POTENTIAL MANAGEMENT OPPORTUNITIES FOR COW/CALF PRODUCERS TO MAXIMIZE PROFIT

by

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B. S., Texas A&M University, 2001
M. S., Texas A&M University, 2003

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Animal Sciences and Industry
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Abstract

The primary study investigated the use of ractopamine HCl and implants in cull beef cows. Thirty-two cull cows were used to determine the effects of feeding ractopamine HCl and/or implanting on feedlot performance and carcass composition. Cows were individually fed a high concentrate diet for 60 days. Carcass data were collected and carcasses were fabricated. Implanted cows had greater dressing percentages and tended to have heavier hot carcass weights than non-implanted cows. Cows that had been treated with implant and ractopamine HCl tended to be fatter than those not treated. Ractopamine HCl fed cows had more marbling than their contemporaries. The data also indicated that younger cows (< 6 years of age) had greater feedlot performance than the older cows.

An experiment was conducted to determine if corn and grain sorghum dried distillers grains could be effective protein supplements for growing cattle. Crossbred heifers (n = 78) were individually fed 2.72 kg·head$\cdot^{-1}$d$\cdot^{-1}$ of supplements containing corn, soybean meal, and grain sorghum; or cracked corn and corn distillers grains with solubles; or cracked corn, sorghum distillers grains with solubles, and ground grain sorghum (all formulated to equal 20% CP). Heifers grazed native-grass and were fed smooth broom hay. A digestion trial was done during the last week of the trial. No differences were noted in weight gain or total diet digestibility, however, DMI was less for heifers receiving either distiller's based supplement.

Ninety-six pregnant, mature, spring-calving cows grazing native grass pasture were used to determine if early weaning calves reduced subsequent winter supplementation cost. Previous to the feeding trial, calves had been weaned at 115 or 212 d of age. Cows were fed either 1.4 $kg \cdot hd^{-1} \cdot d^{-1}$ or 1.27 $kg \cdot hd^{-1} \cdot d^{-1}$ of a common 45% CP supplement. Cows were supplemented for an average of 110 d of pregnancy. Early-weaned cows were heavier and had greater body condition scores than contemporaries at the commencement of supplementation. At calving the early-weaned cows fed the lesser supplemental amount had similar body weight and body condition scores as later-weaned cows fed the greater amount of supplement, thus, the early weaning routine allowed a 30% savings of winter protein supplement.

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Approved by:

Major Professor
Twig T. Marston

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Dedication

I would like to dedicate this manuscript to my entire family.

To my parents:

First and foremost to my parents whose lifelong guidance and support ultimately made this possible. To my father, thank you for showing me that dreams can be obtained through all difficulty and diversity with a little hard work and determination. I would also like to thank my brother, Chris.

To my wife:

Words cannot describe what you mean to me or what part of this you have had. I do know that without your endless support this never would have been possible.

To my children:

Konner and Ava, and any others that may come along. Hopefully one day you can look back at what I have and will hopefully accomplish in my life and it will in some way inspire you to pursue your dreams no matter what obstacles you will face.

Others:

I would also like to thank my "Opie" Raymond Jentsch as the advice "directly or indirectly" you have given. Your influence on my life will never be forgotten. To my grandparents who are no longer with us, I hope that you are looking down on me and can be proud of me and what I have accomplished. And last but definitely not least, to my in-laws, James and Jeannette Long. Your support in every decision

Sondra and I have made has made them that much easier to accomplish. Once again thank you all from the bottom my heart.

Thanks again for all of your support!

CHAPTER 1 - Review of Literature

Introduction

During the past thirty years beef production has maintained a steady supply of beef with 30 million fewer animals (Field and Taylor, 2003). Field and Taylor (2003) state that this production level has been maintained through the improvement of genetics, improved management techniques, a better understanding of ruminant nutrition, the use of feed additives (ionophores and antibiotics), and metabolic modifiers (steroid implants and ractopamine).

There are many variables that affect production income; therefore, cattle producers can control profits by incorporating particular management practices and inputs into their operations. It is well established that the main input in a cow/calf operation is the feed cost. Feed costs in a cow/calf operation typically range from 60-70% of the total cost of production (Kansas Farm Management Association, 2004). As outputs it has been estimated that about 80% of the gross income comes from the sale of calves (National Animal Health Monitoring System, 1997) leaving about 20% of the total income from the sale of cull animals. The sale of these cull animals is often times driven by convenience instead of trying to maximize their profit potential. CattleFax has reported that feeding cull cows by increasing body weight and improving dressing percentage allows producers to market during seasons of greater prices per cwt (Troxel et al., 2002; Wright, 2005). These circumstances include the time of marketing, and optimum management of feed inputs. Other factors that need to be considered are the use metabolic modifiers such as steroid implants and feed additives such as the β-adrenergic agonist ractopamine HCl (trade name Optaflexx™, Elanco). Cranwell and collaborators (1996a), showed the use of steroid implants to be economically additive, compared to only feeding cows a high concentrate diet, in increasing the performance of cull cows fed high concentrate diets in a realimentation program. Ractopamine is a feed additive that is approved for use in cattle fed in confinement for slaughter. Results from studies conducted by Crawford et al. (2006), Griffin et al. (2006), and Winterholler et al. (2006) in which ractopamine HCl was fed to steers and heifers at various levels during the final feedlot stage, resulted in increases in average daily gain. There is no published research investigating the feeding of ractopamine in a cull cow slaughter realimentation program or its effects on mature animals. The purpose of this review is to investigate the incorporation of ractopamine HCl and implants into cull cow feeding program.

Cull Cow Realimentation

Introduction

Many factors affect the results of feeding cull cows and its profitability. Feeding culls can be a challenging venture due to animal variation. These cows are culled for many reasons (Table 1.1; NAHMS, 1997), and often are in various stages of pregnancy; health status, age, breed, and body condition score (Troxel et al, 2002). Alimentation as defined by American Heritage® Stedman's Medical Dictionary (2002) is the act or process of giving or receiving nourishment The National Animal Health Monitoring System, (1997) listed age and pregnancy status as the two main reasons that cattle producers cull cows.

Table 1-1. Cow/calf operations main reasons for culling.[a]

Reason	Percent ± S.E.
Age or bad teeth	39.8 ± 2.5
Pregnancy status	24.3 ± 3.1
Economics	18.5 ± 2.8
Producing poor offspring	5.7 ± 1.0
Other reproductive problems	2.9 ± 0.5
Other	2.9 ± 0.6
Physical soundness	2.1 ± 0.4
Udder problem	1.5 ± 0.3
Temperament	1.3 ± 0.3
Bad eye(s)	0.8 ± 0.1
Respiratory problem	0.2 ± 0.1
Digestive problem	0.0 ± 0.0

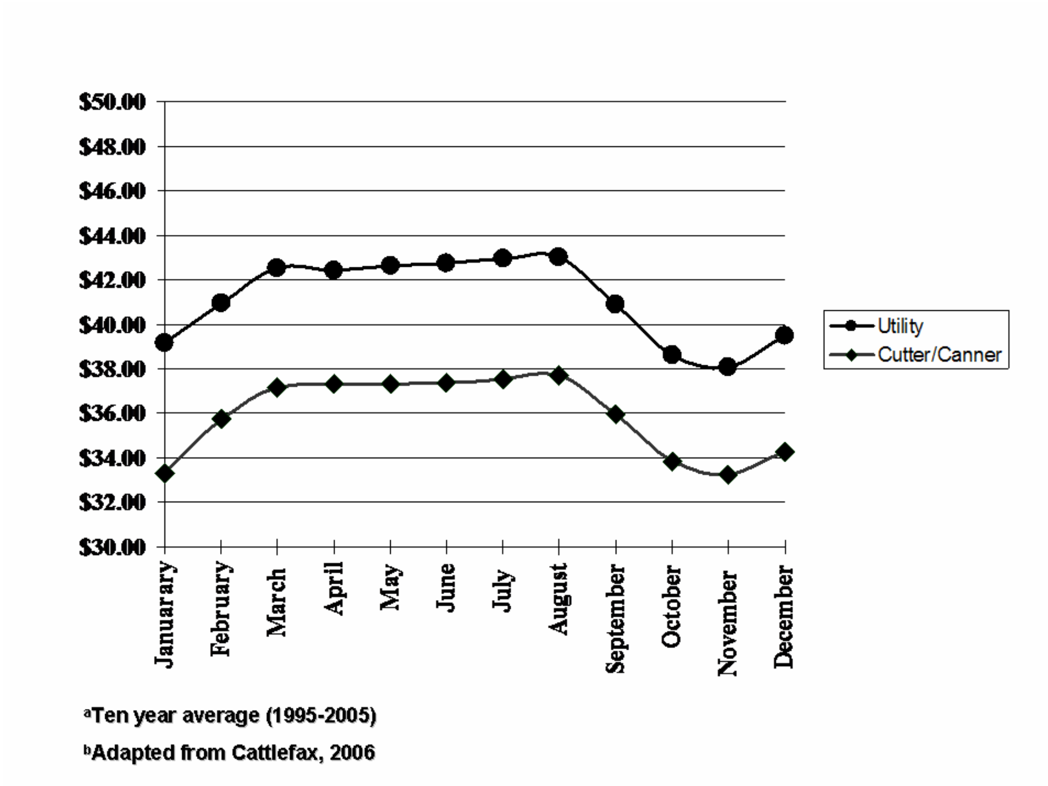
[a]adapted from National Animal Health Monitoring System.1997.

Other reasons cows are culled including injury, disease, drought and extreme weather conditions.

There are four main factors that affect profitability of feeding cull cows. The first and most variable is the seasonality of the cull cow market. While the cull cow market is variable, it is fairly predictable. During the last ten years it has been lowest in the fall and highest in February through August (Figure 1-1: Wright, 2005). The second factor is the feeding system, and includes the length of time cows are fed, the nutrient density of diet, and the cost of the diet. These are the most expensive investments in cull realimentation, but can be managed and controlled. The third factor affecting cull cow profits is the cull cow grading system as Hilton et al. (1998) explains mature cows are not typically classified into one of four grades their maturity's would be eligible for: Commercial, Utility, Cutter, and Canner (USDA, 1996). Instead, most processors of mature cows use there own classification systems (Hilton et al., 1998) to segregate cows into marketable groups. These groups are typically modifications of the USDA system, and are very specific to the needs of the processor and their markets. There is a fairly predictable $5-6 spread between Utility and Cutter/Canner grade (Figure 1-1). The final area affecting the profitability of cull cow involves the use of metabolic modifiers like steroid implants and ractopamine HCl. These products must be considered due to economic advantages obtained from the increase in saleable product, and/or increase in feed efficiencies that have been shown with their use in feedlot steers and heifers.

The realimentation of cull cows can be an economical venture under the correct circumstances (Apple et al., 1999; Troxel et al., 2002; Wright, 2005). These

Figure 1-1. Seasonality of Utility and Cutter/Canner cull cow monthly prices.[a]



circumstances include the time of marketing, and the optimum management of feed inputs. Cranwell and collaborators (1996) showed the use of steroid implants can increase the feedlot performance of cull cows fed high concentrate diets in a realimentation program. Ractopamine HCl (ractopamine hydrochloride) is a feed additive that is approved for use in cattle fed in confinement for slaughter (Elanco, 2003). Ractopamine HCl has shown to increase ADG, longissimus muscle area, and optimize feed efficiency as reported in studies in which steers and heifers were fed levels ranging from 100-300 $mg{\cdot}hd^{-1}{\cdot}d^{-1}$ during the final 28-42 days before slaughter (Schroeder et al., 2003; Laudert et al., 2003 Loe et al., 2005; Winterholler et al., 2006). But, there is currently no published research investigating the use of ractopamine in aged cattle, especially cull beef cows.

Cull Cow Market Seasonality

Ten to 20% of cow/calf operations gross income can come from the sale of cull cows (National Animal Health Monitoring System, 1997). Prices received for cull cows follow a seasonal pattern that is quite predictable and contributes to potentially profitable feeding windows. Historically, the slaughter cow market is directly correlated to the inventory of cows marketed and is at its lowest in the fall and highest in the spring to early summer (Figure 1-1). Traditionally, spring calving operations sell cull cows during fall months shortly after weaning and/or pregnancy examination. The practice of fall selling has historically resulted in lower prices (Wright, 2005) due to the greater number of cows being sold during this time period. In addition, spring-calving cows sold in the fall typically are lighter weight and have less body condition compared to fall calving cows that are sold in the spring. Generally, fall calving cows receive greater prices due to the seasonality of the cull cow market. The condition of the cows at the time of sale will affect price paid per unit of weight. Cows that are have greater body condition scores (BCS > 6; 1 to 9 scale) will have greater live values (Apple, 1999). The seasonality of the cull cow market should be taken into consideration when developing a cull cow feeding program.

Concentrate Feeding

The length of time cull cows should be fed to prepare them for market depends on the initial body condition of the cow and the energy density of the diet. High concentrate diets have shown to shorten the duration needed to take advantage of a cull cow's potential for compensatory gain. Swingle et al. (1979) conducted two experiments utilizing different levels of energy in the diet. In the first experiment cows were fed two levels of dietary energy: moderate (40% concentrate) and high (80% concentrate). While there were no differences in initial or final empty body weight, there were reductions in daily feed intake, decreases in gain:feed, and increases in carcass weight gain with an increase in the energy density of the diet. Cows fed the more moderate diet ate more and gained less carcass weight than cows fed the high energy diet. The second study reported by Swingle et al. (1979) showed more pronounced results as cows fed the moderate (40%) concentrate diet had greater average daily gains, average daily feed intakes, and carcass gains compared to cows fed a low (22%) concentrate diet. Price and Berg (1981) showed that cows fed a grain diet for 63 d increased carcass weight by 18%, longissimus muscle area by 16% and value by at least 23% compared to unfed cows. Schnell and collaborators (1997) fed cull cows a high energy diet for 0, 14, 28, 42, and 56 d. Average daily gains were negative during the first 14 d, but increased every 14 d thereafter. Most recently, Sawyer et al. (2004) fed 125 beef cull cows three different energy levels to determine the optimum rate of gain for cull cows in a short-term feeding program (54 days). Treatments included conservative, standard, and aggressive feeding approaches, and varied by reducing the roughage levels as days on feed progressed. The conservative, standard, and aggressive treatments were fed a thirty percent roughage diet throughout, a decrease from 30 to 10% over 20 days, and a decrease from 30 to 10% over 10 days, respectively. Conservatively fed cows had the highest DMI, and lowest ADG, which in return equated to the lowest gain:feed ($P < 0.05$). There were no significant differences between standard or aggressively fed cows for the feedlot performance variables. Standard treatment cows had greater hot carcass weights than conservatively fed cows ($P < 0.05$), but they were not different than aggressively fed cows. Standard fed cows were also significantly fatter than conservatively and aggressively fed cows ($P < 0.05$). There were significant differences between treatments for dressing percentage, longissimus muscle area, yield grade, marbling score, maturity, or subjective color scores. Results of this study showed that cull cows can be fed intensively for short periods with increasing amounts of concentrate to encourage faster adaptation without affecting feed efficiency. As with other studies reported, Schnell et al. (1997) showed that as the length of the feeding period increases final body and hot carcass weight. Feeding cull cows diets containing concentrate appears to increase body and carcass weight, with the magnitude of the increase dependent in part upon the energy density of the diet.

