BURNETT CENTER INTERNET PROGRESS REPORT

No. 4 - October, 1999

Effects of various implant programs on performance and carcass merit of finishing heifers

M. L. Galyean, S. C. Harris, H. M. Derington, P. J. Defoor, G. A. Nunnery, and G. B. Salyer

Department of Animal Science and Food Technology
Texas Tech University, Lubbock 79409-2141

Introduction

Growth-promoting implants are used extensively by the feedlot industry. These implants typically contain estrogen or estrogen plus trenbolone acetate, and their use in finishing beef cattle markedly increases daily gain and improves feed efficiency (Duckett et al., 1997). Nonetheless, aggressive use of implants has been reported to decrease carcass quality grade (Duckett et al., 1997). Continued evaluation of various implant programs for growing/finishing cattle, particularly programs that might not have deleterious effects on carcass quality grade, is necessary to determine how to best use these products in the feedlot industry.

Experimental Procedures

Cattle. Three hundred twenty (320) medium-framed beef heifers (Charolais sires x Angus or Hereford crossbred dams [dams were 25 to 37.5% Brahman]) were shipped from the VC Ranch in Arcadia, FL to the Dettle Cattle Company Feedyard on July 25, 1998. On arrival at the Dettle Feedyard, the heifers were offered a 65% concentrate receiving diet. Approximately 10 d after arrival, each heifer was given the following products at label dose : 1) Bar Somnus 2P (Anchor); 2) BRSV-Vac 4 (Bayer); 3) Vision 7 (Bayer); and 4) vitamin E-300 (5 mL per heifer; AgriLabs). Heifers that required treatment for respiratory disease were given either Nuflor (Schering-Plough) or Penicillin G. All heifers remained at the Dettle Feedyard until shipment to the Texas Tech University Burnett Center on August 17, 1998. After arrival at the Burnett Center, the heifers were sorted randomly to eight dirt-floor pens with 40 heifers per pen and fed a 70% concentrate receiving diet at the rate of 12 lb (as-fed basis) per heifer.

On August 18, 1998, each heifer was weighed, given a numbered ear tag, and treated with Safeguard (Hoechst Roussel Vet) and Spotton (Bayer). Heifers were then returned to the same dirt-floor pens to which they had been sorted on arrival, with continued access to a 70% concentrate diet.

Experimental Design. Six implant treatments were arranged in a completely random design. Pen was the experimental unit (eight pens per treatment with six heifers per pen). To facilitate weighing and handling of the animals in a timely fashion, the cattle were arbitrarily split into two groups (Starting Groups 1 and 2) that would be started on trial on two consecutive days. The six implant treatments were as follows: 1) **N_N** = Negative control treatment - no implant was administered during the experiment; 2) **N_R** = No implant administered at the start of the experiment, and Revalor H administered on d 84 of the experiment; 3) **R_N** = Revalor H administered at the start of the experiment, and no implant administered on d 84 of the experiment; 4) **R_R** = Revalor H administered at the start of the experiment, and Revalor H administered on d 84 of the experiment; 5) **RIH_R** = Revalor IH (80 mg of trenbolone acetate and 8 mg of estradiol) administered at the start of the experiment, and Revalor H administered on d 84 of the experiment; and 6) **S_R** = Synovex H administered at the start of the experiment, and Revalor H administered on d 84 of the experiment.

Treatment and Pen Assignments. Individual BW data collected on August 18, 1998 were used to select 288 heifers for use in the experiment. On August 25 (Starting Group 1) and 26 (Starting Group 2), 1998, heifers were assigned randomly within BW strata to the six treatments. Pens were assigned randomly to the six treatments within groups of six contiguous pens. Before placement in assigned pens, each heifers was weighed to obtain an initial BW, implanted according to treatment assignments, and treated with the flukicide, clorsulon (Curatrem, Merial). **Revalor IH is an experimental implant (INAD 4667), and strict adherence to disposal requirements and slaughter withdrawal dates was followed for this product**. After sorting to pens, the ear tag number of each heifer was checked against the assignment records to ensure that each heifer was in the correct pen.

