Brahman Crossbred Performance in Distinct Segments of the United States Beef Industry

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Introduction

Brahman crossbred cows comprise a large portion of the cow-calf industry segment throughout the South, producing calves of generally ¼ or less Brahman inheritance. Brahman cattle are very well-adapted to conditions across the Southern United States. Although some calves are managed as stockers in the South and some are fed in South Texas or Southern Arizona, the majority of Southern cattle enter the stocker and feeder segments on the Great Plains. The very obvious environmental differences between that region and the South are climatic and nutritional. Climatic differences are seasonal, as temperatures greatly differ in fall, winter, and spring of most years; humidity is generally lower for most of the year in the Southern Great Plains region than for the Southeastern United States but similar to South-central or Southwestern regions. The nutritional/social world of these Southern calves changes completely in conjunction with long-distance transportation. This results in enormous stress associated with the demand to shift from living and growing in an environment they are well-suited to (especially in the case of calves with ½ or more Brahman background), to an environment to which they are not well-adapted. This unusual combination of requirements surely has no equal in the natural world. After completing this feeding process and conversion to product, there is equal market competition with beef from animals not subjected to this routine. It is not surprising that there are difficulties encountered by the calves in this very un-natural process. The purpose of this paper is to examine experimental results associated with performance of Brahman crossbreds in both environments, that is, in the Southern cow-calf environment and in the stocker and feeder segments. In any evaluation of the performance of Brahman crosses, the way crossbred animals were produced may dramatically influence experimental results. The presence of maternal heterosis (dependent upon the cross) will greatly affect performance of ¾ Brahman calves. Probably of greater importance is the fact that calves produced from matings of Brahman bulls to *Bos taurus* cows are much heavier at birth than calves produced by reciprocal matings; research evidence of this difference for other traits is being accumulated.

Brahman Crossbred Cows in the Southern United States

The *Bos indicus* ancestors of the Brahman breed were originally imported and used in the Southern United States (and in similar or harsher areas around the world) because of their adaptation to the extreme conditions characteristic of the region. The ability to survive and reproduce in harsh tropical and subtropical conditions was almost certainly the initial reason that the Brahman breed became an important part of the U.S. beef production system. There is ample research that documents the ability of Brahman purebred and crossbred cattle to live and perform in such subtropical conditions. Brahman cattle have the ability to maintain lower body temperatures and respiration rates under heat duress; they produce less heat than *Bos taurus* cattle, and may be better able to dissipate that heat. They cope better with parasites such as ticks and horn flies than most cattle of European origin. Brahman and Brahman crosses have been documented with better performance in a variety of traits including a superior ability to minimize the toxic effects of grazing certain fescue varieties in the upper South. Adaptation will continue to be of great importance in beef production.

Almost as important as adaptation today is Brahman contribution to heterosis. Heterosis is the difference between averages of crossbreds and straightbreds for a trait. Substantial levels of heterosis have been experimentally documented for almost all traits of relevance for beef production for Brahman crosses in multiple research settings. Brahman-*Bos taurus* levels of heterosis are generally much larger than heterosis in crosses of *Bos taurus* breeds. This heterosis is especially effective for improving traits that are not easily influenced by selection. These include reproductive traits of cows, which are critical for cattlemen. Every crossbreeding study in the Southern United States that has involved Brahman has reported tremendous superiority of Brahman crossbred cows. These have included estimates of heterosis for traits like calving rate or weaning rate from 10 to 45% of the weighted straightbred average. Brahman crossbreds have also been highly productive on the U.S. Great Plains, where they have ranked at or near the best for calving rates, weaning rates, weaning weights of their calves and weaning weight per cow exposed to breeding in the GermPlasm Evaluation (**GPE**) multi-year multi-cycle project in Nebraska (Cundiff, 2005). Excellent performance of F_1 Brahman-British cows has been documented in Alberta (Peters and Slen, 1967).

In Florida, an experimental cow herd was built using straightbreds and crossbreds of Brahman, Angus, and Romosinuano (criollo *Bos taurus* breed). These cows were born from 2002 through 2005 and were then evaluated through 2010. F_1 cows (reciprocal crosses included) were bred to bulls that were of the third breed; straightbred cows of each breed were divided into 2 groups and bred to bulls of the other 2 breeds. Table 1 documents the superior calving rates and weaning rates of the F_1 Brahman-Angus and Brahman-Romosinuano (this is a popular South American cross because of the reputation for high fertility) cows in this project. Estimates of heterosis were 22% and 16% for Brahman-Angus and Brahman-Romosinuano, respectively, for weaning rate (Table 1). This work extended the confirmation of this hybrid advantage to Brahman crossed with criollo cattle—Brahman had previously been documented as having high levels of heterosis with every other evaluated *Bos taurus* breedtype.

Crossbred Brahman cows excelled in performance on the harsh conditions presented by endophyte-infected tall fescue. In the work of Brown et al. (2005) Brahman-Angus cows (reciprocal crosses included) grazing bermudagrass had calving rate 13% greater than the purebred average; the corresponding estimate for cows grazing endophyte-infected tall fescue was 49% greater than the purebred average. It seems (particularly in this case) that the severity of the environment appears to augment the effects of heterosis.

