Live Animal Ultrasound Information as a Decision Tool in Replacement Beef Heifer Programs

Alecsandro Dos Santos, John D. Anderson, Rhonda C. Vann, and Scott T. Willard

Real-time ultrasound information taken on beef heifers prior to backgrounding is used to develop a logit model to aid heifer retention decisions. The value of ultrasound data is calculated as the difference in certainty equivalents between a decision rule incorporating ultrasound information and one using only visual cues. The value of ultrasound data is found to be around $10 per head but is influenced by heifer value and backgrounding costs.

Key Words: expected utility, heifer development, logit, real-time ultrasound

JEL Classifications: Q11, Q12, Q13

Real-time ultrasound technology (RTU) is a management tool that provides information about relevant carcass characteristics of live animals. Research indicates a positive correlation (moderate to high) between carcass and ultrasound measurement of key physical traits (Brethour). Estimation of carcass characteristics in live animals potentially allows for sorting and selecting animals to be retained for finishing as well as allowing better projections as to the length of the animals' time on feed and target end point. Although this technology has been frequently applied to decisions in the finishing phase of production, little work has been done concerning the potential use of this technology in other aspects of beef production (Anderson, Ferguson, and Brethour). Live animal ultrasound measurements not only can be used to predict carcass quality and yield grades prior to slaughter but also may be a good estimator of other aspects of an animal's physiological development and subsequent physiological functions.

Focusing on a number of physical markers related to physiological maturity (as opposed to carcass quality) and the potential benefit that RTU can bring to a replacement beef heifer breeding program, the objective of this study is to determine whether RTU information can be used to improve beef heifer retention decisions. Specifically, this study will quantify the value of ultrasound information on the relevant physical characteristics of yearling beef heifers in selecting individual animals to include in a replacement heifer development program. Because of the limited information on the cost of obtaining ultrasound information at the farm level in the context of a commercial cow/calf operation, this research focuses on the contribution of ultrasound information to increased gross revenue (though estimates of cost will be

Alecsandro Dos Santos is a former graduate research assistant, animal and dairy science; John D. Anderson is an associate extension professor, agricultural economics; Rhonda C. Vann is an assistant research professor, animal and dairy science; and Scott T. Willard is an associate professor, animal and dairy science, at Mississippi State University.

discussed later). This work is unique in two important respects. First, while the value of ultrasound information as a marketing-decision aid is explored in recent agricultural economics literature, investigations into the value of this technology in evaluating farm-level production decisions are scarce. Second, this research will measure the value of ultrasound information with reference to decision-maker utility, thus taking into consideration the varying degrees of risk associated with all the possible market outlets for the calves under consideration (specifically, sale as stocker/light feeder heifers, heavy feeder heifers, and bred heifers).

Background and Related Studies

Replacement beef heifers represent an important investment in the genetic improvement of the cow/calf enterprise and as such are crucial to the future profitability of the cow/calf operation. In this context, the use of RTU technology allows the measurement of the physical attributes of females being considered as replacement animals. This relationship between RTU information and key physiological characteristics (such as age of puberty) could provide a useful means of improving genetic selection decisions. Specifically, RTU measurements may be of value in predicting which heifers are most likely to reach puberty at the youngest age and successfully conceive in an artificial breeding program and which animals should be marketed (either sold or retained) as feeder cattle. Reducing the number of heifers that fail to reach puberty at physiologic age (12–15 months) and thus also fail to conceive in advanced artificial breeding systems could represent an important means of improving returns to such programs.

Since beef producers typically replace 10% to 20% of their cows each year with new replacement females, heifer selection and development decisions significantly affect a cow/calf operation's productivity and profitability. This productivity and profitability is largely dependant on reproductive performance. Research has shown that heifers calving early in their first calving season continued to calve early and wean heavier calves throughout their lifetime than later-calving heifers (Lesmeister, Burfening, and Blackwell). Consequently, the growth and development of the replacement female as well as her fertility is one of the most economically important traits to the cow/calf producer. RTU technology has been developed as an effective tool for breeders to use in measuring body composition traits. Steiner suggested that changes in metabolism result in metabolic signals that are the cues for onset of puberty. RTU can potentially measure and accurately estimate some physiological changes and carcass attributes that are associated with the onset of puberty and that seem to be related to the reproductive performance of female beef cattle.