Experimental Diets. Three diets were used during the experiment (Table 1). The initial diet fed from the time that the heifers arrived at the Burnett Center and at the beginning of the experiment was a 70% concentrate diet. The heifers were subsequently stepped up to an 80% concentrate diet, which they were fed for approximately 1 wk before being stepped up to the final 90% concentrate diet. Ingredient composition data are shown in Table 1. Each diet contained the same intermediate premix (Table 2) to supply protein, various minerals and vitamins, Rumensin (30 g/ton, DM basis), and Tylan (8 g/ton, DM basis).

Management, Feeding, and Weighing Procedures. Once the total amount of feed for all pens on the experiment was determined, the total was subdivided into batches of approximately 500 lb each. Batches were mixed, delivered to a Rotomix 84-8 mixer/delivery unit, and the amount of feed allotted to each pen within treatment was delivered using the Rotomix 84-8 unit. Dry matter content of ingredients used in the diets was measured every 2 wk throughout the experiment, and these ingredient DM values were used to calculate the DM percentage of each dietary ingredient for the overall experiment. Samples of mixed feed delivered to feed bunks (two randomly selected pens from each group of six contiguous pens) were taken weekly throughout the experiment and dried overnight at 100^{o}C. These bunk sample DM values were used to compute average DM intake (DMI) by the cattle in each pen. Samples of feed taken from the bunk were composited for each 28-d period of the experiment and further composited across the initial 84 d of the experiment and the final 146 d of the experiment. Samples were ground to pass a 2-mm screen in a Wiley mill, and overall composites were analyzed for DM, ash, CP, ADF, Ca, and P (AOAC, 1990; Table 3).

Each feed bunk of the 48 pens was evaluated visually at approximately 0730 to 0800 daily. The quantity of feed remaining in each bunk was estimated, and the daily allotment of feed for each pen was recorded. Feed deliveries were managed in an effort to leave 0 to .5 lb of feed remaining in the bunk. Feed bunks were cleaned and unconsumed feed was weighed at 28-d intervals throughout the trial. Dry matter content of these bunk weighback samples was determined in a forced-air oven by drying overnight at 100^{o}C. Bunk weighbacks and bunk sample DM determinations were used to calculate DMI by each pen.

After 28, 56, and 84 d on feed, heifers in all pens were weighed before the morning feeding (two consecutive days for Starting Groups 1 and 2, respectively). On d 28, the left ear of each heifer was physically palpated to determine and record the status (e.g., implant OK, abscess, bunched, and so on) of the initial implant. On d 84, at the time of a regularly scheduled BW measurement, each heifer was either not implanted or reimplanted (Revalor H) as dictated by treatment assignments and vaccinated with Fortress 7 (Pfizer). Heifers were subsequently weighed at 28-d intervals thereafter, with reimplant status checked by palpation and recorded on d 112. All BW measurements taken during the experiment were obtained using a single-animal scale (C & S Single-Animal Squeeze Chute set on four load cells). The scale was calibrated with 1,000 lb of certified weights (Texas Dept. of Agriculture) on the day before each scheduled weigh day.

Approximately 40 to 50% of the heifers were deemed to have sufficient finish to grade USDA Choice by early April, 1999. Hence, heifers in Starting Group 1 were weighed and shipped to the Excel Corp. slaughter facility in Plainview, TX on April 12, 1999, followed by heifers in Starting Group 2 on April 13, 1999.

Carcass Evaluation. Personnel of the Texas Tech University Meat Laboratory obtained all carcass measurements. Measurements included: hot carcass weight; longissimus muscle area; marbling score; percentage of kidney, heart, and pelvic fat; fat thickness measured between the 12th and 13th ribs; yield grade; and liver abscess score. Liver abscess scores were recorded on a scale of 1 to 7, with 1 = no abscesses, 2 = A-, 3 = A, 4 = A+, 5 = telangiectasis, 6 = distoma (fluke damage), and 7 = fecal contamination that occurred at slaughter.

