PREDICTING QUALITY GRADE AND CARCASS VALUE IN EARLY-WEANED SIMMENTAL STEERS USING A COMBINATION OF A DNA MARBLING MARKER, EXPECTED PROGENY DIFFERENCES, ULTRASOUND, AND LIVE EVALUATION

C.B. Rincker, N.A. Pyatt, L.L. Berger, and D.B. Faulkner
University of Illinois at Urbana-Champaign

SUMMARY

Early-weaned Simmental steers (n = 175, ¾ Simmental or greater) of known genetics were individually fed over a four-year trial period to determine if a DNA marbling marker (GeneSTAR® , Australia), real-time ultrasound, EPDs, live evaluation, or a combination can accurately predict carcass composition. Steers were fed a common, high concentrate diet for 249.7 ± 0.7 d and harvested at 423.3 ± 1.4 d of age. Real-time ultrasound (RTU) scans were recorded for ribeye area (REA), intramuscular fat (IMF), and backfat (BF) each taken four times at 60 d intervals with final ultrasound scans taken < 13 d prior to harvest. Yearling weight (YW), marbling (MARB), percent retail cuts (PRC), and carcass weight (CW) EPD’s were calculated for each steer. Visual animal evaluations were made at < 7 d of harvest by three evaluators to estimated quality (QG) and yield grade (YG). Five-year average priced data were used for dressed beef, grid premiums, and discounts. GeneSTAR® marbling marker frequencies 0-STAR (n = 47), 1-STAR (n = 95), and 2-STAR (n = 33) did not affect marbling score (MS), chemically determined IMF%, QG, or percent Low Choice or higher (P > 0.10). Genetic, live, and carcass parameters were regressed on chemical IMF, dressed price, and profit using step-wise regression analysis. For chemical IMF, 67.0% of the variation was explained by RTU QG (R² = 0.585), MARB EPD (R² = 0.028), PRC EPD (R² = 0.030), MARB (R² = 0.028), Live YG (R² = 0.017), and GeneSTAR® Marbling Test (R² = 0.011) indicating that RTU was the only major contributor. Approximately 17% of the variation in average dressed price was explained by RTU QG (R² = 0.148) and MARB EPD (R² = 0.025). Live YG estimate was highly (P < 0.05) correlated to harvested BF (r = 0.23), and REA (r = 0.32); however, there was no relationship (P > 0.10) between live QG and MS. GeneSTAR® marbling marker was not an efficacious indicator for carcass composition of early-weaned Simmental steers. By using the combination of RTU, EPDs, and live evaluation, producers can accurately predict carcass value.

Key Words: DNA marbling test, gene marker, ultrasound, live evaluation, EPD, early-weaned.
INTRODUCTION

The ability to sort cattle and predict their carcass composition accurately is of increasing importance as more cattle are priced on a grid system. Currently, there are several tools available to help producers accomplish this goal. Expected Progeny Differences (EPDs), ultrasound, live evaluation, and genetic markers are among the most common. By using one, or a combination of these tools, a feedlot manager can predict which marketing grid (e.g. quality grade (QG) or yield grade (YG) emphasis) that would most be the most beneficial based on the estimated harvested composition. Producers could use this information to feed cattle according to their genetic predisposition on marbling and market individual animals based on the QG-YG combination that would generate the most premiums.

Subjective visual appraisal has been used as the principal method of evaluating differences in backfat (BF) of feedlot cattle. Research completed by Warren et al. (1959), Gregory et al. (1964), Brackelsberg et al. (1967), Lewis et al. (1969), and Crouse and Dikeman (1974) suggested that this was an effective preharvest methodology; however it is more difficult for live evaluators to estimate intramuscular fat (IMF) deposition.

Real-time ultrasound (RTU) may be the most accurate tool currently available to predict IMF. Ultrasonics, first reported by Wild (1950), is an accurate aid in estimating carcass composition (Cross and Whittaker, 1992; Houghton and Turlington, 1992; Whittaker et al., 1992; Herring et al., 1994; Shepard et al., 1996).

From a genetic standpoint, nearly all cattle breed associations offer EPDs, but some (such as the American Simmental Association) have accumulated enough data to calculate values for carcass information (e.g. marbling, percent retail cuts, tenderness, carcass weight).

Recent research (Barendse 1997, 2003; Jackwood and Fluharty, 2001; Tracey et al., 2001; Buchanan et al., 2002; McPeake, 2003; Hale et al., 1998; Geary et al., 2003; Bierman et al., 2003) has suggested that genetic markers may be an effective tool to sort cattle according to their ability to marble. There are several genes that affect IMF deposition, but no single one of them is the omnipotent “master marbling gene.” Identification, however, of certain alleles for a specific animal or herd sire may be invaluable for the producer.

There has been some preliminary work done in the area of profit indices. Wilton and Goddard (1996) established a profit equation to compare the effect of controlling age at harvest, weight at harvest, or fat depth at harvest with standard economic variables. Similarly, work by Herring et al. (2000) pooled data from the 1996, 1997, and 1998 Angus Sire Alliance birth weight, weaning weight, marbling, and yield grade EPDs combined with post-weaning average daily gain (ADG) to calculated an relative
economic value (REV) EPD for each trait. The authors found a difference of $42.29 profit per progeny between the highest and lowest rankings of REV.

MATERIALS AND METHODS

Animals. Animals used in this trial were managed according to the guidelines recommended in the Guide for the Care and Use of Agriculture Animals in Agriculture Research and Teaching (Consortium, 1988). Early-weaned Simmental steers (n = 192, ⅔ Simmental or greater) of known genetics were individually fed over a four-year trial period to determine effectiveness of genetic marbling markers, ultrasound, live evaluation, and EPD’s, by themselves or in combination, to predict carcass composition. Correlations were made among GeneSTAR® Marbling test results to marbling score (MS), chemical intramuscular fat percentage (IMF%) deposition, EPDs, ultrasound scans, live evaluation, and economic calculations. Data from these DNA markers was also used to test the efficacy of using GeneSTAR® marbling test as a sorting management tool. Calves were a result of AI matings between registered Simmental sires (n = 20) and dams. Steers were born at the Orr Beef Research Center in Baylis, Illinois.

Expected Progeny Differences. The American Simmental Association (ASA) provided sire and maternal grandsire EPDs for yearling weight (YW), marbling EPD (MARB), percent retail cuts (PRC), carcass weight (CW) allowing EPD calculations to be made for each steer via Herd Handler® (EPDs last updated January 9, 2004). The mean EPD’s calculated were: YW, 56.4 (range 17.8 to 88); MARB, 0.04 (range -0.12 to 0.25); PRC, -0.03 (range -0.41 to 0.32); and CW, 10.23 (range -22.2 to 34.3) (Table 2). Spring 2004 breed averages reported by the ASA were: YW (56.6), MARB (0.05), PRC (-0.01), CW (-0.8). With the exception of CW, our steer population was near breed average for their EPD profile.

Management and Diets. Steers were weaned at 88.0 ± 1.1 d (Table 3) and fed a high concentrate diet for 84.5 ± 0.4 d prior to entering the feedlot. Steers were shipped to Illinois State University Research Farm located in Normal, Illinois and were randomly allotted to one of 12 pens (four head per pen) so that pen weights were similar. Steers were individually fed using the Calan® (American Calan, Northwood, NH) electronic gate system. Steers were subsequently fed a 90% concentrate finishing diet (Table 1) that was balanced to provide 15.5% crude protein, 0.57% calcium, and 0.38% phosphorus. Calves were implanted with Synovex® C (100 mg progesterone and 10 mg estradiol benzoate, Fort Dodge Animal Health, Fort Dodge, IA) at weaning, followed by Synovex® S (200 mg progesterone and 20 mg estradiol benzoate, Fort Dodge Animal Health, Fort Dodge, IA) and then implanted with Revalor® S (120 mg trenbolone acetate, 24 mg estradiol, Intervet, Inc., Millsboro, DE) approximately 120 d prior to harvest. Cattle were fed for 249.7 ± 0.7 d and harvested at 423.3 ± 1.4 d of age.

Performance Analysis. Steer weights were taken every 28 days throughout the finishing period to calculate ADG. Dry matter intake (DMI) and feed refusals were recorded on a daily basis. Gain and feed efficiency (expressed as gain to feed (G:F)) were calculated based on carcass adjusted final weights. Adjusted final weight was calculated by
dividing hot carcass weight (HCW) by the average dressing percent. In Year 3, one steer was removed from trial as a result of illness. In Year 4, two steers died during the feeding period, and one steer was harvested early due to injury.