Considerable research has been done on the issue of culling and replacement decisions in the management of beef cattle herds. Meek, Whittier, and Dalsted note that production systems may differ in the manner in which breeding females are acquired. For example, producers may choose to purchase competitively priced 4-year-old replacements as opposed to bred heifers, thus reducing the risk of reproductive failure and potentially providing greater future net returns. They advocate comparing alternative cattle production systems using net present value in order to assess the investment potential of each system.

Ibendahl, Anderson, and Anderson evaluate culling and replacement decisions using net present value. Their research finds that replacing open cows with bred heifers is not always the most profitable decision, depending on the relationship between cull cow and heifer prices and expected calf prices. Similar results were observed by Tronstad and Gumm, who investigated culling and replacement decisions in the context of an operation with biannual calving (i.e., both a spring and a fall calving season). While this previous work deals directly with the issue of when mature cows should be replaced in the breeding herd, none deals with the issue of deciding how to select heifers for breeding.

Ultrasound technology may offer the potential to improve decision making related to heifer retention decisions. In one of the first articles examining the economic benefit of ultrasound technology, Koontz et al. report that the use of ultrasound data to sort cattle in the feedlot 80 days prior to slaughter could potentially increase the profitability and efficiency of the finishing enterprise. Their results indicate that sorting cattle in the feedlot exhibits diminishing marginal returns and that simple sorting regimes capture most of the benefits. Lusk et al. evaluate the potential of ultrasound readings taken in the feedlot to guide fed cattle pricing decisions. They find that ultrasound measurements can be used to make reasonable predictions of actual carcass merits and that sorting cattle for live, dressed, or grid pricing based on those predictions could increase returns by as much as $25 per head compared to marketing all cattle on a live basis.

Previous studies highlight the potential use of ultrasound technology as an aid to marketing decisions; however, to date, no study has evaluated the economic benefit of sorting based on RTU information outside the context of a commercial finishing operation. This study focuses on the potential value of ultrasound technology in informing on-farm production management decisions, specifically the decision of which females to retain into a development and breeding program. Because of the long amount of time required for a heifer development program and the introduction of additional production risks (e.g., risk of failure to conceive in addition to usual morbidity/mortality risks), the benefits of improved cattle retention decisions are potentially significant.

Data and Methods

Data for this study were collected from 138 Angus-crossbreed heifers between 11 and 13 months of age from a replacement heifer development project conducted at Mississippi State University's Brown Loam Experiment Station over 2 years (2004 and 2005). Each of these heifers was placed into one of five backgrounding programs as follows: supplementation with a high-fat diet (*HF*), supplementation with a low-fat diet (*LF*), supplementation with protein tubs (*PT*), supplementation with a whole cottonseed–based ration, and no supplementation (the control group, *CON*). At that time, heifers were selected by age, weight, and breed type, and ultrasound readings were taken on each heifer. RTU measurements on body composition traits were taken with an Aloka SSD 500V ultrasound machine equipped with a 3.5-MHz, 172-mm transducer. Ultrasound data collected included measures of percentage intramuscular fat (*%IMF*), rib (back) fat (*RBF*), rump fat (*RF*), gluteus medius depth (*GMD*), and ribeye area (*REA*).[1] Toward the conclusion of the backgrounding program, heifers were artificially synchronized with a progesterone implant (EAZI BREED™ CIDR® from Pfizer Animal Health, inserted on day 77 of the feeding period). Prior to receiving the progesterone implant, ultrasound readings were repeated, and each heifer was examined and given a reproductive tract score (RTS: 1–5)[2] to estimate pubertal status and subsequent breeding potential (Andersen et al.). Seven days after CIDR® insertion, the CIDR® was removed, and animals were administered an IM injection of prostaglandin ($PGF_2\alpha$ from Pfizer Animal Health administered on day 84, i.e., at the end of the backgrounding program). Heifers were artificially inseminated (AI) on visual heat detection. Heifers that were not observed in estrus were fixed-time artificially inseminated 72 hours after CIDR® removal. Rectal palpation for pregnancy was performed 60 days after AI.

