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Growth Implant Timing and Effectiveness in Beef Cattle

Herschel Brad Jones

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Growth implant timing and effectiveness in beef cattle

By

Herschel Brad Jones

A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Animal Science
in the Department of Animal and Dairy Sciences

Mississippi State, Mississippi

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2014

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One hundred crossbred beef steers were used in two experiments to evaluate effects of growth implants on performance. Steers were implanted either at 3.5 months and weaning (CALF); at weaning (WEAN); or not implanted (NONE). In Experiment 1 implanted steers weighed more at weaning ($P = 0.01$), and had a higher ADG for the entire trial compared to non-implanted steers ($P = 0.03$). In Experiment 2, at 80 d post wean, implanted steers outweighed NONE ($P = 0.09$). Overall ADG ($P = 0.01$) was greater for cattle that were implanted. In the feedlot the CALF group had the lowest ADG ($P = 0.01$), and final BW ($P = 0.07$). At harvest CALF had the highest dressing percentage ($P = 0.04$), smallest LMA ($P = 0.1$), and lowest IMF ($P = 0.06$). Implants can increase productivity in beef cattle however, marketing and management strategy will dictate use.

DEDICATION

This thesis is dedicated to my children, Tyler and Lauryn Jones. At some point in the last few years I have stopped thinking about what agriculture and the beef industry are to me and what it has to be in the future for my children and the world. Every day the Agriculture industry is asked to feed and clothe more people with fewer resources. Scientific data and technological advancements continually make this possible. I also hope that one day my children will have same admiration and appreciation for livestock that has been instilled in me.

ACKNOWLEDGEMENTS

“So I saw that there is nothing better for a person than to enjoy their work, because that is their lot. For who can bring them to see what will happen after them?” Ecclesiastes 3:22 (NIV).

First and foremost I would like to thank God for opportunity to be where I am today. Many unforeseen opportunities have fallen perfectly into place for me to start this process, much less finish it.

I have had the privilege of working with some great people while completing this thesis. Dr. Daniel Rivera has truly been a mentor and leader for me as my thesis director through this project, but more than that I am proud to say he is a great friend. Dr. Stephanie Ward deserves many thanks for knowing all the answers when Dr. Rivera and I didn't. She was instrumental in this entire process, being sure all bases were covered. Dr. Rhonda Vann, while not being on my committee through the entire process, has helped tremendously all along. Her assistance with on farm carcass data and insight has been a great asset.

I would like to add a huge thanks and much love to my wife and family for supporting me through this process. They are truly my rock of support.

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CHAPTER I

INTRODUCTION

The beef industry today is very diverse, encompassing a variety of producers such as large corporate operations and family farms and ranches (Anderson et.al, 2004). Many technological and managerial improvements have made beef production far more efficient for producers. One technology that allows beef to be produced in a more efficient manner is the use of growth promoting implants. Implants improve the efficiency of the use of absorbed energy in the diet (Guiroy et al, 2002). Anabolic implants improve growth rate (13.7 kg- 41.8 kg), feed conversion, and protein deposition (up to 10%) in cattle under both experimental and commercial conditions. The use of anabolic implants has also resulted in increased carcass weight and increased longissimus muscle area and carcass muscle yield in cattle (Montgomery et al, 2001).

Growth-promoting implants are used routinely by U.S. beef producers to increase rate and efficiency of growth in cattle (FDA, 2014). These growth promoting implants have been available for many yr (40+) in several forms. The two major classes of implants registered for use consist of either estrogenic compounds (estradiol benzoate, estradiol 17 β , zeranol) or androgenic compounds (trenbolone acetate (TBA)) in combination with estradiol benzoate or estradiol 17 β (Duckett and Andrae, 2001). They work to increase muscle accretion and retard protein degradation. Due to their benefits, it is considered routine in the industry to implant cattle with synthetic hormones to improve

growth rate and feed conversion and to reduce costs of live weight gain (Scanga, et al., 1998; Mader, 1998; USDA, 2000).

Implants work in conjunction with the natural hormones in the animal's body resulting in increased weight gain, improved feed efficiency and leaner carcasses. This is done through partitioning of nutrients to support more lean tissue or muscle growth. Estrogenic compounds stimulate the animal's body to increase cell division resulting in increased muscle and skeletal growth rates and delayed fat deposition. Androgenic compounds result in an increase in muscle mass by increasing protein synthesis and slowing the rate of muscle protein degradation. Johnson et al., (1996) found that implanting steers increased carcass protein approximately 10% over unimplanted steers.

Implants contain anabolic, growth-promoting agents and are tools widely used to improve efficiency of beef production (USDA, 2000; Duckett and Andrae, 2001). According to Webb et al., (2002) anabolic implants consisting of estrogenic, androgenic, or combinations of estrogenic and androgenic hormones benefit production by increasing rate of gain and feed efficiency. The result of implanting cattle is the production of a desirable product (lean meat) which takes less feed to produce in a shorter amount of time.

Anabolic implants increase animal gains in each phase of beef production and reduce beef production costs. Research indicates that additional weight gain observed with implanting is additive throughout all phases of beef production. Duckett and Andrae (2001) noted that use of sequential implants in the suckling, stocker and feedlot phases would increase live weight by 57 kg and value by \$93 per animal, in current (2014) market conditions, that equates to \$150-\$200 per animal.

Beef quality, palatability, and production characteristics are influenced by lifetime implant. Platter et al., (2003) found that carcasses from non-implanted cattle had higher marbling scores ($P < 0.05$) and lower shear force breaking values ($P < 0.05$). However, their research suggests that “aggressive” and/or repetitive use of implants may be detrimental to beef carcass quality and tenderness. The effects of repetitive use of anabolic implants on beef carcass quality, tenderness, and consumer ratings for palatability were investigated by Platter et al., (2003) using cross-bred steer calves. Carcasses from the control (non-implanted) group had higher marbling scores than carcasses from steers in all other treatment groups (various implant protocols). Implanting steers at branding, weaning, or back-grounding vs. not implanting steers at these production stages did not affect marbling scores. Steers implanted twice during their lifetime produced carcasses with higher marbling scores than did steers receiving a total of four or five implants ($P < 0.05$). Implanting steers at back-grounding vs. not implanting steers at this production stage increased steak shear force values, but did not influence consumer ratings for like/dislike of steak tenderness or percentage of consumers rating overall eating quality of steaks as satisfactory. Steaks from non-implanted steers were rated as more desirable for overall eating quality than steaks from steers implanted two, three, four, or five times. Platter et al, (2003) also noted use of implants boosted average daily gain from 11.8 to 20.5% from weaning to harvest compared with non-implanted controls. Implant strategies increased hot carcass weight of steers by 8.9 to 13.8% compared with the control group. Implants also increased LMA and decreased estimated percentages of KPH fat, but did not affect dressing percentage or

adjusted fat thickness. Their findings suggest that beef quality, palatability, and production characteristics are influenced by lifetime implant protocols.

CHAPTER II

LITERATURE REVIEW

History, Types, and Mechanisms of Hormone Implants

For over 40 continuous yr the US Food and Drug Administration (FDA) has approved various natural and synthetic estrogen and androgen hormones in beef cattle to improve their rate of growth, feed efficiency (amount of feed necessary for a unit of gain), and leanness of carcass (Mader, 1998). The historical use of implants in ruminants dates to 1947 with the first implanting of Hereford heifers with diethylstilbestrol (DES) by investigators at Purdue University (Dinusson et al., 1948). These studies used a compressed DES tablet as a subcutaneous implant. Side-effects, such as vulvar swelling, riding, and mammary development, were observed. Scientists at Iowa State College later investigated the efficacy of DES administered orally (Preston et al., 1956). Growth stimulation and improved feed utilization were observed in both sheep and cattle, and fewer side-effects were reported with oral use. These studies also demonstrated reduced carcass grade and increased leanness. Orally administered DES for cattle was approved by the U.S. Food and Drug Administration in 1954 and implants were approved for use in 1957, and its use in growing-finishing cattle rations was rapidly adopted (Raun and Preston, 2002). Later developments defined the optimal dosage and form of orally administered DES (Preston et al., 1956). A low incidence of DES residues in the livers of cattle were later found and were associated with misuse. These residues, along with the

report of adenocarcinoma in daughters of mothers treated with prescription DES during pregnancy, led the FDA to remove oral DES for cattle from the market in 1972 and implant the following yr. The removal of DES from the market led to the development of a number of other growth stimulation products for cattle (Raun and Preston, 2002). Since that time, several different implants have been developed with varying degrees of commercial success. It is recognized that the use of anabolic implants in beef cattle offers the greatest return on investment outside of ensuring adequate nutrition (Montgomery et al, 2001).

