Implants - Birth to Finish

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Abstract

Numerous implant strategies are available for use in cattle from suckling through finishing phases of production. Within a specific production system, implants consistently enhance animal productivity and/or efficiency. However, consistent responses to lifetime programs depend not only on product use but timing and sequence as well. Lifetime implant programs should be designed to obtain an optimum growth and efficiency response while minimizing expression of live animal side effects and adverse effects on carcass traits. Recent studies suggest that using, in succession, implants with increasing potency allows for the greatest animal lifetime gain (> 50 kg) while maintaining or slightly improving post-weaning feed conversion when compared to non-implanted cattle. Implant strategies which match implant dose or potency to animal age, weight, and/or production desired are recommended. Beginning in the pre-weaning period with low potency products and ending in the post-weaning period with high potency androgenic containing implant products, which complement the estrogenic response, will maintain positive carryover effects of previous implants. Implant programs should be designed to maintain hormone blood levels within an optimum response range. Hormone levels below or above this range should be avoided once implant programs are initiated.

Introduction

Growth promoting implants have been used extensively in beef production since the 1950's. For over 30 years, available implants contained compounds having primarily estrogenic (E) activity. Recently, trenbolone acetate (TBA), a synthetic analog of testosterone, was approved for use in growth promoting implants. Johnson *et al.* (1996) indicated that estrogenic implants increase the circulating levels of somatotropin (ST) and insulin-like growth factor-1 (IGF-1). Both of these substances enhance nutrient utilization and efficiency of tissue deposition, although IGF-1 is a mitogenic peptide that stimulates cell proliferation and differentiation in muscle and other tissues, depending on ST concentration. Androgenic compounds stimulate cell membrane androgen receptors that increase cellular production of protein, while simultaneously reducing adrenocorticotropic hormone (ACTH) production. Because ACTH increases catabolism of protein, lowering ACTH reduces the rate of protein catabolism. Androgens are thus anabolic compounds which aid in decreasing protein turnover rate.

The combination of E + TBA enhances growth above that found for either hormone independently. The net effect on weight gain is synergistic to that of E or TBA alone. Such action may explain the increases in feedlot performance and the rate of protein accretion associated with combination use.

When growth promoting implants are first placed in the animal there is a rapid release of hormone from the implant. The level of growth promotant being released from the implant will begin to fall after a few days but will remain above the threshold level for effective growth stimulation for months (Figure 1). The length of time the growth promotant remains above threshold will depend on the pharmaceutical design of the implant and the quality of implanting technique. Re-implanting, the administration of a second implant is usually scheduled to coincide with the declining level of circulating implant growth promotant but always above threshold. Because implant growth promotants interact with the production of hormones produced by the animal, implants have not been recommended for use in breeding cattle or calves less than 45 days of age.

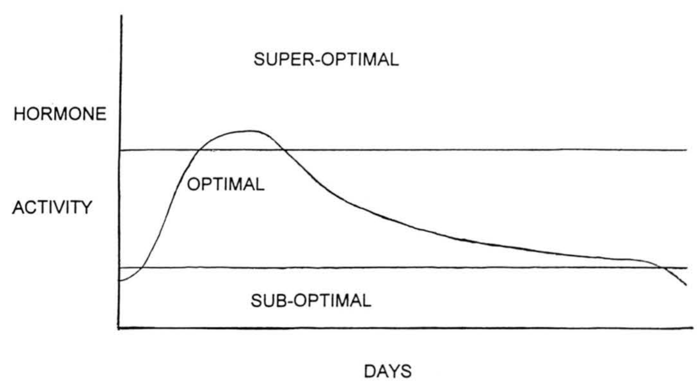

Figure 1. Growth promotant hormone activity with theoretical upper and lower threshold levels (modified from Gill, 1978).

Within a specific production system, implants consistently enhance animal productivity and/or efficiency. Implants in general produce 5 to 10 additional kg in weaning weight when given at approximately 2 months of age. In a summary of trials, Selk (1997) reported an increase in average daily gain above non-implanted controls of approximately .045 kg per day for steer calves administered zeranol or estradiol-progesterone implants. Gain responses in heifers were slightly greater (.054 kg per day). Re-implanting steers during the suckling period does not give as great a response as the initial implant, but may increase weaning weight an additional two to four kg.