**Ultrasound.** Real-time (linear array) ultrasound was used to monitor IMF and BF deposition over the course of the feedlot-finishing period. Aloka® 500V ultrasound equipment (Aloka, Wallingford, CT) with an Aloka® UST-5049-3.5 transducer was used to record an image of the *longissimus dorsi* (LD) area, or ribeye area (REA), IMF, and BF between the 12th and 13th rib. Images were interpreted using the CVI Scan Session Reporting Version 6.2b software in combination with Rib-O-Matic Version 3.5 software (Critical Vision, Atlanta, GA). Ultrasound measurements were recorded four times during the feedlot phase at 60 d. Real-time ultrasound-predicted quality grade (RTU QG) and yield grade (RTU YG) were calculated according to scanned images. The fourth and final ultrasound scans were taken between 3 and 13 d prior to harvest each year.

**Live Evaluation.** Live carcass evaluation was completed in Year 3 and 4 of the trial within 7 d of harvest by three evaluators. Live estimates were made for YG to the nearest tenth and QG to the nearest third grade by qualified experts. Evaluators were aware of the carcass data for the previous two years. The three experts estimated the cattle independently and did not collaborate.

**Carcass Data Analysis.** Steers were harvested at a commercial processing facility. Steers were stunned via captive bolt pistol and exsanguinated. Hot carcass weights (HCW) were taken on the day of slaughter. Measurements were also taken for BF, kidney, pelvic, and heart fat (KPH) percentages, bone maturity scores, and MS by trained university personnel. After carcasses had hung at -4°C for 24 h, chromatography paper was used to make an image of the LD muscle for each steer, and grid measurements were taken. Quality grade was established based on subjective marbling scores. Yield grades were calculated using the formula $[2.5 + 2.5(\text{inches of BF}) + 0.20(\text{percent of KPH}) + 0.0038(\text{lb. of HCW}) – 0.32(\text{square inches of REA})]$ as reported by Taylor (1994).

**Longissimus Dorsi Samples.** Thin (0.25 cm) slices of the LD muscle were removed from the left side of each steer at the 12th – 13th rib interface following carcass data collection to verify percent intramuscular fat (IMF%). Subcutaneous fat surrounding the muscle was removed prior to homogenization. Ten-gram duplicate samples were dried and repeatedly washed with chloroform:methanol in accordance with the procedures of Riss et al. (1983). Extraction values were used to verify grader-called MS as described by Brackebusch et al. (1991).

**DNA Analysis.** Blood (Year 1 and 2) and hair (Year 3 and 4) DNA samples were used by Genetic Solutions Pyd Ltd (Australia) for GeneSTAR® marbling analysis. Cattle were designated 0-STAR, 1-STAR, or 2-STAR based on how many copies of the specific allele was present (0, 1, and 2, respectfully).
Economic Analysis. Five-year price data were collected for feedstuffs (1997-2002) (Table 1), dressed beef (1997-2002), and grid premiums and discounts (1998-2003) (Table 5) to standardize economic condition across the trial. Feed ingredient prices for corn, soybean meal, alfalfa hay, trace mineral salt and molasses (Table 1) were collected from the annual commodity reports (National Agriculture Statistics Service (NASS), 2003). An average dressed price of $110.67/ 45.4kg was used (Cattle-Fax, 2003). Average premiums and discounts (Table 5) were provided by the USDA (2003) and combined with the base price. Subsequently, carcass value was calculated for each animal using actual carcass weight, and associated premiums and discounts for carcass merit. Predicted carcass value was calculated using predicted carcass weight, and ultrasound-predicted carcass merit. Carcass value was calculated on a per 45.4 kg and for total carcass value (Table 6). Similar carcass value and profit predictions were made using the fourth ultrasound scans and for each live evaluator based on quality and yield grade estimates not accounting for weight discounts. Input costs included feed cost, annual cow costs ($327.77/hd; Miller et al., 2001), veterinary/medical and labor ($35/hd), feed markup ($22/ metric ton), yardage ($0.25/hd per d) (Pastoor, 2003) and interest (10%). Profit per steer is defined as the difference between carcass value and total input costs (Table 6). Profit was calculated both on a per 45.4 kg basis and carcass basis based on the actual carcass composition, ultrasound prediction, and live estimations.

Statistical Analysis. Differences among the means of performance, carcass, and laboratory parameters for three marker genomes comparisons were evaluated using the PROC MIXED procedure of Statistical Analysis System (SAS Inst. Inc., Cary, NC) with individual animal as the experimental unit. Independent variables of ADG, G:F, QG, YG, UI QG, UI YG, MS, YW, MARB, PRC, CW, RTU YG, RTU QG, Live YG, Live QG, and chemical IMF% were correlated with GeneSTAR® marbling test. Year was analyzed as a fixed affect in the model.

In addition, differences in percent low Choice and average Choice or better that resulted from genome comparisons were separated using the Chi-Squared analysis of GENMOD. PROC REG was also run for stepwise regression analysis. Independent variables of YW, MARB, PRC, CW, GeneSTAR® marbling marker, ultrasound scan estimates (third and fourth) for YG and QG, and average live evaluation for YG and QG were each modeled against the UI QG, IMF%, actual per hundred weight dressed price, actual carcass price, and actual profit.

Also, simple correlation coefficients were calculated using PROC CORR with the following variables: YW, MARB, PRC, CW, GeneSTAR®, fourth ultrasound scans for YG and QG, average live estimates for YG and QG, BF, REA, MS, KPH, UI YG, USDA YG, UI QG, and USDA QG.
RESULTS AND DISCUSSION

GeneSTAR® Marbling Marker Analysis. There was a bell-shaped distribution among 0-STAR, 1-STAR, and 2-STAR populations at 47, 95, and 33 individuals, respectfully. This study had a higher percentage of 2-STAR cattle than studies reported by Genetic Solutions (GeneNOTE, 2002ab, 2003). When modeled against EPDs available from the ASA, there no differences among genomes for MARB EPD (Table 7) nor was a correlation ($P > 0.10$) was found between GeneSTAR® marbling test and MARB (Table 18). This result may be due to the fact that MARB is polygenic and the GeneSTAR® marbling test only accounts for one gene. However, there was a linear increase ($P < 0.10$) between 1-STAR and 2-STAR genomes for both YW and linear increase among the three genomes with CW (Table 7). There was a ($P < 0.05$) correlation among the marker analysis and CW ($r = 0.27$) (Table 18). The reason for the increase in growth and carcass size due to a marbling marker is unclear. Alternatively, there were a linear decrease ($P < 0.05$) in PRC EPD between 0-STAR and 2-STAR populations (Table 7) and a very strong ($P < 0.0001$) negative correlation was found between GeneSTAR® marbling test and PRC ($r = -0.81$) (Table 18). This data is interpreted to suggest that selecting for marbling using the GeneSTAR® marbling test may also reduce retail yield.

When GeneSTAR® marbling test were analyzed against performance parameters, there no differences ($P > 0.10$) among final live weight, DMI, or ADG (Table 8). However, there was a trend ($P < 0.10$) for a quadratic effect of 0-STAR, 1-STAR, and 2-STAR populations (Table 8). The improved feed efficiency for 1-STAR is unexplained. In addition, GeneSTAR® marbling test was not correlated ($P > 0.10$) to ultrasound estimates for yield or quality grade (Table 24).

GeneSTAR® marbling marker had little effect on carcass composition. There were no differences ($P > 0.10$) among 0-STAR, 1-STAR, and 2-STAR populations with marbling scores or chemically determined percent IMF (Table 9). There were no differences ($P > 0.10$) among the three genomes for QG determined by USDA or UI grader (Table 9). Likewise, there were no differences ($P > 0.10$) in percent Low Choice or percent Average Choice or better (Table 9). No correlations ($P > 0.10$) among GeneSTAR® results and final BF, REA, KPH, or MS (Table 30) or with USDA YG, UI YG, USDA QG, and UI QG (Table 26). Genetic Solutions (2002ab, 2003) likewise did not find differences among genomes for BF, REA, or KPH, but the authors did find a linear increase in MS and QG. However, their results were not statistically analyzed and were used with traditionally weaned cattle. These non-significant differences may be a result of the early-weaned management system that allowed high levels of marbling deposition across all these alleles.

Ultrasound. Fourth ultrasound scan estimates were found to be an excellent indicator for quality and yield grade estimates, carcass value, and predicted profit (Table 10). The estimated YG and QG from the ultrasound scans were close to the actual YG and QG values for the USDA and University of Illinois evaluators (Table 11). RTU scans tended to slightly underestimate IMF. These YG and QG estimates were used to calculate an average dressed price of $111.04 per 45.4 kg (Table 10) by using the five-year average
for quality and yield grade premiums and base price of $110.67 (Cattle-Fax, 2003). On a $/45.4 kg carcass basis, the average deviation between the RTU estimate and actual was only $0.51 (Table 11) indicating that ultrasound scans can be a good predictor of average carcass value.

