2003

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Robbi H. Pritchard
South Dakota State University

Kelly W. Bruns
South Dakota State University

Donald L. Boggs
South Dakota State University

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Robbi H. Pritchard[1], Kelly W. Bruns[2] and Donald L. Boggs[1]
Department of Animal and Range Sciences

BEEF 2003 – 11

Summary

Lifetime implant strategies were developed and applied to steer calves. The design was intended for evaluating strategies rather than specific implants. Strategies involving increasing potency of products used at common stages of production. Initial implants were administered when calves were approximately 2 mo of age. Implants did not increase BW at weaning or after backgrounding ($P > 0.10$) although they did increase ADG 5% over non-implanted controls during backgrounding ($P < 0.05$). The influence of implants on ADG was more pronounced during the finishing phase of production. Implants increased ($P < 0.05$) finishing phase ADG 18%, DMI 7.2%, and feed efficiency 9.4%. Overall post-weaning ADG increased 12% ($P < 0.05$) due to implants. Performance results changed when evaluating data on a live versus carcass weight basis due to differences in dressing percent. Increasing potency of the implant strategies caused progressive increases ($P < 0.05$) in carcass weight and ribeye area. Implanted steers produced fatter carcasses than did non-implanted steers ($P < 0.05$). There were no advances in skeletal or lean maturity attributable to the potency of the implant strategy. The frequency of carcasses grading Average Choice or better declined with implants. Implant strategies had no relevant influence on shear force. Overall, 12% of carcasses had a shear force > 5.0 kg (undesirable).

Introduction

Growth promotants administered as implants are widely used in cattle production because of their cost-benefit ratio. These products increase ADG and gain efficiency and improve the cutability of beef carcasses. While they have been proven effective in most phases of cattle production, there is limited information on the cumulative influences of these products on production rates and carcass characteristics.

The cattle industry has recently become more aware of the importance of consumer satisfaction in the beef produced. Marbling scores and the percentage of carcasses that grade Choice or higher have declined in recent years, the penalty for dark-cutting carcasses and B maturity has increased, and there is a new awareness of toughness of beef retail product. The compounds used in implants can increase the prevalence of each of the previously mentioned carcass defects. However, there is limited data that can quantify how prudent lifetime management of cattle and their exposure to implants affects cattle production rates or beef carcass quality.

This experiment was designed to evaluate the influence of implants on production efficiencies and carcass traits. In forming these strategies, production was divided into three phases. These phases included the suckling phase, a post-weaning backgrounding phase, and a finishing phase. Implants were selected to provide varying degrees of potency to achieve an overall implant strategy. (Table 1)

Materials and Methods

Two cooperating ranches were identified that could each provide 160 steer calves which would provide a total of 80 steers in each of four implant treatment groups. These ranches were typical of operations in central (Ranch C) and western (Ranch W) South Dakota. They produced spring born calves: March - April on Ranch W and April-May on Ranch C. All calves were individually identified. When calves were approximately 2 months of age (May 28, Ranch W and June 16, Ranch C) they were branded, castrated, dehorned (if necessary), and implanted. As calves were randomly restrained, implants were applied in the sequence of None, Ralgro, Ralgro and Synovex-C. Ranch identification was recorded with the implant administered. After processing, calves were turned back onto range with their dams. At each

[1] Professor
[2] Assistant Professor

ranch, calves were managed in common pastures. No creep feeding was done at either ranch.

In the fall, calves were separated from dams and herdmates and sent directly to the SDSU Research Feedlot in Brookings. This occurred on October 27 (Ranch C) and November 3 (Ranch W). Long-stemmed grass hay and water were available in the receiving pens. Steers were allowed to rest overnight in these pens before being processed. During processing, individual BW were determined and used as the weaning BW and feedlot arrival BW. Unique ear tags were applied and cross-referenced with ranch identification. Post weaning implants were administered based upon treatment assignments made at branding (initial implants). There were 159 of 183 steer records that could be matched from Ranch C and 151 of 160 records that could be matched from Ranch W.

