COMPARISON OF FEEDLOT PERFORMANCE, CARCASS MERIT AND CHEMICAL COMPOSITION OF CROSSBRED CATTLE

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DEDICATION

I would like to dedicate this dissertation to my wife Christina and my son Ruben Joseph. Your love and support made this possible.

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ABSTRACT

Feedlot performance, carcass merit and chemical composition were compared using Waguli , Brangus, Hereford x Tuli and Wagyu x Crossbred Gene Combination (CGC) breeds. Steers were penned in the following manner: 6 Waguli steers, 6 Hereford x Tuli, 6 Wagyu x CGC and 8 Brangus. There was a significant difference ($P < 0.05$) between Brangus and Waguli for ADGs. F:G was lower ($P<0.05$) for Hereford x Tuli compared to the other crossbreeds. A heavier final weight was observed ($P<0.05$) for the Wagyu x CGC than all other crossbreds. There was a significant difference ($P<0.05$) for REA between Wagyu x CGC and Hereford x Tuli and Waguli. Wagyu x CGC had higher shear force values (SFV) ($P<0.05$) than all other crossbreeds. Cost of gain was lower ($P<0.05$) for Hereford x Tuli compared the other breeds. Hereford x Tuli also had less protein ($P<0.05$) than to the other breeds.

A second study was conducted comparing limit feeding (LF) vs. full feeding (FF) strategies. 23 steers and 27 heifers were penned by sex and were randomly assigned a treatment; 4 pens received the LF treatment and 4 were FF. ADG was lower ($P<0.05$) for LF and FF heifers compared to both LF and FF steers. Dressing percentage was lower ($P<0.05$) for LF steers compared to LF and FF Heifers. LF heifers YG was higher ($P<0.05$) compared to FF steers. Quality grades were higher ($P<0.05$) for LF and FF heifers compared to LF and FF steers. REA /cwt was significantly higher ($P<0.05$) for FF heifers compared to LF and FF steers. SFV were

lower (P<0.05) for FF heifers compared to LF and FF steers. A significant difference (P<0.05) in cost of gain was noted between LF steers and the rest, also between LF heifers and FF steers. Primal cut price/cwt was significantly lower (P<0.05) for LF heifers compared to FF steers. Lipid percentage was higher (P<0.05) LF heifers compared to FF steers. Moisture percentage was lower (P<0.05) for LF heifer compared to the other groups.

Keywords: feedlot performance, carcass merit, beef cattle breeds, tenderness evaluation, soft tissue chemical composition, limit feeding,

CHAPTER 1:

INTRODUCTION STUDY #1 AND #2

For many years, the utilization of British cattle breeds (eg. Angus, Shorthorns, and Hereford) was the standard for the American beef producer. These types of cattle provided quality carcasses giving palatability to the consumer. However, there was one major disadvantage associated with these carcasses; they had excessive subcutaneous and intermuscular fat. This proved to be an issue for the packer and the consumer. The subcutaneous fat was generally not used for anything but a low value by-product. This became a loss for the packer because it diminished the total pounds of saleable product and the intermuscular fat caused the meat to be less desirable to the consumer. In an effort to improve yield grades, the U.S beef industry initiated the use of crossbreeding. In today's feedlots, the majority of the cattle on feed are crossbreds.

In today's beef market, the main consideration is how to have the highest percentage of quality grade Choice with a yield grade 2 using the least amount of investment (time, environment and capital). Achieving this goal is important to the producer and consumer alike and therefore the evaluation of traits that crossbred calves yield is necessary to optimize production.

Additionally, feeding protocols can greatly change the efficiency outcome of cattle on feed. Feeding strategies such as limit feeding and feeding more than once daily can potentially improve feed efficiency. Limit feeding is also a great strategy to have more beef produced by a single animal. Moreover, limit feeding may allow feedlots to market their cattle at a more profitable time.

In study #1, Waguli steers were compared to Wagyu x CGC, Hereford x Tuli and the Brangus breeds comparing feedlot performance and carcass merit. Feedlot performance was determined on the following: Average Daily Gain (ADG), Feed to Gain ratio(F:G) and cost of gain, while data such as dressing percentage, quality grade, yield grade, tenderness evaluation and chemical composition of the animal were used to determine carcass merit. The overall objective of this study was to compare Waguli's feedlot performance and carcass merit to other crossbred animals.

In study #2, different crossbred cattle (Waguli, Hereford, Angus) were fed using limit feeding. Feedlot performance was determined on the following: ADG, F:G and cost of gain, while data such as dressing percentage, quality grade, yield grade, tenderness evaluation and chemical composition of the animal. The overall objective of this study was to compare once a day feeding at libitum to limit feeding and evaluate feedlot performance, carcass merit and chemical composition of the carcasses.

CHAPTER 2:

LITERATURE REVIEW

Section 2.1: The Crossbreeding System

While most characteristics of purebred cattle are widely known, most cattle in the United States are crossbreds expressing many traits. Crossbreeding programs are used throughout the world because of the vast possibilities of traits they offer. These programs allow for the creation of elite combinations of the most favorable genotypic and phenotypic traits from the various breeds of cattle. This result can also be termed as heterosis. Heterosis can more accurately be defined as offspring that have superior qualities than both parents and will perform well in several different scenarios. Heteroris can be individual, maternal or paternal, with maternal having the greatest influence. This proves to be an advantage of the crossbreeding system which allows for heterosis or hybrid vigor meaning crossbred cattle are more complimentary. Additionally, Franke (1980) found that crossbred cattle will grow faster, grade higher, have more backfat and have a lower shear force value than pure breed parents.

Currently there are several different strategies to creating a productive and profitable crossbreeding program. One crossbreeding program is to combine different types or breeds of cattle. *Bos taurus* cattle breeds can be categorized into two types: British or Continental. Popular British breeds are Angus and Hereford and some Continental breeds include Charolais, Limousin and Gelbvieh. In crossbreeding these types, the British breeds (Hereford, Angus and Shorthorn) offer their ability to increase the quality of the carcass (Casas et al., 2005), whereas the Continental breeds bring increased performance and improved muscling, creating a more desirable meat product. A study conducted by Comerford and associates (1998) found that the Continental breeds (Simmental and Limousin) had significantly greater REA when compared to Hereford and Brahman. It was also noted by Comerford and associates that when the Simmental and Limousin breeds were used in a crossbreeding program their influence tended to increase REA in the offspring.

These crossbred animals allow the rancher to retain high marbling characteristics, while increasing muscling and decreasing subcutaneous fat. An example of a developed breed obtained by crossing a Continental with a British is the Balancer. The Balancer is the hybrid result of the Gelbvieh breed crossed with an Angus. This cross offers better performing cattle (eg. ADG, F:G) with high marbling or intramuscular fat (American Gelvieh Association, 2011).

Another crossbreeding program that is traditionally used is to compare two sub species of cattle: *Bos taurus* and *Bos indicus*. *Bos taurus* cattle generally include European cattle that are more adapted to cooler climates, whereas the *Bos indicus* (or Zebu) are more adapted to hot climates and are more drought resistant. As a result of these characteristics, *Bos indicus* cattle are shipped to places where heat and parasites lowered productivity (Herring et al., 1996). Crossing these two sub-species, resulted in keeping the favorable carcass traits of the British/Continental breeds, while increasing the cattle's resistance to disease and harsh weather conditions (e.g. Heat Tolerance). Beaver et al. (1989) found that *Bos indicus* cattle had smaller organs and less internal, making their maintenance requirements low. When low quality forage was fed to *Bos indicus* and *Bos taurus cattle*, Zebu cattle were shown to better utilize and digest higher amounts of dry matter (DM) (Beaver et al., 1989). The combination of these advantages makes *Bos indicus* cattle, the excellent source to provide heat tolerance and hardiness genes.

Paschal and associates (1994) found that the more commonly used *Bos inducus* breeds are the Red and Gray Brahman. This is due to the lack of availability of the other various Zebu breeds (Paschal et al., 1994). According to Herring et al., Brahman are high in fertility, milk production and longevity (1996). Furthermore, commercial herds in more temperate areas, have an increased percentage of *Bos indicus* influenced cattle because of higher productivity by the cow, as well as calving ease by *Bos indicus* x *Bos taurus* cattle (Paschal et al. 1994). However, they have been found to have delayed age of puberty, newborn calves with lower vigor, and carcasses that have less intramuscular fat and less tender beef when compared to the *Bos taurus* (Herring et al., 1996). Despite these disadvantages, Brahmans still show an economic advantage in a "market-based system" because of their growth characteristics (Herring et. al., 1996). Data suggest that a level of three-eighths for maximum *Bos indicus* to achieve positive heterosis effect and no negative effects on tenderness (Leheska and Montgomery, 2009). Johnson et al. (1980), reported that top loin steaks with the ¼ Brahman influence did not have a significant difference in tenderness when compared to 100% Angus top loin steaks. Furthermore, other researchers quoted by Johnson et al. (1980) reported that tenderness was only significant in cattle possessing 50% plus Brahman. Some examples of breeds that have a Brahman influence include: Brangus, Braford and Droughtmaster. These breeds are especially important to use in feedlots that are located in hot/dry areas, such as Southeast Texas.

There are more aggressive crossbreeding programs that attempt to combine all the positive traits associated with British, Continental, and Brahman (*Bos indicus*) cattle. One example, developed at the King Ranch in Texas, was a breed called Santa Cruz. This breed was created in the late 1980s in response to the need for more "market appropriate" cattle. The Santa Cruz is a composite breed combining the Santa Getrudis (Shorthorn x Brahman), Red Angus and the Gelbvieh. This combination yielded cattle that had superior traits in both the feedlot and seedstock scenarios (Breeds of Livestock, 1995-2009). Like the Santa Cruz, the Southern Balancer breed was developed with the diverse production environments in mind. The Southern Balancer breed is composed of a minimum of 25 % Gelbvieh, 6.25%-50% heat tolerance (Brangus, Beefmaster, Braford, Brahman, Brangus, Red Brangus, Senepol and Santa Gertrudis) and the remaining percentage is comprised of Angus or Red Angus. According to the American Gelbvieh Association 2011, the Southern Balancer, is heat tolerant and can withstand humid environments. Furthermore, milk production, fertility, pounds of weaned calf and carcass consistency are also favorable traits offered by the Southern Balancer.

It is essential to keep finding new combinations of breeds that will perform better under various environmental and situational conditions. The Southwest United States is a semi-arid region that has benefited from the influence of heat-tolerant breeds. Brahman influenced cattle have been the standard for most producers (Paschal et al 1994). However, despite their hardiness, the disadvantage of Brahman carcasses is the low marbling and high shear force values. In addition, due to lower meat quality, feeding and packing industries discriminate against heavily Brahman-influenced cattle (Johnson et al. 1986). Even though profitability and overall production have increased by using *Bos indicus* cattle, a decline of its use has been observed due to the concern for tender beef (Montgomery et al., 2004) Tenderness is mostly affected by the suppression of calpain (a tenderness enzyme), by calpastain, which is higher in *Bos indicus* cattle(Mongomery et al. ,2004). With this in mind, two breeds have been developed and fused to fulfill these requirements. The names of these two breeds are the Wagyu and the Tuli. Alone they possess traits that complement the other one. Moreover, when these two breeds are combined they produce exceptional carcasses.

According to Ibrahim et al.(2008) the Wagyu breed, which originated in Japan, is a moderately framed animal whose carcass is superior in marbling and whose ribeye has low shear force values and excellent palatability. However, it has been reported that Wagyu and Wagyu crossbred cattle have decreased feedlot performance and decreased red meat yield (Radunz et al., 2009). The Tuli breed is known as a Sanga breed, which resulted from the crossing of a *Bos indicus* and *Bos taurus* thousands of years ago in South Africa (Ojango et at., 2006) Looking at the Tuli breed, Herring et al. (1996) found that when compared with other heat-tolerant breeds, the Tuli reaches larger skeletal maturity, has more marbling, and a lower shear value, which is advantageous in a value-based market system. Herring et al. (1996) reported no difference in shear force values between Brahman-sired steers and Tuli-sired steers. The Tuli has also been recognized for their acute foraging ability and increased parasitic resistance, which is a commonality among other African Zebu breeds (Ojango et al., 2006). Tuli-sired steers had higher marbling scores than did Brahman-sired steers, but showed no difference to the Boran-sired steers (Herring et al., 1996).