When comparing ultrasound scans and EPDs, the RTU QG estimate was correlated \( (P < 0.0001) \) to MARB \( (r = 0.36) \) (Table 19) suggesting that MARB is an accurate predictor of IMF deposition. There were no differences \( (P > 0.10) \) among RTU YG and YW, MARB, PRC, and CW EPD’s (Table 19).

The RTU estimate for QG was found to be very highly correlated \( (P < 0.0001) \) to MS \( (r = 0.54) \) (Table 27) indicating that ultrasound was highly associated to marbling. Similarly, RTU QG scan was correlated \( (P < 0.05) \) to KPH \( (r = -0.13) \) and REA \( (r = -0.30) \) (Table 27) demonstrating that cattle with higher quality grades were also cattle with smaller ribeye areas. In addition, the RTU QG estimate was very highly correlated \( (P > 0.0001) \) with QG as determined by USDA \( (r = 0.55) \) or UI \( (r = 0.53) \) (Table 28). The RTU YG estimate was also highly \( (P < 0.001) \) correlated with BF \( (r = 0.50) \) (Table 27) as well as USDA YG \( (r = 0.19; P < 0.10) \) and UI YG \( (r = 0.21; P < 0.0001) \) (Table 28).

Ultrasound estimated YG and QG were highly correlated \( (P < 0.01) \) to each other \( (r = 0.29) \) (Table 19, 23, 26-28) demonstrating the relationship between yield and quality grade. In addition, RTU YG was very highly correlated \( (P > 0.0001) \) with live YG \( (r = 0.43) \) and live QG \( (r = 0.44) \) (Table 28) indicating the relationship between the human eye and real-time ultrasound technology.

*Live Evaluation.* Three qualified live evaluators estimated the yield and quality grades of Year 3 and Year 4 cattle and economic calculations were made according to those estimates (Table 10). Estimated QG and YG were not different \( (P > 0.10) \) among the three evaluators. For yield grade estimates (based on BF and REA estimate only), the three evaluators each averaged YG estimates at 2.90, 2.86, and 2.45 (Table 10). The average of those three \( (2.73) \) only deviated from the USDA YG by 0.83 and actual UI YG estimate by -0.08 (Table 11). Likewise, there was little variation for QG estimates (Table 16) and the average only deviated from the actual USDA QG by 0.02 and the UI QG by -0.19 (Table 11). Notably, the three live evaluators did have prior knowledge of the previous years YG and QG for with this particular group of early-weaned cattle; nonetheless, they accurately estimated both YG and QG. The average live YG and QG estimates were both correlated \( (P <0.05; P < 0.10) \) to MARB EPD \( (r = -0.22; r = 0.18) \) (Table 18). This study had similar results found in May *et al.* (2000) where live evaluation was found to be an accurate indicator for YG and QG.

As expected from the yield and quality grade estimates, the average predicted estimated price per 45.4 kg ($109.88) (Table 10) only underestimated the actual price by $1.16 and carcass price by $9.96 (Table 11). On a profit per head basis, average live estimate overestimated profit by $42.69 (Table 11) showing that qualified live evaluations can be an accurate judge for economic advantages based on YG and QG estimates.
The average of the live evaluators for YG and QG were highly correlated \((P < 0.001)\) with ultrasound scans for YG \((r = 0.39; r = 0.37)\) (Table 26). RTU QG estimates were not correlated \((P > 0.10)\) to live evaluation (Table 26). Live YG estimate was found to be highly \((P < 0.05)\) correlated to actual BF \((r = 0.23)\), REA \((r = 0.32)\), and KPH \((r = 0.27)\) (Table 29). Live YG tended \((P < 0.10)\) to be correlated to UI YG estimate (Table 36). Similarly, live QG estimate were correlated to BF \((r = 0.24; P < 0.05)\), REA \((r = 0.17; P < 0.10)\), and KPH \((r = 0.27; P < 0.05)\) (Table 29) and UI YG \((r = 0.21; P < 0.05)\) (Table 30). Neither live YG or QG estimates were correlated \((P > 0.10)\) with actual MS (Table 29).

**Expected Progeny Differences.** There were no differences \((P > 0.10)\) between MARB and GeneSTAR® Marbling Test (Table 7) as we would have expected. Since there are several genes that affect marbling, this suggests that the individual allele polymorphisms may have no relationship to overall genetic predisposition for marbling.

EPDs can be a useful tool for carcass composition prediction. As anticipated, MARB was found to be highly correlated \((P < 0.01)\) with MS \((r = 0.36)\) (Table 20). Similarly, MARB was also found to be correlated to the USDA YG \((r = 0.22)\) \((P < 0.05)\), USDA QG \((r = 0.37)\) \((P <0.01)\), and UI QG \((r = 0.31)\) \((P < 0.05)\) (Table 21). PRC was not correlated \((P > 0.10)\) with BF or KPH (Table 20), but was correlated \((P < 0.10)\) to USDA QG \((r = 0.21)\) (Table 21).

**Step-wise regression.** Statistical step-wise regression was analyzed for a variety factors including: UI QG, IMF%, dressed 45.4 kg price, total carcass value, and total profit. For the QG, the fourth ultrasound scan was found to be the largest contributor explaining 31.2% of the variation and second was MARB explaining 4.0% of the variation (Table 12). This data suggests that ultrasound QG estimate is an accurate predictor of harvested QG.

The chemically determined IMF% may be a less variable estimate of QG than UI QG because human subjective evaluation is eliminated. Again, the RTU QG estimate was the primary indicator explaining more than 58% of the variation \((R^2 = 0.585)\) (Table 13) reiterating that ultrasound accurately analyzes marbling deposition. Explaining much lower percent of the variation in IMF% were the following factors: PRC \((R^2 = 0.030)\), MARB \((R^2 = 0.028)\), average live YG \((R^2 = 0.017)\), and GeneSTAR® Marbling Test \((R^2 = 0.011)\) (Table 13). GeneSTAR® was the only marker of the three DNA tests that explains variation in IMF%; however, this marker was not a major contributor \((P = 0.13)\) in IMF determination.

The same determinations were made for carcass value both on a $/45.4 kg and total carcass weight basis. Once again, RTU QG explained 14.8% of the variation and MARB explained 2.5% (Table 14) of the variation of dressed price on a $/45.4 kg basis. In this case though, MARB was not a contributor \((P = 0.13)\). Alternatively, when evaluated on a total carcass price, RTU YG explained 20.5% of the variation (Table 15) as opposed to RTU QG (Table 20). Other contributions to carcass price included: average live YG \((R^2 = 0.043)\), yearling weight EPD \((R^2 = 0.034)\), marbling EPD \((R^2 = 0.033)\), and
GeneSTAR® Marbling Test ($R^2 = 0.021$) (Table 15). Since these cattle were purposely fed past their terminal endpoint and no weight discounts were taken into account for our calculations, growth and cutability played the primary role in carcass price determination. If weight discounts were accounted for, RTU QG, live QG, and MARB would have been larger contributors to carcass price variation.

Finally, step-wise regression analysis was to predict total profit. Marbling EPD explained only 2.9% of the variation (Table 16) but was not found to be a contributor ($P = 0.13$) to profitability. Due to the high accuracy of ultrasound, we would have predicted both the RTU quality and yield grade estimates to be major contributors. Animal models that include performance, carcass, and cost parameters would more likely account for a major part of the remaining variation in profit.

Collectively, ultrasound was the primary indicator for QG, IMF%, and dressed carcass price (Tables 12-16). No DNA markers were contributors ($P > 0.10$) to quality grade (Table 12), chemically determined intramuscular fat percentage (Table 13), dressed price on a $/45.4$ kg basis (Table 14) or total carcass price (Table 15). Likewise, marbling EPD was only minor contributor to QG, IMF%, dressed price on a $/45.4$ kg basis, carcass price, and profit (Tables 12-16).