Days on Feed

Producers must determine optimum number of days on feed as well as diet composition for their operation. To optimize income producers should target specific months to market the cull cows. This will then dictate the number of days on feed and needed energy concentration of the diet. Since the most favorable market for cull cows occurs in the spring, cows culled in the fall should be managed if economical possible to be fed and sold later under more favorable market conditions. On the other hand, cows culled in the spring will need to be fed more aggressively to reach a body condition score in the 5 to 6 range and still obtain the premiums that the seasonality of the market is offering. Wooten et al. (1979) concluded that the greatest increase in protein and lean accretion in a cull realimentation program occurs in the first 38 days, but that overall changes in gain (or weight) are ultimately dependent on the cow's initial body condition. Matulis and coworkers (1987) conducted a study evaluating the feedlot performance and carcass characteristics of cull cows fed different lengths of time. Average daily gains were lowest for the first 28 d, highest during the middle 28 d, and then tapered off during the final 28 d to levels similar to the initial 28 d (1.02, 2.06, and 1.13 kg/d, respectively). Similar trends were seen with feed efficiency reported as gain:feed (0.12, 0.18, and 0.08, respectively). Live weight, carcass weight, fat thickness, and longissimus muscle area linearly increased with an increase in days on feed. Quality grade increased linearly ($P < 0.05$) until 56 d on feed and then appeared to remain constant until the end of the 84 d feeding period.

Schnell and others (1997) conducted a study to determine the optimum length of time cull cows should be fed a high concentrate diet. Forty, thin condition (average BCS

< 5) cows were randomly assigned to one of five treatments. The treatments consisted of feeding a high energy concentrate diet for 0, 14, 28, 42, or 56 days. As with the previous mentioned studies (Swingle, 1979; Matulis, 1987; Wooten, 1979), Schnell found that cows gained little during the first 28 days on feed, but subsequent weigh periods indicated cull cows were able to gain approximately 2.0 kg/d. They concluded that a 28 d adjustment period was needed for diet acclimation final weight and ADG increased with time on feed but were not significantly different after 28 d on feed. The same trend was seen with carcass weights, dressing percentage and longissimus muscle area. .

Compositional Changes Due to Realimentation

Swingle et al. (1979) showed that feeding cows from 38 to 108 d increased carcass lipid content, and decreased carcass moisture and protein percentages. More recently, Schnell et al. (1997) performed a serial slaughter study in which cows were harvested at d 0, 14, 28, 42, and 56. As cows were fed longer they had greater amounts of fat-free lean (muscle), fat, subprimal weight, and soft tissue fat percentage. Cows fed longer also had decreasing percentages of soft tissue moisture. Cranwell et al. (1996a) reported that carcass soft tissue from cows fed 0, 28, and 56 d were 79.1, 81.2, and 83.0 %, respectively ($P < 0.05$). Moisture and crude protein as a percentage of carcass soft tissue decreased as cows were fed longer, but lipid percentages increased ($P < 0.05$). As cows are fed longer and increase in body condition score the percentage of protein and moisture in the lean tissue decreases and the lipid percentage increases. Boleman and collaborators (1996) conducted a study to evaluate the realimentation of cull cows on carcass and meat quality characteristics. Cows were managed prior to the study to result in a similar in body condition prior to the study. Upon the start of the study cows were randomly assigned to one of four feeding combinations in a 2 × 2 factorial design with two levels of dietary energy and two levels of protein concentrations. Days on feed (0, 28, 56, or 84 d) and electrical carcass stimulation (stimulated or not stimulated) were also evaluated. There was a linear increase in live weight ($P < 0.01$) as days on feed increased. Fat thickness (0.15, 0.29, 0.70, and 0.99 cm) and adjusted fat thickness (.24, 0.31, 0.78, and 1.24 cm) differences were seen among 0, 28, 56 and 84 days on feed, respectively. Longissimus muscle area remained similar between 0 and 28 d of feeding cows, increased between the 28 and 56 d on feed ($P < 0.05$), and than remained constant from 56 and 84 d fed (69.8, 70.4, 78.1, and 79.5 cm^2 for 0, 28, 56, and 84 d feeding periods, respectively). Therefore, thin cull cows need to be fed at least 28 days to maximize the amount of protein accretion.

Effect of age on Cull Cow Realimentation

Age has shown to be a consistent factor in the results of cull cow realimentation. Graham and Price (1982) performed a study to evaluate the effects of age on the feedlot performance and carcass composition of cull cows of three breed types (Hereford, beef composite and partial dairy genetics). Cows were classified into three age groups Young (2 to 3 years of age), Intermediate (5 to 6 years of age), and Mature (6 years or older). They reported that slaughter weight increased ($P < 0.05$) with age 426, 497, and 550 kg for young, intermediate, and mature cows, respectively. As a result, carcass weights were significantly greater for mature cows than both intermediate and young cows. They also indicated dressing percentages were greater for young cattle ($P < 0.05$) by about 0.5 % compared to intermediate and mature cows. There were no significant differences between age groups for longissimus muscle area, fat thickness, or average daily gain.

They also noted that the mature cow group gained less throughout the entire feeding period than either the intermediate or young cow groups. Sawyer et al. (2004) reported that as age increased, dry matter intake and ADG decreased resulting in a decrease of gain:feed. Decreases in dry matter intake and average daily gain may ultimately increase the cost of gain and breakeven values. Pritchard and Burg (1992) showed that old (10 and 11 years of age) and very old cows (12+ years of age) had lighter initial, final, and carcass weights, and smaller longissimus muscle areas than younger cows. Therefore, when producers are feeding older cows they may expect to see more variability in feedlot performance and body composition, which could be less profitable than feeding younger cows. Regardless, it appears all ages of cows will show some response to realimentation feeding.

Cull Cow Grading Systems

The current grading system used by the USDA for older slaughter cattle aged C maturity and greater (cull cows) calls for them to be classified into one of four classes; Cutter, Canner, Utility and Commercial. They are typically segregated into these categories based on a subjective determination of their expected lean yield (Apple et al., 1999). Historically (over the past ten years) the spread between Utility and Cutter/Canner have ranged consistently between $5-$6/cwt throughout the entire year (Figure 1-1). There are many factors that determine live cull cow value including weight and body condition. While the USDA system is designed to utilize maturity and marbling to determine quality grade it is not practical to do so on a live basis as lean yield and weight have more bearing on value than quality. Other factors that may attribute to premiums or discounts include pregnancy status, breed, health, and size. Most of the slaughter cows are sold on the basis of percent lean tissue in which lean yield decreases from the Canner to Commercial grades (Table 1-2). The rib, loin, and a few select cuts are typically sold as intact fresh products and the rest of the carcass is made into ground beef or processed meat products (Hodgson et al., 1992). Researchers have worked to develop a more accurate evaluation system than the current grading system established by the USDA. Hodgson and others (1992a, 1992b) developed alternative grading systems for use in classifying cull cows more accurately into yield and quality grades segments. This was done to to better reflect their economic relevance or value. When developing a more accurate equation for yield grade the best fit equation took into account the following factors: adjusted fat thickness; kidney, pelvic, and heart fat; and an overall muscle grade. An overall muscle grade was also developed and defined by a scale in which 100 = Canner^{00}, 200 = Cutter^{00}, 300 = Utility^{00}, etc. While the authors did not use actual measurements when determining the scores it was explained that they were used in a subjective estimate of the overall degree of thickness of the carcass (Hodgson et al., 1992b).

Table 1-2. Slaughter cow grades and corresponding dressing percentages, lean yields and body condition scores.[ab]

Grade	Dressing percentage, %	Lean yield, %	BCS[b]
Canner	40-46	90-92	1-3
Cutter	45-49	88-90	4-5
Utility			
Boning	50-52	78-83	5-9
Breaking	52-54	76-82	6-9
Commercial	55-60	70-80	5-9

[a]BCS = Body condition score 1-9; Scale: 1 = emaciated, 9 = Obese.
[b]adapted from Gill, 1998

The best fit equation equaled first principal component so that estimated yield grade equaled 2.04 – (.67 x adjusted fat thickness) – (.21 x kidney, pelvic, heart fat) – (.0016 x overall muscling) with a P-value less than 0.001 and a R^2 = 0.94. In developing a quality grade equation the authors evaluated the following dependent variables: tenderness, juiciness, connective tissue, flavor, and shear force. They also evaluated the independent parameters of overall maturity, lean color, marbling score, lean firmness, lean texture, fat color, and marbling fineness ([marbling texture + marbling distribution]/ 2). The goal was to establish a carcass grading system for cull cows that would determine those superior in palatability and would be more accurate than the current USDA system (Hodgson et al., 1992a). The best fit prediction equation for quality grade = -.052 – [.0031 x overall maturity] + [.0013 x marbling score] + [.31 x fat color] with a P-value less than 0.001 and R^2 = 0.53. Although these quality and yield grade systems were show to be more accurate at classifying cull cows into their appropriate marketing groups they have not been validated on a widespread basis, accepted by the USDA, or used by those in the feeding and slaughter industry.

Mode of Action and Steroid Implants Use

Anabolic compounds have been successfully used in the cattle feeding industry. There are two types of anabolic hormones used in implants — androgenic and estrogenic. Androgenic implants mimic testosterone and have been shown to increase gains, feed efficiency and carcass yields in young animals, but results have varied in trials conducted with mature animals (Oklahoma Agricultural Research Station, 1997). Androgenic implants impart their response through steroid hormone receptors to induce their response. Examples of androgenic implants include testosterone propionate, progesterone and trenbolone acetate. Estrogenic implants impart their response through estrogen receptors (Scanes, 2003). Examples of currently approved estrogenic implants include zeranol, estradiol benzoate and estradiol 17-β. Combination implants (i.e. Revalor-200; 200mg of trenbolone acetate and 20mg estradiol) use of both estrogenic and androgenic compounds to maximize results. The use of combination implants has shown to increase daily gains and protein accretion. Protein accretion from implants such as Revalor-200 has been shown to be from both protein synthesis and a decrease in protein degradation. This skeletal muscle hypertrophy is achieved from an increase in protein content and an increase in muscle cell DNA (Johnson, 2005). The increase in muscle cell DNA is attributed to the activation of satellite cells. Steroid hormones have shown to increase local insulin–like growth factor (IGF-1) levels (Dunn et al., 2003). Many of the performance and carcass gains attributed to steroid hormones are thought to be mediated through the local increase in IGF-1. It has also been proposed that steroid hormones may impart a response through a non-genomic mechanism. These non-genomic mechanisms may impart their responses through second messenger pathways similar to that of the mode of action of ractopamine (Johnson, 2004).

Corah and others (1980) implanted cull beef cows grazing fescue with 36mg zeranol (Ralgro™), resulting in an 11.4% more rapid average daily gain. Matulis and collaborators (1987) reported no significant differences in feedlot performance or any other carcass parameters measured in their study except cows administered Synovex-H® had greater semitendinosus weights. Faulkner et al. (1989) used a 2 × 2 factorial design to study the effects of anabolic steroid implanting and days on feed. Main effects included either no implant or implanted with testosterone propionate and estradiol benzoate (Synovex-H) and feeding for 42 or 84 days. There were no significant differences seen in feedlot performance between implanted or non-implanted cows. Pritchard and Burg (1992) studied the effects of implanting cull cows with Finaplix-H® and reported that implanted cows exhibited similar average daily gains ($P < 0.09$), lower dry matter intakes ($P < 0.04$), and greater gain:feed efficiencies ($P < 0.05$) than non-implanted contemporaries. These results were similar to Matulis et al. (1987) who also reported negligible improvements in cull cow feeding growth performance from implanting. In a study comparing no implants, trenbolone acetate 200 mg (Finaplix-H®), testosterone propionate 200 mg + estradiol benzoate 20 mg (Synovex-H®), and a combination to both implants, Cranwell et al. (1996) clearly demonstrated that implanted cows had an advantage ($P < 0.05$) in the feedlot performance traits of: final weight, average daily gain, and feed efficiency. Using either implant increased average daily gain by about 0.6 kg/day but when used in combination a response of nearly 0.9 kg/day was reported above non-implanted controls regardless of the number of days on feed. Implanted cows also had greater hot carcass weights, longissimus muscle areas, and improved yield grades ($P < 0.05$). Interestingly, results included that trenbolone acetate treated cows had the largest ($P < 0.05$) longissimus muscle areas when compared to non-implanted or Synovex-H-implanted cows (Cranwell et al., 1996a). In summary, when feeding cull cows, use of a combination androgenic/estrogenic implant is advised to increase rate of gain, improve feed efficiency, and produce more carcass weight.

