EFFECTS OF BREED TYPE AND GROWING PROGRAM ON PERFORMANCE AND CARCASS CHARACTERISTICS OF EARLY WEANED CALVES

A Thesis

by

JAKE ANDREW FRANKE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2008

Major Subject: Animal Science

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Approved by:

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	Jason Sawyer
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ABSTRACT

Effects of Breed Type and Growing Program on Performance and Carcass Characteristics of Early Weaned Calves. (May 2008)

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Dr. Jason Sawyer

A 2-yr study using Mashona- (M, yr 1 and 2) and Tuli-sired (T, yr 2) cows produced from a three-breed diallele cow base comprised of Brahman (BB), Romosinuano (RR), and Angus (AA) was conducted to determine effects of breed type and growing strategies on growth performance and carcass characteristics in early-weaned calves. Steers and heifers used were between 90 and 200 d old at arrival. Cattle were randomly split into one of two nutritional treatment groups with sex, breed type, and age stratified across treatments. Calves were either fed a roughage diet (P) or placed immediately on a concentrate grower diet (F) for approximately x d, then finished together in the feedlot. In both years, F calves gained more ($P < .01$) than P calves during the growing stage. In yr 1, P calves gained more ($P < .05$) than F calves during the middle, late and overall finishing period. For yr 2, F calves gained more ($P < .05$) during the early finishing phase, but P cattle gained more ($P < .05$) during the middle portion. In yr 1, P calves had higher ($P < .05$) USDA marbling scores than F calves. Growing program had no effect on carcass characteristics during yr 2. In yr 1, MAA calves gained more ($P < .05$) during the overall finishing period. TAA calves gained

more ($P < .01$) during the growing stage and TBB calves gained more ($P < .05$) for the overall finishing period in yr 2. In yr 1, MAA and MBB were fatter ($P < .05$), and MAA and MAR calves deposited more ($P < .01$) marbling than others. MAA calves also had less ($P < .05$) desirable yield grades than other cattle. In yr 2, TAA calves had more ($P < .05$) marbling than other calves, followed by TRR cattle that deposited more ($P < .05$) than remaining calves.

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INTRODUCTION

Most commercial and purebred cow-calf producers incorporate a traditional management system involving weaning calves at approximately 205 d, regardless of the breed composition of their herds. Several producers throughout the United States, however, have implemented an early weaning strategy to their respective operations to improve cow reproductive performance and possibly carcass traits. Other producers have started to place their weaned calves, regardless of age, on a high concentrate diet instead of running their calves on grass and then placing them on feed. Research on *Bos taurus* cattle has shown calves fed a concentrate upon weaning have a faster rate of gain compared to cattle on a forage-based diet (Myers et al., 1999b; Fluharty et al., 2000; Schoonmaker et al., 2001). Other studies conducted on different growing programs have shown that *Bos taurus* cattle placed directly on high concentrate diets have had a significant increase in USDA quality grade and higher marbling scores compared to cattle that were either grown on pasture or fed a low concentrated feed (Dahmen et al., 1962; Lancaster et al., 1973; Sindt et al., 1993; Myers et al., 1999b; and Wertz et al., 2001). Early weaning has proven to be an effective management strategy to improve marbling and overall carcass quality (Fluharty et al., 2000; Schoonmaker et al., 2001; Myers et al., 1999a; and Meyer et al., 2005). Arthington et al. (2005) evaluated Brahman x English crossbred steers and found no difference in finishing ADG or carcass quality between early and traditional weaned calves, but in this experiment, early-weaned calves were placed on 13.8% crude protein supplement (1% of body

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weight) and grazed annual and perennial pastures.

Throughout the southern United States, Brahman cattle have had a major impact on the commercial cow herd because of them being an important component in crossbreeding with several *Bos taurus* breeds. Tropically-adapted breeds from other countries have been imported to determine their usefulness as alternative breeds to the American beef cattle industry and crossbreeding systems. Studies comparing breed effects on calf growth involving a combination of Brahman, Tuli, Boran, and Senepol bulls sired to either Angus or Hereford cows have shown that no matter which of the previously listed breeds were involved, Brahman-sired calves were heavier at weaning and had higher ADG (Herring et al., 1996; Chase et al., 2000; Holloway et al., 2002). Research has also shown that Tuli-sired calves have more marbling and lower Warner-Bratzler shear force values compared to Brahman-sired cattle (Herring et al., 1996). Several studies that documented that as the percentage of Brahman/*Bos indicus* in the calves increased, the lower the marbling scores and quality grades were (Huffman et al., 1990; Wheeler et al., 1990; and Wheeler et al., 2006). Information from studies such as these has been used to discount Brahman influenced cattle as feeder calves.

Although some research has been conducted, there remains a need for research evaluating the effects of different growing programs on early weaned cattle. There is also a lack of research involving tropically adapted beef cattle breeds in grow-out programs for early-weaning situations. This study will help to provide more insight on the effects of different growing programs on early-weaned, tropically adapted breeds.

As a result of the shortage of research publication concerning these areas, the objectives of this particular research study were to:

1) Determine the effects of different post-weaning growing programs on the feedlot performance and carcass characteristics of early-weaned crossbred calves from tropically adapted breeds, and

2) Determine the effects of different biological types and gender on the performance and carcass traits of early-weaned calves, and their potential interactions with growing program.

LITERATURE REVIEW

Brief Description of Breeds Represented

Throughout the world there is an extremely large number of cattle breeds that although share some similarities, are very different in their production and endpoint composition characteristics. There are several biological types of cattle that are available to producers in the United States including *Bos taurus* and *Bos indicus,* along with the Sanga breeds from Africa. *Bos indicus* cattle are represented primarily in the United States by the Brahman breed, and exhibit excellent heat, insect, and disease tolerance. Cattle with considerable *Bos indicus* influence have shown to grow extremely well under harsh climates, but have also been less desirable in regard to meat tenderness and quality. *Bos taurus* breeds are those that are typically of European and British origins, and are more favorable with regard to carcass quality grade and production in cold environments.

Angus

The Angus breed originated in Scotland, and was imported to the United States in 1873. Angus is a solid black, naturally polled breed that, from a production standpoint, is well-known for their early sexual maturity, excellent fertility, reproductive efficiency, and milking abilities. Angus cattle also perform well in feedyard settings, displaying excellent marbling, meat quality, and dressing percent but are less desirable for retail product and yield percentage. The Angus breed, like most British originated cattle are moderate in their mature size and offer great fleshing ability. From an industry standpoint, Angus cattle have the unique breeding flexibility to be mated with a variety of *Bos indicus* and other *Bos taurus* breeds to produce market-topping feeder cattle and some of the most sought after replacement females in the nation. Because of this complimentarity, the Angus breed is the most popular breed in the United States in terms of annual registrations and branded beef programs.

Brahman

Sanders (1980) described the Brahman as a Zebu breed developed in the United States from the cattle imported from India and Brazil. The same research study explained that of all of the breeds from Asia and Africa, the Guzerat, Nellore, and Gir have had by far the most influence on cattle breeding in the United States. Sanders (1980) stated over 80% of the Zebu cattle that have been imported into the United States have come from Brazil. This article also explained how there are two distinctively different types of Brahman cattle: the Red Brahman and the Gray Brahman. The Gray Brahman is primarily a mixture of Guzerat and Nellore, with some influence from other Zebu breeds. Red Brahmans are primarily a mixture of Gir and Indu-Brazil, with some Guzerat influence.

Brahman cattle continue to play an important role in crossbreeding throughout the southern United States. Most *Bos taurus* breeds cannot perform or gain up to their potential levels in climates of high heat and humidity, but the Brahman breed is well-noted for their heat, humidity, and insect resistance. They have more highly developed sweat glands, which allow them to perspire more freely. Oklahoma State’s Animal Science Department livestock breeds web page also explains how their short, thick hair coat, black pigmented skin, and their ability to produce less internal body heat in warm weather contribute to their ability to excel in adverse climates. They also describe how Brahmans vary in color from a very light grey to a red and even almost black. Domestically, Brahman cattle have become extremely popular in various crossbreeding situations, and have the ability to compliment a wide variety of *Bos taurus* breeds. Besides their success in the United States, Brahman cattle have also prospered due to the breed's rapid growth outside of the breed, and have constituted a large proportion of our breeding cattle exports (OSU, 1995).

Romosinuano

Wheeler et al. (2006) explained how the Romosinuano breed was developed primarily in Colombia and was introduced into the United States from Venezuela at Brookesville, FL. It is considered a red criollo (domestic) breed of Central America that traces back to *Bos taurus* cattle introduced from Portugal and Spain about 400 to 500 years ago. The Romosinuano breed is believed to have become reasonably adapted to tropical conditions. They are smaller framed, slick haired, docile cattle that remain moderate in terms of growth and maintenance requirements and offer reasonably good maternal traits. OSU (1995) describes how mature females will weigh 400 kg, and males will weigh 500 kg.

Mashona

The Mashona breed is a Sanga breed and was developed in Zimbabwe; it has become a useful breed for tropical and semi-tropical breeding systems that have multi-purpose emphasis (Holness, 1992). The breed is black or red in color, and are very efficient foragers, and because of their moderate size do not require high levels of supplement for maintenance. The females have good mothering abilities and are reproductively efficient. This breed could be a good choice for producers wanting to moderate the mature size of their cattle, and still make efficient, heavy-lactating replacements in subtropical environments.

Tuli

Chase et al. (2000) described the Tuli breed as a Sanga breed of cattle that was first imported into the United States from Australia in the form of semen. Tuli cattle were originally developed in Zimbabwe. OSU (1995) explains how the Tuli breed exhibits high fertility, hardiness, adaptability and excellent beef qualities, and this coupled with their docile temperament have made them popular in straight and cross-breeding systems. Their native country remarks on the Tuli's ability to be extremely fertile cattle that exhibit high levels of maternal performance. Tuli cattle are naturally polled, and have three basic colors: red, yellow, and white. The Tuli breed is also known for their calving ease and overall mothering abilities. This versatility of combining useful maternal strengths and environment adaptability with carcass quality make them beneficial to the world-wide beef industry.

Breed Effects on Weaning Weight

Weaning weight is an extremely valuable trait to measure since the majority of American cattlemen market their calves through the local livestock auction facility shortly after weaning. The heavier calves will typically return more total revenue to the producer compared to lighter weight calves.