In the present experiment, 279 heifers were sent to the packing plant, and complete data were obtained for 278 heifers for USDA quality grade, marbling score, fat thickness, and kidney heart, and pelvic fat; 274 heifers for longissimus muscle area; 272 heifers for hot carcass weight and dressing percent; and 268 heifers for USDA yield grade.

Statistical Analyses. During the course of the experiment, nine heifers either died or were removed from the experiment for reasons unrelated to the implant treatments. All data were analyzed with pen considered to be the experimental unit. A completely random design was employed, and computations were made with the General Linear Models procedure of SAS (1987). Pen means for daily gain and average daily DMI were included in the data file, and feed:gain ratio was computed as daily DMI divided by daily gain. In addition, hot carcass weight was divided by a constant dress of 63% to compute a carcass-adjusted final BW. Carcass-adjusted final BW was then used to compute carcass-adjusted daily gain and carcass-adjusted feed:gain ratio. The effect of treatment was considered in the statistical model, with the residual (pen within treatment) as the error term for testing treatment effects. Carcass data were entered on an individual animal basis, and analyzed with a model that included effects for treatment, pen within treatment, and residual. Pen within treatment was specified as the error term for testing treatment effects. The residual mean square in this model for carcass data (not used for testing) included individual animal variation. Two sets of orthogonal contrasts were used to evaluate treatment means. The first set of three orthogonal comparisons involved the N_N, N_R, R_N, and R_R treatments, which were arranged in a 2 x 2 factorial structure. These three contrasts were as follows: 1) initial implant (the average of N_N and N_R vs the average of R_N and R_R); 2) final implant (the average of N_N and R_N vs the average of N_R and R_R); and 3) interaction of initial and final implant. The two remaining orthogonal contrasts compared the R_R, RIH_R, and S_R treatments, and included: 4) R_R vs the average of RIH_R and S_R; and 5) RIH_R vs S_R.

Results and Discussion

Performance Data. Daily gain, DMI, and feed:gain ratio data for various intervals of the experiment are shown in Table 4. Initial BW did not differ ($P > .05$) among the six treatments, with a range of approximately 3 lb. Final BW was approximately 81 lb less for heifers that were never implanted compared with the average of the final BW of heifers in the other five treatment groups. Among the N_N, N_R, R_N, and R_R treatments, the effects of initial and final implant were significant ($P < .01$), as was the initial x final implant interaction ($P < .05$). This interaction reflected the increased final BW for heifers that received an implant (initial, final, or both) vs the N_N heifers. Final BW did not differ between R_R heifers and the average of the RIH_R and S_R heifers or between RIH_R and S_R heifers. Results for adjusted final BW (calculated as hot carcass weight divided by a constant dress of 63%) were similar to those for actual final BW. Increased final BW is a common finding when estrogen + TBA implants are used in beef cattle, and NRC (1996) suggested that such implants increase final BW from 55 to 100 lb.

Daily gain for d 0 to 28, 0 to 56, and 0 to 84 (Table 4) was greater ($P < .01$) by heifers that received an initial implant vs those that did not, but no other contrasts were significant through d 84. Final implants were administered at d 84; hence, only after that time would contrasts involving the final implant be meaningful. Daily gain from d 0 to 112 was increased ($P < .01$) by the use of an initial implant and by the use of a final implant ($P < .05$) among the N_N, N_R, R_N, and R_R groups; however, contrasts involving RIH_R and S_R did not differ through d 112. For d 0 to 140, initial implant ($P < .01$) and final implant ($P < .05$) effects were detected among the N_N, N_R, R_N, and R_R heifers, and RIH_R heifers gained less ($P < .05$) than S_R heifers. Cumulative gain for d 0 to 168 did not differ, however, between RIH_R and S_R heifers, but among the N_N, N_R, R_N, and R_R heifers, initial ($P < .01$), final ($P < .01$), and initial x final implant ($P < .05$) contrasts were significant. Results for d 0 to 196 and 0 to 230 were similar to those for d 0 to 168. When daily gain was calculated from adjusted final BW, trends were similar to those for actual final BW, with significant contrasts for initial ($P < .05$), final ($P < .01$), and initial x final implant ($P < .05$). The 16% increase in daily gain for the average of implanted heifers vs non-implanted heifers is typical of responses noted in the literature (Duckett et al., 1997).

