STOCKER CATTLE RESPONSES TO IMPLANTS[1]

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ABSTRACT

Implanting grazing cattle is one of the most profitable management tools available to stocker operators. Typically, anabolic implants increase cattle weight gains by 8 to 18% or 15 to 40 lb during the grazing season. Stocker steers appear somewhat more responsive to implants than heifers. The additional gain obtained by implanting is directly related to stocker growth rate as influenced by dietary nutritional adequacy. Thus, high forage quality and availability are important to maximize cattle implant responses. A complementary growth response from implanting and supplementing stockers also is commonly observed. Moreover, additive gain responses should be expected from implants, feed additives, and internal and external parasite control products, because the modes of action of these compounds are distinctly different. The feedlot performance and carcass merit of cattle previously implanted as stockers should not be different from the stockers that are not implanted, provided an adequate feedlot implant program is used to maximize finishing performance.

INTRODUCTION

If the definition of management is "applying the practices that pay", then implanting should be high on the must-do list of profit-minded stocker operators. Literally hundreds of experiment station studies and Extension and industry field trials over the last four decades have demonstrated conclusively the growth benefits from implanting grazing calves and yearlings. Yet, producer surveys in various states indicate that only 40 to 65% of stockers are implanted; this results in substantial losses in performance and profitability.

Several FDA approved implants are available currently for stocker cattle, as listed in Table 1. Ralgro® was introduced in the late 1960's for use in both steers and heifers. The active ingredient in Ralgro® is 36 mg zeranol, a non-hormonal anabolic compound with mild estrogenic activity (Mallinckrodt Veterinary, 1984). Synovex® implants were approved in the mid to late 1950's as sex-specific, dual-hormone products for steers and heifers. Synovex®-S contains 20 mg estradiol benzoate and 200 mg progesterone, while Synovex®-H contains 20 mg estradiol benzoate and 200 mg testosterone propionate. Both are considered strong estrogenic products and are approved for cattle over 400 lb (Fort Dodge Animal Health, 1983). In the early to mid 1980's, the first generic implants, STEER-oid™ and HEIFER-oid™, were cleared containing the same active ingredients with the same bioavailability as Synovex®-S and -H, respectively. More recently, these products were renamed Implus™-S and -H. In 1997, another pair of generic bio-equivalent implants, Component™ E-S and -H, comparable to Implus™ and Synovex® products became available for stocker cattle.

Table 1. FDA approved implants for grazing stockers

Steers	Heifers
Ralgro®	Ralgro®
Synovex®-S	Synovex®-H
Implus™-S	Implus™-H
Component™ E-S	Component™ E-H
Compudose®	
Revalor®-G	Revalor®-G

[1]English measurements are used throughout this article to maximize communication and understanding. For those partial to assimilation of research in metric terms, the growth responses reported herein can be interpreted as kg per metric day (52.8 hours or 2.2 avoirdupois days).

In 1982, Compudose® was introduced as a new sustained-release drug delivery system (Elanco Animal Health, 1982). In contrast to the other implants consisting of compressed pellets with commonly accepted effective payout periods of 80 to 120 days, Compudose® is composed of a silicone rubber core with micro-crystals of 24 mg estradiol-17β impregnated in the outer silicone matrix; this provides controlled release of a minimum daily dosage of 35 to 40 micrograms of the natural estrogen over 160 to 200 days. This implant is coated with oxytetracycline to prevent infection. The latest addition to the stocker implant market is Revalor®-G, approved in the mid 1990's specifically for weaned grazing steers and heifers. Revalor®-G contains a unique combination of 8 mg estradiol-17β and 40 mg trenbolone acetate (TBA), a potent synthetic analog of testosterone (Hoechst Roussel Vet, 1991). The only approved implantation site for all brands of implants is subcutaneously in the middle-third of the back of the ear.

Typical Implant Growth Responses in Stockers

Extensive research databases documenting the growth promoting capabilities of the various stocker implants have been published. For example, in a summary of 65 pasture research trials with steers and heifers, Synovex® -implanted stockers out-gained non-implanted controls by .27 lb/day (1.73 vs. 1.46 lb; 18.5%) over an average of 149 days (Fort Dodge Animal Health, 1983). Similarly, the average gain response from a single Ralgro® implant was 26 lb (220 vs. 194 lb; 13.4%) compared to controls in a summary of 60 studies involving 4,188 stocker cattle (Mallinckrodt Veterinary, 1984). A 19-trial summary of Compudose® efficacy involving 1,104 grazing steers found a weight gain advantage of 8.6 to 18.6% by implanted stockers (Elanco Animal Health, 1982).