The cross between these two exceptionally different breeds resulted in the Waguli. The Waguli was further developed at the University of Arizona V-V Ranch (Ibrahim et al., 2008). This breed was developed to yield animals that have the superior carcass merit of the Wagyu while retaining the heat tolerance of the Tuli. The Waguli breed and their crosses produce high quality carcasses.

A breed regularly used in hot/humid climates is the Brangus. Brangus cattle are 5/8 Angus and 3/8 Brahman which makes a hardier breed, while retaining the desirable carcass qualities of the Angus. The Brahman influence also makes the animal produce less subcutaneous fat as well as intermuscular fat. This breed offers great maternal instincts and hardiness from the Brahman side and the superior carcass qualities from Angus.

The Crossbred Gene Combination (CGC) is ½ Angus, ¼ Charolais and ¼ Tarantaise. CGC has all the ingredients to be an excellent breed; Angus provides superior marbling, Charolais add the exceptional muscling and Tarantaise add the resistance to high temperature because it is a high altitude breed. It is suggested that high altitude breeds will have a similar resistance to heat stress as Brahman cattle. When animals are heat stressed, heat shock proteins are up-regulated. Likewise, when mammals are at high altitudes, they tend to produce more heat shock proteins (Wang et al., 2006). As a result, animals that have evolved at higher elevations tend to be more heat stress resistant.

Section 2.2: Feedlot Performance

Overall feeding efficiency of cattle is extremely important with scarce grain supplies. Average daily gain (ADG) and feed to gain (F:G) are important measurements that indicate the overall efficiency and profitability of an animal. For years, British breeds dominated the feedlot industry, but their excessive waste fat was an undesirable trait for producers and consumers alike. Casas and Cundiff showed that British breeds have larger amounts of subcutaneous and intermuscular fat when compared to Norwegian Red, Swedish Red and White, Fresian and Wagyu cattle (2006). This is a disadvantage for producers because it lowers profitability due to increased waste of the carcass. This is also unwanted by the consumers as society continues to be more health conscious and averse to saturated fats. In today's market, crossbred cattle dominate feedlots, taking advantage of desirable genetic traits.

Cattle temperament may also influence performance in feedlot situations. Findings by Café and associates (2010) suggest that Brahman influenced cattle have negative effects on growth rates, feed intake, and time spent eating, thus reducing efficiency; conversely for, Angus growth rate , feed intakes and time spent eating were not affected by their temperament. Sherbeck et al. (1995) found that straight Hereford steers had higher ADG than did Hereford x Brahman crossbreds. Opposing research showed that 50% Brahman and75% Brahman crossbreds had higher feed consumption, higher ADG and heavier final weights (Huffman et. al., 1990).

Steers enter feedlots at various weights and ages. It has been noted by Schoonmaker and associates (2004) that early weaned cattle will have better feedlot performance when compared to yearlings. Therefore, feed efficiency will be superior at an early stage of feeding (compensatory growth, bone and muscle). On the other hand, older steers will only be producing fat which takes longer to deposit.

Section 2.3: Limit Feeding

Arizona's feedlot industry is mainly composed of Holstein cattle. Cattle's feed efficiency can be greatly reduced by extreme heat that is experienced during the summer months. Feed efficiency is compromised due to the elevated temperatures, causing reduced feed intake, reduced body weight gain, and death in extreme cases (Mader et al., 2002). Additionally, a study conducted by Johnson et al. (1980), provided results that suggest tend to have higher shear force values if feed on a in a warm rather than a cool season. Davis et al.(2003) propose that changing cattle's feeding time and amount of feed can reduce body temperature of feedlot cattle. Limit feeding strategy can be used, this works by feeding lower amounts of feed to target gain and allow skeletal and muscle development can be used. Mader and associates (2002) suggest that limit feeding is a proven successful management technique that reduces the negative effects of climatic and metabolic heat load; therefore, improving animal comfort. Even though there are benefits to limit-feeding, Felix and associates (2011) suggest that there are a decreased percentage of carcasses grading USDA Choice or better. Also, McCurdy et al., (2009) reported that cattle that are placed on a grass growing program before finishing, will cause them to have lower marbling scores compared to cattle finished right after weaning, but there will be no significant difference if cattle are fed grain during the growing phase(similar to limit-feeding). However, if all cattle are fed to the same fat thickness (12th rib) end point, there will not be any significant difference in carcass quality and composition (McCurdy et al., 2009). Supporting McCurdy et al. (2009), Wertz et al. (2001), suggest that feeding cattle to the same fat thickness endpoint will yield similar quality grades. On the contrast, cattle fed to the same fat thickness endpoint on either cool or warm season, had different results, cool season calves showed lower shear force values and higher marbling (Johnson et al.,1980). However, days on feed where higher for cool season calves and more high concentrate feedstuffs where consumed (Johnson et al., 1980).

There are many approaches to feed cattle. Limit feeding is a management practice that manipulates feed intake to have a better utilization of nutrients and to improve feed efficiency (Wertz et al., 2001). Additionally, animals that have undergone a nutrient restriction will have compensatory gain when nutrients in excess are consumed (Reinhardt et al., 1998). This mean that these animals will have above average gains because of better utilization of nutrients. This presents an opportunity to manage cattle harvest time and be more profitable. Lower intake will cause the rate of passage to be slower allowing more digestion and absorption to take place. Consequently, long-term ruminal health is improved (Reinhardt et al.,1998). This program is designed to target a specific average daily gain allowing the animal to have constant growth. This constant growth allows cattle to have a better structural development, resulting in greater REA's, thus more muscle at the same body weight of non-limit-fed animals (Felix et al., 2001). Moreover, McCurdy et al.(2009) reported that cattle that undergo a growing program will have higher

HCW when compared to cattle that were fed a finishing diet right after weaning, suggesting that frame development is very important. Furthermore, cattle that are limit fed have lower daily intake and higher feed efficiency when compared to cattle fed ad libitum (Loerch and Fluharty, 1998), but it reduces the rate of gain, reduces carcass fat, and increases feeding time to achieve market weight and body condition (Schoomaker et al. 2004).

Another way to limit feeding is by restricting the energy concentration found in the ration. This can be achieved by increasing the percentage of roughage in the ration and decreasing the percentage of grain and/or tallow. Wertz et al., 2001 used many approaches such as wet corn gluten feed (WCGF)- hay, ad libitum WCGF-corn, dry corn gluten feed (DCGF)-corn, DCGF- corn silage; the results showed that feed efficiency is not compromised by feeding CGF. A problem that occurs by increasing roughage is that cattle will be so full that the target gain will not be reached. What this means for feeders is that concentrate percentages should still be higher than roughage percentage. This is supported by the findings of Wertz and associates, (2001), which show that when limit feeding a high energy source, in their case WCGF- corn and DCGF- corn, will produce better results than hay or silage. Shoomaker and associates, (2004) reported that feeding a high forage diet from 119 to 260 days of age increased final intramuscular fat and extended the growth curve, but was less efficient and may have implication due to age of harvest.

Limit feeding may affect marbling, thus affecting eating quality. Wertz et al., (2001) reported that when limit fed or ad libitum heifers are fed a common length of time, limit fed heifers had lighter carcass and lower marbling scores. Felix et al. (2011) reported that the source of energy (limit fed) may have an impact on marbling, distillers grain with soluble diet increased marbling when fed at the growing stage, whereas a corn based diet decreased marbling when fed during the growing phase. Palatability of beef takes into account, tenderness, juiciness and flavor, which are all related to intramuscular fat. A study conducted in Japan by Khounsaknalth and associates,(2011) found that a majority of consumers rate beef coming from high hay diets as extremely delicious, while 62.5 % thought grass only diet was acceptable. In this study, a high hay system reduced environmental impact and had an impressive taste according to the findings of Khounsaknalth et al., (2011). Various panels conducted at the University of Arizona show that 63% of consumers prefer high marbled beef (Unpublished data).

Section 2.4: Carcass Characteristics

Customer acceptance of beef depends on many factors. These factors include: tenderness, juiciness, flavor, aroma, texture, and color. The breed of the animal, along with degree of finish and age of the animal will affect these factors dramatically. The degree of marbling or intramuscular fat considerably affects juiciness and flavor; therefore, increasing customer acceptance of beef products.

Carcasses are graded on a quality basis. Quality grades, from highest to lowest, include: Prime, Choice, Select, Standard, Commercial, Utility, Cutter and Canner. Quality grades are obtained by combining maturity, marbling, color of lean, firmness of lean and texture of lean. Maturity is determined by observing the shape, size and degree of ossification of cartilage in the lumbar, sacral and vertebral areas. Additionally, other indications of maturity are color, texture and firmness of the lean. Older cattle (30+ months) will have tougher, coarser textured and darker red colored lean, due to the increased myoglobin concentration (Ojha, 2009). Whereas, younger cattle (< 30 months) will have lean that is a light grayish red color and more fine in its texture.

As marbling increases the quality grade increases. Marbling is expressed in terms of quantity as follows: abundant, moderately abundant, slightly abundant, moderate, modest, small, slight, traces, practically devoid and devoid. As marbling increases, shear force values decrease, thus the meat is more tender and better accepted by the consumer.

Yield grade reflects the amount of saleable product. More saleable product means a lower yield grade of the carcass. Research has shown that cattle with 0.4 in. back fat thickness, measured at the 12th rib, will most likely have a yield grade 2, which is very desirable in today's market (Boleman, 1998). Block and associates (2001) found that larger frame/late maturing cattle, such as the Charolais, will have less subcutaneous fat when compared to the traditionally early maturing/medium framed Hereford or Angus cross cattle. Additionally, Herring et al. (1996) reported no significant difference between Brahman, Boran and Tuli sired steers or heifers when comparing yield grades.

Section 2.5: Carcass Merit and Tenderness

Tenderness is one of the biggest factors that affect the purchasing decision and the acceptability of the consumer; therefore, it is important to produce more tender beef. Furthermore, studies have shown that consumers will pay a premium for a guaranteed tender product (Brooks et al., 1998 and Barham et al., 2004) making tender beef an important goal for producers to increase profitability. Carcasses with acceptable tenderness could be worth up to $76 more than tougher carcasses (Barham et al., 2004). One way to evaluate tenderness is by the pounds of force (measured in pressure) needed to shear through a core sample of the cooked ribeye muscle. To measure this, the Warner-Bratzler shear force machine is used. The machine and method was developed by K.F. Warner (USDA Research Scientist) in 1928, it was later revised and modified by L.J. Bratzler (Graduate student Kansas State University) in 1932 and has been the standard for determining tenderness in the meat industry (Makenna, 2000). A series of studies were conducted and data collected was used to create a tenderness scale with the use of the machine. Research has shown that 95% of the population would rate 7.0 lbs of force or less to be tender; 68% would rate 8.6 lbs of force slightly tender; and 88% would rate 10.1 lbs of force to be tough(Makenna, 2000).

The main factors that affect consumer acceptability of beef are tenderness, degree of marbling and appearance (color, texture and firmness). The three contributors to tenderness are sarcomere length, muscle or connective tissue proteins and most importantly proteolytic degradation (calpain and calpastatin activity) (Brewer and Novakofski, 2008). The calpains will allow muscle fiber degradation, thus tenderizing the beef, while calpastatin will antagonize calpain not allowing it to carry out the degradation process. Many researchers have shown Brahman influenced cattle to have higher shear force values and less acceptability in tenderness score sensory panel (Johnson et. al.,1986). Shear force values under 7 lbs. are very tender and their value increases, toughness increases also. According to Ibrahim et al. (2008) high levels of calpastatin found in the Brahman account for the toughness of the beef, on the other hand, Waguli steers have significantly less calpastatin (P=0.02). It was found by Sherbeck and associates (1995), that as the percentage of Brahman breeding increased , tenderness and juiciness decrease and shear force values increased.

