COMPARISON OF RECEIVED PRICES BETWEEN REPLACEMENT HEIFERS

AND FEEDER HEIFERS IN ALABAMA

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COMPARISON OF RECEIVED PRICES BETWEEN REPLACEMENT HEIFERS AND FEEDER HEIFERS IN ALABAMA

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AND FEEDER HEIFERS IN ALABAMA

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VITA

Suzanne Victoria Free, daughter of William and Annette Free, was born December 21, 1983, in Selma, AL. In 2002, she graduated from Hooper Academy in Hope Hull, AL, and entered Auburn University in the fall of that same year. She graduated from Auburn University in May 2006 with a Bachelor of Science degree in Animal Science Pre-Veterinary and a double minor in Spanish and Agricultural Leadership Studies. Suzanne entered Graduate School at Auburn University in August 2006. While at Auburn, Suzanne was active in various organizations across campus and even during graduate school remained active in Ag Ambassadors and Mat Cats. Suzanne and her fiancé Allan got engaged in late April 2008 and will be married on May 23, 2009.

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A constant source of beef replacement heifers is essential. Consignors perceive replacement quality heifers are worth more than feeder heifers. This study examined what factors affected prices received for replacement heifers versus feeder heifers in Alabama. Factors examined included sale name, sale year, adjusted 205-d weight, weaning weight ratio, age of heifer at time of sale, and sire breed.

Data for this study came from 5 different consignment replacement heifer sales across Alabama across various years. Average stockyard prices for the particular month and year the sale occurred in were obtained to make the comparison between replacement and feeder heifers. The 5 sales studied were Alabama Beef Cattle Improvement Association (AL BCIA) heifer sales featuring open heifers with performance data and known genetics and ages.

Nine sire breeds were represented in the study. These included Angus, Brahman, Brangus, Charolais, Gelbvieh, Hereford, Limousin, Simangus, and Simmental. The Angus sire breed was used as a basis for comparison since this sire breed was present in all sales. Angus was also the sire breed with the greatest number of heifers present in the sample size.

The overall model used to test the entire data set included fixed effects of sale name, consignor nested within sale name and sale year, and sire and dam breeds. Covariates of age of heifer at sale, adjusted 205-d weight, and weaning weight ratio were used. Dam breed and adjusted 205-d weight had P-values $P > .05$ indicating these 2 factors were not significant sources of variation. These results indicate buyers paid more for older heifers with a greater weaning weight ratio. The final model accounted for 88% of the total variation of replacement heifer sale price ($R^2 = 0.884$).

Comparisons between Angus and the other breeds showed Angus and each of the other breeds sold for statistically the same price in each of the sales where both breeds were represented. With the sale name comparisons, Angus and each of the other breeds sold for the same price regardless of sale name. One exception was Simangus where the average sale price for Angus and Simangus heifers was statistically different ($P < .05$) between all 4 sales with heifers sold at Ag-O-Rama selling for a higher price than those sold at Chilton County BCIA Heifer Sale, Producers BCIA Heifer Sale, and Herd Builders Replacement Heifer Sale.

KEY WORDS: Beef cattle, Heifer, Profit Margin

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Adoption of management practices should provide tangible benefits to the beef cattle operation. A new management practice should affect sustainability, productivity, or profitability. Commercial beef cattle operations make many management decisions concerning heifer offspring, such as recording birth dates so age at weaning can be determined (Story et al., 2000 and Barker-Neef et al., 2001). Options of marketing heifers as feeder or replacement heifers will dictate the intensity of selection and management and can affect management decisions.

There are other factors to consider besides the decision on how to market heifers. Marketing decisions should begin well in advance of the actual day heifers are sold. By planning ahead it is possible for producers to make management decisions to develop a heifer to be used a replacement heifer. Factors to consider discussed by Myers et al. (1999) focused on weaning the heifer and getting her accustomed to eating a certain diet prior to marketing.

Making the early decision on how to market the heifer and the weaning process are important factors to consider in the preparation process before marketing the heifer. Also the producer may want to look at different management strategies which will affect productivity or longevity of the heifer as a cow such as the combined effects of age at weaning, breeding dates, and grazing season length as discussed by Julien and Tess (2002). Julien and Tess (2002) examined these 3 effects together in a Montana ranching system to determine profitability could be increased in this system by breeding earlier, weaning later, and grazing longer.

To date there have been no reported studies examining marketing heifers through a sponsored replacement heifer sale versus other marketing methods and comparing prices received with the exception of Pierce et al. (1999). Pierce and coworkers (1999) conducted a study quite similar to this one with 1,362 bred heifers sold across 6 different sales. The major difference between their study and this study would be selling bred heifers versus open heifers. Those heifers marketed in a sponsored heifer sale were weaned, vaccinated, preconditioned, with perceived higher quality potential, longevity, and perceived structural correctness. These management practices take a considerable amount of time and effort thus increasing input costs on heifers marketed as replacements.

Profit margins are dependent on many aspects and cannot be attributed to just one factor (Lewis et al. 1990a; Turner et al. 1992). Profit margin factors include cost of developing heifers from birth to sale, selling price, location, time of year, demand of breed type, and overall quality. Producers purchasing replacement heifers are also buying those heifers based on production and longevity potential. The management of developing heifers as replacement heifers can be viewed as more intensive than developing feeder heifers depending on the producer developing the heifers. The end product must be more reliable and higher quality than producing a heifer marketed as a feeder heifer.

Developing heifers as replacement heifers incurs additional costs. These costs include preconditioning, vaccinating, ear tags, deworming, and potential costs associated with facilities to accommodate the heifers after weaning. Producers who take on these additional costs but do not market their heifers as replacement heifers may not see the same profit margins as producers of replacement heifers. It is hypothesized there is a significant difference between the prices received for replacement heifers sold in AL BCIA sponsored sales versus prices received at the local sale barn for heifers marketed as feeder heifers.

LITERATURE REVIEW

Replacement Heifer Programs

From the literature, much can be found on weight targets and nutritional strategies in developing commercial beef replacement heifers for optimal lifetime production (Amer et al., 1994; Pyatt et al., 2005a; and Pyatt et al., 2005b). However little can be found on successful marketing strategies or how commercial replacement heifer programs recording performance information affects sale participation (Pierce et al., 1999). However, related information on management factors affecting cattle prices and price differences based on breed can be readily located in the literature (Lewis et al., 1990a; Story et al., 2000; Barker-Neef et al., 2001; Julien and Tess, 2002; and Anderson et al., 2005).

At least 2 commercial heifer replacement programs for small producers have been established in the United States. The Alabama Beef Cattle Improvement Association (AL BCIA) and Missouri Show Me Select Replacement Heifer Programs (MO Heifer) have provided outlets for commercial producers to market quality replacement heifers. Both programs were established with the premise that utilizing quality bulls in commercial herds will produce replacement quality females that could be marketed for a premium over market price.

AL BCIA was founded in 1964 with approximately 30 members and 3 goals. These goals were to cull low-performing cows, keep replacement heifers from high-producing cows, and performance test bulls. By 1981, progressive minded Extension personnel believed commercial heifer replacement quality was sufficient in Chilton County, AL, to organize a replacement heifer sale. Today in Alabama, as many as 9 sales are organized each year for AL BCIA heifers with performance and pedigree information.

The purpose of AL BCIA has changed a bit since 1964 with 4 modified parts to their purpose. These include promoting the use of performance records as a tool for within herd improvement of production, efficiency, and quality; providing a total herd performance testing program for Alabama producers; emphasizing economically important traits in beef cattle that can be improved through selection and culling programs based on records; and emphasizing the importance of good management practices in breeding, feeding, health, and marketing programs (Michelle Elmore, Alabama Beef Cattle Improvement Association, Clanton, AL, personal communication).

Missouri's Show-Me-Select Program began in 1997 with its first sale under the direction of Extension and other relevant agricultural institutions throughout Missouri (Patterson et al., 2006). The objectives of MO Heifer program focus on working with beef cattle producers to make the production and sale of their heifers more profitable. MO Heifer was designed to reinforce the importance of data recording and management practices related to increasing reproductive efficiency. The success of the program is linked to Missouri producers continuing to adopt management practices that potentially improve reproductive efficiency. Expanding program members among Missouri producers is dependent on relationships among farmers, regional livestock specialists, and veterinarians (Patterson et al., 2006).

A Total Quality Management (TQM) approach is used in MO Heifer (Patterson et al., 2006). By using TQM strategies, Missouri cattle producers produce value-added heifers with more marketing opportunities. In marketing value-added heifers to a wider customer base it is anticipated heifers from MO Heifer will have the reputation of being reliable replacement heifers. More specifically, genetics and management will produce additional profits for those cattle producers adopting such management practices. At this point Missouri heifers from this program have sold to buyers in 16 different states (Patterson et al., 2006).

Another study addresses MO Heifer and in particular, the sale prices through 1998 (Pierce et al., 1999). This study's objective focused on physical and genetic characteristics, expected calf characteristics, market factors, and buyer demographics and how these affected prices of bred replacement heifers. Data was obtained from 6 sales and included 1,362 heifers. Results indicated producers were willing to pay a premium for pens of 10 black heifers having an expected progeny difference (EPD) for birth weight around zero (Pierce et al., 1999). Pierce et al. (1999) found buyers who traveled longer distances were more likely to pay more for heifers, and producers with larger herds typically paid less for heifers.

Management Factors Affecting Cattle Prices

Studies indicate production system (Lewis et al., 1990a; Anderson et al., 2005) and heifer weaning age (Story et al., 2000; Barker-Neef et al., 2001; and Julien and Tess 2002) contribute to market price received. Additionally, breed composition and diet (Myers et al., 1999) and optimal slaughter endpoints (Amer et al., 1994; Pyatt et al., 2005a; and Pyatt et al., 2005b) also affect price. Economic factors and market characteristics (Turner et al., 1992 and Marsh 2001) also contribute to market price received.