**IMPLICATIONS**

In the modern beef economy, with increasing emphasis on individual carcass merit, more effective sorting can lead to increased efficiency and profits. Ultrasound scans and live evaluation prior to harvest were the most accurate methods to predict carcass composition, yield and quality grades. Expected Progeny Difference’s, for growth and carcass values, can also be useful tools for performance and carcass merit analysis. In this particular management scenario with early-weaned Simmental steers, genetic markers for marbling or fat deposition were not found to be an accurate method for quality grade prediction. Using the combination of ultrasound, live evaluation, and marbling Expected Progeny Difference less than two-weeks prior to harvest is a useful means of accurately predicting quality grade, carcass value, or profit.
LITERATURE CITED


Table 1. Diet composition and price of finishing diet for early-weaned Simmental steers

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent of Diet</th>
<th>Average Price&lt;sup&gt;ab&lt;/sup&gt;, $/909.1 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracked corn</td>
<td>67.9</td>
<td>88.0</td>
</tr>
<tr>
<td>Soybean meal&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.8</td>
<td>55.0</td>
</tr>
<tr>
<td>Corn silage</td>
<td>9.9</td>
<td>193.6</td>
</tr>
<tr>
<td>Molasses</td>
<td>4.9</td>
<td>17.6</td>
</tr>
<tr>
<td>Trace mineral salt</td>
<td>0.5</td>
<td>220.0</td>
</tr>
<tr>
<td>Calcium Carbonate</td>
<td>1.0</td>
<td>66.0</td>
</tr>
<tr>
<td>Rumensin&lt;sup&gt;®&lt;/sup&gt; mineral supplement</td>
<td>2.0</td>
<td>220.0</td>
</tr>
</tbody>
</table>

<sup>a</sup>Five year average cost from 1998-2002 (NASS, 2003).
<sup>b</sup>Dry Matter Basis
<sup>c</sup>46.5% protein

Table 2. Means, standard deviations (SD), minimum and maximum values of Expected Progeny Differences<sup>a</sup> (EPDs)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling Weight EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>59.74</td>
<td>14.81</td>
<td>17.80</td>
<td>88.00</td>
</tr>
<tr>
<td>Marbling EPD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.10</td>
<td>0.09</td>
<td>-0.15</td>
<td>0.34</td>
</tr>
<tr>
<td>Percent Retail Cuts EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.03</td>
<td>0.14</td>
<td>-0.41</td>
<td>0.32</td>
</tr>
<tr>
<td>Carcass Weight EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.23</td>
<td>11.84</td>
<td>-22.20</td>
<td>34.30</td>
</tr>
</tbody>
</table>

<sup>a</sup>Provided by the American Simmental Association database on January 9, 2004

Table 3. Means, standard deviations (SD), minimum and maximum values of performance parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Weight, kg</td>
<td>44.1</td>
<td>6.4</td>
<td>27.3</td>
<td>66.8</td>
</tr>
<tr>
<td>Age at Weaning, d</td>
<td>88.0</td>
<td>15.6</td>
<td>41.0</td>
<td>126.0</td>
</tr>
<tr>
<td>Weaning Weight, kg</td>
<td>127.3</td>
<td>20.2</td>
<td>72.7</td>
<td>188.6</td>
</tr>
<tr>
<td>Starting Weight, kg</td>
<td>246.3</td>
<td>30.7</td>
<td>145.5</td>
<td>316.4</td>
</tr>
<tr>
<td>Final Weight, kg</td>
<td>657.4</td>
<td>57.5</td>
<td>507.5</td>
<td>759.1</td>
</tr>
<tr>
<td>Days on Feed, d</td>
<td>249.7</td>
<td>9.6</td>
<td>229.0</td>
<td>259.0</td>
</tr>
<tr>
<td>Dry Matter Intake, kg/d</td>
<td>8.82</td>
<td>1.23</td>
<td>6.13</td>
<td>11.60</td>
</tr>
<tr>
<td>Average Daily Gain, kg/d</td>
<td>1.64</td>
<td>0.17</td>
<td>0.98</td>
<td>2.10</td>
</tr>
<tr>
<td>Gain:feed</td>
<td>0.193</td>
<td>0.023</td>
<td>0.147</td>
<td>0.253</td>
</tr>
</tbody>
</table>
Table 4. Means, standard deviations (SD), minimum and maximum values of carcass characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Harvest, d</td>
<td>423.3</td>
<td>19.7</td>
<td>360.0</td>
<td>463.0</td>
</tr>
<tr>
<td>Hot Carcass Weight, kg</td>
<td>407.9</td>
<td>38.3</td>
<td>296.3</td>
<td>509.1</td>
</tr>
<tr>
<td>12th-13th Rib Fat, cm</td>
<td>1.11</td>
<td>0.35</td>
<td>0.38</td>
<td>2.79</td>
</tr>
<tr>
<td>Ribeye Area, cm²</td>
<td>93.89</td>
<td>8.79</td>
<td>72.26</td>
<td>116.80</td>
</tr>
<tr>
<td>Kidney, Pelvic, Heart fat, %</td>
<td>2.53</td>
<td>0.62</td>
<td>1.00</td>
<td>4.00</td>
</tr>
<tr>
<td>USDA Yield Grade (YG)</td>
<td>2.06</td>
<td>0.66</td>
<td>1.00</td>
<td>4.00</td>
</tr>
<tr>
<td>University of Illinois YG</td>
<td>2.85</td>
<td>0.64</td>
<td>1.35</td>
<td>5.38</td>
</tr>
<tr>
<td>Marbling Score&lt;sup&gt;a&lt;/sup&gt;</td>
<td>581.4</td>
<td>93.4</td>
<td>380.0</td>
<td>850.0</td>
</tr>
<tr>
<td>USDA Quality Grade (QG)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.29</td>
<td>0.83</td>
<td>3.00</td>
<td>8.00</td>
</tr>
<tr>
<td>University of Illinois QG&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.33</td>
<td>0.99</td>
<td>3.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Intramuscular fat, %</td>
<td>5.56</td>
<td>1.65</td>
<td>2.06</td>
<td>11.08</td>
</tr>
</tbody>
</table>

<sup>a</sup>400 = Slight<sup>o</sup>, 500 = Small<sup>o</sup>, 600 = Modest<sup>o</sup>
<sup>b</sup>4 = Select, 5 = Choice<sup>+</sup>, 6 = Choice<sup>+</sup>

Table 5. Five year<sup>a</sup> average grid yield and quality grade premiums and discounts<sup>b</sup> for calculation of final carcass value<sup>c</sup>, $

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2A</th>
<th>2B</th>
<th>3A</th>
<th>3B</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>8.08</td>
<td>6.93</td>
<td>6.73</td>
<td>5.5</td>
<td>5.43</td>
<td>-8.54</td>
<td>-13.94</td>
</tr>
<tr>
<td>Premium</td>
<td>3.96</td>
<td>2.81</td>
<td>2.61</td>
<td>1.38</td>
<td>1.31</td>
<td>-12.66</td>
<td>-18.06</td>
</tr>
<tr>
<td>Choice Low</td>
<td>2.46</td>
<td>1.31</td>
<td>1.11</td>
<td>-0.12</td>
<td>-0.19</td>
<td>-14.16</td>
<td>-19.56</td>
</tr>
<tr>
<td>Choice Select</td>
<td>-6.44</td>
<td>-7.59</td>
<td>-7.79</td>
<td>-9.02</td>
<td>-9.09</td>
<td>-23.06</td>
<td>-26.10</td>
</tr>
</tbody>
</table>

<sup>a</sup>Average of years 1999-2003 (USDA, 2003)
<sup>b</sup>Per 45.4 kg basis according to base price.
<sup>c</sup>Does not take in account weight premiums or discounts.

Table 6. Means, standard deviations (SD), minimum and maximum values of actual carcass price and profit estimates

<table>
<thead>
<tr>
<th>Item, $</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>45.4kg Discount or premium&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>111.07</td>
<td>3.22</td>
<td>102.88</td>
<td>114.63</td>
</tr>
<tr>
<td>Total carcass price&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>1017.92</td>
<td>97.98</td>
<td>649.87</td>
<td>1252.05</td>
</tr>
<tr>
<td>Estimated profit&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>185.78</td>
<td>62.99</td>
<td>-49.21</td>
<td>301.05</td>
</tr>
</tbody>
</table>

<sup>a</sup>Does not include weight discounts, only quality and yield grade premiums or discount. Based on five-year average (1999-2003) (USDA, 2003)
<sup>b</sup>Using five-year average (1999-2003) dressed base price of $110.67/45.4 kg (Cattle-Fax, 2003)
### Table 7. GeneSTAR® marker analysis for Expected Progeny Differences (EPDs)\(^a\)

<table>
<thead>
<tr>
<th>Item</th>
<th>0-STAR</th>
<th>1-STAR</th>
<th>2-STAR</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>n(^b)</td>
<td>47</td>
<td>95</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Yearling Weight EPD(^a)</td>
<td>58.56(^y)</td>
<td>59.50(^yz)</td>
<td>63.27(^z)</td>
<td>2.01</td>
</tr>
<tr>
<td>Marbling EPD(^b)</td>
<td>0.10</td>
<td>0.11</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>Percent Retail Cuts EPD(^a)</td>
<td>-0.02(^y)</td>
<td>-0.03(^y)</td>
<td>-0.09(^z)</td>
<td>0.03</td>
</tr>
<tr>
<td>Carcass Weight EPD(^a)</td>
<td>7.87(^x)</td>
<td>11.84(^y)</td>
<td>15.92(^z)</td>
<td>1.92</td>
</tr>
</tbody>
</table>