[1] The Beef Image Analysis software from Designer Genes Technologies, Inc., was used to determine values of *%IMF*, ribeye area (*REA*), and rib (back) fat (*BF*).

[2] The reproductive tract score (*RTS*) is a subjective measure of the heifer's pubertal status based on the size of the reproductive tract and ovarian follicular development. A score of 1 denotes a heifer with an immature reproductive tract, while a score of 5 denotes a heifer that is already cycling. In general, heifers with more mature reproductive tracts are more likely to breed successfully (Patterson, Herring, and Kerley).

Table 1. Description of Variables Used in Estimating Logit Model to Predict Outcome of Artificial Breeding of Beef Heifers

Independent Variable	Variable Description
Year	Binary variable identifying the year of the heifer development study (2004 or 2005)
BCS	Body condition score of heifer (1–5) as assessed on day 0 (i.e., beginning of development program)
WT	Heifer weight on day 0
$TREAT_1$	Denotes supplementation with a low-fat (low-energy) feed supplement
$TREAT_2$	Denotes supplementation with a high-fat (high-energy) feed supplement
$TREAT_3$	Denotes supplementation with protein tubs
$TREAT_4$	Denotes supplementation with cottonseed-based ration
REA	Ribeye area (in square centimeters) estimated with RTU on day 0
GMD	Gluteus medium depth (in centimeters) estimated with RTU on day 0
RF	Rump fat depth (in centimeters) estimated with RTU on day 0
RBF	Rib (back) fat depth (in centimeters) estimated with RTU on day 0

Conceptual Model

The basic process of determining the value of RTU information in selecting heifers for a breeding program proceeds through a three-step process similar to that employed in Lusk et al. for valuing RTU data in the context of the fed cattle marketing decision. First, the pregnancy status of each heifer after artificial breeding is used to develop two logit models. The first predicts whether a heifer will be successfully bred using readily observable explanatory variables (e.g., weight, age, body condition score, and so on). The second model includes ultrasound information. Equations (1) and (2) describe the general form of these models:

$$\text{(1)}\quad \text{Prob}(Bred = 1) = f(YEAR, TREAT_i, AGE, WT, BCS),$$

and

$$\text{(2)}\quad \text{Prob}(Bred = 1) = f(YEAR, TREAT_i, AGE, WT, BCS, USDAT_i),$$

where *Bred* is a binary variable with a value of 1 if the animal was found to be bred 60 days after artificial insemination, *YEAR* is a binary variable with a value of 1 for observations from year 1 of the heifer development study and a value of 0 for observations from year 2, $TREAT_i$ is a binary variable associated with supplemental feed treatment (i) in the heifer development study, and *AGE*, *WT*, and *BCS* are, respectively, variables or combinations of variables describing the age, weight, and body condition score of the calf at the time the ultrasound reading is taken. In Equation (2), $USDAT_i$ stands for the ultrasound measurement of physiological characteristic (i) taken at the beginning of the heifer development program. These variables are described more completely in Table 1.

The second step in the process of estimating the value of ultrasound data in heifer retention decisions is to use the results of the models from Equations (1) and (2) to sort heifers into two groups: one to be sold as stocker/light feeder cattle and the other to enter the heifer development program. Heifers that are ultimately successfully bred are valued as replacement breeding stock according to existing budgets. Heifers that ultimately fail to breed are valued as feeder cattle (using prices appropriate to their weight). Variable costs for the replacement heifer development operation are adapted from an existing heifer development enterprise budget (Lacy and Rossi), summarized in Table 2.