During this initial processing, calves were vaccinated with MLV vaccine for IBR, BVD, PI_3, BRSV (Resvac 4), clostridia sp, and Haemophilus somnus (Ultrabac 7, somubac[1]) and treated for internal and external parasites (Dectomax[2]). Calves were randomly assigned within treatment and ranch to pens. The Ranch C steers were distributed among 8 concrete floor pens (25' x 25') with approximately 10 steers each and 4 earthen floor pens (60' x 160') of approximately 20 steers. Each treatment was represented by two smaller pens and one of the larger pens. The Ranch W steers were distributed among 16 of the smaller pens with 8, 9, or 10 steers per pen. Steers remained in these pens during the receiving phase of the experiment.

The receiving diet (Table 2) was fed throughout the receiving phase. Feed deliveries were made once daily. Long-stemmed grass hay was added to feedbunks in the afternoons of days 1 to 3 following allotment to pens. Calves were evaluated for thriftiness twice daily. The receiving period lasted 44 d for Ranch C and 41 d for Ranch W steers.

At the end of the receiving period, individual BW were determined and calves were moved to a commercial backgrounding yard. Two commercial pens were used, one pen for each ranch. This precluded evaluation of implant strategy effects on DMI or feed efficiency during the backgrounding phase. During this phase, steers were fed a low energy grower diet (Table 2) intended to support 1.75 lb ADG. This phase continued for 58 d (Ranch C) or 57 d (Ranch W).

All steers were returned to the SDSU Research Feedlot for finishing. Upon arrival at the feedlot, steers were individually weighed and received the next scheduled implant. This followed an overnight rest with access to long-stemmed grass hay and water. The following day steers were sorted to pens by ranch and treatment. Allotment was done so that BW was uniformly distributed in all pen replicates of a treatment. This arrangement provided for 16 pens of steers from each source and 8 pens of steers on each implant strategy.

During the finishing phase, a single high concentrate diet was fed twice daily (Table 2). This required programmed increases in feed deliveries for the initial 21 d after which steers were fed ad libitum. Interim BW were determined after 35, 72, and 107 d for Ranch C steers and 35, 70, and 105 d for Ranch W steers. Final BW were determined after 150 d and 132 d on feed for ranches C and W, respectively. Re-implanting was done while processing on d 70 or 72 according to implant strategies.

During the receiving and finishing phases, feed ingredients were sampled once each week and analyzed for dry matter, crude protein, and ash. NDF and ADF were also determined on the fibrous feedstuffs. Diet composition and DMI were then calculated based upon ingredient assays, feed batching, and delivery records. Daily DMI was summarized at 7 d intervals. During the backgrounding phase only as-fed feed records were available.

The original protocol called for harvesting steers when ribfat depth averaged .4 to .5" and for each implant strategy to have common days on feed. Access to packing facilities was delayed, resulting in a 21 d extension in the feeding period for Ranch W. These calves were harvested after a 132 d finishing period and were fatter than intended. To maintain consistency in management, the Ranch C steers were then fed to a similar fat endpoint, which required a 150 d finishing period.

[1] Smithkline Beecham
[2] Pfizer

Bodyweights were determined in the morning before cattle were fed. There was no restriction of access to feed or water prior to weighing the steers. Consequently, fill is a component of all interim BW data. Cumulative weight changes were calculated as final BW shrunk 4% (Pen mean basis) and also by calculating individual final BW as hot carcass weight ÷ .625.

At harvest, individual steer identity was maintained. SDSU personnel recorded carcass weight, measured ribeye area and ribfat depth, and estimated lean and bone maturity. Marbling scores were estimated to the nearest 0.1 score and KPH, (%) were estimated to the nearest 0.5% by the USDA Grader on duty. Grading followed a 72 h chill. After grading, a 3" section of the rib was removed anterior to the point where carcasses were ribbed for grading. This cut was identified and brought back to SDSU for determination of Warner-Bratzler shear force.

Production and carcass data were analyzed in a model that included main effects of ranch, treatment, and ranch x treatment. Individual BW at weaning/feedlot arrival and carcass variables were evaluated by considering each steer to represent an experimental unit. During the receiving phase and finishing phase of the experiment, data (BW, ADG, DMI, and F/G) were evaluated on a pen mean basis. The ADG of backgrounding (i.e. weaning to beginning of finishing) was tested using steer as the experimental unit since pen integrity was not maintained throughout this phase of production.