Furthermore, appearance at the grocery store is very important when beef is being purchased. Dark cutters are usually discounted greatly. This results from pre-harvest stress that may be caused by many factors such as weather, growth promoters, genetics, disposition, and handling practices before harvest (Scanga et al., 1998). Catecholamines may cause glycogen depletion and dopamine has been shown to have an effect on cortisol secretion and glycogen metabolism (Muchenje et al., 2008). The type of stress has no effect on the outcome, which is that muscle glycogen stores are depleted, as a result there is not sufficient glycogen to produce lactic acid and a reduction on pH does not occurs in the muscle. Consequently, light absorption and water binding abilities are increased by the high pH (>6.0), resulting in dark, dry and firm (DDF) meat which is very undesirable in the market (Scanga et al., 1998). Moreover, high pH may allow microbial growth causing off odors and slime formation (Muchenje et al., 2008). Scanga et al.,(1998) reported a greater percentage of dark cutters and when heifers were re-implanted with estrogenic implants. Also, during periods of hot weather dark cutters for heifers increased when compared to steers (Scanga et al., 1998).

To improve tenderness of the longissimus muscle (LM), high voltage electrical stimulation (ES) is an option which in turn improves quality grade and color of the meat (Roeber et al., 2000). This technique is applied after bleeding of the animal. Electrical stimulation is used in the industry extensively. The massive amount of electricity allows the sarcomeres to breakdown leading to muscle relaxation, thus causing the muscle to become tender. Roeber et al., (2000) found that all carcasses that were treated with ES had lower Warner-Bratzler Shear values than those that were not treated carcasses. Furthermore, it was also found that marbling scores did not differ between electrically stimulated carcasses and those with no stimulation (Roeber et al., 2000). However, since color is increased, graders can better observe marbling, consequently 10% more carcasses will grade Choice (J.A. Marchello, personal communication, August 11, 2011).

Section 2.6: Aging

Another technique that is used in the meat packing industry is dry or wet aging. Brewer and Novakofski (2008) stated that the meat tenderness and its components (i.e. myofibrillar, connective tissue and chemical components) are affected by the postmortem process. According to Epley (1992), aging allows proteolitic enzymes to break down muscle fibers affecting beef tenderness; this technique improves tenderness and also enhances flavor. Research has shown that by extending the aging time from 6 to 18 days, shear force values improve by 20% and panel tenderness ratings by 14%. Research by Barham and associates (2003) showed that tenderness did not differ between non-implanted animals versus implanted animals. Furthermore, a 19 day aging period has proved to be sufficient for steaks to have a 93 % to 98% consumer acceptability (Barham et al., 2003). Brewer and Novakofski (2008) reported that aging increases tenderness after one week, with tougher steaks (initially) having the greater improvement. Mongomery and Leheska mentioned that *Bos Indicus* and Continental cattle may have less tender meat; however, great improvement in WBSF have been noted at 7 days post mortem.

Section 2.7: Economics

Feed efficiency and average daily gain are the two most important metrics in analyzing feedlot performance. Cattle that are poor convertors will reduce profit and increase breakeven pricing. Furthermore, commodity prices are increasing daily due to reasons from drought, subsidizing of corn for ethanol production and exporting of commodities to better markets. Feedlot owner are said to be losing thousands of dollar each year. Successful feedlots will accurately predict cattle's performance using sex, breed age, initial BW.

A way to improve feed efficiency is through the use of estrogenic or androgenic implants. Smith et al., (2007) reported that by using implants, ADG was improved in heifers by 36% and 16% in steers. Furthermore, HCW and LM area (sixth and ninth rib) was increased. The use of implants may have variable outcomes. Research shows that the use of an implant, will increase feed efficiency, but will have negative effects on carcass quality, shear force values, and consumer acceptability. Quoted in Smith et al., (2007), implants have an inverse relationship between marbling score and REA, causing marbling to be diluted in the larger muscle. Also Smith et al., (2007) showed that implanted cattle did not differ in dressing percentage, fat thickness, percentage KPH, yield grade or marbling score. Other research has proven that the use of implants did not have any detrimental effects on beef tenderness. (Barham et al., 2003)

The break-even price is greatly reduced by many products that can be given to cattle. Hormone implants will help cattle grow faster thus reducing time on feed. Barham and associates (2003), have reported that the use of a moderate implant program in *Bos indicus*-influenced cattle has no detrimental effect on beef tenderness and consumer acceptability. Contrarily, quoted by Barham et al., (2003) various researchers have found that carcass quality and tenderness is affected negatively by implants.

Ionophores such as Monensin or Rumensin will shift bacterial population so bacteria that produce propionate are more proliferate thus causing better F:G and ADG. Beta agonist such as Zilmax (zilpaterol hydrochloride) and Optiflex (ractopamine hydrochloride) will increase muscling, increasing HCW with a small effect on marbling. Montgomery et al., (2008) revealed that when feeding zilpaterol hydrochloride to steers and heifers ADG was increased by 36 and 18 % and G:F was increased by 28 and 21% for steers and heifers respectively.

Harvesting and packing plants profit depend greatly on the "drop value" for cattle. Even though beef prices are very high when compared to other protein sources such as chicken and pork, they are still relatively inexpensive. The average American consumes 116 pounds of meat a year, with 65 pounds being beef. Beef consumption is decreasing greatly due to pricing. An advantage to beef over other animal proteins is that it has several valuable products other than retail protein. These products include the hide for leather production and collagen, blood for feed and sausages, organs such as liver, heart, intestines, tripe and kidneys, variety meats like the head meat, tongue and oxtail, and various glands for pharmaceutical products. If the value of the drop decreases the price of beef has to be increased to make profit.

The grid marketing system is usually a more profitable way to sell if the animals being sold are of a *Bos taurus* descent. These animals will usually have better quality grade, making them more desirable carcasses and therefore more profitable. The base price is at a choice carcass with a yield grade of 3. If the quality grade increased the value will go up and if the yield grade decreased the price will go up. As mentioned before, abnormalities with carcasses will reduce value. DDF beef will be reduced significantly due to the fact that consumers will reject it in the grocery stores. Bruised carcasses and injection sites were common, but have been greatly reduced with the help of programs such as Beef Quality Assurance (BQA).

Technology that has allowed feedlots to stay afloat can sometimes be detrimental to the quality of carcasses. The use of Beta-adrenergic agonists such as zilpaterol hydrochloride and ractopamine hydrochloride enhances utilization of nutrients found in the diet and promotes carcass muscle deposition. Furthermore, ADG will increase and F:G will decrease. Montgomery et al.,(2008) reported that feeding zilpaterol hydrochloride to both steers and heifers REA was increased, YG was decreased, and marbling score and quality grade were decreased. The biggest concern is that it reduces tenderness and flavor. Essentially, they cause an increased size in muscle fibers diluting the amount of intramuscular fat found in the carcass; thus making it less flavorful and tougher. Leheska et al., (2009) reported that feeding zilpaterol hydrochloride had negative effects on tenderness and palatability traits.

The value added by selling wholesale cuts is significant. The most important aspect of this is that beef can be put into bags and boxed for shipment throughout the world. This means that it is less costly to transport because less space is used and therefore the consumer will get a less expensive cut of beef.

Section 2.8: Soft Tissue Chemical Composition

Beef is a great source of protein, iron and zinc. Protein from meat has a high biological value, which means that it can be absorbed easily and used for bodily functions. Beef fat is a rich natural source of CLA, which has been shown to have health benefits (Lehska et al., 2008), although, consumers are concerned about the degree of fat found in beef; due to bio-hydrogenation beef will have a high concentration of saturated fatty acids, which in return can cause high cholesterol levels in the blood (Lehska et al., 2008). Also, beef is a great source for essential amino acids that cannot be synthesized by the human body. The composition of a lean cut of beef is as follow, 18% protein, 75.5 % water, 3% lipid and 1 % mineral(Ojha, 2009). In case of the carcass, the composition will change. A study conducted at the University of Arizona reported that chemical composition for a number of steers fed as yearling were as follows: 15.5 % protein, 25.5% lipid and

57.0% moisture for the boneless carcass (Marchello et a., 1985). Using specific gravity to chemical characteristics of steers, Mata-Hernandez et al., (1981) reported that the chemical composition for various calves and yearling steers was 15.5% protein, 25.5% lipid and 57% moisture. Another study compared grass and grain finished beef found that strip steaks from grain fed cattle had 23.2% percent protein, 4.4% fat and 71.6% moisture(Leheska et al., 2008). Furthermore, protein percentage will be similar in most fed cattle, but what will vary is lipid and moisture percentage of the carcass. Also, lipid and moisture will have an inverse relationship. If the lipid percentage is higher moisture will be lower and vice versa (Ojha, 2009). Also, agreeing with this inverse relationship Leheska et. al,(2008) reported that when comparing a leaner grass fed ground beef to a fatter grain fed ground beef, as fat increased, moisture content decreased.

CHAPTER 3:

MATERIALS AND METHODS STUDY #1 AND #2

All procedures involving animal care and management were approved by the University of Arizona Institutional Animal Care and Use Committee (IACUC; No. 08-147).

Section 3.1: Feedlot Performance Study #1

A total of 18 steers were obtained from the University of Arizona's V-V ranch. The breakdown of the steer breeds are as follows: 6 Waguli, 6 Waygu x CGC, and 6 Hereford x Tuli. The steers traveled 207 miles and were received at the University of Arizona feedlot on October 19, 2009. A second lot of cattle (8 Brangus steers) were received from La Playa Ranch in Sonora, Mexico, (180 miles)on the 14th of January.

All steers were started on high quality alfalfa hay for the first 2 days of the trial. On day 3, the steers received a 70% concentrate diet, the concentrate percentage increased until 90% concentrate was reached (Table 1). Step 1 Starter was given for 21 days, Step 2 for through Step 4 for 14 days each and finally Step, the finishing diet was fed for the remainder of the trial. Steam-flaked corn was fed as the energy/carbohydrate source and alfalfa hay was the roughage source. Also included in the diet was molasses, soybean meal, mineral premix, rumensin/tylan and urea.

It should be noted, that the steers in this trial did not receive any implants like most cattle that enter feedlots.

Table 1. Step1 Starter Diet – Step 5 Finishing diet

Commodity	Step 1 % of Ration	Step 2 % of Ration	Step 3 % of Ration	Step 4 % of Ration	Step 5 % of Ration
Corn	60.43	61.86	67.04	72.17	76.39
Alfalfa	28.38	23.14	18.42	13.73	9.11
Molasses	6.31	6.38	6.34	6.31	6.28
Mineral Mix	1.94	4.73	4.24	3.75	4.19
Soybean Meal	1.94	2.16	2.15	2.14	2.13
Pre-mix (Rumensin/Tylan)	1.00	1.00	1.00	1.00	1.00
Urea	0	0.73	0.81	0.90	0.90

The feed bunk was managed using a slick bunk approach. The slick bunk approach is designed so the animals finish the feed ~1 hour before the next feeding time. The bunk was evaluated at 0700 daily and then the amount of feed to be offered was determined on that basis. Additionally, total pounds of feed consumed were recorded daily.

Steer weights were recorded upon arrival and every 28 days after. Weight measurements were taken in the morning before steers were fed to obtain a more accurate “empty” weight. Fat thickness measurements were obtained by using an ultrasound. Ultrasound readings, using a Aloka SSD-500V ultrasound machine equipped with a 5.0-MHz probe (Aloka Co. Ltd., Ithaca, NY), were initiated once steers reached 900 lbs. and every 28 days until desired fat thickness at the 12th rib was reached(Figure 1). Steers were harvested when back fat at the 12th rib reached 0.4in. Steers that did not reach 0.4 in. fat thickness, were harvested when weight gain plateaued over one weigh period. F:G and ADG were calculated for the every 28 day period and averaged among the breeds. Boleman (1998) suggests that "the optimum steer should possess sufficient marbling (0.4" of back-fat opposite the ribeye) and still maintain a yield grade in the 2.0-2.9 range." . This method allows for the determination of the necessary fat thickness to obtain optimum yield and quality grade.

Section 3.2: Feedlot Performance Study #2

A study was designed to determine if limit-feeding is beneficial for use in Arizona. A total of 40 head of cattle (23 steers and 27 heifers) were obtained from the University of Arizona's V-V Ranch. The cattle were penned by sex and were randomly assigned a treatment. 4 pens received the limit feeding treatment (20% less than their counterparts) and 4 were fed using the slick bunk approach. Average weight for the cattle was 378 lbs.