A tremendous number of Extension field trials have been conducted across the United States, especially in the 1970's, to further document the growth responses from implanting grazing cattle, and to encourage more widespread adoption of this technology by stocker operators. Table 2 illustrates the 1971-72 results of 43 University of Missouri field studies involving 3,068 steers summarized by Sewell (1990). Stockers implanted with Ralgro® grew 14.6% faster, resulting in 22 lb more gain per steer over 125 days than controls. In companion studies, Missouri specialists found comparable improvements in gain with Synovex® implants. Similarly, Kansas State specialists (Corah et al., 1977) reported a 20 lb gain advantage in Ralgro®-implanted grazing steers and heifers, in a summary of 19 field studies involving 981 head. Numerous additional stocker trials documenting a 15 to 40 lb gain response per head from a single Compudose®, Ralgro®, Synovex®, or Implus® have been published (Neel et al., 1981; Kuhl, 1982; Elanco Animal Health, 1982; Fort Dodge Animal Health, 1983; Mallinckrodt Veterinary, 1984; Laudert et al., 1984; Lusby and Gill, 1985; Whittington, 1986; Sewell, 1990; Adams and Hinsley, 1990; Johns et al., 1994; Gill and Bevers, 1994; Gill et al., 1995; Brazle and Cook, 1995; Brazle, 1996).

Recently, Revalor®-G was approved for use in grazing steers and heifers. This is the first trenbolone acetate/estradiol implant cleared specifically for stocker cattle. Table 3 summarizes the University studies comparing the growth responses obtained from Revalor®-G, Ralgro® and Synovex® relative to non-implanted controls (Hoechst Roussel Vet, 1991). In three trials averaging 94 days with a total of 1,084 steers, Revalor®-G improved stocker gains by 21.6 lb (16.1%), similar to Ralgro® (14.0%), but more than Synovex®-S (10.5%). In three heifer studies averaging 116 days with 494 head, Revalor®-G boosted total gain by 26.7 lb (15.3%) compared

Table 2. Effect of implanting on performance of grazing yearling steers[1]

Year	No. Trials	No. Steers	Days on Trial	Pounds of Gain/Head		
				Control	Ralgro®	Benefit
1971	26	2,077	120	156[a]	176[b]	20
1972	17	991	131	147[a]	170[b]	23
Overall	43	3,068	125	151[a]	173[b]	22

[1]Sewell, 1990. Summary of University of Missouri field studies in 1971-72.
[ab]Means in the same row with unlike superscripts differ, P<.05.

Table 3. Implant comparisons with Revalor®-G in grazing steers and heifers[1]

Study	Days	Head	Control	Synovex®	Ralgro®	Revalor®-G
STEERS:			----------Average daily gain, lb----------			
Virginia	97	300	1.16[b]	1.22[b]	1.36[a]	1.37[a]
Oklahoma	90	304	1.44[c]	1.65[ab]	1.57[b]	1.71[a]
Kansas	94	480	1.69[b]	1.87[a]	1.95[a]	1.90[a]
Overall	94	1084	1.43[c]	1.58[b]	1.63[ab]	1.66[a]
Response Over Control			---	10.5%	14.0%	16.1%
HEIFERS:						
Kansas	150	196	1.58[c]	1.82[a]	1.69[b]	1.81[a]
Virginia	97	150	1.32[e]	---	1.44[d]	1.47[d]
Nebraska	100	148	1.61[b]	---	1.85[a]	1.90[a]
Overall	116	494	1.50[f]	---	1.66[e]	1.73[d]
Response Over Control			---	---	10.7%	15.3%

[1]Adapted from Hoechst Roussel Vet, 1991.
[abc]Means in a row with unlike superscripts differ, P<.04.
[def]Means in a row with unlike superscripts differ, P<.08.

to controls and 4.6% better than Ralgro®. In one 150-day Kansas summer trial (Blasi et al., 1997), heifer gains were enhanced equally (15%) with a single Revalor®-G or Synovex®-H. However, in a subsequent 151-day heifer study (Blasi and Kuhl, 1997) on rye pasture, daily gains were greater with Synovex®-H than Revalor-G® or Ralgro® (1.79 vs. 1.64 and 1.58 lb, respectively; P<.05). In the earlier Kansas trial, reimplanting at 75 days with Revalor®-G did not improve overall daily gain compared to a single, initial implant (1.83 vs. 1.81 lb); a second Ralgro® tended to enhance performance (1.76 vs. 1.69 lb) but reimplanting with Synovex®-H decreased daily gain (1.68 vs. 1.82 lb; P<.05). Overall, Revalor®-G appears to be a very consistent new growth promotant for grazing steers and heifers.

