PRODUCTION OF YOUNG BULL BEEF

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Numerous reports citing experiment data continue to claim advantages in gain rates and feed efficiency for bulls in comparison with steers. Although most experiment data agree about such advantages, magnitudes differ considerably among the reports for good reason. Variations in the design of bull-steer experiments are almost as copious as the number of stations reporting results. Bulls and steers used in any given experiment are generally of comparable age and have been subjected to the same feeding environment, but rations tend to differ among experiments, as do breed, age, and time on feed. Though some researchers feed to a predetermined slaughter weight which may differ for steers and bulls, others feed both on equal number of days. Likewise, because some studies have been designed for carcass comparisons of steers and bulls, they fail to provide critical feedlot performance data such as feed efficiencies. Carcass data may or may not include slaughter weights, dressing percentages, or yield of retail cuts.

An ideal experiment, designed to estimate differences in feedlot performance and carcass characteristics between bulls and steers, could start with twin bull calves maintained in the same environment before and after one was castrated, and fed like rations until they were slaughtered at the optimal time. The carcasses then would be subjected to duplicate evaluation criteria. Unfortunately, twinning in cattle is not frequent enough to produce an adequate quantity of animals for such experiments.

Equally lacking are data to identify the optimal slaughter point, especially for bulls. From an economic standpoint, optimal slaughter time would be when marginal cost of gain equals marginal value added to the animal, and would reflect the incremental effect of added weight on quality grade, dressing percentage, yield grade or retail yield, and palatability. Unfortunately, animal scientists conducting such feeding trials have given too little attention to this design issue.

Experimental data for feetlot performance and carcass characteristics are available, however, for bulls and steers selected from the same breed, of approximately equal ages, and fed identical rations without artificial growth stimulants the same number of days. The information is restricted to British breeds in an attempt to minimize variation due to breed differences, and selection criteria for experiment data trim the number of reports reviewed to 14 [1-3, 5-9, 11-13, 15, 18, 20]. These data, collected from 947 head of cattle in nine states, are used to estimate differences in feedlot performance and carcass characteristics between bulls and steers.

PROCEDURE

The aforementioned experiments generally report bull and steer mean values for the following variables (or values from which they can be constructed): initial weight, initial age, days on feed, feed efficiency, gain rate, final slaughter weight, dressing percentage, and carcass grade. These mean values can be used within a statistical model to test hypotheses such as zero differences in feedlot performance and carcass characteristics between bulls and steers.

Because the variance associated with gain rate (or any other dependent variable) is expected to be constant for each animal across experiments, *ceteris paribus*, and different numbers of animals are used within experiments, the variance of the mean response is expected to equal δ^2/n_i where δ^2 is the constant variance of observations across experiments and n_i is the number of animals (either bulls or steers) used in the ith experiment. A generalized least squares technique (GLS) is utilized to avoid the inefficiency of ordinary least squares estimation of a model containing heteroscedastic disturbances. Specifically, because the variance of the disturbances is of the form σ^2/n_i, the data are transformed by $\sqrt{n_i}$

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before use of the least squares technique [10, pp. 208-221].

A set of five dependent variables, gain rates (lb./day), feed efficiency (lb. feed/lb. gain), slaughter weight (lb.), dressing percentage, and carcass grade, were regressed on the following explanatory variables: sex condition, initial weight (lb.), initial age (days), days on feed, and breed.

RESULTS

Initially, each dependent variable was regressed on the entire set of explanatory variables (Table 1). As expected, a relatively high degree of pairwise correlation was found between initial weight and initial age. Correlation coefficients ranged from a low of .79 to a high of .97, the latter occurring in the feed efficiency (feed per unit gain) equation. Pairwise correlation between initial age and days on feed was high only for the feed efficiency (feed per unit gain) equation. For all others, it ranged from .18 to .35. Similar results hold for pairwise correlation between initial weight and days on feed.

The equations were respecified by deleting insignificant explanatory variables (Table 2). For the first four dependent variables, this step entails dropping certain dummy variables and generally either initial weight or initial age. As evidenced by the results, this deletion did not greatly change the magnitudes of the coefficients. For feed efficiency (TDN/unit gain), this approach did modify the coefficients. Removing days on feed from the equation for feed efficiency (feed/unit gain) did not greatly affect the estimated coefficients, but did improve their precision.

The final specification (Table 2) indicates that most variation in gain rate, final or slaughter weight, carcass grade, and feed efficiency can be explained by the explanatory variable set. The coefficients are generally highly significant with signs as expected. The results for individual dependent variables follow.