\(^a\)Provided by the American Simmental Association database on January 9, 2004  
\(^b\)Frequency of genomes tested by Genetic Solutions (Australia)  
\(^x,y,z\)Means in same row with differing superscripts differ \( P < 0.10 \)

### Table 8. GeneSTAR® marker analysis for performance parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>0-STAR</th>
<th>1-STAR</th>
<th>2-STAR</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>n(^a)</td>
<td>47</td>
<td>95</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Final Weight, kg</td>
<td>663.4</td>
<td>658.2</td>
<td>645.4</td>
<td>10.5</td>
</tr>
<tr>
<td>Dry Matter Intake, kg/d</td>
<td>8.87</td>
<td>8.78</td>
<td>8.82</td>
<td>0.13</td>
</tr>
<tr>
<td>Average Daily Gain, kg/d</td>
<td>1.64</td>
<td>1.64</td>
<td>1.62</td>
<td>0.03</td>
</tr>
<tr>
<td>Gain:feed</td>
<td>0.187</td>
<td>0.190</td>
<td>0.186</td>
<td>0.003</td>
</tr>
</tbody>
</table>

\(^a\)Frequency of genomes tested by Genetic Solutions (Australia)  
\(^y,z\)Means in same row with differing superscripts differ \( P < 0.10 \)

### Table 9. GeneSTAR® marker analysis for carcass parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>0-STAR</th>
<th>1-STAR</th>
<th>2-STAR</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>n(^a)</td>
<td>47</td>
<td>95</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>Hot Carcass Weight, kg</td>
<td>412.1</td>
<td>408.9</td>
<td>401.0</td>
<td>6.5</td>
</tr>
<tr>
<td>12(^{th})-13(^{th}) Rib Fat, cm</td>
<td>1.16</td>
<td>1.13</td>
<td>1.11</td>
<td>0.06</td>
</tr>
<tr>
<td>Ribeye Area, cm(^2)</td>
<td>94.1</td>
<td>94.4</td>
<td>92.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Kidney, Pelvic Heart fat, %</td>
<td>2.63</td>
<td>2.48</td>
<td>2.61</td>
<td>0.10</td>
</tr>
<tr>
<td>USDA Yield Grade (YG)</td>
<td>2.01</td>
<td>2.13</td>
<td>2.04</td>
<td>0.10</td>
</tr>
<tr>
<td>University of Illinois YG</td>
<td>2.95</td>
<td>2.82</td>
<td>2.90</td>
<td>0.11</td>
</tr>
<tr>
<td>Marbling Score(^b)</td>
<td>582.0</td>
<td>584.0</td>
<td>582.7</td>
<td>15.6</td>
</tr>
<tr>
<td>USDA Quality Grade (QG)</td>
<td>5.30</td>
<td>5.37</td>
<td>5.24</td>
<td>0.14</td>
</tr>
<tr>
<td>University of Illinois QG(^c)</td>
<td>5.36</td>
<td>5.35</td>
<td>5.33</td>
<td>0.17</td>
</tr>
<tr>
<td>Intramuscular fat, %</td>
<td>5.73</td>
<td>5.58</td>
<td>5.59</td>
<td>0.29</td>
</tr>
<tr>
<td>Low Choice(^d), %</td>
<td>82.98</td>
<td>87.37</td>
<td>90.91</td>
<td>-</td>
</tr>
<tr>
<td>Premium Choice(^d), %</td>
<td>42.55</td>
<td>44.21</td>
<td>30.30</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^a\)Frequency of genomes tested by Genetic Solutions (Australia)  
\(^b\)400 = Slight\(^0\), 500 = Small\(^0\), 600 = Modest\(^0\)  
\(^c\)4 = Select, 5 = Choice\(^-\), 6 = Choice\(^0\).  
\(^d\)Determined by Chi-squared analysis
Table 10. Means and standard deviations (SD) of real-time ultrasound (RTU) scans and live evaluation\textsuperscript{a} estimates for yield and quality grade with economic analysis for Year 3 and Year 4 Simmental steers

<table>
<thead>
<tr>
<th>Item</th>
<th>RTU</th>
<th>SD</th>
<th>Eval. 1</th>
<th>SD</th>
<th>Eval. 2</th>
<th>SD</th>
<th>Eval. 3</th>
<th>SD</th>
<th>Ave. Eval.</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield Grade</td>
<td>2.63</td>
<td>0.43</td>
<td>2.90</td>
<td>0.34</td>
<td>2.86</td>
<td>0.29</td>
<td>2.45</td>
<td>0.34</td>
<td>2.73</td>
<td>0.26</td>
</tr>
<tr>
<td>Quality Grade</td>
<td>5.38</td>
<td>0.66</td>
<td>5.49</td>
<td>0.81</td>
<td>5.15</td>
<td>0.86</td>
<td>5.52</td>
<td>0.89</td>
<td>5.39</td>
<td>0.65</td>
</tr>
<tr>
<td>Estimated price per 45.4kg\textsuperscript{cd}, $</td>
<td>111.04</td>
<td>3.68</td>
<td>111.38</td>
<td>2.74</td>
<td>109.73</td>
<td>3.94</td>
<td>110.67</td>
<td>3.88</td>
<td>109.88</td>
<td>3.81</td>
</tr>
<tr>
<td>Estimated price\textsuperscript{cd}, whole carcass value, $</td>
<td>1022.66</td>
<td>99.98</td>
<td>1021.69</td>
<td>104.50</td>
<td>1006.13</td>
<td>102.98</td>
<td>1015.71</td>
<td>111.88</td>
<td>1008.16</td>
<td>108.44</td>
</tr>
<tr>
<td>Estimated profit\textsuperscript{cd}, whole carcass value, $</td>
<td>243.04</td>
<td>84.69</td>
<td>242.15</td>
<td>87.73</td>
<td>226.41</td>
<td>84.43</td>
<td>236.09</td>
<td>97.53</td>
<td>228.46</td>
<td>92.36</td>
</tr>
</tbody>
</table>

\textsuperscript{a}From three experience live evaluators (Eval. 1, Eval. 2, and Eval. 3, respectively)
\textsuperscript{b}4 = Select, 5 = Choice\textsuperscript{-}, 6 = Choice\textsuperscript{0}.
\textsuperscript{c}Based on quality and yield grade premiums and discounts only, not weight discount, with average dress price over the last five years (1999-2003) (USDA, 2003)
\textsuperscript{d}Using five year (1999-2003) average base dress price of $110.67/ 45.4 kg (Cattle-Fax, 2003)
Table 11. Differences than actual means and standard deviations (SD) of fourth real-time ultrasound (RTU) scans and live evaluation\textsuperscript{a} estimates for yield (YG) and quality grade (QG) than University of Illinois (UI) YG and QG estimates and economic analysis for Year 3 and Year 4 Simmental steers

<table>
<thead>
<tr>
<th>Item</th>
<th>RTU</th>
<th>SD</th>
<th>Eval. 1</th>
<th>SD</th>
<th>Eval. 2</th>
<th>SD</th>
<th>Eval. 3</th>
<th>SD</th>
<th>Ave. Eval.</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>YG difference than actual USDA YG</td>
<td>0.73</td>
<td>0.56</td>
<td>0.99</td>
<td>0.71</td>
<td>0.95</td>
<td>0.60</td>
<td>0.54</td>
<td>0.73</td>
<td>0.83</td>
<td>0.66</td>
</tr>
<tr>
<td>YG difference than actual UI YG</td>
<td>-0.17</td>
<td>0.40</td>
<td>0.08</td>
<td>0.58</td>
<td>0.05</td>
<td>0.51</td>
<td>-0.37</td>
<td>0.58</td>
<td>0.08</td>
<td>0.53</td>
</tr>
<tr>
<td>QG\textsuperscript{b} difference than actual USDA QG</td>
<td>0.02</td>
<td>0.65</td>
<td>0.13</td>
<td>0.96</td>
<td>-0.20</td>
<td>1.10</td>
<td>0.15</td>
<td>1.12</td>
<td>0.02</td>
<td>0.91</td>
</tr>
<tr>
<td>QG\textsuperscript{b} difference than actual UI QG</td>
<td>-0.20</td>
<td>0.89</td>
<td>-0.09</td>
<td>1.26</td>
<td>-0.43</td>
<td>1.34</td>
<td>-0.07</td>
<td>1.41</td>
<td>-0.19</td>
<td>1.22</td>
</tr>
<tr>
<td>Difference than actual price per 45.4kg\textsuperscript{c,d}, $</td>
<td>0.51</td>
<td>3.65</td>
<td>0.34</td>
<td>4.27</td>
<td>-1.31</td>
<td>5.20</td>
<td>-0.37</td>
<td>4.94</td>
<td>-1.16</td>
<td>5.18</td>
</tr>
<tr>
<td>Difference than actual price\textsuperscript{c,d}, whole carcass value, $</td>
<td>4.54</td>
<td>34.57</td>
<td>3.56</td>
<td>39.97</td>
<td>-11.99</td>
<td>48.69</td>
<td>-2.42</td>
<td>45.97</td>
<td>-9.96</td>
<td>48.78</td>
</tr>
<tr>
<td>Difference than actual profit\textsuperscript{c,d}, whole carcass value, $</td>
<td>57.26</td>
<td>87.78</td>
<td>56.38</td>
<td>94.25</td>
<td>40.64</td>
<td>91.80</td>
<td>50.31</td>
<td>98.55</td>
<td>42.69</td>
<td>97.11</td>
</tr>
</tbody>
</table>