Holloway et al. (2002) researched the preweaning performance of F_1 Brahman-, Senepol-, and Tuli-Angus calves by studying the records of 489 calves (168 Brahman-, 154 Senepol-, and 167 Tuli-sired calves) over a four-year period. The study was conducted at the Texas Agricultural Research Station in Uvalde and represented a semiarid climate in south Texas. These researchers found the Brahman F_1 calves to be 13.5 kg heavier ($P < .05$) at weaning than the average of the Senepol- and Tuli-sired calves. The Brahman-sired calves averaged 196.8 kg for age-adjusted weaning weight over the four-year period while Senepol- and Tuli-sired calves averaged 186.2 kg and 180.4 kg, respectively. The findings of this experiment were similar to findings of other studies (Herring et al., 1996 and Chase et al., 2000). Chase et al. (2000) studied the effect of tropically adapted sire breeds on preweaning growth performance of F_1 calves by artificially inseminating Angus (A) cows with semen from Brahman (B), Senepol (S), and Tuli (T) bulls at the Subtropical Agricultural Research Station near Brooksville, FL which served as a hot, humid, subtropical environment. Researchers found weaning weights to be greater ($P < .001$) for Brahman x Angus calves than for Senepol x Angus or Tuli x Angus calves. Brahman-sired calves weighed 215 kg for their adjusted weaning weight which was significantly heavier than the Senepol- and Tuli-sired calves that weighed 178.8 kg and 178.6 kg, respectively. Herring et al. (1996) evaluated F_1 calves sired by Brahman, Boran, and Tuli bulls and out of Hereford and Angus cows to distinguish differences in birth, growth, size, and carcass characteristics in McGregor, TX, which is illustrated a hot, humid summer and mild fall and winter seasons found in central Texas. Among the 291 calves produced, the researchers found Brahman crosses had larger ($P < .05$) weaning weights than calves sired by Boran and Tuli bulls. Brahman-sired calves averaged 234.3 kg at weaning compared to 217.1 kg and 209.1 for Boran- and Tuli-sired calves, respectively. Browning et al. (1995) conducted a similar study but used Angus, Brahman, and Tuli bulls on Brahman cows to determine differences in preweaning growth. This research study was performed at the Texas Agricultural Experiment Station in Overton and provided an example of an environment with mean monthly temperature ranges of highs of 16°C and lows of 2°C in January to highs of 35°C and lows of 22°C in July and daily humidity ranges from 50% to 95%. This trial used records from 242 cow-calf pairs, and found weaning weights to be heavier ($P < .01$) for Angus x Brahman calves than for Tuli x Brahman and straight Brahman calves. Angus-sired calves weighed 220.9 kg at weaning compared to Tuli-sired calves that weighed 200.4 kg and Brahman-sired calves that weighed 198.8 kg. Browning et al. (1995) explained how Tuli-sired calves were inferior to Angus-sired calves and similar to straight bred Brahman calves in preweaning growth.

Breed Effects on Pre-weaning ADG

The same studies as mentioned previously examined the effects breed type had on calf pre-weaning gain, and all four studies had similar findings. These results, which utilized breeds similar to the current trial, indicated that breed type of the calf did have an impact on pre-weaning gain.

In using Brahman-, Senepol-, and Tuli-sired calves, Holloway et al. (2002) explained how calves sired by Brahman bulls gained .78 kg/d, which was significantly higher ($P < .05$) than calves sired by both Senepol- and Tuli-sired calves, which gained

.75 and .73 kg/d, respectively. Chase et al. (2000) also studied the effect of Brahman, Senepol, and Tuli sires on Angus cows to determine breed type effects on the resulting offspring. This particular study found the Brahman x Angus calves to gain 866 g from birth to weaning, which was significantly higher ($P < .001$) than Tuli-sired calves that gained 715 g and Senepol-sired calves that gained 708 g from birth to weaning. This specific study also separated the bull and heifer calves on all weight measurements, and the findings were the same for the heifer calves out of Brahman bulls gaining more from birth to weaning ($P < .05$) than both Senepol- and Tuli-sired heifers. Herring et al. (1996) evaluated the differences amongst Brahman, Boran, and Tuli sired calves for several weight intervals along with contrasts in carcass characteristics. The research trial found Brahman-sired cattle to gain 190.5 kg from birth to weaning, which was higher ($P < .05$) than Boran-sired calves (176.5 kg) and Tuli-sired calves (172.3 kg), which did not differ significantly. This study was slightly different in that Boran (an African Zebu breed) bulls were used instead of Senepol; however, both breeds are similar in terms of their characteristics and breed strengths and weaknesses. Also, both Angus and Hereford cows were used in this research study compared to the previous studies that only used Angus, but comparisons of Brahman vs. Tuli produced similar results. Browning et al. (1995) found calves sired by Angus bulls gained .90 kg/d, which was higher than Tuli-sired calves that gained .81 kg/d and straight bred Brahman calves that only gained .78 kg/d. The ranking in this study may have been due to Angus-sired calves having more growth than Tuli-sired calves due to increased heterosis, and that producers must consider the breed of cow, not just breed of sire when making breeding decisions.

Breed Effects on Frame Size

Researchers have shown, through several studies that different breeds not only increase the growth and performance of cattle from a sheer weight standpoint, but also increase the skeletal size of the calves in terms of their hip height measurements or frame scores.

Holloway et al. (2002) found Brahman-sired calves averaged a 6.2 frame score which was significantly larger ($P < .05$) than frame scores of both Senepol- and Tuli-sired cattle which measured 4.4 and 4.5 frame score, respectively. Chase et al. (2000) also reported that weaning hip height was different amongst Brahman-, Senepol-, and Tuli-sired calves. This research where calves were weaned at eight months, explained how Brahman-sired bull and heifer calves ranged in frame size between a 3.5 and 4.0. This was larger compared to Senepol- and Tuli-sired calves. Senepol-sired bull calves framed just over a 2.0, and Senepol-sired heifers framed a 2.5. Tuli-sired bull calves framed right at 2.0, while the heifers framed a 2.5. Herring et al. (1996) also found Brahman-sired calves to be larger in frame size ($P < .05$) than both the Boran- and Tuli-sired calves. In this specific study, Brahman-sired calves framed approximately 5.5, while Boran-sired calves were just above a 4.5, and Tuli-sired cattle were just below a 4.5.

Many research trials have shown that there are differences in total weaning weight, average daily gain prior to weaning, and also with skeletal size due to breed type effects. This is important for cattle producers to know since the majority of commercial cattlemen still market their cattle by the pound at local auction settings and how these performance levels might impact future performance and growth.

Breed Effects on Carcass Characteristics

Smith et al. (2006) explained how *Bos indicus* cattle (> 4” hump) only graded 29.2% Choice (both upper and lower combined) compared to native cattle that graded 54.2% and dairy cattle that graded 59.0% Choice. *Bos indicus* cattle never reached the Prime grade, but native and dairy cattle graded 2.1% and 12.9% Prime, respectively. 57.6% of *Bos indicus* cattle graded Select, but they also had 13.2% that graded Standard or lower. Even more disturbing is that the same report found that *Bos indicus* cattle did not have a great improvement in yield grades compared to native and dairy cattle. The report explained how Brahman-derived cattle harvested with 20.3% yield grade 1, 27.3% yield grade 2, and 46.3% yield grade 3. 6.2% of slaughtered *Bos indicus* cattle graded yield grade fours and fives. Native cattle killed with 15.8% yield grade 1, 33.3% yield grade 2, and 35.9% yield grade 3, but encountered a few problems because 15.0% were yield grade fours and fives. Dairy cattle yielded extremely well, with 22.7% yield grade 1, 31.9% yield grade 2, 41.2% yield grade 3, and only had 4.2% at a yield grade 4 or 5. The entire database of cattle harvested was comprised of 90.9% native type, 8.3% dairy type, and only 0.8% *Bos indicus* type. Perhaps the reason for the small number of *Bos indicus* cattle is because the report classifies *Bos indicus* as cattle with > 4” hump, and the purebred Brahman cattle would be the only cattle to fall in this category. Most purebred Brahman cattle are used for breeding purposes whether in a seedstock operation or for commercial producers, and are not marketed as fed cattle. The American breeds of beef cattle would be included in the native category.

Wheeler et al. (2006) found similar results in regards to breed-type effects on meat quality and tenderness. This particular study explained how as the proportion of *Bos indicus* increased, the less tender the meat was. This is very similar to findings of several past research trials that indicated how problems with meat tenderness increased as the percentage of *Bos indicus* increased in the harvested cattle.

Huffman et al. (1990) conducted studies on 165 steers of known percentage Brahman (B) and Angus (A) to study effects of breed group on feedlot performance and carcass characteristics. Percentages used in the trial were straight Angus (A), 3/4A x 1/4B, 1/2B x 1/2A, and 3/4B x 1/4A steers. 1/2B and 3/4B steers had heavier ($P < .05$) hot carcass weights than the A and 1/4B (309.8 and 318.1 kg vs. 288.8 and 283.0 kg). Huffman et al. (1990) also explained how A and 1/4B steers had larger ($P < .05$) ribeye areas per 100 kg of hot carcass than did the 1/2B and 3/4B (26.1 and 25.0 cm^2/100 kg hot carcass vs. 23.8 and 23.7 cm^2/100 kg). Angus steers also had more desirable yield grades ($P < .05$) than did steers with Brahman influence (2.8 vs. 3.0, 3.1, and 3.1). In regard to carcass quality, A and 1/4B produced carcasses with higher marbling scores ($P < .05$) than carcasses from 1/2B and 3/4B steers, with half blood steers also having higher marbling scores ($P < .05$) than 3/4B steers. (Small^{13} and Small^{11} vs. Slight^{70} and Slight^{30}). Huffman et al. (1990) found A and 1/4A steers to produce a higher percentage of Choice carcasses than Select (55% vs. 45% and 66% vs. 34%). In contrast, the same trial found carcasses from 1/2B steers graded Select more than twice as often as they graded Choice (65% vs. 29%) with 6% Standards, and carcasses from 3/4B steers produced the greatest percentage of Select and Standard (74% and19%) with only producing 7% Choice. Wheeler et al. (1990) studied the effect of postmortem treatments on four breed-types (purebred Hereford, purebred Brahman, Hereford x Brahman, and Brahman x Hereford), and also evaluated breed effects on carcass characteristics. Brahman x Hereford steers had heavier (P < .05) carcasses than Brahman or Hereford steers (295 kg vs. 255 and 263 kg). The Hereford, Brahman x Hereford, and Hereford x Brahman calves each had approximately 1 cm (1.04, 1.06, and .91 cm, respectively) of adjusted fat thickness, but the Brahman breed had less (P < .05) adjusted fat thickness than Hereford or Brahman x Hereford (.73 cm). Wheeler et al. (1990) described how no difference (P > .05) in ribeye area or yield grade between breed types. USDA marbling score and USDA quality grade were lower (P < .05) for Brahman carcasses than for Hereford, Hereford x Brahman, and Brahman vs. Hereford (Traces^{80} vs. Slight^{78}, Slight^{40}, and Slight^{36} and Standard vs. Select). Herring et al. (1996), in using Tuli-, Boran-, and Brahman-sired calves out of Angus and Hereford cows found Tuli-sired steers averaged higher in marbling score (351.0) than Brahman-sired steers (323.9), but did not differ from Boran-sired steers (344.5). This same study explained how Tuli-sired carcasses averaged lower Warner-Bratzler shear force values (3.32) than Boran-sired carcasses (3.76) but did not differ from Brahman-sired carcasses (3.59). Herring et al. (1996) found no differences among sire breeds for fat thickness, adjusted fat thickness, ribeye area, or KPH.

