depth of 2.8 cm to 8.2 cm between the 12th and 13th ribs. This loss of signal is a good indication of the amount of fat and connective tissue within the LM. These marbling measurements were collected with the sector probe and quantified by the ultrasound machine. Three measurements were collected on each steer. The measurements were collected longitudinally from the top, middle, and end sections of the LM.

Individual steer data were used to develop regression equations, using Minitab (1994). These equations were validated with data from individually fed steers varying widely in cattle type and body size from two independent Cornell experiments (CU, 129 individually fed steers) described by Perry et al. (1991) and a series of pen-fed experiments at Michigan State (MSU, 96 pens) described by Tylutki et al. (1994). The regression equations were validated by regressing predicted on observed values, using the procedures described by Tylutki et al. (1994).

## Results

Table 2 shows the descriptive statistics for the steers. The final data (Table 2) included 162 steers; the other 30 were either removed from experiment because of health problems (three steers) or were excluded because part of their ultrasound data was not collected (20 steers) or carcass data (7 steers) was not available from the packing plant. The mean value for percentage of carcass weight contained in wholesale boneless retail yield (BRY), calculated as  $100\% - (\text{fat trim, \%} + \text{lean trim, \%} + \text{bone, \%})$ , of 68.2%, compares with the mean value of 74.5% (1.27 cm trim) and 73.5% (.64 cm trim) for English, Continental, and Holstein steers obtained in Texas A&M studies (Knapp et al., 1989).

Two adjusted weights were calculated to compensate for differences in body size of the cattle and degree of maturity at slaughter as described by Tylutki et al. (1994). The standard reference weight animal as described by Tylutki was a 467-kg steer at 28% empty body fat (EBF). Final shrunk weight at 28% EBF (AFBW) =  $(\text{EB weight} + [28 - \text{EBF}\%] \times 19) / .891$ , and final shrunk weight (FSBW) adjusted to equal the standard reference animal (EQSW) is  $(467 / \text{AFBW}) \times \text{FSBW}$ .

The equations developed from the data described in Table 2 to predict CF%, YG and BRY are shown below.

1. From carcass measurements,  $\text{CF}\% = -4.93 + .781\text{FT} + .0935\text{EQSW} - .000045\text{EQSW}^2$  ( $R^2 = .96$ ). This equation predicted CF% in the CU and

MSU data sets with an  $R^2$ , bias, and  $S_{y.x}$  of .95, 3% and .02 and .91, 3%, and .03, respectively (Figure 1).

- From carcass measurements,  $\text{YG} = 4.38 + .991\text{FT} - .2\text{LMAKg} + .000639\text{EQSW}$  ( $R^2 = .93$ ). This equation predicted YG in the CU and MSU data sets with an  $R^2$ , bias, and  $S_{y.x}$  of .94, 3%, and .02 and .86, 6%, and .04, respectively (Figure 2).
- When ultrasound measures are used, FT is  $.0351 + .904\text{FTU}$  ( $R^2 = .82$ ; Figure 3) and LMAKg is  $(6.83 + .908\text{LMA}) / (\text{FSBW}/100)$  ( $R^2 = .79$ , Figure 3). When FTU and LMAU predicted from the ultrasound equations are used in equations 1 and 2, CF% and YG in the CU data set were predicted with an  $R^2$ , bias, and  $S_{y.x}$  of .95, 3%, and .02 and .71, 0%, and .05, respectively (Figure 4).
- $\text{BRY} = .389 + .00672\text{FT} + .00579\text{LMAKg} - .000038\text{EQSW}$  ( $R^2 = .35$ ). When FTU and LMAU are used in equation 4,  $R^2$  is .30.

Equations were developed to predict CW in live cattle varying in body size as they progress during the feeding period and were validated with all three data sets.

- Equivalent empty body weight (EQEBW) =  $.891\text{EQSW}$  (NRC, 1984).
- Equivalent carcass weight (EQCW) =  $(\text{EQEBW} - 30.3) / 1.36$  (Garrett and Hinman, 1969).
- CW proportion (CWP) =  $\text{EQCW} / \text{EQSW}$ .
- Predicted CW =  $\text{CWP} \times \text{SBW}$ .