Reimplanting stockers with Ralgro®, Synovex® or equivalent products midway through a full-season grazing program, or using Compudose® initially, generally should be considered when forage quality and environmental conditions are adequate to support reasonable cattle gains during the latter part of the grazing season. Sewell (1983) found that a Ralgro® reimplant at 79 days improved overall stocker gains by 9.5 lb (4.0%) compared to a single Ralgro® in 11 field trials averaging 166 days in length. Similarly, in eight companion studies averaging 181 days, a Synovex® reimplant at 92 days increased total gain per head by 6.3 lb (2.7%). However, in five of those trials, where daily gain during the second half of the grazing season was 1.23 to 2.29 lb, the Synovex® reimplant program boosted total stocker gains by 14.8 lb over a single Synovex®. In 13 additional field trials averaging 172 days, Sewell (1990) found that a single Compudose® increased total stocker gains by 13 lb compared to steers implanted with a single Ralgro® (225 vs. 212 lb, 5.8%). Steers given either Compudose® or reimplanted with Ralgro® at 98 days produced similar gains in five further studies averaging 187 days. These results are consistent with the findings of five 196-day research trials conducted in Texas, Kansas, Oregon, and Colorado comparing a single Ralgro® or Compudose® implant in grazing steers, and a summary of 54 field studies comparing Compudose® with single and reimplant programs using Ralgro® or Synovex®-S (Elanco Animal Health, 1982), as well as trials on wheat/rye pasture (Laudert et al., 1983; Adams and Hensley, 1990; Gill and Bevers, 1994). Collectively, these studies amply demonstrate the performance benefits of reimplanting or using a sustained-release implant in stockers grazing more than 130 to 150 days, provided late-season cattle gains are adequate to elicit an anabolic response.

Factors Influencing Stocker Responses to Implants

Numerous factors have been suggested to impact the growth responsiveness of grazing cattle to implants. These include inherent stocker growth rate as influenced by pasture type, forage quality and availability, grazing system and supplementation, as well as stocker sex, weight and genotype.

Stocker Growth Rate: Gain responses obtained from implanting grazing steers and heifers are related to the basal growth rate as affected by forage quality or quantity, and associated nutritional limitations (Fort Dodge Animal Health, 1983; Lusby and Gill, 1985; Sewell, 1990). Table 4 illustrates the most extensive database available on this relationship, compiled by Dr. John Bonner (Mallinckrodt Veterinary, 1984). In this analysis of 73 trials averaging 120 days, the response of stockers to Ralgro® implants was related definitively to the total pasture gain of non-implanted controls, stratified in 50 lb gain increments from 25 to 275 lb (.21 to 2.29 lb/day). The growth response from implanting stockers improved dramatically, from 3 to 40 lb per head, as grazing performance of the controls increased.

A similar relationship was demonstrated between the response of stockers to Compudose® and the growth rate of their non-implanted herdmates in a summary of 19 research studies averaging 143 days, as shown in Table 5 (Elanco Animal Health, 1982). As the daily gain of control steers increased from 1.16 to 1.45 lb, attributable to higher pasture quality and/or supplementation, the response to Compudose® implants improved from .10 lb/day (8.6%) to .27 lb/day (18.6%).

This strong relationship between the basal growth rate of grazing cattle and their responsiveness to implants is consistent with our current understanding of the mode of action of these anabolic compounds, as discussed elsewhere in these proceedings. Of practical significance to stocker operators is the fact that the intricate metabolic responses and interactions of endogenous and exogenous (implant) hormones that mediate growth are controlled largely by the nutritional status of the animal (Lemieux et al., 1983; Preston, 1987; Reinhardt et al., 1993; Wester et al., 1994). Dr. Rod Preston has calculated that the energy consumption of cattle should exceed about 1.5 times

Table 4. Effect of stocker growth rate on response to Ralgro® implants[1]

	120-Day Gain of Non-Implanted Cattle, lb					
Item	**25**	**75**	**125**	**175**	**225**	**275**
Implant Response:						
Gain/head, lb	3	10	23	34	40	40
Daily gain, lb	.02	.08	.19	.28	.33	.33
Benefit, %	12.0	13.3	18.4	19.4	17.8	14.5

[1]Adapted from Mallinckrodt Veterinary, Inc., 1984. Summary of a 73-trial database with stockers grazing an average of 120 days.