Five hormone compounds are currently approved to be delivered by subcutaneous implants, including estradiol, testosterone, progesterone, zeranol, and trenbolone acetate (FDA, 2014). Estradiol, testosterone, and progesterone are naturally occurring hormones in animals (and some plants) while TBA and zeranol are synthetic hormones. Zeranol is a non-steroidal estrogen agonist, a mycotoxin, derived from fungi in the *Fusarium* family. The natural hormones are thought to increase the circulating levels of growth hormone and other factors involved in regulation of growth resulting in increased protein deposition (Baker and Floyd, 2013). Zeranol mimics estrogen, acting similar to the synthetics. Trenbolone acetate acts directly on receptors in muscle to reduce the amount of protein degradation, thereby resulting in a net increase in protein deposition. With the exception of zeranol all USDA approved growth hormones are steroids or have steroid-like properties. A steroid is a class of compounds that increases protein and bone growth. The approved hormonal implants are formulated to deliver single hormones or combinations of two hormones. The hormones are compressed into various carrying matrices as pellets for implanting, including lactose, cholesterol, or polyethylene glycol.

A silicone rubber matrix is utilized by one implant delivering a single estrogen compound. The rate and duration of release of hormones from implants vary depending on the type of carrier matrix, the type of hormone, and the presence of multiple hormones. In general, the duration of useful hormone delivery from commercial implants ranges from 60 to greater than 350 d (Baker and Floyd, 2013).

Chronology of Cattle Anabolic Agents in the United States

(Raun and Preston, 2002):

- 1954 Oral DES approved for cattle.
- 1955 DES implants approved for cattle.
- 1956 Estradiol benzoate/progesterone implants approved for steers.
- 1958 Estradiol benzoate/testosterone propionate implants approved for heifers.
- 1968 Oral melengesterol acetate approved for heifers.
- 1969 Zeranol implants (36 mg) approved for cattle.
- 1982 Silastic estradiol implant approved for cattle.
- 1984 Estradiol benzoate/progesterone implants approved for calves
- 1987 Trenbolone acetate implants approved for cattle.
- 1991 Estradiol/trenbolone acetate implants approved for steers.
- 1993 Bovine somatotropin approved for lactating dairy cows.
- 1994 Estradiol/trenbolone acetate implants approved for heifers.
- 1995 72-mg zeranol implants approved for cattle.
- 1996 Estradiol/trenbolone acetate implants approved for stocker cattle.

Early studies conducted in the 1970's have shown growth promoting implants to increase live weight gain up to 10 kg through a season in grazing cattle (Sewell, 1990),

and anywhere from 10-16% improvement in average daily gain (Elanco Animal Health, 1982; Lusby and Gill, 1985; and Gill et al., 1995). In addition, Selk (1996), determined that implanting suckling beef calves can increase ADG 0.5 kg/d in steers and 0.5-0.6 kg/d in heifers from implanting (at branding) to weaning. Despite these benefits, the 2008 National Animal Health Monitoring System reports that only 11.9% of cow/calf operations implant their calves at any point prior to and at weaning.

Implants are approved for every stage of production in beef cattle production, from cow-calf farms and ranches raising nursing calves to back-grounding and stocker operations and feedlots of all sizes. The biological effects of implants on growth rates, feed efficiency, and carcass leanness occur in individual animals and are not dependent on the size of the herd or group.

Anabolic implants are used to reduce the cost of beef cattle production and have been used in the beef industry for 40 yr to improve daily gains, and feed efficiency. Implant products are available for suckling calves, grazing cattle, and finishing cattle. Improvements of 6%, 15%, and 20% in average daily gain can be realized in suckling calves, stockers, and feedlot cattle, respectively, with implanting (Duckett and Andrae, 2001). Producers have numerous choices available today when using implants to lower production costs with over 26 brands available. There has been a well-documented growth response to anabolic steroids; 25 kg to 45 kg (Guiroy et. al., 2002). It has also been shown that cattle receiving growth implants have higher muscle mass due to increased growth and maturity with little to no effects on quality (Foutz et. al, 1997).

Regulations governing the use of implants are set by the U.S. Food and Drug Administration (FDA, 2014). Manufacturer's directions and recommendations, as approved by the FDA-CVM should be followed when implanting any cattle.

All implants must be administered subcutaneously in the middle third of the ear which is the FDA approved location (Figure 2.1), with the goal of avoiding blood vessels. If part of the ear has been lost because of frostbite or injury, the implant should be placed in the last half of the ear. This should place the implant outside the cartilage ring at the base of the ear. Implants should never be placed in locations other than the ear. (FDA, 2014)

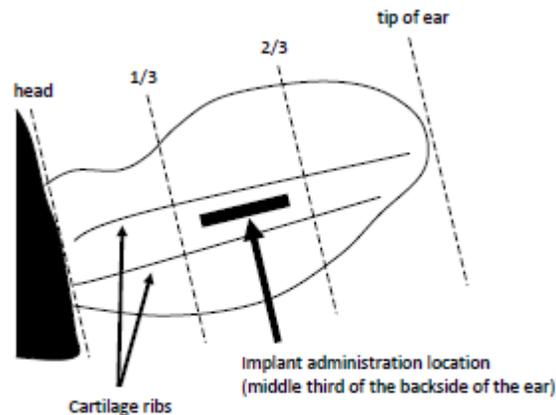


Figure 2.1 Implant Placement (Parish and Rhinehart, 2011)

It has long been recognized that naturally produced hormones in humans and other animals play an important role in the physiological, biochemical, and behavioral changes associated with growth and development (Montgomery et. al., 2001). Growth promotants, such as steroidal implants and β -adrenergic agonists, shift nutrient use toward carcass lean tissue deposition at the expense of adipose tissue (Bradley and

Chung, 2007). Bradley and Chung (2007) also hypothesized that growth promotants first impact the direction that certain non-differentiated “stem cell–like” mesodermal cells precede.

Anabolic implants affect specific muscles and fiber types within muscles (Maltin, et.al, 1990). In cattle, muscle accretion is regulated by response to growth hormone (GH), whose receptors are regulated by steroids. Trenkle (1983) stated that estrogenic and estrogen-like compounds are believed to increase protein deposition by increasing the amount of GH and insulin secreted. The presence of high affinity estrogen receptors in bovine skeletal muscle testifies to another avenue of action for estrogen and estrogen-like compounds. Androgenic implants increase carcass protein content by stimulating muscle protein synthesis (Webb et.al, 2002).

Cattle must have adequate nutrition before implants can positively influence feed efficiency and gain. The greatest response to implants tends to be observed in older cattle, near peak periods of lean tissue deposition (Duckett and Andrae, 2001). Typically these would be yearling cattle consuming high levels of high quality, high energy feed. The implant response is associated with nutrients available and the level of implant growth promotant circulating in the animal (Duckett and Andrae, 2001).

According to Baker and Floyd (2013) estrogenic implants increase the circulating levels of somatotropin (ST) and insulin-like growth factor-1 (IGF-1). Both of these substances are produced by the animal and have a marked effect on how nutrients are used by the animal to produce muscle, bone, and fat. The approved anabolic agent, trenbolone acetate (TBA) does not seem to stimulate the production of ST, but it does

significantly increase the circulating levels of IGF-1 and decreases the normal loss of muscle tissue in sedentary animals (Baker and Floyd, 2013).

After the initial placement of growth promoting implants in an animal there is a rapid release of hormone from the implant. The level of hormone being released from the implant will begin to fall after a few days (NAHMs, 2000) but will remain above the threshold level for effective growth stimulation for months. The length of time the growth promotant remains above threshold will depend on the pharmaceutical design of the implant and the quality of technique used when administering the implant. 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. The optimum re-implant time is referred to as the re-implant window, and can vary from 60-180d (NAHMs, 2000).

For maximum benefit, it is important to maintain the level of implant growth promotant above threshold throughout the ownership of the stocker or feeder animal. The length of time an implant releases growth promotant above threshold or payout, varies between implants. The rate of gain improvement appears to follow the declining level of growth promotant released from an implant. Therefore, the highest rates of gain can be expected during the first part of the payout period.

Because implant growth promotants interact with the production of hormones produced by the animal, the implants have not been recommended or approved for use in breeding cattle or calves less than 45 d of age (Duckett and Andrae, 2001).

Impact of Implants on Cattle Performance and Carcass Quality

Pre-feeding Phase

The cow calf industry uses implants in calves to improve weaning weights and efficiency in pre-weaning stages of calf growth. Implanting suckling steer calves (> 45 d of age) increases ADG by about 5 to 6% over un-implanted controls, similar responses were seen in heifer calves also. Re-implanting steer calves twice during the suckling phase increased ADG by about 1.3% compared to a single implant (Selk, 1997). Despite these benefits the 2008 National Animal Health Monitoring System reports that only 11.9% of cow/calf operations implant their calves at any point prior to and at weaning.