Gain Rates

Bulls gain significantly faster than steers, averaging about 15.0 percent more per day.

TABLE 1. RESULTS OF GENERALIZED LEAST SQUARES (GLS) REGRESSIONS, INITIAL SPECIFICATION

	Explanatory variables							
Dependent variable	Constant	Bull-steer dummy (steer = 0 bull = 1)	Initial weight	Initial age	Days on feed	Breed dummy (Hereford = 0, Angus = 1)	R^2 [d]	Valid N
Gain rate	3.318**** (9.09)[a]	0.314** (3.12)	0.001 (0.83)	-0.004* (-1.71)	-0.003**** (6.63)	-0.131 (0.80)	.96	46
Final or slaughter weight	411.505**** (6.17)	73.016*** (3.97)	0.814*** (4.08)	-0.248 (-0.65)	0.775**** (8.12)	-30.660 (-1.03)	.60	46
Dressing percentage	56.759**** (22.80)	0.024 (0.06)	0.016* (2.25)	-0.009 (-1.11)	-0.005* (-2.64)	0.344 (0.53)	.27	42
Carcass grade	17.075**** (11.38)	-1.851*** (-7.37)	0.013** (2.90)	-0.016** (-3.19)	0.002* (1.83)	0.249 (0.63)	.66	42
Feed efficiency [b]	-2.175 (-0.52)	-0.757** (-3.72)	-0.003 (-0.66)	0.026 (1.70)	0.005**** (5.73)	2.487 (1.14)	.77	22
Feed efficiency [c]	7.019** (3.81)	-1.212**** (-6.04)	0.012*** (4.14)	-0.017* (-2.53)	0.003 (0.52)	1.096** (3.54)	.84	20

[a]Parentheses contain calculated t-values.

[b]Measured as total digestible nutrients (TDN) per unit of gain.

[c]Measured as feed per unit of gain.

*significant at .1 level.

**significant at .01 level.

***significant at .001 level.

****significant at .0001 level.

[d]Based on untransformed variable. Values for the transformed dependent variables were approximately .99.

Feed Efficiency

In the experiments, measures of feed efficiency are expressed as units of total digestible nutrients (TDN) per unit of gain or units of feed per unit of gain; therefore, observations have been grouped and regressed separately. Bull-steer comparisons of feed efficiency should be comparable, however, regardless of approach. Bulls are estimated to be 11.9 percent more efficient in the TDN group and 13.9 percent in the other. Note that increasing values for the feed efficiency variable would indicate declining efficiency in feed conversion.

Slaughter Weights

If one assumes equal initial weights and days on feed, bulls slaughter heavier than steers by a significant 7.1 percent. However, if animals of equal ages are assumed and the bulls' initial weights are 5 percent heavier than the steers', bull slaughter weight would be 8.9 percent greater for equal days on feed.

Dressing Percentage

Variations between bull and steer dressing percentages are negligible; however, initial weights and days on feed were significantly related to dressing percentages.

Carcass Grade

Bull carcasses averaged about two thirds of a grade lower than steer carcasses, if one allows for differences in initial age, days on feed, and initial weights. The negative sign of the coefficient of initial age indicates that, other things held constant, carcass grade declines with advanced age. This observation corresponds with USDA grading standards in effect prior to February 23, 1976.

OTHER CHARACTERISTICS

In addition to variables used in the regressions, other considerations are related to the production of bull beef. Although the experiments neither uniformly address nor measure such factors as carcass yields, feedlot behavior, and consumer acceptance of bull beef and Good grade beef, the reports do provide information on these topics.

Carcass Yields

Experiment data consistently credit bull carcasses with a higher proportion of wholesale

TABLE 2. RESULTS OF GENERALIZED LEAST SQUARES (GLS) REGRESSIONS, FINAL SPECIFICATION

	Explanatory variables							
Dependent variable	Constant	Bull-steer dummy (steer =0 bull = 1)	Initial weight	Initial Age	Days on feed	Breed dummy (Hereford = 0 Angus = 1)	R^2 [d]	Valid N
Gain rate	3.250**** (13.28)	0.296** (3.16)		-0.002* (-2.41)	-0.003**** (-6.91)		.84	53
Final or slaughter weight	377.758**** (6.13)	63.238** (3.06)	0.731**** (6.91)		0.782**** (6.94)		.51	55
Dressing percentage	57.466**** (24.16)		0.009* (1.71)		-0.004* (-1.81)		.33	51
Carcass grade	16.983**** (10.55)	-1.833**** (-7.05)	0.013** (2.95)	-0.017*** (-4.08)	0.003* (2.13)		.64	49
Feed efficiency [b]	2.346*** (4.48)	-0.732** (-3.69)		0.009**** (4.95)	0.005**** (6.73)		.76	22
Feed efficiency [c]	7.953**** (20.21)	-1.218**** (-6.24)	0.012*** (4.41)	-0.019** (-3.37)		1.026** (3.77)	.84	20