Eight pens of growing cattle were separated by weight and sex, 4 pens received at libitum feed (3 steers pens and 1 heifer pen) and 4 received a limited intake ration (1 steer pen and 3 heifer pens). Cattle were weighed upon arrival to the feedlot and every 28 days after. Fat thickness measurements were obtained using an ultrasound once the steers reached 900 lbs. and every 28 days until desired back fat thickness was reached. Steers were harvested when fat thickness at the 12th rib reached 0.4 in. Steers that did not reach .4 in. fat thickness were harvested when weight gain plateaued. Following this method allowed for the determination of the necessary fat thickness to obtain the optimum yield and quality grade. Feedlot performance and carcass merit were collected. Furthermore, chemical composition data was obtained using a procedure developed by Marchello et al., (1983).

Section 3.3: Harvesting Method Study #1 and #2

When steers reached harvest criteria, they were transported from the UA Feedlot to the University of Arizona Food Product and Safety Lab. Steers were delivered one day before they were to be harvested and were not fed the night of arrival in order to reduce the fill of the animal; all animals had access to water. Fill refers to the amount of material found inside the animal's digestive tract. Steers were weighed the morning of the day they were to be harvested. Captive bolt (4100R Jarvis Industries, Calgary AB, Canada) was used to render the animal unconscious, which was followed by exsanguination of the animal achieved by cutting the carotid artery. Upon exsanguination, the use of the Jarvis low voltage beef stimulator (model ES-4, Jarvis Products Corp, Middleton, CT) was applied to deliver 300 volts of electricity for 30 seconds to each carcass, in order to improve tenderness and color. After carcasses where split and trimmed they were weighed and recorded (Mettler Toledo, Colombus, OH). Carcasses were examined and trimmed for any external particles and were sprayed with acetic acid to reduce and retard bacterial growth, if any were present. Carcasses were then moved in to the hotbox (33 °F) to begin the chilling process and after 48 hours moved into the cooler (35 °F) for the dry aging process.

Section 3.4: Carcass Data Study #1 and #2

Carcasses were dry aged for 14 days. On the 15th day, carcasses were ribbed between the 12th and 13th rib. Ribbing is when a cut is made to expose the longissmus muscle (ribeye) for evaluation.

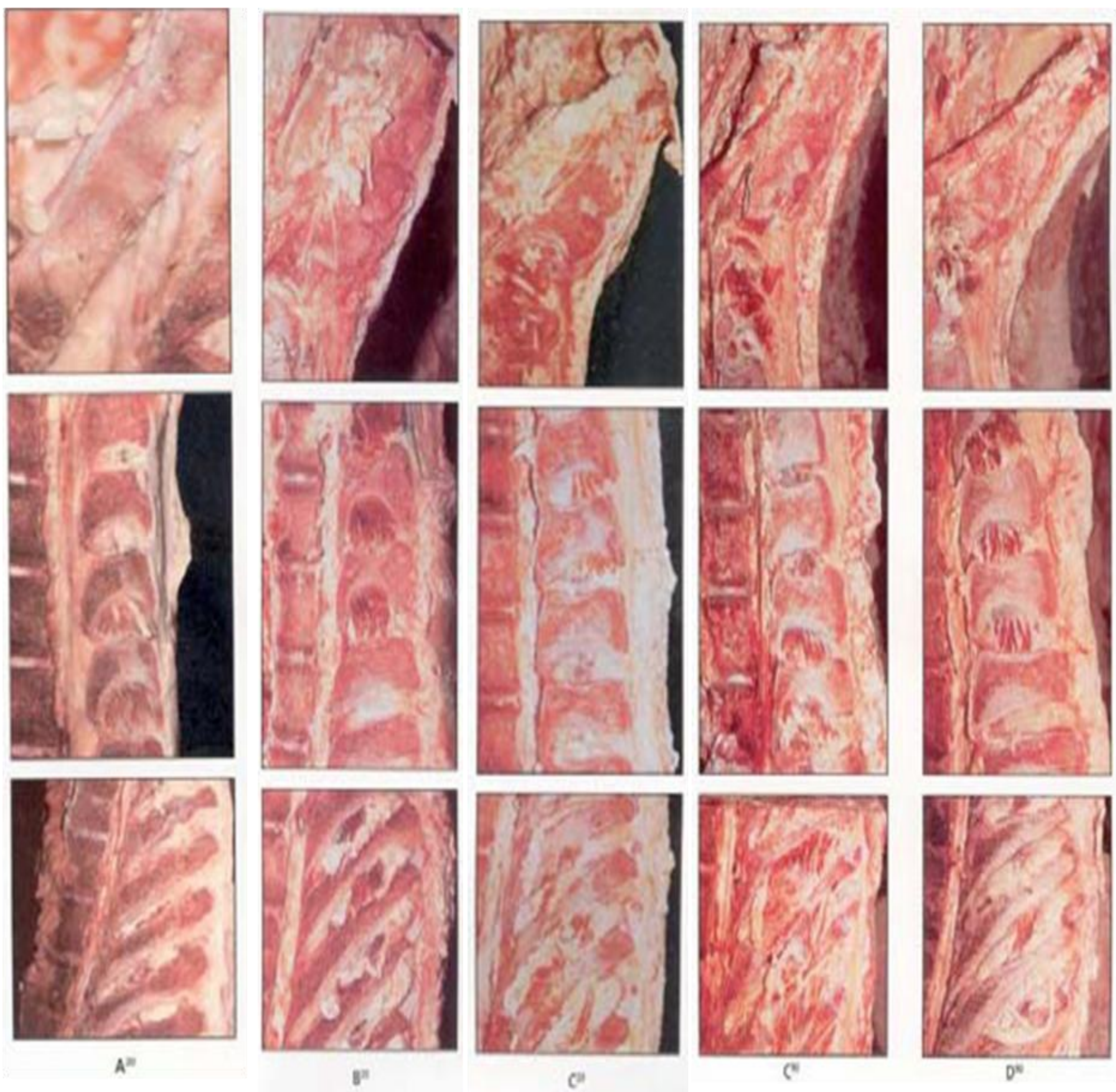
The carcasses were evaluated for quality and yield grade factors and then fabricated into primal cuts. The following data: maturity score (Figure 2 and Table 2), marbling score (Figure 3), color of lean (Figure 4), firmness and texture scores were obtained and recorded at this time. This combination of data was used to determine the quality grade for each carcass. Quality grades were obtain by using a USDA grading chart (figure 7) along with color, texture and firmness. Marbling scores were as follows: Prime (Abundant, Moderately Abundant and Slightly Abundant)=800-1000, Choice(Moderate, Modest and Small)=500-799, Select(Slight)=400-499, Standard(Traces and Practically Devoid)=0-400. Ribeye area was measure with a grid (Figure 6). Yield grade was obtained by combining the following factors: hot carcass weight, ribeye area, percent of kidney, pelvic and heart fat and 12th rib fat thickness (Figure 5) (Boleman, 1998) this method was developed by the USDA grading service in the 1960's. These data were recorded for each carcass to assess yield grade. Yield Grade was calculated using the following equation 2.5 + (2.5 x Adjusted fat thickness, inches) + (.2 x percent kidney, pelvic and heart fat) + (.0038 x hot carcass weight, pounds) - (.32 x rib eye area, square inches).

Carcasses were priced using yield grade and quality grade. The base price any for a carcass a between Choice 0 - Choice 30 and Yield grade 3.0-3.49. If the quality and yield grade increases the price will also increase. If the quality and yield grade decrease the price will also decrease. The best paying carcass in A maturity would be a Prime 70 or up with a yield grade of 1-1.49, while the worst carcass would be a Standard 0 with a yield grade of 5(Figure 8 and Figure 9). This grid method was developed by the University of Arizona's Meat Science Lab. Live, rail and primal cut prices were obtained from the USDA livestock and grain market news (USDA AMS, 2013).

Weights of all trimmed primal cuts were obtained. These were used to determine cut-out percentages and carcass value. Evaluation of tenderness was determined by the calculated shear force values. Shear force values were generated using a Warner-Bratzler Shear Force machine (G-R Manufacturing Company; Manhattan, KS) and related procedures were followed. A 12th rib steak measuring 1" was cooked to an internal temperature of 160° F and chilled to 70-73° F after cooking. Ten cores, measuring ½", were taken from the each steak and its shear force values was to be determined by the Warner-Bratzler Shear Force Machine. Of the ten cores, the highest and lowest values were eliminated and the remaining eight were averaged to determine tenderness value for each steer.

Figure 1. Ultrasound Reading

Figure 2. Maturity Chart



9-30 months 30-42 months 42-72 months 72-96 months >96 months

Table 2. Age Classifications

Carcass Maturity	Approximate Live Age
A	9-30 months
B	30-42 months
C	42-72 months
D	72-96 months
E	➢ 96 months