Producers in the stocker industry gather young cattle from different backgrounds and place them into similar groups. They manage and feed or graze them until they reach a target size (variable among operations) and then transport them to feedlots, typically in the Midwest or Western U.S. Although the stocker industry in the southeast U.S. is large, the many variations in the industry make it difficult to estimate how many cattle move through this portion of the industry (Anderson, et al., 2004). The use of growth implants has been shown to have a significant impact on rate and efficiency of gain which can impact profit. Often these cattle are turned out in large numbers with primarily forage based diets and sold by weight. This adds a huge emphasis on average daily gain and feed efficiency for this sector of the industry. In a review of implant effects on performance in stocker cattle (Kuhl, 1997), implants increased ADG over un-implanted controls by 12 to 16% in grazing steers. Paisley et al., (1999) reported that implanting steers grazing dormant tall-grass prairie during the winter increased daily gains by 14 (10 mg estradiol benzoate + 100 mg progesterone), 14 (20 mg estradiol benzoate + 200 mg

progesterone), and 25% (8 mg estradiol-17beta + 40 mg trenbolone acetate) over unimplanted controls over a five month period. This indicates that positive responses to implanting may be realized even when cattle are gaining at a lower rate (low quality pasture or feed).

A more consistent response for implanting is observed in stocker cattle than with suckling calves (Duckett and Andrae, 2001) due to them typically having a higher plane of nutrition in their diet and being at a different stage of growth and development. Goetsch, et al., (1991) also showed that growth stimulants increase daily gain in pasture settings for growing cattle. While most of these trials have been conducted on wheat pasture or dormant pasture, little to no data in the literature exists for implants used in ryegrass grazing scenarios, however, similar results are expected in ryegrass settings as ryegrass is a cool-season annual.

Feedlot Use

Anabolic implants are integrated into the management practices of the finishing phase of US beef production to enhance animal performance and carcass yield (Duckett and Andrae, 2001). The USDA National Animal Health Monitoring System (NAHMS, 2000) conducted a survey of feedlots in 12 leading cattle feeding states with a minimum of 1,000-animal capacity. Sixty-seven percent of the cattle weighing over 318 kg were implanted one time and the other 30% were implanted twice, resulting in 97% of cattle being implanted. Of the cattle implanted one time, 60% received an implant containing an androgenic compound. Of the cattle implanted twice, 78% received an implant containing an androgenic compound. Implanting feedlot steers improves average daily

gain and feed efficiency on average by 18 and 8%, respectively, compared with unimplanted steers (Duckett et al., 1996).

Carcass Characteristics

Return on investment from the use of implants is generally positive, but its effect on carcass quality and palatability varies with implant protocols (Smith, et al., 2001).

A summary of implant usage by Duckett and Andrae (2001) showed an inverse relationship between marbling score and Longissimus Muscle (LM) area. As LM area increased, marbling score decreased, suggesting that implants have an indirect effect on lipid deposition (i.e., dilution of intramuscular (IM) fat in a larger LMA). Moreover, IM fat content of LMA was decreased by early administration of an estradiol-trenbolone acetate implant (Bruns et. al, 2005).

There were concerns with the effect of implants on beef cattle implanted during early stages of growth (suckling and stocker) and its impact on feedlot performance. Research indicates that altering timing of implant administration (during the feeding phase) in relation to slaughter can reduce the effects of implanting on quality grade (Duckett and Andrae, 2001). Additionally, aggressive use of implants may be detrimental to beef carcass quality. Platter et al., (2003) investigated this and found that carcasses from non-implanted cattle had higher marbling scores ($P<0.05$) and lower shear force breaking values ($P<0.05$).

Platter et al., (2003) findings suggest that beef quality, palatability, and production characteristics are influenced by lifetime implant protocol. The effects of repetitive use of anabolic implants on beef carcass quality, tenderness, and consumer ratings for palatability were investigated using cross-bred steer calves. Carcasses from the

control (non -implanted) group had higher marbling scores than carcasses from steers in all other treatment groups (various implant protocols; $P < 0.05$). Implanting steers at branding, weaning, or back-grounding vs. not implanting steers at these production stages did not affect marbling scores. Steers implanted twice during their lifetime produced carcasses with higher marbling scores than did steers receiving a total of four or five implants ($P < 0.05$). Implanting steers at back-grounding vs. not implanting steers at this production stage increased steak shear force values, but did not influence consumer ratings for steak tenderness or percentage of consumers rating overall eating quality of steaks as satisfactory. Steaks from non-implanted steers were rated as more desirable for overall eating quality than steaks from steers implanted two, three, four, or five times. Implant strategies increased hot carcass weight of steers by 8.9 to 13.8% compared with the control group. Implants also increased LMA and decreased estimated percentages of KPH fat, but did not affect dressing percentage or adjusted fat thickness. These results suggest that lifetime implant protocols affected both the eating quality and tenderness of beef and emphasize the importance of choosing implant programs based on specific marketing targets for cattle. Despite studies such as this research looking into management protocols is still somewhat lacking.

Summary and Objectives

Despite the proven benefits of implant use, there are still producers who do not use this technology in their management systems. Some issues with using implant may involve consumer views and concerns with food safety. This is a misconception as the FDA requires no withdrawal period before harvest of implanted cattle. Beef from implanted cattle has very low levels of estrogenic activity compared to many other

common foods. In addition, the potential amount of estrogen consumed in beef is extremely low in comparison to that produced daily in the human body (FDA, 2014).

Another reason smaller size operations may not be using this technology is the perception that the labor and actual cost of purchasing the implants may not be returned in gain. However, this may be a misconception, Berthiaum et al, (2005) suggested that forage-fed, non-implanted beef would cost less than implanted grain-fed beef, the reduction in weight and quality grade would result in a lower income for the producer. Producers who choose to raise cattle in systems with no implants would get the same price per pound but a lower income per animal as those using management systems with these growth promotants due to lighter weights at the same age (Berthiaum et al., 2005).

Despite the data that has demonstrated the effectiveness of this tool; much work needs to be done to optimize its use. Data from Bruns et al, (2005) suggested that growth of IM fat is sensitive to anabolic growth promotants administered during early periods of growth. Another recent study on abrupt weaned calves suggests that intake in cattle managed in this fashion can be very erratic for 2-3 weeks post weaning (Loyd, et al, 2012), with calves often not even meeting consumption requirements for maintenance, much less consuming enough to maintain steady growth. A producer using any implant may be losing efficacy of the product to implant at weaning, only to have a huge variance in consumption and growth (if any) for a period of time. With that in mind a focus on what type of implant we use and when it is administered should be heavily considered in management schemes along with when and how the cattle would be marketed.

Implanting heifers intended to enter the breeding herd is controversial. Management considerations must be adhered to before using an implant program for

replacement heifers. Highlights of these considerations include selecting an implant approved for use in replacement heifers, providing adequate nutrition for growth and leaving adequate time between implanting and breeding. Implanting replacement breeding bull calves is not approved or recommended (NAHMS, 2000).

All cattle in the suckling through finishing phases of production respond to implants (Nichols et al, 2002). With production becoming more and more advanced producers are constantly seeking new management techniques to improve production and economic feasibility. More information and research on timing and management of implant use is needed. Moreover, much data exist using implants in feedlot settings, however there are fewer studies examining the use of growth promotants in grazing or stocker cattle situations. Several questions have arisen that need addressing: When is the optimal time to implant? How often can implants be used in a growing environment before feedlot performance is affected?

There is still much to be understood regarding the use of implants in beef production. A thorough understanding of the mode of action of these repartitioning agents is needed. Moreover, efforts to understand the mode of action of anabolic implants on protein accretion and lipid metabolism are of vital economic importance, particularly in reference to intramuscular fat deposition. Further research should be dedicated to developing optimum implant strategies for a particular group of cattle; factors such as breed, body condition score, mature body weight, and nutrition need to be more closely related to implant use and the final effect on meat production and quality.

CHAPTER III

RESEARCH

Introduction of Studies

Early studies conducted in the 1970's have shown growth promoting implants to increase live weight gain up to 9.07 kg in grazing cattle (Sewell, 1990), and anywhere from 10-16% improvement in average daily gain (Elanco Animal Health, 1982; Lusby and Gill, 1985; and Gill et.al, 1995). In addition, Selk (1996), determined that implanting suckling beef calves can increase ADG 0.5 kg in steers and 0.5-0.6 kg in heifers from implanting (at branding) to weaning. Despite these benefits, the 2008 National Animal Health Monitoring System reports that only 11.9% of cow/calf operations implant their calves at any point prior to and at weaning. Factors such as not understanding the actual benefit of implanting calves, and negative perceptions may influence producer's decision not to implant their cattle. Therefore the objective of the following study was to evaluate different management options for pre- and post-weaned beef calves managed under typical small /mid-size farm conditions in Mississippi. During initial planning this project was designed to be two concurrent yr of the same study, done in the same herd of cattle, utilizing similar sires. Nonetheless, due to extreme weather conditions that varied herd management dictated that the cattle had to be early weaned and sold early in yr 1, while we were able to wean older heavier calves in yr 2 and maintain data on them

through a feeding phase. Based upon these differences the two studies were analyzed separately rather than as a whole study.