[a]Parentheses contain calculated t-values.

[b]Measured as total digestible nutrients (TDN) per unit of gain.

[c]Measured as feed per unit of gain.

[d]Based on untransformed variable. Values for the transformed dependent variables were all approximately .99.

*significant at .1 level

**significant at .01 level

***significant at .001 level

****significant at .0001 level.

and retail cuts. However, no consistent measure of carcass yield that could be used as a dependent variable in the regressions appeared among the reports.

Behavior Problems

Another consideration in feeding young bulls is their temperment and feedlot behavior. At best, unfettered aggressiveness retards gains; at worst, it damages facilities and injures cattle or personnel. Observations from the experiments, however, do not indicate behavior problems. Klosterman [11, 12] and Field et al. [5] record very little or no difference in the amount of restlessness between bulls and steers in the feetlot or in handling during feeding and weighing. Matsushima and Sprague state apropos of bulls weighing 400 to 600 pounds, "Steers and bulls can be fed together in the same pen provided that they are put in the feetlot at the same time. Certain amount of riding will take place during the first few days but it will gradually subside and be no problem" [14, p. 6].

Smith offers the following guidelines for feeding young bulls [17, p. 14].

1. Bulls should be fed to finish as fast as possible. Therefore, a high energy ration should be fed throughout the finishing period.

2. Slaughter weight should be obtained before 18 months of age.

3. Bulls do not respond to hormone or hormone-like compounds such as DES.

4. After bulls have started on feed, do not add new bulls to the pen.

5. When selling bulls, strive not to mix bulls any more than necessary. If possible, do not permit bulls to stand in pen overnight prior to slaughter.

Maintaining the integrity of a pen of bulls or a mixed pen does not appear to constitute an inconvenience to the operator of a modern feedlot facility and might prevent management problems.

Consumer Acceptance

Bull Beef. Several experiments include sensory evaluation of bull and steer meat to determine what, if any, differences can be detected by taste panels. Field et al. examined the effect of age and sex on tenderness, flavor, and juiciness of meat from British straight and crossbreeds [4]. They compared bull to steer and heifer meat from animals in the age groups 300-399, 400-499, 500-599, and 600-699 days. Results indicate that bull meat from animals under 400 days is just as palatable as meat with comparable marbling from steers and heifers. Steer and heifer beef inthe 400-499 day range rates slightly superior to bull beef in tenderness, flavor, and juiciness, although differences in tenderness are not significant at the .01 level. In the 500-599 day age class, the difference in tenderness between the steer and heifer beef and bull beef is statistically significant at the .01 level. From 600 to 699 days the steer and heifer beef is significantly (.01 level) superior to bull beef in tenderness, flavor, and juiciness.

Though the report indicates that taste panels can detect increasing differences between steer and bull meat prepared under strict laboratory conditions as the animals mature beyond 400 days, these slight differences at the younger ages might not be noticed by consumers in their wide range of home preparations. However, published research involving consumer preparation and evaluation of meat from bulls is limited.

Of the 14 experiments used for this study, only reports by Miller et al. [15] and Field et al. [5] contain consumer evaluation based on home preparation of bull and steer beef. In the report by Miller et al., returns from consumer questionnaires reveal that at least 82 percent of the time retail cuts from bull carcasses, when evaluated for flavor, tenderness, and overall acceptability, rate the same as or better than meat normally purchased. In the latter study, "Consumers gave bull steak significantly lower taste and tenderness ratings but thought that chuck roasts from bulls were more desirable because of less intermuscular fat" [5, p. 23]. "Ninety and 91 percent of the consumers who bought steaks and 88 and 92 percent of the consumers who bought roasts from bulls and steers, respectively, said they would buy them again" [5, p. 23].