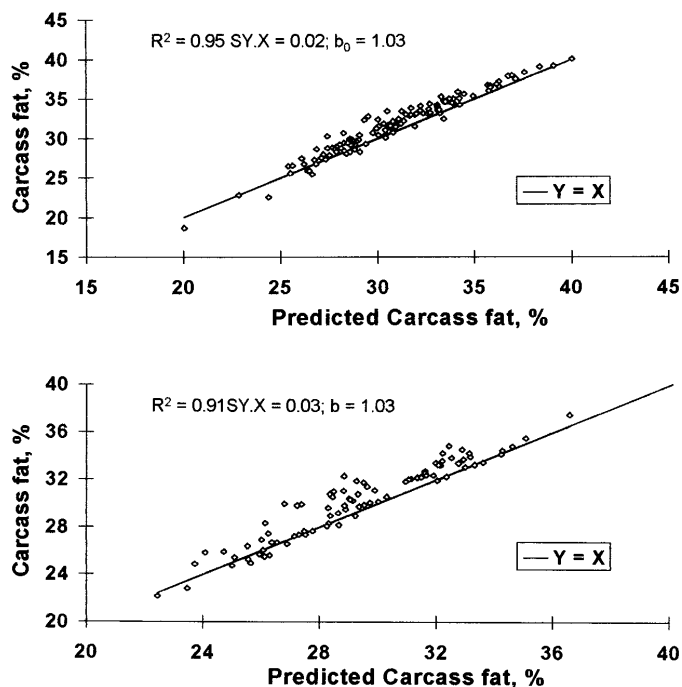


Figure 1. Validation with Cornell University (top) and Michigan State University (bottom) databases of Carcass fat percentage predicted from carcass fat thickness depth and equivalent shrunk live body weight.

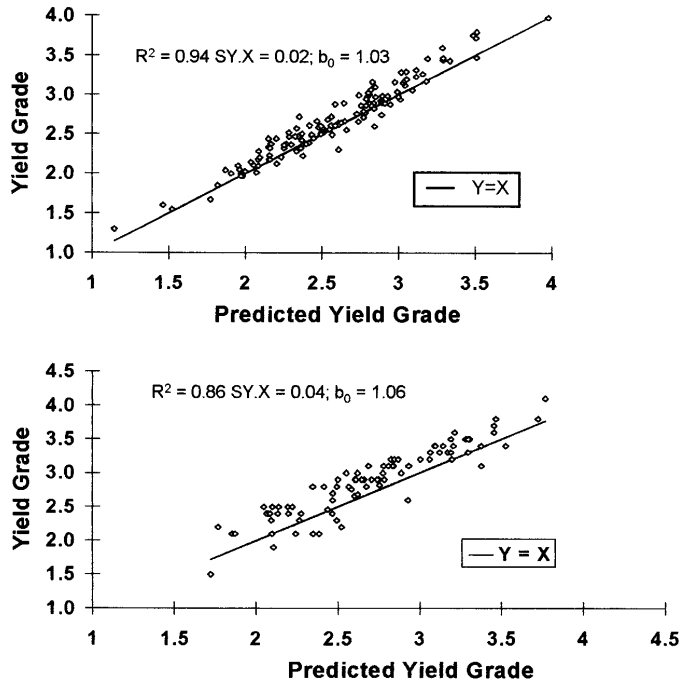


Figure 2. Validation with Cornell University (top) and Michigan State University (bottom) databases of Yield grade predicted from carcass fat thickness, longissimus area and equivalent shrunk live body weight.

These equations predicted CW in the two CU and the MSU data sets with an  $R^2$  and bias of .84 and 0%, and .83 and 1%, and .88 and 3%, respectively (Figure 5, top, middle, and bottom, respectively).