Experiment 1. Growth Implant Timing and Effectiveness in Beef Cattle; yr 1

Abstract

Forty four head of crossbred (primarily *Bos Taurus* x *Bos Indicus*) beef steers (BW = 166 kg) were used to evaluate effects of growth implants on performance. Calves were implanted either at calfhood vaccination (approximately 3.5 mo. old) with 100 mg of progesterone and 10 mg estradiol benzoate and again at weaning with 40 mg of trenbolone acetate and 8 mg of estradiol (CALF); at weaning with 40 mg of trenbolone acetate and 8 mg of estradiol (WEAN); or not implanted at all (NONE). Cattle were weighed at weaning, and subsequently on d 28, 45, and 80 post weaning. On d 80, all steers were ultrasounded to measure longissimus muscle area (LMA), intramuscular fat (IMF), and rib fat thickness. At weaning, steers implanted at calf-hood, exhibited a greater pre-weaning ADG (1.12 vs 1.0 kg, respectively; $P= 0.06$) and BW (229.71 vs 223.27 kg, respectively; $P= 0.01$) compared to non-implanted steers. At 45 d post weaning, no differences were noted for body weight; however, a tendency was noted in ADG from weaning to d 45 between CALF and NONE (0.61 vs. 0.46 kg, respectively, $P = 0.19$). Surprisingly, no difference in ADG was detected between NONE and WEAN (0.48 vs. 0.52 kg, respectively). Overall ADG was greater ($P= 0.03$) for cattle that were implanted compared to untreated controls (0.90, 0.99 and 0.94 kg/d for NONE, CALF and WEAN, respectively). Ultrasound measurements noted a tendency for decreased IMF for the CALF and WEAN compared to controls ($P = 0.12$). Results suggest that use

of growth promoting implants may be of benefit to cattle producers; however, producers should exercise caution in the timing of implants in relation to weaning period length.

Materials and Methods

All procedures were approved by the Institutional Animal Care and Use Committee of Mississippi State University. Cattle for this study were used from the White Sand Branch Unit breeding herd, located in Poplarville, MS (crossbred beef cattle predominantly *Bos Taurus* with some *Bos Indicus* influence). Calves were stratified by birthdate and within strata assigned to one of three treatments: NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calfhooD with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

Calves were born from December 2010 until February 2011. At branding (approximately 3-4 mo. of age), calves were vaccinated with IBR-PI3-BVD (Modified Live; Boehringer Ingelheim, St. Joseph, MO), 7-Way Clostridial (Clostrishield 7; Novartis, Greensboro, NC), and dewormed with ivermectin (Ivomec Plus; Merial, Deluth, GA), which is typical management at White Sand Branch Unit. Those in the CALF group were initially implanted with 100 mg progesterone + 10 mg estradiol at this time. Additionally, an individual weight was obtained for each calf. Following processing calves were returned to their dams and allowed to graze.

Due to extremely dry conditions in South MS, it was determined by personnel at the White Sand Branch Unit to early wean the calves in an effort to extend forage base for the cows. Normally, calves are weaned in August; however in 2011 they were weaned in June. At weaning calves were physically separated from their dams, re-

vaccinated with IBR-PI3-BVD (Modified Live; Boehringer Ingelhiem, St. Joseph, MO), 7-Way Clostridial (Clostrishield 7; Novartis, Greensboro, NC), and dewormed with ivermectin (Ivomec Plus Merial, Deluth, GA). Those in the WEAN and CALF groups were implanted with 40 mg trenbolone acetate + 8 mg estradiol. Following processing, calves were collectively moved to a dry-lot where they had free choice access to dry hay and were limit fed a weaning ration (Table 3.1 and Table 3.2, respectively). Calves were weighed on d 28, 45, and 80, and at d 80 ultrasound measurements of longissimus muscle area (LMA), back fat and intramuscular fat (IMF) were obtained.

Statistics

Data were analyzed as a linear model in SAS, with animal as the experimental unit. Fixed effects were implant management. When the model was considered significant ($P < 0.10$), means were separated using the PDIFF option in SAS.

Table 3.1 Ingredients of Weaning Ration, fed at a rate of 1.5%¹ of BW per d; yr 1

Item	DM Values	% as mixed/kg
DDGS Syrup	6.25	17.89
Gin Mote	39.25	31.79
Soybean Hulls	54.5	50.31

¹ Based on average weight of herd at weaning: 225.41kg, cattle received =33.81 kg/hd. /d

Table 3.2 Analysis of Weaning Ration, fed at a rate of 1.5%¹ of BW per d; yr 1

Item	Dry Matter Basis²
Crude Protein %	12.3
Crude Fat %	4.66
Acid Detergent Fiber %	53.4
Total Digestible	73.9
Nutrients %	

¹ Based on average weight of herd at weaning: 225.41kg, cattle received =33.81 kg/hd.
²86.3% Dry Matter

Experiment 2. Growth Implant Timing and Effectiveness in Beef Cattle, Feedlot Carryover; yr 2

Abstract

Fifty six head of crossbred (primarily *Bos Taurus* x *Bos Indicus*) beef steers (Average Weight = 165.91 kg) were used to evaluate effects of growth implants on performance from three months of age through harvest. Calves were implanted either at branding (approximately 3.5 mo. old) with 100 mg of progesterone and 10 mg estradiol benzoate and again at weaning with 40 mg of trenbolone acetate and 8 mg of estradiol (CALF); at weaning with 40 mg of trenbolone acetate and 8 mg of estradiol (WEAN); or not implanted at all (NONE). Cattle were weighed at weaning, and subsequently on d 28, 47, and 80 post weaning. On d 80, all steers were ultrasounded to measure longissimus muscle area (LMA), intramuscular fat (IMF), and rib fat thickness. Approximately, 10 d later, cattle were shipped north 1499 km to a commercial feedlot in Tabor, IA, where they were all managed similar to any cattle going on feed in a typical feedlot setting (feed management, and implant management). All 56 steers received a 200 mg progesterone and 20 mg estradiol benzoate implant and were weighed upon arrival at the feedlot and were subsequently re-implanted with 100 mg of trenbolone acetate and 14 mg of estradiol

benzoate and weighed on d102. A final weight was taken prior to harvest after 189 d on feed at which time cattle were shipped 167 km to a commercial slaughter facility where carcass data were collected. On farm data showed a difference in overall ADG/kg ($P=0.01$; 0.68, 0.67, 0.58; CALF, WEAN, and NONE, respectively) and BW ($P=0.09$; 306.01, 303.99, 288.21; respectively). But, the CALF group showed a decline in IMF% compared to WEAN and NONE groups ($P=0.06$; 2.75, 3.05, 3.41; respectively). As in the previous yr we also saw higher IMF % from the NONE and WEAN groups ($P=0.06$; 2.75, 3.05, 3.40; respectively).

Feedlot data showed the WEAN and NONE began to out-perform the CALF group in several measured areas as final ADG (kg) was: 1.51, 1.69, 1.68; respectively; $P=0.08$). This also showed in the final body weight for each group (580.81 kg, 605.40 kg, 608.93 kg; respectively; $P=0.07$). Carcass data taken after harvest indicated the CALF group had a higher dressing percentage than WEAN or NONE group (62.3%, 61.5%, 61.4%, respectively; $P=0.04$). A difference was also noted in marbling with the NONE group outperforming both CALF and WEAN groups (406.80, 401.70, 462.20; respectively; $P=0.1$). Results suggest that use of growth promoting implants may be of benefit to cattle producers; however, producers should exercise caution in the timing of implants in relation to weaning period length, and consider marketing strategies when using implants.

Materials and Methods

All procedures were approved by the Institutional Animal Care and Use Committee of Mississippi State University. Cattle for this study were used from the White Sand Branch Unit breeding herd, Poplarville, MS (crossbred beef cattle,

predominantly *Bos Taurus* with some *Bos Indicus* influence) and were stratified by birthdate and within strata assigned to one of three treatments: NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calfhoo d with 100 mg progesterone + 10 mg estradiol and at weaning with 40g trenbolone acetate + 8 mg estradiol.

After reviewing the random groups it was noted that the initial weight of the CALF group was noticeably lower than the CONTROL and WEAN groups (NONE=169.12 kg, WEAN= 168.98 kg, CALF=162.45 kg,) and when analyzed was shown to be a significant covariate, therefore, initial calf weight was used as a covariate for subsequent analyses.

Calves were born in between December 2011 and early February 2012. On April 17, 2012 at branding (approximately 3-4 mo. of age) calves were vaccinated with IBR, BVD Types I and II, PI3 and BRSV(killed virus vaccine),(Pyramid 5 IBR-BVD; Boehringer Ingelhiem, St. Joseph, MO), 7-Way Clostridial (Novartis Clostrishield; Novartis, Greensboro, NC), Mannheimia (*Pasteurella*) haemolytica type A1 bacterin toxoid (One Shot; Zoetis, Florham Park, NJ), and dewormed with ivermectin (Ivomec Plus; Merial, Deluth, GA), which is typical management at White Sand Branch Unit. Those in the CALF group were implanted with 100 mg progesterone + 10 mg estradiol. Additionally, an individual weight was obtained for each calf. Following processing calves were returned to their dams and returned to grazing.