Four of the bull-steer experiment reports offer taste-panel evaluations of bull and steer beef prepared under laboratory conditions; they reflect no significant difference between bull and steer beef for tenderness, juiciness, flavor, and overall acceptability [2, 3, 6, 13].

Klosterman et al. also note no significant differences in tenderness [11]. Arthaud et al. present results indicating that steer beef is more tender and less off-flavored than bull beef (.01 level), but they find no significant differences in juiciness and flavor intensity [1]. Hedrick et al. [7] discern no significant difference in flavor or juiciness, but find steer beef more tender (.05 level). However, in their experiment bulls averaged 624 days at slaughter compared with the mean steer age of 610, a difference significant at the .05 level. Their results resemble the finding of Field et al. that bull meat is significantly less tender than steer meat beyond 500 days [4].

A separate classification of slaughter cattle was established, effective July 1, 1973, by the U.S. Department of Agriculture to distinguish between young bulls less than approximately 24 months of age and older bulls. Animals qualifying for this new class are termed "bullocks" and are graded by quality grade standards essentially the same as those for steers of comparable maturity [19]. Revised USDA grade standards, effective February 23, 1976, allow slightly leaner beef (less marbling) to qualify for Prime and Choice grades and redefine the Good grade to make it more restrictive. Despite the available marketing classification for young bull beef of Good or Choice quality and the fact that research indicates consumers would find young bull beef acceptable, little or no beef is currently being marketed as "bullock." Additional research seems warranted, especially in the marketing sector, to assess consumer acceptance of young bull beef as well as the price one would be willing to pay for the product.

Good Grade Beef. Beef from bulls less than 500 days old may be limited to Good quality, primarily as a result of insufficient marbling. Much of the beef marketing system and consuming public, however, is oriented toward Choice grade beef. Research by F. C. Parrish et al. indicates that among rib steaks with slight, modest, and moderately abundant marbling, the ". . .degree of marbling had essentially no effect on flavor, tenderness, juiciness, [and] overall acceptability" [16, p. 431]. Additional research is needed to confirm or refute these findings and to identify the benefits, if any, that accrue from fattening young cattle to Choice grades.

IMPLICATIONS

Producers

Total production costs for bulls exceed those for steers on a per head basis, but are lower per pound of carcass weight if identical dressing percentages are assumed (Table 3). Regression results indicated bull-steer differences in dressing percentage were not significant. Net returns per head are sensitive to the price discount between Choice and Good grades and is assumed that bullock beef would receive no additional price discrimination. In the example shown, changing the Choice-Good price spread from $3.00 per hundredweight to $2.50 moves the bull beef from $1 per head less profitable than steer to $4 per head more profitable.

These bull-steer cost and return comparisons are based on feetlot feeding after weaning. If feed grain prices rise and/or cattle prices fall to the point that feeding calves becomes unprofitable, steers have an advantage in that they can be grass-fed for a year or so before slaughter, with or without a brief finishing period in the feedlot. Bulls become less palatable with advancing age more quickly than steers, and thus do not have as much flexibility for attaining heavier weights on pasture.

Consumers

Price and cholesterol conscious consumers have generated enough demand for lean beef to encourage some grocery chains to market Good grade steer and heifer beef under house brands. Because feeding costs can be reduced by eliminating the amount of feed required for the additional fat needed to raise the carcass grade from Good to Choice, total production cost falls. Higher gain rates and better feed efficiency enable bulls to produce Good grade carcasses with palatability characteristics comparable to those of steers at lower cost. This advantage could be passed on to the consumer. Price incentive combined with health considerations probably would stimulate demand for the bull product.

TABLE 3. ECONOMIC IMPLICATIONS FOR PRODUCERS

Example data	Unit	Steer	Bull
Performance			
Initial weight	Lb.	450	473
Gain rate	Lb./day	1.98	2.27
Days on feed		240	240
Total gain	Lb.	475	545
Sale weight	Lb.	925	1,018
Slaughter grade		Choice	Good
Dressing percentage		61.5	61.5
Costs and returns			
Feeder cost @$50/cwt.	Dol.	225	236
Feedlot cost @40¢/lb. of gain	Dol.	190	190 (545 X .4 X .871)
Total cost	Dol.	415	426
Cost per lb. of carcass weight	Dol.	.73	.68
Total returns,			
@$44/cwt. for Choice	Dol.	407	
@$41/cwt. for Good	Dol.		417
Net returns	Dol.	-8	-9
Net returns @$41.50/cwt. for Good	Dol.	-8	-4

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