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Effect of Frame Size and Hormone Implant on Performance and Carcass Characteristics of Finishing Yearling Heifers: Returns to a Value-Based Market

Allen Trenkle
Iowa State University

J. C. Iiams
Iowa State University

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Abstract
Four groups of yearling heifers representing different frame sizes—small, medium, and large Angus and medium Simmental—were fed high-grain finishing diets to average Low Choice quality grade. Half the heifers were implanted with estrogen and trenbolone acetate. Backfat and ribeye area were measured by ultrasound four times during the study to assess growth of muscle and fat. Increasing frame size resulted in increased feed intake, greater rates of gain, and a trend towards reduced feed conversion. Greater returns would have been realized from each of the four groups had they been sold in a premium market based on yield grade rather than the conventional grade and yield market. Increasing frame size resulted in greater returns to the value-based market. Implants increased rate of gain and improved feed conversion but did not result in significantly greater returns to the value-based market compared with the grade and yield market. Ribeye area and backfat increased with body weight and time on feed. Increase in ribeye area was linear with time, whereas accumulation of backfat was exponential. Rate of increase in area of ribeye tended to increase and backfat tended to decrease as frame size increased. Implants increased rate of increase in ribeye area but had no effect on rate of deposition of subcutaneous fat. Equations describing growth of ribeye area and backfat for each group predicted average growth for the heifers but did not predict growth of individual heifers. Final carcass yield grade was related to initial thickness of backfat but not to initial ribeye area. These results indicate that the type of cattle selected to be fed for a premium market based on yield grade is important to the success of the program. More work is needed to develop growth equations from ultrasound measurements, but ultrasound will likely be a useful tool in selecting feeder cattle for a value-based market.

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Effect of Frame Size and Hormone Implant on Performance and Carcass Characteristics of Finishing Yearling Heifers: Returns to a Value-Based Market

A.S. Leaflet R1343

Allen Trenkle, professor of animal science, and
J. C. Iiams, graduate research assistant

Summary

Four groups of yearling heifers representing different frame sizes--small, medium, and large Angus and medium Simmental--were fed high-grain finishing diets to average Low Choice quality grade. Half the heifers were implanted with estrogen and trenbolone acetate. Backfat and ribeye area were measured by ultrasound four times during the study to assess growth of muscle and fat. Increasing frame size resulted in increased feed intake, greater rates of gain, and a trend towards reduced feed conversion. Greater returns would have been realized from each of the four groups had they been sold in a premium market based on yield grade rather than the conventional grade and yield market. Increasing frame size resulted in greater returns to the value-based market. Implants increased rate of gain and improved feed conversion but did not result in significantly greater returns to the value-based market compared with the grade and yield market. Ribeye area and backfat increased with body weight and time on feed. Increase in ribeye area was linear with time, whereas accumulation of backfat was exponential. Rate of increase in area of ribeye tended to increase and backfat tended to decrease as frame size increased. Implants increased rate of increase in ribeye area but had no effect on rate of deposition of subcutaneous fat. Equations describing growth of ribeye area and backfat for each group predicted average growth for the heifers but did not predict growth of individual heifers. Final carcass yield grade was related to initial thickness of backfat but not to initial ribeye area. These results indicate that the type of cattle selected to be fed for a premium market based on yield grade is important to the success of the program. More work is needed to develop growth equations from ultrasound measurements, but ultrasound will likely be a useful tool in selecting feeder cattle for a value-based market.

Introduction

Selection for larger frame size and use of hormone implants have been used to increase growth rate of cattle and improve economic returns. Large-frame cattle are usually not as efficient as those of medium frame and may not always be the most economical. The value of the beef carcass is determined primarily by weight, quality grade, and yield grade. Because small-frame cattle are fatter than large-frame cattle at equal live weights, they cannot be fed to similar weights, thereby reducing total weight gain in the feedlot. Implants, however, increase growth rate and improve feed efficiency. Implanting cattle results in more total gain in the feedlot without accumulation of excessive fat in the carcass. This experiment was conducted to compare feedlot performance of yearling heifers of different frame size and to study the effects of a hormone implant on performance and carcass characteristics. A second objective was to compare the effects of body type and implants on how the heifers would have performed in a value-based market determined by yield grade and to evaluate the use of ultrasound in predicting placement of the heifers into marketing groups.