Daily DMI (Table 4) did not differ among treatments during d 0 to 28; however from d 0 to 56, heifers that received an initial implant consumed more DM (P < .05) than non-implanted heifers among the N_N, N_R, R_N, and R_R treatments. This same response was evident (P < .01) for d 0 to 84, 0 to 112, 0 to 140, 0 to 168, 0 to 196, and 0 to 230. The initial x final implant interaction (P < .05) also affected daily DMI from d 0 to 196 and 0 to 230 among the N_N, N_R, R_N, and R_R heifers. Contrasts for R_R vs the average of RIH_R and S_R and for RIH_R vs S_R were not significant at any of the cumulative periods of the experiment. An increased quantity of DMI is a common experimental finding with the use estrogen and estrogen + TBA implants (Duckett et al., 1997). Daily DMI was lower than expected (NRC, 1996) by the heifers used in the present experiment. Reasons for this low intake are not readily apparent, but presumably reflect the type of heifer and length of the feeding period.

Feed:gain ratio (Table 4) was affected by the initial implant (P < .01) for d 0 to 28, 0 to 56, and 0 to 84 among the N_N, N_R, R_N, and R_R treatments, with improved feed efficiency for heifers that received an initial implant. After the final implant was administered on d 84, the final implant contrast for the N_N, N_R, R_N, and R_R treatments also became significant (P < .01) for all the remaining cumulative time periods; however, the effect of initial implant on feed:gain diminished with time on feed and was not significant for d 0 to 196 and 0 to 230. Although the initial x final implant interaction among the N_N, N_R, R_N, and R_R treatments was significant (P < .05) for d 0 to 168 and d 0 to 196, this contrast was not significant for the overall experimental period of d 0 to 230. Feed:gain calculated on the basis of actual DMI and adjusted daily gain followed a similar pattern to feed:gain calculated on the basis of unadjusted final gain (based on actual final BW), with an effect (P < .01) of final implant among the N_N, N_R, R_N, and R_R treatments, but no differences detected for contrasts involving R_R, RIH_R, and S_R. For the overall experiment, feed:gain was improved by 7.2% for the average of all implant treatments compared with the non-implanted controls.

Based on feed composition values from NRC (1996), calculated dietary NEm was 2.14 Mcal/kg of DM and NEg was 1.46 Mcal/kg of DM. Heifer performance (initial and final shrunk BW, DMI, and shrunk ADG) data were used to calculate dietary NEm and NEg concentrations that would be required to match the observed performance. These performance-based energy values were in close agreement with calculated dietary values. Performance-based NEm and NEg values (Mcal/kg of DM) were as follows: N_N = 2.14 and 1.46; N_R = 2.19 and 1.51; R_N = 2.13 and 1.46; R_R = 2.20 and 1.52; RIH_R = 2.18 and 1.50; and S_R = 2.18 and 1.50.

Implant checks were performed 28 d after the initial (Table 5) and final (Table 6) implants were administered. Implants that were abscessed with all, partial, or no pellets remaining varied only slightly among the implant treatment groups on both occasions. Success of implanting was greater for the final implant (4.3% problem rate) than for the initial (13.6% problem rate) implant.