Table 5. Effect of growth rate of stocker cattle on response to Compudose® implants[1]

	Number of Trial Comparisons				
Item	**Nine**	**Five**	**Five**	**Five**	**Five**
Steer Daily Gain, lb:					
Not implanted	1.16	1.22	1.31	1.35	1.45
Compudose®	1.26	1.39	1.51	1.56	1.72
Implant Response:					
Lb/day	.10	.17	.20	.21	.27
Percent	8.6	13.9	15.3	15.6	18.6

[1]Elanco Animal Health, 1982. Summary of 19 studies with 1,104 steers grazed an average of 143 (97-196) days.

their maintenance requirement in order to elicit a measurable implant response. This is consistent with practical recommendations that stockers should gain at least .7 to 1 lb daily in order to obtain a reasonable response from implanting although the minimum rate of gain will likely vary with genotype and relative growth potential of the cattle (Elanco Animal Health, 1982; Fort Dodge Animal Health, 1983; Mallinckrodt Veterinary, 1984; Laudert et al., 1984; Lusby and Gill, 1985; Sewell, 1990; Gill and Bevers, 1994; Brandt et al., 1995).

While little or no response should be expected from implants when stocker gains are limited due to poor pasture or environmental conditions, no adverse effects have been demonstrated. Several grazing studies have shown no detrimental impact on performance from implanting stockers even when gains were as low as .1 to .5 lb/day (Armbruster et al., 1980; Rust et al., 1981; Elanco Animal Health, 1982; Fort Dodge Animal Health, 1983; Sewell, 1983; Mallinckrodt Veterinary, 1984; Gill et al., 1995).

Stocker Supplementation: Effective supplementation programs that improve stocker performance by correcting nutritional deficiencies or by stretching the available forage supply should enhance the response to implants. Table 6 illustrates the complementary effect of late-season supplementation on the response of stockers to reimplantation with Synovex® (Sewell, 1983). In five Missouri field studies with no protein/energy supplementation, stocker daily gains (.96 lb) were not affected by reimplanting. However, in three companion trials where stockers were supplemented, reimplanting improved gains by 5.2% (2.03 vs. 1.93 lb/day).

The synergistic effect of implants, stocker supplementation, and use of growth-promoting feed additives such as Rumensin ® and Bovatec® also has been documented. Studies at North Dakota, Kentucky, Texas, Nebraska and Illinois evaluated the response of steers to Compudose®, energy supplementation, and Rumensin®, as summarized in Table 7 (Elanco Animal Health, 1982). Compudose® alone improved stocker gains by 13.9%, while 2 lb of supplement with 200 mg Rumensin® daily increased gains by 18.9% compared to controls. However, the combination of implant, supplement and Rumensin® boosted steer gains by .50 lb/day (41.0%)--more than an expected from an additive response alone. In three additional trials conducted in Kansas, Florida and Texas, the average stocker response to Ralgro® or Synovex® was 8.6%, while feeding a supplement containing Rumensin® improved gains by 18.0%. Again, the complementary effect of implant and Rumensin® supplement enhanced daily gain by .40 lb (31.2%). In two earlier trials, additive responses from implants and Rumensin® on stocker summer gains were found (Corah, 1977; Armbruster et al., 1980). Similarly, a two-year study by Florida researchers (Horton et al., 1981) found that winter pasture supplementation, Bovatec® and Ralgro® were fully additive in boosting stocker performance. An additive response to implanting and deworming grazing cattle also has been shown (Neel et al., 1981; Mallinckrodt Veterinary, 1984).

Overall, theses studies clearly demonstrate a greater response to implants as the nutritional status of stockers is improved. This relationship is consistent with the results of cow-calf trials documenting a greater implant response in suckling calves associated with creep feeding and higher dam milk production levels (Hendrix et al., 1979; Robinson et al., 1983; Selk, 1996).

Table 6. Complimentary effect of supplementing stockers and reimplanting with Synovex[1]

No. Trials	Daily Supplement	Overall Daily Gain, lb		Reimplant Benefit
		Single Implant	Reimplanted	
5	None	.96	.96	0%
3	5-7 lb	1.93	2.03	5%

[1]Sewell, 1983. Studies averaged 181 days with stockers reimplanted after 100 days on grass.

Table 7. Complimentary response of grazing steers to Compudose®, energy supplementation and Rumensin®[1]

Treatment	Daily Gain, lb	Growth Response	
		Lb/day	Percent
Control	1.22	---	---
Compudose®	1.39	.17	13.9
Supplement, 2 lb/day	1.35	.13	10.7
Supplement + 200 mg Rumensin®	1.45	.23	18.9
Compudose®, supplement and Rumensin®	1.72	.50	41.0

[1]Adapted from Elanco Animal Health, 1982. Summary of 5 trials with 512 steers grazed for 112-140 days.