Materials and Methods

Ninety-five 17- to 18-month-old Angus and Simmental heifers in the Iowa State University breeding herd that were not pregnant after the breeding season were used in this study starting in late September. The Angus heifers were offspring of Angus crossbred cows and Angus bulls representing small-, medium-, and large-frame scores. The Simmental heifers were from crossbred cows and medium-frame-score Simmental bulls. The heifers had been grazed during the summer months and had not been implanted prior to this study. Upon arrival at the feedlot, they were given loose hay and a mixed diet containing 60% grain and supplement and 40% ground corn cobs. The hay was gradually removed from the diet during the first week, and the heifers were switched to the finishing diet described in Table 1. The diet was formulated to contain 13% crude protein and to provided adequate minerals and vitamins to meet established requirements of the heifers. Six heifers were allotted at random from weight-outcome groups within each of the four groups to each of four pens (five Simmental heifers in one pen) and two pens from each group were allotted at random to be implanted with Synovex®-H and Finaplix®-H at the start of the experiment.

The heifers were weighed individually in the morning, before feeding, on two consecutive days at start and end of the experiment and at 28-day intervals throughout. Height at the hips of each heifer was measured at the start and end of the experiment. Area of the *longissimus* muscle and depth of subcutaneous fat over the 11th and 12th ribs were measured for each heifer using ultrasound at 5, 48, 98, and 117 days from the beginning of the experiment. The heifers were fed twice daily and had free access to water. Heifers were sold when judged by visual appraisal to grade Low Choice. All the small-frame Angus and two heifers showing the most finish in each of the pens of medium Angus were sold after being fed 97 days. The remainder of the heifers were sold after being fed 117 days. All the heifers were slaughtered at a commercial beef-packing plant. Weights of hot carcasses were taken after slaughter, and measurements on the carcasses were obtained after 48 hours in the cooler. Ribeyes were traced on acetate paper and backfat was measured with a ruler while the carcasses were on the moving line in the grading area of the cooler. Yield grades from individual carcasses were calculated from measurements on the carcasses by using the standard yield grade equation. Dressing percentage was calculated from hot carcass weight and the average of the two final liveweights taken at the farm.

Feedlot performance and carcass data were analyzed as a factorial design by analysis of variance with frame size and implant as main effects. Standard error of the means and least significant difference ($p < .05$) between means also were calculated. Regression analysis was used to establish curves to fit the ultrasound measurements.

Table 1. Composition of diet (dry basis)

Ingredient	% of dry matter
Cracked corn	79.0
Alfalfa pellets	12.0
Molasses	2.0
Urea	.77
Soybean meal	5.0
Dicalcium PO_4	.032
Limestone	.80
NaCl	.30
Elemental sulfur	.025
Trace mineral premix	.024
Vitamin A premix[a]	.08
Cattlyst premix[b]	.0111

[a]Provided 1,400 IU of vitamin A per pound of dry matter.
[b]Provided 5.55 mg potassium laidlomycin propionate per pound of dry matter.

Results and Discussion

Feedlot and carcass data

The feedlot performance of the heifers used in this study is summarized in Tables 2 and 4. Feed intake and rate of gain increased with frame score, but large-frame heifers required about 5% more feed per unit of gain. On average, implants increased gain 5% and improved feed conversion 6%. The growth response to implants containing estradiol and trenbolone acetate by these heifers was less than that observed in previous experiments with yearling heifers (A.S. Leaflet R1142); however, carcass weights of the implanted heifers were significantly heavier. The implants did not increase feed intake as observed in other experiments. The medium- and large-Angus heifers had greater height at the hips at the start of the experiment and grew an average of 2.4 inches compared with 1.2 inches in the small Angus heifers. Implants did not increase hip height during the relatively short period the heifers were exposed to the anabolic stimulus. Liver abscesses were not a significant problem in this study.

Carcasses from larger heifers were heavier, had larger ribeye areas, less backfat, and had a greater percentage of yield grades 1 and 2 (Tables 3 and 4) than the small Angus heifers. The percentage of yield grades 1 and 2 was increased 44% in the medium and large Angus heifers compared with the small Angus heifers. Simmental heifers had lighter carcasses with similar ribeye size compared with the large Angus and therefore tended to have a greater percentage of yield grades 1 and 2. However, fewer of the carcasses from the Simmental heifers graded Choice. Implants increased carcass weight and area of ribeye and tended to decrease the percentage of Choice carcasses. The percentage of yield grade 1 and 2 carcasses was increased 14%, but average yield grade, fat thickness, and percentage of kidney-heart-pelvic fat were not significantly changed by the implant.