Mode of Action of Ractopamine HCl

Ractopamine HCl is a member of a large family of compounds commonly called β-adrenergic agonists (β-agonists). Beta-agonists are similar in structure to other endogenous chemicals called catecholamines. Examples of catecholamines include norepinephrine and epinephrine. β-agonists are also called repartitioning agents as they cause changes in body composition when fed to livestock. β-agonists obtain their name from the β-adrenergic receptors that they bind. Several sub-types of β-adrenergic receptors are found in different proportions on the surface of most mammalian cells according to species and tissue. The three currently known sub-types of β-adrenergic receptors are β_1, β_2, and β_3 (Beermann, 2002). It is through these receptors that ractopamine is thought to mediate its response (Mersmann, 1998). Beta-agonists bind to their preferential subtype receptor. Activation of the receptor complex initiates activation of the G-protein which in turn causes the activation of adenylyl cyclase. Adenylyl cyclase produces cyclic adenosine monophosphate (cAMP). Cyclic AMP then causes a response through the protein kinase A pathway. Protein kinase A phosphorylates key enzymes which in return control protein and lipid synthesis and degradation (Johnson, 2004).

Use of Ractopamine in Feedlot Cattle

Ractopamine hydrochloride, (Optaflexx™, Elanco Animal Health, Greenfield , IN) was approved in 2003 for use in cattle fed in confinement to increase feed efficiency, weight gain, and carcass leanness. It was approved to be fed at levels ranging from 70 - 430 $mg \cdot hd^{-1} \cdot d^{-1}$ for the final 28 to 42 d prior to slaughter. It has combination approval with Rumensin®, Tylan® and MGA®. Ractopamine is one of many in a family of β-adrenergic agonists (others include Cimaterol, Clenbuterol, and Zilpaterol) (Johnson, 2004). Zilpaterol is the only other β-agonist currently approved for use beef cattle in the United States. Beta-adrenergic agonists obtain their name from the receptors that they affect. While there are α- and β-adrenergic receptors and β_1, β_2, and β_3 sub-types within the β-group, ractopamine has an affinity for the β_1 receptor. There have been no studies published evaluating the use of ractopamine in mature cattle, but there has been reports published of its efficacy in steers and heifers (Table 1-3). Schroeder et al. (2003a) reported the effects of ractopamine fed at various levels and lengths of time to feedlot steers. The results of this study showed that steers fed ractopamine had greater average daily gains and gain:feed values ($P < 0.001$) than control steers. Ractopamine-fed steers in the same trial also had heavier carcass weights and larger longissimus muscle areas when compared to controls ($P < 0.05$). In a five-trial summary registration report, Schroeder et al. (2003a) reported no differences in fat thickness or marbling scores between ractopamine-treated steers and controls. Similar results where reported in another five-trial summary registration report by Schroeder and others, (2003b) in which ractopamine-treated heifers had heavier final weights, greater average daily gains, and greater gain to feed values. A 2.04 kg advantage in hot carcass weights was seen in heifers fed 200 $mg \cdot hd^{-1} \cdot d^{-1}$ or greater compared to controls. Heifers fed 300 $mg \cdot hd^{-1} \cdot d^{-1}$ had 3.23 cm^2 larger longissimus muscle area than controls. In one of the few post-registration reports, a summary combining six studies, Laudert and collaborators (2003) reported linear increases in final weights, average daily gains, and gain:feed in steers fed 0, 100, 200 $mg \cdot hd^{-1} \cdot d^{-1}$ ($P < 0.05$). Linear increases were also seen in hot carcass weights (344, 348, and 350 kg for steers fed 100, 200, and 300 $mg \cdot hd^{-1} \cdot d^{-1}$, respectively) and longissimus muscle areas (0.6 cm^2 per 100 mg increase) in ractopamine-fed steers.

Table 1-3. Comparative responses of studies administering ractopamine HCl to steers or heifers.

Sex	Dose[a]	Days	ADG	Feed:Gain	ADFI	DP	MS	LMA	FT	Reference
				------------------------- Control = 100 -------------------------						
Steers	200	28-42	120	84	100	101	100	103	100	Schroeder et al., 2003a
Steers	300	28-42	126	80	100	101	98	104	100	Schroeder et al., 2003a
Heifers	200	28-42	118	86	102	100	101	101	100	Schroeder et al., 2003b
Steers	200	28-32	117	84	100	100	99	102	100	Laudert et al., 2003
Steers	200	28	105	96	101	100	101	102	NA	Winterholler et al. 2006
Steers	100	42	103	97	100	101	101	103	93	Crawford et al., 2006
Steers	200	42	105	93	96	101	97	108	91	Crawford et al., 2006
Heifers[b]	200	31-38	103	93	102	100	99	100	100	Griffin et al., 2006
Steers	200	29	118	88	103	100	NA	NA	NA	Loe et al., 2005

[a]Dose expressed as mg·hd^{-1}·d^{-1}.

[b]Control received MGA 0.4 mg·animal^{-1}·d^{-1} during the finishing period.

As presented in Table 1.3, Loe and others (2005) conducted a study utilizing ractopamine in commercial feeding operations. Ractopamine at a level of 200mg mg·animal^{-1}·d^{-1} for an average of 29 days improved feed efficiency, and while not presented in table 1.3, ractopamine increased hot carcass weight, and did not significantly change the distribution of USDA quality grades. However, there were a higher percentage of ractopamine-treated steers receiving USDA yield grade scores of 1 and 4, and a lower percentage of ractopamine treated steers receiving a USDA yield grade of 2 (Loe et al., 2005). Winterholler et al. (2006) conducted a study to determine the effect of ractopamine, (200 mg·hd^{-1}·d^{-1}) on steers fed for 150, 171, and 192 days with ractopamine being fed during the final 28 days of each feeding period. As shown in table 1.3 steers fed ractopamine had significantly greater average daily gains, (5 %) and improvement in feed conversion (4 %) compared to steers receiving no ractopamine. Crawford et al. (2006) conducted a 3 × 3 factorial comparing dose (0, 100, and 200 mg·hd^{-1}·d^{-1}) and duration (28, 35, and 42 days of ractopamine administration) hoping to determine the optimum dosage and length of time ractopamine should be administered to feedlot steers. There was a significant linear dosage effect on feedlot performance as steers receiving ractopamine had lower dry matter intakes, greater average daily gains, and gain: feed efficiencies. Linear increase were also seen for carcass weight, longissimus muscle area, and USDA yield grade. Duration of feeding ractopamine had no effect on feedlot performance or carcass characteristics. Crawford and collaborators (2006) concluded that feeding ractopamine up to 200 mg·hd^{-1}·d^{-1} from 28 to 42 days was beneficial as indicated by increases in weight gain, feed efficiency, and longissimus muscle area.

Griffin et al. (2006) performed a study to evaluate feeding ractopamine to heifers fed MGA®, a feed additive that is an orally active progestin used to suppress estrous in feedlot heifers. Heifers were randomly assigned to treatments in which half were administered 0.4 $mg \cdot hd^{-1} \cdot d^{-1}$ MGA for the entire finishing period and half were fed 0.4 $mg \cdot hd^{-1} \cdot d^{-1}$ MGA for the entire finishing period plus 200 $mg \cdot hd^{-1} \cdot d^{-1}$ of ractopamine during the final 31-38 days of the finishing period. Heifers fed MGA plus ractopamine had significantly greater dry matter intakes, and achieved greater gain:feed values ($P < 0.03$). There were no other significant differences seen in any of the other feedlot performance and carcass characteristics. Griffin concluded that there were no negative ramifications of using ractopamine in heifers being fed MGA, however, its benefits in feedlot heifers may be limited.

A non-peer reviewed study reported by Holmer et al. (2005) investigated the use of ractopamine in cull beef cows. Ractopamine was administered at a level of 200 mg during the final 35 days on feed of a 57 day feeding period. Cows fed ractopamine tended to have greater carcass weights, dressing percentages, and longissimus muscle ($P > 0.05$.)

Ractopamine has shown to improve average daily gain, improve feed efficiency, and increase longissimus muscle area in steers. There appears to minimal benefit of the use of ractopamine in feedlot heifers. To advocate the use of ractopamine in a cull cow realimentation program we must first determine its efficacy, and then determine if it is a viable economic input.

Conclusion

Income from the sale of cull cows has been shown to represent 10 to 20% of an operation's gross income. The realimentation of cull cows can be a profitable venture but many factors influence profitability. There is no simple solution that fits all production scenarios to help a producer decide how to manage their cull cows. The time of year in which the cows will be marketed can drastically affect profits from cull cow management. Managing cows to be sold in the spring versus the late fall can significantly affect income. The seasonality of the cull cow market has been predictable over the past ten years, and those who were in a position to take advantage of fluctuations in price seasonality generated substantial profits. No matter what time of year cows are sold, increasing cow weight and body condition has been shown to increase their value (Troxel et al, 2002; Apple et al., 1999). Cull cow research has shown that feeding high concentrate diets for a minimum of 28 days can efficiently increase cow body weight, lean yield, and overall value. Most research shows the optimum number of days on feed should range from 56-84 d in order to reach peak efficiency in lean tissue gains. Cost of the diet is also a factor in determining the length of time cull cows should be fed, thus diet cost and breakeven or projected operating margins should be balanced to determine the length of time cows should be fed.

The historical results of the utilization of steroid implants in cows have been variable, but when one considers the possible returns on a minimal input, an aggressive implant strategy should be considered. The use of β-adrenergic agonist in cattle fed in confinement for slaughter has shown to be beneficial in young steers and less effective in heifers, but there has been no published research to determine its value in cull cow realimentation programs. The benefits of increasing feed efficiency and protein accretion could directly benefit a cull cow feeding program and should be investigated. Due to the possible overlap in their modes of action, the interaction between steroid implants and β-adrenergic agonist deserves further study to determine if they have a negative, additive, or synergistic effect.

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CHAPTER 2 - Effects of Ractopamine HCl and Steroid Implants on Feedlot Performance and Carcass Characteristics of Cull Beef Cows

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Abstract

Thirty-two open crossbred cows were used in a 2 × 2 factorial experiment to determine the effects of feeding ractopamine HCl (Optaflexx®, Elanco, at 300 mg·head^{-1}·d^{-1} for 28 d) and steroid implants (Revalor® 200, Intervet, 60d) on feedlot performance and carcass composition. Cows were blocked by weight (heavy and light) and randomly assigned to one of four serial slaughter groups. Following a warm-up period cows were individually fed an ad libitum 86% concentrate diet (CP = 14.63%, NE_m = 2.12 Mcal/kg, NE_g = 1.46 Mcal/kg) for 60 d. Within slaughter groups cows were allotted to treatment combinations. The combinations were: 1) Control (no implant or ractopamine HCl); 2) Implant (implanted only); 3) ractopamine HCl (ractopamine fed only); or 4) Combination (implanted and fed ractopamine). The results of this study showed that implanting cull cows with Revalor-200 and/or feeding ractopamine HCl during the last 28 days on feed had minimal effects on performance and carcass characteristics of cull cows fed a high concentrate diet for 60 d.

Introduction

The marketing of culls cows contributes 10-20% of a cow/calf operations gross income (NAHMS, 1997). Increasing the lean tissue and quality grade of the cull cows marketed could increase their potential profitability. Many studies (Price and Berg, 1981; Matulis et al., 1987; Cranwell et al., 1996) have evaluated the effects of feeding high concentrate diets to cull cows and shown improvements in feedlot performance and carcass characteristics. Growth implants have been shown to be beneficial in many facets of the cattle feeding industry, especially cattle less than 2 years of age, by improving feed efficiency, increasing lean tissue accretion, and increasing average daily gain (Mader, 1994). Growth implants have also been shown to increase rate of gain, feed efficiency, and lean meat yield in cull cow realimentation programs (Simms, 1997; Cranwell et al., 1996[ab], Matulis et al., 1987). Ractopamine HCl (Optaflexx™) is a β-adrenergic agonist approved to feed cattle in confinement for the last 28 to 42 days prior to slaughter (Feed Additive Compendium, 2005). While ractopamine is cleared to be fed to all classes of confinement fed cattle, there is no published work that evaluates the use of ractopamine and its interaction with implants in cull cows. It is thought that ractopamine (through a cyclic adenosine monophosphate pathway) and steroid implants (through local anabolic hormones such as IGF-1) act mostly through two different modes of action. Recent research has shown that implants may also elicit a response through receptors that use secondary messenger systems (Johnson, 2004) similar to that of ractopamine. While utilizing the combination of ractopamine and steroid implants in cull cow realimentation program may optimize the compensatory lean tissue and compositional gains of cull beef cows due to there different modes of action, recent research has shown the possibility of an overlap in modes of action which may effect their efficacy. Keeping these issues in mind, the objectives of this study were two-fold; first, to investigate the effects of ractopamine on the feedlot and carcass characteristics of cull beef cows fed in confinement for slaughter, and second, to determine the interaction between ractopamine and steroid implants administered to mature beef cows.

Materials and Methods

Experimental Animals

Crossbred Angus cows (n = 32) were obtained from the Kansas State University Cow/Calf teaching unit, Manhattan, and Western Kansas Agricultural Research Station, Hays, herds. Cows had an average initial BW of 552 kg (SD = 51), .39 cm (SD = .2) of ultrasound-measured external fat at the 12th rib, and were approximately 6 (SD = 3) years of age (determined by examination of incisors, and confirmed by birth records). All experimental procedures were approved by the Kansas State University Institutional Animal Care and Use Committee.

Treatments

Cows were blocked by weight (heavy and light) and randomly allotted to a combination of implant strategies and ractopamine feeding. Therefore, treatment combinations made the experimental design a 2 × 2 factorial. Animals were individually implanted and fed making animal the experimental unit. Treatment combinations consisted of: 1) no implant (Revalor-200®, Intervet) on day 0 (**N**) and 0 mg•animal^{-1}•d^{-1} ractopamine (**0mg**); 2) implanted with Revalor-200 on day 0 (**I**) and feeding of 0 mg•animal^{-1}•d^{-1}of ractopamine (**0mg**); 3) no implant (N) and 300 mg•animal^{-1}•d^{-1} of ractopamine (**300mg**); 4) implanted (**I**) and fed ractopamine at a level of 300 mg•animal^{-1}•d^{-1} (**300 mg**). The designated amount of ractopamine(Optaflexx®, Elanco) was individually fed during the final 28 of the feeding period. Implants were administered per manufacturer's recommendation in the cow's right ear. Ractopamine was added to each cow's diet as a premix containing 300 mg of ractopamine and .1 kg of finely ground corn.