Figure 3. Marbling Chart

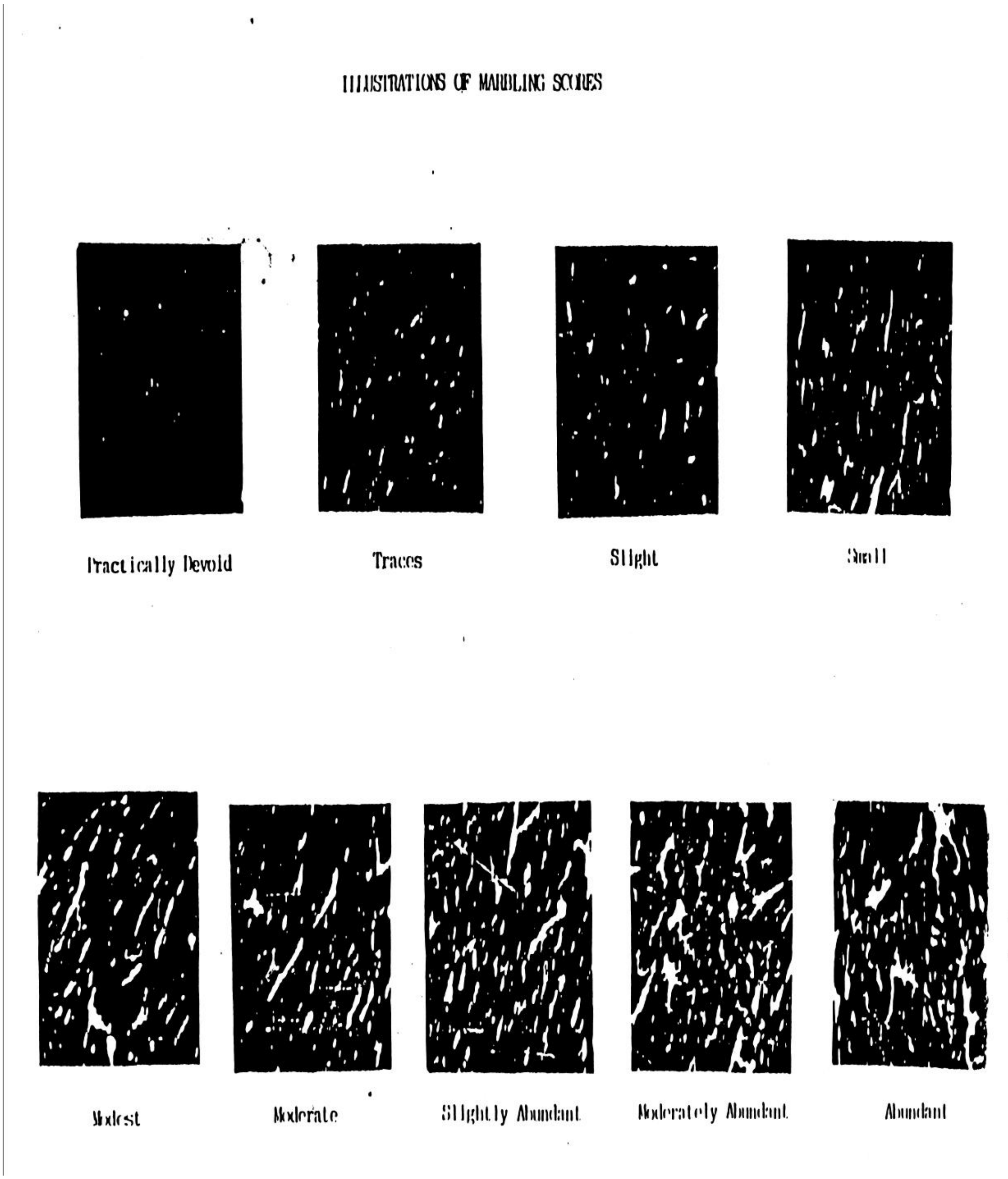


Figure 4. Color Chart

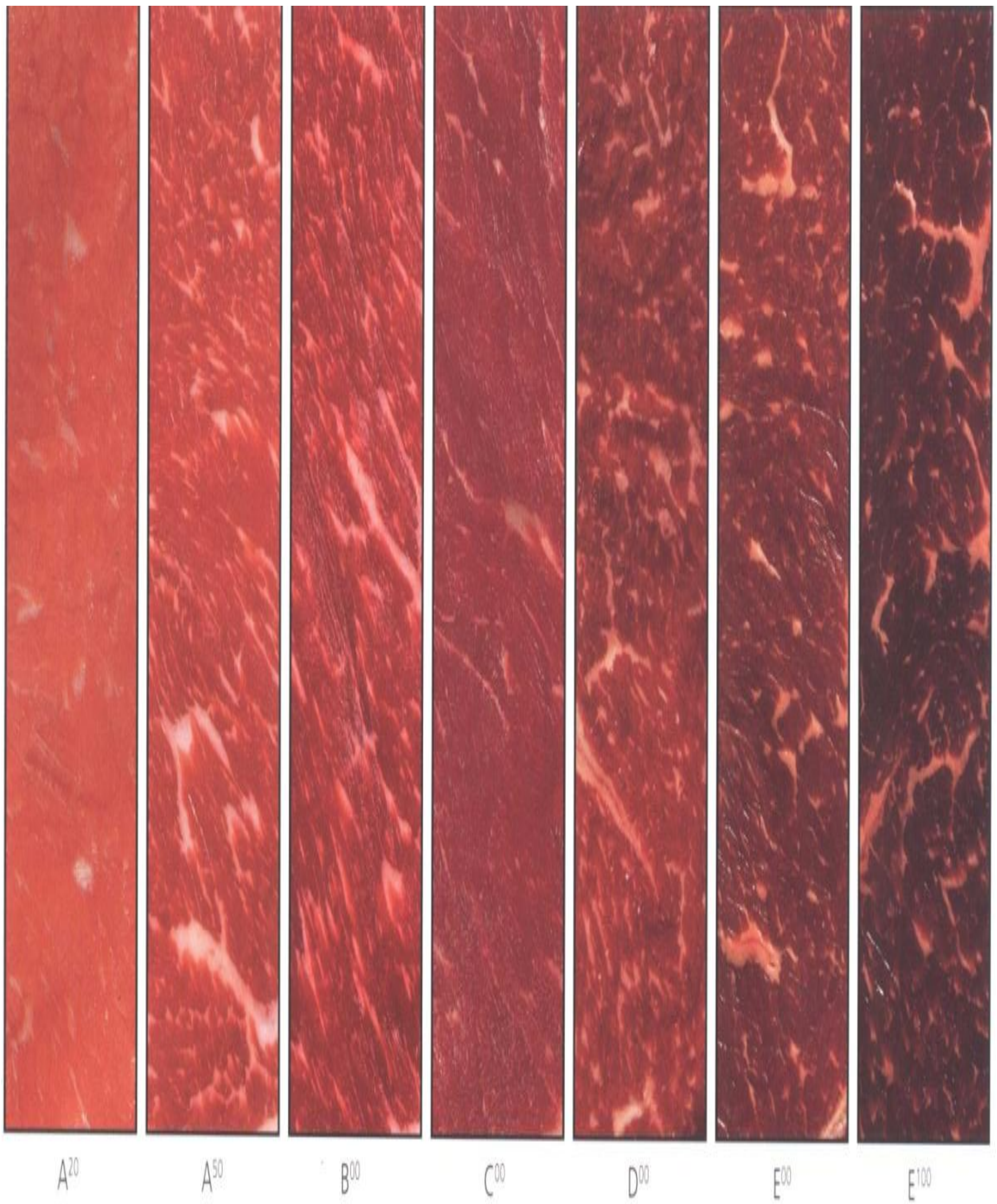


Figure 5. Measuring Fat Thickness at 12th Rib

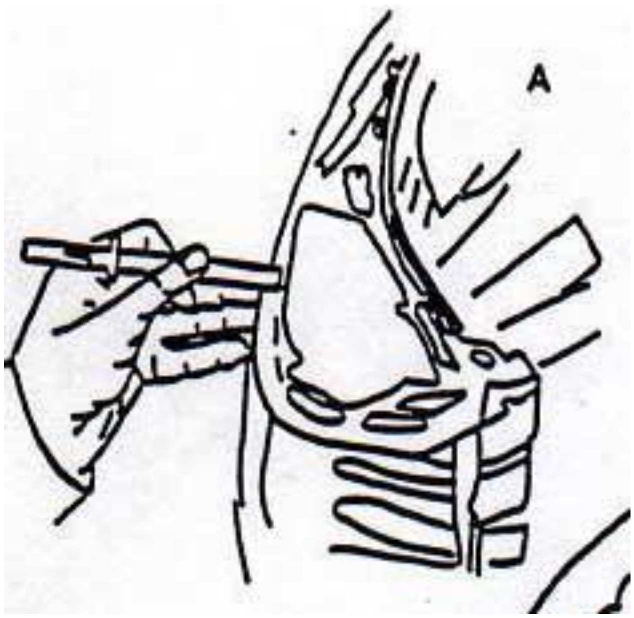
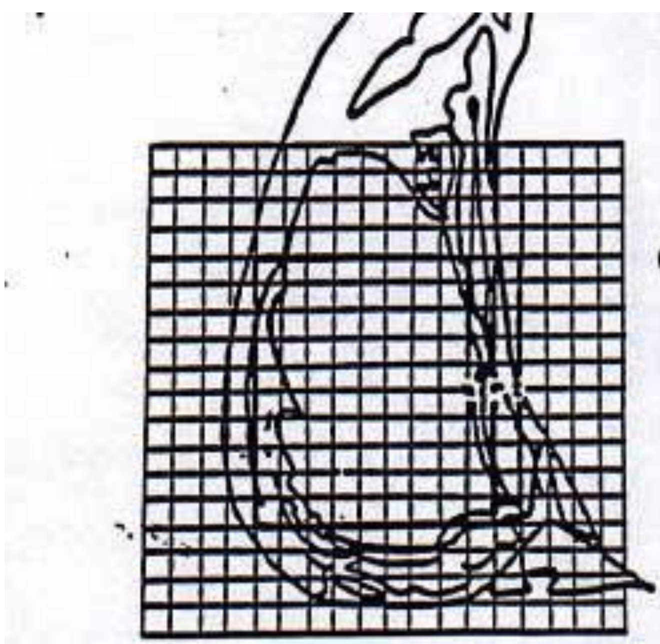


Figure 6. Measuring REA



Each square represents 1/10 of an in².

Figure 7. USDA Grading Chart

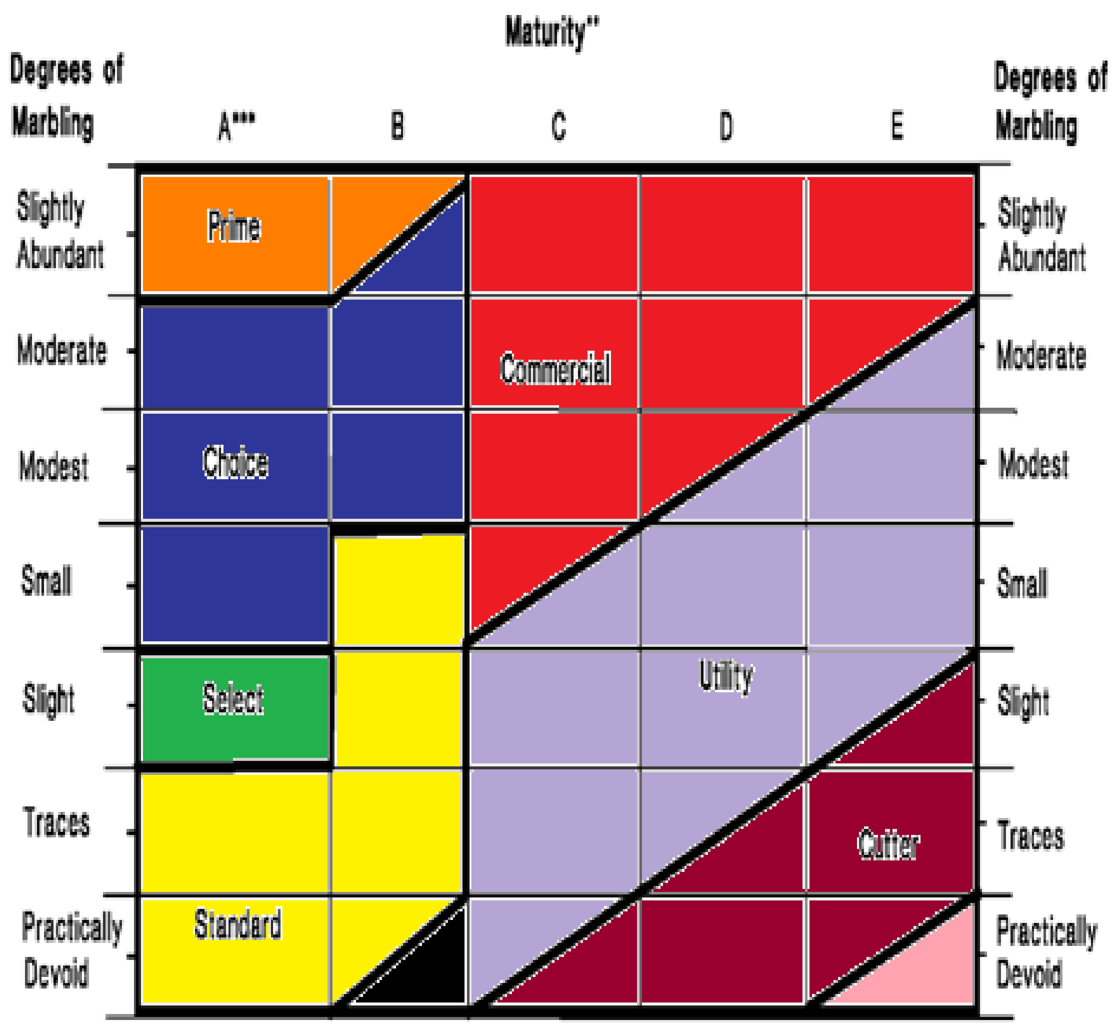


Figure 8. Rail Grid Study #1

	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	3.0-3.49	3.5-3.99	4	5
P70 and UP	$166.99	$166.22	$164.68	$164.26	$15.43	$163.22	$149.55	$144.55
P40 – 70	$163.13	$162.36	$160.82	$160.40	$11.57	$159.36	$145.69	$140.69
P0 – 30	$160.24	$159.47	$157.93	$157.51	$8.68	$156.47	$142.80	$137.80
CH70 and UP	$157.35	$156.58	$155.04	$154.62	$5.79	$153.58	$139.91	$134.91
CH40 – 70	$155.42	$154.65	$153.11	$152.69	$3.86	$151.65	$137.98	$132.98
CH0 – 30	$3.69	$2.92	$1.38	$0.96	$147.87	-$0.08	-$13.75	-$18.75
S70 and UP	$147.92	$147.15	$145.61	$145.19	-$3.64	$144.15	$130.48	$125.48
S0-30					-10.91			

Figure 9. Rail Grid Study #2

	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	3.0-3.49	3.5-3.99	4	5
P70 and UP	$204.07	$203.30	$201.76	$201.34	$15.43	$200.30	$186.63	$181.63
P40 – 70	$200.21	$199.44	$197.90	$197.48	$11.57	$196.44	$182.77	$177.77
P0 – 30	$197.32	$196.55	$195.01	$194.59	$8.68	$193.55	$179.88	$174.88
CH70 and UP	$194.43	$193.66	$192.12	$191.70	$5.79	$190.66	$176.99	$171.99
CH40 – 70	$192.50	$191.73	$190.19	$189.77	$3.86	$188.73	$175.06	$170.06
CH0 – 30	$3.69	$2.92	$1.38	$0.96	$184.95	-$0.08	-$13.75	-$18.75
S70 and UP	$185.00	$184.23	$182.69	$182.27	-$3.64	$181.23	$167.56	$162.56
S0-30					-10.91			

Section 3.5: Soft Tissue Chemical Composition Study #1 and #2

The flank (primal) was taken from the left side of the carcass and then ground. The ground flank was sub-sampled to obtain a sample for chemical analysis. Protein and lipid analyses were performed. Carbohydrate mineral and vitamins were pre-determined as 3 % for all sample because of their consistency. Therefore, moisture was obtained by difference. Using the values obtained from the analysis of the ground flank, prediction equations developed by Marchello et al., (1985), were uses to obtain % protein and % lipid.

