Revalidation of a REA, IMF and BF Projection Model Using Real-time Ultrasound Imaging and Feeding Data in Cattle

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Summary and Implications

The use of an initial real-time ultrasound image (RTU) of the 12^{th} rib longissimus dorsi muscle (REA), external backfat (BF) and intramuscular fat (IMF) when coupled with feeding data collected on feedlot cattle can be used to project final REA, BF and IMF. By doing these estimates, subsequent quality and yield grades of the finished animal can be projected.

Introduction

The use of RTU for evaluating carcass characteristics of live animals became quite popular in the 1990's. This technology provided a noninvasive means to determine some key carcass measures such as REA, BF and IMF. These measures are significant since they were used to value beef carcasses sold on a meat quality grid which occasionally is used in the marketing of cattle. In the dissertation, "Development and Validation of a Finishing Cattle Monitoring system with Microcomputer Compatibility" (Iowa State University Library Collection) written in 1997 from data collected in 1995-1996, the use of these measures when coupled to feed-out data was shown to provide an accurate means by which the initial RTU measure could be used to accurately project these carcass measures at the end of the finishing phase. The series of equations developed for this purpose were incorporated into the ISU Beef Feedlot Monitoring software for those users who wished to use this option to project not only weight gain and subsequent breakeven value, but also a pen's yield and quality grades. Since this original paper, the technology and interpretation of RTU images have developed further so the purpose of this study was to determine if the principals outlined in this original dissertation still apply today, 15 years later.

Material and Methods

Thirty pens of four, yearling steers of a crossed English and Continental breed type were fed rations composed of corn, dry distillers grains, dry hay and a supplement. The proportions of corn and distillers grains varied to represent a range of contemporary rations used to finish cattle. Cattle were RTU scanned at the start of the feed-out phase which was 147 days prior to harvest and rescanned 54 days prior to harvest. Cattle were sent to a Tyson Fresh Meats plant in Denison Iowa where actual carcass REA, BF, weight and quality grade (final IMF was estimated from quality grade) measures were obtained at that time. Using the equations outlined in the dissertation mentioned above the calculated REA, BF and IMF were compared to the actual values using a paired, 2 tail, Student's T-Test to test differences.

Results and Discussion

Equations 1, 2 and 3 outline the original computations used to project REA, BF and IMF. Tables 1, 2 and 3 outline the results of the calculated versus actual measures. Looking at these tables, notice that a calculated projection was made using the initial RTU measure taken 147 days prior to slaughter and also another one based on the RTU measures collected 54 days prior to slaughter. It is interesting that the initial measure provides as good or maybe a better estimate than a measure taken close to the finish especially when considering the difference between the raw averages of measured versus actual. Considering the items measured both based from an initial RTU and a late RTU, the calculated REA shows a significant and consistent upward bias of 10.26 cm^2 and 11.29 cm^2 (overestimate) and the calculated IMF results in a significant overestimate of 0.81 and 1.29 percentage units. A T-Test indicates that this would be significant in difference and not a good equation set to use for estimating REA and IMF; however, before the system is completely scrapped it should be noted that this bias is consistent across all estimates and the standard error of prediction confirms this point. The BF calculation when estimated from an initial RTU image is not different from the actual measured values. It was very encouraging to see this relationship stand up over the course of time. The key that allowed this system to work well when originally developed was that the feeding data such as animal average daily gain and intake relative to body weight provided a means by which the initial measure could be adjusted over the feeding phase in terms of tissue accretion. The REA and IMF estimates, although failing an initial T-Test, do not fail if the above mentioned biases are subtracted from this estimate. For instance if all of the calculated REA from the initial RTU measure are reduced by 10.26cm^2 or all of the initial IMF values are reduced by 0.81percentage points, the T-Test approaches "1" indicating no difference between the calculated and actual values.