In backgrounding and/or stocker programs, in which cattle receive moderate energy diets, average daily gain increases from 15 to 20% can be expected due to implanting steers; heifer response to implants will be slightly less. Using approved combinations of estrogenic and androgenic compounds will most likely provide another 3 to 5% improvement in gain. For cattle wintered or programmed for low rates of gain (i.e., less than .5 kg/head/day), the return from implanting may not be justified. The use of implants will provide the greatest benefits when cattle are on higher planes of nutrition. Additional data on the response of implants in stocker cattle has been reported by Kuhl (1997).

In finishing programs, implant considerations become more important. Reducing cost of gain is the primary focus, however, carcass quality considerations may influence decisions regarding product use. In a summary of 37 trials Duckett *et al.* (1996) reported that compared to nonimplanted cattle, implanted cattle had 18% greater gain, 6% greater intake, and 8% better feed to gain ratio, but 14.5% (74.0 vs 59.5) fewer cattle grading choice. Implant response in the finishing period not only varies with product used, but with sex of animal as well. The heifer response to implants tends to be more variable than the steer response with more potential for negative side effects to be expressed.

Review of Lifetime Implant Trials

Steers and heifers destined for slaughter through a feedlot production system could easily receive four and possibly as many as six or more implants throughout their lifetime using various implant strategies. In initial implant systems research, Ward *et al.* (1978) compared 16 different Ralgro® implant sequences on steers and heifers through suckling, growing, and finishing phases of production; while McReynolds *et al.* (1978) compared 18 different implant sequences using Ralgro® and Synovex-S®. These early studies, although limited in the number of cattle involved, demonstrated that not only a large number of different implant sequences are possible, but that carryover effects into subsequent production phases were often observed from previous implants. Carryover effects in these studies were measured in subsequent production periods as the differences in gain between previously implanted and previously non-implanted cattle.

Positive carryover effects in gain were found from suckling to growing and from growing to finishing phases of production, however, suckling implants (zeranol) tended to have a negative carryover effect on finishing and overall post-weaning performance (Table 1). Positive carryover from suckling to growing phases of production are most pronounced and have been found by others (Gill *et al.*, 1986; Mader, *et al.*, 1985; Simms *et al.*, 1988).

Three subsequent studies (Laudert *et al.*, 1981; Mader *et al.*, 1985, Simms *et al.*, 1988) assessed effects of suckling implant on subsequent implant effects post-weaning. These studies were conducted with steers and utilized zeranol (36 mg) as the only implant. A summary of the studies (Table 2) demonstrate the magnitude of the gain response attributed to implanting but tended to indicate that little or no improvements in finishing period feed efficiency were obtained due to implanting, unless the implants were administered only in the finishing period.

Table 1. Effect of previous implant treatment on finishing period average daily gain[a].

	Steers		Heifers	
	No finishing implant	Finishing implant	No finishing implant	Finishing implant
	kg			
Birth implant	1.06	1.25	1.02	1.02
No birth implant	1.20	1.31	1.07	1.11
Carry-over effect	-.14	-.06	-.05	-.09
Growing implant	1.15	1.28	1.11	1.08
No growing implant	1.10	1.28	.99	1.05
Carry-over effect	.05	.0	.12	.03

[a]Ward *et al.*, 1978

Table 2. Effect of previous implant on finishing phase performance[a].

	Implant Treatment			
Suckling:	N	N	N	I
Growing:	N	N	I	I
Finishing	N	I	I	I
ADG, kg	1.18	1.32	1.31	1.27
Feed intake, kg	9.16	9.30	9.66	9.57
Feed/gain	7.58	6.98	7.31	7.47
Final wt., kg	510	530	538	534
Change in wt. gain, kg	—	20	28	24

[a]Three trial summary - CO, KS and NE.
N = no implant, I = implanted with 36 mg zeranol.

Mader *et al.* (1985) and Simms *et al.* (1988) both found growth promoting effects of the suckling implant extended beyond weaning, although very little gain response was obtained at weaning due to implanting. The implant mediated growth response appeared to continue to occur 150 to 200 d following implantation (Simms *et al.*, 1988) The slow release of growth promoting substances in the suckling phase and subsequent continued release in the growing phase, when cattle are on a higher plane of nutrition, is one possible explanation for the carryover or delayed implant response.