\textsuperscript{a}From three experienced live evaluators (Eval. 1, Eval. 2, and Eval. 3, respectively)
\textsuperscript{b}4 = Select, 5 = Choice\textsuperscript{c}, 6 = Choice\textsuperscript{0}.
\textsuperscript{c}Based on quality and yield grade premiums and discounts only, not weight discount, with average dress price over the last five years (1999-2003) (USDA, 2003)
\textsuperscript{d}Using five-year (1999-2003) average base dress price of $110.67/ 45.4 kg (Cattle-Fax, 2003)
### Table 12. Step-wise regression for University of Illinois quality grade estimate

<table>
<thead>
<tr>
<th>Variable</th>
<th>Slope and SEM&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Partial R²</th>
<th>Model R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.73 ± 0.82</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fourth Ultrasound QG&lt;sup&gt;b&lt;/sup&gt; Estimate</td>
<td>0.81 ± 0.15</td>
<td>0.312</td>
<td>0.312</td>
</tr>
<tr>
<td>Marbling EPD&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.77 ± 1.29</td>
<td>0.040</td>
<td>0.352</td>
</tr>
</tbody>
</table>

<sup>a</sup>Standard Error of the Mean  
<sup>b</sup>Quality Grade, based on percent intramuscular fat ultrasound scan.  
<sup>c</sup>Expected Progeny Difference available from the American Simmental Association on January 9, 2004

### Table 13. Step-wise regression for chemical intramuscular fat measurement

<table>
<thead>
<tr>
<th>Variable</th>
<th>Slope and SEM&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Partial R²</th>
<th>Model R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-4.88 ± 1.25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fourth Ultrasound Quality Grade</td>
<td>1.39 ± 0.15</td>
<td>0.585</td>
<td>0.585</td>
</tr>
<tr>
<td>Percent Retail Cuts EPD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.98 ± 0.70</td>
<td>0.030</td>
<td>0.615</td>
</tr>
<tr>
<td>Marbling EPD&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.28 ± 1.31</td>
<td>0.028</td>
<td>0.643</td>
</tr>
<tr>
<td>Average Live Yield Grade</td>
<td>0.72 ± 0.38</td>
<td>0.017</td>
<td>0.659</td>
</tr>
<tr>
<td>GeneSTAR® Marbling Test&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.20 ± 0.13</td>
<td>0.011</td>
<td>0.670</td>
</tr>
</tbody>
</table>

<sup>a</sup>Standard Error of the Mean  
<sup>b</sup>Expected Progeny difference available from the American Simmental Association on January 9, 2004  
<sup>c</sup>Tested by Genetic Solutions (Australia)

### Table 14. Step-wise regression for dressed carcass price<sup>a</sup> on a per 45.4kg basis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Slope and SEM&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Partial R²</th>
<th>Model R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>98.87 ± 3.32</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fourth Ultrasound QG&lt;sup&gt;c&lt;/sup&gt; Estimate</td>
<td>1.98 ± 0.63</td>
<td>0.148</td>
<td>0.148</td>
</tr>
<tr>
<td>Marbling EPD&lt;sup&gt;de&lt;/sup&gt;</td>
<td>7.97 ± 5.24</td>
<td>0.025</td>
<td>0.173</td>
</tr>
</tbody>
</table>

<sup>a</sup>No weight discounts were taken into account.  
<sup>b</sup>Standard Error of the Mean  
<sup>c</sup>Quality Grade, based on percent intramuscular fat ultrasound scan.  
<sup>d</sup>Expected Progeny Difference available from the American Simmental Association on January 9, 2004
### Table 15. Step-wise regression for total carcass price\(^a\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Slope and SEM(^b)</th>
<th>Partial R(^2)</th>
<th>Model R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>341.76 ± 129.75</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fourth Ultrasound YG(^c) Estimate</td>
<td>86.87 ± 25.85</td>
<td>0.205</td>
<td>0.205</td>
</tr>
<tr>
<td>Average Live YG(^d) Estimate</td>
<td>106.94 ± 44.90</td>
<td>0.043</td>
<td>0.248</td>
</tr>
<tr>
<td>Yearling Weight EPD(^e)</td>
<td>-17.62 ± 11.32</td>
<td>0.034</td>
<td>0.282</td>
</tr>
<tr>
<td>Marbling EPD(^f)</td>
<td>243.08 ± 125.46</td>
<td>0.033</td>
<td>0.315</td>
</tr>
<tr>
<td>GeneSTAR® Marbling Test(^f)</td>
<td>-20.25 ± 13.16</td>
<td>0.021</td>
<td>0.336</td>
</tr>
</tbody>
</table>

\(^a\)No weight discounts were taken into account.
\(^b\)Standard Error of the Mean
\(^c\)Yield Grade, based on subcutaneous backfat scan and ribeye area at the 12\(^{th}\) rib
\(^d\)Yield Grade based on live analysis by three trained evaluators within 2 weeks of harvest taking into account backfat and ribeye area only
\(^e\)Expected Progeny Difference available from the American Simmental Association on January 9, 2004
\(^f\)Tested by Genetic Solutions (Australia)

### Table 16. Step-wise regression for total profit\(^a\)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Slope and SEM(^b)</th>
<th>Partial R(^2)</th>
<th>Model R(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>161.63 ± 16.59</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marbling EPD(^c)</td>
<td>142.65 ± 93.35</td>
<td>0.029</td>
<td>0.029</td>
</tr>
</tbody>
</table>

\(^a\)No weight discounts were taken into account.
\(^b\)Standard Error of the Mean
\(^c\)Expected Progeny Difference available from the American Simmental Association on January 9, 2004

### Table 17. Simple correlation coefficients among expected progeny differences (EPDs) and a DNA marbling marker

<table>
<thead>
<tr>
<th>Item</th>
<th>YW</th>
<th>MARB</th>
<th>PRC</th>
<th>CW</th>
<th>GS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling Weight (YW) EPD(^a)</td>
<td>1.00</td>
<td>-0.13</td>
<td>-0.18</td>
<td>0.26</td>
<td>0.04</td>
</tr>
<tr>
<td>Marbling (MARB) EPD(^a)</td>
<td>1.00</td>
<td>-0.12</td>
<td>0.29</td>
<td>-0.05</td>
<td></td>
</tr>
<tr>
<td>Percent Retail Cuts (PRC) EPD(^a)</td>
<td>1.00</td>
<td>-0.80</td>
<td>-0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass Weight (CW) EPD(^a)</td>
<td></td>
<td></td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GeneSTAR® (GS)(^b)</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Available from the American Simmental Association on January 9, 2004
\(^b\)Test performed by Genetic Solutions (Australia)
\(w\)Significant at \(P < 0.10\)
\(x\)Significant at \(P < 0.05\)
\(y\)Significant at \(P < 0.001\)
\(z\)Significant at \(P < 0.0001\)
Table 18. Simple correlation coefficients among expected progeny differences (EPDs) and average live evaluation for yield (YG) and quality (QG) grades

<table>
<thead>
<tr>
<th>Item</th>
<th>YW</th>
<th>MARB</th>
<th>PRC</th>
<th>CW</th>
<th>Live YG</th>
<th>Live QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling Weight (YW) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.13</td>
<td>-0.18&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.26&lt;sup&gt;w&lt;/sup&gt;</td>
<td>-0.04</td>
<td>-0.08</td>
</tr>
<tr>
<td>Marbling (MARB) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.12</td>
<td>-0.22&lt;sup&gt;x&lt;/sup&gt;</td>
<td>-0.18&lt;sup&gt;w&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent Retail Cuts (PRC) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.80&lt;sup&gt;z&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass Weight (CW) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.04</td>
<td>-0.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live Yield Grade&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.85&lt;sup&gt;z&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live Quality Grade</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Available from the American Simmental Association

<sup>b</sup>Average live estimate for yield grade based on visual analysis of backfat and ribeye area at the 12<sup>th</sup> rib only

<sup>y</sup>Significant at $P < 0.10$

<sup>w</sup>Significant at $P < 0.05$

<sup>x</sup>Significant at $P < 0.01$

<sup>z</sup>Significant at $P < 0.001$

<sup>z</sup>Significant a $P < 0.0001$
Table 19. Simple correlation coefficients among expected progeny differences (EPDs) and fourth real-time ultrasound (RTU) scans for yield (YG) and quality grade (QG) estimates