### Applications

The equations we developed, along with other published equations (NRC, 1984; Fox et al., 1992; Tylutki et al., 1994; NRC, 1996), can be used to predict carcass composition and feed requirements of individual steers varying widely in body size. The objective is to predict carcass and empty body composition so that incremental cost of gain, quality, and yield grade can be predicted as steers progress during the feeding period to determine the point of optimum profitability (sale point).

1. Predict EQSW (Fox et al., 1992; Tylutki et al., 1994);  $AFBW = (EBW + ((28 - EBF\%) \times 19)) / .891$ ;  $EQSW = SBW(467/AFBW)$ .
2. Predict NEg required and FFG from ADG, EQSW and diet NEg (Fox et al., 1992; NRC, 1996);  $RE = .0635 EQEBW^{.75} EBG^{1.097}$ ; EQEBW is  $.891EQSW$ .  $FFG = RE/diet NEg$ .
3. Predict NEM required and FFM from NEM required and diet NEM, which can be calculated as described by Fox et al. (1992) and NRC (1996). The NEM and NEg values to use in the system to

predict FFM and FFG should be developed in each feedlot with well-described historical data. This is accomplished by using this system to predict ADG on the historical data set, using actual DMI. The apparent feed NEM and NEg values are those resulting when adjusted (by changing diet TDN in the 1996 NRC model) until predicted and observed ADG agree. These apparent NE values will reflect feedlot feed processing and environmental and seasonal effects not accounted for in the system or any tabular values.

4. Individual DM required is FFM + FFG; Pen DM required is sum of individual DM required.
5. Adjusted individual DM required = Individual DM required  $\times$  (actual pen DMI/pen DM required).
6. Equivalent carcass weight (EQCW) =  $(EQEBW - 30.3)/1.36$  (Garrett and Hinman, 1969).
7. CW proportion (CWP) =  $EQCW/EQSW$ .
8. Predicted CW =  $CWP \times SBW$ , used to predict if CW is within minimum and maximum CW thresholds, and incremental cost of gain on a CW basis.
9. Predict FT from ultrasound;  $= .0351 + (.904FTU)$ .
10. Predict LMAkg from ultrasound;  $LMAkg = (6.83 + (.908LMAU))/(FSBW/100)$ . All ultrasound measurement equations should be developed for each individual operator to help minimize differences between operators and equipment, which will reduce the errors associated with ultrasound measurements.
11. Predicted YG;  $YG = 4.38 + .991FT - .2LMAUkg + .000639EQSW$ .

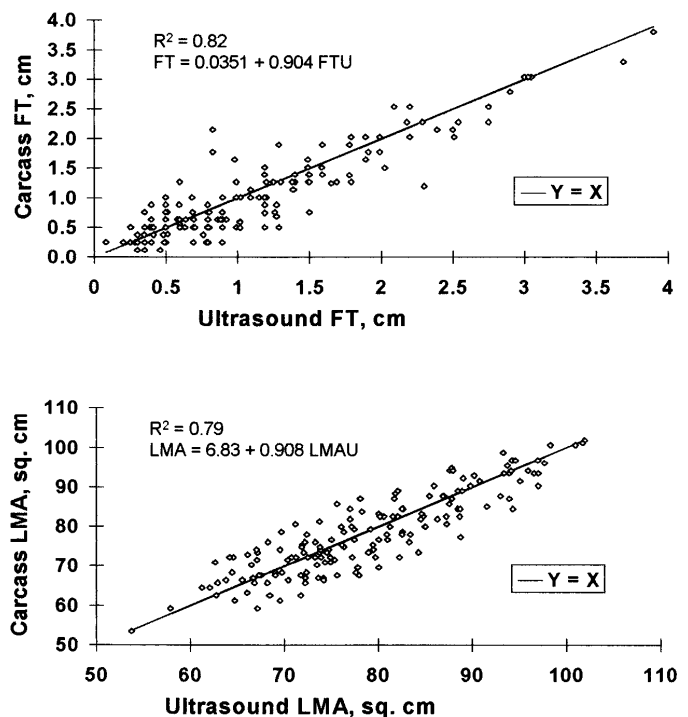


Figure 3. Carcass fat thickness (FT) and carcass longissimus area (LMA) predicted with ultrasound.