The final step in estimating ultrasound value in this study is to use historic feeder and replacement heifer prices in a stochastic simulation to determine expected utility from three alternative sorting protocols: placing all

Table 2. Variable Costs for Heifer Development Program

Item	Unit	Units/Head	Price ($/Unit)	Cost/Head
Calf	Cwt.	5.00	82.00	$410.00
Winter grazing	Acre	0.67	125.00	$83.33
Hay	Tons	0.08	45.00	$3.38
Receiving ration	Tons	0.23	175.00	$40.43
Supplemental feed	Tons	0.18	105.00	$18.90
Mineral and ionophore	Pounds	45.00	0.28	$12.60
Vet and medicine	Head	2.00	4.50	$9.00
Repairs	Head	1.00	0.80	$0.80
Land rental	Acre	0.67	20.00	$13.33
Labor	Hours	2.00	9.02	$18.04
Death loss	%	0.01	410.00	$4.10
Interest on operating capital	%	0.07	609.81	$21.05
Total variable cost per head			$224.96	

heifers in the development program (i.e., no sorting), sorting based on external physical characteristics (Equation [1]), and sorting based on external physical characteristics and RTU information (Equation [2]). Certainty equivalents are calculated using a constant relative risk aversion (CRRA) utility function. The CRRA utility function is represented mathematically as

$$(3) \quad E(U)_r = \sum_{i=1}^{n} \omega_i \frac{W_i^{1-r}}{1-r}, \quad r \neq 1$$

or

$$(4) \quad E(U)_r = \sum_{i=1}^{n} \omega_i \ln(W_i), \; r = 1,$$

where $W_i = W_0 + NR_i$, r is a risk aversion coefficient, and ω_i is the weight associated with each observation i. W_i represents simulated ending wealth, initial wealth is represented by W_0, and net returns are represented by NR_i. Initial wealth is assumed to be $100,000 (a level corresponding to roughly 100% equity in the 138 feeder heifers used in this study). Utility values are calculated for risk aversion coefficients of 1, 2, and 3. Hardaker, Huire, and Anderson suggest that relative risk aversion coefficients for a risk-averse individual will be in the range of 0.5 to 4. They offer the following scale summarizing the degree of risk aversion associated with each level of the relative risk aversion coefficient: 0.5, hardly risk averse at all; 1.0, somewhat risk averse (normal); 2.0, rather risk averse; 3.0, very risk averse; and 4.0, almost paranoid about risk (p. 102). Thus, the range of coefficients examined here (1–3) should be sufficient to capture the majority of producer risk attitudes. It is broadly consistent with the range of risk aversion considered by Van Tassel et al. in a similar context. Certainty equivalents for each hedge ratio are calculated by inverting Equation (3) or (4), that is, solving for the level of certain net return that would result in an observed level of utility (Hardaker, Huirne, and Anderson). The value of ultrasound information is taken to be the difference in certainty equivalents between the latter two sorting strategies.[3]

[3] The use of certainty equivalents rather than simply net returns is considered important in the context of this decision because the level of price variability associated with the three possible market outlets for an individual heifer (stocker/light feeder heifer, heavy feeder heifer, or bred heifer) may not be consistent. Thus, the different sorting strategies examined here are likely to differ not only in the level but also in the variability of returns. Use of the expected utility framework incorporates the impact of such differences in variability on the optimal strategy for a decision maker of a defined level of risk aversion. According to Van Tassel et al., cow/calf producers are generally risk-averse individuals, preferring to accept a lower expected return in exchange for a lower oscillation of income.