<table>
<thead>
<tr>
<th>Item</th>
<th>YW</th>
<th>MARB</th>
<th>PRC</th>
<th>CW</th>
<th>RTU YG</th>
<th>RTU QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling Weight (YW) EPDa</td>
<td>1.00</td>
<td>-0.13</td>
<td>-0.18v</td>
<td>0.26w</td>
<td>0.05</td>
<td>-0.16</td>
</tr>
<tr>
<td>Marbling (MARB) EPDa</td>
<td>1.00</td>
<td>-0.12</td>
<td>-0.80z</td>
<td>0.29y</td>
<td>0.07</td>
<td>0.36z</td>
</tr>
<tr>
<td>Percent Retail Cuts (PRC) EPDa</td>
<td>1.00</td>
<td>-0.80z</td>
<td>-0.04</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass Weight (CW) EPDa</td>
<td>1.00</td>
<td>0.14</td>
<td>-0.05</td>
<td>0.29x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTU Yield Gradef</td>
<td>1.00</td>
<td></td>
<td>0.29x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTU Quality Gradeg</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*aAvailable from the American Simmental Association on January 9, 2004

*Ultrasound estimate for yield grade based on scans of backfat and ribeye area at the 12th rib only

vSignificant at $P < 0.10$

wSignificant at $P < 0.05$

zSignificant at $P < 0.0001$
### Table 20. Simple correlation coefficients among expected progeny differences (EPDs) and actual carcass parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>YW</th>
<th>MARB</th>
<th>PRC</th>
<th>CW</th>
<th>BF</th>
<th>REA</th>
<th>KPH</th>
<th>MS</th>
<th>IMF%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling Weight (YW) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.13</td>
<td>-0.18&lt;sup&gt;w&lt;/sup&gt;</td>
<td>0.26&lt;sup&gt;x&lt;/sup&gt;</td>
<td>-0.04</td>
<td>0.00</td>
<td>-0.04</td>
<td>-0.17</td>
<td>-0.09</td>
</tr>
<tr>
<td>Marbling (MARB) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.12</td>
<td>0.29&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.00</td>
<td>0.01</td>
<td>-0.22&lt;sup&gt;x&lt;/sup&gt;</td>
<td>0.36&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.43&lt;sup&gt;z&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Percent Retail Cuts (PRC) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.80&lt;sup&gt;z&lt;/sup&gt;</td>
<td>0.10</td>
<td>0.08</td>
<td>0.04</td>
<td>0.05</td>
<td>0.22&lt;sup&gt;w&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass Weight (CW) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.05</td>
<td>-0.01</td>
<td>-0.06</td>
<td>-0.04</td>
<td>-0.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backfat (BF)</td>
<td>1.00</td>
<td>0.13</td>
<td>0.32&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.09</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribeye area (REA)</td>
<td>1.00</td>
<td>0.23&lt;sup&gt;x&lt;/sup&gt;</td>
<td>0.05</td>
<td>-0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney, Pelvic, and Heart Fat (KPH)</td>
<td>1.00</td>
<td>0.04</td>
<td>-0.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marbling Score (MS)</td>
<td>1.00</td>
<td>0.64&lt;sup&gt;z&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Intramuscular fat % (IMF%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPDs available from the American Simmental Association on January 9, 2004

<sup>w</sup>Significant at \( P < 0.10 \)

<sup>x</sup>Significant at \( P < 0.05 \)

<sup>y</sup>Significant at \( P < 0.001 \)

<sup>z</sup>Significant at \( P < 0.0001 \)
Table 21. Simple correlation coefficients among expected progeny differences (EPDs), USDA and the University of Illinois (UI) yield (YG) and quality grade (QG) estimates

<table>
<thead>
<tr>
<th>Item</th>
<th>YW</th>
<th>MARB</th>
<th>PRC</th>
<th>CW</th>
<th>USDA YG</th>
<th>UI YG</th>
<th>USDA QG</th>
<th>UI QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearling Weight (YW) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.13</td>
<td>-0.18&lt;sup&gt;v&lt;/sup&gt;</td>
<td>0.26&lt;sup&gt;w&lt;/sup&gt;</td>
<td>0.12</td>
<td>0.12</td>
<td>-0.15</td>
<td>-0.15</td>
</tr>
<tr>
<td>Marbling (MARB) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.12</td>
<td>0.29&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.22&lt;sup&gt;w&lt;/sup&gt;</td>
<td>0.04</td>
<td>0.37&lt;sup&gt;x&lt;/sup&gt;</td>
<td>0.31&lt;sup&gt;w&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Percent Retail Cuts (PRC) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>-0.80&lt;sup&gt;z&lt;/sup&gt;</td>
<td>-0.10</td>
<td>-0.04</td>
<td>0.21&lt;sup&gt;v&lt;/sup&gt;</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass Weight (CW) EPD&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.16</td>
<td>0.08</td>
<td>-0.09</td>
<td>-0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA Yield Grade</td>
<td>1.00</td>
<td>0.62&lt;sup&gt;z&lt;/sup&gt;</td>
<td>0.07</td>
<td>0.21&lt;sup&gt;w&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Illinois Yield Grade</td>
<td>1.00</td>
<td>0.12</td>
<td>0.26&lt;sup&gt;w&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA Quality Grade</td>
<td>1.00</td>
<td>0.71&lt;sup&gt;y&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Illinois Quality Grade</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>EPDs available from the American Simmental Association

<sup>v</sup>Significant at \( P < 0.10 \)

<sup>w</sup>Significant at \( P < 0.05 \)

<sup>x</sup>Significant at \( P < 0.01 \)

<sup>y</sup>Significant at \( P < 0.001 \)

<sup>z</sup>Significant at \( P < 0.0001 \)
Table 22. Simple correlation coefficients among a DNA marker and average live evaluation estimates for yield (YG) and quality (QG) grades

<table>
<thead>
<tr>
<th>Item</th>
<th>GeneSTAR®</th>
<th>Live YG</th>
<th>Live QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeneSTAR®</td>
<td>1.00</td>
<td>-0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Live YG</td>
<td>1.00</td>
<td></td>
<td>0.84*</td>
</tr>
<tr>
<td>Live QG</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*GeneSTAR® test performed by Genetic Solutions (Australia)

bAverage live estimate for yield grade based on visual analysis of backfat and ribeye area at the 12th rib only

zSignificant at \( P < 0.001 \)

Table 23. Simple correlation coefficients among a DNA marker and fourth real-time ultrasound (RTU) estimates for yield (YG) and quality (QG) grades

<table>
<thead>
<tr>
<th>Item</th>
<th>GeneSTAR®</th>
<th>RTU YG</th>
<th>RTU QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeneSTAR®</td>
<td>1.00</td>
<td>0.16</td>
<td>0.00</td>
</tr>
<tr>
<td>RTU YG</td>
<td>1.00</td>
<td></td>
<td>0.29*</td>
</tr>
<tr>
<td>RTU QG</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*GeneSTAR® test performed by Genetic Solutions (Australia)

dUltrasound estimate for yield grade based on scans of backfat and ribeye area at the 12th rib, live weight and kidney, pelvic and heart fat was not taken in account.

eUltrasound estimated base on percent intramuscular percent fat between the 12th and 13th rib

zSignificant at \( P < 0.01 \)

Table 24. Simple correlation coefficients among a DNA marker and actual carcass parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>GS</th>
<th>BF</th>
<th>REA</th>
<th>KPH</th>
<th>MS</th>
<th>IMF%</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeneSTAR® (GS)</td>
<td>1.00</td>
<td>-0.08</td>
<td>-0.07</td>
<td>-0.02</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Backfat (BF)</td>
<td>1.00</td>
<td></td>
<td>0.13</td>
<td>0.32y</td>
<td>0.09</td>
<td>0.14</td>
</tr>
<tr>
<td>Ribeye area (REA)</td>
<td>1.00</td>
<td></td>
<td>0.32</td>
<td>0.05</td>
<td>-0.10</td>
<td></td>
</tr>
<tr>
<td>Kidney, Pelvic, and Heart (KPH) fat, %</td>
<td>1.00</td>
<td></td>
<td>0.04</td>
<td>-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marbling Score (MS)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td>0.64z</td>
<td></td>
</tr>
<tr>
<td>Chemical Intramuscular Fat % (IMF%)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*ySignificant at \( P < 0.001 \)

zSignificant a \( P < 0.0001 \)
Table 25. Simple correlation coefficients among a DNA marker, USDA and the University of Illinois yield (YG) and quality grade (QG) estimates