A satisfactory scientific basis for carryover (positive or negative) has not been determined. Blood levels of growth promotant compounds would suggest that hormone activity initially peaks, post-implanting, and then declines gradually over time. However, discrepancies exist relative to time of peak blood levels and long-term growth promotant payout for both estrogenic and androgenic compounds (Brandt *et al.*, 1994; Johnson *et al.*, 1996). Carryover effects, as well as release rate, most likely depend on implanting technique, implant type and dosage, and carrier (Bartle *et al.*, 1992). Elevating blood levels of growth promotant compounds above lower threshold levels should produce a positive performance response; while the greatest response to growth promotants should occur when blood levels are near upper threshold levels (Figure 1). Hormone activity levels above upper thresholds levels would most likely produce no more positive performance response and would possibly contribute to negative effects.

In an effort to maintain positive carryover effects and optimize lifetime implant responses, Mader *et al.* (1994) compared lifetime implant regimens based upon studies (Mader, 1994) that demonstrated that the post-weaning response to implant/reimplant programs were enhanced when lower implant doses were followed by higher implant doses at reimplanting (Table 3). Also, using trenbolone acetate (TBA) as part of a terminal implant, to enhance the estrogen implant response, was evaluated as a part of a lifetime implant regimen. Synovex®-C was used as the pre-weaning implant with Synovex-S and -H (S) used post-weaning in steers and heifers, respectively.

Table 3. Growing and finishing response to zeranol implants[a].

Growing implant:	0	0	0	36 mg	36 mg
Finishing implant:	0	36 mg	72 mg	36 mg	72 mg
Daily gain, kg	1.13	1.21	1.28	1.28	1.31
% change	—	7.1	13.3	13.3	15.9
Feed/gain	7.12	6.85	6.75	6.86	6.57
% change	—	-3.8	-5.2	-3.7	-7.7

[a]Mader, 1994

Although interactions for weights and gains between sex and implant treatment (P < .10) were observed in this study, data were pooled by sex (Table 4). Analysis by sex is shown in the original publication (Mader, *et al.*, 1994). A large portion of the weight interaction is attributed to the larger implant weaning weight response shown by heifers (15 kg) vs steers (7.5 kg). Compared to control groups (NNNN), implants significantly increased gain and intakes in both growing and finishing periods. Over the entire post-weaning period (combined growing and finishing), implants increased intake, as a % of body weight, in cattle implanted in post-weaning periods only (NNNN vs NSSS). Implanted cattle tended to be more efficient in feed conversion than non-implanted cattle, with TBA implanted cattle having the lowest (numerically) feed to gain ratio (F/G). During the finishing period, F/G averaged 6.63 for control cattle and had an average range of 6.42 to 6.51 in implanted cattle groups. Differences in trends in feed conversion among implant treatments between steers and heifers were apparent, however additional studies are needed before firm conclusions can be made regarding implant response between steers and heifers. Lifetime implant programs did reduce the percentage of carcasses grading choice and prime by approximately 30% in both steers and heifers.

One apparent trend was the greater weaning and final weight response of implanted heifers vs steers (Mader *et al.*, 1994; Hardt *et al.*, 1995). Data (Table 5) would suggest that the gain response attributed to lifetime implant systems is considerably greater in heifers than in steers. Because lifetime implant studies in which the weaning weight response was similar between steers and heifers were not found, caution should be exercised in making conclusions from data shown in Table 5. The gain response to implants post-weaning may be more closely related to the gain response pre-weaning and not a function of sex. More data are needed to deter-

Table 4. Performance of cattle assigned to implant strategies using Synovex®-C (C), -S or -H (S), and trenbolone acetate (TBA)[a]

Implant treatment:	NNNN	NSSS	CSSS	CSSS-TBA
Weaning wt., kg	184[b]	184[b]	197[c]	196[c]
Feedlot daily gain, kg				
Growing (G)	1.01[b]	1.12[c]	1.12[c]	1.11[c]
Finishing (F)	1.21[b]	1.36[cd]	1.35[c]	1.41[d]
Overall G and F	1.15[b]	1.28[cd]	1.26[c]	1.31[d]
Feedlot DM intake, kg	7.43[b]	8.07[c]	8.15[cd]	8.36[d]
DM intake, % BW	2.36[b]	2.44[c]	2.38[bc]	2.41[bc]
Feedlot feed/gain	6.51	6.32	6.43	6.37
Final wt., kg	448[b]	478[c]	489[d]	498[d]
USDA Ch. and Pr., %[e]	92.3	68.7	55.3	60.5