Lewis et al. (1990a) looked at differences between an intensive and extensive beef production system in Nebraska for 3 yrs and how each system affected break-even prices for feeder calves. Intensive systems finished calves on a high-grain diet immediately after weaning at 234 kg. Extensive system stockered calves on crop residues, grazed on summer pasture, and then finished on a high-grain diet. All calves were born in the spring and given 30 d to adjust to weaning before the experiment began (Lewis et al., 1990b). Results from this study suggested corn price and purchase price affected both systems similarly with increases or decreases in either having similar effects on the intensive and extensive system.

However, interest rate, wintering yardage, and finishing yardage affected each system differently. Extensive systems had the highest interest rate and increased finishing yardage while the intensive system had increased wintering yardage. Overall, the extensive system produced additional weight gain in calves and usually showed lower final break-even prices. The end result suggested it was more economical to stocker calves for added weight gain prior to finishing (Lewis et al., 1990a).

Anderson et al. (2005) conducted a 3 yr study evaluating resource inputs, animal performance, and carcass characteristics based on 2 systems with cows and steers in each group. Control cows grazed pasture and had hay in the winter while control steers finished in the University of Nebraska feedlot for 211 d after weaning. Treatment cows grazed pasture and crop residue and had hay in the winter. After weaning treatment steers grazed crop residue followed by pasture grazing in spring and summer and finishing in the feedlot for 90 d.

Cows from both systems had similar calving rates but cows from the treatment system had greater body condition scores when returning from crop residue grazing. Feedlot performance and carcass data for both systems were evaluated as well as break-even and profit potential. The control steers had more days on feed than the treatment steers and had a slightly higher ADG ($P < .05$). In the end the treatment steers had the greatest hot carcass weight (HCW) and longissimus muscle (LM) area but a slightly lower yield grade, 12th rib fat thickness, and marbling score ($P < .05$) than control steers. Control steers showed a greater weaning breakeven and cost per weaned calf. Profit potential was lower than that for treatment steers when sold on a live or financial (cost per weaned calf) basis but there was no difference when sold on a grid basis.

Myers et al. (1999) conducted a 2 yr study utilizing crossbred steers of 3 different biological types. Angus-, Simmental- or Wagyu-sired steers were divided into 1 of 2 treatment groups. They were fed ad libitum high concentrate (CONC) or grown on pasture for 82 d and then finished on high concentrate (PAST). Harvest weights were comparable for the 2 groups. While CONC had a higher ADG they actually had a lower DMI. ADG was similar for the 3/4Ax1/4S and 3/4Sx1/4A steers ($P > .05$). CONC steers showed greater gain, less intake, and better feed efficiency than PAST steers. British breed type steers had lower slaughter weights and consumed less feed compared to Continental breed type steers. Wagyu breed type steers had less gain and more undesirable feed efficiencies while consuming the same amount of total concentrate.

A 10 yr study examining teleauction results in Georgia from 1977-1988 conducted by Turner et al. (1992) divided the decade into 2 periods. One period was defined as 1977-1982 and the second was defined as 1983-1988. The study examined whether the influence of various factors changed between periods. Production and economic factors included in the model were breed of calf, health treatments received, and market conditions which included pencil shrink, cutback, and nearby feeder cattle future contract prices. Cutback refers to the seller giving the buyer the option to remove either a number or percentage of the cattle when they were picked up by the buyer (Turner et al., 1992).

Hereford-sired calves were discounted from 1983-1988 while Angus-sired calves brought a premium from 1977-1982. Over the 2 time periods optimal lot size increased from 228 to 280 cattle. Treatment for specific diseases, not defined by Turner and coworkers (1992), and preconditioning increased cattle prices in both time periods. With summer used as the base season, all the seasons were significantly discounted compared to summer in period 1. In period 2 the only season that was significantly discounted compared to summer was winter ($P < .05$). The sale order in the teleauctions also appeared to have a decreasing effect over both periods.

In studies examining age at weaning, Story et al. (2000) focused on evaluating calves weaned at 150, 210, or 270 d of age and the effect this would have on cow and calf performance as well as production economics. Barker-Neef et al. (2001) looked at the effect of early weaning on carcass characteristics and economic returns and defined early weaning differently from Story et al. (2000). Story et al. (2000) divided calves into early, normal, and late weaning groups defined by whether they were weaned at 150, 210, or

270 d of age. Cows with early weaned calves had higher body weight (BW) and body condition scores (BCS) before being bred back compared to those cows with normal or late weaned calves.

Early weaned calves weighed considerably less than the 210- or 270-d weaned calves (Story et al., 2000). In the feedlot phase all 3 groups had similar ADG ($P < .01$) but different DMI ($P < .001$). Early weaned calves had slightly more fat depth ($P < .05$), quality grade ($P < .10$), and yield grade ($P < .10$) with 94% grading USDA Choice or greater ($P < .05$). According to Story et al. (2000) annual cow costs were least for cows with early weaned calves. However, the early weaned calves had a higher break-even than the normal or late weaned calves. Profit potential of each system was affected by feed costs and time of the year (Story et al., 2000).

Barker-Neef et al. (2001) divided cattle into 2 groups: early and normal weaned with early being at 100 d of age and normal at 200 d. Early weaned steers weighed more at the time the normal weaned calves were weaned but had a lower live weight at harvest ($P <.01$). ADG for early weaned steers was greater than normal weaned steers from the time the early group was weaned until the normal group was weaned but during the initial 100 d of finishing period normal weaned had a greater ADG ($P < .01$). During the final 60 d of the finishing period early weaned steers had a greater ADG and the entire finishing period normal weaned steers had a greater ADG ($P < .01$).

From early weaning through harvest the early weaned steers had the overall greater ADG when compared to the normal weaned steers ($P < .01$). While early weaned steers had lighter HCW ($P <.01$) they had similar yield grades and marbling scores to normal weaned steers ($P > .01$). Early weaned steers had a higher percent of carcasses to grade prime but a lower percent to grade greater or equal to high choice than calves weaned at 200 d of age but the choice and prime percent values were not statistically different ($P > .01$).

In Montana, Julien and Tess (2002) conducted a study examining breeding and weaning date as well as range removal date using computer simulation to create different management scenarios. The model assumed calving took place in the spring and calves were marketed at weaning. Breeding, weaning, and range removal date which is defined as the date when range grazing ended and winter feeding began were all significant for herd size ($P <.05$).

Having older calves during the grazing season increased calf weight. Extending weaning date led to a longer lactation period which led to increased forage consumption of the cow herd and thus decreased herd size. Older and heavier calves at sale time by either breeding earlier or weaning later made Montana or western ranches more efficient. Lengthening of the range removal date caused a decrease in the break-even price. Julien and Tess (2002) suggested for a ranch with a fixed size, profitability could be increased by breeding earlier, weaning later, and grazing longer.

Marsh (2001) used data from 1970 to1999 to study Mexican feeder calf prices and predict future feeder calf and yearling prices. The final prediction model included interest rate, profit risk, hay cost, and ranch and feedlot technology. These input variables affected real feeder cattle price by $12.82/cwt and constituted 66% of the major effect on slaughter price. Marsh (2001) argued this could be applied to affect future feeder cattle prices in a similar manner and that by using future pricing one can guard against risks associated with grain costs and fed cattle.

Pyatt et al. (2005b) examined early-weaned Simmental steers of known genetics that were individually fed postweaning. They examined differences in animal performance, carcass value, and profitability and explored importance of EPD, performance, and carcass data to explain differences. Carcass weight, marbling score, and yield grade had the most affect on carcass value differences explaining almost 80%. These 3 factors along with DMI made up 78% of the variation in profitability. The study concluded management strategies, future marketing conditions, and various biological cattle types would cause these factors to change (Pyatt et al., 2005b).

Amer et al. (1994) described a bioeconomic model of a beef feedlot which examined different beef breeds and determined an optimal slaughter end point for each breed. The bioeconomic model included feed and labor requirements, postweaning carcass growth and fat deposition, and value at slaughter for feedlot cattle. Optimal slaughter endpoint was defined as the point where the current value of farm operation profits is maximized. Pyatt et al. (2005a) refuted the idea of examining beef breeds to determine an optimal slaughter end point. Pyatt et al. (2005a) concluded increasing HCW and reducing overweight HCW penalties would increase farm profitability.

Troxel et al. (2006) examined how certain management factors such as body condition, castration, horn status, fill, health, preconditioning, and individual or group sales affected selling prices ($P < .001$). Results found preconditioned calves earned a premium over healthy calves ($P < .001$). Troxel et al. (2006) also indicated calves sold in groups sold for more than calves marketed as singles ($P < .001$). Producers have the ability to affect the selling price of their calves by monitoring body condition scores, castration, horns, fill, health, and selling in groups.

Breed Differences

Numerous studies have been conducted at the United States Meat Animal Research Center (MARC) since the late sixties and early seventies to characterize beef breed differences for various economically important traits (Smith et al., 1976a). By understanding and utilizing breed differences producers can make informed breeding decisions. Many studies evaluating breed differences have demonstrated that no single breed or breed type excels in all traits and reinforces the importance of crossbreeding (Laster et al., 1976; Smith et al., 1976a; Smith et al., 1976b; Notter et al., 1978a; and Cundiff et al., 1984).

Traits examined in the past 40 yrs at MARC include mature size, growth rate, maturing rate, milk production, body composition, gestation length, dystocia, calf mortality, preweaning growth, postweaning growth, feed efficiency, ADG, relative growth rate (RGR), carcass composition, quality, and palatability. The studies at MARC were divided into 7 cycles. Each cycle utilized specific sire breeds primarily mated to Hereford-Angus cows. Table 1 contains a complete list of the sire breeds utilized in each cycle.