Results and Discussion

Suckling and Backgrounding Phases. Upon arrival at the feedlot in the fall, records were matched on 79, 75, 78, and 78 steers from treatments 1, 2, 3, and 4, respectively. All of these steers remained as part of the experiment through harvest. The Ranch C steers were younger than the Ranch W steers and were lighter upon arrival at the feedlot (Table 4). Ranch C calves also had a high incidence of pinkeye that required therapy. Otherwise, health problems during the receiving periods were minimal

Weaning weights measured at feedlot arrival were not affected by previous implant ($P > 0.10$). Age and genetics have significant influences on early growth and contribute to a large variance associated with weaning weight. The use of ADG as a test for pre-weaning growth is more sensitive but was not feasible in this experiment.

During the receiving period, implanted steers grew faster and more efficiently than non-implanted steers ($P < 0.01$; Table 4). DMI was not affected by implants. Behavioral aspects of weaning and relocation could override intake stimulatory effect of implants during the short receiving period.

When steers were relocated to the grower pens, treatments were co-mingled within source for 57 or 58 d. Consequently, DMI and feed/gain (F/G) could not be quantified for the entire backgrounding phase. Implants did not cause higher ADG ($P > 0.05$) while in the grower pens. For the entire backgrounding phase, ADG was increased ($P < 0.05$) by implanting, and the ranking of means at this stage was consistent with the perceived potencies of the implants administered (Table 5). When evaluated on a pen mean basis (finishing phase allotment), Treatment 4 did cause higher BW than other treatments at the end of backgrounding (Table 6).

Finishing Phase. The BW at the end of backgrounding was also the initial BW for the feedlot finishing phase. At this point, Ranch C steers were lighter than Ranch W steers (687 vs 726 lb; $P < 0.01$). It was clear that this difference in BW would probably cause differences in time required to achieve condition suitable for harvest. The decision was made to re-implant according to a common timeline and let payout on the final implant be variable. Schedule conflicts caused slight deviations in days between interim weights (Table 3). To simplify the semantics, interim periods during the finishing phase were described as A, B, C, and D. The BW-D (Table 5) is the final live, unshrunk, body weight recorded the day before harvest.

The ADG, DMI, and F/G responses were improved by implant treatments during Period A (Table 6). There was a trend ($P < 0.10$) for Treatments 2 & 3 to cause a higher ADG and lower F/G than Treatment 4. This effect was not evident during Period B. The cumulative early performance (Period A & B) was improved by implanting but did not differ among implant treatments (Table 6). Re-implanting occurred at the beginning of Period C. During the 35 d following re-implanting, implants increased ADG and DMI and lowered F/G (P < 0.05). Steers on Treatment 3 grew faster and more efficiently than steers on Treatments 2 or 4. The advantage of Treatment 3 over Treatment 2 could be anticipated. The previous implant history for these two treatments were identical until the beginning of Period C. At re-implanting a 72 mg Zeranol implant would not have as much growth-promoting activity as 72 mg Zeranol + 140 mg trenbalone acetate (TBA). The cause for improved performance by Treatment 3 over 4 is unclear. It could be a difference in the Zeranol +TBA growth promotion as compared to Revalor-S or an influence of cumulative implant exposure over time causing diminished responses in Treatment 4, or a combination of both factors.

The surge in performance demonstrated by Treatment 3 during Period C was transient. During Period D, ADG was similar among implant treatments. Treatment 3 did sustain higher DMI during this period than occurred with Treatments 2 and 4. Implanted steers continued to consume more feed and grew faster than non-implanted steers (P < 0.05) in this final phase of production.

Cumulative performance was calculated on a live weight basis (4% shrink) or by estimating final live BW of each individual as carcass weight ÷ 0.625. On a live basis, implants increased (P < .05) ADG and DMI and reduced (P < 0.05) F/G (Table 7). Among implants, Treatment 3 tended (P < 0.10) to cause higher final BW, ADG, and DMI than Treatment 2. When performance was determined by calculation from carcass weight, Treatment 4 caused higher final BW (P < 0.05) and lower F/G (P < 0.05) than Treatments 2 or 3. Treatment 3 tended (P < 0.10) to cause a heavier final BW and higher ADG than Treatment 2.