Effects of Growing Strategies

In addition to breed considerations, there are also different growing strategies such as creep feeding, implanting, and/or pasture management that producers utilize to improve the weaning weight performance of their calf-crop. Beef cattle producers throughout the United States implement many different growing programs towards their individual operations. Decisions about supplementation of the cow herd during lactation, creep feeding calves, use of various implanting schemes, and pasture management are all issues addressed by producers with respect to the individual environment. Annual precipitation levels, average cow herd age, and calving season also influence which specific management strategy producers might incorporate.

Myers et al. (1999b) conducted a study using Simmental, Angus, and Wagyu steers to determine performance and carcass trait differences between a pasture growing period and finishing diet at weaning for steers weaned at 117 days of age. The steers on the finishing ration were fed a high concentrate diet ad libitum (CONC), while the other half were rotated three times on endophyte-infected tall fescue, smooth bromegrass, and orchard grass pastures for 82 days and supplemented daily with 0.91 kg of cracked corn (PAST). The PAST steers were then placed on a high concentrate finishing diet. Myers et al. (1999b) found the CONC steers to have an ADG that was 0.17 kg/d higher and intake levels 1.09 kg/d lower than PAST steers overall, with no difference in total concentrate consumed. The CONC steers experienced an ADG that was 0.85 kg/d higher than PAST steers before 208 day of age, but had a .12 kg/d lower ADG after day 208, which could be an effect of compensatory gain. This is consistent with findings from Barker-Neef et al. (2001), who found early-weaned Angus and Angus cross steers to have higher ADG from the time of weaning (100 d of age) to normal weaning (200 d of age) than nursing, normally weaned calves (1.27 vs. 0.86 kg/d). Barker-Neef et al. (2001) did find those same early-weaned calves to have lower ADG for the entire finishing period than did normally weaned steers (1.33 vs. 1.39 kg/d). Myers et al. (1999b) found the feedlot performance of CONC steers to be extremely efficient between days 127 and 208, where the cattle consumed 4.58 kg/d and exhibited a gain: feed ratio of .287, but their efficiency was lower by .012 units in relation to the PAST steers during days 208 to 413. Dry matter intake of the PAST and CONC groups were 1.9% and 1.7% of their body weight for each treatment group, respectively. This finding was consistent with Fox et al. (1988), who suggested a 10% decrease in predicted DMI for cattle started on a concentrate diet as calves compared to cattle entering the feed yard as yearlings.

Myers et al. (1999b) found no difference between the growing treatments for carcass characteristics or sensory attributes except that CONC steers tended to improve percentage of steers grading Average Choice or higher by 47% over PAST steers (56% vs. 38%). Both treatment groups graded 89% Choice, and there were no differences witnessed in the percentage of carcasses grading Prime or higher. This improvement to cattle grading in the upper 2/3 of Choice suggests that early weaned cattle placed directly on feed could excel and be advantageous for producers who target a quality grade driven marketing venue (Myers et al., 1999b). Sindt et al. (1993) reported a significant increase in quality grade when cattle were weaned and immediately placed on concentrate as opposed to being fed corn stalks before entering the feedlot as yearlings. The quality grade related advantage within the Myers et al. (1999b) study is similar to findings of Lancaster et al. (1973), who reported significantly higher marbling scores for steers weaned at 205 d of age that were placed directly on a high-concentrate finishing diet (5.11) compared to those placed in a 76-d growing period (4.58), where 4 = slight^{00} and 5 = small^{00}. Dahmen et al. (1962) found that steers in the feed yard that were fed a low level of concentrate diet for the first 140 d of feeding had smaller amounts of marbling than steers fed a higher level of concentrate to begin with. Although these last two studies involved normal weaned cattle at 205 d of age, the suggested principle behind accelerated rate of marbling deposition and in turn, potential quality grade improvements due to higher concentrate diets fed immediately following weaning is shown.

Wertz et al. (2001) evaluated the effects of postweaning nutritional management on feedlot performance, carcass merit, and the relationship of intramuscular and subcutaneous fat deposition for early-weaned, Angus x Simmental heifers. The trial involved 16 heifers weaned at approximately 73 d of age and grazed on endophyte-infected tall fescue for 18 months before entering the feedlot (early-weaned-P). Additionally, 80 heifers from the subsequent year’s calf crop were weaned at 71 d of age and were allowed either ad libitum access to a 25% concentrate diet (early-weaned-25C) or limit-fed a 90% concentrate diet (early-weaned-90C) to achieve a similar ADG. As a whole, the heifers finished as calves deposited marbling at a faster rate relative to subcutaneous fat than the yearling calves did. Between the two early-weaned groups, the early-weaned-25C calves had less subcutaneous fat cover than early-weaned-90C calves at slaughter (1.17 cm vs. 1.59 cm). This might help to explain the reason that early-weaned-90C cattle had higher dressing percentages than early-weaned-25C even though hot carcass weights were similar among the two. The only difference in carcass weights that were seen by Wertz et al. (2001) involved early-weaned-90C and yearling heifers, where the early-weaned-90C heifers had carcasses with weights that fell within the industry standard (250 to 340 kg) at the time, whereas average hot carcass weight for yearling heifers exceeded this acceptable range. Wertz et al. (2001) also explained how a tendency for marbling scores assigned by the grader at slaughter to be higher for early-weaned-25C than for early-weaned-90C occurred. The study also described how the chi-square analysis of the frequency distributions for quality grade, tenderness, and yield grade indicated no significant difference in the distribution of quality grades or tenderness scores as a result of weaning and nutritional management. Wertz et al. (2001) later illustrated how the majority of the carcasses from early-weaned calves received a yield grade 2 or 3, with the early-weaned-90C calves having no carcasses that were yield grade 1, but only 7.14% of the carcasses were yield grade 5. Contrary, 8.33% of early-weaned-25C heifer carcasses received a yield grade 1, with no carcasses from this sector receiving a yield grade greater than 4. The finishing period was terminated when it was estimated by visual appraisal that heifers had 1.5 cm of fat over the 12th rib. Perhaps this recorded figure is due to lighter hot carcass weights of early-weaned-25C. Data from this research study implies when feeding heifers for a quality-grade rewarded market, finishing early-weaned heifers as calves results in carcasses with adequate marbling and more desirable hot carcass weights.

Fluharty et al. (2000) utilized 64 Angus crossbred steers that were either weaned at 93 d and fed one of four diets, weaned at 210 d without creep, or weaned at 210 d with access to creep feed for 60 d prior to weaning. The diets for the early-weaned cattle were a 100% concentrate diet containing 12% crude protein (CP), 100% concentrate diet with 16% CP, 90% concentrate ration, or a 60% concentrate diet. Early-weaned calves had greater ADG than normal-weaned calves (1.28 vs. 0.82 kg/d). Early-weaned calves that were fed either 100 or 90% concentrate rations experienced higher ADG (1.40, 1.34, and 1.46 kg/d) between days 93 and 210 compared to the calves fed 60% concentrate (1.18 kg/d), but there were not any performance differences between the 100% concentrate diets with different CP levels. The researchers indicated that despite their young age, the calves did not respond to increasing levels of the important CP heights. Differences were also experienced for the calves fed the 100% and 90% concentrate diets for having more fat thickness on d 210 along with a faster accretion of fat thickness in relation to the cattle on the 60% concentrate diet. Fluharty et al. (2000) found, that upon slaughter, the steers fed the 100% concentrate, 12% CP diet and the 100% concentrate, 16% CP diet both had 1.8 cm of fat thickness and calculated a 4.2 yield grade. The authors described how this fat thickness and yield grade may be unacceptable to many segments and markets of the beef industry, and are also higher values than the early-weaned cattle fed the 60% concentrate diet finished with. Fluharty et al. (2000) explained a potential remedy with aggressive implant strategies for early-weaned Angus crossbred steers fed high-concentrate diets to help counter the accretion of fat and direct nutrients towards protein instead of fat. The implications of this study suggest how early weaning calves could be a marketing scheme to provide young cattle for markets that have strict selection pressure for quality-grade focused cattle.

Meyer et al. (2005) studied the effects of weaning age and implant strategy for 140 Angus x Gelbvieh and purebred Angus steers who were either weaned early at 90 d (EW) or traditionally weaned at 174 d (TW) and implanted (EWI, TWI) or non-implanted (EWN, TWN). EW calves had heavier hot carcass weights (290.4 vs. 279.7 kg) and greater USDA marbling scores (51.25 vs. 46.26) compared to TW. The marbling scores used in this study were: 40.0 to 49.9 = Small and 50.0 to 59.9 = Modest. Also, more EW steers graded USDA Choice or greater compared to TW. EWI calves had heavier hot carcass weights than did EWN (309.12 vs. 282.16 kg), and although the EWI steers had more fat deposited adjacent the 12th rib than EWN steers (1.40 vs. 1.21 cm) they still had less fat thickness in relation to body weight, and both groups were statistically equal for marbling likely due to the length of time on feed Meyer et al. (2005).

Schoonmaker et al. (2001) used 143 Angus x Simmental steers in a 2-yr study to determine the effects of weaning age, implant regimen, and the weaning age x implant regimen interaction on growth, performance, and carcass characteristics. Steers were weaned early at an average age of 108 d (EW) or normally-weaned at 202 d (NW). Both groups were allotted to either an aggressive plan with Synovex-C (10mg estradiol benzoate, 100 mg progesterone) at an average age of 163 d and Revalor-S (24mg estradiol, 120 mg trenbolone acetate) at an average age of 204 d and 295 d, or to a nonaggressive regimen with Synovex-S (20 mg estradiol benzoate, 200 mg progesterone) at an average of age of 204 d and 295 d. Early-weaned calves had higher overall ADG compared to normal-weaned calves (1.61 vs. 1.50 kg/d), but normal-weaned calves had faster rate of gain in the feedlot (1.76 vs. 1.61 kg/d). Early-weaned steers on the aggressive implant regimen and EW steers given a nonaggressive implant did not differ in the amounts of DM they consumed, but EW, NW, and aggressive and nonaggressive implant main effects resulted in 93.7, 85.2, 90.3, and 88.6% of carcasses grading Choice, respectively, suggesting that young, aggressively implanted steers can deposit enough marbling to grade Choice (Schoonmaker et al., 2001). The calves were fed to a body weight of 546 kg. This trial explained how EW steers with aggressive implants had increased carcass protein by 0.6 percentage points compared to the nonaggressive EW calves, but in the NW steers it only increased it by 0.1 percentage point, which indicated that an aggressive implant regimen may be more effective at increasing muscle in young, fast growing calves. Schoonmaker et al. (2001) later described how implant regimen did not affect quality grade or sensory characteristics, and that EW calves produced steaks that were more tender than NW calves possibly because of longer days on a concentrate diet. This is related to findings by Williams et al. (1975), Myers et al. (1999a), and Fluharty et al. (2000) who demonstrated that early-weaning steers and immediately placing them on a high-concentrate diet can increase intramuscular fat deposition. Schoonmaker et al. (2001) concluded that early-weaning and feeding a high-concentrate diet may allow sufficient marbling deposition to occur early in the feeding process which could enhance quality grade regardless of age and implant regimen, meaning placing early-weaned calves on an implant scheme is a viable management option. Schoonmaker et al. (2001) did find that administering a high-concentrate diet to early-weaned calves might result in a few cattle having lower performance levels. Hopefully an aggressive implant will ensure proper weight gain in cattle being started and finished on a high-concentrate diet.