Carcass Data. Carcass measurements are shown in Table 7. Hot carcass weight was affected by the initial implant (P < .05), final implant (P < .01), and initial x final implant interaction (P < .05) among the N_N, N_R, R_N, and R_R heifers; however contrasts for R_R vs the average of RIH_R and S_R and for RIH_R vs S_R were not significant. Increased hot carcass weight with implanting is a common finding in implant experiments and would be expected with increased final BW. Dressing percent did not differ among treatments, ranging from 62.34 to 63.28%. In a literature summary, Duckett et al. (1997) noted no difference in dressing percent among various initial and final implant programs compared with non-implanted controls. Longissimus muscle area (LMA) was greater (P < .05) in heifers that received a final R implant among the N_N, N_R, R_N, and R_R heifers and greater (P < .05) in S_R heifers than in RIH_R heifers. Increased LMA has been observed in other experiments in response to administration of final estrogen and estrogen + TBA implants (Duckett et al., 1997). Fat thickness did not differ among the N_N, N_R, R_N, and R_R treatments, but was less (P < .05) for R_R heifers than for the average of RIH_R and S_R heifers. These results are in contrast to the summary of Duckett et al. (1997), which indicated a decrease in fat thickness in heifers given initial and final implants of estrogen and(or) estrogen + TBA. Kidney, pelvic, and heart (KPH) fat was affected by the initial implant (P < .05) and initial x final implant interaction (P < .01) among the N_N, N_R, R_N, and R_R treatments, but no other contrasts were significant for KPH. Overall, KPH was 14.5% lower in implanted heifers than in non-implanted controls. Despite an increased KPH for the N_N group, yield grade did not differ among the treatments.

Although marbling score did not differ among treatments, the percentage of USDA Choice, Select, and Standard carcasses varied considerably among the six groups (Table 7). Carcasses from non-implanted heifers (N_N) averaged 57.45% Choice compared with an average of 40.46% Choice for implanted heifers. Among heifers that received both and initial and final implant (R_R, RIH_R, and S_R)), 34.1% graded Choice, suggesting a negative effect of the final implant on quality grade. In a statistical summary of several experiments, Duckett et al. (1997) reported that estrogen + TBA final implants decreased quality grade in heifers. The percentage of Standard carcasses among implanted groups varied from a low of 2.08% with the N_R treatment to 17.78% for the R_R treatment.

Similar to quality grade, carcass bone maturity varied among treatments (Table 7). None of the N_N, N_R, and RIH_R carcasses had B or C maturity bone scores; however, 13.33% of the R_N, 13.33% of the R_R, and 12.77% of the S_R carcasses had bone maturity scores of B. Moreover, 4.44% of the R_R carcasses had C maturity bone. Comparison of the bone maturity scores by quality grade within treatment indicated that lower quality grades in the implanted groups were a function of both low marbling scores and bone maturity scores. There was one N_R carcasses that graded Standard and no B maturity bone scores in this treatment group. For the R_N group, four carcasses graded Standard, but only one of these four carcasses had B maturity bone. Among the R_R group, eight carcasses graded Standard, with one of these carcasses having B maturity bone and one having C maturity bone. Among the RIH_R group, five carcasses graded Standard, but no carcasses had B maturity bone, whereas among the S_R group, five carcasses graded Standard, but two of these carcasses had B maturity bone.

Only three carcasses were rated as dark cutters (data not shown; one R_N, one

RIH_R, and one S_R), none of which were full dark cutters. In contrast to these results, the statistical summary of Duckett et al. (1997) indicated a strong negative effect of multiple estrogen + TBA implants on percentage of dark cutters. None of the carcasses had B lean maturity scores (data not shown); however, a small number of carcasses had lean maturity scores that fell between A and B. Percentage of lean maturity scores between A and B by treatment group were as follows: N_N = 0%; N_R = 0%; R_N = 13.33%; R_R = 15.56%; RIH_R = 0%; and S_R = 12.27

Liver scores (Table 8) did not vary greatly among treatments. Approximately 90% of the livers were not condemned, and less than 5% of livers from heifers in any of the treatment groups were detected with abscesses. Indeed, condemnation that occurred as a result of contamination of livers during the slaughter process was as common as condemnation for liver abscesses.

Summary and Conclusions

Results of this experiment suggest, as expected, that the implant treatments applied increased daily gain and DMI and improved feed:gain by growing/finishing heifers. Carcass quality grade seemed to be negatively affected by implanting, particularly by the use of both an initial and final implant. Percentage of B bone maturity scores seemed to be affected more by the initial implant than by the final implant. The use of a new low-dose Revalor (Revalor IH) implant did not seem to offer any significant performance or carcass advantages over Revalor H or Synovex H as the initial implant when Revalor H was used as the final implant.