The advantages in heterosis and adaptation offered by the Brahman crossbred cows are too big to ignore in the Southern United States. These advantages support the widespread use of Brahman crossbred cows throughout the South. Approximately 35 to 40% of the calves that enter the U.S. beef production chain have some Brahman background. This large fraction is notable considering market pressure against calves with visible Brahman background (Barham and Troxel, 2007); however, as crosses with Angus (F_1 Brahman Angus and ¼ Brahman ¾ Angus) sale price per hundred lb was very high relative to other crossbred groups (Troxel and Barham, 2012).

Transportation/Receiving

There are at least 3 major stressors for cattle moved from the Southeastern United States to the Great Plains for stocker and feedlot phases. Those include weaning, long-haul transportation, and the potential for large change (decrease) in ambient temperatures. Many of the cattle moved from the South or Southeast to the Great Plains are freshly weaned in the fall of the year and are consequently very susceptible to health problems, which are exacerbated by the long transport and the colder weather encountered after arrival. Tropical adaptation that is an advantage in the South becomes a detriment on the Great Plains through the winter. Cattle of any breed or type would find these a challenging set of scenarios.

Brahman F_1 steers were heavier than all other steers in Florida at weaning at 7 months of age; they also gained more in the 21 to 35 day period immediately after weaning compared to purebred Brahman and Angus (Table 2; Coleman et al., 2012). Heterosis for ADG in this period was enormous (64%, Table 3). These steers were shipped each year to a research location in Central Oklahoma. F_1 Brahman steers had greater shrink on that 24-hour ride than the other breed groups and unfavorable heterosis for shrink (Table 2), but they had greater daily gain in the 28 days after arrival in Oklahoma (relative to receiving weight), with heterosis of 43% (Table 3). This large estimate may in part represent recovery of water lost in transit. There was no death loss during transportation and the receiving period. These steers were not commingled with steers from other locations, which may have helped minimize potential problems.

Brahman on Winter Pasture

Among those steers (Coleman et al., 2012), ADG of F_1 Brahman-Angus steers grazing winter wheat did not differ from that of Angus steers (Table 2). Brahman-Angus heterosis was 11% (0.2 lb) for ADG during this phase (Table 3). These steers grazed wheat from November through May; the lower ADG of straightbred Brahman and Romosinuano and F_1 Brahman-Romosinuano probably is due in part to their inability to cope well with cold weather, since each of these breed groups would be expected to have minimal adaptation to winter conditions of temperate areas. Straightbred Brahman steers had lower ADG than F_1 Brahman-Angus, F_1 Brahman-Tuli (African *Bos taurus* breed), and ¼ Brahman ¼ Hereford ½ Simmental steers on winter pastures in Oklahoma and Texas (Rouquette et al., 2005); ADG of F_1 Brahman-Angus steers and ¼ Brahman ¼ Hereford ½ Simmental steers did not differ (Table 4). Ferrell et al. (2006) evaluated steers with fractions of 0, ¼, ½, and ¾ Brahman inheritance in Nebraska; the complementary fraction within each group of steers was MARC III composite (¾ British ¼ Continental). These steers were produced by artificial insemination of MARC III cows and F_1 Brahman-MARC III cows to Brahman bulls (½ and ¾ Brahman steers) and F_1 Brahman-MARC III cows bred to MARC III bulls (¼ Brahman steers). Steers were fed either bromegrass hay (as a low-gain, forage-based diet) or corn silage (as a high-gain, forage-based diet) in a 119-day growing period in dry lot in order to measure intake. Dry matter intake, crude protein intake, metabolizable energy intake (metabolizable energy is that energy available for maintenance or growth above that required to digest the source from which it was obtained), and ADG of ½ Brahman steers were highest but did not differ from MARC III steers (Table 5). There were no breed group differences in these intakes per pound of gain; that is steers with different fractions of Brahman background responded to these different growing diets similarly. These steers were evaluated in winter, which may have influenced results.

Brahman in Feedlot

Gain

In the evaluation of Florida steers, the feedlot phase occurred from May through September in Oklahoma; summers on the Great Plains often have high temperatures. Straightbred Brahman had lower ADG in the feedlot phase than all other breed groups (Table 2), which were similar to each other (Coleman et al., 2012). Brahman-Angus heterosis for ADG was 14% (0.26 lb, Table 3). Feedlot ADG of F_1 Brahman-Angus steers did not differ from ¼ Brahman ¼ Hereford ½ Simmental steers (Table 4); these steers were fed during Texas Panhandle summer conditions (Rouquette et al., 2005). Huffman et al. (1990) reported the highest ADG for Angus steers, followed by ¾ Brahman, ½ Brahman, and ¼ Brahman steers (Table 6). Pringle et al. (1997) evaluated steers with fractions 0, ¼, ⅜, ½, ¾, and 1 Brahman (with Angus as the complementary fraction). Days of feeding to reach target backfat end points were lowest for straight Angus, ¼, and ⅜ Brahman steers (Table 7). Steers in both those studies (Huffman et al., 1990; Pringle et al., 1997) were fed in Florida. Sherbeck et al. (1995) reported the highest ADG for Hereford steers as compared to ¼ Brahman ¾ Hereford and ½ Brahman ½ Hereford that were fed in Eastern Colorado (Table 8).