[a]Cattle were not implanted (NNNN), implanted at 0, 74, and 148 d post-weaning only (NSSS), or implanted with C preweaning and S 0, 74, and 148 d post-weaning (CSSS) plus TBA 148 d post-weaning (CSSS-TBA).
[bcd]Means within a row lacking common superscript letter differ (P < .10).
[e]Control vs implant treatment groups (P < .10).

Table 5. Effect of Synovex-C® and S or -H (CSSS) or no implants (NNNN) on weaning and final weights in heifers and steers.

	Heifers		Steers	
	NNNN	CSSS	NNNN	CSSS
Weaning wt., kg				
Mader *et al.*,1994	177.0	196.0	191.0	197.0
Hardt *et al.*, 1995	239.6	263.3	256.6	260.2
Mean	208.3	229.7	223.8	228.6
Difference	21.4		4.8	
Final wt., kg[a]				
Mader *et al.*, 1994	423	479	473	498
Hardt *et al.*, 1995	451	535	494	535
Mean	437	507	483.5	516.5
Difference	70		33	

[a]Adjusted to 62% dress.

mine the nature of these interactions. In a summary of suckling implants, Selk (1997) found heifers to have a slightly greater weaning weight response to implants than steers. However, Owens and Duckett (1997) found the gain response to feedlot implant programs to be positive for steers, whereas the heifer response was more inconsistent and not always positive. It should be noted that steer and heifer comparisons should be made with herd mates in which replacement heifers have not been selected from.

The aggressiveness of (number and type of implants used) implant programs may also influence the lifetime implant response. However, with aggressive implant programs, performance enhancement may not always be realized when compared to less aggressive implant programs provided growth promotant blood levels of cattle in both program are maintained near threshold levels for optimum performance response. A large study reported by Booker (1996) demonstrated the potential for negative carryover effects when aggressive implant programs are used. In this study, 18 pens containing over 9,000 steers were initially implanted with Ralgro® then reimplanted with Revalor-S® at day 45 or day 70 of the feeding period.

No significant differences were observed in daily gain (1.57 vs 1.56 kg) or feed/gain ratio (6.88 vs 6.83); although a significant ($P < .05$) increase in daily DM intake (10.79 vs 10.63 kg) was observed in the 45 day reimplant group. In addition, the proportion of riders (4.10 vs 2.84%) was significantly ($P < .05$) greater in the 45 day vs the 70 day reimplant group (Figure 2). Reimplanting early (45 vs 70 days) did not allow rider rate to return to near zero and appeared to carryover or add to rider activity associated with the initial implant. Exceeding upper threshold hormone levels (Figure 1) would appear to enhance negative carryover effects from previous implants, which may manifest themselves as side-effects rather than performance effects.

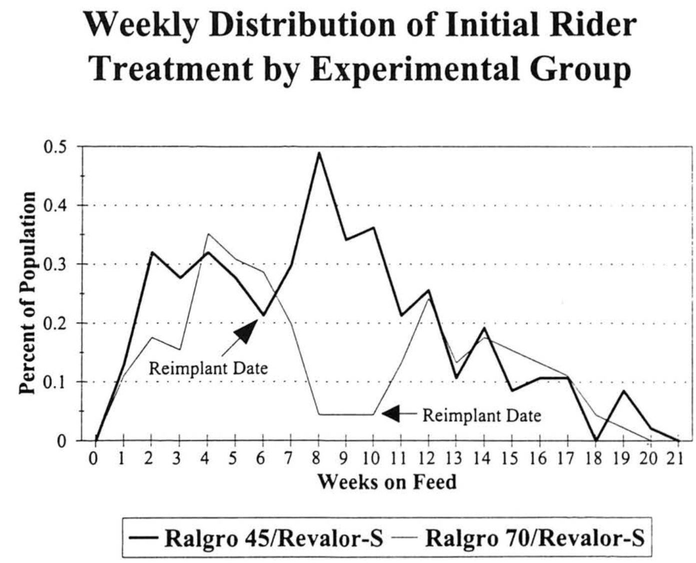

Figure 2. Effect of reimplant time (45 vs 70 days) on initial rider percentage (Booker, 1996).