Table 3. Estimated Parameters for Logit Model to Predict Outcome of Artificial Breeding of Beef Heifers using Visual and Real-Time Ultrasound Data

Independent Variable	Visual Data			Ultrasound Data		
	Estimate	Wald χ^2	$P > \chi^2$	Estimate	Wald χ^2	$P > \chi^2$
Intercept	−8.167	12.972	<0.001	−125.400	4.188	0.041
Year	0.232	0.103	0.749	1.346	2.223	0.136
WT	0.005	1.637	0.201			
BCS	1.128	7.729	0.005	20.468	2.976	0.085
$TREAT_1$	−0.190	0.117	0.732	−0.636	0.905	0.342
$TREAT_2$	0.698	1.356	0.244	0.319	0.199	0.656
$TREAT_3$	−2.520	6.335	0.012	−3.557	7.803	0.005
$TREAT_4$	−0.459	0.306	0.581	−0.204	0.044	0.835
REA/(RF+RBF)				0.348	11.199	<0.001
*GMD*BCS*				−4.481	2.199	0.138
$GMD*BCS^2$				0.020	1.460	0.227
GMD/(RF+RBF)				−0.332	8.257	0.004
GMD				28.932	3.216	0.073
GMD^2				−0.762	2.385	0.123

Results and Discussion

The results of the estimation of Equations (1) and (2) are reported in Table 3. In the model incorporating ultrasound data, parameters on GMD appeared to be very important in helping to predict whether an animal would successfully breed. Interaction terms (linear and quadratic) between *GMD* and *BCS* were not statistically significant at $P < 0.10$ but did improve model predictions considerably and so were left in the model. Interaction terms between *REA* and external fat (*RF* and *RBF*) and between *GMD* and external fat were highly statistically significant. Linear and quadratic terms on *RF* and *RBF* alone were investigated but were found to be not statistically significant and to have little impact on predictions and so were dropped from the model. These results appear to be broadly consistent with observations by Minick et al. reporting data from carcass characteristics and reproductive performance on yearling beef heifers showing that heavier heifers tend to have more rump fat than lighter heifers. As a consequence, heavier heifers with more external fat are more likely to have more mature reproductive tracts at breeding and an increased probability of early breeding. Previous research also supports the notion that heifers that are farther along in growth and development (as evidenced by physical characteristics such as heavier weights, larger ribeye areas, and more rump fat) are more likely to have higher reproductive tract scores and to be cycling at 1 year of age. (Patterson et al. provide a good summary of this literature.)

Probability estimates from equations in Table 3 are used to sort heifers into different groups. In the first analysis, if the predicted probability of the heifer being successfully bred is less than 0.50, then the heifer is valued as a stocker/light feeder calf being sold prior to backgrounding/heifer development. A stocker calf production cost of $350 is assessed to determine a net return for the calf. If the predicted probability is equal to or greater than 0.50, then the heifer is retained for breeding purposes. Retained heifers are valued either as bred heifers, if successfully bred, or as commercial feeder cattle, if not successfully bred. Additional costs of $225 for backgrounding prior to breeding, $46.10 for progesterone implants and breeding,[4] and $50 for maintenance and development costs

[4] Breeding costs per head consist of the following: CIDR® implant, $8.60; applicator, $12.50; technician fee, $10; and semen, $15.

Table 4. Summary of Predictions of Heifer Conception from Three Alternative Sorting Strategies

Sorting Strategy	True Positive	False Positive	True Negative	False Negative	Total
No Sort	86	52	0	0	138
Visual Sort	72	21	31	14	138
RTU Sort	75	18	34	11	138

Note: True positive denotes a heifer that was successfully bred after being predicted to breed; false positive denotes a heifer that failed to breed after being predicted to breed; true negative denotes a heifer that failed to breed after being predicted not to breed; and false negative denotes a heifer that was successfully bred after being predicted not to breed.

from breeding to pregnancy check are assessed.