Management

Cows were individually fed an 86% concentrate diet (CP = 14.63%, NE_m = 2.12 Mcal/kg, NE_g = 1.46 Mcal/lb*)* at ad libitum intake for 60 d. A 3 step-up ration strategy was used to acclimate the cows to the 86% concentrate diet. The diets fed are presented in Table 2-1. Two cows from each treatment (one from each weight block) were randomly assigned to one of four slaughter groups. During the 60 d feeding periods, cows were individually housed and fed in 1.5 × 9 m concrete floor pens, each equipped with an automatic watering device and an individual concrete feed bunk. A south facing open shed covered the feed bunks and approximately one-third of each pen.

Initial Ultrasound Measurements

Initial ultrasound measurements were taken on day one by an experienced ultrasound technician. These data were used as a baseline value for comparisons, but more importantly, were used as covariates in the statistical analysis. The measurements obtained were marbling score, longissimus muscle area, fat thickness at the twelfth rib and ribeye muscle depth.

Table 2-1. Compositions of experimental diets.[a]

Item	Diet 1[b]	Diet 2[b]	Diet 3[b]	Diet 4[b]
Ingredient				
Grain sorghum wet distillers grains, %	20.00	20.00	20.00	20.00
Alfalfa hay, %	40.00	31.33	22.67	14.00
Steam flaked corn, %	35.89	44.56	53.22	61.89
R/T premix[c], %	2.23	2.23	2.23	2.23
Mineral premix, %	1.88	1.88	1.88	1.88
Calculated composition				
CP, %	16.19	15.67	15.15	14.63
C, %	1.11	1.01	0.90	0.79
P, %	0.42	0.42	0.43	0.43
NEm, Mcal/kg	1.81	1.90	2.01	2.12
NEg, Mcal/kg	1.17	1.26	1.37	1.45

[a]Dry matter basis.

[b]Duration fed: Diet 1, days 1-3; Diet 2, days 4-6; Diet 3, days 7-9; Diet 4-days 10-60.

[c]Formulated to provide 300 mg of monensin and 90 mg tylosin per cow daily.

Live Animal Performance

Weights were recorded on consecutive days for initial, interim (taken every two weeks throughout the trial), and final body weights. Body condition score (Scale 1-9, Wagner et al., 1988) was assessed on d 0 and 60 as the average of scores estimated by two trained individuals. Average daily gain and gain:feed were calculated on a carcass basis with final BW estimated as HCW divided by a common dressing percent (56.96%). One cow died due to complications caused by respiratory disease. Cows were removed from feed 12 hours before slaughter, but had full access to water. The first slaughter group was harvested on February 3, 2006, and each subsequent group at weekly intervals thereafter. Cows were humanely slaughtered at the Kansas State University, Department of Animal Sciences and Industry abattoir.

Carcass Traits

Hot carcass weight was collected at harvest. All other carcass data was collected 48 hours post mortem. Carcass data collected included hot carcass weight; longissimus muscle area; adjusted fat thickness; and percent kidney, pelvic, and heart fat. Marbling score (Scale of 100 to 999: 400 = Slight^{00} degree of marbling; 500 = Small^{00} degree of marbling), skeletal, lean, and overall maturity (Scale of 100 to 599: 200 = B^{00} maturity; 300 = C^{00} maturity; 400 = D^{00} maturity; 500 = E^{00} maturity.), subjective fat color (scale1 to 8; 1 = White, 9 = canary yellow), and instrumental lean and fat color scores were also recorded after a 30-min bloom period. Lean red meat yield is defined as the total weight of the subprimal cuts and the lean trim adjusted to 80% lean.

Carcass Fabrication

The right side of each carcass was processed at 72 hours postmortem into primal, subprimal, select individual muscles, lean trim, fat trim, and bone. Primal and boneless subprimal cuts were fabricated according to specifications (NAMP, 1997). Forequarter (NAMP# 102) and hindquarter (NAMP# 155) weights were recorded and each fabricated into the following; the forequarter was fabricated into the Chuck (NAMP# 113), Brisket, Rib (NAMP# 123), Foreshank (NAMP# 117), and Plate (NAMP# 121). Brisket plate and shank are express as a combined value (BPS). From the chuck, the shoulder clod (NAMP# 114C), chuck tender (NAMP# 116B), chuck roll (NAMP# 116D), and muscle weights of the *Triceps Brachii* and *Infraspinatus* were recorded. The rib section was fabricated into the Ribeye (NAMP# 112A). The hindquarter was fabricated to the Beef round (NAMP# 158), loin (NAMP# 172), tenderloin (NAMP# 189A), and flank from which the flank steak (NAMP# 193) was removed. The beef round was further fabricated to the eye of round (NAMP #171C), inside round (NAMP# 169), outside round (NAMP# 171), and knuckle (NAMP# 167A). The loin was separated into the Beef loin (NAMP# 180, PSO 3-2.5 cm rib end and 2.5 cm sirloin end), top sirloin butt (NAMP# 184B), and ball tip (NAMP# 185B). All subprimals were trimmed to no more than 0.25 cm fat thickness. All lean trim, fat trim, and bone from forequarter and hindquarter were kept separate until a weight was recorded. Lean trim from the fore- and hindquarter were ground and homogenized for later analysis. Fat trim was handled in the same manner. Following grinding and mixing to form a homogenous sample, a random 250-g sub-sample was sent to the analytical lab at Kansas State University for determination of percentages of moisture, lipid (ether extract), ash and crude protein

(AOAC, 1980). These values were used to adjust each individual lean trim to a constant 80:20 lean trim percentage.

Instrumental Color

Carcasses were ribbed between the 12th and 13th ribs at 24 h postmortem. The exposed longissimus thoracis was allowed to bloom for 30 min, and three instrumental color measurements (CIE L*, a*, and b* values) were taken of the exposed muscle with a Hunter Lab Miniscan (Hunter and Associates, Reston, VA) and averaged. Illuminant C was used with a 10° observer through a 2.54-cm aperture. External fat CIE L*, a*, and b* values were measured of the external fat dorsal to the longissimus dorsi muscle; these measurements were taken during fabrication. Hue angle (tan (b*/a*)) and saturation index = $(a^{*2}+b^{*2})1/2$ were also calculated.

Sarcomere Length

Sarcomere length was measured using the protocol of Koolmees et al. (1986). Samples were fixed in a 5% solution of glutaraldehyde in 0.1 *M* NaHPO4 buffer at pH 7.2 and 4°C. After 4 h, the glutaraldehyde solution was replaced with a 0.2*M* sucrose solution in 0.1*M* NaHPO4 buffer at pH 7.2. Samples were held overnight at 4°C. Individual fibers (n = 6) were teased from each sample, placed on a glass microscope slide, and immersed in a drop of sucrose solution. Sarcomere length was measured by passing the beam of a He-Ne laser (model 102-3, Spectra-Physics Inc., Eugene, OR; γ = 0.6328) through the fiber. Six measurements were taken from each fiber totaling 36 per experimental unit. The sarcomere length was calculated from the distance between the first order diffraction bands, according to Cross et al. (1981).

Statistical Analysis

Data were analyzed with the Proc MIXED procedure of SAS, Release 8.02 (SAS Inst., Inc., Cary, NC). The fixed effects included the main effects of ractopamine and implants, and the main effect interaction. The means of significant interactions were separated and presented by treatments. Slaughter group was included as a random effect. Age, initial weight, ultrasound backfat, ultrasound marbling, and ultrasound longissimus muscle area were all tested as covariates for various parameters. The covariate years of age was used throughout all analyses.

Results and Discussion

Initial Ultrasound

Initial ultrasound data is shown in table 2-2. Ultrasound data was obtained to be utilized as a baseline in the statistical analysis. All values were used as covariates in their respective categories as designed. There were no significant differences between treatments for 12th rib back fat, longissimus muscle area, or muscle depth.

Live Animal Performance

Feedlot performance data is presented in Table 2-3. Least squares means were not different for initial body condition scores or initial weight.

As with Cranwell et al. (1996) there were no significant differences in daily dry matter intake (DDMI) between implanted and non-implanted cows. Implant did not affect feed efficiency. However, implanted cows exhibited an advantage ($P = 0.09$) in ADG of nearly 0.5 kg/d compared to non-implanted cows during the entire feeding period (2.20 vs. 1.70 kg/d, respectively). Cranwell and others (1996a) showed a 30 percent increase in gain from implanting cows. Cows showed no significant responses to ractopamine treatment (RAC) for DDMI, ADG, or gain:feed. Ractopamine-treated cows tended to have greater overall gains, but these differences were not significant ($P > 0.35$). The interactions between implant and ractopamine feeding tended to increase rate of gain during the 60 day feeding period, as cows receiving both an implant and ractopamine tended ($P > 0.12$) to have greater ADG than any other main effect combination.

Table 2-2. Least squares means for initial ultrasound measurement.

	Implant		Ractopamine			P - value		
Item	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[a]	IMP × RAC[b]
12th rib back fat, mm	.38	.39	.34	.43	.06	0.90	0.32	0.61
Longissimus muscle area, cm^2	66.71	68.52	66.65	68.65	1.99	0.42	0.39	0.56
Marbling score[c]	522	496	487	532	35	0.40	0.15	0.28
Muscle Depth, mm	50.84	55.00	53.00	53.00	3.27	0.34	0.96	0.14

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.
[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.
[c]Marbling scale: 400 = USDA Slight^{00}, 500 = USDA Small^{00}, etc.

Table 2-3. Effects of ractopamine HCl and steroid implants on the feedlot performance of cull beef cows.

	Implant		Ractopamine HCl			P – value		
Item	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Initial weight, kg	556	550	551	555	16.67	0.64	0.78	0.56
Initial body condition score	5.43	5.51	5.56	5.37	0.163	0.73	0.40	0.88
Dry matter intake, kg/d								
d 0 to 32	13.1	13.4	13.1	13.5	0.55	0.61	0.43	0.25
d 32 to 60	14.6	13.8	14.4	14.0	0.80	0.37	0.68	0.67
d 0 to 60	13.7	13.7	13.8	13.6	0.63	0.96	0.74	0.68
Average daily gains, kg								
d 0 to 32	1.67	2.16	1.80	2.02	0.213	0.09	0.45	0.47
d 32 to 60	1.88	2.25	1.95	2.10	0.360	0.40	0.57	0.17
d 0 to 60	1.77	2.20	1.87	2.10	0.263	0.09	0.35	0.12
Feed efficiency, gain:feed								
d 0 to 32	0.13	0.15	0.15	0.13	0.038	0.46	0.15	0.64
d 32 to 60	0.08	0.11	0.11	0.08	0.019	0.40	0.35	0.86
d 0 to 60	0.13	0.13	0.15	0.17	0.045	0.36	0.36	0.26

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.

[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.

Carcass Characteristics

Carcass weight and carcass characteristics are presented in table 2-4. When compared on a carcass basis, implanted cows tended to have heavier final live weights ($P = 0.09$), hot carcass weight ($P = 0.09$), and dressing percentage ($P = 0.06$) than non-implanted cows. These results are similar to those reported by Cranwell et al. (1996a) as cows implanted with a 200 mg testosterone propionate + 20 mg estradiol (TEB) had significantly greater dressing percentages than cows implanted with trenbolone acetate (TBA) alone or no implant. Implanted cows had lower skeletal maturity values when compared to non-implanted cows ($P = 0.07$; Table 2-5). There were no significant differences in lean maturity or overall maturity between implant treatments. Implant did not affect lean color ($P = 0.96$), lean firmness ($P = 0.91$), lean texture ($P = 0.97$), or subjective fat color ($P = 0.77$). There were no differences in USDA yield grade between implanted and non-implanted cows ($P= 0.91$). These results contradict Cranwell et al. (1996a) whose results indicated that implanted cows had lower numerical yield grades than cows receiving no implant ($P < 0.05$). Implanting appeared to increase longissimus muscle area from 87 to 91 cm^2, but the differences was not significant. Ractopamine treatment showed no differences in final body weight ($P = 0.35$), hot carcass weight ($P = 0.35$), dressing percentage ($P = 0.93$), longissimus muscle area ($P = 0.17$), or USDA yield grade ($P = 0.92$). Cows treated with ractopamine tended to have greater longissimus muscle areas ($P = 0.17$) and 12^{th} rib adjusted fat thickness ($P = 0.10$), and a significant difference was seen between ractopamine-treated cows vs. non-ractopamine treated cows for kidney-pelvic-heart fat percentages ($P = 0.05$). Ractopamine-treated cows had numerically greater ($P = 0.14$) marbling scores when compared to non-ractopamine treated cows.

Table 2-4. Effects of ractopamine HCl and steroid implants on carcass characteristics of cull beef cows.

	Implant		Ractopamine HCl			P–value		
Item	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Final weight, kg	658	684	664	678	15.8	0.09	0.35	0.11
Hot carcass weight, kg[c]	375	390	378	386	9.1	0.09	0.35	0.12
Dressing percentage, %	56.73	58.15	57.47	57.41	0.53	0.06	0.93	0.43
Adjusted 12th rib backfat, cm	1.55	1.63	1.35	1.70	0.13	0.49	0.10	0.02[d]
Longissimus muscle area, cm^2	87	91	87	90	3.1	0.14	0.17	0.64
Kidney-pelvic-heart fat, %	2.00	2.03	1.83	2.11	0.10	0.35	0.05	0.66
USDA yield grade	3.36	3.38	3.36	3.38	0.18	0.91	0.92	0.05[e]
USDA quality grade[f]	391	393	379	403	8.8	0.88	0.04	0.18
Red meat yield, kg[g]	112	122	117	118	4.1	0.06	0.75	0.85

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.

[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.

[c]Calculated on a carcass basis using a common dressing percentage of 56.96%.

[d]Significant interaction between treatments: Implant/No ractopamine HCl (1.80) > No Implant /ractopamine HCl (1.68) > Implant/ractopamine HCl (1.57) > No Implant/No ractopamine HCl (1.27).

[e]Significant interaction between treatments: Implant/No ractopamine HCl (3.48) > No Implant /ractopamine HCl (3.47) > Implant/ractopamine HCl (3.18) > No Implant/No ractopamine HCl (3.06).