At weaning (August 14, 2012) calves were physically separated from their dams, re-vaccinated with IBR-PI3-BVD (Modified Live,Boehringer Ingelhiem; St. Joseph, MO), 7-Way Clostridial (Novartis Clostrishield 7; Novartis, Greensboro, NC),

Mannheimia (Pasteurella) haemolytica type A1 bacterin toxoid (One Shot; Zoetis, Florham Park, NJ), and dewormed with ivermectin (Ivomec Plus; Merial, Deluth, GA). Those in the WEAN and CALF groups were implanted with 40 mg trenbolone acetate + 8 mg estradiol. Following processing, calves were collectively moved to a dry-lot where they had free choice access to dry hay and a weaning ration (Tables 3.3 and 3.4, respectively) at a rate of 1.5% of body weight per d. Post weaning (PW) calves were weighed on d 28, d 47 (Table 4.3) and at d 80 ultrasound measurements of longissimus muscle area (LMA), rib fat and intramuscular fat (IMF) were obtained (Table 4.4).

Approximately 10 d following the d 80 weight and measurements, the cattle were shipped 1499 km to a commercial feedlot (Gregory Feeders, Tabor, IA) for finishing. Cattle were implanted with 200 mg Progesterone, 20 mg Estradiol benzoate at arrival, and adapted to high concentrate finishing ration (Table 3.5). Steers were re-implanted after 102 d on feed with 100 mg of trenbolone acetate and 14 mg of estradiol benzoate. When feedlot personnel determined that cattle had sufficient finish to grade USDA Choice, they were shipped 167 km to a commercial abattoir (Tyson Foods, Denison, IA). At slaughter, trained carcass data collection personnel collected animal ID, carcass number and hot carcass weights (HCW). After a 24 h chill, personnel returned and collected LMA, fat thickness at the 12th rib, percentage of kidney pelvic and heart fat, maturity score (not reported) and marbling score. Hot carcass weight was used with final feedlot weight to determine dressing percentage. Marbling score were used with maturity score to determine USDA Quality Grades. Other measurements were used to calculate USDA Yield Grade (Kinsman et al., 1994).

Statistics

Data were analyzed as a linear model in SAS, with animal as the experimental unit. When the model was considered significant ($P < 0.10$), means were separated using the PDIFF option in SAS.

Table 3.3 Ingredients of Weaning Ration, fed at a rate of 1.5%¹ of BW per d; yr 2

Item	D.M. Basis (%)	% as mixed/kg
Soybean Hulls	38	40.17
Corn Dist. Grain	22	24.84
Gin Mote	18.5	14.9
Peanut Pellets	21.5	20.01

¹ Based on average weight of herd at weaning: 225.41kg, cattle received =33.81 kg/hd. /d

Table 3.4 Analysis of Weaning Ration, fed at a rate of 1.5%¹ of BW per d; yr 2

Item	Dry Matter Basis²
Crude Protein %	24.4
Crude Fat %	3.88
Acid Detergent Fiber %	16.7
Total Digestible Nutrients %	80.0

¹ Based on average weight of herd at weaning: 273.87 kg, cattle received =41.08 kg/hd. /d
² 86.05% Dry Matter

Table 3.5 Ingredients of Feedlot Ration; yr 2

Item	% as mixed
Dry Corn	41.07
Grass Hay	5.38
Conditioner	3.43
Dried distillers grains	30.7
Corn stalks	2.52
Mineral package	3.49
Corn Silage	9.56
Vitamin package	3.85

CHAPTER IV

RESULTS AND DISCUSSION

Experiment I

Greater pre-weaning BW (229.71 vs 223.27 kg, respectively; $P= 0.01$; Table 4.1) and ADG (1.12 vs 1.0 kg, respectively; $P= 0.06$; Table 4.2) was noted in implanted steers compared to non-implanted steers. These results were similar to a study (Selk, 1997) that reported that implanting steer calves twice during the suckling phase increased ADG by 1.3% compared to a single implant. Others have also shown growth promoting implants to increase live weight gain up to 10 kg through a season in grazing cattle (Sewell, 1990), and anywhere from 10-16% improvement in average daily gain (Elanco Animal Health, 1982; Lusby and Gill, 1985; and Gill et al., 1995). In addition, Selk (1996), determined that implanting suckling beef calves can increase ADG 0.5 kg/d in steers and 0.5-0.6 kg/d in heifers from implanting (at branding) to weaning.

No differences among treatments were noted in the 28 d post-wean BW, nor the 28 d post wean ADG ($P > 0.10$; Table 4.1). Loyd et al. (2011) demonstrated that weaned calves do not consume sufficient feed to meet their NEm requirements for up to 21 d. Moreover, the stress associated with weaning can lead to increased cortisol (Hickey et al., 2003) which can negatively affect growth hormone (Nikolic et al., 1996). Perhaps the compounded effects led to the lack of treatment effects noted in the first 28 d post weaning. Average daily gain had a tendency to increase for cattle administered the

CALF treatment compared to the NONE and WEAN group ($P=0.17$; Table 4.2) at 28-45 d post wean. No differences were noted with BW at 45 d and 45-80 d no differences were noted in ADG. At 80 d post-wean CALF and WEAN tended to outweigh NONE (302.04, 295.47, 289.21kg; respectively; $P=0.17$; Table 4.1). Overall, from branding to 80 d post weaning, cattle receiving two implants had greater ADG ($P= 0.03$; Table 4.2) than WEAN or NONE. While cattle in the WEAN group performed similarly to the CALF group in ADG ($P = 0.06$; Figure 4.1) for an 80 d post weaning period, the initial increase in performance noted with CALF (pre-weaning) was sufficient to increase performance throughout the study. Perhaps this also demonstrates that the WEAN group did not utilize the implant as efficiently as CALF. Body weight, while numerically greater, was not significant.

Calves in the NONE group tended ($P = 0.12$; Table 4.3) to have greater IMF than those in CALF and WEAN groups. Foutz et al., (1997) demonstrated that use of growth promoting implants increased LMA and decreased marbling when administered to market cattle. No differences were noted regarding rib fat among treatments.

Results from this study resembled similar modeled studies that focus on efficacy of implants such as Kuhl (1997). Higher pre-wean and post wean weights and ADG (Table 4.1 and Table 4.2, respectively) growth benefits can be seen with the use of implants. Carcass data would suggest that marketing strategy plays a key role in implanting strategies (Table 4.3).

Table 4.1 Growth Hormone Implant Effects on Steer Weights (kg); yr 1

Item	NONE ¹	CALF ¹	WEAN ¹	SE ²	P ³
Initial Wt.	166.26	165.71	167.17	7.26	0.95
Weaning Wt.	223.27 ^a	229.71 ^b	223.27 ^a	8.07	0.01
28d Post-Wean Wt.	232.15	237.46	230.52	8.44	0.65
45d Post Wean Wt.	244.76	257.46	247.03	7.53	0.23
80d Post Wean Wt.	289.21	302.04	295.46	7.44	0.14

^{a-c} Within a row means lacking a common superscript letter differ ($P < 0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calf-hood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

² Standard Error

³Significance Level

Table 4.2 Effects of Implant Management on Steers Average Daily Gain (ADG, kg/d) Comparison; yr 1

Item	NONE ¹	CALF ¹	WEAN ¹	SE ²	P ³
Pre-Wean ADG	1.00 ^a	1.125 ^b	0.98 ^a	0.05	0.06
0-45 d PW ADG	0.32	0.28	0.38	0.037	0.48
45-80 d PW ADG	0.46	0.59	0.50	0.07	0.17
0-80 d PW ADG	0.83	0.91	0.91	0.06	0.35
Total ADG	0.90 ^a	0.99 ^b	0.94 ^c	0.03	0.03

PW=Post Wean, BW=Body Weight, ADG=Average Daily Gain

^{a-c} Within a row means lacking a common superscript letter differ ($P < 0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calfhoo with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

² Standard Error

³Significance Level

Table 4.3 Ultrasound Data Comparison of Steers in Implant Study; Yr 1

Item	NONE ¹	CALF ¹	WEAN ¹	SE ²	P ³
LMA ⁴ area cm ²	43.02	45.60	42.41	1.47	0.26
IMF% ⁵	3.54	3.23	3.24	0.14	0.12
Rib fat cm	0.31	0.28	0.25	0.12	0.39

^{a-c} Within a row means lacking a common superscript letter differ ($P < 0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calfhood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