Implants in general increased carcass weight and ribeye area and caused a slight increase in carcass maturity while lowering marbling scores. There was a numerical decline in the proportion of higher Quality Grade carcasses as the aggressiveness of the implant strategy increased (Table 8). Repeated use of implants did not cause dark cutters or Standard Grade carcasses. There were no shifts in the frequencies of very tender or tough carcasses characterized as shear force < 3.5 or > 4.9, respectively. There was no biologically relevant shifts in overall mean shear force values attributable to implants (Table 8).

The two sources of cattle were harvested at similar BW and fat endpoints (Table 9). Subjective measures (i.e. KPH, marbling, and maturity) did differ (P < .05) between sources as did shear force. These may have been real or may reflect the variability associated with these more subjective determinations. The Ranch C cattle were younger when weaned and exposed to post-weaning implants. Genetics also differed between sources. These factors could have influenced carcass traits. It is important to note that there were no source x treatment interactions applicable to carcass traits. This indicates that the influence of implant strategies was consistent in spite of the differences in age, genetics, and days on feed.

Conclusions

The emphasis of this experiment was on the cumulative influence of implant strategies on finishing phase performance and especially upon carcass traits. Increasing the aggressiveness of the implant strategy increased final BW and improved efficiency in the feedlot. It is interesting that final live BW were similar between Treatments 3 and 4 but that carcass weights differed between these treatments. This should be investigated further to determine if prolonged exposure to higher potency implants would consistently improve dressing percentage.

The results of this experiment suggest that lifetime implant strategies can be adjusted to optimize production efficiencies and quality grades for a specific set of circumstances. These strategies had consistent effects across cattle of different genetic backgrounds (but similar biological type). Finally, it appears that relatively aggressive implant strategies can be applied over the lifetime of a calf without causing increases in unacceptable carcasses or reducing tenderness of the meat produced.

Tables

Table 1. Implant use by production phase

Production phase	Treatment 1	Treatment 2	Treatment 3	Treatment 4
	Implant Used			
Suckling	None	Ralgro	Ralgro	Synovex C
Backgrounding	None	Ralgro	Ralgro	Revalor-g
Finishing				
Initial	None	Ralgro	Ralgro	Synovex-S
d70 Re-implant	None	Magnum	Magnum/ Component TS	Revalor-s

Table 2. Diets used[a]

	Receiving	Background	Finish
Grass hay	40.00		6.00
Corn silage		66.55	
Oat hay		13.47	
Wheat straw		10.74	
Cracked corn	50.59		
Whole corn			66.20
Soybean meal	4.50	6.21	2.25
Commercial Liquid A		3.04	
Commercial Liquid B			4.25
Limestone	0.60		0.70
Trace mineralized salt	0.30		
$ZnSO_4$	0.01		
Wheat midds			0.60
Wet corn gluten feed			20.00
Molasses	4.00		
CP[b]	12.4	11.5	12.4
NE_m, Mcal/cwt[b]	77.6	64.1	91.7
NE_G, Mcal/cwt[b]	45.1	40.0	61.3

[a]% DM basis.
[b]Calculated values.

Table 3. Chronology of events

Event	Ranch C Date	Ranch C Elapsed days since previous event	Ranch W Date	Ranch W Elapsed days since previous event
Initial implant	6/16	0	5/28	0
Weaning	10/27	133	11/3	159
Begin background	12/11	44	12/15	41
Begin finishing	2/8	58	2/11	57
Finishing BW				
A	3/15	35	3/18	35
B (re-implant)	4/21	37	4/22	35
C	5/26	35	5/27	35
D	7/8	43	6/23	27
Harvest	7/9	1	6/24	1