Section 3.5.1: Lipid Procedure

An adaptation of the ether extract procedure was used for the lipid procedure. Cellulose thimbles measuring 33mm x 80mm (Whatman Supplies, GE Healthcare) were used. The thimbles were placed in a desiccator for 30 minutes and an initial weight in grams was taken, and a 2 gram ground flank sample was placed in the thimble. Next, the thimble was placed into the Pyrex Soxhlet apparatus (Corning Inc., Tewksbury MA), which was attached to a 500ml round bottom flask containing 250ml of ethyl ether anhydrous (Fisher Scientific Pittsburg, PA), followed by the Allihn Condenser (Corning Inc., Tewksbury MA) being placed upon the extraction unit. The complete extraction unit was clamped into the Thermo Scientific Electrothermal (Pittsburg, PA) heating stand. Water lines were connected providing a continuous flow of water through the system. The sample stayed in the extraction unit for three hours. The water was then disconnected and the electrothermal heater was removed. All the extracts were allowed to siphon into the round bottom flask. The thimble Soxhlet section was then flushed with 20mls of ether to collect all the extracts. The flask with extractive was placed into the sand bath (Fisher Scientific Isotemp Pittsburg, PA) at 165° F until approximately 50mls remained. The 50 ml beakers were cleaned and dried at 215 °F for 10 minutes and stored in a desiccator to prevent moisture to attach to them. The remaining extractive was then added to the previously mentioned beakers, allowing for the ether to evaporate. Finally, the weight of extractive was recorded to be used in calculations. *Adapted from Ether Extract in Meat 39.1.05 (Official Method of Analysis, 2005).*

The following prediction equation was used to predict lipid percentage in soft tissue of the carcass using the flank (primal).

3.05 – 0.039 x HCW + 0.09 x 7 REA + 3.31 x YG + 0.785 x KPH + 0.464 x QG + 0.242 x % fat in the flank soft tissues.

Section 3.5.2 Protein Analysis: Digestion

A Kjeldahl analysis was performed to measure the amount of protein. First, a 2 gram sample of ground flank was weighed and added to a 100ml digestion flask along with 15mls of sulfuric acid (Fisher Scientific Pittsburg, PA), two finely crushed Kjeldahl catalyst tablets (FisherTab CT-50, Fisher Scientific Pittsburg, PA), and 5 hollow glass boiling beads (Fisher Scientific, Pittsburg, PA). The flask was then placed upon the heating element (Labconco 6 Burner, Kansas City, MO). Heat was started at low (to prevent solution from boiling out of the flask) and was increased every 15-20 minutes until boiling. The flask was lightly swirled to achieve even digestion. Upon maximum heat, the remained sample was to remain boiling until the solution was a clear slightly green in color indicating a complete digestion (about 4-5 hours). Heat was then turned off allowing the sample to cool. Once the sample had cooled down, 100 mls of distilled water were added slowly and poured into a 500ml distillation flask; an additional 150 mls were used to rinse all solution out of the 100 ml flask into the 500 ml distillation flask. Fifty milliliters of sodium hydroxide (Fisher Scientific, Pittsburg, PA) was added to the distillation flask and was quickly covered with parafilm (Pechiney Plastic Packaging, Neenah, WI) to prevent any volatile gasses from escaping.

Section 3.5.3: Protein Analysis: Distillation

50ml of 4% Boric (Fisher Scientific, Pittsburg, PA) and 5 drops of bromocresol green-methyl red (color indicator) were added into a 250ml Erlenmeyer to function as the nitrogen trap. This flask was then attached to the distillatory (Labconco Protein Distillatory, Kansas City, MO) with the outlet fully submerged into the Boric acid solution. At that time, the distillation flask was connected to the distillatory very quickly, to reduce loss of nitrogen and heat was turned to high. Once boiling was reached the outlet was clamped for a few second to prevent siphoning. The sample was allowed to distill for approximately 15 minutes until 100-125 mls where collected. Parafilm was used to cover flask as the distillation was complete.

Section 3.5.4: Proteion Analysis: Titration

The boric acid solution was titrated using .2N hydrochloric acid (Fisher Scientific, Pittsburg, PA) while being stirred continuously (VWR Dylastir Magnetic Stirrer, Radnor, PA), until color change from blue to red was noted.

Calculations for nitrogen were as follows: (((ml HCL to titrate* .2N HCL)*1.4007)/sample weight)*6.25=protein. *Adapted from Nitrogen in Meat 39.1.15 (Official Method of Analysis, 2005)*

The following prediction equation was used to predict percent protein in the carcass flank (primal). Values for REA and FT were cconverted to metric.

15-0.964 x FT + 0.021 x REA – 0.065 x MS – 0.033 x %fat of the flank + 0.208 x % protein of the flank -0.019 x % moisture content of the flank soft tissues

Section 3.6: Statistical Analysis

For both studies the statistical analysis was run using Microsoft Excel 2007 with a data analysis Toolpack. Simple regressions were used to run the analysis comparing all treatments/breeds to each other. Significant values were $P<0.05$ and non-significant values were $P>0.05$.

CHAPTER 4:

RESULTS STUDY#1

Section 4.1: Feedlot Performance

All steers started at an average initial weight (370lbs). However, the Brangus steers started at a later date, but entered the trial at a heavier weight (515lbs) so that the weights among all four breeds remained similar at that given time. There was a significant difference ($P<0.05$) between Brangus and the rest of the breeds for initial weight. In addition, this was not taken into account in the statistical analysis. Average daily gains were similar for Waguli ADG = 2.11lbs; Wagyu x CGC ADG= 2.53 lbs; Hereford x Tuli ADG= 2.46 lbs; Brangus ADG =2.89lbs; however, there was a significant difference ($P<0.05$) between Brangus and Waguli (Table 7). F:G conversion were as follows: Waguli F:G= 7.85lbs; Wagyu x CGC F:G= 7.01 lbs; Hereford x Tuli F:G=6.14; Brangus F:G= 7.12lbs; a significant difference ($P<0.05$) between Hereford x Tuli and the rest of the breeds was observed. Final weights were as follows: Waguli FW= 985lbs; Wagyu x CGC FW= 1062 lbs; Hereford x Tuli FW=994 lbs; Brangus FW=1005 lbs; a significant difference ($P<0.05$) between the Wagyu x CGC and the rest of the breeds was observed (Table 3).

Table 3. Feedlot Performance Study #1

ITEM	Wagyu x CGC	Hereford x Tuli	Waguli	Brangus
Initial BW[1], lbs	**394[a]**	**348[a]**	**367[a]**	**515[b]**
Final BW,lbs	**1062[a]**	**994[b]**	**985[b]**	**1005[b]**
ADG[2], lbs	**2.53[ab]**	**2.46[ab]**	**2.11[b]**	**2.89[a]**
F:G[3], lbs	**7.02[a]**	**6.14[b]** `	**7.85[a]**	**7.12[a]**

[ab]=Values with different superscript in the same row are significantly different ($P<0.05$)
[1]BW= Body Weight
[2]ADG= Average Daily Gain
[3]F:G = Feed to Gain

Section 4.2: Carcass Merit

Carcasses were electrically stimulated and dry aged, as noted in the materials and methods. Dressing percentage (DP) was calculated on HCW and the results were Waguli DP=58; Wagyu x CGC DP=57;Hereford x Tuli DP=60; Brangus DP=59; no significant difference ($P<0.05$) was observed for DP. No significant difference ($P<0.05$) was noted between breed in the aspect of quality grade(QG). Quality grades were as follows, Waguli QG=Choice 30; Wagyu x CGC QG=Choice 25; Hereford x Tuli QG= Choice 20; Brangus QG= Choice 40. Ribeye area (REA) was exceptional for all breed, REA was Waguli REA=11.1 in^2 and 1.94 in^2/cwt ; Wagyu x CGC REA=12.6 in^2 and 2.0 in^2/cwt; Hereford x Tuli REA=11.3 in^2 and 1.94in^2/cwt; Brangus REA 11.9in^2 and 1.99in^2/cwt; showing a significant difference ($P<0.05$) between Wagyu x CGC and Hereford x Tuli and Waguli. Yield grade (YG) were desirable for all breeds and no significant difference ($P<0.05$)   was noted. YG averaged 2.47 for Waguli; 2.53 for Wagyu x CGC; 2.97 for Hereford x Tuli ; and 2.60 for Brangus. Average tenderness shear force values were as follows: 5.97lbs for Waguli; 6.71 lbs for Wagyu x CGC; 5.34lbs for Hereford x Tuli; and 5.28lbs for Brangus; there was a significant difference (P<0.05) between Wagyu x CGC and the rest of the breeds (Table. 4).

Table 4. Carcass Merit Study #1

ITEM	Wagyu x CGC	Hereford x Tuli	Waguli	Brangus
DP[1]	**57[a]**	**60[a]**	**58[a]**	**59[a]**
COLOR	**6[a]**	**6[a]**	**6[a]**	**6[a]**
FIRMNESS	**6[a]**	**6[a]**	**6[a]**	**6[a]**
TEXTURE	**6[a]**	**6[a]**	**6[a]**	**6[a]**
QG[2]	**Choice 25[a]**	**Choice 20[a]**	**Choice 30[a]**	**Choice 40[a]**
REA[3]	**12.6[a]**	**11.3[b]**	**11.1[b]**	**11.9[ab]**
REA/Cwt	**2.00[a]**	**1.90[a]**	**1.94[a]**	**1.99[a]**
YG[4]	**2.53[a]**	**2.97[a]**	**2.48[a]**	**2.60[a]**
SFV[5]	**6.71[a]**	**5.35[b]**	**5.97[b]**	**5.28[b]**

[ab] =Values with different superscript in the same row are significantly different (P<0.05)
[1]DP= Dressing Percentage
[2]QG= Quality Grade
[3]REA= Ribeye area
[4]YG= Yield grade
[5]SFV=Pounds of shear force value

Section 4.3: Economics

The cost of gain for the study were as follows, $.73 for Waygu X CGC, $.56 for Hereford Tuli, $.82 for Waguli and $.74 for the Brangus Steers; with Hereford x Tuli having a significant difference (P<0.05) from all the other breeds. Live price was $92.89/cwt and it was the same for all the breeds. Rail price/cwt was $149.56 for

Wagyu x CGC, $148.67 for Hereford x Tuli, $150.42 for Waguli and $151.14 for Brangus with not significant differences between breeds. Primal cut price/cwt results were as follows, $162.83 for Wagyu x CGC, $168.05 for Hereford x Tuli, $169.56 for Waguli and $165.56 for Brangus. No significant diiferences (P<0.05) were noted (Table 5).