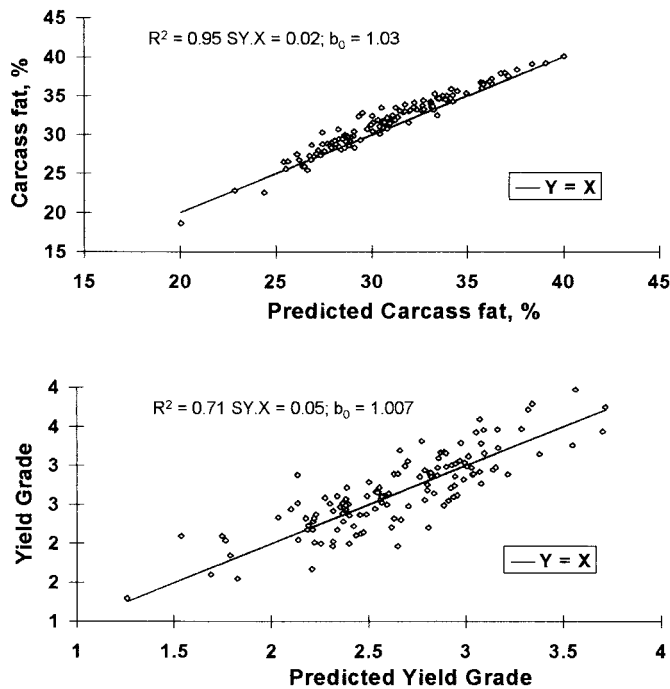


Figure 4. Top: Validation with Cornell University data base of carcass fat percentage predicted from ultrasound predicted carcass fat thickness and equivalent shrunk live body weight. Bottom: Validation with Cornell University data base of Yield grade predicted from ultrasound predicted carcass fat thickness depth and longissimus, and equivalent shrunk live body weight.

12. Predicted CF%;  $CF\% = -4.93 + .781FT + .0935EQSW - .000045EQSW^2$ .
13. Predicted quality grade (QG; Table 3); if  $CF\% < 21.0\%$ , QG = Standard; if  $CF\% \geq 21.0$  and  $\leq 31.1$ , QG = Select; if  $CF\%$  is  $\geq 31.1$  and  $\leq 33.7$ , QG = low Choice; if  $CF\% > 33.7$ , QG = average Choice.

Ultrasound attenuation correctly identified quality grade in 82% of the steers (data not shown).

To predict AFBW from carcass data for retrospectively computing cost of gain from actual carcass data:

1. Predict EBW;  $EBW = 1.316CW + 32.29$  (Garrett et al., 1978).
2. Predict EBF%;  $EBF\% = ((.351EBW + 21.6YG - 80.8)/EBW) \times 100$ ;  $R^2 = .82$ .
3. Predict AFBW;  $AFBW = (EBW + ((28 - EBF\%) \times 19))/.891$ .

To demonstrate the application of this system in accounting for differences in maintenance and growth requirements, Table 4 shows the results of these calculations applied to the data of eight (two each of Angus, Holstein, Simmental, and Angus  $\times$  Simmental) of the individually fed steers. The predicted average daily DM required is a function of main-

tenance (**FFM**, actual average body weight, breed type) and growth requirement (**FFG**, average EQSBW and ADG). The second Angus has a higher 28% EBF weight (508 vs 469 AFBW) and has a 14% higher daily feed requirement because of a larger average weight and higher ADG. However, these two Angus steers were at the same stage of growth because of nearly identical average EQSBW. The second steer is predicted to be in the Choice grade, while the first is predicted to be Select. Despite differences in body size, the two Holstein steers have a similar ADG and daily feed requirement; the higher SBW of the first Holstein and higher FFM is offset by the lower average EQSBW and FFG. The first Holstein is predicted to be low Choice grade, whereas the second must be fed longer to reach the Choice grade. The first Simmental has a higher DM requirement, because of both a higher body size and ADG,