Value-based marketing

These results show that body type or frame score of feeder cattle is an important consideration in a premium market based on yield grade (Tables 3 and 4). The large Angus heifers were slightly less efficient in the feedlot, but they gained an average of 457 pounds per head compared with the small Angus that gained 330 pounds per head. All larger heifers returned more dollars to the feedlot above costs based on performance (Figure 1). All the groups of heifers in this study would have benefited from a premium market, because the heifers were not overfed. However, a higher percentage of the carcasses from the medium and large heifers would have received a premium which would have further increased the dollars returned per heifer from those groups (Figure 1). The medium Angus were superior to large Angus or Simmental heifers in either market. Most of this superiority resulted from less initial cost of the medium heifers and lower total feed costs. For the length of time they were fed, the Simmental heifers would have performed satisfactorily in a value-based market paying premium for improved yield grade, but in the grade and yield market which discounted heifers not grading Choice, they did not return as many dollars as the medium or large Angus. In this comparison all heifers were priced the same as feeders, whereas there probably would have been differences in the market place. The heifers in this study were sold in two groups. Additional sorting of the heifers would have resulted in each heifer being sold nearer her optimum marketing time. This might have changed the economic returns to each group in the two marketing programs compared.

Table 2. Summary of feedlot performance.

	Frame size									
	Small Angus		Medium Angus		Large Angus		Simmental		SEM[a]	LSD[b]
Item	C	I	C	I	C	I	C	I		
No. heifers	12	12	12	12	12	12	11	12		
Starting wt., lb	720	719	778	780	905	916	827	848	5.9	19.4
Ending wt., lb	1033	1064	1165	1210	1362	1374	1266	1286	15.2	49.9
No. days	97	97	110	110	117	117	117	117		
Daily gain, lb	3.23	3.56	3.51	3.89	3.91	3.92	3.75	3.75	.132	.431
Feed DM, lb/d	17.7	17.4	19.4	19.4	21.3	21.3	20.2	20.2	.368	1.50
Feed/gain	5.52	4.88	5.53	4.98	5.47	5.44	5.38	5.38	.153	.498
Liver abscesses	3	1					5			
Hip height, in										
Start	45.4	45.0	48.8	48.5	52.0	51.7	51.1	52.0	.521	1.700
End	46.8	46.1	51.4	50.7	54.9	54.1	53.0	54.5	.445	1.45

[a]Standard error of the mean.
[b]Least significant difference among means ($p < .05$).

Table 3. Summary of carcass data.

	Frame size									
	Small Angus		Medium Angus		Large Angus		Simmental		SEM[a]	LSD[b]
Item	C	I	C	I	C	I	C	I		
Carcass wt., lb	608.0	631.6	685.9	708.4	796.6	813.7	744.0	761.3	9.52	31.1
Dressing %	58.8	59.3	58.9	58.5	58.4	59.2	58.7	59.1	.401	1.31
Ribeye area, in^2	11.3	11.5	11.7	12.5	13.3	13.7	13.3	13.8	.289	.94
Fat cover, in	.52	.64	.43	.47	.48	.44	.43	.38	.061	.200
KHP fat, %	2.8	2.8	2.9	2.4	3.0	2.6	2.7	2.7	.155	.505
Quality grade										
Choice	10	10	11	9	12	11	7	6		
Select	2	2	1	3		1	4	6		
% choice	83.3	83.3	91.7	75.0	100.0	91.7	65.0	50.0	11.1	36.7
Yield grade										
1			1	1	1		2	2		
2	6	3	5	6	4	8	5	8		
3	5	5	6	5	6	4	4	2		
4	1	4			1					
Average	3.08	3.38	3.01	2.83	3.07	2.83	2.69	2.46	.231	.654

[a]Standard error of the mean.
[b]Least significant difference among means ($p < .05$).

Implants had less effect than body type on returns to a premium market based on yield grade (Table 4 and Figure 1), because implants did not significantly increase the percentage of yield grade 1 and 2 or reduce the number of yield grade 4 carcasses (Table 3). Implants, however, tended to increase the percentage of yield grade 1 and 2 in the large Angus and Simmental heifers. The economic benefits of implants resulted from heavier carcasses and improved feed conversion.