Steers from Cycle V of GPE were evaluated to assess the different aspects of gain while being fed a high concentrate diet (Ferrell and Jenkins, 1998). F_1 steers sired by Brahman, Angus, Hereford, Boran, and Tuli sires and out of MARC III cows were assigned to one of 3 groups: 1) an initial (prior to test) slaughter group, in order to facilitate regression estimates of various types of gain; 2) a limit-fed group; and 3) a group fed ad libitum. Table 9 shows means for intake and gain by breed group for these steers. Among the steers in the limit-fed group, Angus and Hereford F_1 steers had greater energy gain than the Brahman F_1 steers. In the ad libitum group, however, there were no differences in energy gain among these 3 breed groups; all were greater than Boran and Tuli F_1 steers. There were no differences for carcass traits within breed and feeding group combinations. Angus F_1 steers had greater carcass weight, backfat, and yield grades than Brahman and Hereford (Table 10). Quality grades were lower for Brahman F_1 steers, but ribeye area was similar for these 3 breed groups. At low intakes, Brahman F_1 steers organ weights were lower than Angus F_1 steers, but were similar at high intakes, indicating greater adaptability or responsiveness to increased feed intake than Angus F_1 steers. Brahman F_1 steers had greater fasting heat production (that is, independent of the heat production associated with digestion) than Angus, and consequently they required a higher metabolizable energy intake for maintenance. Brahman F_1 steers had the highest efficiency of use of metabolizable energy for gain; Angus had the lowest. This work did not support the notion that Brahman cattle have lower energy requirements for maintenance than *Bos taurus* cattle under those conditions. The influence of the winter feeding conditions of this project was not assessed. Brahman F_1 steers seemed to adapt (respond and gain) to a greater extent than the *Bos taurus* steers when permitted the higher intake associated with ad libitum feeding.

Intake

Intake of straightbred Brahman cattle has been reported to be low relative to other breeds or crosses (e.g., Elzo et al., 2009; Table 11); intake of F_1 Brahman cattle has often been reported to be high relative to other groups. Dry matter intake means of F_1 Brahman-Angus and Angus were essentially the same (Table 2, Coleman et al., 2012). F_1 Brahman-Angus and ¾ Brahman ¼ Angus steers had greater dry matter intake than Angus (Table 6; Huffman et al., 1990); these steers were fed in Florida under conditions which may have depressed the appetites of straightbred Angus steers. Among steers and heifers fed in North Florida, Elzo et al. (2009) reported intake means of animals grouped by residual feed intake (**RFI**) values. Residual feed intake is daily dry matter intake of an animal adjusted to the average size (metabolic weight) and growth rate (ADG) of cattle evaluated together; low (that is, negative values, since by definition the mean RFI = 0) RFI values are considered to be favorable. Among those calves (from the work of Elzo et al., 2009) that were in the high RFI group (that is, inefficient) and the medium RFI group, F_1 Brahman-Angus, ⅜ Brahman ⅝ Angus and ¼ Brahman ¾ Angus all had higher daily intake than Angus (Table 11). However, the breed group daily intake differences were much lower among the low RFI (efficient) group of calves. In their comparison of F_1 steers, Ferrell and Jenkins (1998) reported greater F_1 Angus-MARC III intake (dry matter and metabolizable energy) than that of F_1 Brahman-MARC

III steers when fed ad libitum; Brahman F_1 steer intake did not differ from F_1 Hereford-MARC III intake (Table 9). They reported no breed differences when steers were limit-fed. Ferrell et al. (2006) reported that dry matter intake, crude protein intake, and metabolizable energy intake of F_1 Brahman-MARC III steers and MARC III steers did not differ in a growing phase when fed a high roughage diet or when fed a high concentrate feed diet; these were higher than ¼ Brahman and Brahman steers (Table 5). Estimates of heritability for intake or RFI are as large as those for weight traits, which are easily altered with selection. Selective improvement of efficiency by lowering RFI of steers would almost certainly result in decreased intake in their half siblings that will become the cows on pasture in the South (C. L. Ferrell, J. O. Sanders, personal communication). This seems counter to the best interests of a producing cow in order to conceive, maintain pregnancy, and perform maternally. Forbes et al. (1998) reported superior intakes of F_1 Brahman cows on pasture relative to other breed types. There may be heterosis for intake on pasture or for the efficient utilization of nutrients from such a forage diet. There may be heterosis for intake in steers fed a high concentrate diet; but it was not detected in Brahman-Angus, Brahman-Romosinuano, or Angus-Romosinuano (Coleman et al., 2012).