Stocker Sex and Biological Type: The relative response from implanting grazing steers vs. heifers has not been examined conclusively, because contemporary herdmates of equal age, genetics and background seldom have been used. Thus, the differential implant response attributable to sex is limited largely to comparisons across trials. Nevertheless, a 10-year summary of grazing studies (Fort Dodge Animal Health, 1983) in 20 states is illustrative. In 29 trials with 2,308 steers, Synovex®-S improved weight gain above controls averaged .41 lb/day (2.04 vs. 1.63 lb; 25.1%); while Synovex®-H increased heifer gain an average of .23 lb/day (1.69 vs. 1.46 lb; 15.7%) in 10 studies with 703 head. Similarly, Laudert et al. (1984) summarized the implant responses in 10 steer and seven heifer trials on cereal grain pastures. Compared to controls, Ralgro® and Synovex®-S boosted steer gains an average of 19.6 and 18.3%, respectively; heifer gains were improved 15.6 and 11.6% with Ralgro® and Synovex®-H, respectively. The somewhat lower responsiveness of weaned stocker heifers to estrogenic implants is consistent with other reports (Mallinckrodt Veterinary, 1984; Hutcheson and Rouquette, 1986; Hoechst Roussel Vet, 1991; Brazle, 1996). However, this conclusion contrasts with results from preweaning implant summarized by Selk (1996) in which implant response to suckling-phase by heifers to suckling-phase implants was equal to or better than that of steers. Presumably, this inconsistency is related to the onset of puberty and the attendant increases in endogenous levels of estrogen in stocker heifers. Indeed, spayed yearling heifers respond more to estrogenic implants than their intact counterparts on pasture (Rupp et al., 1983).

The influence of genetics or biological type on the response of stockers to implants has not been studied extensively. However, virtually every breed type has been utilized in the hundreds of stocker implant studies conducted over the last 40 years. In general, the implant responses reported in those trials, conducted with British, Continental, Brahman and dairy breeds or their crosses of various frame sizes, have been fairly consistent when forage quality and environmental conditions were adequate to support reasonable growth rates (Rust et al., 1981; Elanco Animal Health, 1982; Davis, 1982; Robinson et al., 1983, Brethour, 1983; Fort Dodge Animal Health, 1983; Mallinckrodt Veterinary, 1984; Hutcheson and Rouquette, 1986; Whittington, 1986; Rush et al., 1989; Brazle and Coffey, 1991; Hoechst Roussel Vet, 1991; Johns et al., 1994; Brandt et al., 1995; Gill et al., 1995; Brazle, 1996; Fankhauser et al., 1997; Kuhl et al., 1996). Thus, while the gainability of stockers varies with biological type and genetic adaptation to climatic and environmental stresses, their relative growth rate and responsiveness to implants appears closely linked to dietary nutritional quality and availability.

Forage Type and Quality: Stocker implant studies have been conducted on virtually every forage species grazed across the United States. These forages have covered the spectrum of warm and cool season, native and introduced, and annual and perennial species in monoculture and mixed stands ranging from bluestem to buffalograss, brome to bermudagrass, crabgrass to crop residues and summer annuals to winter cereals. An overview of the referenced studies clearly indicates that forage quality is the dominant factor controlling stocker growth rate and the resultant magnitude of the response to implants. Thus, the level and duration of forage nutritional quality and availability as influenced by plant species, stage of maturity, stocking rate and climatic conditions largely regulates stocker performance and implant responses.

Specific implants have been shown to be beneficial in minimizing the detrimental effects on stocker gains of the fungal endophyte *Acremonium coenophialum* which infects most of the tall fescue pastures in this country. In a two-year study, Brazle

Table 8. Stocker gain response to Ralgro® on low and high endophyte fescue pastures[1]

Item	20% Endophyte Fescue			82% Endophyte Fescue		
	None	RAL-36	RAL-72	None	RAL-36	RAL-72
Daily gain, lb	1.28[b]	1.43[c]	1.48[c]	.95[a]	1.30[b]	1.39[bc]
Response, lb	---	.15[a]	.20[a]	---	.35[b]	.44[b]
Benefit, %	---	12%	16%	---	37%	46%

[1]Brazle and Coffey, 1991. Summary of two 87-day fall grazing trials with 300 steers. Implant treatments were: None=Control; RAL-36=one 36 mg Ralgro®; RAL-72=2 Ralgro®.
[abc]Means in a row with unlike superscripts differ, P<.05.