⁴LMA: Longissimus Muscle Area

⁵IMF: Intramuscular Fat

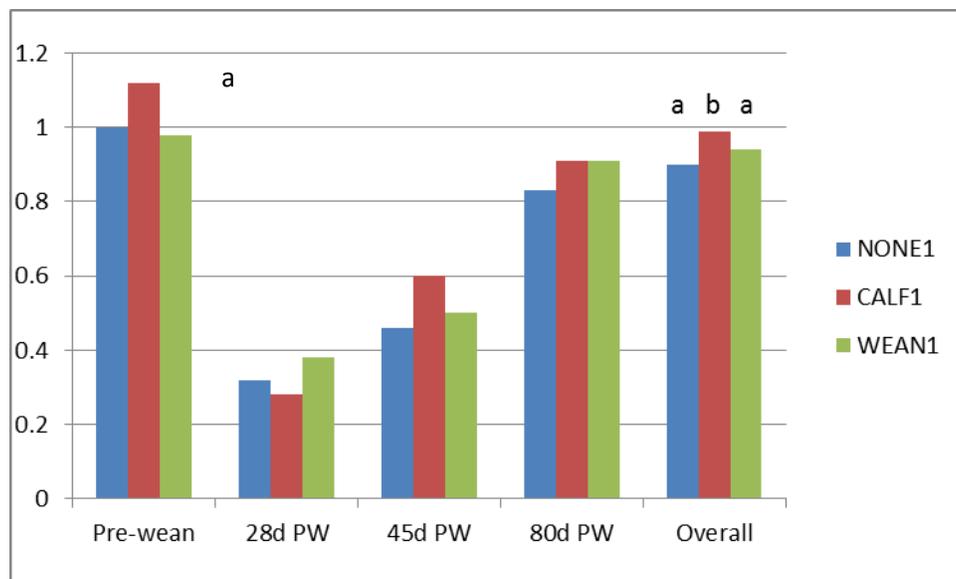


Figure 4.1 Comparison of ADG, kg/d on farm from steers in implant management study; yr 1, SE² = 0.068, P³=0.06

PW=Post Wean, ADG=Average Daily Gain

^{a-c} Within a column means lacking a common superscript letter differ ($P < 0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calfhood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

Experiment II

Initially no differences were noted in body weight (Table 4.4) or ADG until the last on farm weight, taken at 80 d post-wean. Steers in the CALF (306.08 kg) and WEAN (303.99 kg) groups out-weighed NONE (288.21 kg; $P=0.09$; Table 4.5). Average daily gain from the last weigh on farm period showed that CALF and WEAN group out-performed the NONE group in that weigh period (0.34, 0.38, 0.18; respectively; $P=0.08$; Table 4.5, Figure 4.2). At the conclusion of the on the farm section of the study a difference was also noted as the CALF and WEAN groups had higher overall ADG (kg) than the NONE group (0.68, 0.67, 0.59; respectively; $P = 0.09$; Table 4.5). All of these results remain constant with prior studies indicating a similar pattern as Selk, (1997) who stated that implanting steer calves twice during the suckling phase increased ADG by about 1.3 percentage units compared to a single implant. Others have also shown growth promoting implants to increase live weight gain up to 10 kg's through a season in grazing cattle (Sewell, 1990), and anywhere from 10-16% improvement in average daily gain (Elanco Animal Health, 1982; Lusby and Gill, 1985; and Gill et al., 1995). In continuation, Selk (1996), determined that implanting suckling beef calves can increase ADG 0.5 kg/d in steers and 0.5-0.6 kg/d in heifers from implanting (at branding) to weaning.

No differences among treatments were noted in the 28 d post-wean BW, nor the 28 d post wean ADG ($P > 0.10$; Table 4.4). Loyd et al. (2011) demonstrated that weaned calves do not consume sufficient feed to meet their NEm requirements for up to 21 d. Moreover, the stress associated with weaning can lead to increased cortisol (Hickey et al., 2003) which can negatively affect growth hormone (Nikolic et al., 1996). Perhaps the

compounded effects led to the lack of treatment effects noted in the first 28 d post weaning.

Ultrasound data showed a difference in IMF among the groups (CALF=2.75, WEAN=3.05, NONE=3.41; $P = 0.06$; Table 4.6). Foutz et al., (1997) demonstrated that use of growth promoting implants increased LMA and decreased marbling when administered to cattle. Keane and Drennan (1987) also found that implanted cattle had 23.1 kg more lean, with the increase in carcass weight accounted for entirely by the increase in carcass lean.

In the feedlot the WEAN group continued to out-perform NONE and efficiency in the CALF group showed a decline as final ADG (kg) (1.51, 1.69, 1.68; CALF, WEAN, and, NONE respectively; $P = 0.01$; Figure 4.3). This also showed in the final body weight for each group (580.81 kg, 605.40 kg, 608.93 kg; respectively; $P=0.07$; Table 4.7). Carcass data taken after harvest indicated the CALF group had a higher dressing percentage than WEAN or NONE group (62.3%, 61.5%, 61.4%, respectively; $P=0.04$; Table 4.8). A difference among all three groups was noted in LMA cm^2 (80.65, 83.87, 82.52; respectively; $P=0.1$; Table 4.8). IMF measurements showed the CALF group having a significant ($P=0.06$) drop off in fat deposition compared to WEAN and NONE (CALF=2.75, WEAN=3.05, NONE=3.4; respectively; $P=0.06$; Table 4.8). Platter et al., (2003) investigated this also, and found that carcasses from non-implanted cattle had higher marbling scores ($P < 0.05$) and lower shear force breaking values ($P < 0.05$).

As with Exp.1, this data also suggested that use of growth promoting implants may be of benefit to cattle producers; however, longer retention periods post weaning may be needed to realize full benefit of implanting. Marketing schemes may also play

into implant protocols as cattle with multiple implants prior to entering the feedlot showed a decrease in efficiency and production.

Table 4.4 Growth Hormone Implant Effects on Steer Weights (kg); yr 2

Item	NONE ¹	CALF ¹	WEAN ¹	S.E ²	P ³
Initial Wt.	169.16	162.45	168.98	6.39	0.73
Adjusted Initial Wt. ⁴	167.35	167.35	167.35	0	0
Weaning Wt.	272.81	276.51	272.29	5.22	0.83
28d PW Wt.	278.82	283.67	283.18	4.81	0.73
47d PW Wt.	289.93	293.61	292.79	4.81	0.86
80d PW Wt.	288.21 ^a	306.01 ^b	303.99 ^b	6.26	0.09

PW=Post Wean, ADG=Average Daily Gain

a-c Within a column means lacking a common superscript letter differ ($P < 0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calfhoo with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

⁴Initial trial weights were adjusted due to a difference in actual initial weights after random sorting resulting in skewed data as the trial progressed.

Table 4.5 Effects of Implant Management on Steers, Average Daily Gain (ADG, kg/d) Comparison; yr 2

Item	NONE ¹	CALF ¹	WEAN ¹	S.E ²	P ³
Pre-Wean ADG	0.88	0.92	0.88	0.05	0.10
0-47 d ADG	0.20	0.24	0.36	0.10	0.52
47-80 d PW ADG	0.35	0.35	0.42	0.07	0.71
0-80 d PW ADG	0.18 ^a	0.34 ^b	0.38 ^b	0.06	0.08
Total on Farm ADG	0.58 ^a	0.68 ^b	0.67 ^b	0.03	0.01

PW=Post Wean, ADG=Average Daily Gain

^{a-c} Within a row means lacking a common superscript letter differ ($P<0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calthood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

Table 4.6 On Farm Ultrasound Data Comparison of Steers in Implant Study; yr 2

Item	NONE ¹	CALF ¹	WEAN ¹	S.E ²	P ³
LMA⁴ cm²	50.45	49.87	48.65	1.48	0.54
IMF⁵%	3.41 ^a	2.75 ^b	3.05 ^a	0.12	0.06
Rib Fat cm	0.48	0.46	0.46	0.05	0.76

a-c Within a column means lacking a common superscript letter differ ($P<0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calthood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

⁴LMA: Longissimiss Muscle Area

⁵IMF: Intramuscular Fat

Table 4.7 Treatment Effects on Cattle Growth in Feedlot (kg); Yr 2

Item	NONE ¹	CALF ¹	WEAN ¹	S.E ²	P ³
Arrival BW ⁴	301.22	308.98	311.75	7.67	0.79
Re-implant BW ⁴	466.58	460.49	478.46	9.61	0.18
Final BW ⁴	608.93 ^a	580.816 ^b	605.39 ^a	10.7	0.07

BW=Body Weight,

a-c Within a column means lacking a common superscript letter differ (P<0.1)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calthood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

Table 4.8 Carcass Data, Post-Harvest from steers in implant management study; yr 2

Item	NONE ¹	CALF ¹	WEAN ¹	S.E ²	P ³
Carcass Wt.	373.24 kg	361.78 kg	372.24 kg	6.76	0.22
Dressing %	61.4 ^a	62.3 ^b	61.5 ^a	0.2	0.04
12 th Rib Fat	1.35	1.24	1.40	0.08	0.17
LMA ⁴ cm ²	28.22	27.56	28.66	0.24	0.10
Kph fat	2.44	2.45	2.37	0.08	0.46
Yield Grade	3.35	3.25	3.31	0.14	0.60
Marbling	462.2 ^a	406.8 ^b	401.7 ^b	15	0.05

a-c Within a column means lacking a common superscript letter differ (P<0.01)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calthood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