Table 4. Receiving period production traits by ranch and treatment

	Ranch		Var
	C	W	
Weaning BW, lb	470[a]	516[b]	4.7
End receiving BW, lb	603[a]	654[b]	4.9
ADG, lb	3.03[a]	3.37[b]	0.082
DMI, lb	13.50	13.50	0.149
F/G	4.46[a]	4.06[b]	0.085

	Treatment				Var
	1	2	3	4	
Weaning BW, lb	490	491	491	500	6.7
End receiving BW, lb	615	639	626	635	6.9
ADG, lb	2.94[a]	3.49[b]	3.18[b]	3.20[b]	0.216
DMI, lb	13.26	13.56	13.75	13.43	0.116
F/G	4.51[a]	3.93[c]	4.38[b]	4.22[bc]	0.120

[a,b,c]Means in same row without common superscripts differ (P < 0.01).

Table 5. Body weights and interim ADG based upon individual steer observations

	Treatment				SEM
	1	2	3	4	
n	79	75	78	78	
Weaning BW, lb	493	488	490	498	6.6
End receiving BW, lb	619	635	626	635	7.5
End background BW, lb	699	704	704	720	7.8
Finishing phase					
BW A, lb	842[a]	859[ab]	864[ab]	870[b]	9.3
BW B, lb	978[a]	998[ab]	997[ab]	1012[b]	10.1
BW C, lb	1092[a]	1132[b]	1157[b]	1153[b]	10.9
BW D, lb	1182[a]	1244[b]	1267[b]	1271[b]	11.6
	ADG, lb				
Receiving	2.96[a]	3.47[c]	3.20[b]	3.22[b]	0.066
Growing	1.40[bc]	1.19[a]	1.35[b]	1.48[c]	0.041
Background	2.06[a]	2.15[b]	2.13[ab]	2.22[b]	0.033
Feedlot					
Early	3.93[a]	4.16[b]	4.14[b]	4.11[b]	0.058
Late	2.90[a]	3.51[b]	3.87[c]	3.71[c]	0.067
Cumulative	3.09[a]	3.49[b]	3.64[c]	3.55[bc]	0.045
Overall ‡	2.66[a]	2.93[b]	3.01[b]	3.00[b]	0.033

[a,b,c] Means without common superscripts differ (P < 0.05).
‡ 2 vs. 3 (P < 0.10).

Table 6. Steer performance during the finishing phase

	Treatment				
	1	2	3	4	SEM
Initial BW, lb	700[a]	703[a]	704[a]	720[b]	1.4
Period A					
ADG, lb*	4.07[a]	4.43[b]	4.58[b]	4.27[ab]	0.076
DMI, lb	19.32[a]	19.92[ab]	20.34[b]	19.88[ab]	0.156
F/G	4.77[a]	4.51[b]	4.45[b]	4.67[ab]	0.059
Period B					
ADG, lb	3.80	3.90	3.75	3.96	0.096
DMI, lb	22.13[a]	23.76[b]	24.01[b]	23.47[b]	0.245
F/G*	5.85[a]	6.11[ab]	6.49[b]	5.97[ab]	0.067
Early cumulative[d]					
ADG, lb	3.93[a]	4.16[b]	4.16[b]	4.11[ab]	0.055
DM, lb	20.74[a]	21.86[b]	22.20[b]	21.70[b]	0.184
F/G	5.30	5.25	5.35	5.28	0.053
Period C					
ADG, lb	3.24[a]	3.80[b]	4.56[c]	4.03[b]	0.067
DMI, lb	23.33[a]	24.44[b]	25.46[c]	24.77[bc]	0.241
F/G	7.24[a]	6.43[b]	5.61[c]	6.15[b]	0.108
Period D					
ADG, lb	2.54[a]	3.25[b]	3.15[b]	3.38[b]	0.109
DMI, lb	23.06[a]	25.42[b]	26.22[c]	25.36[b]	0.191
F/G	9.15[a]	7.99[ab]	8.50[ab]	7.57[b]	0.291
Late cumulative[e]					
ADG, lb	2.90[a]	3.53[b]	3.88[c]	3.71[c]	0.505
DMI, lb	23.24[a]	24.92[b]	25.84[c]	25.06[bc]	0.163
F/G	8.02[a]	7.09[b]	6.68[c]	6.75[bc]	0.097

[a,b,c]Means without common superscripts differ ($P < 0.05$).