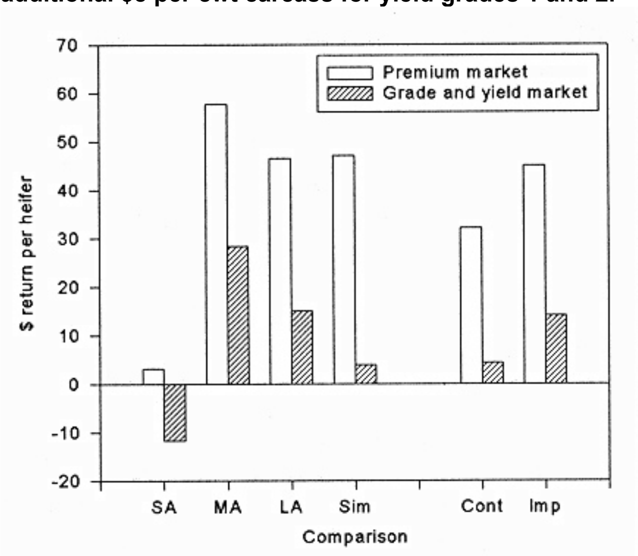
The data from this study with yearling heifers indicates that certain types of cattle are better suited to certain markets. In a grade and yield market, the medium Angus heifers were the most profitable. In a premium market, however, heifers with larger frames returned profits similar to the medium heifers and considerably more profit than the small heifers. The results also indicate that implants will not make the wrong type, such as the small Angus heifers, work in a premium market.

Value of ultrasound to market cattle

Results from the ultrasound measurements are shown in Figures 2, 3, 4, and 5 and Table 5. Area of ribeye and thickness of backfat significantly increased with increases in body weight or time on feed (Table 5). Implants tended to increase the rate of growth of ribeye area but had no effect on rate of increase of backfat. Thickness of backfat increased exponentially in relation to time (Figure 2). The large Angus heifers had somewhat slower rates of accumulation of backfat compared with the other groups. This observation is in agreement with that of Brethour (Kansas State University Report of Progress 570, 1989), who observed that large-frame steers accumulated backfat at a slower rate than smaller steers. The exponents in the growth equations calculated from this study with heifers ranged from .0119 for the large Angus heifers to .0151 for the Simmental heifers. Exponents in equations for

Brethour's steers ranged from .0072 to .01121. Implants did not significantly alter these exponents for finishing heifers.

Figure 1. Effect of frame score and hormone implant on economic returns to two marketing systems. SA, MA, LA, and Sim = small, medium, and large Angus and Simmental heifers. Cont and Imp = control and implanted heifers, respectively. See footnote to Table 4 for economic assumptions. Premium market paid an additional $8 per cwt carcass for yield grades 1 and 2.



Growth in area of the *longissimus* muscle was linear over the time these animals were studied (Figure 3). The unexpected finding was the extent of growth of this muscle (Table 4) from the first to the last ultrasound measurement. Even though these heifers had been managed as replacement heifers for the breeding herd, growth of the *longissimus* muscle seemed to have been compromised with the plane of nutrition the heifers received (grazing grass for the five months before this experiment was initiated). At the first ultrasound measurement, there was a significant positive relationship between size of the ribeye and thickness of backfat (REA, sq in = 7.59 + 3.14(backfat, in); $r = .24$; regression coefficient = 3.14 ± 1.30, $p < .05$)). This observation suggests that thickness of backfat at the first ultrasound measurement was related to previous quantity of nutrients available to the heifers. The heifers with more backfat tended to have larger ribeyes. After the heifers had been finished, there was no significant relationship between backfat and area of ribeye. In another study of steers coming from summer and fall grazing to the feedlot, similar small ribeye areas along with the positive relationship between backfat and ribeye area were observed at the first ultrasound measurement. The ultrasound measurements indicated that the small Angus heifers were fatter and more mature compared with the other heifers at the start of the experiment (Table 4). Increase in area of the ribeye was the least and increase in thickness of backfat was greatest for the small Angus.

Use of the growth equations to predict thickness of backfat (Figure 2) and size of ribeye (Figure 3) from the first ultrasound measurements is shown in Figure 4. The equations underpredicted both measurements but were reasonably close for the average of each type of heifer. However, the correlation of predicted size of ribeye or thickness of backfat from the first ultrasound measurements with the final measurements by ultrasound or actual measurements from the carcass were not significant, indicating these equations did not predict growth of individual heifers. (carcass ribeye area = 9.77 + 2.52(ribeye area predicted from first ultrasound); $r = .18$; regression coefficient = $2.52 \pm .14$; $p > .2$ and carcass backfat = .483 - .023(backfat predicted from first ultrasound); $r = .02$; regression coefficient = $.023 \pm .1$; $p > .8$) This lack of prediction of individual heifers may have resulted from the apparent relationship of previous nutrition and growth of these tissues up to the time of the first measurements. Animals that had superior nutrition thus were able to achieve a greater proportion of their muscle growth before the start of the experiment and therefore had less growth during the experiment. Including all the heifers, those with more initial backfat tended to have less growth of ribeye (gain in area of ribeye = 5.74 - 8.68(initial backfat, in); $r = .29$; regression coefficient = $8.68 \pm .89$; $p < .01$). It seems that heifers having fewer nutrients available for growth prior to this study had smaller ribeyes that had greater increase in size during the experiment. Cattle must have some genetic potential for area of ribeye, but gain of ribeye area was not related to the initial size of ribeye measured by ultrasound. The genetic potential for size of ribeye must have been masked by the effects of prior nutrition.