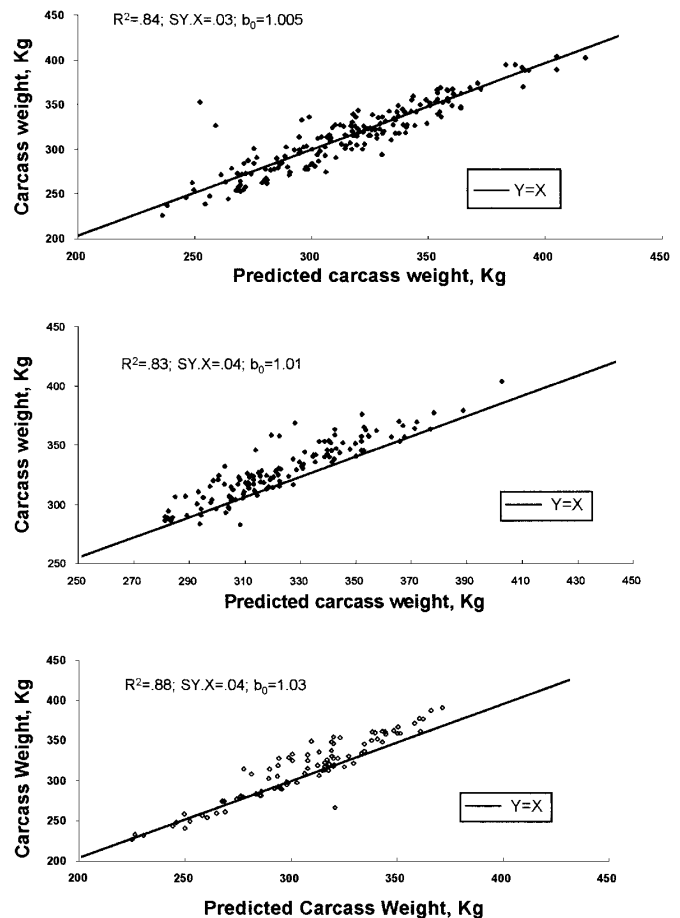


Figure 5. Top: Validation with Cornell University base equations database of carcass weight predicted from equivalent empty body and carcass weight equations. Middle: Validation with Cornell University database of carcass weight predicted from equivalent empty body and carcass weight equations. Bottom: Validation with Michigan State University database of carcass weight predicted from equivalent empty body and carcass weight equations.

Table 2. Description of data used to develop equations

Variable (n = 162)	Mean	Min	Max	SD
Days on feed	206	129	346	55
Final weight, kg	516	390	680	56
Carcass weight, kg	315	226	404	37
Estimated KPH %	2.24	1.00	4.00	.68
Fat thickness, cm	1.05	.13	3.81	.73
Longissimus area, cm <sup>2</sup>	78.4	53.5	102	10.3
Longissimus area/kg	15.3	11.0	21.4	2.20
Yield grade	2.71	.56	6.21	1.11
Marbling score <sup>a</sup>	5.65	3.0	9.5	1.24
Quality grade <sup>b</sup>	5.75	3.00	9.8	1.39
Carcass protein %	14.4	10.9	17.4	1.40
Carcass fat %	33.4	14.7	50.6	7.25
Fat trim, %	7.50	3.71	10.73	1.56
Bone, %	17.8	13.3	25.9	2.35
Lean trim %	6.5	.75	11.8	1.99
Boneless cut yield %	68.2	50.9	73.9	2.87

<sup>a</sup>3 = traces; 4 = slight; 5 = small; 6 = modest; 7 = moderate; 8 = slightly abundant; 9 = abundant.