Table 4 summarizes the results of each of the three sorting strategies (i.e., no sort, a visual sort, and a sort based on RTU data) in terms of number of correct and incorrect predictions. Note that the use of RTU data does appear to improve predictions related to successful AI breeding. Of the 86 heifers successfully bred in this study, 75 were correctly predicted using RTU data. This compares with 72 correctly identified using a visual sort. Likewise, of the 54 heifers that failed to conceive, 34 were correctly predicted using the RTU data compared with 31 using the visual sort. Thus, six more animals (about 4% of the total sample) were correctly sorted using RTU data compared to using just a visual assessment.

Historic stocker and feeder cattle prices from Oklahoma City for the period 1991–2005 are used to stochastically simulate 1,000 possible outcomes for stocker, feeder, and bred heifer prices. Bred heifer prices are not readily available; however, prices from the Missouri Show-Me Select Heifer sale from 1998 through 2004 are available. The correlation between these prices and the Oklahoma City feeder heifer price series for those same years is very high (0.96). On average, with these data, the bred heifer prices are about 150% of the commercial feeder heifer price. Consequently, rather than simulate a separate bred heifer price series with limited data, simulated commercial feeder heifer prices are scaled up by 150% to derive a stochastic bred heifer price series. Sensitivity analysis is conducted to assess the effect of alternative assumptions about backgrounding costs and bred heifer premiums on results.

Calculated certainty equivalents for no sorting, sorting based on visual characteristics observed at the beginning of backgrounding, and sorting based on ultrasound readings taken at the beginning of backgrounding are reported in Table 5.[5] (Recall that these certainty equivalents are based on a herd size of 138 head.) These results indicate that the value of RTU data is about $10 per head across the different risk aversion levels investigated here.

It should be pointed out that as heifer development cost increases, the difference between certainty equivalents from not sorting and from sorting using either method (i.e., visual characteristics or RTU data) increases steadily, reflecting primarily the effect of saving heifer development costs on heifers that will fail to breed. However, the value of RTU is defined here as the difference between sorting using RTU data and sorting using only visual characteristics. That difference is not affected by changes in backgrounding costs. The reason for this is that changes in backgrounding costs will affect returns only on retained heifers. Coincidentally, both the model using visual characteristics and the model using RTU data retain the same number of heifers (the sum of true and false

[5] Certainty equivalents reported in Table 5 are based on an initial wealth value of $100,000. As noted, this is a level of wealth roughly equivalent to 100% equity in the 138 feeder heifers used in this study. Sensitivity analysis was performed with the initial wealth level varying from $50,000 to $200,000 in $50,000 increments. Certainty equivalents increased some (roughly 3%–5%) with each $50,000 increase in initial wealth; however, since certainty equivalents for all sorting strategies were affected similarly by changes in initial wealth, the value of RTU data is not affected in any meaningful way by the initial wealth level.

Table 5. Certainty Equivalents from Alternative Heifer Sorting Strategies Including Sorting Based on Real-Time Ultrasound (RTU) Data Taken Prior to Backgrounding

Backgrounding Cost ($/head)	No Sort	Visual Sort	RTU Sort	Value of Visual Sort	Value of RTU Sort	Value of RTU Data ($/head)
			Risk aversion coefficient = 1			
185	28,982	29,470	30,875	488	1,893	10.18
225	23,391	25,716	27,121	2,325	3,730	10.18
260	18,493	22,429	23,834	3,936	5,341	10.18
			Risk aversion coefficient = 2			
185	27,413	28,315	29,702	902	2,289	10.05
225	21,752	24,527	25,913	2,775	4,161	10.04
260	16,787	21,209	22,595	4,422	5,807	10.04
			Risk aversion coefficient = 3			
185	25,885	27,188	28,556	1,303	2,671	9.91
225	20,155	23,366	24,734	3,212	4,579	9.91
260	15,124	20,018	21,385	4,894	6,261	9.91

Note: Reported certainty equivalent and RTU value per head are based on herd size of 138 head of cattle.

positives in Table 4) though not the same heifers.