Brahman Carcass Traits

In U.S. research trials (Tables 2, 4-8, 10, 12, 13), Brahman F_1 steers have generally had better than average carcass traits related to quantity (carcass weight, dressing percentage, backfat thickness, ribeye area, and yield grade; of course under the assumption that less fat is desirable), but generally lower values for traits related to quality (marbling score, Warner-Bratzler shear force, trained sensory evaluation of tenderness). Results of Brahman (and other *Bos indicus* breeds) across the duration of the GPE cycles in Nebraska were similar (Wheeler et al., 2005). Experimental results have indicated that ¼ Brahman steers did not differ from straightbred *Bos taurus* for marbling score/quality grade or Warner-Bratzler shear force/sensory panel tenderness (Tables 5, 6). Exceptions to this included the results (Tables 7 and 8) of Sherbeck et al. (1995) and Pringle et al. (1997). However, Pringle et al. (1997) reported no difference between quality grades of ¼ Brahman and Angus groups, as well as no marbling score differences of F_1 Brahman-Angus and straightbred Angus steers. No interaction of sire breed and dam breed (representative of breed type) was detected in analyses of marbling score, Warner-Bratzler shear force, and sensory panel tenderness (Riley et al., 2012), but Brahman sire breed means were lower than Angus and Romosinuano for these traits (Table 12). Results from one of the largest comparisons of steers with differing backgrounds of Brahman (Elzo et al., 2012) indicated no difference in tenderness of steaks from ¼ Brahman, F_1 Brahman-Angus, and Angus steers, but Warner-Brazler shear forces of Angus were slightly better than either. All breed groups with any proportion Brahman had lower marbling scores than Angus steers (Table 13). The differences between straightbred Brahman and *Bos taurus* shear force are real and confirmed by most research to date. Much of the research results involving F_1 Brahman, and really almost all of the ¼ Brahman results (especially when carcasses were electrically-stimulated) reported Warner-Bratzler shear force averages of 10 lb or less, which fits into at least a category of 'slightly tender' (see Platter et al., 2005; Boleman et al. [1997] and Miller et al. [2001] also presented different assessments of consumer acceptability and Warner-Bratzler shear force values in which this threshold of 10 lb appears consistent). Within GPE, F_1 Brahman steers had higher Warner-Bratzler shear force and lower sensory panel tenderness means than F_1 Hereford-Angus, F_1 Hereford-MARC III, and F_1 Angus-MARC III, and were more variable (Wheeler et al., 2005). Marbling score of crossbred Brahman steers has been consistently reported to be lower than Angus or British crossbreds. There appears to be substantial additive genetic variation to permit selective improvement of marbling score in the Brahman breed (Smith et al., 2009).

Summary

1. Brahman crossbred cows continue to be widely used across the Southern United States because of superior adaptability to rough conditions and the extremely high levels of heterosis for most traits (but especially reproductive traits) as crosses with really any *Bos taurus* breed.
2. The movement of Brahman crossbred calves from the South to the Great Plains represents an enormous stress on these animals. However, calves with as much as ½ Brahman background appear to grow and perform very well in the stocker and feeder phases on the Great Plains, especially during the summer. Stocker programs in the South may be advantageous for cattle to recover from the stress of weaning and gain weight, but also to avoid spending winter on the Great Plains. Crossbreds with more than ½ Brahman would likely perform better in feedlots in areas with milder winters, e.g., South Texas or Southern Arizona.
3. After feeding, Brahman crossbred carcasses generally have very good values for traits related to quantity of beef. Most research has documented lower marbling scores (as well as all fat content) and therefore quality grades of carcasses from Brahman crossbreds. There appear to be selective opportunities to improve marbling score in the Brahman breed, should that become an appropriate goal.
4. Steers of ¼ Brahman inheritance and to a lesser extent, F_1 Brahman steers, are the most likely Brahman crossbreds to enter the conventional beef production process, especially the feedlot segment on the Great Plains. Cattle that are ¼ Brahman will qualify for many premium carcass programs. There is substantial research that indicates that both types will perform acceptably for most traits of economic importance.
5. Selection for reduced RFI as a method of improving efficiency during the feedlot stage is discouraged within the breed, as anything that would suppress intake of Brahman crossbred cows on pasture conditions would be undesirable.

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Table 1. Brahman, Angus, and Romosinuano straightbred and crossbred cow reproductive traits

	N	Pregnancy rate	Calving rate	Weaning rate
Straightbred				
Brahman	175	0.76	0.76	0.70
Angus	161	0.84	0.84	0.82
Romosinuano	194	0.82	0.82	0.78
F_1				
Brahman-Angus	420	0.95	0.95	0.93
Brahman-Romosinuano	462	0.89	0.89	0.86
Romosinuano-Angus	397	0.87	0.86	0.81
Heterosis				
Brahman-Angus		0.15 (18%)	0.15 (19%)	0.17 (22%)
Brahman-Romosinuano		0.10 (13%)	0.10 (13%)	0.12 (16%)

[1]Cows were born from 2002 to 2005 and were first exposed to bulls as yearlings. First calves as 2-year olds not included in these results. Records through 2010 were included in these results.
[2]Cows were exposed to bulls annually: F_1 cows were exposed to bulls of the 3rd breed. Straightbred cows of each breed were exposed in approximately equal numbers to bulls of the other 2 breeds.
[3]Reciprocal F_1 cows combined into single groups.
[4]Heterosis was not detected for Romosinuano-Angus cows for these traits.
[5]Numbers represent numbers of cows in each breed group for palpation. Cows in excess of 40 for each breed group were sold as bred 3-year olds.
[6]Cows were culled after 2 failures to wean a calf.