<sup>b</sup>3 = Standard; 4 = Select; 5.0 = Choice-; 6.0 = Choice0; 7.0 = Choice+; 8 = Prime-; 9 = Prime0; 10 = Prime+.

despite being at an earlier stage of growth (EQSBW of 317 vs 366). This steer must be fed to 670 kg to reach low Choice grade; the second Simmental is predicted to be at Choice grade. The two crossbred steers have the highest daily feed requirements because they have the highest ADG. This group of eight steers consumed 14,971 kg of feed to date; the predicted DMI required is 15,155, or 98.79% of the predicted was consumed. This percentage multiplied by the predicted feed requirement gives the correct amount to charge against each steer.

The group-fed and individually fed animals in the CU studies, which were fed the same diet in the same environment at the same time, were used to test the system. The group-fed cattle were used to determine apparent diet NEm and NEg values, which were then used to predict DM required in those individually fed. The system accounted for 48% of the variation in actual DMI, with a 3% overprediction bias and  $Sy.x$  of .08 (Figure 6). The variation not accounted for was likely due to individual animal variation that the system cannot fully account for, including main-

tenance requirements, diet digestibility and metabolizability, and body composition. Predicted DM requirements contain all the accumulated errors in predicting each component. However, all the feed is allocated by multiplying the actual pen DMI by each animal's proportional share. Therefore, this system provides a method for allocating feed to individuals fed in a group on a biological basis, considering differences known to affect requirements (breed type, body size, and stage and rate of growth).

The predicted carcass as a percentage of shrunk weight can also be adjusted for local conditions by adding or subtracting the difference between predicted and observed values based on historical data. Using a constant of EBW/SBW of .891 based on NRC (1984), the equations presented to predict CW from EBW result in a range of carcass as a percentage of shrunk body weight from 54.1% at 218 kg to 60.7% at 523 kg at 28% EBF, which allows for adjustment for the increasing proportion of EBW that is CW as an animal approaches 28% EBF. This relationship between EBW and CW was similar in five different published studies

Table 3. Relationship of carcass and empty body fat to quality grade<sup>a</sup>

Number of pens	USDA quality grade <sup>b</sup>	Mean marbling score <sup>c</sup>	Mean carcass fat %	Mean empty body fat (EBF) %	EBF SD
4	3.5	4.2	21.0	18.8	.52
32	4.5	4.9	26.5	23.8	.74
47	5.5	5.9	31.1	28.1	1.29
14	6.5	6.1	33.7	30.5	1.30

<sup>a</sup>Data from Michigan State University and Cornell University trials described previously excluding pens averaging above modest marbling. Values in a row are means for that grade.

<sup>b</sup>Standard = 3 to 4; Select = 4 to 5; low Choice = 5 to 6; mid Choice = 6 to 7.

<sup>c</sup>3 = traces; 4 = slight; 5 = small; 6 = modest.

Table 4. Demonstration of system to predict feed requirements and carcass composition

Breed	Angus		Holstein		Simmental		Angus × Simmental crossbred	
IWT, kg	225	241	180	181	241	289	191	246
SBW, kg	451	580	595	493	596	549	455	533
Days on feed	185	234	318	234	234	185	157	178
ADG, kg	1.22	1.45	1.31	1.33	1.52	1.41	1.68	1.61
AFBW <sup>a</sup>	469	508	545	498	670	511	464	560
Avg ASBW, kg	347	374	362	339	456	400	328	403
Avg EQSBW, kg <sup>a</sup>	345	344	311	318	317	366	330	336
FFG, kg/d <sup>b</sup>	4.38	5.26	4.94	5.14	5.21	5.32	5.98	5.79
FFM, kg/d <sup>c</sup>	3.25	3.44	3.75	3.57	3.98	3.61	3.11	3.63
DM required, kg/d <sup>d</sup>	7.63	8.70	8.69	8.71	9.19	8.93	9.09	9.42
Total DM requirement, kg <sup>e</sup>	1,412	2,036	2,763	2,038	2,150	1,652	1,427	1,677
Share of DM fed <sup>f</sup>	1,395	2,011	2,730	2,013	2,124	1,632	1,410	1,657
EQCW, kg <sup>g</sup>	272	327	312	280	250	306	277	269
CW, kg <sup>h</sup>	273	356	364	299	359	335	276	322
FT, cm <sup>i</sup>	1.64	1.39	.48	.49	.57	.39	.57	.75
LMA kg <sup>2j</sup>	15.3	15.9	13.2	14.4	14.5	16.2	18.2	17.8
YG <sup>k</sup>	3.2	2.9	2.5	2.3	2.3	1.9	1.6	1.8
CF% <sup>l</sup>	29.3	33.2	31.4	29.1	26.6	31.0	28.9	28.3
QG <sup>m,n</sup>	4	5	5	4	4	5	4	4