The first paper published with Cycle I results examined dystocia and preweaning growth (Smith et al., 1976a). Results indicated Charolais and Simmental crosses were heaviest at 200 d of age, had the largest birth weights, and the fastest preweaning ADG ($P < .05$). South Devon and Limousin were similar to Hereford-Angus crosses with respect to 200-d weight, were intermediate for birth weights, and were more closely similar to Charolais and Simmental crosses with regard to calving difficulty level ($P < .05$). Jersey crosses were lightest at birth and 200 days of age but had considerably less dystocia than all other crosses but Hereford-Angus crosses (P <.05).

Gestation length was longest for Limousin and shortest for Jersey and Hereford-Angus crosses at the P < .05 level (Smith et al., 1976a). Preweaning relative growth rate (RGR) was shown to be highest for Jersey, intermediate for Hereford-Angus, and lowest for South Devon, Limousin, Charolais, and Simmental crosses (P < .05). Sire breed, dam breed, dam age, and calf sex were significant sources of variation for all traits (P < .05). Relative growth rate as defined by Smith et al. (1976) is the percentage change in the body weight per day for the calf.

Charolais and Simmental crosses were found to be the largest and fastest gaining postweaning followed by South Devon crosses at the P < .05 level (Smith et al. 1976b). Hereford-Angus crosses and Limousin crosses were similar for ADG and 405-d weight while the Jersey crosses were the smallest, slowest growing of all the breeds (P < .05). Breed group rankings were shown to be similar for ADG and RGR with Devon and Simmental having the highest RGR and Limousin and Jersey the lowest (P < .05). Feed efficiency was evaluated over age and weight intervals to a fat-constant end point. At the age-constant end point Jersey crosses were less efficient than Charolais who were more efficient than all other crosses except South Devon (P < .05). Limousin crosses were least efficient at the fat-constant endpoint but not different at the P <.05 level than Simmental crosses. Hereford-Angus crosses were most efficient but not different from South Devon, Charolais, or Jersey crosses (P > .05).

Jersey cross heifers were found to be the lightest at puberty. Limousin, Simmental, South Devon, and Hereford-Angus were intermediate and Charolais were heaviest at puberty (Laster et al., 1976). Heifers out of Angus dams reached puberty 26 d earlier and weighed 9 kg less than heifers out of Hereford dams. Notter and coworkers (1978a) examined dystocia and preweaning growth in 2- and 3-yr old calvings. The calf sire breeds with the heaviest birth weights were Charolais, Simmental, and South Devon crosses in both 2- and 3-yr old age classes ($P < .05$).

Dams in this study were Hereford-Angus reciprocal crosses and crosses of Hereford-Angus cows mated to Simmental, Charolais, Jersey, Limousin, and South Devon sires. Calves from the 2 yr olds were sired by Hereford, Angus, Brahman, Holstein, and South Devon while calves from the 3 yr olds were sired by Hereford, Angus, Maine-Anjou, Chianina, and Gelbvieh. Jersey crosses were the lightest with the shortest gestation length and lowest percent of dystocia among 2 yr olds ($P < .05$). South Devon and Limousin-sired cows had the heaviest birth weight, longest gestation length, and most dystocia at the $P < .05$ level (Notter et al. 1978a). In the 3 yr olds, Jersey-sired cows had the lowest birth weights while Jersey and Hereford-Angus-sired cows had the shortest gestation length. Hereford-Angus-sired cows had the highest percent of dystocia among the breeds examined ($P < .05$).

Notter et al. (1978b) focused on pre-weaning growth and weight at 120 and 200 days in 2 and 3 yr old cows' progeny. Among the 2 yr olds, Jersey-sired cows had the lowest birth weight and highest RGR ($P < .05$). Simmental- and Jersey-sired cows had the greatest ADG while these 2 breeds along with Charolais-sired cows had the largest 120- and 200-d weights. In the 3 yr olds, Jersey-sired cows again had the lowest birth weight and highest RGR while Simmental-sired cows had the highest ADG and 120- and 200-d weights at the $P < .05$ level (Notter et al., 1978b).

Young et al. (1978) examined postweaning growth traits among steers in Cycle I. Brahman-sired steers were heaviest at 200-d ($P < .05$). South Devon-sired steers had the lowest ADG ($P < .05$). Hereford Angus-sired steers from a clean-up bull had the highest RGR ($P < .05$). Steers from Brahman- and Holstein-sired cows had the heaviest 452-d weight ($P < .05$).

Gregory et al. (1978) published the first paper for the second cycle. Hereford-Angus cows were bred to sire breeds of Hereford, Angus, Red Poll, Brown Swiss, Gelbvieh, Maine-Anjou, and Chianina. For perinatal mortality, Gelbvieh, Maine Anjou, and Chianina crosses had the highest perinatal losses ($P < .05$). Maine Anjou and Chianina crosses had the highest percent of calving difficulty but the highest RGR ($P < .05$). Gestation length was longest for Chianina and Gelbvieh crosses and these 2 crosses along with Maine Anjou had the lowest percent calf crop weaned ($P < .05$). Brown Swiss, Gelbvieh, Chianina, and Maine Anjou had higher birth weights, ADG, and 200-d weight than Herford-Angus and Red Poll crosses ($P < .05$). The age of dam was important for birth weight, ADG, RGR, and 200-d weight when looking at differences for 4 yr olds versus those 5 yrs and older ($P < .01$).

Laster et al. (1979) examined postweaning growth traits in Cycle II. Hereford-Angus and Red Poll crosses had the lowest 200-d weight and Red Poll crosses had the lowest 400- and 550-d weights ($P < .05$). Chianina crosses were the oldest at puberty and Red Poll, Brown Swiss, and Gelbvieh crosses were the youngest ($P < .05$). Chianina crosses were heaviest at puberty while Red Poll crosses were the lightest ($P < .05$). Laster et al. (1979) also found that all breeds had a pregnancy rate of 84% or higher.

Cundiff et al. (1984) examined postweaning growth and feed efficiency among steers from Cycle III. Brahman-sired crosses were heaviest at 200-d while Brahman- and Tarentaise-sired crosses were heaviest at the beginning of the feeding trial ($P < .05$). ADG and adjusted 424-d weight was lowest for Sahiwal-sired crosses ($P < .05$). There were no significant differences among breed groups in feed trials 0 to 213 d postweaning with respect to feed efficiency ($P > .05$). Sahiwal-sired crosses had the greatest metabolic energy (ME) than other breed groups in the weight interval from 250 to 470 kg ($P < .05$). Hereford-Angus crosses were more efficient than all other breed group to marbling and fat end points at the $P < .05$ level (Cundiff et al., 1984).

Cundiff et al. (1998) examined birth and weaning traits in Cycle IV and found all breeds exhibited 88% or higher percent of unassisted calvings and survival from birth to weaning. Gestation length was longest for Nellore-sired progeny and they were heaviest at 200-d ($P < .05$). Longhorn-sired progeny had the lowest birth weight at the $P < .05$ level (Cundiff et al., 1998). Thallman et al. (1999) examined postweaning growth and heifer puberty. Results showed Charolais-sired progeny had the highest 200-, 400-, and 550-d weights ($P < .05$). ADG was highest for Shorthorn, Hereford, Angus, and Galloway-sired progeny from 200 to 400 d of age and highest for Nellore, Longhorn, and Piedmontese from 400 to 500 d of age at the $P < .05$ level (Cundiff et al., 1998).

Cushman et al. (2007) examined the influence on fertility which had not been previously studied in the cattle involved in the germ plasm studies until this time. They looked primarily at the postpartum interval and the estrous cycle and tested 3 hypotheses:

1. Breeds tend to differ in postpartum interval to estrus (PPIE) and estrus cycle length.

2. Increased pregnancy rates are seen when a longer estrous cycle immediately before breeding is observed.
3. More cycles before breeding increases conception rates.

Results support hypothesis concerning breed differences in PPIE and estrous cycle length immediately before breeding. This study showed no increase in conception rates for those cows that had more estrous cycles. Conception rate was shown to decrease when length of estrous cycle right before breeding increased.

Many other studies have been conducted examining breed differences for various traits but not as many have been published on heifers alone. Baker et al. (1989) conducted a study on growth, size, and puberty of second-generation heifers in order to estimate breed effects using a five-breed diallel utilizing Angus, Brahman, Hereford, Holstein, and Jersey. Weight, height, BCS, and measurements were taken monthly at the onset of puberty.

Weight at 4 different points in time and post-weaning weight gain from 270 to 360 d and 360 to 450 d was examined. Holstein purebreds were heaviest at all ages and Jersey were lightest at all ages (Baker et al., 1989). Angus and Brahman purebreds were heavier than Herefords but lighter than Holsteins. Among crossbreds, Holstein crosses were heavier, Jersey crosses were lightest, Brahman-Holstein heifers were heaviest at all ages (Baker et al., 1989). Holsteins and Jerseys were slowest gaining among purebreds from 270 to 360 d but Holsteins and Brahman were the fastest gaining from 360 to 450 d. Many changes in rank were seen among crossbreds between the two periods of 270 to 360 d and 360 to 450 d. The Baker study concluded these rank changes to be random rather than genetic in nature.

Dow et al. (1982) concentrated on determining actual age at puberty in purebred and crossbred heifers. This study focused on purebred Hereford and Red Poll heifers as well as crossbreds of Red Poll-Hereford, Angus-Hereford, Brahman-Hereford, Hereford-Red Poll, Brahman-Angus, and Angus-Charolais. Weights and examination of puberty were evaluated at 11.5, 15, 19.5, and 24 mos. Brahman-sired calves were younger at weaning than Hereford-, Red Poll-, or Angus-sired calves. At 15 mos puberty percentage had the most apparent sire breed variation with Red Poll ranking highest and Brahman ranking lowest at the $P < .05$ level (Dow et al., 1982).