* 3 vs. 4 ($P < 0.10$).

[d]Periods A through B.

[e]Periods C through D.

Table 7. Cumulative finishing phase performance using shrunk or carcass adjusted final body weight

	Treatment				
	1	2	3	4	SEM
Live weight					
ADG, lb[I]	3.09[a]	3.49[b]	3.65[b]	3.55[b]	0.038
DMI, lb[I,*]	21.98[a]	23.37[b]	23.98[b]	23.35[b]	0.123
F/G	7.12[a]	6.70[b]	6.58[b]	6.57[b]	0.057
Final BW, lb[I]	1146[a]	1208[b]	1230[c]	1234[c]	5.5
Carcass adjusted					
ADG, lb[I]	2.99[a]	3.44[b]	3.57[bc]	3.61[c]	0.037
F/G	7.36[a]	6.80[b]	6.73[b]	6.47[c]	0.058
Final BW, lb[I]	1120[a]	1198[b]	1206[b]	1230[c]	5.3

[a,b,c]Means without common superscripts differ ($P < 0.05$).

[I] 2 vs 3 ($P < 0.10$).

*3 vs 4 ($P < 0.10$).

Table 8. Carcass characteristics of implanted steers

	Treatment				
	1	2	3	4	SEM
Dress, %[a]	61.7[e]	62.1[e]	61.9[e]	62.9[f]	0.17
Carcass Wt, lb	700[e]	742[f]	752[fg]	768[g]	2.2
Ribeye area, in^2	12.25[e]	12.45[ef]	12.76[f]	13.10[g]	0.123
Fat depth, in	0.54[e]	0.62[f]	0.61[f]	0.60[f]	0.017
KPH, %	2.51[e]	2.28[f]	2.33[f]	2.23[f]	0.042
Lean maturity[b]	1.53[e]	1.59[f]	1.59[f]	1.59[f]	0.009
Bone maturity[b]	1.47[e]	1.61[f]	1.61[f]	1.62[f]	0.010
Yield grade[c]	3.10[e]	3.34[f]	3.26[ef]	3.18[ef]	0.066
Marbling[d]	5.68[e]	5.54[ef]	5.38[f]	5.38[f]	0.095
Shear force, kg	4.02[ef]	3.84[e]	4.06[ef]	4.15[f]	0.093
	Distributions, %				
Yield Grade					
1 & 2	34	19	31	32	
3	58	67	58	59	
4	8	15	12	9	
Quality Grade					
Avg., High Choice & Prime	25	20	15	14	
Low Choice	56	57	59	58	
Select	19	23	26	27	
Standard	0	0	0	1	
Shear force					
< 3.5, kg	22	32	19	20	
> 3.4 < 5.0, kg	66	58	68	67	
> 4.9, kg	12	11	13	13	

[a]Hot carcass weight/shrunk (4%) final BW.
[b]100 = A° 200 = B°.
[c] Calculated by formula.
[d] 4.0 = Slight°; 5.0 = Small°.
[e,f,g] Means without common superscripts differ ($P < 0.05$).

Table 9. Carcass traits by cattle source

	Ranch C	Ranch W	SEM
Dress, %[a]	62.5[e]	61.8[f]	0.12
Carcass wt, lb	744	737	5.0
Ribeye area, in^2	12.7	12.6	0.086
Fat depth, in	.60	.59	0.012
KPH, %	2.49[e]	2.18[f]	0.030
Lean maturity[b]	1.57	1.58	0.007
Bone maturity[b]	1.60[e]	1.56[f]	0.007
Yield Grade[c]	3.26	3.18	0.047
Marbling[d]	5.39[e]	5.60[f]	0.066
Shear force, kg	4.13[e]	3.91[f]	0.065

[a]Hot carcass weight/shrunk (4%) final BW.
[b]100 = A^o 200 = B^o.
[c] Calculated by formula.
[d] 4.0 = $Slight^o$; 5.0 = $Small^o$.
[e,f]Means differ ($P < 0.05$).