Bred heifer value does have a significant impact on the value of RTU data, influencing the benefit received from more correctly identifying heifers to include in the breeding program. Table 6 summarizes the value of sorting in general and with RTU data in particular at two different levels of bred heifer prices. Note that bred heifer values are expressed as a percentage of feeder heifer value.

In this table, the value of sorting with either method decreases as bred heifer value increases. This is due to the fact that as bred heifer value increases, the benefit received from sorting off heifers that do not breed is more fully offset by forgone income on heifers that would have bred but were incorrectly sorted off. Still, even at a fairly high level of bred heifer premium, the value of sorting (either visually or with RTU) remains positive. Moreover, the value of RTU data (again, taken to be the difference between certainty equivalents from RTU sorting and visual sorting) increases as bred heifer values increase. As heifer value increases, the improved accuracy of the RTU sort, in terms of not sorting off animals that would successfully breed, obviously becomes more valuable.

The value of ultrasound data taken at day 84 (progesterone implant removal prior to artificial breeding) of the backgrounding program was also briefly investigated. While ultrasound readings taken at this point were found to improve predictions of which cattle could be successfully bred, the value of those predictions was greatly limited by the fact that

Table 6. Certainty Equivalents from Alternative Heifer Sorting Strategies at Different Levels of Bred Heifer Premium

Bred Heifer Premium	No Sort	Visual Sort	RTU Sort	Value of Visual Sort	Value of RTU Sort	Value of RTU Data ($/head)
130%	11,963	16,141	17,147	4,177	5,184	$7.29
150%	23,391	25,716	27,121	2,325	3,730	$10.18
170%	34,818	35,290	37,093	472	2,275	$13.07

Note: Bred heifer premium shows bred heifer value as a % of 800-pound feeder heifer value. Backgrounding cost in each scenario is assumed to be $225/head. Reported certainty equivalents and RTU value per head are based on herd size of 138 head of cattle.

most of the costs associated with heifer development had already been incurred by this point in the production process. Sorting based on ultrasound data taken at progesterone implant removal prior to breeding actually resulted in a lower certainty equivalent than placing all cattle into the breeding program.

Conclusions

Ultrasound measures taken at the beginning of the heifer development program, which allowed cattle with a low probability of breeding to be sorted out as stocker calves, were found to have a positive value in most cases. With the data from 138 heifers used in this study, the value of RTU data was around $10 per head over a fairly wide range of production cost and risk aversion levels. Obviously, the remaining relevant question is whether this amount is economically significant. Walker estimates the cost of taking ultrasound readings on carcass merits at reimplant in a commercial feedlot to be $4.58 per head. Clearly, however, ultrasounding replacement females on the farm is a much different proposition than ultrasounding fed cattle in a large commercial feedlot. Skalland reports technician fees for on-farm RTU readings in the range of $10 to $17 per head. This suggests that the economic significance of the value for RTU data estimated from this research would be questionable. Under certain conditions related to backgrounding costs and/or bred heifer value, sorting females based on RTU readings could provide some positive net benefit.[6] Moreover, it is likely that the cost of ultrasounding on the farm would vary with the number of head being ultrasounded, with lower per head rates for larger herd sizes. If this is the case, then the economic significance of RTU value will vary directly with the scale of production.

It is quite possible that RTU data on replacement females could have value beyond simply predicting fertility. Relationships between female carcass merits and the carcass merits of offspring could serve as a useful means of predicting grade and yield of those offspring. That would mean that ultrasound data on females could potentially be used as a guide to marketing decisions on their offspring in a similar fashion to that investigated in Koontz et al. and Lusk et al. An investigation of this possibility is an important subject for further research in this area.

[6] The fact that the value of RTU data was not influenced by backgrounding costs for this particular set of heifers is likely an aberration. The principles illustrated with these data—that the value of more accurate sorting increases as backgrounding cost increases and that RTU data can improve the accuracy of sorting relative to visual sorting—suggest that, in general, higher backgrounding costs should increase the value of RTU data.

[Received October 2006; Accepted July 2007.]

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