[f]100= Cutter, 200 = Canner, 300 = Utility, 400 = Commercial.

[g] Include subprimal weights and lean trim weight (80 percent lean, 20 percent fat).

There was no difference found between ractopamine treatments for skeletal maturity, lean maturity, overall maturity, lean color, lean firmness, lean texture, or fat color. Adjusted fat thickness (P = 0.02) was less for cows fed ractopamine and implanted than cows fed ractopamine only or implant only, but cows that did not receive either ractopamine or implant had the least amount of adjusted backfat. Since 12th rib back fat thickness is a major component of the yield grade calculation it can be expected that the same interaction would be displayed in yield grade, and thus cows that did not receive an implant or were fed ractopamine had the lowest numerical yield grades (Table 2-4) of all combinations. Cows that received either ractopamine or implant had greater numerical yield grades, and cows that received both ractopamine and implant had lower numerical yield grades (3.18, USDA yield grade). A significant difference for the interaction of ractopamine and implant was measured in marbling score (P= 0.03). Cows fed ractopamine had the highest marbling score (Small 80), with intermediate marbling scores for cows receiving both ractopamine and implant (Small 20) but those cows were similar to cows that did not receive either ractopamine or implant (Slight 80 and Slight 90, respectively).

Table 2-5. Effects of ractopamine HCl and steroid implants on subjectively scored carcass quality traits of cull beef cows.

	Implant		Ractopamine HCl			P - value		
Item	N[a]	I[a]	0 mg	300 mg	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Marbling score[c]	531	510	501	540	18	0.41	0.14	0.03[i]
Skeletal maturity[d]	566	517	541	541	20	0.07	0.99	0.90
Lean maturity[d]	337	368	360	345	22	0.33	0.63	0.86
Overall maturity[d]	478	459	472	465	14	0.30	0.68	0.71
Lean color[e]	6.05	6.03	6.07	6.01	0.30	0.96	0.88	0.63
Lean firmness[f]	5.08	5.10	5.16	5.02	0.20	0.91	0.60	0.71
Lean texture[g]	3.43	3.42	3.53	3.31	0.28	0.97	0.55	0.77
Fat color[h]	2.10	2.13	2.03	2.21	0.11	0.77	0.13	0.87

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.
[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.
[c]Marbling scale: 400 = Slight^{00} and 500 = Small^{00}.
[d]100 = A^{00} and 500 = E^{00}.
[e]1 = light red and 8 = black.
[f]1 = extremely soft and 7 = very firm.
[g]1 = very coarse and 7 = very fine.
[h]1 = White and 8 = canary yellow.
[i]Significant interaction between treatments: No Implant /ractopamine HCl (580) >Implant/No ractopamine HCl (520) > Implant/ractopamine HCl (498) > No Implant/No ractopamine HCl (480).

Instrumental Color Measurements

Instrumental color measurements of longissimus muscle area and external fat are shown in tables 2-6 and 2-7, respectively. Implant treatment had no effect on longissimus muscle or external fat color traits (P > 0.51). Significantly greater values were seen in Hunter a* (Redness; greater the value the redder the sample) and b* (Yellowness; greater the value the more yellow the sample) measurements at 56 days on feed. Cranwell et al. (1996b) also reported no difference in Hunter Lab color scores between non-implanted and implanted cows. However, feeding cull cows a high concentrate diet improved lean color (Cranwell et al., 1996b). Data indicated an increase in Hunter L* (L* = greater value; lighter the sample) between 0, 28, and 56 days on feed (P < 0.05). Boleman and collaborators (1996) showed a similar trend in Hunter L* color measures as they increase with cows that were fed a high concentrate diet, but there were no differences between cows fed for past 28 d. The opposite was seen for Hunter a* and b* as there was a lower number seen for these measures compared to the increase seen by Cranwell and others, (1996b). In this study no differences were seen between ractopamine treatments for Hunter Lab color measurements of longissimus muscle (P > 0.26; Table 2-6). A numerical increase (P = 0.26) was seen between ractopamine-treated and non-ractopamine treated cows for Hunter L* values (higher the value = lighter the sample) of the external fat. Similar numerical differences were seen between ractopamine treatments as both Hunter a* (P = 0.06) and b* (P = 0.09) values were lower for external fat color of ractopamine-treated cows. Cows fed ractopamine exhibited lower saturation levels on external fat (P =0.05).

Table 2-6. Effects of ractopamine HCl and steroid implants on Hunter Lab color measures of longissimus muscle of cull beef cows.

	Implant		Ractopamine HCl			P - value		
Color Measure	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Hunter L*	42.00	42.04	41.46	42.59	2.05	0.97	0.26	0.06
Hunter a*	32.81	33.11	32.63	33.30	0.87	0.67	0.35	0.32
Hunter b*	26.31	25.68	26.14	25.85	1.19	0.51	0.76	0.65
Hue angle[c]	3.66	3.59	3.70	3.55	0.45	0.83	0.65	0.58
Saturation index[d]	42.16	41.93	41.91	42.18	1.32	0.80	0.76	0.83

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.

[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.

[c]Hue angle = Tan $(b^*/a^*)^{-1}$. Explains the vividness of the sample.

[d]Saturation index = $(a^{*2}+b^{*2})^{.5}$. Determines the saturation of redness in the sample.

Table 2-7. Effects of ractopamine HCl and steroid implants on Hunter Lab color measures of external fat of beef cull cows.

	Implant		Ractopamine HCl			P - value		
Color Measure	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Hunter L*	75.05	76.10	74.53	76.63	0.85	0.39	0.10	0.57
Hunter a*	17.68	16.98	18.30	16.35	0.98	0.48	0.06	0.29
Hunter b*	24.5	24.5	25.69	23.26	1.26	0.96	0.09	0.37
Hue angle[c]	0.90	0.86	0.90	0.86	0.513	0.48	0.46	0.58
Saturation index[d]	30.27	29.83	31.63	28.46	1.53	0.77	0.05	0.29

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.

[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.

[c]Hue angle = Tan $(b^*/a^*)^{-1}$. Explains the vividness of the sample.

[d]Saturation index = $(a^{*2}+b^{*2})^{.5}$. Determines the saturation of redness in the sample.

Carcass Fabrication Yield

In order to determine if ractopamine feeding and/or implant administration had an effect on carcass subprimal yields, the right side of each carcass was separated into the primal and then into subprimal cuts using North American Meat Purveyors specifications, (NAMP, 1997). Increasing the more valuable cuts of the cull cow could increase the overall value of the carcass. Subprimal results are reported as weight in tables 2-8 and as a percentage of chilled side weight in Table 2-9.

Implanted cows had heavier flank steak weights than non-implanted cows (P = 0.02). They also tended to have heavier knuckle (P = 0.07) and lean trimming weights (P = 0.06). Ractopamine-treated cows had heavier shoulder clod weights than non-ractopamine treated cows (P = 0.005).

Both implant- and ractopamine-treated cows had greater percentages of side weights for the shoulder clod when compared to non-implanted and non-ractopamine treated cows, respectively. Implanted cows had a lower percentage of subprimal weights for the inside round (P = 0.025). A similar trend was seen for ractopamine-treated cows compared to non-ractopamine fed cows (P =0.07). Shoulder clod weights were a greater percentage (P = 0.03) of side weight for implanted cows compared to non-implanted cows (5. 42 vs. 5.09%). Similar values were reported by Matulis and coauthors (1979). Results from their study showed a three percent decrease in round percentage of side as the days on feed increased. Apple and coworkers (1999) also reported primal and sub primal data. They found that chuck and round percentages decreased as body condition increased, as well as a percentage increases in brisket, plate and fore shank, and flank weight.

Table 2-8. Effects of ractopamine HCl and steroid implants on boneless subprimal yields and tissue components (expressed as weight) of cull beef cows.

	Implant		Ractopamine HCl			P - value		
Item[c]	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Shoulder clod, kg	20.46	22.23	20.21	22.48	0.57	0.02	0.004	0.89
Chuck roll, kg	18.33	18.46	18.81	17.98	1.12	0.92	0.51	0.15
Chuck tender, kg	2.54	2.76	2.61	2.68	0.14	0.26	0.72	0.99
Ribeye roll, kg	13.26	13.77	13.51	13.53	0.42	0.38	0.97	0.17
Brisket, kg	10.9	10.7	10.45	11.17	0.36	0.77	0.40	0.67
Strip loin, kg	12.37	12.89	12.54	12.72	0.29	0.18	0.64	0.31
Top sirloin butt, kg	11.58	12.50	11.84	12.23	0.50	0.79	0.40	0.10
Tenderloin, kg	7.09	7.36	7.11	7.34	0.16	0.26	0.32	0.28
Flank steak, kg	2.00	2.32	2.16	2.15	0.09	0.02	0.88	0.91
Inside round, kg	20.65	21.12	21.03	20.73	0.52	0.48	0.65	0.96
Outside round, kg	13.76	14.61	13.84	14.07	0.31	0.35	0.58	0.55
Eye of round, kg	5.83	6.12	5.96	5.98	0.20	0.31	0.93	0.65
Knuckle, kg	10.75	11.39	11.13	11.01	0.23	0.07	0.70	0.90
Ball tip, kg	1.93	2.07	1.90	2.11	0.31	0.61	0.44	0.82
Lean trimmings, kg	116.18	134.96	124.23	126.91	7.66	0.06	0.76	0.82
Fat trimmings, kg	55.23	47.8	49.26	53.77	7.57	0.47	0.66	0.84

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.
[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = Interaction.
[c]Trimmed to 0.25 cm fat thickness.

Table 2-9. Effects of ractopamine HCl and steroid implants on subprimal yields (expressed as a percentage of chilled side weight) of cull beef cows.

	Implant		Ractopamine HCl			P - value		
Item	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Shoulder clod, %	5.09	5.42	5.07	5.44	0.10	0.03	0.02	0.30
Chuck roll, %	4.57	4.54	4.69	4.42	0.21	0.90	0.22	0.30
Chuck tender, %	0.65	0.62	0.63	0.64	0.27	0.42	0.77	0.36
Ribeye roll, %	3.40	3.32	3.37	3.35	0.06	0.37	0.75	0.08
Brisket, %	2.82	2.62	2.63	2.81	0.14	0.22	0.26	0.99
Strip loin, %	3.10	3.09	3.10	3.09	0.04	0.74	0.74	0.46
Top sirloin butt, %	2.95	2.91	2.95	2.91	0.07	0.70	0.70	0.37
Tenderloin, %	1.81	1.80	1.80	1.81	0.04	0.89	0.77	0.54
Flank steak, %	0.51	0.54	0.54	0.51	0.02	0.21	0.12	0.89
Inside round, %	5.23	5.04	5.23	5.05	0.09	0.05	0.07	0.47
Outside round, %	3.50	3.44	3.49	3.45	0.08	0.38	0.57	0.10
Eye of round, %	1.48	1.48	1.48	1.49	0.04	0.99	0.83	0.60
Knuckle, %	2.69	2.65	2.68	2.66	0.06	0.69	0.79	0.81
Ball tip, %	0.50	0.55	0.51	0.53	0.05	0.41	0.67	0.80
Lean trimmings, %	8.35	8.00	8.14	8.22	0.21	0.26	0.80	0.24
Fat trimmings, %	8.29	7.92	7.90	8.31	0.40	0.49	0.44	0.80
Bone, %	5.99	5.92	6.06	5.84	0.26	0.83	0.56	0.55

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.
[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = interaction.

Sarcomere Length

Main effect treatments on sarcomere length are shown in Table 2-10. Implanted and non-implanted cows had similar (P = 0.74) measurements (1.022 vs. 1.025 μm). There were no significant differences between ractopamine treatments. Sarcomere length has been correlated to meat tenderness, with shorter sarcomere lengths being tougher than longer sarcomere lengths (Wheeler and Koohmaraie, 1999). Wheeler and Koohmaraie reported the correlation between raw and cooked sarcomere lengths to be 0.97. Thus raw sarcomere length could possibly be used as an indicator for muscle tenderness.

Table 2-10. Effects of ractopamine HCl and steroid implants on raw longissimus muscle sarcomere length.

	Implant		Ractopamine HCl			P - value		
Item	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Sarcomere length, µm	1.0215	1.0233	1.0223	1.0225	0.00675	0.86	0.99	0.39

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.

[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = interaction.

Economics of Feeding Ractopamine HCl

Economic data is presented in Table 2-13. Estimated cost of feeding ractopamine was \$21.95/animal when fed at a rate of 300 mg·animal^{-1}·d^{-1} for 28 d. Implants cost per animal were estimated to be \$2.75 (average of available online animal health product retailers). Value of gain was determined by using a 10 year average of Cutter/Canner cull cow prices (assuming initially all cows would grade Canner or lower) and final value (all cows would grade Utility or higher, CattleFax™, 2006). Medicine cost, yardage, interest, and insurance were not included in the calculations as they were considered to be equal and therefore irrelevant to this comparison. Main effects of implant or ractopamine were no different in terms of initial value, cost of gain, and final net value ($P \geq 0.05$).

Table 2-11. Economics of feeding ractopamine HCl to cull beef cows.

	Implant		Ractopamine HCl			P - value		
Item	N[a]	I[a]	0 mg[a]	300 mg[a]	SEM	IMP[b]	RAC[b]	IMP × RAC[b]
Initial value, $[c]	612	603	608	608	15	0.68	0.96	0.56
Total feed Cost, $	72.2	71.8	71.7	72.3	2.47	0.90	0.87	0.30
Cost of gain, $/kg	0.29	0.28	0.30	0.28	0.035	0.77	0.59	0.30
Final value, $ ($0.86/kg)[d]	748	744	739	753	15.7	0.87	0.54	0.40
Profit, $[e]	52.6	53.4	58.6	47.4	12.02	0.92	0.24	0.64

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; 0 mg = 0 mg of ractopamine HCl fed for 28 d; 300 mg of ractopamine HCl fed for 28 d.
[b]IMP = Main effects of implant treatment; RAC = Main effects for ractopamine HCl treatments; IMP × RAC = interaction..
[c]Initial value = initial weight × $0.79/kg.
[d]Final value= final weight × $0.86/kg.
[e]Profit = Final value = (final weight × $0.86/kg) - feed cost - treatment cost). Estimated treatment costs: Implant cost = $2.75, Optaflexx cost = $21.93).