Literature Cited

AOAC. 1990. Official Methods of Analysis (15th Ed.). Association of Official Analytical Chemists. Washington, DC.

Duckett, S. K., F. N. Owens, and J. G. Andrae. 1997. Effects of implants on performance and carcass traits of feedlot steers and heifers. In: Symposium: Impact of Implants on Performance and Carcass Value of Beef Cattle, pp 63-82, Oklahoma Agric. Exp. Sta., P-957.

NRC. 1996. Nutrient Requirements of Beef Cattle (7th Ed.). National Academy Press, Washington, DC.

SAS. 1987. SAS/STAT Guide for Personal Computers (Version 6 Ed.). SAS Inst. Inc., Cary, NC.

Table 1. Ingredient composition (%, DM basis) of the experimental diets[a]

	Dietary concentrate level		
Ingredient	70%	80%	90%
Cottonseed hulls	15.05	10.08	4.99
Ground alfalfa hay	15.27	10.26	4.98
Whole shelled corn	10.37	10.37	10.05
Steam-flaked corn	44.48	54.40	65.14
Cottonseed meal	4.49	4.46	4.41
Molasses	3.89	3.94	3.95
Fat (yellow grease)	3.00	3.03	3.07
Urea	.91	.91	.89
TTU premix[b]	2.54	2.55	2.52

[a]The 70% concentrate diet was fed from August 25, 1998 to September 1, 1998,at which time the cattle were switched to the 80% concentrate diet. The 80% concentrate diet was fed until September 9, 1998, at which time the cattle were switched to the 90% concentrate diet.

[b]Premix composition is shown in Table 2.

Table 2. Composition of the TTU premix used in experimental diets

Ingredient	%, DM basis
Cottonseed meal	23.9733
High-calcium limestone	42.1053
Dicalcium phosphate	1.0363
Potassium chloride	8.0000
Magnesium oxide	3.5587
Ammonium sulfate	6.6667
Salt	12.0000
Cobalt carbonate	.0017
Copper sulfate	.1572
Iron sulfate	.1333
EDDI	.0025
Manganese oxide	.2667
Selenium premix, .2% Se	.1000
Zinc sulfate	.8251
Vitamin A, 650,000 IU/g[a]	.0122
Vitamin E, 275 IU/g[a]	.1260
Rumensin, 80 mg/lb[a]	.6750
Tylan, 40 mg/lb[a]	.3600

[a]Concentrations noted by the ingredient are on a 90% DM basis.

Table 3. Chemical composition of the experimental diets[a]

Item	Dietary concentrate level		
	70%	80%	90%
Dry matter, %	85.22	85.48	82.72
Ash, %	5.94	4.46	4.50
Acid detergent fiber, %	16.29	12.76	7.72
Crude protein, %	14.02	12.50	14.22
Calcium, %	.64	.35	.51
Phosphorus, %	.27	.27	.32

[a]All values except Dry matter, % are expressed on a DM basis. Values represent analyses conducted on a sample of each diet composited across the periods of the experiment during which a diet was fed.

Table 4. Effects of various implant programs on performance by finishing beef heifers