Gregory et al. (1966) examined growth rate in beef heifers of Hereford, Angus, Shorthorn, and the 6 corresponding crossbreds from these breeds. Results indicated crossbreds were superior in 200 d weight, ADG from weaning to 396 d, ADG from weaning to 550 d, ADG from 396 to 550 d, 396-d weight, 550-d weight, and 550-d score. Gregory et al. (1966) found that Herefords were superior to the Angus and Shorthorn breeds among crossbreds but these differences were not significant.

DeRouen and Franke (1989) examined heifers for calving rate and date while considering sire breed, breed type, age, and weight. Angus, Brahman, Charolais, and Hereford heifers were used along with 2-, 3-, and 4-breed rotational crossbred heifers. Specifically they examined crossbred versus straightbred heifers for calving rate percent, calving date measured in days, heifer age at breeding measured in days, and breeding season weight. Crossbred heifers had a higher calving rate percent than the purebred heifers ($P < .05$). DeRouen and Franke (1989) found straightbred and crossbred heifers had nearly the same calving date and heifer age at breeding ($P < .05$). Breeding season weight, however, was significantly higher for crossbred than straightbred heifers. These results concur with those of other studies that have been presented.

Steffan et al. (1985) conducted a study which again studied purebred and crossbred heifers and this time the breeds examined were Hereford, Angus-Hereford, ¼ Simmental- ¾ Hereford, and Simmental-Hereford. Results for postweaning growth traits indicated ADG for 140-d weaning period was different for each breed at the $P < .05$ level except for Angus-Hereford and ¼ Simmental- ¾ Hereford which were found to be superior for the 140-d ADG. Simmental-Herefords had the heaviest 365-d weight while Herefords had the lightest 365-d weight ($P < .05$). Prebreeding weight was greatest for Simmental-Hereford and Angus-Hereford and least for Hereford at the $P < .05$ level (Steffan et al., 1985).

Herefords were statistically superior to all other breeds at the $P < .05$ level for age at puberty (Steffan et al., 1985). However, no differences existed for weight at puberty. Age at puberty was studied at 12, 13, 14, and 15 mo of age. Steffan et al. (1985) found at 12 mo of age, Hereford heifers had significantly fewer reaching puberty compared to all crosses. This was also the case for the other 3 ages examined in this study. Weight at puberty was studied at 273, 295, 318, and 341 kg. At 273 and 341 kg, all breeds were statistically the same. Steffan et al. (1985) indicated at 295 kg, Hereford-Angus, Hereford, and ¼ Simmental- ¾ Hereford had the greatest percent and Hereford, Angus-Hereford, and Simmental-Hereford had the least percent reaching puberty at the $P < .05$ level. All breeds statistically had the same percent reaching puberty by 318 kg (Steffan et al. 1985).

A studied conducted by Sy et al. (1997) examined traits preferred by breeders, cow-calf producers, and feeders in Canada. While the study focused on collecting data on steers and bulls, parallels can be drawn to heifers with respect to the reproduction trait preferences. Sy et al. (1997) indicated purebred breeders had a higher preference for reproduction traits and commercial cow-calf producers had the highest preference for temperament and calving ease. As expected by Sy and coworkers (1997), feeders had the highest preference for feed efficiency and slaughter weight.

From nearly 4 decades of studies completed on various breed and breed combinations looking at numerous traits, there is not a single breed that excels in all traits. As breeds have evolved and changed over the years it has been interesting to see whether or not their performance for certain traits has varied. This knowledge of how genetics of cattle affect how they perform combined with knowing certain management factors can increase productivity and profitability comprises a valuable set of tools for cattle producers to use when making management and marketing decisions.

COMPARISON OF RECEIVED PRICES BETWEEN REPLACEMENT AND FEEDER HEIFERS IN ALABAMA

Introduction

Adoption of management practices should provide tangible benefits to the beef cattle operation. A new management practice should affect sustainability, productivity, or profitability. Commercial beef cattle operations make many management decisions concerning heifer offspring, such as recording birth dates so that age at weaning can be determined (Story et al., 2000 and Barker-Neef et al., 2001). Options of marketing heifers as feeder or replacement heifers will dictate the intensity of selection and management and can affect decisions.

Other factors are important to consider when choosing marketing options. Marketing plans must be decided well in advance. Marketing plans can impact breeding season, breed decisions, and the adoption of more intensive management practices. Another management factor to consider discussed by Myers et al. (1999) focused on weaning the heifer and preconditioning practices prior to marketing.

Making the early decision on how to market the heifer and the weaning process are important factors to consider in the preparation process. Also the producer may want to look at different management strategies which will affect productivity or longevity such as the combined effects of age at weaning, breeding dates, and grazing season length as discussed by Julien and Tess (2002). Julien and Tess examined these 3 effects together in a Montana ranching system to determine that profitability could be increased in this system by breeding earlier, weaning later, and grazing longer.

Profit margins are dependent on many aspects and cannot be attributed to just one factor (Lewis et al. 1990a; Turner et al. 1992). Profit margin factors include cost of developing heifers from birth to sale, selling price, location, time of year, demand of breed type, and overall quality. Producers purchasing replacement heifers are buying those heifers based on production and longevity potential. Developing heifers as replacement heifers has additional costs as well. These costs include preconditioning, vaccinating, ear tags, deworming, and potential costs associated with facilities in which to accommodate the heifers after weaning before selling them.

It is hypothesized there is a significant difference between the prices received for replacement heifers sold in AL BCIA sponsored sales versus prices received at the local sale barn for heifers marketed as feeder heifers.

MATERIALS AND METHODS

Records for this study were obtained from open replacement heifer sales sponsored by the Alabama Beef Cattle Improvement Association (AL BCIA). Table 2 includes a description of sale data for each of the 5 sales analyzed in this study. Data records include sale name, sale date, sale price, sale weight, consignor, birthdate, adjusted 205-d weight, weaning weight ratio, and breed composition. AL BCIA prices were compared to Agricultural Market Service (AMS) price averages for the same month the sale occurred for heifers marketed in auction barns in the same weight class.

A total of 1,091 observations were used in this study. Many more heifers have been marketed, but many sales did not record sale day weight so those heifers were not included in this study. Records used all contained sale day weight and sale price. Sale day weight was needed in order to calculate the stockyard value when using stockyard prices from AMS. All records also contained breeds of sire and dam for each heifer. Dam breeds were classified as Bos indicus, English, Continental, Bos indicus-English, Bos indicus-Continental, and English-Continental crosses as well as Angus, Simangus, Simmental, and unknown making a total of 10 different dam breed classifications. Consignor information was also known for all records and there were a total of 68 consignors with 6 consignors having consigned heifers to multiple sales. Each record also contained sale date, sale name, 205-adjusted weights, weaning weight ratios, age of the heifer on sale day, and sale year. Table 3 contains the number of heifers sold at each sale by sire breed.

AL BCIA members who consigned heifers to a sale followed established guidelines set forth by AL BCIA. Members must consign a minimum of 3 to 5 heifers with a minimum adjusted 205-d weight of 227 kg. Heifers must also meet the minimum weaning weight ratio of 90 and typically for the sales discussed in this study, the heifers should be open, fall born heifers.

Commercial heifers in AL BCIA sales were generally sold in lots of 3 to 5 as yearling, open heifers. Heifers were sold on a per head basis and total pen price determined by multiplying the per head price (PRICE) by the number of heifers in the lot. The individual heifer stockyard value (STYD PRICE) was obtained by multiplying the sale weight by the state average for the month of the particular year in which the sale was conducted. The state average price was the Alabama feeder heifer price average for medium/large framed, heavy muscled heifers. The STYD PRICE served as a basis of comparison between replacement and feeder heifer values. Adjustments to PRICE and STYD PRICE were made to reflect the sales commission costs estimated to be an average of 5%. This was taken out of both PRICE and STYD PRICE and the adjusted STYD PRICE became ADJ STYD PRICE. An additional $50 was deducted from PRICE to account for additional costs associated with developing replacement heifers and became ADJ PRICE.

While sale commission costs do differ from sale to sale and from auction barn to auction barn 5% was the most common commission cost seen across the state. The $50 adjustment for raising replacement heifers more specifically was allotted to account for preconditioning and presale costs which include costs for weaning. These costs can depend on how the heifers were fed before being marketed. Also heifers sold in AL BCIA sales were vaccinated and boostered and this was included in the $50 adjustment. Heifers sold in an auction barn could also be vaccinated but there is no way to verify this. Table 4 contains simple means and standard deviations for all variables.

Data was edited and analyzed in SAS (SAS Institute Inc., Cary, NC). The data was edited to check for errors and to assign sire breed numbers. The general linear models procedure was utilized to determine significant sources of variation affecting PRICE. Fixed effects included sale name, consignor nested within sale name and sale year, sire breed, and dam breed. Covariates included weaning weight ratio, adjusted 205-d weight, and heifer age (in mos). PRICE was the correct dependent variable to use because it was necessary to determine significant sources of variation before adjustments were made or the fixed effects and covariates used in the models may have been incorrect. A solutions statement was added to the end of the model statement for the full model to obtain β values for the covariates of weaning weight ratio, adjusted 205-d weight, and age of heifer at sale. The full model was:

$$y_{ijkl} = \mu + \text{sale name}_i + \text{con(sale name * sale year)}_j + \text{sire breed}_k + \text{dam breed}_l + e_{ijkl}$$

Where:

y = PRICE

i = sale name fixed effect

j = consignor nested within sale name and sale year fixed effect

k = fixed sire breed effect

l = fixed dam breed effect

and covariates of age of heifer at sale, adjusted 205-d weight, and weaning weight ratio were used. The full model was analyzed in order to determine the significant sources of variation for PRICE.