Table 2. Growth of straightbred and F_1 steers weaned in Florida and transported to Oklahoma

	Brahman	Angus	Romosinuano	F_1 BA	F_1 BR	F_1 RA
N	48	38	74	77	113	118
Prewean ADG, lb/day	1.9	1.7	1.7	2.0	2.0	1.8
Weaning BW, lb	518	441	465	537	524	487
Postwean recovery						
ADG, lb/d (21 to 35 d)	0.8	0.7	0.6	1.2	0.9	0.9
Transition						
Shipping BW, lb	545	465	483	579	555	518
Ship loss, %	8.5	9.5	8.7	9.1	8.7	9.4
Receiving ADG, lb/day (28 d)	0.4	1.0	0.4	1.0	0.5	0.5
Wheat pasture						
Final BW, lb	811	853	784	951	864	872
ADG, lb/d	1.5	2.1	1.7	2.0	1.7	2.0
Feedlot						
Final BW, lb	1045	1100	1062	1217	1121	1159
ADG, lb/d	1.8	2.1	2.1	2.2	2.1	2.2
Overall ADG, lb/day (wean to final)	1.4	1.9	1.6	1.9	1.7	1.8
Intake/efficiency						
N	27	30	29	57	61	57
DMI, lb/d	17.5	18.9	18.7	19.2	18.0	19.5
Feed:Gain	7.75	8.2[illegible]	7.58	7.91	7.84	7.97
Residual feed intake	–0.37	0.6[illegible]	–0.01	–0.20	–0.44	0.60
Carcass						
N	48	38	72	79	109	118
Carcass wt, lb	657	695	671	778	721	738
Dressing percentage	61.5	61.5	61.5	63.1	62.1	62.5
Fat thickness, in	0.42	0.6[illegible]	0.41	0.63	0.48	0.52
Ribeye area, in^2	11.1	12.1	12.0	12.4	12	12.6
Ribeye area, in^2/100 lb carcass	1.70	1.7[illegible]	1.81	1.61	1.68	1.72
Yield grade	2.9	3.3	2.7	3.5	3.2	3.1

[1]Means of F_1 steers include reciprocal crosses.
[2]Postwean recovery period was from 21 to 35 d. Steers were weaned at average of 7 months of age.
[3]Steers were weighed immediately prior to loading in Florida and immediately after unloading in Oklahoma. Steers were kept in a grass paddock with access to feed for the 28-day receiving period.
[4]Steers grazed wheat pasture for an average of 120 days.
[5]A subset of steers (n = 90) from all breed groups was evaluated for intake and efficiency each year (2003, 2004, 2005) using Calan feeding system.
[6]Steers were randomly assigned to feeding periods which averaged 101, 129, and 157 days (summer feeding), and were slaughtered commercially in the Texas Panhandle.
[7]Adapted from Coleman et al. (2012) and Riley et al. (2012).

Table 3. Estimates of heterosis, direct and maternal breed effects for steer traits

	Heterosis					
	Brahman-Angus		Brahman-Romosinuano		Romosinuano-Angus	
	Amount	%	Amount	%	Amount	%
Prewean ADG, lb/day	0.20	11	0.13	7.2	0.13	7.8
Wean BW, lb	57	12	33	6.7	35	7.8
Postwean recovery ADG, lb/day	0.46	63.6			0.29	46
Shipping BW, lb	75	14.8	39.7	7.7	44	9.3
Ship loss, lb	8.4	18.5	5.5	12.5	6.2	14.4
Arrival BW, lb	66.1	14.4	35.3	7.5	37.5	8.7
Receive ADG, lb/day	0.29	42.6	0.15	42.4	–0.20	–30
Winter wheat						
Initial BW, lb	81.6	15.5	44.1	8.4	35.3	7.1
Final BW, lb	119.1	14.3	66.1	8.3	52.9	6.5
ADG, lb/day	0.20	11	0.13	8.3	0.07	3.4
Feedlot						
Final BW, lb	29.5	13.4	66.1	6.3	77.2	7.1
ADG, lb/d	0.26	13.6				
Overall ADG, lb/day	0.26	16.1	0.13	8.6	0.11	6.3
Feed:Gain	8.17	14.1				
Carcass wt, lb	102	15.1	57	8.6	56	8.1
Dressing percentage	1.7	2.7			1.1	1.7
Fat thickness, in	0.10	19.9	0.06	15.6		
Ribeye area, in^2	0.82	7.1	0.39	3.3	0.56	5
Ribeye area, in^2 / 100 lb	–0.11	–6.6	–0.08	–4.3	–0.06	–3
Yield grade	0.4	13.6	0.3	9.5		

[1]Adapted from Coleman et al. (2012). Trait details correspond to those described in Table 1.
[2]Empty cells indicate that effects were not statistically different from 0.
[3]Traits from Table 2 are omitted here if no heterosis was detected.
[4]Adapted from Coleman et al. (2012) and Riley et al. (2012).