Smith et al. (2007) conducted two research trials involving Angus steers and heifers to determine the effects of anabolic implants on performance, changes in ultrasound measurements, and carcass quality. Results of the study indicated a higher ($P < .01$) average daily gain for implanted heifers (1.78 vs. 1.31 kg) and steers (1.79 vs. 1.53) compared to their non-implanted control counterparts. The same trial reported heavier hot carcass weights for implanted heifers (375.62 kg vs. 338.84 kg) and steers (322.43 vs. 299.07 kg). Smith et al. (2007) also explained how implanting did not affect ($P > 0.10$) dressing percent, fat thickness, percentage of KPH, yield grade, or marbling score. The researchers also described how the intramuscular lipid content did not differ ($P > 0.10$) between treatments. This specific study concluded that anabolic implants do not appear to have direct effects on i.m. deposition. For experiment 1, non-implanted heifers had an average daily gain of 1.31 kg, while the implanted heifers averaged 1.78 kg across the feeding period. Steers in experiment 1 that were not implanted averaged 1.53 kg per day, while the implanted steers grew 1.79 kg per day. From a carcass standpoint, the trial explained how at the end of the feeding period during experiment 1 the control heifers scanned an average of 5.57% of intramuscular fat (IMF), while the implanted heifers averaged 5.47% IMF. During the second experiment, control steers averaged a 5.23% IMF scan reading and the implanted steers surprisingly averaged 5.79%. This finding seems to contradict the perception that implanting negatively affects carcass quality from an IMF perspective. Even more interesting is that the carcass data upon harvest revealed that the heifers in experiment 1 had USDA marbling scores of 566 and 612 (500 = Small ^{00} and 600 = Modest ^{00}) for control and implanted heifers, respectively. Carcass data for the second experiment demonstrated the control steers to harvest with a USDA marbling score of 526 and the implanted steers railed a 519. The conclusion of the experiments were that implanting did not have a direct effect on intramuscular lipid deposition, and explained that this was perhaps particularly true for cattle with high genetic promise to deposit amounts of IMF capable of reaching the Choice grade. The final results of this study were similar to those of Gerken et al. (1995) and Johnson et al. (1996) where both studies found single-combination implants to have no effect on quality grade. Gerken et al. (1995) used genetically identical Brangus steers, and fed these cattle for 112 days. Johnson et al. (1996) used large framed crossbred cattle in the experiment. Other reports contradicted this, and found implanting strategies to lower carcass quality grades and decrease marbling scores (Duckett et al., 1997; Belk, 1992; Morgan, 1997; Roeber et al., 2000).

Schoonmaker et al. (2002) studied the effect of early weaning on the performance and carcass characteristics for Angus x Simmental bull and steer calves that were all weaned at an average of 115 d. This trial was designed to evaluate differences between bulls and steers using three phases. Phase 1 included d 115 to d 200, phase 2 was from 201 to 207 d of age, and phase 3 involved d 278 until slaughter. Schoonmaker et al. (2002) found the overall gains to be similar for the bulls and steers, but noticed the bulls consumed 140 kg more DM, were 27 kg heavier, and remained in the feedlot 18 more days than steers to achieve a similar amount of fat thickness. The major benefits for the bulls included increased muscle growth, deposition of fat at more favorable locations, and reached their targeted fat thickness at a later time (Schoonmaker et al., 2002). Specifically, the bulls were able to finish out at a heavier market weight in terms of ideal fat thickness which enabled them to dress with a higher carcass weight. This could be beneficial especially since the industry and many value-based grid pricing systems are allowing for heavier cattle before discounts are endured. Besides having heavier carcasses, the bulls had larger longissimus muscle areas, and unexpectedly had greater intramuscular fat when the cattle were slaughtered at a constant fat thickness (Schoonmaker et al., 2002).

In a study conducted by Arthington et al. (2005), 40 crossbred steers (Brahman x English) were placed into two groups: 1) early weaned (EW); and 2) normal weaned (NW), where feedlot performance and measures of stress were evaluated. The cattle were weaned on d 89 and d 300 for EW and NW. The researchers provided the early-weaned calves with a supplement (1% of body weight), and grazed cattle on annual and perennial pastures until NW, where all calves were then shipped to the feedlot. As an estimate of stress during the receiving phase, plasma was collected and analyzed for the acute-phase proteins, haptoglobin and ceruloplasmin. Arthington et al. (2005) concluded the EW calves were lighter at normal weaning than NW calves, but had improved gain:

feed during both the receiving and growing periods. Findings also included how ceruloplasmin concentrations increased in NW but not in EW calves (27.6 and 34.2 mg/100 mL for EW and NW calves respectively), and that haptoglobin concentrations increased in both groups and were greatest in NW calves on d 3 (7.63 vs. 14.86 mg of haptoglobin/hemoglobin complexing /100 mL). The research trial found no differences for ADG and gain: feed during the finishing phase, along with the carcass measures of marbling score, backfat thickness, USDA yield grade, and loin muscle area to not be different for EW and TW calves. Data from Arthington et al. (2005) implied that EW calves, which are maintained onsite before shipping, may be more tolerant to the stressors associated with transportation and feed yard entry. This could prove to be a useful management tool in preventing the shipping fever, which costs producers and stocker operators major expenses each turn.

There needs to be more research performed on the effects of early weaning growing strategies, especially involving tropically adapted breeds and cattle that have yet to be researched with the early weaning interaction. This trial will provide useful information not only to the effects of different growing and finishing programs, but will also evaluate tropically adapted breeds that have not been studied with the management practice of early weaning. The detailed objectives of this particular research study are: 1) Determine the effects of different post-weaning growing programs on the feedlot performance and carcass characteristics of early-weaned crossbred calves from tropically adapted breeds, and

2) Determine the effects of different biological types and gender on the performance and carcass traits of early-weaned calves, and their potential interactions with growing program.

MATERIALS AND METHODS

In May of 2004 66 calves were received (group 1) with another 47 calves arriving in July of 2004 (group 2) from the USDA-ARS station in Brooksville, FL at the Texas A&M University research center in McGregor. There were 58 calves that were received in May of 2005 (group 3), along with another 58 in August of 2005 (group 4), and weighed about 225 lb at arrival. These cattle ranged in age at arrival from 90 to 200 days and were a mixture of steers and heifers. All calves had been weaned a minimum of 14 days before transportation to McGregor. These cattle were early-weaned calves that were produced as part of a three-breed diallele research project using Brahman, Angus, and Romosinuano heifers mated to Mashona (2003) or Tuli and Mashona sires (2004) to produce their first calf.

Upon arrival to McGregor the calves from both years were randomly assigned to one of two nutritional treatment groups with sex, breed type, and age stratified across treatments. One treatment group was fed a roughage diet (grazing Bermuda grass pastures and/or fed hay) for approximately 112 days and then placed into the McGregor feedlot. During year 1, pasture calves were supplemented with 1.5 lb/head/day of cottonseed meal (CSM) on July 16, 2004. These calves were later supplemented with 3 lbs/head/day of CSM and sorghum sudan hay in September, and then given 100 lb of CSM for the entire pasture group before joining the feedlot cattle in late October 2004. Pasture cattle in year 2 were supplemented with 1 lb/head/day of CSM on May 25, 2005 until they were joined with feedlot calves in November 2005. The other treatment group was started on a grower diet in the McGregor feedlot upon arrival for 112 days. During year 1, feedlot calves were fed 10 lb/head/day from May to August 16, 2004 and then placed on 12.5 lb/head/day until November 18, 2004, where all cattle were placed on the finishing ration and fed ad libitum. Feedlot calves in year 2 were fed 10 lb/head/day for a week, and then placed on 12 lb/head/day from June 3, 2005 until January 22, 2006 where they were all on full feed until their respective slaughter date. At the end of the 112 day period, cattle from the two treatments were combined where all cattle were fed a common finishing diet to achieve approximately 0.5 inches of fat cover at the 12th rib. Cattle were weighed at 28-d intervals throughout the trial. During year 2, all feedlot cattle (group 3 and 4) and group 3 pasture calves were implanted on November 10, 2005 with Synovex C. Pasture cattle in group 4 were implanted on December 8, 2005 with Synovex C as well. Cattle were stepped up to and finished on the Int-4 diet after growing program treatments were combined in the feedlot. The diets fed for this project are presented in Table 1.

Table 1. Rations fed at the Texas A&M University Center at McGregor

Ingredients	**Int - 1**	**Int - 2**	**Int - 3**	**Int - 4**
Ground milo	15	20	20	20
Ground corn	10.25	17.25	31.25	39.25
Cottonseed meal	15	13	9	8
Cottonseed hulls	45	35	25	20
Molasses	10	10	10	8
Premix*	3	3	3	3
Ammonium chloride	0.25	0.25	0.25	0.25
R-1500***	1.5	1.5	1.5	1.5
Dry Matter, %	89	88.9	88.9	89.2
Crude Protein, %	12.4	12.4	11.5	11.5
NEm (Mcal/kg)	1.27	1.43	1.6	1.69
NEg (Mcal/kg)	0.71	0.85	1	1.09
Crude Fiber, %	24.2	19.4	14.5	12.1
Calcium, %	0.88	0.87	0.85	0.82
Phosphorous, %	0.39	0.4	0.39	0.39

*Composition of premix: ground limestone, 60%; trace mineralized salt, 16.7% (NaCl, 98%; Zn, 0.35%; Mn, 0.28%; Fe, 0.175%, Cu, 0.035%, I, 0.007%, Co, 0.007%); mono-dicalcium phosphate, 13%; potassium chloride, 6.7%; Vitamin premix, 3.3% (vitamin A, 2,200,00 IU/kg; vitamin D, 1,100,000 IU/kg, vitamin E, 2,200 IU/kg); Zinc oxide, 0.33%.

***R-1500 contains 1.65 g monensin sodium (Rumensin™) per kg.

Because of a wide range in age, sex differences, breed type differences, management treatments, and the attempt to have consistent fat thickness endpoint, three kill groups were utilized in 2005 and 2006. In both years, cattle were killed at Sam Kane Beef Processors, Inc. in Corpus Christi, Texas. The kill dates in 2005 were July 23, September 9, and November 9, and in 2006, cattle were slaughtered on June 27, September 19, and November 7. Carcass weight was recorded at slaughter, and fat thickness, Longissimus area, KPH percent, marbling score, lean maturity, and skeletal maturity were collected at 48 h following slaughter by Texas A&M University personnel.