As seen from Table 3, sire breeds were not cross classified. To estimate differences among sire breeds, 8 sets of analyses were performed comparing Angus to each of the other breeds in order to obtain LSMeans for each sire breed type for each sale. Four different analyses were included in each set. Model 1 included the fixed effects of sire breed, sale name, sale year, and consignor, with PRICE as the dependent variable. It was important to use this model to see if there were significant differences in PRICE without any covariates being added to the model or adjustments being made. Model 1 took into account the significant sources of variation found in the full model and began the breed comparisons for PRICE. Model 1 was:

$$y_{ijkl} = \mu + \text{sire breed}_i + \text{sale year}_j + \text{sale name}_k + \text{con}_l + e_{ijkl}$$

Where:

y = PRICE

i = sire breed fixed effect

j = sale year fixed effect

k = sale name fixed effect

l = consignor fixed effect.

The change made to Model 2 added the weaning weight ratio, adjusted 205-d weight, STYD PRICE, and age of heifer on sale day in the model statement as covariates. Model 2 accounted for additional sources of variation determined by the full model but not included in Model 1. It was important to see how much the covariates explained the variation of the model and to see if this would result in significant differences in PRICE. Model 2 was:

$$y_{ijkl} = \mu + \text{sire breed}_i + \text{sale year}_j + \text{sale name}_k + \text{con}_l + e_{ijkl}$$

Where:

y = PRICE

i = sire breed fixed effect

j = sale year fixed effect

k = sale name fixed effect

l = consignor fixed effect

and covariates of age of heifer at sale, adjusted 205-d weight, STYD PRICE, and weaning weight ratio were used.

ADJ PRICE was the dependent variable in Model 3. Fixed effects and covariates were the same. This model accounted for breed differences using ADJ PRICE as opposed to PRICE which was used in the previous models. Model 3 was:

$$y_{ijkl} = \mu + \text{sire breed}_i + \text{sale year}_j + \text{sale name}_k + \text{con}_l + e_{ijkl}$$

Where:

y = ADJ PRICE

i = sire breed fixed effect

j = sale year fixed effect

k = sale name fixed effect

l = consignor fixed effect.

and covariates of age of heifer at sale and STYD PRICE were used.

Model 4 was identical to the third with the sole exception of changing STYD PRICE to ADJ STYD PRICE in the model statement as a covariate. No differences in the model were expected but the important thing in this model was to look at the significance of the covariate of ADJ STYD PRICE. It was stated as:

$$y_{ijkl} = \mu + \text{sire breed}_i + \text{sale year}_j + \text{sale name}_k + \text{con}_l + e_{ijkl}$$

Where:

y = ADJ PRICE

i = sire breed fixed effect

j = sale year fixed effect

k = sale name fixed effect

l = consignor fixed effect

and covariates of age of heifer at sale and adjusted stockyard value were used.

The only additional changes made for the sets of analyses included removing sale name or sale year when there was only one sale name or sale year that included Angus and the other breed evaluated. Tests for significance were evaluated at the $P < .05$ level and LSMeans was used as a mean separation test.

The GLM procedure was performed to test for the significance of the difference between ADJ PRICE and ADJ STYD PRICE. It included fixed effects of sale year, sale name, consignor nested within sale name and sale year, and sire breed. It included covariates of weaning weight ratio, adjusted 205-d weight, and age of heifer at sale. The model was stated as:

$$y_{ijkl} = \mu + \text{sire breed}_i + \text{sale year}_j + \text{sale name}_k + \text{con}_l + e_{ijkl}$$

Where:

y = difference between ADJ PRICE and ADJ STYD PRICE

i = sire breed fixed effect

j = sale year fixed effect

k = sale name fixed effect

l = consignor fixed effect.

Results can be found in Table 5 for the differences between ADJ PRICE and ADJ STYD PRICE.

RESULTS AND DISCUSSION

Full model results indicated fixed effect of breed of dam and the covariate of adjusted 205-d weights had no bearing on PRICE. Covariates of weaning weight ratio and age of heifer at sale were significant sources of variation. There were 184 different dam breed combinations and even after classifying each as Bos indicus, English, or Continental dam breed was still not a significant source of variation. Dam breed may not have been significant in this study due to the small number of breed comparisons compared to MARC studies where many more breeds were compared. Sire and dam breed were significant in an early MARC study (Smith et al., 1976a).

The β value for weaning weight ratio indicated that for every unit increase in weaning weight ratio PRICE increase $2.28. The β value for age of heifer at sale indicated that for every increase in months of age PRICE increased $29.51. These results indicate that for these sales buyers paid more for older heifers with a greater weaning weight ratio. Julien and Tess (2002) found older and heavier calves at sale time by either breeding earlier or weaning later made Montana or western ranches more efficient which is supported in these findings with older heifers selling for more than younger heifers.

Fixed effects of consignor nested within sale name and sale year, sale name, and sire breed were significant sources of variation. The full model accounted for 88% of the total variation of replacement heifer sale price (R^2 = 0.884). Pierce et al. (1999) found 47% of variation in heifer price across pens was explained by physical and genetic characteristics, calves expected performance characteristics, market factors, and buyer demographics.

A GLM procedure performed on differences in ADJ PRICE and ADJ STYD PRICE indicated that ADJ PRICE and ADJ STYD PRICE were statistically different thus indicating that price received from the heifers marketing as replacement heifers was greater than the price that the same heifers could have sold for if marketed as feeder heifers. In this study performing this GLM procedure as opposed to examining the differences in Models 1-4 is appropriate. If the variable difference were used then all the LSMeans would indicate the difference and not the PRICE or ADJ PRICE LSMeans which are easier to present in tables and still see differences between sire breeds or sale names. Weaning weight ratio was not a significant source of variation for this model examining differences in ADJ PRICE and ADJ STYD PRICE and the model accounted for 51% of the variation in the difference (R^2 = .511).

Table 6 contains the least squares means for the differences in ADJ PRICE and ADJ STYD PRICE for all 5 sale names. All sales did see a positive difference between the ADJ PRICE and ADJ STYD PRICE with the exception of the Producers BCIA Heifer Sale. A possible explanation for the unexpected results from this sale could be due to the lack of buyers because if buyers were not willing to pay market price for the heifers then starting prices could have been lowered until a price was reached where someone would bid on the heifer or pen of heifers being sold. Only the final year of this sale was used in this study so this could have been a skewed comparison for this sale due to that reason and lack of buyers present. Pierce et al. (1999) found differences in heifer prices when examining regions of the state. These differences were attributed to buyer characteristics and importance of cattle in that region of the state. This may well be the case for differences between sales seen here.

The 4 models used for comparisons between sire breeds were each important for different reasons. Model 1 compared PRICE with no adjustments being made and only fixed effects of sire breed, sale year, sale name, and consignor being examined. There were no covariates included in this model. If results from Model 1 showed differences in PRICE than it could be expected that the next 3 models might have similar results. Model 2 added covariates of weaning weight ratio, adjusted 205-d weight, STYD PRICE, and age of heifer on sale day to test whether or not the addition of covariates to the set of fixed effects would indicate any differences in PRICE when examining results. This model was important to see the impact of covariates being added to Model 1.

The only change made to Model 3 changed the dependent variable from PRICE which had been used in Model 1 and 2 to ADJ PRICE. Results from this model may have not shown significant differences since PRICE had been adjusted to account for 5% commission costs and 50 dollar pre-sale costs. This model was important to indicate if differences would still be present even when adjustments were made to PRICE. Model 4 merely changed the covariate of STYD PRICE to ADJ STYD PRICE which was expected to show no differences except in the significance of covariates. In this study, ADJ STYD PRICE was not a significant covariate for Angus-Charolais and Angus-Gelbvieh sire breed comparisons.

Pens of Continental breed heifers received a $67.74/head premium compared to Angus while Amerifax breed heifers were discounted $36.05/head compared to Angus (Pierce et al., 1999). This is important to note before beginning the discussion on sire breed comparisons. The first comparison of PRICE and STYD PRICE was between Angus-sired and Brangus-sired replacement and feeder heifers. Statistically Angus and Brangus sold for the same sale price (Table 7) and there was no difference ($P > .05$) between the cattle marketed in the Herd Builders Replacement Heifer Sale versus those marketed at Ag-O-Rama (Table 8). A total of 85 Brangus were present for both sales combined. Models 1-4 had the following R^2 values respectively: .842, .890, .851, and .851.

When comparing Angus to Charolais results indicated that Angus and Charolais sold for similar amounts ($P > .05$) independent of which model was used (Table 9). The prices for Southwest Alabama BCIA Replacement Heifer Sale versus the Herd Builders Replacement Heifer Sale were also similar (Table 10). A total of only 13 Charolais were present between these 2 sales and a larger sample of this sire breed may have resulted in variation in the sale prices. There is also the potential that buyers at these particular sales were looking for characteristics that were not seen in heifers of these particular breeds at those sales. Models 1-4 had the following R^2 values respectively: .842, .890, .851, and .851.

Smith et al. (1976a) did find that Charolais had a lower preweaning RGR compared to other breeds in the study. However, Charolais and Simmental were the fastest gaining postweaning (Smith et al., 1976b). Charolais were found to be the heaviest at puberty but for some reason in this study where Charolais were probably heavier than Angus there was not a difference in sale price. This supports the idea that the other significant factors of PRICE variation were more important to buyers than weight alone. Notter et al. (1978b) further supported findings of Smith et al. (1978b) indicating Charolais-sired cows had the largest 120- and 200-d weights among the 2-yr olds.