Table 4. Growth and carcass traits of Brahman straightbred and crossbred steers

	¼ Brahman ¼ Hereford ½ Simmental	½ Brahman ½ Angus	½ Brahman ½ Tuli	Brahman
N	47	35	37	30
ADG winter, lb/day	2.5	2.4	2.0	1.7
ADG feedlot, lb/day	3.2	3.4	2.6	2.9
Carcass wt, lb	889	848	685	672
Backfat, in	0.37	0.48	0.33	0.25
Ribeye area, in^2	14	13.5	12.3	11.4
Yield grade	2.78	3.06	2.44	2.47
Marbling score	366	392	367	342
Shear force, lb	7.9	8.1	8.1	10.3
Tenderness score	6.0	5.8	6.0	5.3

[1]Weaned steers grazed cool-season annuals in East Texas or Central Oklahoma from December to mid-May.
[2]Steers were commercially-fed in the Texas Panhandle in the summers of 1993 and 1994 to a target of 0.4 inches of backfat.
[3]Marbling score 300 to 399 = Select.
[4]Tenderness scores evaluated by a trained panel using values from 1 (extremely tough) to 8 (extremely tender).
[5]Adapted from Rouquette et al. (2005).

Table 5. Comparison of intake, growth, and carcass traits of steers with different fractions of Brahman inheritance in Nebraska

Fraction of Brahman inheritance	0	¼	½	¾
N	15	20	7	9
Growing period				
Initial weight, lb	602	562	708	604
Final weight, lb	796	717	906	747
ADG, lb/day	1.6	1.3	1.7	1.2
Dry matter intake lb/day	16.1	13.7	17.6	14.6
Crude protein intake, lb/day	1.7	1.5	1.9	1.6
Metabolizable energy intake, Mcal/day	18.1	15.2	19.7	16.2
DMI/gain lb/lb	13.2	13.9	13.2	19.2
Crude protein intake/gain, lb/lb	1.3	1.4	1.4	1.9
Metabolizable energy intake/gain lb/lb	30.8	32.5	31	44.3
Residual ADG	–0.02	0.03	0.02	–0.03
Residual metabolizable energy intake	0.46	–0.44	–0.03	–0.13
Finishing period				
Initial weight, lb	796	717	906	747
Final weight, lb	1241	1213	1268	1246
Days to finish	155	196	134	199
ADG, lb/day	2.9	2.6	2.6	2.6
Dry matter intake lb/day	18.5	17.0	18.5	15.0
Crude protein intake, lb/day	2.2	2.0	2.2	1.8
Metabolizable energy intake, Mcal/day	26	23.8	25.9	21
Dry matter intake/gain lb/lb	6.5	6.6	7.1	5.9
Crude protein intake/gain lb/lb	0.75	0.74	0.82	0.68
Metabolizable energy intake/gain lb/lb	20.1	20.5	21.9	18.3
Residual ADG	0.04	–0.05	–0.01	0.05
Residual metabolizable energy intake	0.46	–0.44	–0.03	–0.13
Final wt, lb	1243	1213	1268	1248
Carcass				
Carcass wt, lb	750	745	792	769
Dressing percentage	60.4	61.6	62.3	61.6
Marbling score	470	490	390	364
Quality grade	16.2	16.2	15	14.3
Fat thickness, in	0.40	0.59	0.51	0.57
Adjusted fat thickness, in	0.35	0.51	0.43	0.53
Ribeye area, in^2	12.4	11.5	12.2	11.8
Yield grade	2.86	3.45	3.38	3.29

[1]The complementary fraction of steers in each breed group was MARC III (¾ British ¼ Continental).
[2]Steers were fed through the winter either diets of bromegrass hay or corn silage during the growing period of 119 days.
[3]Steers were fed to a target body weight of 1,235 lb.
[4]Marbling score: Slight = 300; Small = 400; Modest = 500.
[5]Quality grade: $Select^{o}$ = 14, $Select^{+}$ = 15, $Choice^{-}$ = 16.
[6]Adapted from Ferrell et al. (2006).

Table 6. Growth, efficiency, and carcass means for steers of different fractions of Brahman inheritance

Fraction of Brahman inheritance	0	¼	½	¾
Feedlot				
N	41	42	41	41
Days on feed	121	103	102	107
Slaughter wt, lb	1012	990	1087	1100
ADG, lb/day	3.5	3.6	3.9	3.9
Dry matter intake, lb/day	19.4	19.4	21.6	21.8
Feed:Gain	5.6	5.4	5.6	5.6
Carcass				
N	31	32	31	31
Carcass wt, lb	637	624	683	701
Dressing percentage	63	62	62.6	63.4
Ribeye area, in^2	11.6	10.9	11.3	11.6
Ribeye area, in^2/100 lb	1.83	1.76	1.69	1.69
Yield grade	2.8	3	3.1	3.1
Marbling score	Sm^{13}	Sm^{11}	Sl^{70}	Sl^{30}
% Choice	55	66	29	7
% Select	45	34	65	74
% Standard	0	0	6	19

[1]The complementary fraction of breed inheritance was Angus.
[2]Steers were either fed as calves or grazed winter pastures until June and were then fed in Florida in 1985 and 1986. There were fed to 2 backfat end point targets: 0.4 or 0.6 in. Intake was assessed using the Calan system. No breed by age-season interactions detected.
[3]Adapted from Huffman et al. (1990).