There were major differences involved in the research studies between the two years. First, during year 1, only Mashona bulls were used on the three-breed diallele cow herd, but both Tuli and Mashona bulls were used during year 2 on the same type of females. Also, there were not any implant schemes administered during year 1, but calves were implanted with Synovex-C and later with Synovex-S or H in year 2. Although implants were used, this particular trial did not evaluate the results of implanting. A third year of the trial was planned that would have replicated procedures from year 2, but drought conditions at McGregor prevented receiving cattle in 2006.

Several calculations of average daily gain in both the growing and finishing stages were made during both years. Table 2 shows the specific dates that were used to calculate the average daily gains during the growing and finishing phases for each arrival group.

Average daily gains were calculated for the first half of the growing phase (GG1), second half of the growing phase (GG2), overall growing phase (GGALL), early finishing phase (FinGE), middle finishing phase (FinGM), late finishing phase (Fin GL), and overall finishing phase (FinADG). FinGL for year 1 was made by taking the calves' weights on their slaughter date (July 23, September 9, or November 8) and subtracting that by their weights on June 9. The FinGL of the cattle slaughtered in the first kill group lasted for 44 days, while the second and third kill groups lasted 92 and 152 days, respectively. FinGL for year 2 was calculated by subtracting the calves' weights on their slaughter dates (June 27, September 19, or November 7) by their weights on May 12. FinGL lasted 45 days for the calves slaughtered in the first group, 129 days for cattle in the second kill group, and 178 days for the third slaughter group.

Table 2. Dates used to calculate ADG during growing and finishing phases for different arrival groups

Variable	**Arrival Group 1**	**Arrival Group 2**	**Arrival Group 3**	**Arrival Group 4**
GG1	5/12/04 - 8/4/04	8/4/04 - 9/29/04	5/25/05 - 8/18/05	8/18/05 - 10/13/05
GG2	8/4/04 - 10/29/04	9/29/04 - 11/24/04	8/18/05 - 11/10/05	10/13/05 - 12/15/05
GGALL	5/12/04 - 10/29/04	8/4/04 - 11/24/04	5/25/05 - 11/10/05	8/18/05 - 12/15/05
FinGE	10/29/04 - 2/17/05	11/24/04 - 2/17/05	11/10/05 - 2/17/06	12/15/05 - 2/17/06
FinGM	2/17/05 - 6/9/05	2/17/05 - 6/9/05	2/17/06 - 5/12/06	2/17/06 - 5/12/06
FinGL	6/9/05 - Slaughter	6/9/05 - Slaughter	5/12/06 - Slaughter	5/12/06 – Slaughter
FinADG	10/29/04 - Slaughter	11/24/04 - Slaughter	11/10/05 - Slaughter	12/15/05 – Slaughter

Data were analyzed separately for each year through analysis of variance procedures with growing program, sex, breed type, and relevant interactions included as independent effects. Least square means from significant F-tests were compared through contrasts and/or individual t-tests.

RESULTS AND DISCUSSION

Year 1- Growing Program Effects on Gain

Table 3 shows how different growing programs affected average daily gains during the growing and finishing phases during year 1. Growing treatment did affect gain during the early growing phase ($P < 0.01$) with feedlot calves gaining 0.26 kg/d more than cattle on pasture. This could be due to differences in expected diet quality. The same results were seen during the second half of the growing stage where cattle grown in confinement gained 0.34 kg/d more than those grown on pasture ($P < 0.01$). Overall, growing program effected gain ($P < 0.01$) throughout the entire growing phase where cattle on the grain-based diet gained 0.29 kg/d more than roughage fed cattle.

Growing strategy did not influence ADG early in the finishing period, however, calves grown on pasture had higher ADG during the second and third finishing periods ($P < .05$), such that overall finishing ADG was 0.12 kg/d greater for cattle grown on pasture.

The higher average daily gains experienced by cattle placed directly on feed in our experiment were similar to results concluded by Myers et al. (1999b), Fluharty et al. (2000), and Schoonmaker et al. (2001). These studies found cattle weaned early and placed on a high concentrate experienced higher ADG compared to normal weaned calves left on the cow and roughage diet. The compensatory gain of pasture cattle in our research was also consistent with findings from Myers et al. (1999b), Fluharty et al. (2000), and Schoonmaker et al. (2001). Myers et al. (1999b) used Simmental, Angus, and Wagyu steers in their experiment, whereas Fluharty et al. (2000) and Schoonmaker et al. (2001) both evaluated Angus x Simmental steers for their trials, respectively. Wertz et al. (2001) also found that early-weaned Angus x Simmental heifer calves placed directly on high concentrate diets were lighter and grew slower during the finishing phase. This was consistent with results from year one of our experiment as well.

Table 3. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for feedlot and pasture growing strategies in 2004-05

Item[1]	Feedlot	Pasture	P-Value
N	53	55	
GG1	.63 ± .13	.37 ± .15	<.0001
GG2	.72 ± .12	.38 ± .15	<.0001
GGALL	.67 ± .11	.38 ± .13	<.0001
FinGE	.80 ± .14	.80 ± .19	0.4325
FinGM	.80 ± .19	1.04 ± .21	<.0001
FinGL	.75 ± .17	.86 ± .15	0.0316
FinADG	.78 ± .12	.90 ± .13	0.0002

N = 52 for FinGL and FinADG.

[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

Year 1 - Breed Type Effects on Gain

Table 4 describes how breed type influenced average daily gain during the growing and finishing phases during year 1. Rate of gain during the first segment of the growing phase were not statistically different (P = 0.15) among breed types, however, MBB cattle were numerically lower (at least 0.13 kg/d) than any other type. Breed did not statistically effect on average daily gain during the final part of the growing stage (P = 0.36) although MRR calves were numerically lower than other breeds. There was no statistical difference for breed type effects on the overall average daily gain throughout the entire growing phase (P = 0.58).

Breed type did influence gain during the early finishing stage (P = 0.02) with MAA calves being numerically higher (at least 0.11 kg/d) than any other breed composition. There was a tendency for MAA cattle to be numerically higher ADG (0.10-0.19 kg/d) than other breed types during the middle portion of the finishing phase (P = 0.08). Breed type influenced average daily gain during the late finishing phase (P = 0.01), with MAA calves having the greatest ADG and MRB calves having the lowest ADG and all others intermediate. Overall finishing ADG was affected by breed type (P = 0.003) with MAA cattle gaining faster (at least 0.13 kg/d) than other breeds.

Table 4. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for multiple breed types[2] in 2004-05

Item[1]	MAA	MAB	MAR	MBB	MRB	MRR	P-Value
N	10	22	28	6	28	14	
GG1	.49 ± .12	.52 ± .15	.51 ± .19	.36 ± .23	.50 ± .24	.50 ± .17	0.1505
GG2	.59 ± .20	.55 ± .19	.57 ± .21	.55 ± .11	.54 ± .26	.51 ± .21	0.3602
GGALL	.54 ± .15	.54 ± .17	.54 ± .20	.45 ± .17	.52 ± .24	.50 ± .18	0.5773
FinGE	.93 ± .15[a]	.80 ± .20[b]	.82 ± .15[a]	.67 ± .12[b]	.76 ± .16[b]	.78 ± .13[b]	0.0228
FinGM	1.09 ± .25	.91 ± .22	.91 ± .18	.99 ± .27	.89 ± .27	.90 ± .20	0.0833
FinGL	.95 ± .18[a]	.78 ± .15[c]	.87 ± .16[a,b]	.75 ± .11[b,c]	.72 ± .18[c]	.80 ± .15[b,c]	0.0012
FinADG	.99 ± .18[a]	.83 ± .12[b,c]	.86 ± .11[b]	.80 ± .10[b,c]	.80 ± .15[c]	.82 ± .12[b,c]	0.0026

MAR only had 27 calves for FinGL and FinADG.

[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

[2]MAA = Mashona x Angus, MAB = Mashona x Angus-Brahman, MAR = Mashona x Angus-Romosinuano, MBB = Mashona x Brahman, MRB = Mashona x Romosinuano-Brahman, MRR = Mashona x Romosinuano

[a-c]Breed types with different superscripts differ ($P < .05$)

Year 1- Arrival Group Effects on Gain

Table 5 describes how arrival group affected average daily gains during the growing and finishing phases for experiment 1. Arrival group affected average daily gain during the first half of the growing phase (P = 0.01), the second half of the growing phase (P < 0.01), and the entire growing stage (P < 0.01). Cattle that arrived in group 1 consistently gained more (average of 0.11 kg/d) compared to cattle in the second arrival group. During the early finishing stage, cattle from group 1 had greater ADG than those from group 2 (P = .02). Cattle in group 2 gained more (0.18 kg/d) than calves in group 1 during the middle finishing phase (P < .01). Although arrival group did not affect average daily gain during the last part of the finishing stage (P = 0.12), time of arrival did affect the overall average daily gain for the finishing phase (P = 0.04). Calves in group 2 gained more (0.05 kg/d) than cattle in group 1.

Group 1 calves arrived in May while group 2 arrived in July/August, and the quality and availability of forage could have also affected the outcome in how the cattle gained in each group during the growing phase.

Table 5. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for early (1) and late (2) arrival groups in 2004-05

Item[1]	1	2	P-Value
N	63	45	
GG1	.53 ± .14	.45 ± .24	0.0142
GG2	.60 ± .17	.47 ± .25	<.0001
GGALL	.57 ± .14	.46 ± .24	<.0001
FinGE	.83 ± .15	.75 ± .18	0.0162
FinGM	.85 ± .20	1.03 ± .22	<.0001
FinGL	.79 ± .17	.82 ± .18	0.1213
FinADG	.82 ± .15	.87 ± .13	0.0368

There were 62 arrival group 1 calves for FinGL and Fin ADG.
[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase

Year 1- Sex Effects on Gain

Table 6 illustrates effects of sex on average daily gains during the growing and finishing phases for year 1. Sex did not statistically affect average daily gain during the first half (P = 0.26), second half (P = 0.9963), or the overall average daily gain of the growing phase (P = 0.50). Sex also did not affect average daily gain during the early part of the finishing stage (P = 0.18), but did have a statistical effect on average daily gain during the middle finishing phase (P = 0.01) where steers gained more (.09 kg/d) compared to heifers. The last part of the finishing stage was not affected by sex (P = 0.60). Overall, sex did affect average daily gain throughout the entire finishing phase (P = 0.01), in which steers gained more (0.06 kg/d) versus heifers. The results of sex on average daily gain during both phases were somewhat varied, with sex affecting the middle portion and overall finishing phase but had no affect on the growing stage. This experiment involved smaller framed, lower performing breeds of cattle, and this could be attributed to sex not having a significant impact on gain.