The next comparison was between Angus and Hereford sire breeds and again it is seen that there is no statistical difference between these 2 breeds in regard to sale prices (Table 11), adjusted or not. While there is no statistical difference between those cattle marketed in the Herd Builders Replacement Heifer Sale versus Southwest Alabama BCIA Replacement Heifer Sale (Table 12), although there is a difference of almost $200 between the 2 sales for all 4 models. Standard errors were larger for Angus and Hereford than any other comparison between Angus and another breed. Herefords had the lightest 365-d weight in a study of Hereford, Angus-Hereford, ¼ Simmental- ¾ Hereford, and Simmental-Hereford (Steffan et al., 1985). Models 1-4 had the following R^2 values respectively: .558, .678, .632, and .632. Comparing these values to those for the prior 2 sire breed comparisons it is noted that less of the variation in either PRICE or ADJ PRICE can be explained by the models.

Angus and Limousin were the next breeds compared and in this case there was only 1 sale in which Angus and Limousin were both represented. This was the Southwest Alabama BCIA Replacement Heifer Sale. Again Angus and Limousin sold for similar amounts (Table 13). Only 9 head of Limousin cattle were present so again the question arises about whether or not a larger number of Limousin-sired heifers would have resulted in statistically similar sale prices for the sire breeds in question. There is also the issue of what buyers were looking for in this particular sale which could have led to a premium for heifer breeds that a producer was willing to pay a little more for than another particular breed. Models 1-4 had the following R^2 values respectively: .517, .637, .636, and .636.

For the next set of comparisons Angus was compared to Simangus. In this case Angus and Simangus were statistically sold for the same price regardless of which model's output was examined (Table 14). A possible explanation for no differences seen in comparing these 2 breeds may originate from the fact that the 2 breeds are quite similar with the Simangus being a composite of Simmental and Angus. Angus and Simangus sold at Ag-O-Rama and Herd Builders Replacement Heifer Sale (Table 15). For models 1, 3, and 4 Simangus heifers sold for significantly higher pries at the Ag-O-Rama sale than the other 3 sales. There were 43 head of Simangus cattle represented across the various sales. Models 1-4 had the following R^2 values respectively: .916, .875, .925, and .925.

Angus and Simmental were shown to have sold for statistically the same sale price regardless of which model was used (Table 16). LSMeans for Simmental were very similar to the LSMeans found for Simangus in the prior comparison which might be expected since Simangus is a composite of Simmental and Angus. There are 364 head of Simmental cattle represented across all the sales making Simmental the most widely represented breed besides Angus. Smith et al. (1976b) found Simmental and Charolais to be the fastest gaining postweaning. Models 1-4 had the following R^2 values respectively: .619, .707, .700, and .700.

Angus and Simmental sire breeds were found in all 5 sales were analyzed. There were no price differences found between the breeds and sales (Table 17). All 4 models show for the 5 sale names sale prices are equal regardless of which sale the heifers were marketed at the $P < .05$ level. This would indicate that for these breeds the sale prices remained relatively constant across time and across sales which is consistent with the other breed comparisons as well. While the LSMeans show no statistical difference there is almost $150 difference between Ag-O-Rama and Southwest Alabama BCIA Replacement Heifer Sale in Model 1 and at least a $100 difference between the 2 sales for the other 3 models.

The next comparison looking at Angus and Gelbvieh sire breeds was treated in a similar manner since the Angus and Gelbvieh sire breeds were only present together in the Southwest Alabama BCIA Replacement Heifer Sale and only 6 head of Gelbvieh were sold. Again it is noted that the sale prices are not statistically different with all P-values $P > .05$ (Table 18). Such a small number of Gelbvieh-sired heifers could lead to seeing no difference between the 2 sire breeds. Models 1-4 had the following R^2 values respectively: .097, .509, .485, and .485. A potential explanation for such a low value for Model 1 could be that the covariates were a more significant source of PRICE variation for these 2 breeds than other breed comparisons examined in this study. With the exception of this one low R^2 value all values were .485 or higher for all breed comparisons.

The Herd Builders Replacement Heifer Sale is the only sale in which Angus and Brahman sire breeds are both represented and only 7 head of Brahman cattle are present. Angus and Brahman sire breeds are shown to have statistically the same sale prices for each of the 4 models (Table 19). Young et al. (1978) found Brahman-sired steers were heaviest at 200-d as well as 452-d of age. Cundiff et al. (1984) also found Brahman-sired steers were heaviest at 200-d. However, Dow et al. (1982) found Brahman-sired calves had the lowest puberty percentage at 15 mos of age. This may cause Brahman heifers who are the same age as heifers of another breed to possible sell for less if the buyer is looking to breed the heifer immediately and there is a concern the Brahman-sired heifer has not reached puberty yet. Models 1-4 had the following R^2 values respectively: .705, .854, .742, and .742.

When looking back at the causes of variation in PRICE examined in the full model it is important to further discuss consignor. In this study consignor was a significant source of variation when sale name and sale year were nested within consignor. Six consignors out of 68 had heifers that sold in more than 1 sale across the state. These particular consignors could be well respected cattle producers so cattle supplied by these producers may sell for more simply based on their reputation as a respected cattle breeder. Location of the sale was studied by Pierce et al. (1999) and was taken into account in this study. Pierce et al. (1999) did find sale location to be significant while in this study it was only significant in Simangus and Angus sire breed comparisons.

It is worth noting that in Alabama the locations of the AL BCIA heifer sales followed concentrations of cattle in Alabama and where programs and principles of AL BCIA were emphasized. Perhaps a greater push for AL BCIA in other parts of the start where there is a heavy concentration of cattle could have resulted in more participation and sales developed for those areas of the state. Patterson et al. (2006) noted participation in MO Heifer in 103 out of 114 counties in their state. Such an extensive support system set forth in MO Heifer could contribute to such wide participation among producers with producers, veterinarians, extension agents, and university personnel promoting the program.

While the literature points out breed differences (Laster et al., 1976; Smith et al., 1976a; Smith et al., 1976b; Notter et al., 1978a; and Baker et al., 1989) breed differences are not seen in this study except in the full model. Possible reasons for not seeing significant differences in PRICE for the breeds when comparing them to each other include low numbers of heifers for certain breeds, high standard errors, and consistency in PRICE regardless of breed at the sale. There could have been buyers who were looking for the breeds of low numbers. Breeds with low numbers are pointed out throughout the results of this study to indicate which breed comparisons this could have affected.

Implications

This study addressed the difference seen in replacement heifer prices versus feeder heifer prices with replacement heifer prices being greater for all sales but one based on breed comparison results between Angus and the other breeds examined. An evaluation of variation in sale price was also conducted and showed that of the fixed effects of sale name, sire breed, sale year, and consignor nested within sale name and sale year all are significant sources of variation. Dam breed was expected to be a source of variation but was not. Adjusted 205-d weight was not found to be a significant source of variation among the covariates of weaning weight ratio, age of heifer at sale, and adjusted 205-d weight so it could be argued that the age of heifer at sale and weaning weight ratio are important pieces of information in the eyes of the buyer. These results indicate buyers paid more for older heifers with a greater weaning weight ratio. Reputation of the consignor could also be a valuable piece of information as indicated by consignor nested within sale name and sale year being a significant source of variation.

The fact still remains when heifers are marketed at a local stockyard a producer purchases the animals on a per pound basis while producers purchasing heifers at a replacement heifer sale most likely are purchasing heifers on an individual or per pen basis. In this case, the weight of the animal plays a role in determination of sale price but is definitely not the only factor which affects it as seen in this study where sire breed, sale name, sale year, and consignor nested within sale name and sale year are significant sources of variation in PRICE for the full model. It could be argued that Model 4 is the most important model used in this study if one does not want to look at PRICE differences before adjustments are made and covariates are added to the model and changed from one model to another. Results support the use of all 4 models as important models depending on what is being examined.

On some level producers are receiving a premium for producing quality animals being purchased by producers to be used as replacement heifers on their own farms. While breed differences were expected to play a larger role in the sire comparisons it is possible that with a larger sample of heifers to study these breed differences would be more predominant in sire breed comparisons since sire breed is a significant source of variation in the full model. Perhaps there would also be more differences seen between sales for the sire breed comparisons.

As hypothesized there was a significant difference between prices received for replacement heifers sold in AL BCIA sponsored sales versus prices received at the local sale barn for heifers marketed as feeder heifers. Whether or not the difference between replacement and feeder heifers is profit depends on the break-even price for each producer. Further research could examine buyers' reasons for buying certain heifers as replacement heifers. With this additional information parallels could be drawn betweens factors seen as statistical sources of variation in PRICE and factors viewed as important by the buyers. It is likely that if a future study were conducted the adjustment for pre-sale costs of $50 would be at least $100 to account for the rise in feed and fuel costs in recent years.