²Standard Error

³Significance Level

⁴LMA: Longissimus Muscle Area

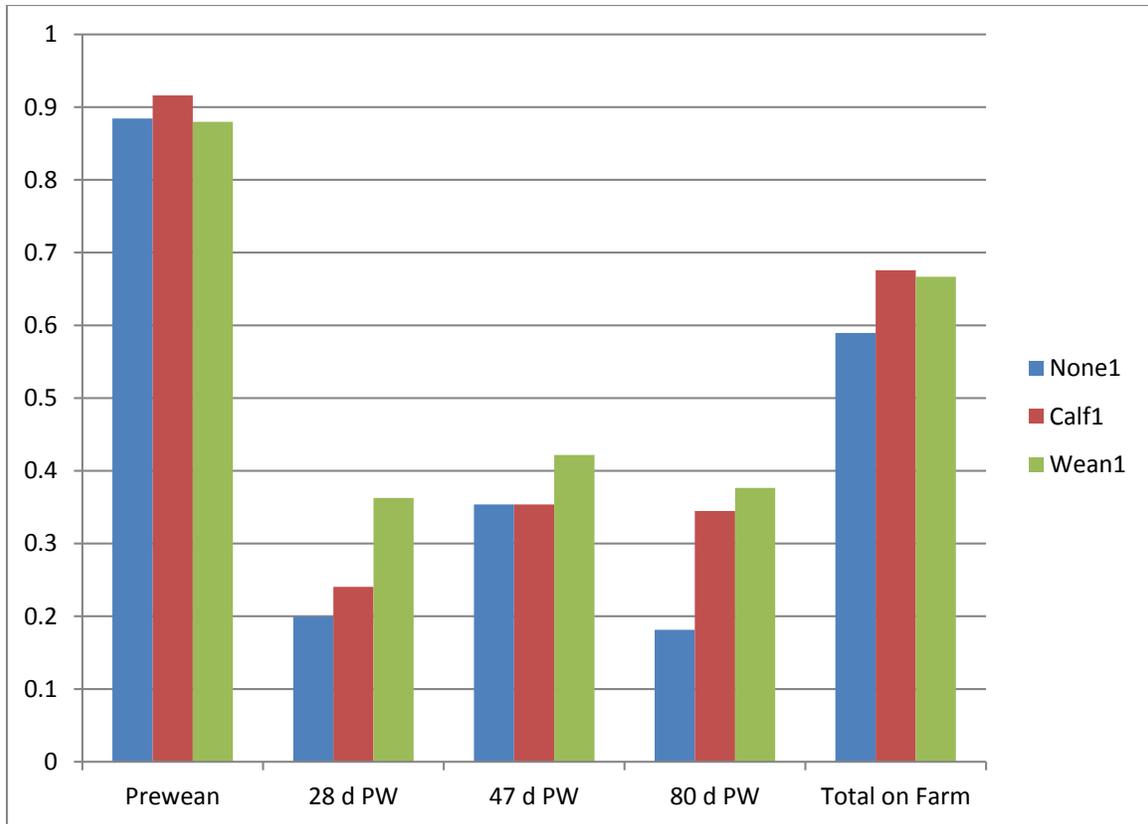


Figure 4.2 Comparison of ADG, kg/d on Farm from steers in implant management study; yr 2; S.E. ²=0.23, $P^3=0.08$,

PW=Post Wean, ADG=Average Daily Gain

^{a-c} Within a column means lacking a common superscript letter differ ($P<0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calthood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

² Standard Error

³Significance Level

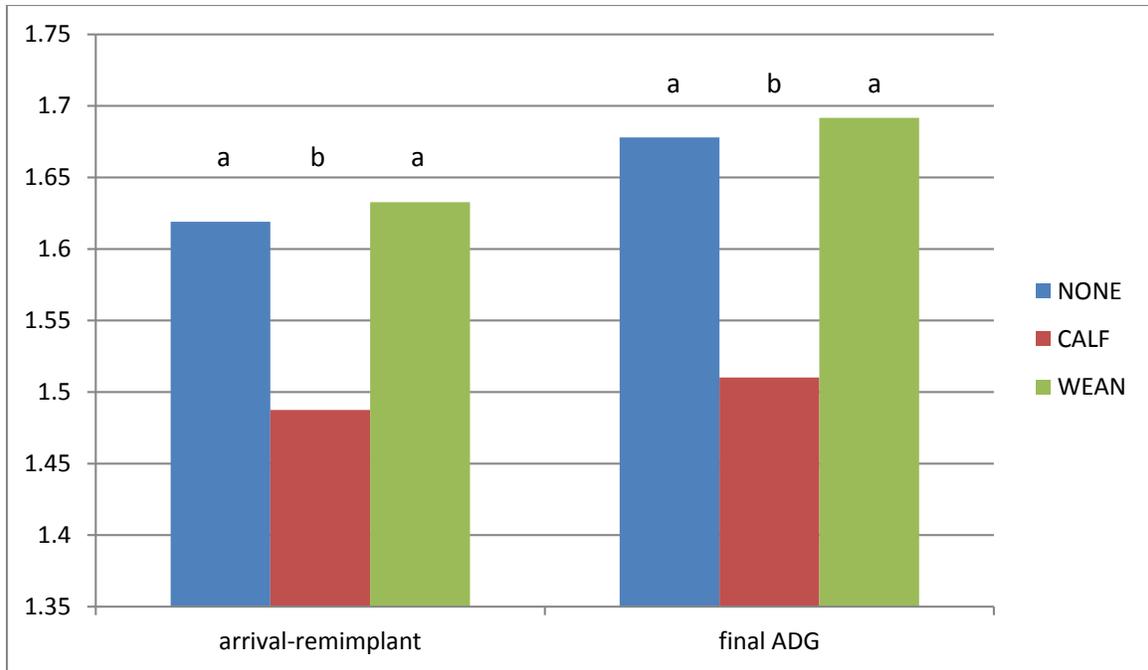


Figure 4.3 Feedlot ADG from steers in pre-feedlot implant management study; yr 2; S.E.² = 0.03, P³=0.08

PW=Post Wean, ADG=Average Daily Gain

^{a-c} Within a column means lacking a common superscript letter differ ($P < 0.1$)

¹NONE: no implant; WEAN: implant only at weaning with 40 mg trenbolone acetate + 8 mg estradiol; and CALF: implanted twice; once at calthood with 100 mg progesterone + 10 mg estradiol and at weaning with 40 mg trenbolone acetate + 8 mg estradiol.

² Standard Error

³ Significance Level

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

The use of implants in cow-calf operations can increase performance of animals from pre-weaning up to 80 d post weaning. However, producers who retain ownership for a back-grounding phase may consider keeping the cattle longer than 45 d in order to maximize return of the implant. Those that sell calves directly off the dam at a young age (4-6 months) seem to have the most to gain from an early age implant protocol.

Producers who maintain ownership through the feeding period and harvest may consider several options to implant management depending on how cattle are sold and type of grid marketing strategy (yield grade vs. quality grade). Marketing schemes may also play a role into implant protocols as cattle with multiple implants prior to entering the feedlot showed a decrease in efficiency and production.

The producer can adjust implant strategies to fit variable market conditions, including high vs. low diet costs, live BW restrictions, carcass weight restrictions, and so on. By understanding how steroid implants work, coupled with knowledge of growth physiology, cattle genetics, and the market, a producer can use these tools to fit many different feeding and economic scenarios (Nichols et.al, 2003) beef quality, palatability, and production.

As with Montgomery et al., (2001) we believe there is still much to be understood regarding the use of implants in beef production. A thorough understanding of the mode

of action of these repartitioning agents is needed. Moreover, efforts to understand the mode of action of anabolic implants on protein accretion and lipid metabolism at different stages of growth and management are of vital economic importance, particularly in reference to fat deposition. Further research should be dedicated to developing optimum implant strategies for a particular group of cattle; factors such as breed, body condition score, mature body weight, and nutrition need to be more closely related to implant use and the final effect on meat quality and production.

As Platter et.al, (2003) findings suggest, characteristics of growth and meat quality seem to be influenced by lifetime implant protocols.