Table 6. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for heifers and steers in 2004-05

Item[1]	Heifers	Steers	P-Value
N	56	52	
GG1	.50 ± .20	.49 ± .19	0.2622
GG2	.55 ± .21	.55 ± .22	0.9963
GGALL	.53 ± .20	.52 ± .20	0.4967
FinGE	.78 ± .14	.81 ± .19	0.1844
FinGM	.88 ± .23	.97 ± .22	0.0089
FinGL	.80 ± .16	.82 ± .18	0.6013
FinADG	.81 ± .14	.87 ± .14	0.0141

There were 51 steer calves for FinGL and FinADG.
[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during entire growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

Year 2 – Growing Program Effects on Gain

Table 7 explains how different growing programs affected average daily gain during the growing and finishing phases during year 2. Growing treatment did statistically affect rate of gain for both halves of the growing phase and thus overall, with cattle placed directly on feed gaining 0.28 kg/d more than pasture cattle ($P < 0.01$). This trend of feedlot cattle consuming a grain-based diet growing faster was consistent with our findings in the first year, and exemplifies the benefits of concentrate rations' advantages in rate of gain over forage-based diets. The same results were concluded by Myers et al. (1999b) using Simmental, Angus, and Wagyu steers, and Fluharty et al. (2000) and Schoonmaker et al. (2001) that used Simmental x Angus steers where both studies found cattle placed on a concentrate diet instead of grown on pasture had faster rate of gain.

Growing strategy did affect gain through the first stage of finishing the cattle (P = 0.004). Here, the feedlot calves grew faster (1.10 vs. 1.01 kg/d). Gain during the middle portion of the feedlot phase was also statistically affected by growing treatment (P = 0.01) where the pasture cattle gained 0.14 kg/d more than feedlot cattle which was similar to the trend in year 1. By the late portion of the finishing segment, growing program did not have an effect (P = 0.10) on gain, which was different from findings in the first experiment. Overall, rate of gain during the finishing phase was not affected by growth strategy (P = 0.73). This particular result was different from our first year findings and from research done by Myers et al. (1999b), Fluharty et al. (2000), and Schoonmaker et al. (2001).

Table 7. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for feedlot and pasture growing strategies in 2005-06

Item[1]	Feedlot	Pasture	P-Value
N	55	58	
GG1	.75 ± .15	.47 ± .11	<.0001
GG2	.67 ± .10	.40 ± .15	<.0001
GGALL	.71 ± .10	.43 ± .11	<.0001
FinGE	1.10 ± .19	1.01 ± .24	0.0041
FinGM	.89 ± .21	1.03 ± .27	0.0094
FinGL	1.08 ± .30	1.02 ± .26	0.0953
FinADG	1.00 ± .17	1.03 ± .19	0.7348

[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

Year 2 – Breed Type Effects on Gain

Table 8 presents breed types effects on growth during the growing and finishing phases. Breed type influenced gain during both the early stage (P = 0.0003) and the latter half of the growing period (P = 0.008). During both phases MRR calves on average gained the least while calves produced by straight-bred Angus dams (TAA and MAA) experienced the highest average daily gains. Breed type did have a statistical effect on the overall gain through the growing segment (P = 0.001). Breed type also influenced gain during the initial finishing phase (P = 0.01) with MRR and TAA cattle having the lowest gains and TAR calves gaining the fastest. Breed effects on gain during the middle section were not statistically different, but TBB cattle ranked higher (at least 0.25 kg/d) than any other breed. Also, during the late portion of the finishing phase, breed effects on gain were not statistically different (P = 0.08). Breed did have a statistical effect (P = 0.05) on the overall average daily gain of the finishing period, and TBB calves gained more (at least 0.16 kg/d) than any other breed combination.

Table 8. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for multiple breed types[2] in 2005-06

Item[1]	MAA	MAB	MAR	MBB	MRB	MRR	TAA	TAB	TAR	TBB	TRB	TRR	P-Value
n	3	11	14	1	19	8	2	10	16	4	18	7	
GG1	.55 ± .15^{g}	.66 ± .20^{c}	.60 ±.19^{d,e,f}	.55^{g}	.57 ±.16^{f,g}	.46 ±.13^{h}	.79 ±.10^{a}	.63 ±.21^{c,d}	.70 ±.23^{b}	.58 ±.15^{e,f,g}	.59 ±.22^{d,e,f,g}	.61 ±.14^{d,e}	0.0003
GG2	.66 ± .37^{a}	.54 ±.20^{e,f}	.49 ± .21^{h}	.59^{b,c}	.55 ±.15^{d,e,f}	.42 ±.15^{i}	.64 ±.00^{a}	.60 ±.15^{b}	.55 ±.21^{c,d,e}	.58 ±.19^{b,c,d}	.51 ±.21^{f,g,h}	.50 ±.17^{g,h}	0.0076
GGALL	.60 ± .24^{b,c,d}	.60 ±.20^{c,d,e}	.55 ±.19^{g}	.57^{e,f,g}	.55 ±.14^{f,g}	.44 ± .11^{h}	.71 ±.05^{a}	.61 ±.17^{b,c}	.63 ±.20^{b}	.58 ±.17^{d,e,f}	.55 ±.20^{g}	.55 ±.15^{f,g}	0.0006
FinGE	.95 ± .31^{e,f}	1.06 ±.28^{b}	1.17 ±.23^{a}	.97^{d,e,f}	1.00 ±.15^{b,c,d,e}	.90 ±.17^{f}	.90 ±.15^{f}	1.13 ±.26^{a}	1.19 ±.20^{a}	1.05 ±.30^{b,c}	1.01 ±.18^{b,c,d,e}	.99 ±.14^{c,d,e}	0.014
FinGM	.91 ± .12	.88 ±.31	.93 ±.23	.85	.92 ±.21	.94 ±.25	.58 ±.01	.93 ±.25	.99 ±.25	1.30 ±.20	1.05 ±.24	.94 ±.27	0.1838
FinGL	1.05 ± .18	1.22 ±.36	.92 ±.22	.81	.92 ±.22	.97 ±.24	1.06 ±.12	1.16 ±.32	1.10 ±.27	1.28 ±.16	1.08 ±.27	1.00 ±.33	0.0772
FinADG	.97 ± .18^{d,e}	1.05 ±.23^{b,c}	1.00 ±.17^{c,d}	.85^{f}	.95 ±.15^{e}	.95 ±.15^{e}	.89 ±.00^{f}	1.07 ±.20^{b}	1.07 ±.17^{b}	1.23 ±.06^{a}	1.05 ±.18^{b,c}	.99 ±.16^{d,e}	0.0496

[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

[2]MAA = Mashona x Angus, MAB = Mashona x Angus-Brahman, MAR = Mashona x Angus-Romosinuano, MBB = Mashona x Brahman, MRB = Mashona x Romosinuano-Brahman, MRR = Mashona x Romosinuano, TAA = Tuli x Angus, TAB = Tuli x Angus-Brahman, TAR = Tuli x Angus-Romosinuano, TBB = Tuli x Brahman, TRB = Tuli x Romosinuano-Brahman, TRR = Tuli x Romosinuano

[a-h]Breed types with different superscripts differ ($P < .05$)

Year 2 – Arrival Group Effects on Gain

Table 9 explains how time of arrival affected average daily gain during the growing and finishing phases. Arrival group did not affect average daily during the beginning of the growing stage (P = 0.70). Average daily gain during the second half (P < 0.0001) and for the overall growing phase (P = 0.01) was statistically affected by arrival group, and cattle arriving in group 3 grew faster (0.09 and 0.06 kg/d, respectively), compared to calves in group 4. Arrival group also affected average daily gain during the early (P = 0.03) and middle (P < 0.0001) portions of the finishing phase. During the early finishing phase, calves in group 3 gained more (0.09 kg/d) than group 4 cattle, but calves in group 4 grew more (0.25 kg/d) compared to group 3 for the middle stage, which could be due to compensatory gain. Arrival group did not affect gain during the last portion of the finishing phase (P = 0.08), but group 4 cattle ranked higher (0.10 kg/d) than group 3. During the entire finishing portion of the study, arrival group did statistically affect average daily gain (P = 0.001), and cattle arriving in group 4 gained more (0.10 kg/d) versus group 3.

Table 9. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for early (3) and late (4) arrival groups in 2005-06

Item[1]	3	4	P-Value
N	57	56	
GG1	.61 ± .19	.60 ± .20	0.697
GG2	.58 ± .15	.49 ± .22	<.0001
GGALL	.60 ± .15	.54 ± .20	0.014
FinGE	1.10 ± .24	1.01 ± .19	0.032
FinGM	.83 ± .21	1.08 ± .22	<.0001
FinGL	1.00 ± .31	1.10 ± .23	0.075
FinADG	.97 ± .18	1.07 ± .15	0.009

[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

Year 2 – Sex Effects on Gain

Table 10 explains differences in average daily gains during the growing and finishing phases due to sex. Sex had statistical effects on average daily gain during all of the growing and finishing stages except the latter half of the growing period ($P = 0.17$). During each measured phase, steers gained more compared to heifers. The first section ($P = .0067$) and overall average daily gain ($P = 0.01$) during the growing phase was affected by sex. The early ($P < 0.0001$), middle ($P < 0.0001$), and late ($P = 0.01$) segments of the finishing stage was statistically impacted by sex. Overall, sex also affected average daily gain across the entire finishing phase ($P < 0.0001$), and steers outperformed (0.17 kg/d) heifers.

Table 10. Growth responses (least squares means ± SE, kg/d) during growing and finishing periods for heifers and steers in 2005-06

Item[1]	Heifers	Steers	P-Value
N	58	55	
GG1	.58 ± .16	.63 ±.22	0.0067
GG2	.52 ±.19	.54 ±.19	0.1690
GGALL	.55 ±.16	.59 ±.19	0.0105
FinGE	.98 ±.16	1.15 ±.24	<.0001
FinGM	.85 ±.21	1.07 ±.24	<.0001
FinGL	.99 ±.26	1.11 ±.28	0.0132
FinADG	.94 ±.14	1.11 ±.16	<.0001

[1]GG1 = ADG during first half of growing phase, GG2 = ADG during second half of growing phase, GGALL = overall ADG during growing phase, FinGE = ADG during the early finishing phase, FinGM = ADG during middle finishing phase, FinGL = ADG during late finishing phase, FinADG = overall ADG for entire finishing phase.

Year 1 – Growing Program Effects on Carcass Characteristics

Table 11 presents feedlot and pasture growing strategies effects on carcass traits during the first year of the experiment. Growing treatment did not affect hot carcass weight (P = 0.51). This was similar to results of Wertz et al. (2001) who evaluated Angus x Simmental heifers, and found no difference in hot carcass weight. The effects of growing program on back fat were not statistically different (P = 0.12). The same findings were similar for adjusted back fat where treatment held no statistical effect (P = 0.08). Growth strategy did not influence ribeye area (P = 0.71) or KPH (P = 0.16). USDA marbling score was affected by growing treatment (P = 0.002) where pasture-grown cattle were higher (61 units) than feedlot cattle. This contrasts results from Dahmen et al. (1962), Lancaster et al. (1973), Williams et al. (1975), Sindt et al. (1993), Myers et al. (1999B), Fluharty et al. (2000), and Wertz et al. (2001) who explained that cattle fed higher levels of a concentrated ration had improvements in marbling score and quality grades. Our experiment utilized smaller framed, tropically adapted cattle as compared to non-tropically adapted cattle in the previously mentioned studies that used

Bos taurus cattle. USDA yield grade was not statistically affected (P = 0.08) by growing treatment. Our results on yield grade differences were different from Fluharty et al. (2000) and Wertz et al. (2001) who found that calves placed on higher levels of concentrate feed encountered more problems with higher numeric yield grades.