The relation between the last ultrasound measurements taken a few days before slaughter and the actual carcass measurements were statistically significant (Figure 5 and Table 5). The lack of a better fit of these data are the result of errors in the ultrasound measurements as well as the measurements of the carcasses taken on the moving chain at the packing plant. We think the accuracy of these measurements can be improved.

Using ultrasound measurements to predict yield grade was partially successful (Table 5). Initial backfat was a much more important determinant than area of ribeye. In this study, the first measurement of backfat by ultrasound predicted yield grade as accurately as the final measurement of backfat by ultrasound. If the equation in Table 5 based on the first ultrasound measurement had been used to place the heifers into a marketing group based on premiums for yield grade 1 and 2, 57 heifers would have been selected and 40 (70%) of those would have graded 1 or 2 at slaughter. Twelve heifers graded 1 or 2 that would not have been selected. None of the selected heifers graded 4. The prediction equation did not predict any of the yield grade 1 or 4 heifers. Fifty-two of the 95 heifers (55%) graded 1 or 2. Use of the equation relating the first ultrasound measure of backfat to final yield grade with these heifers would have increased the percentage of heifers grading 1 or 2 in the selected group.

The potential uses of ultrasound measurements of feedlot cattle include sorting incoming feeder cattle into potential value-based market groups as discussed in this report. Another use is to make the measurements when the cattle are nearly finished to more accurately establish selling dates to optimize returns from individual animals.

Implications

Fastest-gaining cattle might not always be the most economical in the feedlot if the costs of achieving the gain are too great. Feed cost and initial cost of the animals in this experiment seemed to be important considerations. Cattle with medium to large frame size are more suitable for a premium market based on yield grade. Implants improve economic returns to cattle feeding by improving performance but do not improve returns more significantly in a value-based market than in a more conventional market. This is our first attempt to use ultrasound measurements to predict future carcass value. The results of this study indicate that initial backfat may be the most important determinant of carcass value in yearling cattle that have been subjected to less than optimal growth conditions and then fed finishing diets for short periods of time. Additional studies are needed to determine if an initial measure of backfat and ribeye area along with growth prediction equations can be used to more accurately sort cattle into potential marketing groups.

Acknowledgments

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Table 4. Averages for body type and implant.

	Body type				Implant	
	SA	MA	LA	Sim	Control	Implant
No. animals	24	24	24	23	47	48
Daily gain, lb	3.40	3.70	3.91	3.75	3.60	3.78
Feed DM, lb/d	17.5	19.4	21.3	20.2	19.6	19.5
Feed/gain	5.20	5.25	5.46	5.38	5.48	5.17
Carcass						
Carcass wt, lb	619.8	697.2	805.1	752.7	708.6	728.6
Fat cover, in	.58	.45	.46	.41	.46	.48
Ribeye area in^2	11.4	12.1	13.5	13.5	12.4	12.9
% choice	83.3	83.3	95.8	57.5	85.0	75.0
% YG 1 & 2	37.5	54.2	54.1	73.9	51.1	58.3
Avg YG	3.23	2.92	2.95	2.58	2.96	2.88
First ultrasound						
Fat cover, in	.14	.10	.12	.07		
Ribeye area, in^2	7.9	7.6	8.3	8.0		
Last ultrasound						
Fat cover, in	.44	.39	.44	.38		
Ribeye area, in^2	11.0	12.8	13.9	13.5		
Economics[a]						
Total cost, $/head	640.97	712.85	825.37	768.82	732.36	740.27
Premium market value, $/carcass	644.13	770.60	871.82	815.91	764.86	785.30
Profit, $/head	3.16	57.75	46.45	47.09	32.05	45.03
Grade & yield value, $/carcass	629.33	741.22	840.44	772.77	736.73	754.40
Profit, $/head	-11.64	28.37	15.07	3.95	4.36	14.13

[1a]Economics were calculated with the following assumptions: purchase cost of feeder heifers, $66/cwt; feed cost, $6.50/cwt; nonfeed costs, $.35 per head/day; processing and transportation cost, $20/head; implant cost, $3/head; and Choice yield grade 3 carcass, $1.08/cwt. Discounts of carcass value were: yield grade 4, $15/cwt; < 500 lb carcass, $20; 500 - 534 lb carcass, $10; 535 - 575 lb carcass, $3; >900 lb carcass, $20; and Select grade, $10. Incentives for the premium market were: yield grade 1 and 2, $8/cwt.