<sup>a</sup>Predicted as shown in equation 1.

<sup>b</sup>Predicted as shown in equation 2.

<sup>c</sup>Predicted as shown in equation 3.

<sup>d</sup>Predicted as shown in equation 4.

<sup>e</sup>Predicted DMI required to date.

<sup>f</sup>Predicted as shown in equation 5, based on 14,971 kg actually fed and 15,155 kg DM required by the total of eight steers.

<sup>g</sup>Computed as shown in equation 6.

<sup>h</sup>Computed as shown in equations 7 and 8.

<sup>i</sup>Predicted as shown in equation 9.

<sup>j</sup>Predicted as shown in equation 10.

<sup>k</sup>Predicted as shown in equation 11.

<sup>l</sup>Predicted as shown in equation 12.

<sup>m</sup>Predicted as shown in equation 13.

<sup>n</sup>4 = Select; 5 = Choice—.

compared by Fox et al. (1976). In the equations presented in this article, a constant of .891 for EBW/SBW is used for all stages of growth, based on NRC (1984). In the studies of Fox et al. (1976) and Abdalla et al. (1988), EBW/SBW varied from 86 to 94% at an EBF of 10% to 92 to 96% at 28% EBF. Therefore, further adjustment of the prediction of EBW/SBW is needed for variations in gut fill, and historical database can be used for this purpose as described above.

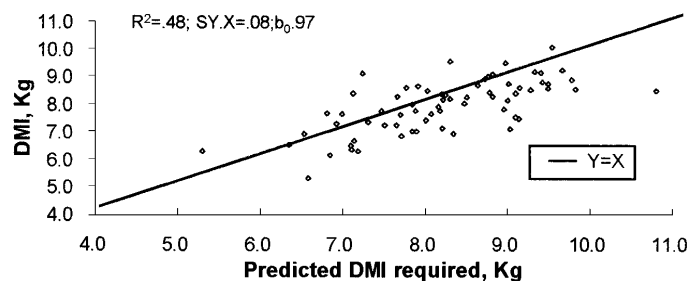


Figure 6. Validation of system to predict dry matter intake (DMI) requirements of individual cattle varying in body size and breed type.

However, we do not recommend changing the .891 factor to compute EBW from SBW and  $.956 \times \text{ADG}$  to compute EBW in the equation used to predict RE. Predicted RE was substituted for NE<sub>g</sub> in the equation used to predict ADG (Fox et al., 1992; NRC, 1996) to test for errors in interconversions between shrunk and empty body weight and shrunk and empty body ADG in predicting RE or ADG. The equation to predict ADG uses EQSBW and  $(\text{DMI} - \text{FFM}) \times \text{diet NE}_g$  to predict net energy available for gain (NEFG). When this is done, predicted and observed ADG agreed for each group in the CU data set. Therefore, these two equations are internally consistent when .891 is used to interconvert between SBW and EBW and .956 is used to interconvert between ADG and EBADG.

## Implications

A system is presented that provides a method for allocating feed to individuals fed in a group on a biological basis, considering differences known to affect requirements (breed type, body size, and stage and rate of growth). This, along with equations developed to predict carcass weight and compositional

changes during growth, can be used to market cattle on an individual basis at the optimum time, considering incremental cost of gain and carcass weight and composition discounts.

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