Table 11. Carcass trait responses (least squares means ± SE) for feedlot and pasture growing strategies in 2004-05

Item[1]	Feedlot	Pasture	P-Value
N	52	55	
HCW (kg)	257.4 ± 10.7	262.4 ± 16.7	0.5068
BF (cm)	1.07 ± .48	1.17 ± .48	0.1229
ABF (cm)	1.32 ± .43	1.40 ± .48	0.0787
REA (cm^2)	75.23 ± 9.74	76.26 ± 6.52	0.707
KPH (%)	1.90 ± .65	1.98 ± .56	0.1617
MARB	388 ± 92	449 ± 111	0.0024
YG	2.45 ± .72	2.58 ± .67	0.0831

There were 54 pasture calves for BF, ABF, REA, KPH, SCORE, and YG.
[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, MARB = USDA marbling score (300 = slight^{00}; 400 = small^{00}, etc.), YG = USDA yield grade.

Year 1 – Breed Type Effects on Carcass Characteristics

Table 12 demonstrates how different breed types influenced carcass traits during year 1. Breed type did not have any statistical effect on hot carcass weight (P = 0.47), but MBB calves were numerically lighter (at least 5.60 kg) than all other breeds. Breed type did effect both back fat (P = 0.01) and adjusted back fat (P = 0.02) with MAA calves being fatter than other breeds. Breed type did not influence ribeye area (P = 0.48), but MAA cattle ranked lower (at least 1.81 cm^2) compared to other breeds. Breed type did effect KPH (P = 0.01). Breed composition did influence USDA marbling score (P = 0.001) with MAA cattle ranking the highest and Brahman-crosses ranking the lowest. Breed type also statistically affected USDA yield grade (P = 0.02). MAA calves calculated higher (at least 0.78 units) than any other breed. This finding was due to the tandem of having greater fat deposition and smaller ribeye areas compared to other breeds. The MAA cattle graded in the top half of Choice, but only endured two yield grade-related discounts.

Table 12. Carcass trait responses (least squares means ± SE) for multiple breed types[2] in 2004-05

Item[1]	MAA	MAB	MAR	MBB	MRB	MRR	P-Value
N	10	22	27	6	28	14	
HCW (kg)	265.8 ± 17.3	265.9 ± 23.8	263.5 ± 16.0	247.7 ± 18.9	255.9 ± 19.4	253.3 ± 24.1	0.4653
BF (cm)	1.65 ± .53^{a}	1.19 ± .43^{b,c}	.99 ± .38^{c}	1.42 ± .69^{a,b}	.99 ± .46^{c}	.99 ± .43^{c}	0.0127
ABF (cm)	1.85 ± .53^{a}	1.42 ± .43^{b}	1.30 ± .36^{b}	1.45 ± .69^{a,b}	1.24 ± 1.09^{b}	1.19 ± .38^{b}	0.0159
REA (cm^2)	73.03 ± 5.87	76.26 ± 9.35	75.55 ± 7.10	78.52 ± 12.84	74.84 ± 7.81	77.87 ± 9.10	0.4814
KPH (%)	2.35 ± .47^{a}	1.84 ± .56^{b}	2.02 ± .58^{a,b}	1.50 ± .89^{c}	1.81 ± .57^{b}	2.11 ± .56^{a,b}	0.0124
MARB	508 ± 134^{a}	409 ± 100^{c,d}	459 ± 103^{a,b}	352 ± 48^{c}	367 ± 70^{d}	424 ± 116^{b,c}	0.0012
YG	3.32 ± .60^{a}	2.54 ± .69^{b}	2.51 ± .51^{b}	2.40 ± 1.07^{b}	2.38 ± .62^{b}	2.23 ± .74^{b}	0.0173

MRB had 27 for BF, ABF, REA, KPH, SCORE, and YG

[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, MARB = USDA marbling score (300 = slight^{00} 400 = small^{00}, 500 = modest^{00}, etc.), YG = USDA yield grade

[2]MAA = Mashona x Angus, MAB = Mashona x Angus-Brahman, MAR = Mashona x Angus-Romosinuano, MBB = Mashona x Brahman, MRB = Mashona x Romosinuano-Brahman, MRR = Mashona x Romosinuano

[a-c]Breed types with different superscripts differ (P < .05)

Year 1 – Arrival Group Effects on Carcass Characteristics

Table 13 shows influence of arrival group on carcass measures. Time of arrival had no effect on hot carcass weight (P = 0.89). The same was true for back fat (P = 0.09), adjusted back fat (P = 0.70), ribeye area (P = 0.41), and KPH (P = 0.31). Time of arrival did statistically affect USDA marbling score (P = 0.03), in which cattle that arrived in the first group had higher (61 units) marbling scores than cattle arriving in the second group. USDA yield grade was not statistically affected by arrival group (P = 0.83).

Table 13. Carcass trait responses (least squares means ± SE) for early (1) and late (2) arrival groups in 2004-05

Item[1]	1	2	P-Value
N	62	45	
HCW (kg)	260.2 ± 20.0	259.7 ± 21.3	0.8867
BF (cm)	1.07 ± .48	1.19 ± .51	0.0868
ABF (cm)	1.37 ± .46	1.32 ± .46	0.6994
REA (cm^2)	74.52 ± 6.77	77.42 ± 9.74	0.4089
KPH (%)	2.02 ± .63	1.83 ± .55	0.3128
MARB	445 ± 120	384 ± 71	0.0251
YG	2.57 ± .67	2.45 ± .74	0.8265

There were 61 arrival group 1-calves for BF, ABF, REA, KPH, SCORE, and YG.
[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat MARB = USDA marbling score (300 = slight^{00}; 400 = small^{00}, etc.), YG = USDA yield grade.

Year 1 – Sex Effects on Carcass Characteristics

Table 14 shows how sex impacted carcass traits during the first year. Sex statistically affected hot carcass weight (P = 0.03), back fat (P = 0.0002), adjusted back fat (P < 0.0001), KPH (P = 0.04), USDA marbling score (P = 0.0003), and USDA yield grade (P = 0.0002). Steers had heavier hot carcass weights (10.90 kg) than heifers.

Heifers deposited more back fat (0.33 cm) and had higher adjusted back fat levels (0.35 cm) compared to steers. Although not statistically different (P = 0.06), there was a trend for steers to have larger ribeye areas (3.35 cm^2) as compared to heifers. Consistent with the back fat findings, heifers also had higher KPH fat (0.22%), and ultimately, higher numeric yield grades (0.46 units).

Table 14. Carcass trait responses (least squares means ± SE) for heifers and steers in 2004-05

Item[1]	Heifers	Steers	P-Value
N	56	51	
HCW (kg)	254.8 ± 20.4	265.7 ± 19.0	0.0336
BF (cm)	1.27 ± .53	.94 ± .38	0.0002
ABF (cm)	1.52 ± .48	1.17 ± .36	<.0001
REA (cm^2)	74.13 ± 6.84	77.48 ± 9.29	0.0598
KPH (%)	2.05 ± .64	1.83 ± .54	0.0359
MARB	449 ± 121	387 ± 76	0.0003
YG	2.74 ± .70	2.28 ± .62	0.0002

There were 55 feedlot calves for BF, ABF, REA, KPH, SCORE, and YG.
[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, SCORE = USDA marbling score (300 = slight^{00}; 400 = small^{00}, etc.), YG = USDA yield grade.

Year 2 – Growing Program Effects on Carcass Characteristics

Table 15 describes carcass trait differences due to growing programs during year 2. Growing treatment did not statistically affect hot carcass weight (P = 0.24). The same was true for effects on back fat (P = 0.50) and adjusted back fat (P = 0.66). These overall results were similar to year 1. Growing treatment also had no statistical affect on ribeye area (P = 0.81). Growing program did not affect KPH (P = 0.58). In contrast to year 1, growing program did not statistically influence USDA marbling score (P = 0.80). Several others have documented concentrate-fed calves having higher marbling scores than roughage-fed calves Dahmen et al. (1962), Lancaster et al. (1973), Williams et al.

(1975), Sindt et al. (1993), Myers et al. (1999B), Fluharty et al. (2000), Wertz et al. (2001). Growing program did not statistically effect USDA yield grade (P = 0.38) which was consistent with year 1 and Myers et al. (1999b) who found no difference in yield grade between concentrate-fed calves and pasture-grown calves (2.81 vs. 2.77).

Table 15. Carcass trait responses (least squares means ± SE) for feedlot and pasture growing strategies in 2005-06

Item[1]	Feedlot	Pasture	P-Value
N	55	58	
HCW (kg)	290.2 ± 23.3	287.2 ± 30.8	0.2377
BF (cm)	.94 ± .41	.86 ± .43	0.5028
ABF (cm)	.99 ± .46	.91 ± .46	0.6644
REA (cm^2)	83.16 ± 7.10	83.94 ± 9.23	0.8095
KPH (%)	2.61 ± .57	2.48 ± .57	0.5798
MARB	467 ± 102	454 ± 100	0.8036
YG	2.28 ± .60	2.11 ± .81	0.3803

[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, MARB = USDA marbling score (300 = slight^{00} 400 = small^{00}, etc.), YG = USDA yield grade.

Year 2 – Breed Type Effects on Carcass Characteristics

Table 16 describes breed type effects on carcass traits during the second year. Breed type effects on hot carcass weight were not statistically different (P = 0.40), but MAA calves were numerically lower (at least 17.80 kg) than any other breed group. This was consistent with findings in the first year, but the margin of difference in hot carcass weight was greater for year 2. In contrast to year 1, breed type had no statistical effect on back fat (P = 0.81) or adjusted back fat (P = 0.69).

The statistical effect of breed type on ribeye area were not significant (P = 0.33). This was similar to findings in year 1, but cattle slaughtered in the second year had larger longissimus dorsi areas on the average. Similar to results in year 1, breed type did not statistically effect KPH (P = 0.58). Breed type did influence USDA marbling score (P = 0.02), and the TAA calves marbled significantly higher (at least 187.14 units) than any other breed, but there were only two TAA calves. Brahman-influenced calves were consistently lower for marbling score compared to other breeds, which was consistent with our results from year 1. Breed type effects on USDA yield grade were not statistically different (P = 0.59) which is different to the findings in year 1. Another contrast to the first year was the yield grade of MAA cattle. In year 1, MAA calves averaged a 3.32 yield grade, but in year 2, MAA cattle averaged 1.47 which was numerically lower (at least 0.43 units) than all other breed types.