Table 1. Sire breeds for each MARC cycle

	Cycle	Years					
	I	II	III	IV	V	VI	VII
	1970-1974	1973-1974	1975-1976	1986-1990	1992-1994	1997-1998	1999-2000
Sire Breed							
Angus	X	X	X	X	X	X	X
Belgian Blue					X		
Boran					X		
Brahman	X		X	X	X		
Brown Swiss	X						
Charolais	X			X			X
Chianina	X	X					
Fresian						X	
Galloway				X			
Gelbvieh	X	X		X			X
Hereford	X	X	X	X	X	X	X
Holstein	X						
Jersey	X						
Limousin	X						X
Longhorn				X			
Maine Anjou	X	X					
Nellore				X			
Norweigan Red						X	
Piedmontese				X	X		
Pinzgauer			X	X			
Red Angus							X
Red Poll	X						
Sahiwal			X				
Salers				X			
Shorthorn				X			
Simmental	X						X
South Devon	X						
Swedish Red and White						X	
Tarentaise			X				
Tuli					X		
Wagyu						X	

Table 2. Simple averages of sale weight and price

Sale Name	Location	No.	Average Sale Weight	Average Sale Price
Ag-O-Rama[1]	Winfield, AL	124	344 kg	$888.03
Southwest[2]	Frisco City, AL	224	322 kg	$678.83
Chilton[3]	Clanton, AL	314	325 kg	$792.18
Producers[4]	Autaugaville, AL	38	321 kg	$636.62
Herd Builders[5]	Uniontown, AL	391	313 kg	$718.59
TOTAL		1091	325 kg	$742.85

[1] Ag-O-Rama (2001, 2004)
[2] Southwest Alabama BCIA Replacement Heifer Sale (2001-2004, 2006)
[3] Chilton County BCIA Heifer Sale (2001-2006)
[4] Producers BCIA Heifer Sale (2003)
[5] Herd Builders Replacement Heifer Sale (1999-2005)

Table 3. Number of heifers sold at each sale by sire breed

	Sale[1]					
	Ag-O-Rama	Chilton	Herd Builders	Producers	Southwest	Total
Sirebreed						
Angus	85	105	217	23	138	568
Brangus	12		63			75
Brahman			7			7
Charolais			8		5	13
Gelbvieh					6	6
Hereford			10		6	16
Limousin					9	9
Simangus	7	21	9	5	1	43
Simmental	20	188	77	10	59	354

[1] See Table 1 for sale locations and years

Table 4. Simple means and standard deviations for all heifers sold in AL BCIA[7] sales used in analyses

Variable	Number of Observations	Mean	SD
Adjusted 205-d weight (kg)	933	267.33	25.68
Weaning Weight Ratio	992	102.5	6.89
Age (mos)	1162	10.05	1.15
Price ($)[1]	1162	747.94	140.83
Sale weight (kg)	1162	322.09	31.57
Stockyard Price ($/kg)[2]	1162	1.88	0.30
Stockyard Value ($)[3]	1162	603.98	111.44
Adjusted Stockyard Value ($)[4]	1162	573.78	105.87
Adjusted Price ($)[5]	1162	660.54	133.79
Difference ($)[6]	1162	86.77	100.58

[1] Actual price per head heifers sold for in AL BCIA sale
[2] State average for the month of the particular year in which the sale was conducted
[3] Sale weight x Stockyard Price
[4] Stockyard Value – 5%(Stockyard Value)
[5] Price – [5%(Stockyard Value) + $50]
[6] Adjusted Price - Adjusted Stockyard Value
[7] AL BCIA-Alabama Beef Cattle Improvement Association (www.albcia.org). See Table 1 for descriptions of sales and locations.

Table 5. Least Squares Means for price differences between replacement and feeder heifer sale prices by sire breed

Sire Breed	Difference($)	SE	95% CL Limits	
Angus	123.91 [adfghi]	17.03	90.48	157.34
Brangus	76.61 [bdehi]	24.94	27.67	125.56
Charolais	188.93 [cfi]	27.07	135.80	242.07
Hereford	104.61 [abdefghi]	25.50	54.55	154.67
Limousin	66.30 [bdehi]	30.97	5.50	127.09
Simangus	147.05 [acdfghi]	21.65	104.54	189.55
Simmental	134.32 [adfghi]	16.75	101.44	167.21
Brahman	65.55 [abdefghi]	49.62	-31.84	162.94
Gelbvieh	123.73 [abcdefghi]	36.30	52.47	194.98

[1] Different superscripts within rows denote statistical difference (P < .05)

[2] Difference is ADJ PRICE – ADJ STYD PRICE. See Table 4 for full explanation.

Table 6. Least Squares Means for price differences between replacement and feeder heifer sale price by sale name

Sale Name	Difference($)[1,2]	SE	95% Confidence Limits	
Ag-O-Rama	320.94[c]	53.70	215.54	426.33
Chilton County BCIA Heifer Sale	105.63[de]	11.61	82.84	128.41
Herd Builders Replacement Heifer Sale	122.04[ef]	9.93	102.55	141.53
Producers BCIA Heifer Sale	-196.38[g]	97.01	-386.80	-5.97
Southwest Alabama BCIA Replacement Heifer Sale	6.51[h]	11.58	-16.22	29.25

[1] Different superscripts within rows denote statistical difference ($P < .05$)
[2] Difference is ADJ PRICE – ADJ STYD PRICE. See Table 4 for full explanation.

Table 7. Least Squares Means for sale price for Angus-sired compared to Brangus-sired heifers in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Brangus	SE
1	763.51[e]	20.79	766.25[e]	46.53
2	799.93[g]	30.55	776.22[g]	109.90
3	678.38[i]	17.56	681.01[i]	39.24
4	678.38[k]	17.56	681.01[k]	39.24

[1] –Model Definitions

1- Dependent variable: price
Fixed variables: sire breed, sale name, sale year, and consignor

2- Dependent variable: price
Fixed variables: sire breed, sale name, sale year, consignor

3- Dependent variable: adjusted sale price
Fixed variables: sire breed, sale name, sale year, consignor

4- Dependent variable: adjusted sale price
Fixed variables: sire breed, sale name, sale year, consignor

[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 8. Least Squares Means for sale price for Angus and Brangus by sale name in dollars

Model[1,2]	Sale Name Ag-O-Rama	SE	Sale Name Herd Builder Replacement Heifer Sale	SE
1	771.97[e]	39.95	757.79[e]	24.81
2	789.85[g]	58.65	786.31[g]	54.59
3	686.70[i]	33.60	672.69[i]	21.09
4	686.70[k]	33.60	672.69[k]	21.09

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 9. Least Squares Means for sale price for Angus-sired compared to Charolais-sired in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Charolais	SE
1	619.17[e]	50.73	701.59[e]	127.45
2	612.51[g]	48.38	679.72[g]	131.77
3	541.08[i]	46.58	597.87[i]	123.98
4	541.08[k]	46.58	597.87[k]	123.98

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 10. Least Squares Means for sale price for Angus and Charolais by sale name in dollars

Model[1,2]	Sale Name Southwest Alabama BCIA Replacement Heifer Sale	SE	Sale Name Herd Builders Replacement Heifer Sale	SE
1	652.65[e]	88.53	668.10[e]	76.47
2	634.07[g]	84.81	658.07[g]	77.74
3	576.84[i]	85.61	562.11[i]	71.82
4	576.84[k]	85.61	562.11[k]	71.82

[1] See Table 7 for definitions

[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 11. Least Squares Means for sale price for Angus-sired compared to Hereford-sired in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Hereford	SE
1	622.16[e]	44.84	650.04[e]	103.89
2	629.42[g]	44.86	611.21[g]	114.48
3	549.20[i]	37.68	542.89[i]	95.93
4	549.20[k]	37.68	542.89[k]	95.93

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 12. Least Squares Means for sale price for Angus and Hereford by sale name in dollars

Model[1,2]	Sale Name Southwest Alabama BCIA Replacement Heifer Sale	SE	Sale Name Herd Builders Replacement Heifer Sale	SE
1	523.61[e]	138.65	748.59[e]	95.79
2	527.98[g]	137.87	712.65[g]	95.49
3	450.03[i]	117.08	642.06[i]	81.76
4	450.03[k]	117.08	642.06[k]	81.76

[1] See Table 7 for definitions

[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 13. Least Squares Means for sale price for Angus-sired compared to Limousin-sired in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Limousin	SE
1	591.87[e]	17.38	474.20[e]	43.29
2	590.53[g]	12.29	484.06[g]	39.90
3	511.27[i]	12.20	408.30[i]	35.37
4	511.27[k]	12.20	408.30[k]	35.37

[1] See Table 7 for definitions

[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 14. Least Squares Means for sale price for Angus-sired compared to Simangus-sired in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Simangus	SE
1	798.83[e]	18.90	788.86[e]	28.40
2	786.83[g]	9.11	804.13[g]	15.06
3	707.25[i]	14.39	694.83[i]	22.30
4	707.25[k]	14.39	694.83[k]	22.30

[1] See Table 7 for definitions

[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 15. Least Squares Means for sale price for Angus and Simangus by sale name in dollars

Model[1,2]	Sale Name Ag-O-Rama	SE	Sale Name Herd Builders Replacement Heifer Sale	SE	Sale Name Chilton County BCIA Heifer Sale	SE	Sale Name Producers BCIA Heifer Sale	SE
1	956.75^{e}	62.42	805.84^{fgh}	42.74	739.21^{fgh}	37.43	673.59^{fgh}	58.13
2	866.26^{i}	20.78	706.60^{i}	29.31	831.56^{i}	11.78	777.50^{i}	19.52
3	844.23^{m}	48.28	709.85^{nop}	32.55	656.70^{nop}	28.50	593.37^{nop}	44.25
4	844.23^{q}	48.28	709.85^{rst}	32.55	656.70^{rst}	28.50	593.37^{rst}	44.25

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 16. Least Squares Means for sale price for Angus-sired compared to Simmental-sired in dollars

	Sire Breed	SE	Sire Breed	SE
	Angus		Simmental	
Model[1,2]				
1	748.09[e]	29.90	769.92[e]	34.56
2	749.61[g]	11.39	767.78[g]	12.97
3	661.68[i]	13.03	680.31[i]	15.07
4	661.68[k]	13.03	680.31[k]	15.07

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 17. Least Squares Means for sale price for Angus and Simmental by sale name in dollars