If this system is to be promoted for use in projecting the mentioned carcass measurements, the issue spawning the bias must be addressed. Robust and repeatable qualities are necessary for a functional commercial model. The strong consistency of bias, if repeatable with a different technician, in a different feedyard would focus the blame on the interpretation software and RTU machinery involved. If this is the reason, allowing for a bias input would easily solve the problem. Another factor that may be occurring and is a little more difficult to address would be the effect caused by the ration or other management. Initial measures and daily weight gain are major drivers in determining the result. From a ration and implant perspectives, in the past when the original system was developed, the rations composed of high levels of whole corn tended to provide a limited quantity of protein relative to energy especially in the early finishing phase. Some, but not all rations used in this trial tended to limit energy before protein since the distillers grains provide a major protein source. The potency of the anabolic implant also has changed from those used earlier, yet at this time I do not feel comfortable in changing the calculation based on any of this speculation.

Equation 1. Ribeye Area Estimation

REAC = REA + [(ADG x .0285 + DMF x .0061 - WTR x .0483) x DOF] x 6.452

REAC is the current ribeye area (cm^2),
REA is the initial ribeye area (cm^2),
ADG is the cumulative average daily gain (kg) since initial ribeye measurement,
DMF is the ratio of current daily dry matter intake over current body weight (kg) multiplied by 100,
WTR is the initial shrunk body weight subtracted from the current shrunk body weight divided by weight when 50% of cattle in lot will grade Choice as described by Fox et al., 1992, DOF are the days since initial ribeye area measurement.

Equation 2. Back Fat Estimation

BFC = BF + [(ADG x .0009 + IMF /(BW x 2.20456) x .0935 + BWR x .0046) x DOF] x 2.54

BFC is the current backfat (cm),
BF is the initial backfat (cm),
ADG is the cumulative average daily gain (kg) since initial backfat depth measurement,
IMF is the initial percent intramuscular fat,
BW is body weight (kg) at time of measurement,
BWR is the initial backfat (cm) over body weight (kg) at time of measurement multiplied by 100,
DOF are the days since initial backfat depth measurement.

Equation 3. Intramuscular Fat Estimation

IMFC = IMF + (BW x .0001 - DMF x .0092 + BF x .0307) x DOF

IMFC is the current percentage of intramuscular fat,
IMF is the initial percentage of intramuscular fat, BW is the live weight (kg) at initial IMF measure,
DMF is the ratio of current daily DMI over current bodyweight multiplied by 100,
BF is the initial backfat measure (cm),
DOF are the days since initial IMF measurement.

Table 1. Projected REA calculated from initial and later RTU measures compared with actual finished measures.

	REA –Projected from Initial Measure	REA – Projected from Late Measure	Actual End Point REA
Average (cm^2)	91.32	92.35	81.06
Standard Deviation	5.00	4.17	3.41
Correlation of initial measures with actual end point REA	0.56	0.53	------
Bias from Actual (cm^2)	-10.28	-11.29	------
T-Test prob. > T	< 0.01	<0.01	------
Standard Error of Prediction	4.2	3.74	------

Table 2. Projected BF calculated from initial and later RTU measures compared with actual finished measures.

	BF –Projected from Initial Measure	BF – Projected from Late Measure	Actual End Point BF
Average (cm)	1.25	1.44	1.27
Standard Deviation	0.10	0.20	0.23
Correlation of initial measures with actual end point BF	0.80	0.86	------
Bias from Actual (cm)	0.03	-0.17	------
T-Test prob. > T	0.40	<0.01	------
Standard Error of Prediction	0.16	0.12	------

Table 3. Projected IMF calculated from initial and later RTU measures compared with actual finished measures.

	REA –Projected from Initial Measure	REA – Projected from Late Measure	Actual End Point REA
Average (%)	7.92	8.40	7.11
Standard Deviation	0.71	0.73	0.59
Correlation of initial measures with actual end point IMF	0.16	0.53	------
Bias from Actual (% points)	-0.81	-1.29	------
T-Test prob. > T	< 0.01	<0.01	------
Standard Error of Prediction	0.84	0.65	------

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