Table 16. Carcass trait responses (least squares means ± SE) for multiple breed types[2] in 2005-06

Item[1]	MAA	MAB	MAR	MBB	MRB	MRR	TAA	TAB	TAR	TBB	TRB	TRR	P-Value
N	3	11	14	1	19	8	2	10	16	4	18	7	
HCW (kg)	256.1±8.9	286.4±36.5	292.1 ±31.9	270.9 ±.00	289.9±25.5	276.2 ±23.4	294.8 ±11.3	289.7 ±27.3	292.6 ±30.6	298.1 ± 32.8	294.0 ±23.2	281.6 ±17.6	0.3987
BF (cm)	.71 ±.08	.91 ±.38	.97 ±.46	1.52 ±.00	.94 ± .48	1.04 ±.28	.76 ±.00	.86 ±.43	.84 ±.30	.66 ±.38	.91 ±.58	.99 ±.33	0.8092
ABF (cm)	.74 ±.13	.99 ±.46	1.01 ±.53	1.72 ±.00	.99 ±.56	.96 ±.25	.76 ±.08	.91 ±.48	.84 ±.33	.71 ±.38	.97 ±.61	.97 ±.33	0.6892
REA (cm^2)	87.74 ±6.13	84.39 ±8.71	87.68 ±7.81	82.29 ±.00	86.39 ±9.68	86.39 ±7.74	85.81 ±7.29	79.35 ±5.29	82.39 ±9.23	85.16 ±6.45	79.81 ±7.23	78.65 ±3.87	0.3269
KPH (%)	2.17 ±.29	2.55 ±.76	2.57 ±.43	2.50 ±.00	2.37 ±.55	2.25 ±.38	3.00 ±.71	2.65 ±.75	2.81 ±.48	2.25 ±.65	2.56 ±.59	2.71 ±.49	0.5834
MARB	473 ±57^{c,d,e}	444 ±77^{e,f}	481 ±127^{c,d}	420 ± 0^{f}	421 ±83^{f}	450 ±104^{d,e,f}	710 ±127^{a}	435 ±114^{f}	499 ±61^{b,c}	363 ±21^{g}	451 ±94^{d,e,f}	523±96^{b}	0.0242
YG	1.47 ±.40	2.17 ±.74	2.09 ±.00	2.90 ±.00	2.08 ±.86	1.91 ±.49	2.05 ±.21	2.42 ±.65	2.22 ±.54	1.90 ±.57	2.45 ±.94	2.46 ±.64	0.5918

[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, MARB = USDA marbling score (300 = slight^{00}; 400 = small^{00}, 500 = modest^{00}, 600 = moderate^{00}, 700 = slightly abundant^{00}), YG = USDA yield grade.

[2]MAA = Mashona x Angus, MAB = Mashona x Angus-Brahman, MAR = Mashona x Angus-Romosinuano, MBB = Mashona x Brahman, MRB = Mashona x Romosinuano-Brahman, MRR = Mashona x Romosinuano, TAA = Tuli x Angus, TAB = Tuli x Angus-Brahman, TAR = Tuli x Angus-Romosinuano, TBB = Tuli x Brahman, TRB = Tuli x Romosinuano-Brahman, TRR = Tuli x Romosinuano

$^{a-h}$Breed types with different superscripts differ ($P < .05$)

Year 2 – Arrival Group Effects on Carcass Characteristics

Table 17 demonstrates how time of arrival effects carcass traits during the second year. Arrival group statistically affected hot carcass weight (P = 0.01), where calves arriving in group 3 weighed more (7.60 kg) than cattle arriving in group 4. Arrival group had no effect on back fat (P = 0.62) or adjusted back fat (P = 0.51), REA (P = 0.07), KPH (P = 0.57) USDA marbling score (P = 0.11), or USDA yield grade (P = 0.55).

Table 17. Carcass traits (least squares means ± SE) for early (3) and late (4) arrival groups in 2005-06

Item[1]	3	4	P-Value
N	57	56	
HCW (kg)	292.4 ± 29.9	284.8 ± 24.1	0.01
BF (cm)	.91 ± .41	.91 ± .43	0.6207
ABF (cm)	.94 ± .48	.94 ± .46	0.5086
REA (cm^2)	84.97 ± 8.65	82.13 ± 7.55	0.0664
KPH (%)	2.64 ± .53	2.45 ± .59	0.5656
MARB	487 ± 110	434 ± 83	0.1108
YG	2.17 ± .70	2.22 ± .74	0.5472

[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, MARB = USDA marbling score (300 = ^{slight00} 400 = small^{00}, etc.), YG = USDA yield grade.

Year 2 – Sex Effects on Carcass Characteristics

Table 18 illustrates sex influences on carcass traits during the second year. Sex statistically affected all carcass traits evaluated in this particular experiment except KPH (P = 0.07). Steers weighed 22.90 kg more (P < 0.0001) versus heifers. Heifers deposited more subcutaneous fat (P = .01 and P = .003). Steers had larger ribeye areas (5.09 cm^2). Heifers had 69 units higher (P = .0001) marbling scores than steers. Steers had 0.30 units lower (P = 0.07) yield grades compared to heifers.

Table 18. Carcass trait responses (least squares means ± SE) for heifers and steers in 2005-06

Item[1]	Heifers	Steers	P-Value
N	58	55	
HCW (kg)	277.5 ± 23.4	300.4 ± 26.6	<.0001
BF (cm)	1.02 ± .46	.81 ± .36	0.0045
ABF (cm)	1.04 ± .51	.84 ± .41	0.0034
REA (cm^2)	81.10 ± 8.32	86.19 ± 7.35	0.0001
KPH (%)	2.62 ± .55	2.46 ± .58	0.0703
MARB	494 ± 99	425 ± 91	0.0009
YG	2.34 ± .81	2.04 ± .57	0.0068

[1]HCW = hot carcass weight, BF = back fat, ABF = adjusted back fat, REA = ribeye area, KPH = kidney, pelvic, and heart fat, MARB = USDA marbling score (300 = ^{slight00} 400 = small^{00}, etc.), YG = USDA yield grade.

SUMMARY AND CONCLUSIONS

The overall results of this experiment clarified potential answers to questions regarding effects of growing program and breed type on performance and carcass characteristics. From a growing program standpoint, cattle placed directly on feed gained more during both years than calves on pasture during the entire growing stage. This was expected due to the cattle being on a concentrate diet versus foraging on Bermuda grass. Once brought together on a similar finishing diet, cattle grown on pasture experienced more overall gain during year 1 than calves developed on a concentrate diet. This fact was also speculated due to the compensatory gain benefits of the calves on a lower quality developing nutritional plane compared to cattle being started directly on feed. This was, however, not true for year 2, with growing program having no effect on overall average daily gain. Perhaps this was because of the implanting scheme used in year 2 and/or because of additional breed types.

With regard to effects on carcass quality and composition, growing program strategy seemed to influence carcass characteristics more in year 1 versus year 2. The major finding within the trial was the effect of growing program on USDA marbling score during year 1. Cattle grown on pasture marbled significantly greater than cattle started on a concentrate diet. This is inconsistent with studies suggesting marbling begins early and is affected by the quality and amount of nutrition. This was also inconsistent with year 2 findings where the cattle were considerably leaner at harvest. Perhaps implanting slowed the development of marbling more in cattle not on a high plane of nutrition upon weaning, or this simply may be a reflection of differences in fat thickness.

The effects of breed type on calf gain seemed to vary between years, and more than likely was because of the addition of Tuli bulls in the breeding system during year 2. During year 1, calves out of straight Angus cows outperformed calves comprised of Brahman and Romosinuano during the finishing stage. Meaning, the heterosis advantages typically seen in the beef industry was not present in this particular study. There were not any gain differences during the growing stage across breeds. During year 2, Tuli-sired calves out of straight Angus cows gained more during the overall growing phase than other cattle, but only two of these were in the study. Tuli-sired calves out of Angus x Romosinuano cows were second to TAA in gain during the growing stage. From a finishing standpoint, Tuli-sired cattle out of straight Brahman cows outgained cattle of other breed compositions. Tuli- and Mashona-sired cattle out of crossbred cows seemed to perform better than calves out of straight-bred cows, suggesting advantages due to heterosis effects.

Calf arrival time seemed to have an impact on gain during both years of the experiment. Cattle arriving in the early group outperformed late arrival calves during the growing stage for both years 1 and 2. This is probably attributed to the forage quality and availability during the growing stage. Early calves arrived in May, and had availability to higher quality grass with more protein. Cattle arriving in July and August were on lower quality forage due to maturation of the grass and due to the grass being heat stricken. It is also possible that differences in ambient temperature during these two times of the year influenced results, however this was not evaluated. Later-arriving calves did excel in the feedyard by outgaining early arrival cattle in both years. This may be another compensatory gain effect due to the late calves being on a low quality nutritional plane during the growing phase and excelling once on a higher quality nutritional plane. Arrival group had little effect on carcass characteristics. During year 1, cattle arriving in May had significantly more marbling than cattle that arrived in July. This could be due to the cattle in May being older and perhaps having more maturity upon harvest.

Evaluation of sex effects on gain concluded various results across both years. Surprisingly, during year 1, heifers outgained steers for the overall growing stage, but steers had higher gains for the entire finishing stage, which is to be expected because of steers being more efficient than heifers in a feedyard setting. For year 2, steers gained more than heifers for both the finishing and growing phases.

Sex differences in carcass characteristics seemed consistent for both years and with predicted outcomes. Steers railed heavier carcasses that had larger Longissimus areas, and lower numerical yield grades. Heifers had more subcutaneous fat and had substantially higher marbling scores versus steers in both years. All of these carcass findings are consistent with gains recorded, because steers outgained heifers, heavier hot carcass weights were expected. Also, steers were leaner than heifers which explain the marbling advantages of heifers, but also the yield advantages of steers.

Increasing production costs, particularly steadily rising feed and grain costs might limit the number of early-weaned calves that can be placed directly on feed, and therefore increase the number of stocker cattle placed on pasture. This will make them heavier, older, and probably spend fewer days on feed. Other considerations for early weaning programs include precipitation levels, because during a drought year cow body condition score can be improved if calves are weaned early, thus decreasing the amount of supplemental nutrition needed from a rebreeding standpoint.

Other research trials have studied the effects of early weaning on calves of English and European backgrounds and a few trials have evaluated different growing programs' effects on gain and carcass characteristics. Research involving *Bos indicus* cattle's response to early weaning has been limited, and so has the effects of different growing programs for early-weaned Brahman-influenced cattle. More research needs to be conducted on growing strategies for early-weaned, tropically adapted cattle, and its effect on both gain and carcass traits. More general studies on the effects of early weaning in *Bos indicus* cattle should also be evaluated to determine how *Bos indicus* cattle react to an early weaning program compared to a traditional, 205 d weaning protocol. Perhaps if this is known, adjustments within the growing programs can be made to optimize gain and carcass characteristics, and ultimately improving the profitability of *Bos indicus* cattle in a feedyard situation.

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