Table 7. Growth and carcass traits for steers with different fractions of Brahman inheritance

Fraction of Brahman inheritance	**0**	**¼**	**⅜**	**½**	**¾**	**1**
N	11	13	10	12	12	11
Days on feed	156	156	157	172	168	202
Carcass						
Carcass wt, lb	692	728	679	739	697	712
Dressing percentage	60.7	61.8	60.5	63.1	61.9	62.7
Fat thickness, in	0.47	0.51	0.39	0.43	0.47	0.39
Ribeye area, in^2	12.4	11.6	11.3	12.4	11.3	73
Ribeye area, in^2/100 lb	1.83	1.62	1.69	1.69	1.62	1.62
Yield grade	2.8	3.2	2.8	2.8	3.1	3
Marbling score	436	418	416	366	354	315
Quality grade	607	594	595	556	547	521
% Choice	82	54	60	25	17	9
% Select	18	46	40	58	58	64
% Standard	0	0	0	17	25	27
Shear force (14 days aging), lb	9.5	11.0	9.3	10.4	10.6	13.4
Tenderness	5.9	5.3	6.1	5.6	5.5	4.4
Connective tissue amount	6.1	5.9	6.3	6	6	5

[1]The complementary fraction of inheritance in these steers was Angus.
[2]Steers grazed winter pastures until approximately 1 year of age. They were contract fed in Florida through the winter to backfat end points of either 0.4 or 0.6 inch and slaughtered at University of Florida facilities.
[3]Marbling score: Slight = 300 to 399; Small = 400 to 499.
[4]Quality grade: Select$^-$ = 500 to 549; Select$^+$ = 550 to 599; Choice$^-$ = 600 to 633.
[5]Detectable amount of connective tissue and tenderness scores evaluated by a trained panel using values from 1 (extremely tough; abundant amount) to 8 (none detected, extremely tender).
[6]Adapted from Pringle et al. (1997).

Table 8. Growth and carcass traits of steers with different fractions of Brahman inheritance

Fraction of Brahman inheritance	0	¼	½
N	77	80	79
ADG, lb/day	4.0	3.5	3.3
Carcass wt, lb	699	703	719
Fat thickness, in	0.45	0.44	0.41
Ribeye area , in^2	11.8	12.4	12.4
Yield grade	3.11	2.91	2.92
Marbling score	Sl^{91}	Sl^{47}	Sl^{45}
Shear force, (6 days aging), lb	7.9	9.0	10.1
Tenderness, (6 days aging)	4.9	4.7	4.1
Shear force, (18 days aging), lb	6.4	7.3	8.4
Tenderness, (18 days aging)	5.5	5.3	4.8

[1]The complementary fraction of breed inheritance was Hereford.
[2]Steers had grazed native Great Plains pasture or had been fed a backgrounding diet in a dry lot; time of year not reported. Steers (11 or 12 months of age) were fed to 1 of 4 days-on-feed (84, 98, 112, or 126 days) in Eastern Colorado in 1994. Purebred Hereford were from temperate areas of the United States. Crossbred Brahman steers were from Texas and Mississippi.
[3]Adapted from Sherbeck et al. (1995).

Table 9. Intake and growth on feed of F_1 steers

		Dry matter intake		Metobolizable energy intake				
	N	lb/d	lb/($wt^{0.75}$ /d)	Mcal/d	kcal/($wt^{0.75}$ /d)	Days on feed	Initial wt, lb	ADG, lb/d
Limit-fed								
Angus	4	7.5	0.097	10.7	137	137	780	0.93
Boran	8	6.7	0.095	9.5	134	139	657	0.73
Brahman	8	7.0	0.097	9.9	137	140	690	0.66
Hereford	4	6.9	0.097	9.9	138	143	685	0.71
Tuli	8	6.8	0.099	9.7	141	138	666	0.44
Ad libitum								
Angus	4	18.1	0.204	25.8	290	137	796	2.87
Boran	8	12.7	0.164	18.1	233	139	637	2.25
Brahman	8	16.2	0.190	23.0	270	140	708	2.80
Hereford	4	16.7	0.197	23.7	280	143	717	2.78
Tuli	8	14.4	0.177	20.0	251	138	677	2.14

[1]Steers were out of MARC III (¾ British ¼ Continental) dams.
[2]Fed as calves through the winter in Nebraska.
[3]Adapted from Ferrell and Jenkins (1998).

Table 10. Carcass traits of F_1 steers

Initial slaughter group	N	Carcass wt, lb	Ribeye area, in	Fat thickness, in	Yield grade	Quality grade
Angus	4	434	9.0	0.16	2.0	12.5
Boran	8	348	7.8	0.11	1.8	11.9
Brahman	8	401	8.6	0.11	1.8	11.5
Hereford	4	366	8.2	0.07	1.6	12.3
Tuli	8	357	8.5	0.09	1.6	12.0
Limit-fed						
Angus	4	520	8.9	0.09	2.1	14.0
Boran	8	443	8.7	0.11	1.9	12.4
Brahman	8	463	8.5	0.09	1.9	12.1
Hereford	4	459	9.3	0.11	1.8	13.0
Tuli	8	430	8.5	0.09	1.9	12.5
Ad libitum						
Angus	4	710	11.3	0.56	3.6	16.0
Boran	8	564	10.4	0.27	2.6	13.4
Brahman	8	679	10.5	0.46	3.4	13.9
Hereford	4	661	11.1	0.49	3.2	16.0
Tuli	8	589	11.3	0.34	2.6	14.5