Conclusion

Implant and ractopamine treatments had minimal impact on live animal performance. Feeding ractopamine caused a significant improvement in marbling score, however, this increase was not enough to change the overall value of the carcasses. Similar differences were seen in some subprimal yields, but again the improvements were not substantial enough to warrant the use of ractopamine in a cull cow feeding program operating under similar conditions.

Implications

There were no major improvements of feedlot performance or carcass value of cull beef cows fed 300 mg·animal^{-1}·d^{-1} of ractopamine (Optaflexx®) for 28 d alone or in combination with a Revalor-200® implant during a sixty day feeding trial. Past research and trends within this study show that steroid implants can be used in a cull cow feeding program as the benefits outweigh the cost.

Areas for Future Study

In order to further understand the possible interactions of steroid implants and ractopamine, research projects should be conducted with aged females within an experimental design that will allow the initial implant to lose its efficacy. This could be done by increasing the number of days on feed to 90 d or more. Research may also need to be conducted to determine if other doses or durations of feeding of ractopamine could be more effective. Different β-agonists that act through different receptor types also need to be investigated.

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CHAPTER 3 - Effect of Age on Feedlot Performance and Carcass Characteristics of Cull Beef Cows

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Abstract

Data utilizing thirty-one open crossbred cull cows was used to investigate the effect of cow age on live animal performance, carcass composition, and subprimal yield. Cows were separated into two age groups young (≤ 5 years of age, n= 16) and mature (≥ 6 years of age, n = 15). Mature cows were only slightly heavier than young cows initially. Young cows had greater ADG, DDMI, and feed efficiencies ($P \leq 0.05$) during the duration of a 60 d feeding period. Young cows had heavier hot carcass weights ($P < 0.001$), and greater dressing percentages ($P < 0.001$) than older cows. Young cows had larger longissimus muscle area ($P < 0.001$) than mature cows. There were no differences between young and mature cows for adjusted 12th fat rib fat thickness and USDA yield grade. Young cows had greater quality grades ($P = 0.001$) primarily because of lower maturity scores ($P < 0.01$). Young cows also had greater ribeye roll, strip loin, tenderloin, inside round, outside round, eye of round, and knuckle weights when compared to mature cows. While there was no difference in lean trim weights ($P = 0.51$) between mature and young cows, young cows had significantly greater fat trim weights ($P = 0.02$) which may have influenced the difference in dressing percentage. Mature cows had greater initial values due to their weight advantage ($P < 0.01$), but younger cows had lower cost of gains ($P < 0.01$), greater final live market ($P < 0.01$) and net values ($P < 0.01$) when compared to the mature cows. These data indicate young cull cows were more profitable in a 60 d feeding period than older, mature cows.

Introduction

The greatest reason cow/calf producers cull cows is due to their age or the lack of viable teeth (National Animal Health Monitoring System, 1997). Producer's maximizing the profits in their operation must take advantage of the 15-20% of gross income that can be obtained from the marketing of cull cows. On the other hand, some cattle feeders develop cull cow feeding programs to take advantage of seasonal price fluctuation and increases in animal value associated with feeding high concentrate diets. Cull cow feeding has shown to be economical as the compensatory nature of their growth is exploited during the realimentation period. As cull cows increase in age other researchers have shown there is a decrease in average daily gain, feed efficiency, and carcass parameters (Pritchard and Burg, 1992; Sawyer et al., 2004). Troxel and collaborators (2002) reported that as cows increase in age their selling price decreases. With the greatest proportion of cows being culled for age, we would suspect the population of cull cows to be older. Knowing that cow age directly affects animal performance, the value of gain and selling prices can be better managed and estimated.

The purpose of this study was to determine the effects of cull cow age on feedlot performance, carcass characteristics, carcass subprimal yield, and their overall final live and carcass values.

Materials and Methods

Treatments and Cow Management

Crossbred Angus cows (n=31) were individually fed a high concentrate diet for 60 d. Cows were weighed on consecutive weeks to at the beginning, midpoint, and end of the feeding periods. Cows were started on feed at weekly intervals for four consecutives weeks to accommodate harvest facilities. The step-up rations and final diets are listed in Table 3.1. Other management strategies including implant and β-agonist treatments were accounted for in the statistical analysis. Cows were classified by dental inspection and verified by individual animal records. These determinations of age were used to classify cows into two age groups: Young (Cows ≤ 5 yr of age) and Mature (≥ 6 yr of age). Cows were fed and housed individually in 1.5 × 9-m concrete floor pens, each equipped with an automatic watering device and an individual concrete feed bunk. A south facing open shed covered the feed bunks and approximately one-third of each pen. All experimental procedures were approved by the Kansas State University Institutional Animal Care and Use Committee.

Table 3-1. Compositions of experimental diets.[a]

Item	Diet 1[b]	Diet 2[b]	Diet 3[b]	Diet 4[b]
Ingredient				
Grain sorghum wet distillers grains, %	20.00	20.00	20.00	20.00
Alfalfa hay, %	40.00	31.33	22.67	14.00
Steam flaked corn, %	35.89	44.56	53.22	61.89
R/T premix[c], %	2.23	2.23	2.23	2.23
Mineral premix, %	1.88	1.88	1.88	1.88
Calculated composition				
CP, %	16.19	15.67	15.15	14.63
C, %	1.11	1.01	0.90	0.79
P, %	0.42	0.42	0.43	0.43
NEm, Mcal/kg	1.81	1.90	2.01	2.12
NEg, Mcal/kg	1.17	1.26	1.37	1.45

[a]Dry matter basis.

[b]Duration fed: Diet 1, days 1-3; Diet 2, days 4-6; Diet 3, days 7-9; Diet 4-days 10-60.

[c]Formulated to provide 300 mg of monensin and 90 mg tylosin per cow daily.

Live Animal Performance

Weights were recorded on consecutive days for initial, interim (taken every two weeks throughout the trial), and final body weights. Initial body condition score (Scale 1-9, Wagner et al., 1988) was assessed on day 0 as the average of scores estimated by two trained individuals. Average daily gain and gain:feed were calculated on a carcass basis with final BW estimated as HCW divided by a common dressing percent (56.96%). Cows were removed from feed 12 hours before slaughter, but had full access to water. The first slaughter group was harvested on February 3, 2006, and each subsequent group at weekly intervals thereafter. Cows were humanely slaughtered at the Kansas State University, Department of Animal Sciences and Industry abattoir.

Carcass Traits

Carcass data, except hot carcass weight, was collected 48 hours post mortem. Carcass data collected included hot carcass weight; longissimus muscle area; adjusted fat thickness; and percent kidney, pelvic, and heart fat. Marbling score (Scale of 100 to 999: 400 = Slight^{00} degree of marbling; 500 = Small^{00} degree of marbling, BIF, 2002), skeletal, lean, and overall maturity (Scale of 100 to 599: 200 = B^{00} maturity; 300 = C^{00} maturity; 400 = D^{00} maturity; 500 = E^{00} maturity.), subjective fat color (scale1 to 8; 1 = White, 9 = canary yellow), and instrumental lean and fat color scores were also recorded after a 30-min bloom period.

Carcass Fabrication

The right side of each carcass was processed at 72 hours postmortem into primal, subprimal, select individual muscles, lean trim, fat trim, and bone. Primal and boneless subprimal cuts were fabricated according to specifications (NAMP, 1997). Forequarter (NAMP# 102) and hindquarter (NAMP# 155) weights were recorded and each fabricated into the following; the forequarter was fabricated into the Chuck (NAMP# 113), Brisket, Rib (NAMP# 123), Foreshank (NAMP# 117), and Plate (NAMP# 121). Brisket plate and shank are express as a combined value (BPS). From the chuck, the shoulder clod (NAMP# 114C), chuck tender (NAMP# 116B), chuck roll (NAMP# 116D), and muscle weights of the *Triceps Brachii* and *Infraspinatus* were recorded. The rib section was fabricated into the Ribeye (NAMP# 112A). The hindquarter was fabricated to the Beef round (NAMP# 158), loin (NAMP# 172), tenderloin (NAMP# 189A), and flank from which the flank steak (NAMP# 193) was removed. The beef round was further fabricated to the eye of round (NAMP #171C), inside round (NAMP# 169), outside round (NAMP# 171), and knuckle (NAMP# 167A). The loin was separated into the Beef loin (NAMP# 180, PSO 3-2.5 cm rib end and 2.5 cm sirloin end), top sirloin butt (NAMP# 184B), and ball tip (NAMP# 185B). All lean trim, fat trim, and bone from forequarter and hindquarter were kept separate until a weight was recorded. Lean trim from the fore- and hindquarter were ground and homogenized for later analysis. Fat trim was handled in the same manner. Following grinding and mixing to form a homogenous sample, a random 250-g sub-sample was sent to the analytical lab at Kansas State University for determination of percentages of moisture, lipid (ether extract), ash, crude protein (AOAC, 1980). The values received from this sample were used to adjust lean trim measures to an 80% lean:20% fat value.

Statistical Analysis

Data were analyzed with the Proc MIXED procedure of SAS, Release 8.02 (SAS Inst., Inc., Cary, NC). Age group was used as a fixed effect. Slaughter group was included as a random effect. Initial weight, ultrasound backfat, ultrasound marbling, and ultrasound longissimus muscle area were all tested as covariates for various parameters and kept in the model if the P-value was less than 0.05.

Results and Discussion

Live Animal Performance

Live animal performance results between young and mature cows are presented in Table 3-2. Mature cows were 14 kg heavier than young cows at the beginning of the trial. Young cows had greater (1.8 kg/d) DMI than mature cows throughout the 60-d trial ($P < 0.04$). Young cows also had significantly greater ADG and gain to feed ratios (.83 kg/d and 23% improvement, respectively). These results support the trends in performance reported by Sawyer et al. (2004) as well as Pritchard and Burg (1992) that older aged cull cows may have reduced feedlot performance when compared to their younger counterparts.

Carcass Characteristics

Young cows had heavier carcass weights ($P < 0.001$), greater dressing percentages ($P < 0.001$), and larger longissimus muscle areas ($P < 0.001$). Young cow carcasses weighed 46 kg more than the mature cows and had a hot yield that was nearly .9% greater. Younger cows had higher USDA quality grades ($P = 0.001$), but this can be attributed to the young age group's lower maturity scores as no significant difference between age groups for marbling score was measured (Table 3-3). Adjusted fat thickness measured at the 12th rib was not different between the two age groups, making these data agree with both Sawyer et al. (2004) and Pritchard and Burg (1992). These data also show that younger cull cows of similar genetics and mature size as older contemporaries have the potential to be more valuable because they produce more lean product and are eligible for higher quality grades due to there maturity scores.

Table 3-2. Least squares means for the effects of age on live animal performance of cull beef cows.

	Age Groups			
Item	Young[a]	Mature[a]	SEM	P -Value
Initial weight, kg	514	528	38	0.45
Initial body condition score[b]	5.1	5.5	0.21	0.16
Dry matter intake, kg/d				
d 0 to 32	13.8	12.3	0.62	0.03
d 32 to 60	15.2	12.5	0.86	0.02
d 0 to 60	14.2	12.4	0.68	0.04
Average daily gains, kg				
d 0 to 32	2.18	1.81	0.37	0.38
d 32 to 60	2.64	1.35	0.24	0.001
d 0 to 60	2.40	1.56	0.18	0.001
Feed efficiency, gain:feed				
d 0 to 32	0.13	0.14	0.008	0.81
d 32 to 60	0.17	0.11	0.015	0.001
d 0 to 60	0.16	0.13	0.020	0.007

[a]Age groups: Young ≤ 5 years of age, Mature ≥ 6 years of age.

[b]Body condition score 1= emaciated, 9 = obese.

Table 3-3. Least squares means for the effects of age on carcass characteristics of cull beef cows.

	Age Groups[a]			
Item	Young[a]	Mature[a]	SEM	P -Value
Final weight, kg	691	629	11.3	0.29
Hot carcass weight, kg[b]	397	351	9.52	0.001
Dressing percentage, %	57.16	56.23	.008	0.001
Adjusted 12th rib backfat, cm	1.65	1.42	0.153	0.17
Longissimus muscle area, cm^2	91.7	83.8	3.55	0.001
USDA Yield Grade	3.28	3.34	0.22	0.80
Quality Grade [c]	413	367	10.6	0.001
Red Meat Yield, kg	116	107.5	4.4	0.14
Marbling score[d]	507	519	26	0.70
Skeletal maturity[e]	489	590	33.9	0.001
Lean maturity[e]	318	384	20.3	0.03
Overall maturity[e]	422	513	10.8	0.001
Lean color[f]	5.70	6.34	0.28	0.08
Lean firmness[g]	4.77	5.41	0.21	0.01
Lean texture[h]	3.33	3.53	0.25	0.58
Fat color[k]	2.10	2.70	0.19	0.34

[a]Age groups: Young ≤ 5 years of age; Mature ≥ 6 years of age.

[b]Carcass basis HCW/56.9 (average dressing percentage).

[c]300= Utility; 400 = Commercial.

[d]400 = Slight^{00} and 500 = Small^{00}, BIF.

[e] 100 = A^{00} and 500= E^{00}.

[f]1 = light red and 8 = black.

[g]1 = extremely soft and 7 = very firm.

[h]1 = very coarse and 7 = very fine.

[k]1 = white and 8 = canary yellow.

Subprimal Yields

Least square means for subprimal measures were reported as weights (Table 3-4) and as a percentage of chilled side weight (Table 3-5). Mature cows had heavier chuck roll weights than young cows when reported as a percentage of chilled side weight ($P = 0.04$). Young cows had heavier ribeye rolls ($P = 0.0003$), strip loins ($P = 0.0003$), tenderloins ($P < 0.01$), inside rounds ($P = 0.0004$), outside rounds ($P < 0.001$), eye of rounds ($P = 0.003$), and adjusted fat trim weights ($P = 0.02$) when compared to mature cows. No prior research was found comparing differences in subprimal yields between young and mature cull cows. The differences seen in this study of subprimal weights show a more detailed breakout of the overall differences in live animal weight performance. Younger cattle not only gained more weight, but the weight gains were in carcass cuts that are more valuable, thus creating an increase in value above live animal performance.