	Sale Name[3]	SE	Sale Name	SE	Sale Name	SE	Sale Name	SE	Sale Name	SE
	AOR		HB		CCO		PHS		SWA	
Model[1,2]										
1	827.91[e]	61.76	762.61[e]	33.12	794.09[e]	32.19	729.62[e]	95.48	680.79[e]	39.60
2	810.47[j]	24.87	796.08[j]	19.65	791.55[j]	13.12	717.02[j]	35.49	678.38[j]	14.62
3	716.30[o]	27.16	675.79[o]	14.59	708.03[o]	14.40	652.39[o]	41.61	602.47[o]	17.28
4	716.30[t]	27.16	675.79[t]	14.59	708.03[t]	14.40	652.39[t]	41.61	602.47[t]	17.28

[1] See Table 7 for definitions

[2] Different superscripts within rows denote statistical difference (P < .05)

[3] AOR = Ag-O-Rama HB = Herd Builders Replacement Heifer Sale CCO = Chilton County BCIA Heifer Sale PHS = Producers BCIA Heifer Sale SWA = Southwest Alabama BCIA Replacement Heifer Sale

Table 18. Least Squares Means for sale price for Angus-sired compared to Gelbvieh-sired in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Gelbvieh	SE
1	663.94[e]	13.89	630.48[e]	31.58
2	667.70[g]	25.31	674.68[g]	69.20
3	586.37[i]	22.81	593.00[i]	62.46
4	586.37[k]	22.81	593.00[k]	62.46

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

Table 19. Least Squares Means for sale price for Angus-sired compared to Brahman-sired in dollars

Model[1,2]	Sire Breed Angus	SE	Sire Breed Brahman	SE
1	706.28[e]	11.81	808.40[e]	37.57
2	744.89[g]	15.12	615.58[g]	35.53
3	690.09[i]	21.13	740.24[i]	25.60
4	690.09[k]	21.13	740.24[k]	25.60

[1] See Table 7 for definitions
[2] Different superscripts within rows denote statistical difference ($P < .05$)

LITERATURE CITED

Amer, P.R., R.A. Kemp, J.G. Buchanan-Smith, G.C. Fox, and C. Smith. 1994. A bioeconomic model for comparing beef cattle genotypes at their optimal economic slaughter end point. J. Anim. Sci. 72: 38-50.

Anderson, R.V., R.J. Rasby, T.J. Klopfenstein, and R.T. Clark. 2005. An evaluation of production and economic efficiency of two beef systems from calving to slaughter. J. Anim. Sci. 83: 694-704.

Baker, J.F., C.R. Long, G.A. Posada, W.H. McElhenney, T.C. Cartwright. 1989. Comparison of cattle of a five-breed diallel: size, growth, condition, and pubertal characters of second-generation heifers. J. Anim. Sci. 67: 1218-1229.

Barker-Neef, J.M., D.D. Buskirk, J.R. Black, M.E. Doumit, and S.R. Rust. 2001. Biological and economic performance of early-weaned Angus steers. J. Anim. Sci. 79: 2762-2769.

Cundiff, L.V., R.M. Koch, and K.E. Gregory. 1984. Characterization of biological types of cattle (cycle III) IV. postweaning growth and feed efficiency. J. Anim. Sci. 58: 312-323.

Cundiff, L.V., K.E. Gregory, and R.M. Koch. 1998. Germplasm evaluation in beef cattle-cycle IV: birth and weaning traits. J. Anim. Sci. 76: 2528-2535.

Cushman, R.A., M.F. Allan, R.M. Thallman, and L.V. Cundiff. 2007. Characterization of biological types of cattle (cycle VII): influence of postpartum interval and estrous cycle length on fertility. J. Anim. Sci. 85: 2156-2162.

DeRouen, S.M., and D.E. Franke. 1989. Effects of sire breed, breed type and age and weight at breeding on calving rate and date in beef heifers first exposed at three ages. J. Anim. Sci. 67: 1128-1137.

Dow Jr, Jay S. J.D. Moore, C.M. Bailey, and W.D. Moore. 1982. Onset of puberty in heifers of diverse beef breeds and crosses. J. Anim. Sci. 55: 1041-1047.

Gregory, K.E., L.A. Swiger, R.M. Koch, L.J. Sumpton, J.E. Ingalls, W.W. Rowden, and J.A. Rothlisberger. 1966. Heterosis effects on growth rate of beef heifers. J. Anim. Sci. 25: 290-298.

Gregory, K.E., L.V. Cundiff, G.M. Smith, D.B. Laster, and H.A. Fitzhugh, Jr. 1978. Characterization of biological types of cattle II:I. birth and weaning traits. J. Anim. Sci. 47: 1022-1030.

Julien, D.J. and M.W. Tess. 2002. Effects of breeding date, weaning date, and grazing season length on profitability of cow-calf production systems in southeastern Montana. J. Anim. Sci. 80: 1462-1469.

Laster, D.B., G.M. Smith, and K.E. Gregory. 1976. Characterization of biological types of cattle IV. postweaning growth and puberty of heifers. J. Anim. Sci. 43: 63-70.

Laster, D.B., G.M. Smith, L.V. Cundiff, and K.E. Gregory. 1979. Characterization of

biological types of cattle (Cycle II) II. postweaning growth and puberty of heifers. J. Anim. Sci. 48: 500-508.
Lewis, J.M., T.J. Klopfenstein, G.A. Pfeiffer, and R.A. Stock. 1990a. An economic evaluation of the differences between intensive and extensive beef production systems. J. Anim. Sci. 68: 2506-2516.
Lewis, J.M., T.J. Klopfenstein, R.A. Stock, and M.K. Nielsen. 1990b. Evaluation of extensive versus intensive systems of beef production and the effect of level of beef cow milk production on postweaning performance. J. Anim. Sci. 68: 2517-2524.
Marsh, John M. 2001. U.S. feeder cattle prices: effects of finance and risk, cow-calf and feedlot technologies, and Mexican feeder imports. J. Agric. Resour. Econ. 26: 463-477.
Myers S.E., D.B. Faulkner, T.G. Nash, L.L. Berger, D.F. Parrett, and F.K. McKeith. 1999. Performance and carcass traits of early-weaned steers receiving either a pasture growing period or a finishing diet at weaning. J. Anim. Sci. 77: 311-322.
Notter, D.R., L.V. Cundiff, G.M. Smith, D.B. Laster, and K.E. Gregory. (a) 1978. Characterization of biological types of cattle VI. transmitted and maternal effects on birth and survival traits in progeny of young cows. J. Anim. Sci. 46: 892-907.
Notter, D.R., L.V. Cundiff, G.M. Smith, D.B. Laster, and K.E. Gregory. (b) 1978. Characterization of biological types of cattle VII. milk production in young cows and transmitted and maternal effects on preweaning growth of progeny. J. Anim. Sci. 46: 908-921.
Patterson, D.J., R.L. Weaber, M.F. Smith, D.C. Busch, and J.L. Parcell. 2006. The Missouri Show-Me-Select Replacement Heifer Program. J. Anim. Sci. 84: 187.
Pierce, V., J. Parcell, and R. Randle. 1999. "Determinants of Replacement Heifer Price Differentials." Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL.[http://www.farmdoc.uiuc.edu/nccc134].
Pyatt, N.A., L.L. Berger, D.B. Faulkner, P.M. Walker, and S.L. Rodriguez-Zas. (a) 2005. Factors affecting carcass value and profitability in early-weaned Simmental steers: II. Days on feed endpoints and sorting strategies. J. Anim. Sci. 83: 2926-2937.
Pyatt, N.A., L.L. Berger, D.B. Faulkner, P.M. Walker, and S.L. Rodriguez-Zas. (b) 2005. Factors affecting carcass value and profitability in early-weaned Simmental steers: I. Five-year average pricing. J. Anim. Sci. 83: 2918-2925.
SAS. 2002-2003. SAS user's guide: Statistics (version 9.1). SAS Institute Inc., Cary, NC.
Smith, G.M., D.B. Laster, and K.E. Gregory. (a) 1976. Characterization of biological types of cattle I. dystocia and preweaning growth. J. Anim. Sci. 43: 27-36.
Smith, G.M. D.B. Laster, and L.V Cundiff. (b) 1976. Characterization of biological types of cattle II. postweaning growth and feed efficiency of steers. J. Anim. Sci. 43: 37-47.
Steffan, C.A., D.D. Kress, D.E. Doornbos, and D.C. Anderson. 1985. Performance of crosses among Hereford, Angus, and Simmental cattle with different levels of Simmental breeding. III. Heifer postweaning growth and early reproductive traits. J. Anim. Sci. 61: 1111-1120.

Story, C.E., R.J. Rasby, R.T. Clark, and C.T. Milton. 2000. Age of calf at weaning of spring-calving beef cows and the effect on cow and calf performance and production economics. J. Anim. Sci. 78: 1403-1413.

Sy, H.A., M.D. Faminow, G.V. Johnson, and G. Crow. 1997. Estimating the values of cattle characteristics using an ordered probit model. Amer. J. of Ag. Econ. 79: 463-479.

Thallman, R.M., L.V. Cundiff, K.E. Gregory, and R.M. Koch. 1999. Germplasm evaluation in beef cattle-cycle IV: postweaning growth and puberty of heifers. J. Anim. Sci. 77: 2651-2659.

Troxel, T.R., B.L. Barham, S. Cline, J. Foley, D. Hardgrave, R. Wiedower, and W. Wiedower. 2006. Management factors affecting selling prices of Arkansas beef calves. J. Anim. Sci. 84: 12-13.

Turner, S.C., J.C. McKissick, M.A. McCann, and N.S. Dykes. 1992. Market value and managerial decisions: implications from a decade of feeder cattle teleauctions. J. Anim. Sci. 70: 1015-1021.

Young, L.D., L.V. Cundiff, J.D. Crouse, G.M. Smith, and K.E. Gregory. 1978. Characterization of biological types of cattle VIII. postweaning growth and carcass traits of three-way cross steers. J. Anim. Sci. 46: 1178-1191.