[1]Steers were out of MARC III (¾ British ¼ Continental) dams.
[2]Fed as calves through the winter in Nebraska. Limit-fed steers were fed approximately 77 kcal ME/$lb^{0.75}$
[3]Quality grade: $Standard^{o}$ = 11, $Standard^{+}$ = 12, $Select^{-}$ = 13, $Select^{o}$ = 14, $Select^{+}$ = 15, $Choice^{-}$ = 16.
[4]Steers in the initial slaughter group were slaughtered after an adaptation period of 3 months. Steers in the other groups were slaughtered after 140 days on feed.
[5]Adapted from Ferrell and Jenkins (1998).

Table 11. Postweaning efficiency traits in steers and heifers with varying fractions of Brahman inheritance

RFI group/fraction Brahman	N	Gain, lb	Feed:Gain	Intake, lb/day	RFI
High RFI					
1	21	154	11.24	24.1	2.24
¾	14	170	10.96	25.4	2.51
½	37	183	11.05	27.0	2.42
⅜	20	197	10.08	27.7	2.95
¼	22	208	9.69	27.3	2.33
0	30	180	10.43	25.8	2.34
Medium RFI					
1	23	154	9.53	18.9	-0.04
¾	27	207	7.41	21.0	-0.16
½	44	208	7.77	21.4	-0.13
⅜	63	228	6.93	21.6	-0.11
¼	33	224	7.16	21.9	-0.02
0	72	210	7.36	20.8	-0.10
Low RFI					
1	47	156	6.94	14.0	-2.21
¾	8	191	6.86	18.1	-1.35
½	34	186	6.70	16.8	-1.92
⅜	24	211	6.14	18.1	-1.58
¼	11	198	6.49	17.2	-2.34
0	51	186	6.81	16.8	-1.70

[1]Calves were evaluated in a 70-day trial after 2 weeks of acclimation to procedures in a GrowSafe feeding system. Calves were an average of 8 months of age and had been weaned for approximately 1 month.

[2]After adjustment of intake for body weight and ADG (RFI = residual feed intake) during the test period (which was from November through early January), calves were ranked by intake from lowest to highest and divided into

low (RFI < overall mean – 1 standard deviation),
medium (overall mean – 1 standard deviation < RFI < overall mean + 1 standard deviation), and
high (RFI > overall mean + 1 standard deviation) groups.

[3]Adapted from Elzo et al. (2009).

Table 12. Sire breed averages for carcass traits of steers produced by crosses of Brahman, Angus, and Romosinuano

Breed	Brahman	Angus	Romosinuano
Marbling score	360	475	393
% Choice	31	75	46
% Standard	23	5	10
Shear force, lb	9.7	8.6	9.3
Tenderness	5.4	5.8	5.8
Connective tissue amount	6.1	6.5	6.5

[1]Steers were commercially slaughtered after averages of 101, 129, or 157 days on feed. All steers previously grazed wheat pasture for an average of 120 days through the winter in Oklahoma.
[2]Dam breed was also significant as a main effect for these traits and means were similar to these.
[3]Marbling score: Slight = 300 to 399; Small = 400 to 499.
[4]Tenderness scores and detectable amount of connective tissue evaluated by a trained panel using values from 1 (extremely tough; abundant amount) to 8 (extremely tender; none detected).
[5]Dam breed means were similar to the sire breed means.
[6]Adapted from Riley et al. (2012).

Table 13. Carcass traits of steers with different fractions of Brahman inheritance

Fraction of Brahman inheritance	0	¼	⅜	½	¾	1
N	216	182	224	341	206	198
Carcass wt, lb	713	753	751	793	756	719
Dressing percentage	61.7	62.4	62.6	63.2	63.2	63.3
WBSF, lb	7.6	7.9	8.1	8.3	8.7	9.2
Tenderness	5.8	5.6	5.5	5.5	5.1	4.6
Connective tissue amount	6.1	6	5.9	5.9	5.5	5.1
Marbling score	446	420	407	394	367	341
Ribeye area, in^2	12.6	12.9	12.8	13.2	12.6	12.0
Fat thickness, in	0.51	0.51	0.51	0.51	0.43	0.35

[1]Fractions of Brahman inheritance reported here are categories—actual fractions were ranges. The complementary fraction was Angus.
[2]From 1989 to 1995 steers were fed in a South Texas feedyard. From 2006 to 2009 they were contract fed in North Florida. Steers were fed as calves through the winter to a target of 0.5 inch backfat and slaughtered commercially in South Texas.
[3]Detectable amount of connective tissue and tenderness scores evaluated by a trained panel using values from 1 (extremely tough; abundant amount) to 6 (none detected) or 8 (extremely tender).
[4]Marbling score: Slight = 300 to 399; Small = 400 to 499.
[5]Adapted from Elzo et al. (2012).