	Initial implant/Final implant[a]							
Item	N_N	N_R	R_N	R_R	RIH_R	S_R	SE[b]	Contrast[c]
Initial BW, lb	541.5	542.9	541.5	542.2	544.6	539.2	2.72	NS
Final BW, lb	1,043.7	1,122.0	1,111.4	1,129.0	1,124.2	1,136.5	13.68	1*,2*,3†
Adj. final BW, lb[d]	1,043.3	1,117.6	1,105.6	1,116.4	1,123.5	1,140.6	14.96	1†,2*,3†
Daily gain, lb								
d 0 to 28	3.09	2.90	3.74	3.55	3.39	3.54	.157	1*
d 0 to 56	2.80	2.77	3.45	3.37	3.12	3.33	.098	1*
d 0 to 84	2.71	2.71	3.25	3.17	2.90	3.08	.082	1*
d 0 to 112	2.46	2.69	2.91	2.97	2.78	2.94	.070	1*,2†
d 0 to 140	2.34	2.63	2.74	2.80	2.66	2.88	.071	1*,2†,5†
d 0 to 168	2.21	2.57	2.57	2.60	2.56	2.70	.067	1*,2*,3†
d 0 to 196	2.16	2.51	2.48	2.52	2.50	2.61	.061	1*,2*,3†
d 0 to 230	2.18	2.52	2.47	2.56	2.51	2.59	.057	1*,2*,3†
Adj. d 0 to 230[d]	2.18	2.50	2.45	2.51	2.50	2.61	.062	1†,2*,3†
Daily DMI, lb/heifer								
d 0 to 28	13.44	13.25	13.62	13.49	13.48	13.25	.187	NS
d 0 to 56	13.59	13.61	14.03	14.11	13.81	14.07	.189	1*
d 0 to 84	13.49	13.70	14.22	14.19	13.87	14.18	.175	1*
d 0 to 112	13.16	13.40	13.95	13.88	13.57	13.87	.181	1*
d 0 to 140	13.11	13.54	14.09	13.90	13.63	14.01	.210	1*
d 0 to 168	12.88	13.44	13.88	13.64	13.52	13.87	.209	1*
d 0 to 196	12.84	13.54	13.85	13.66	13.61	13.92	.208	1*,3†
d 0 to 230	12.96	13.79	14.08	13.85	13.88	14.09	.211	1*,3†
Feed:gain								
d 0 to 28	4.41	4.79	3.66	3.82	4.06	3.79	.247	1*
d 0 to 56	4.88	4.95	4.08	4.21	4.43	4.25	.112	1*
d 0 to 84	4.99	5.07	4.39	4.49	4.80	4.62	.103	1*
d 0 to 112	5.36	4.99	4.83	4.68	4.90	4.73	.093	1*,2*
d 0 to 140	5.62	5.17	5.17	4.97	5.15	4.88	.097	1*,2*
d 0 to 168	5.85	5.24	5.43	5.26	5.30	5.15	.093	1†,2*,3†
d 0 to 196	5.97	5.41	5.61	5.43	5.45	5.35	.089	2*,3†
d 0 to 230	5.95	5.48	5.71	5.43	5.53	5.45	.087	2*
Adj. d 0 to 230[d]	5.95	5.52	5.77	5.53	5.55	5.42	.092	2*

[a]N = no implant; R = Revalor H; RIH = Revalor IH; S = Synovex H. The final implant was administered after 84 d on feed.

[b]Pooled standard error of treatment means, n = eight pens/treatment.

[c]Orthogonal contrasts: 1) average of N_N and N_R vs average of R_N and R_R; 2) average of N_N and R_N vs average of N_R and R_R; 3) interaction of initial (N or R) and final (N or R) implants; 4) R_R vs average of RIH_R and S_R; 5) RIH_R vs S_R. * = $P < .01$; † = $P < .05$; NS = not significant, $P > .05$.

[d]Adj. final BW = adjusted final BW, which was calculated by dividing hot carcass weight by .63, and this value was used to calculate adjusted daily gain and adjusted feed:gain.

Table 5. Distribution of initial implant status scores (% of total) in finishing beef heifers administered various implant programs

	Initial implant/Final implant[a]					
Item	N_N	N_R	R_N	R_R	RIH_R	S_R
Implant OK	-	-	85.10	85.42	91.66	83.33
Abscess with all pellets	-	-	4.26	0.00	0.00	2.08
Abscess with partial pellets	-	-	4.26	6.25	4.17	8.34
Abscess with no pellets	-	-	4.26	6.25	4.17	4.17
Implant in cartilage	-	-	2.12	2.08	0.00	2.08

[a]N = no implant; R = Revalor H; RIH = Revalor IH; S = Synovex H. The final implant was administered after 84 d on feed.