Table 5. Equations relating ultrasound measurements to predicted and actual carcass measurements.

Equation	R^c	SE^a regressions First	SE^a regressions Second	P^b First	P^b Second
Ribeye area related to body weight					
All heifers: REA = $.026Wt^{.86}$	.84	.030		<.0001	
Control heifers: REA = $.033Wt^{.83}$	.82	.044		<.0001	
Implanted heifers: REA = $.021Wt^{.89}$	.85	.042		<.0001	
Ribeye area related to days on feed					
All heifers: REA = $6.17days^{.145}$	.86	.005		<.0001	
Control heifers: REA = $6.30days^{.136}$	.83	.007		<.0001	
Implanted heifers: REA = $5.99days^{.153}$	.89	.006		<.0001	
Fat cover related to body weight					
All heifers: Fat = $(1.7x10^{-8})Wt^{2.36}$	.69	.132		<.0001	
Control heifers: Fat = $(1.7x10^{-8})Wt^{2.34}$	.71	.178		<.0001	
Implanted heifers: Fat = $(1.7x10^{-8})Wt^{2.37}$	.68	.196		<.0001	
Fat cover related to days on feed					
All heifers: Fat = $.044days^{.431}$	.77	.019		<.0001	
Control heifers: Fat = $.042days^{.425}$	.79	.025		<.0001	
Implanted heifers: Fat = $.045days^{.435}$	.76	.028		<.0001	
Relation of ultrasound and carcass measures					
Carcass fat cover = .0312 + 1.07(last US fat)	.75	.099		<.0001	
Carcass REA = 4.84 + .609(last US REA)	.59	.087		<.0001	
Estimation of yield grade					
Carcass YG = 2.61 + 6.87(first US fat) - .053(first US REA)	.53	1.16	.090	<.0001	<.56
Carcass YG = 3.35 + 2.95(last US fat) - .053(last US REA)	.62	.420	.034	<.0001	<.0003

[a]Standard error of estimate of regression coefficient.
[b]Probability of regression coefficient being different than zero.
[c] Correlation coefficient.

Figure 2. Increase in backfat (BF) in relation to time on feed. SA, MA, LA, and Sim = small, medium, and large Angus and Simmental heifers. Exponential growth equations to estimate thickness of backfat (in) at time t (days from measurement)were: $Y = X*e^{0.0126t}$, $Y = X*e^{0.0135t}$, $Y = X*e^{0.0119t}$, $Y = X*e^{0.0151t}$, for SA, MA, LA, and Sim, respectively. Y = predicted BF, X = present BF, e is the base for natural logarithms, and t is time in days. Days were standardized by fitting the initial measures of BF on the curve and adjusting for time (days).