Table 3-4. Least squares means of subprimal weights (expressed as a percent of side weight) between age groups of cull cows fed a high concentrate diet for 60 d.

	Age Groups[a]			
Item	Young[a]	Mature[a]	SEM	P - Value
Shoulder clod, %	5.19	5.30	0.12	0.53
Chuck roll, %	4.3	4.76	0.20	0.04
Chuck tender, %	0.63	0.64	0.025	0.82
Ribeye roll, %	3.38	3.34	0.06	0.62
Brisket, %	2.67	2.76	0.16	0.55
Strip loin, %	3.11	3.09	0.04	0.68
Top sirloin butt, %	2.87	2.98	0.07	0.23
Tenderloin, %	1.83	1.78	0.037	0.20
Flank steak, %	0.53	0.53	0.02	0.98
Inside round, %	5.14	5.16	0.10	0.90
Outside round, %	3.53	3.42	0.09	0.17
Eye of round, %	1.49	1.46	0.05	0.44
Knuckle, %	2.75	2.59	0.05	0.30
Ball tip, %	0.49	0.55	0.045	0.23
Adj. Lean trimmings, %	29.35	29.92	2.06	0.81
Fat trimmings, %	15.20	9.14	1.91	0.01

[a]Age groups: Young ≤ 5 years of age, Mature ≥ 6 years of age.

Table 3-5. Least squares means of subprimal weights between age groups of cull cows fed a high concentrate diet for 60 d.

	Age Groups[a]			
Item	Young[a]	Mature[a]	SEM	P - Value
Shoulder clod, kg	2.35	2.39	0.07	0.67
Chuck roll, kg	8.44	8.28	0.536	0.80
Chuck tender, kg	1.22	1.80	0.073	0.51
Ribeye roll, kg	6.58	5.67	0.232	0.003
Brisket, kg	5.27	4.51	0.378	0.07
Strip loin, kg	6.03	5.40	0.159	0.003
Top sirloin butt, kg	5.62	5.22	0.267	0.14
Tenderloin, kg	3.55	2.98	0.089	0.001
Flank steak, kg	0.99	0.95	0.053	0.48
Inside round, kg	9.93	8.98	0.263	0.004
Outside round, kg	6.84	5.80	0.156	0.001
Eye of round, kg	2.93	2.47	0.104	0.003
Knuckle, kg	5.31	4.72	0.128	0.002
Ball tip, kg	0.95	0.84	0.153	0.41
Adj. Lean trimmings, kg	57.87	54.79	3.659	0.51
Fat trimmings, kg	29.57	17.18	3.690	0.02

[a]Age groups: Young ≤ 5 years of age, Mature ≥ 6 years of age.

Economics between Age Groups

Without an actual assessment of initial value, all cows were assumed to grade in the Cutter/Canner grade and an initial value was determined utilizing the ten-year average for this grade. Final value was determined with the ten-year average price for Utility cull cows obtained from CattleFax (2006), since all cows graded Utility or higher. Economic results are reported in Table 3-8. Mature cows were more valuable at the beginning of the feeding period as they had heavier initial weights ($P = 0.45$). Younger cows had greater feed cost (because they ate more), final values, and net values than mature cows ($P < 0.01$).

Table 3-8. Least squares means for overall initial and final value between age groups of cull beef cows.

	Age Groups[a]			
Item	Young[a]	Mature[a]	SEM	P-value
Initial market value, $/head	588	624	18.0	0.01
Feed Cost, $/head	74	64	2.5	0.01
Cost of gain, $/kg	0.23	0.37	0.037	0.01
Final market value, $/head	762	694	12.7	0.01
Profit, $/head[b]	87	30	11.6	0.01

[a]Age groups: Young ≤ 5 years of age; Mature ≥ 6 years of age.

[b]Profit = (final weight × $.86/kg) – estimated feed cost.

Conclusion

Younger cows (≤ 5 years of age) had the ability to gain more body weight, produce heavier carcasses and greater dressing percentages, while maintaining a comparable external fat thickness when compared to older cows (≥ 6 years of age). Young cows also exhibited significant advantages in the more valuable subprimal weights of ribeye roll and strip loin, as well as most other subprimals from the hindquarter. Their performance advantages in combination with their potential for an increase in quality grade led to greater carcass values and more marketing opportunities for their carcass components.

Implications

Feeding cull cows for at least 60 d increases their value due live weight gain, especially as lean tissue and body condition (fat) accretion occurs during compensatory gain. The results of this study confirmed that young cows (≤ 5 years of age) gained more live carcass weight, and weight in the more valuable cuts such as the ribeye roll, strip loin, and tenderloin than mature cows (≥ 6 years of age) and thus have more carcass value than older cows when fed for the same duration of time.

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CHAPTER 4 - Comparison of Corn and Gain Sorghum Dried Distillers Gains as Protein Supplements for Growing Heifers[1,2]

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Abstract

An experiment was conducted to determine if corn and grain sorghum dried distillers grains could be effective protein supplements for growing beef replacement heifers. Crossbred heifers (n = 78) were individually fed 2.72 kg/head/day (dry matter basis) of a particular supplement. The three supplements compared were: 1) 50% cracked corn, 25% soybean meal, and 25% ground grain sorghum; 2) 50% cracked corn and 50% corn distiller's grains with solubles, and 3) 50% cracked corn, 31% sorghum distiller's grains with solubles, and 19% ground grain sorghum (all formulated to contain 20% CP). Heifers grazed a common native-grass pasture as well as having ad libitum access to smooth broom hay fed in round bale feeders. During the last week of the trial, heifers from each supplement type (n = 4) were used to determine diet digestibility. Feed, fecal, and feed refusal samples were collected from each heifer. Samples were dried at 55°C, composited, and ground in a Wiley mill (Thomas Scientific, Swedesboro, NJ) to pass a 2-mm screen. Acid detergent insoluble ash (ADIA) concentrations of samples were determined by Ankom 200 Fiber Analyzer (Ankom Co., Fairport, NY) and subsequent ashing in a muffle oven at 450°C overnight. Digestibility was determined by calculations using total diet intake, the amount of ADIA consumed, and the concentration of ADIA in the feces. Fecal grab samples were collected every 8 hours, with the sampling time advanced by 2 hours each day, so that a fecal sample was obtained every 2 hours in a 24-hour period during the last 4 days of the data collection period.

Although there were no differences in weight gain or total diet digestibility, dry matter intake as a percentage of body weight was less for heifers receiving supplements containing dried distillers grains from either corn or grain sorghum. Our data indicate that producers can expect similar growth performance regardless of the grain source of dried distillers grains used to formulate a 20% crude protein supplement fed at about 1% of body weight daily.

Key Word: Growing Cattle, Dried Distillers Grains

Introduction

With the expansion of ethanol production in Kansas, the availability of ethanol co-products will continue to increase. There are many uses for these co-products as animal feed due to their high protein and energy content, but the physical characteristics and nutrient profiles suggest potential for use in diets for growing cattle. A majority of the research involving distiller's grains has focused on their use as protein/energy supplements in confinement feeding or as forage replacements. University of Nebraska researchers recently demonstrated that corn dried distillers grains can be a suitable supplement for high protein forages because it contains little starch but much fermentable fiber (MacDonald, 2004 and Stalker et al., 2005). It is possible, based on differences in chemical composition, that dried distillers grains from corn or grain sorghum could lead to differences in diet digestibility due to the differences in degradable and undegradable protein. Therefore, the objective of this study was to determine if dried distillers grains originating from either corn or grain sorghum could be used interchangeably in a 20% crude protein supplement used in a management system for growing cattle grazing on medium- to low-quality forage.

Experimental Procedures

Seventy-eight crossbred heifers (average starting weight=289 kg) were individually fed supplements for 71 days. Treatments (Table 3-1) consisted of feeding about 2.72 lb/heifer daily (dry matter basis) of 20% crude protein supplements made from: 1) 50% cracked corn, 25% soybean meal, and 25% ground grain sorghum; 2) 50% cracked corn and 50% corn distillers grains with solubles; or 3) 50% cracked corn, 31% sorghum distillers grains with solubles, and 19% ground grain sorghum. When not being fed supplements, heifers grazed a common Flint Hills, native-grass pasture near Manhattan, Kansas, with unlimited access to brome hay (in round-bale feeders), fresh water, and a commercial pasture-type mineral supplement. The experiment was designed as a completely randomized design. Because the supplements were fed daily to individual animals, each animal was considered an experimental unit. The trial began on February 15, 2005. Heifers were weighed on February 15, March 10, April 5, and April 27. All heifers were weighed after being held off feed and water overnight. During the final 2 weeks of the trial, all heifers were placed in dry lot, with free access to brome hay fed in round bale feeders. A digestibility trial was conducted during the last week of the animal performance trial. Four heifers were randomly selected from each treatment and individually fed supplement and brome hay for 7 days. Feed, fecal, and feed refusal samples from each heifer for each collection were dried at 55°C, composited, and ground in a Wiley mill (Thomas Scientific, Swedesboro, NJ) to pass a 2-mm screen. Acid detergent insoluble ash (ADIA) concentrations of samples were determined by Ankom 200 Fiber Analyzer (Ankom Co., Fairport, NY) and subsequent ashing in a muffle oven at 450°C overnight. Digestibility was determined by calculations using total diet intake, the amount of ADIA consumed, and the concentration of ADIA in the feces. Fecal grab samples were collected every 8 hours, with the sampling time advanced by 2 hours each day, so that a fecal sample was obtained every 2 hours in a 24-hour period during the last 4 days of the data collection period.

Table 4-1. Ingredient and nutrient composition of supplements and brome hay fed to heifers grazing native grass pastures.

Item	Supplement			Brome hay
	Soybean meal	Corn DDGS[a]	Sorghum DDGS[a]	
Ingredient composition (%)				
Soybean meal	25.0			
Corn dried distillers grains with solubles		50.0		
Sorghum dried distillers grains with solubles			31.3	
Ground grain sorghum	25.0		18.7	
Cracked corn	50.0	50.0	50.0	
Amount fed, kg/head/day	2.81	2.72	2.72	Ad libitum
Nutrient composition				
Moisture, %	6.3	9.2	9.7	7.7
Crude protein, %[b]	20.5	19.9	20.2	10.8
ADF, %[b]	4.8	12.5	13.4	40.5
NDF, %[b]	8.4	23.7	16.0	66.4
Estimated NEm, Mcal/lb[b]	0.91	0.88	0.86	0.56
Estimated NEg, Mcal/lb[b]	0.58	0.55	0.54	0.23
Estimated TDN, %[b]	79.1	76.5	75.5	52.6
Ether extract (fat), %[b]	3.7	7.3	5.3	2.8

[a]DDGS = Dried distillers grains with solubles.
[b]Dry Matter Basis.

Results and Discussion

One heifer was removed from the trial (Treatment 1 with SBM) due to refusal to readily consume her supplement, which was possibly due to her aversion to the confines of the feeding facilities. For the remaining heifers, once they became accustomed to the facilities and feeding routines, no feed refusals were noted for any of the supplements. Therefore, we believe that the palatability of the supplements had no effect on our results. Previous research has indicated that, due to its high fat content, the maximum inclusion amount for corn dried distillers grains with solubles is between 1.36 and 1.59 kg/day for growing cattle weighing 225 to 320 kg (Tjardes and Wright, 2002). Producers typically feed growing cattle about 1% of body weight daily of a supplement (grain mix) containing 20% crude protein. In consideration of these two criteria, supplements were formulated to contain about 20% crude protein via the addition of cracked corn and ground grain sorghum and were fed at 2.72 lb/heifer daily (dry matter basis). Supplements differed in fat content (Table 3-1). Body weights and gains are presented in Table 3-2. No differences in heifer weights and average daily gains were noted among treatments ($P = 0.13$). Heifers receiving the corn dried distillers grains supplement exhibited a slight numerical advantage in gain early in the trial; this is interesting because the digestibility of the corn dried distillers was numerically less (Table 3-3). This difference can possibly be explained by the greater fat content of the corn distiller's grains. Diet digestibility data are presented in Table 3-3. Total diet intake was similar among all treatments ($P = 0.42$), but dry matter intake as a percentage of body weight was significantly greater for heifers receiving the soybean meal treatment ($P = 0.02$). The difference in intake may possibly be due to the greater degradable intake protein content of the soybean meal, but the entire diet was formulated to be sufficient in degradable intake protein as analyzed by the National Research Council beef cattle model (NRC, 1996). The starch concentrations in the supplements were similar because cracked corn, the main source of starch, was present in equal amounts in all supplements. The total diet digestibilities were also similar among treatments (P=0.51).

Implications

The results of this study showed that co-products of ethanol production, of either corn or grain sorghum origin, can be used as a component of a protein supplement in a management system for growing cattle grazing on medium- to low-quality forage.

Table 4-2. Performance of heifers fed supplements while grazing native grass pastures and having access to brome hay.

	Supplement			
	Soybean meal	Corn DDGS[a]	Sorghum DDGS[a]	SEM
No. heifers	25	26	26	
In wt - Feb. 15, kg	288	289	289	4.4
Wt gains, kg				
Feb. 15 to March 10	17.7	19.1	16.3	1.12
March 10 to April 5	16.3	20.0	19.0	2.09
April 5 to April 27	5.0	4.1	3.6	2.32
End wt - April 27, kg	327	332	327	1.86
Daily gain, kg				
Feb. 15 to April 27	0.55	0.61	0.55	0.072

[a]DDGS =Dried distillers grains with solubles.

Table 4-3. Total tract digestibilities.

	Supplement			
	Soybean meal	Corn DDGS[a]	Sorghum DDGS[a]	SEM
No. heifers	4	4	4	
Average wt, kg	328	330	346	10
Daily DMI, kg	9.4	8.9	9.4	0.13
Daily DMI, % BW	2.86[b]	2.70[c]	2.72[c]	0.04
DM digestibility, %	61.2	57.2	62.5	3.2

[a]DDGS =Dried distillers grains with solubles.