Table 6. Distribution of final implant status scores (% of total) in finishing beef heifers administered various implant programs

	Initial implant/Final implant[a]					
Item	N_N	N_R	R_N	R_R	RIH_R	S_R
Implant OK	-	97.92	-	91.30	100.00	93.61
Abscess with all pellets	-	0.00	-	0.00	0.00	0.00
Abscess with partial pellets	-	0.00	-	0.00	0.00	2.13
Abscess with no pellets	-	0.00	-	4.35	0.00	0.00
Implant in cartilage	-	2.08	-	4.35	0.00	4.26

[a]N = no implant; R = Revalor H; RIH = Revalor IH; S = Synovex H. The final implant was administered after 84 d on feed.

Table 7. Effects of various implant programs on carcass characteristics of finishing beef heifers

	Initial implant/Final implant[a]							
Item	N_N	N_R	R_N	R_R	RIH_R	S_R	SE[b]	Contrast[c]
Hot carcass wt, lb	657.3	704.1	696.5	703.3	707.8	718.6	9.69	1[†],2[*],3[†]
Dressing percent	63.00	62.75	62.73	62.34	62.59	63.28	.313	NS
LM area[d], sq. in.	13.48	13.77	13.49	13.90	13.70	14.19	.169	2[†],5[†]
Fat thickness, in.	.37	.38	.40	.32	.42	.37	.027	4[†]
KPH[e], %	2.91	2.45	2.31	2.57	2.45	2.65	.104	1[†],3[*]
Yield grade	2.56	2.62	2.66	2.43	2.76	2.51	.109	NS
Marbling score[f]	428.8	413.5	406.3	391.2	388.6	388.6	13.62	NS
Choice, %[g]	57.45	50.00	51.11	37.78	34.78	29.79	-	-
Select, %	42.55	47.92	40.00	44.44	54.35	59.57	-	-
Standard, %	0.00	2.08	8.89	17.78	10.87	10.64	-	-
A maturity bone, %	100.00	100.00	86.67	82.23	100.00	87.23	-	-
B maturity bone, %	0.00	0.00	13.33	13.33	0.00	12.77	-	-
C maturity bone, %	0.00	0.00	0.00	4.44	0.00	0.00	-	-

[a]N = no implant; R = Revalor H; RIH = Revalor IH; S = Synovex H. The final implant was administered after 84 d on feed.

[b]Pooled standard error of treatment means, n = eight pens/treatment.

[c]Orthogonal contrasts: 1) average of N_N and N_R vs average of R_N and R_R; 2) average of N_N and R_N vs average of N_R and R_R; 3) interaction of initial (N or R) and final (N or R) implants; 4) R_R vs average of RIH_R and S_R; 5) RIH_R vs S_R. [*] = $P < .01$; [†] = $P < .05$; NS = not significant, $P > .05$.

[d]LM = longissimus muscle.

[e]KPH = kidney, pelvic, and heart fat.

[f]300 = Slight^0; 400 = Small^0; 500 = Modest^0.

[g]Choice, % includes cattle that graded Prime; Standard, % includes heifers that graded Utility.

Table 8. Distribution of liver scores (% of total) in finishing beef heifers administered various implant programs

	Initial implant/Final implant[a]					
Item	N_N	N_R	R_N	R_R	RIH_R	S_R
Not condemned	89.35	91.67	88.89	88.89	89.13	89.35
A-	2.13	4.17	2.22	4.44	0.00	0.00
A	0.00	0.00	0.00	0.00	0.00	0.00
A+	0.00	0.00	2.22	0.00	0.00	0.00
Telangiectasis	2.13	0.00	0.00	0.00	4.35	2.13
Distoma/fluke	4.26	2.08	2.22	4.44	0.00	4.26
Contamination[b]	2.13	2.08	4.45	2.23	6.52	4.26

[a]N = no implant; R = Revalor H; RIH = Revalor IH; S = Synovex H. The final implant was administered after 84 d on feed.

[b]Liver condemned because of contamination with feces or digestive tract contents at the plant.