In conclusion, lifetime implant programs should be designed to obtain optimum growth response with minimum expression of live animal side-effects and limited adverse effects on carcass traits. Strategically using low, moderate, and high potency implants (Tables 6 and 7) in practical implant systems (Figure 3) should accomplish these objectives. Also, for maximum benefit, it is important to maintain the level of implant growth promotant above minimum threshold levels. The length of time an implant releases growth promotant above threshold or payout, varies between implants and must be taken into account in implant selection. Implant strategies based upon a pre-determined slaughter target date (finished endpoint), which match implant dose or potency to animal age, weight, and/or production desired, are recommended. Beginning in the

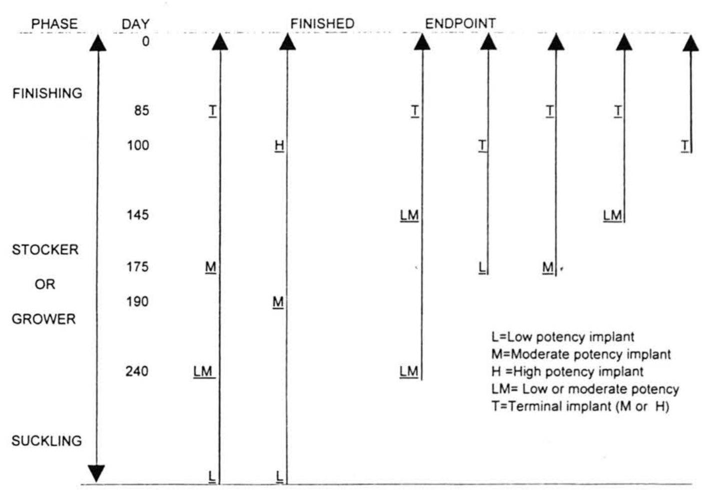

Figure 3. Possible implant programs relative to days from slaughter and initial control point of implant program.

Table 6. Growth promoting implants approved for cattle in the U.S.

Product name	Estrogen (mg)	Androgen (mg)	Progesterone (mg)
Ralgro®	36 zeranol		
Synovex®	10 E_2 benzoate		100
Calfoid®	10 E_2 benzoate		100
Synovex®-S	20 E_2 benzoate		200
Implus®-S	20 E_2 benzoate		200
Synovex®-H	20 E_2 benzoate	200 testosterone	
Implus®-H	20 E_2 benzoate	200 testosterone	
Ralgro Magnum®	72 zeranol		
Finaplix®-S		140 trenbolone acetate	
Finaplix®-H		200 trenbolone acetate	
Revalor®-G	8 E_2-17β	40 trenbolone acetate	
Revalor®-H	14 E_2-17β	140 trenbolone acetate	
Revalor®-S	24 E_2-17β	120 trenbolone acetate	
Synovex®-Plus	28 E_2 benzoate	200 trenbolone acetate	
Compudose®	24 E_2-17β		

Table 7. Implant potency and approximate payout optimums based on estrogenic (E) and/or androgenic (A) activity.

Name	Activity	Relative potency	Payout, days[a]
Ralgro (Ral)	E	Low	60-100
Synovex-C	E	Low	60-120
Calfoid	E	Low	60-120
Compudose	E	Moderate	150-200
Magnum	E	Moderate	80-120
Synovex-S/H (Syn)	E	Moderate	80-120
Implus-S/H (Imp)	E	Moderate	80-120
Revalor-G	A/E	Moderate	—
Finaplix-S/H	A	—	70-105
Finaplix-S/H + Syn, Imp or Ral	A/E	High	90-110
Revalor-S/H	A/E	High	90-120
Synovex Plus	A/E	High	90-120

[a]May vary with age of animal and plane of nutrition.

pre-weaning period with low potency products and ending in the post-weaning period with high potency androgenic containing implant products, which complement the estrogenic response, should maintain positive carryover effects of previous implants. Implant programs should be designed to maintain hormone blood levels within an optimum response range. Hormone levels below or above this range should be avoided once implant programs are initiated.

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