Table 5. Economics Study #1

ITEM	Wagyu x CGC	Hereford x Tuli	Waguli	Brangus
COST OF GAIN[1]	**\$.73^{a}**	**\$.56^{b}**	**\$.82^{a}**	**\$.74^{a}**
LIVE PRICE/CWT	**\$92.89^{a}**	**\$92.89^{a}**	**\$92.89 ^{a}**	**\$92.89^{a}**
RAIL PRICE/CWT	**\$149.56^{a}**	**\$148.67^{a}**	**\$150.42^{a}**	**\$151.14^{a}**
PRIMAL CUT PRICE/CWT	**\$162.83^{a}**	**\$168.05^{a}**	**\$169.56^{a}**	**\$165.56^{a}**

^{ab} =Values with different superscript in the same row are significantly different (P<0.05)
[1]Cost of gain= Price per pound of gain

Section 4.4: Soft tissue chemical analysis

Predicted percent protein was as follows: 15.23 %for Wagyu x CGC, 14.28% for Hereford x Tuli, 14.91% for Waguli and 14.78% for Brangus; a significant difference (P<0.05) was noted between Hereford x Tuli and the rest of the breeds. Lipid prediction were as follows: 28.44% for Wagyu x CGC, 28.81% for Hereford x Tuli, 28.80% for Waguli and 29.37% for Brangus; no significant difference (P>0.05) was noted. Moisture prediction was as follows 53.33% for Wagyu x CGC, 53.89% for Hereford x Tuli, 53.28% for Waguli and 52.84% for Brangus; no significant difference ($P>0.05$) was noted for moisture (Table 6).

Table 6. Soft Tissue Chemical Analysis Study #1

ITEM	Wagyu x CGC	Hereford x Tuli	Waguli	Brangus
% Protein[1]	**15.23^{a}**	**14.28^{b}**	**14.91^{a}**	**14.78^{a}**
%Lipid[2]	**28.44^{a}**	**28.81^{a}**	**28.80^{a}**	**29.37^{a}**
%Moisture[3]	**53.33^{a}**	**53.89^{a}**	**53.28^{a}**	**52.84^{a}**

^{ab}=Values with different superscript in the same row are significantly different ($P<0.05$)
[1]%Protein= predicted percent protein found in the soft tissues of the carcass
[2]%Lipid= predicted percent Lipid found in the soft tissue of the carcass
[3]%Moisture= predicted percent moisture found in the soft tissue of the carcass

CHAPTER 5:

RESULTS STUDY #2

Section 5.1: Feedlot Performance

Limit fed(LF) animals had an initial average weight of 360.28 lbs, with the LF heifers having an initial weight of 352.5 lbs and 383.6lbs for LF steers; initial average weight for all full fed(FF) cattle was 394.63 lbs, 363.2 for FF heifers and 405.11lbs for FF steers, no significant difference ($P>0.05$) was noted. Average final weights were 1042.75 lbs. for all LF animals with 1041.33 lbs for LF heifers and 1047 lbs for LF steers; final average weights for all FF animals were 1053.73lbs, 1031lbs for FF heifers and 1061.33 lbs for FF steers, no significant difference($P>0.05$) was noted. All LF animals had an ADG of 2.43lbs, 2.29 lbs for LF heifers and 2.88 lbs. for LF steers. FF animals had an ADG of 2.67 lbs, 2.12 lbs for FF heifers and 2.74 for FF steers. A significant difference ($P<0.05$) was noted between LF heifers and both LF and FF steers , also FF heifers to both LF steers and FF steers. F:G average was 8.17 lbs of feed for all LF animals, 8.76 lbs for LF heifers and 6.40lbs for LF steers: all FF cattle had a F:G average of 7.54 lbs,7.96 for FF heifers and 7.4 for FF steers; no significant difference ($P>0.05$) was noted (Table 7).

Table 7. Feedlot Performance Study #2

	Limit Fed		Full Fed	
ITEM	**Heifers**	**Steers**	**Heifers**	**Steers**
Initial BW[1], LBs	352.5^{a}	383.6^{a}	363.2^{a}	405.11^{a}
Final BW, lbs	1041.33^{a}	1047^{a}	1031^{a}	1061.33^{a}
ADG[2], Lbs	2.29^{a}	2.88^{b}	2.12^{ab}	2.74^{b}
F:G[3], lbs	8.76^{a}	6.40^{a}	7.96^{a}	7.4^{a}

[ab]=Values with different superscript in the same row are significantly different (P<0.05)
[1]BW= Body Weight
[2]ADG= Average Daily Gain
[3]F:G = Feed to Gain

Section 5.2: Carcass Merit

DP 58.15% for all LF animals , 59% for LF heifers and 58% for LF steers; all FF steers had a DP of 58.53%, 61% for FF heifers and 58.2 for FF steers, a significant difference (P<0.05) was noted between LF steers and both LF and FF heifers. YG was a 3.55 for all LF cattle, 3.68 for LF Heifers and 3.18 for LF Steers; all FF animals has a 2.99 YG, FF heifers had a 2.85 and 3.04 for FF steer; a significant difference (P<0.05) was noted between LF heifers and FF steers and heifers. Quality grades were Choice50 for all LF carcasses, Choice85 for LF heifers and Choice 23 for LF steers; all FF carcasses had an average quality grade of Choice60, Choice94 for FF heifers and Choice 33 for FF steers; a significant difference ($P<0.05$) was noted between both LF and FF heifers and both LF and FF steers . REA was 11.27in^2 for all LF carcasses, 11.45in^2 for LF heifers and 10.45 in^2 for LF steers; all FF carcasses had a REA of11.36 in^2, 12.5 in^2 for FF heifers and 11.21in^2 for FF steers; a significant difference ($P<0.05$) was noted between LF steers and FF heifers. REA/cwt was 1.82in^2 for all LF carcasses, 1.83in ^{2} for LF heifers and 1.78in^2 for LF steers; all FF carcasses had a REA/cwt of 1.83 in^2, 2.0 in^2 for FF heifers and 1.78 in^2 for FF steers; a significant difference ($P<0.05$) was noted between FF heifers and both LF and FF steers. SFV for all LF steaks was 6.01 lbs, 5.8lbs for LF heifers and 6.42 lbs for LF steers; all FF steaks had a SFV of 5.08lbs, 4.99 lbs for FF heifers and 6.07 lbs for FF steers ;a significant difference ($P<0.05$) was noted between FF heifers and both LF and FF steers(Table 8).

Table 8. Carcass Merit Study #2

	Limit Fed		Full Fed	
ITEM	**Heifers**	**Steers**	**Heifers**	**Steer**
DP[1]	59^{a}	58^{b}	61^{a}	59.2^{ab}
COLOR	6^{a}	6^{a}	6^{a}	6^{a}
FIRMNESS	6^{a}	6^{a}	6^{a}	6^{a}
TEXTURE	6^{a}	6^{a}	6^{a}	6^{a}
QG[2]	Choice 85^{a}	Choice 23^{b}	Choice 94^{a}	Choice 33^{b}
REA[3]	11.45^{ab}	10.72^{a}	12.5^{bc}	11.21^{ab}
REA/Cwt	1.83^{abc}	1.78^{b}	2.0^{ac}	1.76^{bc}
YG[4]	3.68^{a}	3.18^{ab}	2.85^{b}	3.04^{b}
SFV[5]	5.8^{abc}	6.42^{a}	4.99^{c}	6.07^{ab}

[ab] =Values with different superscript in the same row are significantly different (P<0.05)
[1]DP= Dressing Percentage
[2]QG= Quality Grade
[3]REA= Ribeye area
[4]YG= Yield grade
[5]SFV=Pounds of shear force value

Section 5.3: Economics

Cost of gain was $1.24 for all LF cattle, $1.35 for LF heifers and $0.95 for LF steers; All FF cattle has a cost of gain of $1.13, $1.22 got FF heifers and $1.10 for FF steers; a significant difference (P<0.05) was noted between LF steers and the rest, also between LF heifers and FF steers. Rail price/cwt average was $184.56 for all LF cattle, $185.32 for LF heifers and $182.3 for LF steers; all FF cattle had an average rail price/cwt of $186.53, $187.99 for FF heifer and $186.04 for FF steers, no significant difference (P>0.05)was noted. Furthermore primal cutout price/cwt was $201.37 for all LF cattle, $199.07 for LF heifers and $208.26 for LF steers; All FF cattle had a Primal cutout price/cwt of $207.31, $202.93 for FF heifers and $208.77 for FF steers; a significant difference(P<0.05) was noted between LF heifers and FF steers (Table 9).

Table 9. Economics Study #2

	Limit Fed		Full Fed	
ITEM	**Heifers**	**Steers**	**Heifers**	**Steers**
Cost of Gain[1]	**$1.35^{a}**	**$0.95^{b}**	**$1.22^{ac}**	**$1.10^{cd}**
Live Price/cwt	**$117.61^{a}**	**$117.61^{a}**	**$117.61^{a}**	**$117.61^{a}**
Rail Price/cwt	**$185.32^{a}**	**$182.30^{a}**	**$187.99^{a}**	**$186.04^{a}**
Primal Cutout Price/cwt	**199.07^{a}**	**$208.26^{ab}**	**$202.93^{ab}**	**$208.77^{b}**

^{ab}=Values with different superscript in the same row are significantly different (P<0.05)
[1]Cost of Gain= Cost for every steer pound
[2]Value/cwt= Value for every 100 lbs. of carcass
[3]Value R= Value on the Rail

Section 5.4: Soft Tissue Chemical Analysis

Predicted protein for all LF carcasses averaged 14.87 %, 14.76% for LF heifers and 15.21% for LF steers. All FF carcasses had a predicted protein of 15.24%, 15.05% for heifers and 15.30% for steers; no significant difference ($P>0.05$) was found. Predicted lipid for all LF carcasses averaged 33.04%, 33.94% for LF heifers and 30.33% for LF steers. All FF carcasses had a predicted lipid of 29.92%, 30.44% for heifers and 29.75% for steers; there was a significant difference ($P<0.05$) between LF heifers and FF steers. Predicted moisture for all LF carcasses averaged 49.09%, 48.30% for LF heifers and 51.45% for LF steers. All FF carcasses had a predicted moisture of 51.84%, 51.51% for heifers and 51.94% for steers. There was a significant difference ($P<0.05$) between LF heifers and all other treatments. (Table 10).

Table 10. Soft Tissue Chemical Analysis Study #2

	Limit Fed		**Full Fed**	
ITEM	**Heifers**	**Steers**	**Heifers**	**Steers**
% Protein[1]	**14.76^{a}**	**15.21^{a}**	**15.05^{a}**	**15.30^{a}**
%Lipid[2]	**33.94^{a}**	**30.33^{ab}**	**30.44^{ab}**	**29.75^{b}**
%Moisture[3]	**48.30^{a}**	**51.45^{b}**	**51.51^{b}**	**51.94^{b}**

^{ab}=Values with different superscript in the same row are significantly different ($P<0.05$)
[1]%Protein= predicted percent protein found in the soft tissues of the carcass
[2]%Lipid= predicted percent Lipid found in the soft tissue of the carcass
[3]%Moisture= predicted percent moisture found in the soft tissue of the carcass

CHAPTER 6:

DISCUSSION STUDY #1

There is very limited research published on the crossbred cattle used in this trial for feedlot performance and/or carcass merit. Therefore, the present trial will be discussed drawing on literature published about the individual breeds used to attain each crossbred. The traits of these breeds will be examined and used as comparison for the results found in the research conducted.

Section 6.1: Feedlot Performance

In this study, the ADG of the Brangus steers are higher than the Wagyu x CGC, Hereford x Tuli, and the Waguli groups. This supports the findings of Casas et al. (2010), who found that when a Brangus bull was used as a grandsire, the offspring had higher growth rates. Huffman and associates (1990), found that Brahman crossbreds spent less time in the feedlot versus Angus and Angus crossbreds. The Wagyu x CGC cross also ranked among the highest forADG.

Radnuz et al.(2009) found that Wagyu-sired steers had both lower ADG and DMI when compared to Angus sired steers. However, in this trial, the Wagyu was crossed with other breeds that have higher growth characteristic, which can serve as justification for these results. Additionally, the Waguli breed had the lowest ADG, this is similar to a study done comparing Wagyu- and Angus- sired calves. It was determined that the Wagyu, had a slower rate of gain leading to decreased daily intake and more days on feed (Radnuz et al., 2009).