and Coffey (1991) evaluated the response of stockers to graded levels (0, 36 or 72 mg) of zeranol when grazed on either low or high (20 vs. 82%) endophyte-infected fescue (Table 8). Zeranol, the active ingredient in Ralgro®, improved fall stocker daily gains .15 to .20 lb (12 to 16%) on the low endophyte pastures; the gain response was over two-fold higher -- .35 to .44 lb (37 to 46%) -- on high endophyte fescue. The rectal temperature of Ralgro®-implanted steers also was lower, indicating a reduction in endophyte-induced heat stress. No significant gain differences were found between 36 and 72 mg of zeranol but only 36 mg Ralgro® is approved for use in stockers. Morrow et al. (1986) also found a greater than normal gain response to Ralgro® in stockers grazing high endophyte fescue. Similarly, Brazle and Whittier (1988) reported a much greater response in weaning weight (40 vs. 11 lb) to a Ralgro® reimplant program in suckling calves grazing 70% vs. 40 to 45% endophyte-infected pastures. Collectively, these studies demonstrate that Ralgro® is beneficial in reducing the adverse effects of fescue toxicosis on grazing cattle performance. Whether other implant types have a similar effect has not been investigated adequately.

Effect of Grazing Implants on Feedlot Performance and Carcass Traits

The potential carryover effects of implanting during the suckling or growing phases on subsequent cattle performance continues to be widely debated. Fortunately, a number of studies have been conducted to help answer these legitimate concerns. Rust et al. (1981) found no impact of implanting suckling calves on their postweaning grazing gains. Ralgro®-implanted steers and heifers gained 23 to 30 lb more during the suckling phase, and when reimplanted after weaning, they continued to gain as rapidly as herdmates that received their first Ralgro® as yearlings. This response is consistent with other suckling/growing studies (Kuhl, 1982; Mallinckrodt Veterinary, 1984; Lusby and Gill, 1985; Mader, 1996).

The influence of implanting stocker cattle on their subsequent feedlot performance also has been investigated. Table 9 illustrates the results of a grazing/feedlot study utilizing estrogenic implants in both phases (Rush et al., 1989). Steers implanted with Synovex®-S or Ralgro® gained 21 and 33 lb more, respectively, than controls during the 143-day grazing stage. During the subsequent 114-day finishing phase, when all steers were implanted with Compudose®, no differences in daily gain or feed conversion were observed. The added gain from implanting the stockers was maintained throughout the finishing period, and no significant differences in carcass traits were found. Similarly, Hutcheson and Rouquette (1986) evaluated the impact of a Ralgro® reimplant program during a 180-day rye/ryegrass grazing period on the feedlot performance of Senepol-cross steers and heifers. All cattle received Ralgro® during the 126 to 168-day feeding phase. Implanted stockers gained .2 lb/day faster than controls, with no influence on subsequent finishing performance. Cattle implanted on grass tended to have higher quality grades, with no effect on other carcass traits. Likewise, other workers (Horton et al., 1981; Dinusson et al., 1982; Davis, Jr., 1982; Robinson et al., 1983; Brethour, 1983; Mallinckrodt Veterinary, 1984) have detected no impact of estrogenic stocker implants on subsequent performance, although Coffey et al. (1990) reported a trend for lower feedlot gains in steers reimplanted with Synovex®-S on fescue pasture. Carcass characteristics were not influenced by pasture implant, however.

More recently, researchers have studied the potential carryover effects of estrogenic implants in stockers followed by estrogen/TBA implants in the feedlot. In a two-year study, Brandt (1995) evaluated Synovex®-S implants in steers grazing season-long (145 days) or intensive-early-stocked (71 days) native range. In the feedlot (122 to 137 days), all cattle

received Synovex®-S initially followed by Synovex®-S and Finaplix®-S on day 60 (Table 10). The intensive-early managed cattle gained faster and produced more beef per acre than those grazed season-long. Accordingly, the double-stocked steers exhibited a greater response to Synovex®-S on pasture. During the finishing phase, the intensively stocked steers gained faster and more efficiently than their full season counterparts. Implanting during the stocker phase had no effect on feedlot performance or carcass merit. Across both grazing systems, implanting cattle on grass increased final slaughter and carcass weights about 20 and 12 lb per head, respectively, compared to controls.

The comparative pasture and feedlot performance of stockers implanted prior to grass with Revalor®-G, Ralgro® or Synovex®-S, and subsequently implanted with Synovex®-S or Revalor®-S in the feedlot, has been evaluated (Kuhl et al., 1997). Four hundred and eighty steers were used in the 94-day intensive-early-stocked phase; one-half of the steers on each pasture treatment were finished for 140 days (Table 11). All three stocker implants improved gains compared to non-implanted controls. Overall, pasture-implanted steers gained 13% faster (.22 lb/day) and had 20 lb heavier off-grass weights than controls. In the feedlot phase, Revalor®-S improved daily gain 7.9% and feed efficiency 5.1% compared to Synovex®-S across pasture implant treatments. Grazing implants had no significant influence on feedlot performance or quality and yield grades, but pasture implants increased carcass weights an average of 18 lb. Likewise, Brazle (1996) found no effect of Ralgro® or Synovex®-S grazing implants on subsequent feedlot gains of Revalor®-S reimplanted steers in one trial, while feedlot gain was reduced by pasture implants an average of 4.6% in a second study.