REFERENCES

- Anderson, J.D., C. Lacy, C.F. Forrest, and R.D. Little. 2004. Stocker Cattle Ownership vs. Contract Grazing in the Southeast. *Journal of Agricultural and Applied Economics*, 36(3): 719-730.
- Baker, M., J. Floyd. 2013, GROWTH PROMOTANTS.
<http://www.ansci.cornell.edu/courses/as360/lecture/feedlot/implants.pdf>
Accessed: January, 2014
- Berthiaume, R., I. Mandell, L. Faucitano, and C. Lafreniere. 2005. Comparison of alternative beef production systems based on forage finishing or grain-forage Diets with or without growth promotants: 1. Feedlot performance, carcass quality, and production costs. *J. Anim. Sci.* Vol. 84, (8), 2168-2177.
- Bradley, J.J., K.Y. Chung. 2001. Alterations in the Physiology of Growth of Cattle with Growth-Enhancing Compounds. *Vet Clin Food Anim*, (23), 321-332.
- Bruns, K.W., R.H. Pritchard, and D.L. Boggs. 2005. The effect of stage growth and Implant exposure on performance and carcass composition in steers. *J. Anim. Sci.* vol.83, (1), 108-116.
- Dinusson, W. E., F. N. Andrews, and W. M. Beeson. 1948. The effects of stilbestrol, testosterone, and thyroid alterations on growth and fattening of beef heifers. *J. Anim. Sci.* 7:523–524
- Duckett, S.K., and J.G. Andrae. 2001. Implant strategies in an integrated beef production system. *J. Anim. Sci.* (79): E110-E117.
- Duckett, S. K., D. G. Wagner, F. N. Owens, H. G. Dolezal, and D. R. Gill. 1996. Effects of estrogenic and androgenic implants on performance, carcass traits, and meat tenderness in feedlot steers: A review. *Prof. Anim. Sci.* (12):205–214.
- Elanco Animal Health, 1982. *Compudose Technical Manual and Updates*.
- FDA. (2014). Food and Drug Administration approved animal drug products database. Available at:
<http://www.fda.gov/AnimalVeterinary/SafetyHealth/ProductSafetyInformation/ucm055436.htm> Accessed : January, 2014

- Foutz, C.P., H.G. Dolezal, T.L. Gardner, D.R. Gill, J.L. Hensley, and J.B. Morgan. 1997. Anabolic implant effects on steer performance, carcass traits, sub-primal yields, and longissimus muscle properties. *J. Anim. Sci.* vol. 75, (5), 1256-1265.
- Gill, D. R., S. C. Smith, W. T. Nichols, and M. R. Montague. 1995. Performance of stocker steers implanted with Ralgro, Synovex S or Revalor G. *Okla. Anim. Sci. Res. Rep.* P943:163-166.
- Goetsch, A.L., G.E. Murphy, E.W. Grant, L.A. Forster Jr., D.L. Galloway Sr., L. West, and Z.B. Johnson, Z.B. 1991. Effects of animal and supplement characteristics on average daily gain of grazing beef cattle. *J. Anim. Sci.* vol. 69, (2), 433-442.
- Guiroy, P.J., L.O Tedeschi, D.G. Fox, and J.P. Hutcheson. 2002. The effects of Implant strategy on finished bodyweight of beef cattle. *J. Anim. Sci.* vol. 80, (7), 1791-1800.
- Hickey, M. C., M. Drennan, and B. Earley. 2003. The effect of abrupt weaning of suckler calves on the plasma concentrations of cortisol, catecholamines, leukocytes, acute-phase proteins and in vitro interferon-gamma production. *J. Anim. Sci.* 81: 2847-2855.
- Johnson, B. J., P. T. Anderson, J. C. Meiske, and W. R. Dayton. 1996. Effect of a combined trembolone acetate and estradiol implant on feedlot performance, carcass characteristics, and carcass composition of feedlot steers. *J. Anim. Sci.* 74:363–371.
- Keane, M. G., and M. J. Drennan. 1987. Lifetime growth and carcass composition of heifers and steers non-implanted or sequentially implanted with anabolic agents. *Anim. Prod.* 45:359–370
- Kinsman, D. M., Kotula, A. W., and Breidenstein, B. C. 1994. *Muscle Foods: Meat Poultry and Seafood Technology.* Chapman and Hall, New York, NY.
- Kuhl, G. L. 1996. Stocker cattle responses to implants. Oklahoma State University Implant Symposium, pp. 51-62, Oklahoma State University, Stillwater.
- Kuhl, G. L. 1997. Stocker cattle responses to implants. Symposium: Impact of implants on performance and carcass value of beef cattle. *Okla. Agric. Exp. Sta. P-957:51-62.*
- Loyd, A.N., R.C. Vann, J.P. Banta, T.H. Welsh, J.A. Carroll, and R.D. Randel. 2012. Characterization of feeding behavior of abrupt-weaned crossbred heifer calves. *J. Anim. Sci.* vol. 89, e-supplement, 328.
- Lusby, K. S., and D. R. Gill. 1985. Implanting beef cattle. *Great Plains. Ext. Factsheet,* 1603.

- Mader, T. L. Implants. 1998. *Vet. Clin. of North Am.: Food Anim. Pract.* 14:279–290.
- Maltin, C. A., M. I. Deld, S. M. Hay, G.M. Innes, and P.E.V. Williams. 1990. Effects of bovine pituitary growth hormone alone or in combination with β -agonist clenbuterol on muscle growth and composition in veal calves. *Br. J. Nutr.* 63:535.
- Montgomery, T.H., P.F. Dew, and M.S. Brown. 2001. Optimizing carcass value and the use of anabolic implants in beef cattle. *J. Anim. Sci.* (79):E296-E306.
- NAHMS. 2000. USDA National Animal Health Monitoring System report on Implant usage by U.S. feedlots. Available at: http://www.aphis.usda.gov/vs/ceah/cahm/Beef_Feedlot/FD99impl.htm.
- National Animal Health Monitoring System. 2008. Beef 2008-2008. Part 1, Reference of beef cow/calf management practices in the United States, 2007- 2008. United States Dept. of Agric. Accessed at : http://www.aphis.usda.gov/animal_health/nahms/beefcowcalf/downloads/beef0708/Beef0708_dr_PartI_rev.pdf.
- Parish, J.A., J.D. Rihnehart. (2011) .Growth-Promoting Implants for Beef Cattle. Mississippi State University Extension Service. Publication 2485
- Nikolic, J.A., J. Begovic, V. Resanovic, I. Dankovic, and S. Filipovic. 1996. Serum hormones and insulin-like growth factor-1 in male and female calves and their possible relation to growth. *Acta Veterinaria-Beograd.* 46:17-26.
- Nichols, W.T., M.L. Galyean, D.U. Thomson, and J.P. Hutcheson. 2002. Review: Effects of Steroid Implants on the Tenderness of Beef. *Professional Animal Scientist.* vol. 18 no. 3 202-210
- Paisley, S.I., G.W. Horn, C.J. Ackerman, B.A. Gardner, and D.S. Secrist. 1999. Effects of implants on daily gains of steers wintered on dormant native tallgrass prairie, subsequent performance, and carcass characteristics.
- Platter W.J., J.D. Tatum, K.E. Belk, J.A. Scanga, and G.C. Smith. 2003. Effects of repetitive use of hormonal implants on beef carcass quality, tenderness, and consumer ratings of beef palatability. *J. Anim. Sci.* vol.77, 291-299.
- Preston, R. L., E. Cheng, C. D. Story, P. Homeyer, J. Pauls, and W. Burroughs. 1956. The influence of oral administration of diethylstilbestrol upon estrogenic residues in the tissues of beef cattle. *J. Anim. Sci.* 15:3–12.
- Raun, A. P., R.L. Preston. History of diethylstilbestrol use in cattle. 2002. American Society of Animal Science.

- Scanga, J. A., K. E. Belk, J. D. Tatum, T. Grandin, and G. C. Smith. 1998. Factors contributing to the incidence of dark cutting beef. *J. Anim. Sci.* 76:2040
- Selk, G. 1996. Implant effects on intake, growth rate and efficiency: calves and replacement heifers. *Proc. Symp. Impact of implants on performance and carcass value of beef cattle.* Oklahoma Sta. Univ. and Plains Nutr. Council.
- Selk, G. 1997. Implants for suckling steer and heifer calves and potential replacement heifers. In: *Proc. Impact of Implants on Performance and Carcass Value of Beef Cattle*, Oklahoma Agric. Exp. Sta., Oklahoma State Univ., Stillwater. P-957:40-50.
- Sewell, H.B. 1990. Growth stimulants (implants). *Missouri Agric. Guide G2090.*
- Smith, K.R., S. K. Duckett, M. J. Azain, R. N. Sonon, Jr. and T. D. Pringle. 2001. The effect of anabolic implants on intramuscular lipid deposition in finished beef cattle. *J. Anim. Sci.* 85:430-440.
- Trenkle, A. 1983. Mechanisms of action for the use of anabolics in animals. In *Anabolics in Animal Production*. E. Meissonnier (Ed.). p 65. Office International des Epizooties, Paris, France.
- USDA. 2000. Part I: Baseline Reference of Feedlot Management Practices, 1999. USDA:APHIS:VS, CEAH, National Animal Health Monitoring System. Fort Collins, CO
- Webb, A.S., R.W. Rogers, and B.J. Rude. 2002. Review Androgenic, Estrogenic, and Combination Implants: Production and Meat Quality in Beef. *The Professional Animal Scientist.* 18:103-106