Huffman and associates (1990) observed that Hereford cattle tend to have better gains. Whereas Tuli steers, do not excel in this area because it has the characteristics of being large framed, growth type cattle which can cause them to have a lower ADG (Ojango et al., 2006). This supports this trial's results as the Hereford x Tuli cross seemed to show no significant difference in ADG.

Although the Hereford x Tuli cross did not prove to excel in gain, these steers were most efficient in feed conversion. Even though breed characteristics have changed dramatically since 60's and 70's, these findings agree with the findings of Butler et al. (1962) who found when comparing Herefords to other British breeds that they demonstrated higher feed efficiency. However, it opposes some findings in which Herefords were not more efficient in feed utilization and did not gain more (Kappel et al., 1972). Furthermore, the results of this study disagree with the findings of Block and associates (2001), who observed no difference in feed efficiency when comparing Angus, Charolais and Hereford. The Wagyu x CGC had the second most efficient use of feed, which may provide evidence that a crossbreeding system does highlight the positive aspects of each breed being used. Radnuz et al. (2009) also found that Wagyu cattle display a higher gain to feed ratio when compared to the British breeds. Additionally, Randuz and associates showed decreased DMI and ADG by Wagyu-sired calves. The Brangus and the Waguli groups exhibited less efficient utilization of feed. This is conflicts with the results of Huffman et al. (1990) who found that when a crossbreeding system utilizes the Zebu influence feedlot performance is improved.

Section 6.2: Carcass Merit

Dressing percentages observed in this study were below average when compared to other fed cattle in the industry. It should be noted that fill in the digestive tract was observed visually when cattle were weighed. Furthermore, a usual 2%-4% pencil shrink (to account for digestive tract fill) was not applied. As previously stated, Hereford x Tuli group had the highest average DP followed by the Brangus, Wagyu x CGC , and the Waguli. The difference among breeds was relatively small and not significant. This finding disagrees with research conducted by Butler et al. (1962) and Casas et al. (2010), where they observed Herefords dressing at a lower percentage compared to other breeds (Angus and Brangus). In the same study by Casas and associates,(2010) they found, the Brangus had the highest dressing percentage. In this study, it is believed that the Hereford x Tuli group dressed the highest because of the crossing of the two breeds. It has been observed by Kappel et al. (1972) that the Zebu influence (specifically Brahman) has been shown to increase dressing percentage.

Data did not mimic the typical results seen in previous research. Although all carcasses were all graded as Choice grade, the Brangus breed had the highest Choice grade followed by the Waguli, Wagyu x CGC, and lastly the Hereford x Tuli cross. This goes against prior findings that show marbling scores for Brahman crossbred cattle rank lower than other cattle crosses (Sherbeck et al., 1995).

The anticipated results were that the two crosses that have Wagyu influence would have the highest QG; however, the results that were observed may be an insight to what occurs with crossbreeding. It has been shown by Ibrahim et al. (2008) that the Wagyu is more likely to grade Choice when compared to other British breeds and that the Waguli has a higher QG than Brahman cattle. Results show that the influence of the British breed (e.g. Angus) dominated in this British x Zebu. The fact that the Hereford x Tuli group had the average lowest QG supports other studies showing that Angus or Angus crosses tend to outperform Herefords in carcass merit (Casas et al., 2010).

As previously stated, YG depends on a multitude of different factors and the lower the YG the better. This portion of the study was the one area of carcass merit in which the Waguli group excelled. They had the lowest average YG of all the breeds in the study. This is believed to be a result of the heterosis of the Tuli and Wagyu breeds. In a study conducted by Kappel and associates(1972), it was noted that the Brahman crossbred cattle had lower yield grades (1972). Therefore, this shows that Zebu cattle may prove to have a tendency to decrease YG because of less fat. Adding to this the Wagyu has been observed to have a lower YG than other breeds (Casas and Cundiff, 2006).

YG results continued from lowest to highest as follows: Wagyu x CGC, Brangus, and Hereford x Tuli. The differences were not significant but relatively expected as the British influence would increase YG. The present results support the finding of

Casas et al. (2010) finding that Brangus cattle had lower YG grades than Hereford cattle.

The breeds' greatly varied between REA and REA per hundredweight. When looking at REA, the Waygu x CGC cross had the largest REA followed by the Brangus, Hereford x Tuli cross and lastly the Waguli. It is believed that the Waygu x CGC had the largest REA due to the influence of the Charoalis, Angus and Tarantaise. The Brangus group had the second largest REA because it has been shown by Ibrahim and colleagues(2008) that the more Brahman ancestry the smaller the size of the REA. Additionally, Sherbeck and associates (1995) found that Brahman crossbreds have a smaller REA than British cattle breeds .

Adams et al. (1977) found that the Hereford breed is not known to have a large REA when compared to other crossbred steers. However, due to the growth characteristics of the Tuli, which can result in increased size of REA (Herring et al., 1996) the Hereford x Tuli was observed to have a moderate size REA. Supporting these results, Sherbeck et al. (1995) found the Hereford crosses tend to have a larger REA. The results of this study showed that although Ibrahim et al. (2008) found that Waguli cattle had significantly higher REA values compared to Brahman cattle. However, Brahman crosses did surpass the other crossbred cattle in this study.

In order to eliminate a weight bias, carcasses' REA were also evaluated in per hundredth weight basis. When comparing REA per hundred weight, one of the main factors is the weight of the carcass. The more moderately sized carcass will have a higher REA per hundred weight value. In this data section, the Wagyu x CGC was the largest followed by the Brangus, Waguli and the Hereford x Tuli. These results correlate with what was found by Radnuz et al. (2009) in which the Wagyu proved to have a larger REA than the British breeds. Although the Hereford x Tuli had a large REA, they coincidently had the highest carcass weight thus resulting in the smallest REA per hundred weight. The other breeds were more moderately sized and thus the data was more favorable for their average REA per hundred weight.

As explained in the material and methods section, the SFV translates into the tenderness measurement for the carcass. Again the Brangus, had the lowest SFV or in other words was the most tender. The results are indicative of the influence of British cattle, which tend to be tender because of their ability to marble. It is thought that the Brangus outperformed the Hereford cross because of the Angus influence. This is supported by research completed by Butler and associates (1962), in which they compared the carcass merit of the Angus to the Herefords and found that the SFV was lower for the Angus steers. The results of the present trial disagree with research published on the Wagyu, as they have been shown to be used in crossbreeding systems to actually lower or improve SFV of other breeds (Radnuz et al., 2009).

Section 6.3: Economics

As data from feedlot performance showed ADG and F:G are very important on profitability. Hereford x Tuli exceeded in terms of cost of gain. Although this breed did not excel in ADG they had the lower F:G making better utilization of nutrients.

This agrees with data reported by Huffman et al., (1990) that Herefords have higher gains resulting in less expensive cost of gains. Contrasting the Hereford x Tuli, Brangus had the best ADG but took more feed, thus increasing cost of gain. Since the Brangus entered the study at a later date, it has been shown that heavier steers will not gain as well when entering the feed lot (McCurdy et al., 2009).

The Waguli breed had lower ADG and longer days on feed, which in return caused a higher cost of gain. Radunz et al.(2009) reported that Wagyu sired cattle will take longer to finish. Consequently, the longer feeding time caused the Waguli to be on feed during the summer months. It has been reported that cattle will reduce feed intake and can have a 20 to 25% decline in gain performance during the hot summer months(Ray and Roubicek, 1971). This may explain the higher cost of gain of the Waguli breed.

Once all the carcasses were evaluated there was no significant difference ($P<0.5$) between breeds using the grid selling chart. Even though there were not statistically significant differences between breeds, the Brangus breed had the highest selling price and the Hereford x Tuli had the lowest. Hereford x Tuli had a lower rail price/cwt because of the higher YG and lower QG. Wagyu x CGC was lower because of lower quality grade. Brangus had a relatively low YG and high QG making the rail price/cwt higher. Although, Waguli did not have the highest QG, it had the better YG allowing the rail price/cwt to be second.

Once the carcass was fabricated to primal cuts, the Waguli has the best primal cutout price/cwt, because of its excellent YG and moderate frame size. Wagyu x CGC had the lowest primal cutout price/cwt, and this is probably caused by the larger and heavier frame influence from the Charolais breed. The medium frames cattle such as the Hereford and the Brangus most likely reflects the average primal cutout price/cwt.

Section 6.4: Soft Tissue Chemical Composition

Hereford x Tuli had the lowest percentage of protein in soft tissue. This can be explained by the higher YG, thus referring to the higher amount of fat found in the carcass. Percent lipid and percent moisture were all close between breed and no significant difference was noted (P>0.05). This relationship will be affected by the degree of finish. Percent protein, percent lipid and percent moisture values correlate with previously reported values by Marchello et al. (1985) and Mata-Hernandez et al. (1981).

CHAPTER 7:

DISCUSSION STUDY #2

Section 7.1: Feedlot Performance

In this study ADG was highest for LF steers; this was not the best outcome since target gain was expected to be 2 pounds. Loerch (1990) had similar findings, steers fed restricted high concentrate diet had higher ADG compared to steers fed ad libitum corn silage. However, F:G was also best for LF steers; thus, achieving the goal of reducing feed cost. This supports the findings of Loerch and Fluharty (1998), that steers fed to achieve a stepwise increase in growth rate had lower ADG but higher F:G. Initial and final BW did not vary and no significant difference (P>0.05) was observed.

Section 7.2: Carcass Merit

There was no significant difference (P>0.05) found when comparing limit fed to full fed carcasses. This agrees with other researchers (Loerch and Fluharty, McCurdy et al.,2009 and Wertz et al., 2001) but there were differences when comparing individual treatments. Dressing percentage was highest for FF heifers. This is probably due to the fact that fat thickness (FT) was higher, causing more weight to stay on the carcass. LF steers had the lowest DP because of the lower FT. Color, firmness and texture were the same for all carcasses, there was not a major change because all carcasses were A maturity and stress levels were minimal when cattle were moved. Quality grades were better for the FF carcasses, which is supported by Felix et al.(2001) who found that limit feeding will result in a smaller percentage of carcasses grading high and average Choice. Furthermore, FF and LF heifers had higher QG than their counterparts, which could be to the estrogen influence on fat deposition. REA/cwt was higher for FF heifers which contradicts common knowledge that males have larger muscularity. Furthermore, limit feeding should have had a positive effect on REA as reported by Felix et al.(2001).

Cutability as measured by YG was the best for FF cattle, with LF heifer having the worst. This is explained by the higher FT found in the LF heifers. Limited cooling space to store the carcasses resulted in longer time on feed for LF heifers and FF heifers. SFV were lower for FF heifers. As mentioned before, there is a correlation between marbling score and tenderness, thus causing a lower SFV for FF heifers. Although, SFV were higher for the other treatments they were very acceptable.

Section 7.3: Economics

As mentioned before ADG and F:G are very important on profitability. Cost of gain was best for LF steers, this is because they had the best ADG and F:G. Live price/cwt is the same for all treatment. Rail price/cwt was not significantly different ($P>0.05$). Even though there was not a significant difference, FF heifers had the highest price, due to the higher marbling scores thus higher quality grades. On the other hand, LF steers had the lowest value because of lower QG. When selling primal cuts the best price was for both LF steers and FF steers. This is because of the less amount of fat on the carcass.

Section 7.4 Soft Tissue Chemical Composition

Chemical composition was very similar for all treatments. Cattle that were FF though tended to have a protein percentage, lower lipid percentage and a higher moisture percentage. As mentioned before , higher lipid will cause moisture to be lower. Longer days on feed for LF heifer resulted in a higher fat content, Thus causing a lower moisture percentage.

CHAPTER 8:

CONCLUSION STUDY #1 and STUDY#2

Study #1 demonstrated the various outcomes that occur when using a crossbreeding system. Results showed that both feedlot performance and carcass merit can vary between breeds. This research shows that the selection of a breed for any operation depends on several factors (environment, objective of operation, etc.) and therefore overall success of performance is dependent on a combination of factors not just a consequence of breed.

Study # 2 demonstrated that limit feeding can be a good management strategy. Steers were benefited the most from this strategy making good profits. On the contrary, even though heifers had higher quality grades it was their overall yield was decreased, therefore making limit feeding a strategy that should be used cautiously when feeding heifers.

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