In another large scale study, Fankhauser et al. (1997) evaluated the performance of 480 stockers given either Ralgro®, Synovex®-S or no implant on double-stocked range, followed by Synovex® Plus™ or a Ralgro®/Synovex® Plus™ reimplant program during the finishing phase, on overall performance and carcass merit. During the 84-day grazing period, stocker gains averaged only 1.35 lb/day as a result of a late, dry spring. Consequently, Ralgro®-implanted steers gained only 9.3% faster than controls, while gains of Synovex®-S stockers were intermediate. In the finishing phase, steers initially implanted with Synovex® Plus™ gained 11.7% faster and 7.9% more efficiently than Ralgro®-implanted cattle during the first 56 days on feed. However, when the Ralgro® feedlot steers were reimplanted with Synovex® Plus™, they gained 22.2% faster and 21.1% more efficiently during the last 76 days on feed. Over the entire 132-day finishing period, the cattle on the feedlot reimplant program gained 4.0% faster and 7.5% more

Table 9. Effect of implanting grazing yearlings with Ralgro® or Synovex®-S followed by Compudose® in the feedlot on performance and carcass traits[1]

	Pasture Implant		
Item	**None**	**Ralgro®**	**Synovex®-S**
No. steers	25	26	28
Pasture daily gain, lb	1.55[a]	1.78[b]	1.70[b]
Finishing Phase[2]:			
Daily gain, lb	2.89	2.88	2.84
Daily DM intake, lb	22.2	21.6	21.8
Feed DM/gain	7.7	7.5	7.7
Carcass Traits:			
Dressing %	59.5	58.6	58.7
Backfat, in.	.56	.54	.56
Marbling score	Sm^{50}	Sm^{20}	Sm^{20}
Yield grade	2.5	2.4	2.4

[1]Rush et al., 1989. Steers averaging 615 lb grazed crested wheatgrass for 143 days followed by a 114-day finishing period.
[2]Based on carcass-adjusted final weight using a common dressing percent of 61.7.
[ab]Means in a row with unlike superscripts differ (P<.10).

Table 10. Effect of grazing system on native range and pasture implant on stocker/feedlot performance and carcass traits[1]

Item	Early Intensive--71 days		Season Long--145 days	
	Control	Synovex®-S	Control	Synovex®-S
Pasture Phase:				
Gain/head, lb[ab]	113	137	204	216
Daily gain, lb[d]	1.59	1.93	1.41	1.49
Feedlot Phase:				
Days on feed	122	122	137	137
Daily gain, lb[a]	3.78	3.77	3.32	3.39
DM intake, lb[ab]	21.9	22.6	20.9	21.9
Feed DM/gain[a]	5.78	6.03	6.33	6.51
Carcass Traits:				
Carcass wt, lb[ac]	735	748	786	798
Dressing %[a]	62.4	62.0	63.4	64.1
Backfat, in.	.42	.40	.41	.43
Marbling score	SM^{04}	SL^{95}	SM^{15}	SL^{98}
% USDA Choice	66	54	58	55

[1]Brandt et al., 1995. Summary of 2-year study with 288 steers initially averaging 612 lb.
All Synovex®-S pasture cattle were implanted at turnout, and season-long steers were reimplanted after 71 days. In the feedlot, all cattle received Synovex®-S initially followed by Synovex®-S and Finaplix®-S after 60 days on feed.
[a]Main effect of grazing system, P<.05.
[b]Main effect of pasture implant, P<.05.
[c]Main effect of pasture implant, P<.10.
[d]Grazing system × pasture implant interaction, P<.05.

efficiently than those implanted with Synovex® Plus™ alone. Steer feedlot gains and feed intakes were similar for all pasture implant treatments, with no significant pasture/feedlot performance interactions. However, pasture-implanted steers tended to be less efficient than controls during the finishing phase, especially when a feedlot reimplant program was not used. Neither pasture or feedlot implant treatment significantly influenced carcass characteristics.

Collectively, these pasture/feedlot studies demonstrate that the positive growth benefits obtained with pasture implants generally are retained through the finishing phase in steers, provided sufficient hormonal stimulation is maintained throughout the feeding period by a feedlot implant program designed to optimize terminal performance and carcass merit. This conclusion is consistent with other research summaries (Kuhl, 1982; Sewell, 1990; Duckett et al., 1996; Mader, 1996). However, additional research on carryover effects with grazing/finishing heifers is needed.