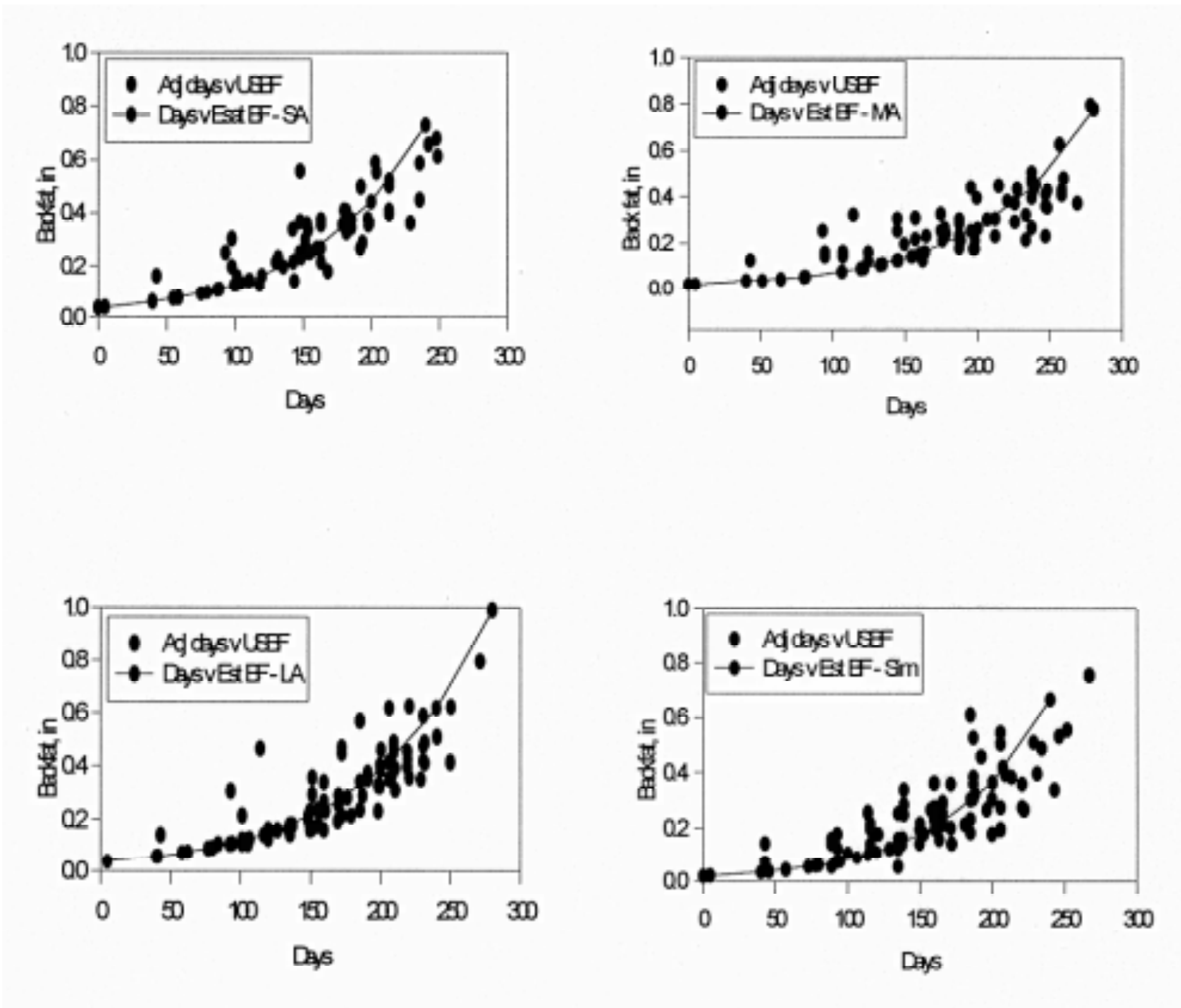

Figure 3. Increase in ribeye area (REA) in relation to time on feed. SA, MA, LA, and Sim = small, medium, and large Angus and Simmental heifers. Growth equations to estimate area of REA(sq in) at time t (days from measurement) were: Y = X + 0.0153t, Y = X + 0.0191t, Y = X + 0.0312t, Y = X + 0.0245t, for SA, MA, LA, and Sim, respectively. Y = predicted REA, X = present REA, and t is time in days. Days were standardized by fitting the initial measures of REA on the curve and adjusting for time (days).