[b,c]Means with different superscript differ significantly (P=0.02).

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CHAPTER 5 - Influence of early weaning on the requirement for winter protein supplementation of spring-calving beef cows grazing native tallgrass prairie.

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Abstract

Ninety-six pregnant, mature, spring-calving cows grazing low-quality tallgrass prairie were used in a study to determine if early weaning of calves reduces the supplementation cost during the subsequent winter. Calves were removed from the early-weaned cows on June 23, 2003 and removed from fall-weaned cows on October 15, 2003. Cows were randomly assigned to winter feeding groups and fed one of two supplement amounts, each containing a common soybean meal-milo supplement (45% crude protein; dry matter basis). The two supplementation amounts were fed three times weekly and were prorated to 1.4 $kg \cdot hd^{-1} \cdot d^{-1}$ and 1.27 $kg \cdot hd^{-1} \cdot d^{-1}$. The four treatment groups were: 1) early weaned 100% of formulated supplement (EW100), 2) early weaned 70% of formulated supplement (EW70), 3) fall weaned 100% of formulated supplement (FW100), and 4) fall weaned 70% of formulated supplement (FW70). Cows were supplemented from November 14, 2003 to calving (early March 2004). Cows with calves weaned early were heavier and had greater initial body condition scores than cows that were weaned in the fall. From Nov. 14 to Jan. 7, FW100 cows gained more body weight than either group of early weaned cows, but there were no significant differences in body condition score changes during the same period. There was no difference in final body weight between FW100 and EW70, but EW70 cows had greater final body condition score. In conclusion, body weight and body condition scores of EW70 cows at the end of the supplementation period were similar to those of FW100 cows, indicating that cow calf producers can feed 30% less winter supplement to spring calving cows that are early weaned than those weaned in the fall and still maintain cow body weight and body condition.

Introduction

Results of investigations over the last two decades have suggested that early weaning of spring-born calves may result in production advantages. Although several investigators have evaluated many facets of early weaning, the long-term effects on cow performance are worthy of further investigation. Significant summer body condition score gains are possible by the dams of early weaned calves, and this represents an opportunity for cow calf producers to establish favorable body condition scores before the cows enter the rigors of the winter grazing period. Previous investigations have noted the relationship between body condition and reproductive performance. Likewise, the summer and fall increases in body weight and body condition scores may have the potential to moderate the herd's dependence on winter protein supplementation while grazing the typically low-quality forage of tallgrass prairie. In doing so, significant reductions in winter feed costs may be realized. This study was to evaluate the effects of early weaning calves on the supplemental protein requirement of their dams during the subsequent winter.

Experimental Procedures

Ninety-six mature, pregnant, spring-calving, crossbred beef cows previously utilized in a collaborative study evaluating the effect of calf age at weaning on calf performance were blocked by winter grazing group (i.e. pasture; each pasture= 300 acres), stratified by body weight and body condition, and randomly assigned to one of three grazing groups (within each previous treatment, i.e., early weaning (6-23-03) or fall weaning (10-15-03)). Two winter supplementation levels were randomly assigned to the feeding groups. The four treatments utilizing a common soybean-milo supplement were as follows: 1) Early weaning, 100% supplement (1.81 kg/day of the supplement); 2) Early weaning, 70% supplement (1.26 kg/day of the supplement); 3) Fall weaning, 100% supplement (1.8 kg/d of the supplement); and 4) Fall weaning, 70% supplement (1.26 kg/d of the supplement). Supplementation commenced on Nov. 14, 2003 and continued until calving at which time all cows were handled similarly. All cows were bunk fed 3 days per week (Monday, Wednesday, and Friday), with the amount of supplement prorated to deliver the designated daily quantity. Cow body weights and body condition scores were recorded on Nov. 14, Jan.7, Feb. 13, and within 48 hours of calving. A commercial mineral supplement was provided throughout the experiment.

Results and Discussion

As expected, cows with calves weaned early were heavier ($P < 0.01$; Table 4-1) and had greater initial body condition scores ($P < 0.01$) at the beginning of the experiment (Table 4-2) than cows that were weaned in the fall. From Nov. 14 to Jan. 7, FW100 cows gained more body weight ($P = 0.05$) than either group of early weaned cows, but there were no significant differences in body condition score changes between these groups during the same period. Fall-weaned 100 cows gained body condition score from Jan. 7 through Feb. 13 when compared to EW70 ($P = 0.05$), but showed no difference in body weight ($P = 0.36$). As stated earlier, early weaned cows were heavier and had greater body condition scores initially but they also had more body condition to lose as they lost more during the last third of the trial than the fall weaned cows. Overall, EW70 of the supplement lost more body weight ($P = 0.02$) and body condition ($P = 0.01$) than the fall weaned cows, but when the final weight and body condition scores are considered, this loss is outweighed by the reduced supplement cost. There was no difference in final body weight (P = 0.74) between FW100 and EW70, but the EW70 cows did exhibit a greater final BCS (P = 0.04).

Conclusion

The body weight and body condition scores of early weaned cows receiving 30% less supplement at the end of the supplementation period were consistent with fall weaned receiving a 100% of the formulated supplement, indicating that cow calf producers can feed less winter supplement to early weaned spring calving cows and maintain an acceptable body weight and body condition score.

Areas for Future Study

A study should be conducted to see if 30% less supplement is the lowest a producer may use to maintain an early weaned cow's body condition. Also, investigating the ideal age for early weaning of calves is one area that needs to evaluated, especially for producers who are looking to incorporate this into their normal production practices.

Table 5-1. Influence of early weaning and supplementation amount on beef cow body weight.

	Treatment[a]					Statistical Comparisons (P-values)		
Item	Early Wean 100%	Early Wean 70%	Fall Wean 100%	Fall Wean 70%	SEM[b]	Early Wean vs. Fall Wean	Fall Wean 100% vs. Early Wean	Fall Wean 100% vs. Early Wean 70%
No. of cows	23	24	24	26				
Initial weight, kg	616	581	561	555	9.9	<0.01	0.02	0.19
Period weight changes, kg								
Nov.14-Jan. 7	14	8	17	10	1.95	0.25	0.05	0.02
Jan. 7-Feb. 13	14	16	21	20	3.22	0.23	0.26	0.36
Feb. 13-Calving[c]	-72	-78	-70	-77	3.94	0.72	0.35	0.20
Cumulative weight change, kg								
Nov. 18-Calving[c]	-45	-53	-33	-46	4.89	0.07	0.02	0.02
Final weight, kg	570	523	528	505	9.16	0.01	0.13	0.74

[a]Treatment: Early Wean = June 23; Fall Wean = Oct. 15; 100% = 4 $kg \cdot hd^{-1} \cdot d^{-1}$ of soybean meal-milo supplement (45% crude protein; dry matter basis); 70% = 2.8 $kg \cdot hd^{-1} \cdot d^{-1}$ of soybean meal-milo supplement (45% crude protein; dry matter basis).

[b]SEM = standard error of the mean.

[c]Average calving date = mid March.

Table 5-2. Influence of early weaning and supplementation amount on beef cow body condition scores.[a]

	Treatment[b]					Statistical Comparisons (P-values)		
Item	Early Wean 100%	Early Wean 70%	Fall Wean 100%	Fall Wean 70%	SEM[c]	Early Wean vs. Fall Wean	Fall Wean 100% vs. Early Wean	Fall Wean 100% vs. Early Wean 70%
No. of cows	23	24	24	26				
Initial BCS	5.8	6.0	5.1	5.1	0.15	<0.01	<0.01	<0.01
BCS changes								
Nov. 14-Jan. 7	-0.12	-0.19	-0.09	-0.16	0.05	0.55	0.32	0.20
Jan. 7-Feb. 13	-0.04	-0.12	0.02	-0.09	0.05	0.30	0.10	0.05
Feb. 13-Calving[d]	-0.44	-0.30	-0.11	-0.07	0.07	<0.01	0.03	0.13
Cumulative BCS change								
Nov 18-Calving[d]	-0.61	-0.62	-0.19	-0.31	0.08	<0.01	<0.01	0.01
Final BCS	5.25	5.35	4.91	4.73	0.12	<0.01	0.04	0.04

[a]Body condition score: 1 = emaciated; 9 = obese.

[b]Treatment: Early Wean = June 23; Fall Wean = Oct. 15; 100% = 1.81 $kg \cdot hd^{-1} \cdot d^{-1}$ of soybean meal-milo supplement (45% crude protein; dry matter basis); 70% = 1.27 $kg \cdot hd^{-1} \cdot d^{-1}$ of soybean meal-milo supplement (45% crude protein; dry matter basis).

[c]SEM = standard error of the mean.

[d]Average calving date = mid-March.

CHAPTER 6 - Appendix

Table 6-1. Effects of ractopamine HCl and steroid implants on primal yields (expressed as a percentage of chilled side weight) of cull beef cows.

	Implant		Ractopamine HCl			P - value		
Item	N	I	0 mg	300 mg	SEM	I	O	I x O
Forequarter, %	52.56	53.13	52.87	52.82	0.31	0.10	0.82	0.78
Chuck, %	26.32	27.04	26.68	26.68	0.67	0.43	0.99	0.16
Rib, %	9.19	9.15	9.12	9.22	0.21	0.80	0.53	0.60
Brisket, plate, and foreshank, %	17.51	17.08	17.04	17.51	0.39	0.19	0.20	0.08
Hindquarter, %	47.44	46.87	47.13	47.18	0.31	0.10	0.81	0.77
Round, %	23.22	22.26	23.09	22.50	0.30	0.02	0.09	0.17
Loin, %	15.26	15.22	14.99	15.49	0.19	0.84	0.04	0.03
Flank, %	5.71	6.25	5.71	6.24	0.30	0.19	0.20	0.66
Tenderloin, %[b]	1.81	1.80	1.80	1.81	0.04	0.90	0.77	0.54

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; O = ractopamine HCl; I x O = Interaction between Implant and ractopamine HCl.

[b]Tenderloin weight recorded separately to keep intake.

Fatty Acid Composition

Two hundred and fifty mg samples of *longissimus dorsi* muscle were sent to Kansas State University analytical laboratory for fatty acid composition determined by gas chromatography (Sukhija and Palmquist, 1988). Approximately 250 mg, pulverized samples was mixed with 2 ml of internal standard solution (2 mg methyl tridecanoic acid/ ml benzene) and 3 ml of methanolic-HCL (20 ml acetyl chloride in 100 ml of methanol) in test tubes. Tubes were gassed with nitrogen and capped tightly. Samples were then heated for 2 h in a water bath (ISO Temp 228; Fisher Scientific, Fairlawn, NJ) set at 70°C, were allowed to cool at room temperature, and 5 ml of 6% potassium carbonate and 2 ml benzene were added to each tube. Tubes were centrifuged (J-6B; Beckman Instruments, Inc., Palo Alto, CA) at 500 x *g* for 5 min. The upper layer of organic solvent was removed and placed in a crimp-top gas chromatography vial.

Separation of fatty-acid methyl esters was performed with a gas chromatograph (GC-17A; Shimadzu, Columbia, MD) equipped with a flame ionization detector and a Supelco column (SP2560 Fused Silica Capillary Column, 100 m x 0.25 mm x 0.2 µm film thickness; Supelco, Bellefonte, PA) by using high-purity helium as the carrier gas, with a hydrocarbon trap and carrier gas purifier at a 60 ml/min flow rate and 20 cm/s velocity, and a split ratio of 48:1, with a sample injection volume of 1.0 µl. Initial temperature was 140°C for 5 min, followed by an increase of 4°C/min to a final temperature of 240°C for 15 min. Injector and detector temperatures were both set at 260°C.

Table 6-2. Effects of ractopamine HCl and steroid implants on fatty acid percentage (expressed as a percent of total fatty acid content) for longissimus muscle of cull beef cows.

	Implant		Ractopamine HCl			P - value		
Item	N[a]	I[a]	0 mg	300 mg	SEM	I[a]	O[a]	I x O[a]
Total FA, %	6.24	5.64	5.47	6.41	0.71	0.58	0.35	0.38
Fatty acid, % of total FA content								
C12:0	0.11	0.11	0.11	0.11	0.004	0.73	0.58	0.98
C14:0	2.8	2.9	2.8	2.9	0.08	0.37	0.35	0.30
C16:0	26.3	26.7	26.2	26.8	0.32	0.40	0.16	0.43
C16:1n7	3.96	3.92	3.76	4.13	0.147	0.81	0.02	0.69
C18:0	13.71	14.24	14.28	13.67	0.32	0.25	0.19	0.45
C18:1c7	2.87	2.82	2.84	2.81	0.175	0.82	0.73	0.54
C18:1t9	2.72	3.12	2.96	2.83	0.18	0.13	0.75	0.15
C18:1c9	36.56	35.77	36.18	36.15	0.55	0.25	0.96	0.04
C18:2c9t11	0.33	0.41	0.40	0.39	0.02	0.32	0.71	0.56
C18:2t10c12	0.058	0.059	0.060	0.056	0.008	0.96	0.67	0.28
C18:2t9t11	0.04	0.02	0.02	0.04	0.008	0.13	0.06	0.95
C18:3c9c12c15	0.49	0.56	0.52	0.52	0.02	0.03	0.93	0.78
C20:5c5c8c11c14c17	0.048	0.045	0.047	0.046	0.0023	0.41	0.76	0.76
Saturated FA	46.03	46.72	46.83	46.36	0.52	0.36	0.98	0.15
Unsaturated FA	53.92	53.23	53.56	53.59	0.52	0.36	0.97	0.15
Monounsaturated FA	48.15	47.41	47.70	47.90	0.49	0.29	0.80	0.08
Polyunsaturated FA	5.80	5.83	5.87	5.72	0.31	0.90	0.74	0.67
Trans FA\	3.35	3.77	3.59	3.52	0.18	0.11	0.78	0.12
Omega 6:Omega 3	3.60	3.46	3.56	3.50	0.17	0.49	0.81	0.59

[a]N = No implant; I = Implanted on Day 0 with Revalor-200; O = ractopamine HCl; I x O = Interaction between Implant and ractopamine HCl.