<table>
<thead>
<tr>
<th>Item</th>
<th>GeneSTAR®a</th>
<th>USDA YG</th>
<th>UI YG</th>
<th>USDA QG</th>
<th>UI QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeneSTAR®a</td>
<td>1.00</td>
<td>-0.11</td>
<td>-0.03</td>
<td>-0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>USDA YGd</td>
<td>1.00</td>
<td>0.62z</td>
<td>0.07</td>
<td>0.21y</td>
<td></td>
</tr>
<tr>
<td>UI YG</td>
<td>1.00</td>
<td>0.12</td>
<td>0.26y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA QG</td>
<td>1.00</td>
<td></td>
<td></td>
<td>0.71z</td>
<td></td>
</tr>
<tr>
<td>UI QG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
</tbody>
</table>

aGeneSTAR® test performed by Genetic Solutions (Australia)

ySignificant at $P < 0.05$

zSignificant at $P < 0.001$

Table 26. Simple correlations coefficients among fourth real-time ultrasound (RTU) scans for yield (YG) and quality (QG) grade estimates and live evaluation for YG and QG

<table>
<thead>
<tr>
<th>Item</th>
<th>RTU YG</th>
<th>RTU QG</th>
<th>Live YG</th>
<th>Live QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTU YGa</td>
<td>1.00</td>
<td>0.29y</td>
<td>0.43z</td>
<td>0.44z</td>
</tr>
<tr>
<td>RTU QGb</td>
<td>1.00</td>
<td>0.11</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Live YGc</td>
<td>1.00</td>
<td>0.85z</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live QG</td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aUltrasound estimate for yield grade based on scans of backfat and ribeye area at the 12th rib only

bUltrasound estimated base on percent intramuscular percent fat between the 12th and 13th rib

cAverage live estimate for yield grade based on visual analysis of backfat and ribeye area

ySignificant at $P < 0.01$

zSignificant at $P < 0.0001$
### Table 27. Simple correlation coefficients among fourth real-time ultrasound (RTU) scans and actual carcass parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>RTU YG</th>
<th>RTU QG</th>
<th>BF</th>
<th>REA</th>
<th>KPH</th>
<th>MS</th>
<th>IMF%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTU Yield Grade (YG)\textsuperscript{a}</td>
<td>1.00</td>
<td>0.29\textsuperscript{x}</td>
<td>0.50\textsuperscript{y}</td>
<td>-0.06</td>
<td>0.15</td>
<td>0.18\textsuperscript{w}</td>
<td>0.26\textsuperscript{x}</td>
</tr>
<tr>
<td>RTU Quality Grade (QG)\textsuperscript{b}</td>
<td>1.00</td>
<td>0.06</td>
<td>-0.30\textsuperscript{x}</td>
<td>-0.13</td>
<td>0.54\textsuperscript{z}</td>
<td>0.77\textsuperscript{z}</td>
<td></td>
</tr>
<tr>
<td>Backfat (BF)</td>
<td>1.00</td>
<td>0.13</td>
<td>0.32\textsuperscript{y}</td>
<td>0.09</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribeye Area (REA)</td>
<td>1.00</td>
<td>0.32</td>
<td>0.05</td>
<td>-0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney, Pelvic, and Heart (KPH) fat</td>
<td>1.00</td>
<td>0.04</td>
<td>-0.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marbling Score (MS)</td>
<td>1.00</td>
<td>0.64\textsuperscript{z}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical intramuscular fat % (IMF%)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a}Ultrasound estimate for yield grade based on scans of backfat and ribeye area at the 12\textsuperscript{th} rib only

\textsuperscript{b}Ultrasound estimated base on percent intramuscular percent fat between the 12\textsuperscript{th} and 13\textsuperscript{th} rib

\textsuperscript{x}Significant at $P < 0.10$

\textsuperscript{y}Significant at $P < 0.05$

\textsuperscript{z}Significant at $P < 0.001$

\textsuperscript{w}Significant at $P < 0.0001$
Table 28. Simple correlations coefficients among fourth real-time ultrasound (RTU) scans, USDA and the University of Illinois yield and quality grade estimates

<table>
<thead>
<tr>
<th>Item</th>
<th>RTU YG</th>
<th>RTU QG</th>
<th>USDA YG</th>
<th>UI YG</th>
<th>USDA QG</th>
<th>UI QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fourth Ultrasound Yield Grade (YG)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.29&lt;sup&gt;x&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;z&lt;/sup&gt;</td>
<td>0.64&lt;sup&gt;z&lt;/sup&gt;</td>
<td>0.19&lt;sup&gt;w&lt;/sup&gt;</td>
<td>0.21&lt;sup&gt;x&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fourth Ultrasound Quality Grade (QG)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.00</td>
<td>0.04</td>
<td>0.10</td>
<td>0.55&lt;sup&gt;z&lt;/sup&gt;</td>
<td>0.53&lt;sup&gt;z&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>USDA Yield Grade Estimate</td>
<td>1.00</td>
<td>0.62&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.07</td>
<td>0.21&lt;sup&gt;x&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Illinois (UI) Yield Grade</td>
<td>1.00</td>
<td>0.12</td>
<td>0.26&lt;sup&gt;x&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA Quality Grade</td>
<td>1.00</td>
<td>0.71&lt;sup&gt;y&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Illinois Quality Grade</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Ultrasound estimate for yield grade based on scans of backfat and ribeye area at the 12<sup>th</sup> rib, live weight and kidney, pelvic and heart fat was not taken in account.

<sup>b</sup>Ultrasound estimated base on percent intramuscular percent fat between the 12<sup>th</sup> and 13<sup>th</sup> rib

<sup>w</sup>Significant at P < 0.10

<sup>x</sup>Significant at P < 0.05

<sup>y</sup>Significant at P < 0.001

<sup>z</sup>Significant a P < 0.0001
Table 29. Simple correlation coefficients among live evaluation for estimates for yield and quality grade and actual carcass parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Live YG</th>
<th>Live QG</th>
<th>BF</th>
<th>REA</th>
<th>KPH</th>
<th>MS</th>
<th>IMF%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Estimate of Yield Grade (YG)(^a)</td>
<td>1.00</td>
<td>0.06</td>
<td>0.23(^w)</td>
<td>0.32(^w)</td>
<td>0.27(^w)</td>
<td>-0.05</td>
<td>0.12</td>
</tr>
<tr>
<td>Live Estimate of Quality Grade (QG)</td>
<td>1.00</td>
<td>0.24(^w)</td>
<td>0.17(^x)</td>
<td>0.27(^w)</td>
<td>0.00</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Backfat (BF)</td>
<td>1.00</td>
<td>0.13</td>
<td>0.32(^y)</td>
<td>0.09</td>
<td>0.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ribeye Area (REA)</td>
<td>1.00</td>
<td>0.32</td>
<td>0.05</td>
<td>-0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney, Pelvic, and Heart (KPH) Fat %</td>
<td>1.00</td>
<td>0.04</td>
<td>-0.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marbling Score (MS)</td>
<td>1.00</td>
<td></td>
<td>0.64(^z)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical Intramuscular fat % (IMF)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Average live estimate for yield grade based on visual analysis of backfat and ribeye area at the 12\(^{th}\) rib, live weight and kidney, pelvic and heart fat was not taken in account.

\(^w\)Significant at \(P < 0.10\)

\(^x\)Significant at \(P < 0.05\)

\(^y\)Significant at \(P < 0.01\)

\(^z\)Significant at \(P < 0.001\)

\(^z\)Significant a \(P < 0.0001\)
<table>
<thead>
<tr>
<th>Item</th>
<th>Live YG</th>
<th>Live QG</th>
<th>USDA YG</th>
<th>UI YG</th>
<th>USDA QG</th>
<th>UI QG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Yield Grade (YG)</td>
<td>1.00</td>
<td>0.06</td>
<td>-0.06</td>
<td>0.17(^x)</td>
<td>0.39</td>
<td>0.00</td>
</tr>
<tr>
<td>Live Quality Grade (QG)</td>
<td>1.00</td>
<td>0.01</td>
<td>0.21(^y)</td>
<td>0.02</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>USDA Yield Grade</td>
<td>1.00</td>
<td>0.62(^z)</td>
<td>0.07</td>
<td>0.21(^y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UI Yield Grade</td>
<td>1.00</td>
<td>1.00</td>
<td>0.12</td>
<td>0.26(^y)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USDA Quality Grade</td>
<td>1.00</td>
<td>1.00</td>
<td>0.71(^z)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UI Quality Grade</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Average live estimate for yield grade based on visual analysis of backfat and ribeye area at the 12\(^{th}\) rib only

\(^x\)Significant at \(P < 0.10\)

\(^y\)Significant at \(P < 0.05\)

\(^z\)Significant at \(P < 0.001\)