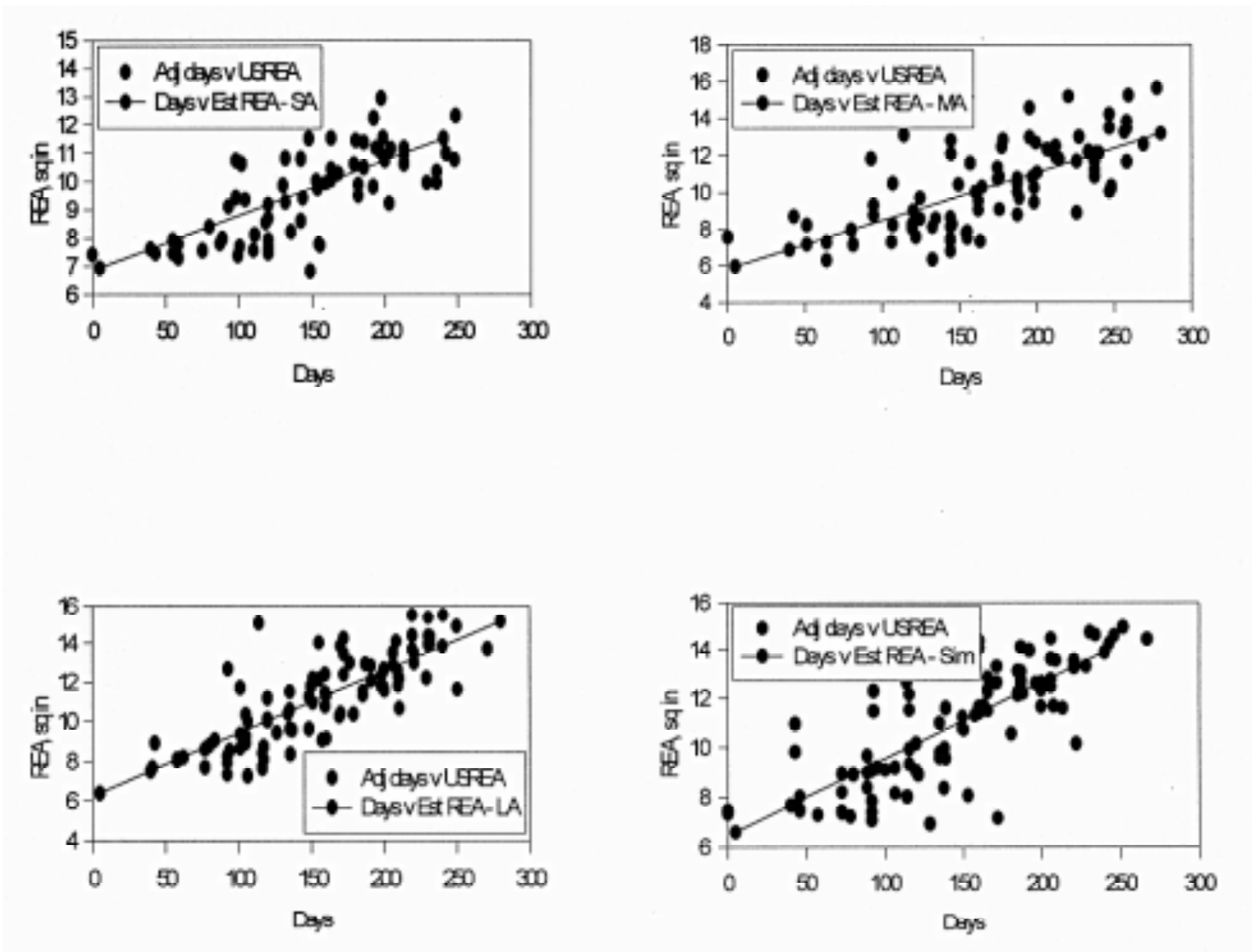

Figure 4. Relation of REA and backfat predicted from use of the first ultrasound measurements in the growth equations given in Figures 2 and 3 and REA and backfat measured on the carcasses.

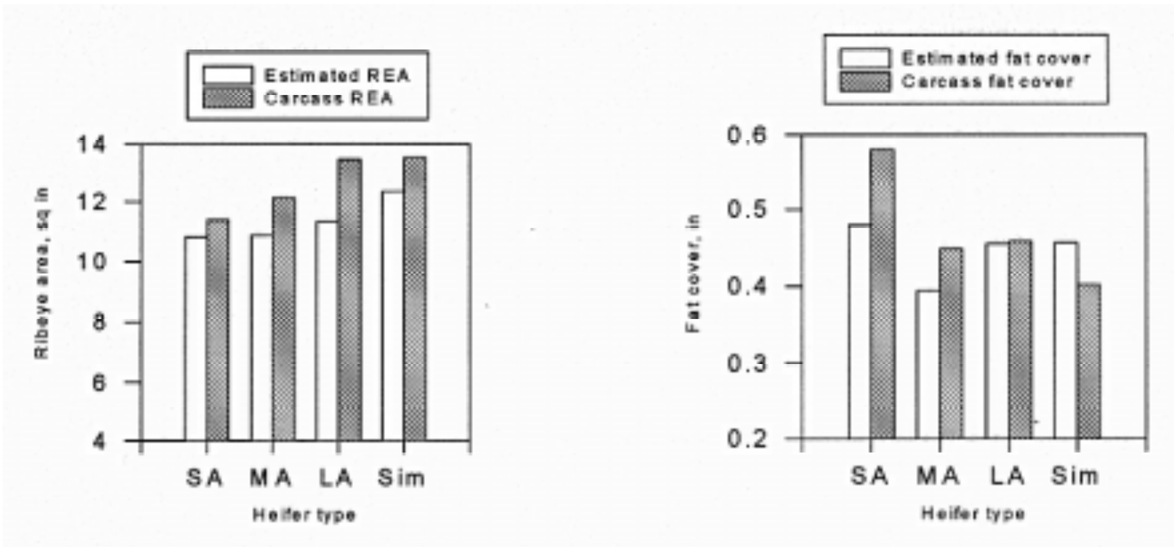

Figure 5. Relation of last ultrasound measure of REA and backfat with REA and backfat measured on the carcasses.