Table 11. Growth response of grazing steers implanted with Revalor®-G, Ralgro® and Synovex®-S, and subsequent finishing performance and carcass merit[1]

Pasture Treatment:	Control		Revalor®-G		Ralgro®		Synovex®-S	
Feedlot Treatment:	Rev-S	Syn-S	Rev-S	Syn-S	Rev-S	Syn-S	Rev-S	Syn-S
Pasture Phase--94 days:								
Gain/head, lb[a]	159		179		183		176	
Daily gain, lb[a]	1.69		1.90		1.95		1.87	
Finishing Phase[2]--140 days:								
Daily gain, lb[b]	3.53	3.22	3.50	3.44	3.55	3.23	3.65	3.30
DM intake, lb[cef]	23.6	22.4	22.6	24.0	24.2	23.1	24.5	23.3
Feed DM/gain[b]	6.71	6.94	6.49	6.99	6.85	7.14	6.71	7.04
Overall gain/head, lb[bg]	658	610	668	662	690	6.34	687	637
Carcass Traits:								
Carcass wt, lb[be]	786	756	789	790	806	773	804	774
Dressing %	62.9	63.0	63.8	63.4	63.3	63.6	63.4	63.6
Backfat, in.[dg]	.50	.41	.41	.51	.42	.44	.55	.53
Yield grade	3.16	2.89	2.87	3.16	2.91	2.99	3.30	3.21
Marbling score	SM^{19}	SM^{18}	SL^{91}	SM^{21}	SL^{00}	SL^{85}	SM^{00}	SM^{09}
% USDA Choice	77	83	57	77	57	67	70	73

[1]Kuhl et al., 1997. Study with 480 crossbred steers initially averaging 590 lb. One-half of stockers on each pasture treatment were finished, and received either Revalor®-S or Synovex®-S.
[2]Feedlot gain and efficiency based on carcass-adjusted final weight using 63% standard dress.
[a]Control vs implanted, P<.01.
[bc]Main effect of feedlot implant, [b]P<.01 and [c]P<.05.
[de]Main effect of pasture implant, [d]P<.02 and [e]P<.13.
[fg]Pasture × feedlot implant interaction, [f]P<.01 and [g]P<.12.

Table 12. Impact of implanting stockers with Ralgro® or Synovex®-S followed by Synovex® Plus™ or a Ralgro®/Synovex® Plus™ reimplant program in the feedlot on steer grazing/finishing performance and carcass merit[1]

Pasture Treatment:	Control		Ralgro®		Synovex®-S	
Feedlot Treatment[2]:	Syn +	Ral/Syn +	Syn +	Ral/Syn +	Syn +	Ral/Syn +
Pasture Phase--84 days:						
Gain/head, lb	108[a]		118[b]		113[ab]	
Daily gain, lb	1.29[a]		1.41[b]		1.35[ab]	
Finishing Phase--132 days:						
Daily gain, lb:						
Day 1--56[ce]	4.77	4.13	4.44	3.97	4.60	4.13
Day 57-132[e]	2.90	3.19	2.60	3.26	2.53	3.24
Day 1-132[e]	3.69	3.59	3.38	3.56	3.41	3.62
Feed DM/gain, lb:						
Day 1-56[ce]	4.58	4.87	4.74	5.29	4.69	4.98
Day 57-132[e]	8.14	6.81	8.85	6.83	9.05	6.99
Day 1-132[de]	6.14	5.82	6.54	6.07	6.52	5.97
Carcass Traits:						
Carcass wt, lb	785	776	767	779	764	786
Dressing %	61.5	61.9	62.2	61.6	61.6	62.1
Backfat, in.	.41	.38	.43	.40	.39	.39
Yield grade	2.6	2.4	2.7	2.6	2.7	2.5
Marbling score	SL^{64}	SL^{85}	SL^{81}	SL^{57}	SL^{71}	SL^{69}
% USDA Choice	41	58	52	34	46	42

[1]Fankhauser et al., 1997. Study with 480 crossbred steers initially averaging 675 lb. Pasture/finishing performance and dressing percentage based on unshrunk weights.
[2]Ralgro®/Synovex® Plus™ steers were implanted with Synovex® Plus™ after 56 days on feed.
[ab]Means in the same row with unlike superscripts differ, P<.05.
[c]Main effect of pasture treatment (Control vs Ralgro®) on finishing performance, P<.08.
[d]Main effect of pasture treatment (Control vs Ralgro® and Synovex®-S) on feed efficiency, P<.08.
[e]Main effect of feedlot implant program on finishing performance, P<.06.

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