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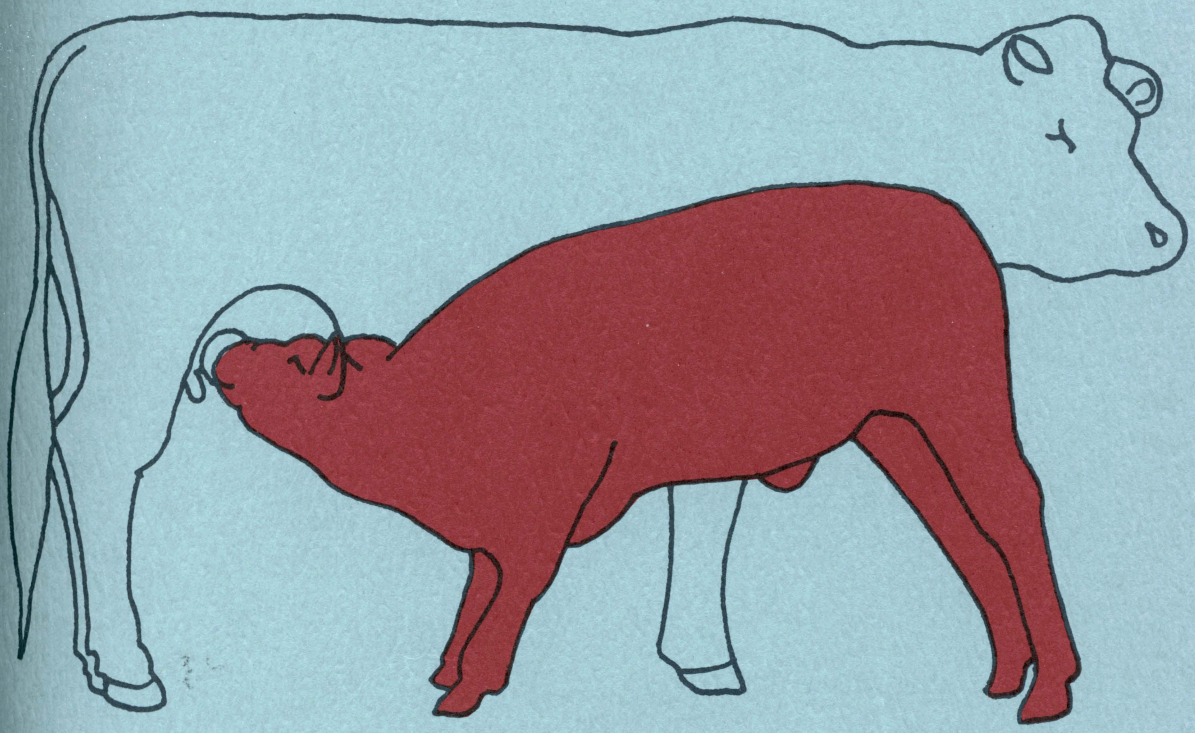
Using Hybrid Vigor to Improve Production Efficiency in Beef Cattle



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contents

Using Hybrid Vigor to Improve Production Efficiency in Beef Cattle

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When searching for methods to improve investment returns in the cow and calf industry, we have not taken full advantage of hybrid vigor as a method of improving production efficiency. This "animal breeding tool," when combined with selection programs in the purebred industry based on the economically important traits, can increase production efficiency by 10 to 25 percent in many commercial cow and calf herds in Texas. Using hybrids in commercial breeding herds represents maximum use of purebred animal resources. Purebred cattle must be maintained and used constantly to keep a high level of hybrid vigor, otherwise the hybrid advantage will dissipate.

THE GENETICS OF CROSSBREEDING FOR HYBRID VIGOR

Hybrid vigor is created in the offspring resulting from mating one breed with another. The hybrid is a mixture of parental breeds and its traits of physiological fitness (including hardiness, fertility, growth and overall productivity) tend to be enhanced. The genetic explanation for the hybrid's extra vigor is basically the same as that for hybrid corn, hybrid sorghum, coastal bermuda, hybrid poultry, hybrid hogs, etc. Crossing two breeds, two inbred lines or even two species increases productivity because the newly created gene combinations possess a greater total number of possible gene forms and because of the increased masking of undesirable recessive genes. Other genetic causes are operative, but they are complicated and not completely understood by geneticists.

Traits high in heritability respond consistently to selection but show little response in hybrid vigor. Traits low in heritability usually show good response in hybrid vigor. Table 1 illustrates the inverse relationship between hybrid vigor and heritability.

Table 1. Approximate categories of heritability and hybrid vigor percentages

	Trait Categories	Heritability Level	Hybrid vigor Level*
I.	Tenderness, ribeye area Specific conformation points Mature weight Butterfat %	High, 50% & higher	Low, 5% or less
II.	Rate of gain in feedlot Milking ability Birth weight Weaning weight Overall conformation	Medium, 20 to 50%	Medium, 5 to 10%
III.	Mothering ability Calving interval Conception rate	Low, 20% & lower	High, 10% or more

*Hybrid vigor is percent increase of the F_1 over the average of the two parent breeds.
Source: Cartwright, 1967, Texas

The level of hybrid vigor for all traits depends on the breeds crossed. The greater the genetic difference between the two breeds, the greater the hybrid vigor expected. The genetic difference between a British breed and an Indian origin breed is greater than the difference between one British breed and another British breed. A British and a Continental or Island breed are expected to be intermediate between the two examples above.

Hybrid vigor can be contrasted to inbreeding depression. When related animals (a half-brother and half-sister or two cousins for example) are mated, the resulting offspring is inbred. The inbreeding intensity depends on the closeness of the sire and dam's relationship. Loss of vigor tends to be proportional to the inbreeding intensity. Mating individuals genetically diverse (different breeds) instead of genetically similar (two relatives) tends to increase vigor in proportion to the diversity. Hybrid vigor is maximum in the F_1^1. The extra vigor is partially dissipated in the second cross or backcross. Generally, if an F_1 is bred to an F_1 of the same type, the vigor is halved in the resulting F_2. The same halving occurs in the backcross resulting from mating an F_1 back to one of its parent breeds. About half of the vigor remaining in an F_2 is again lost in the F_3 and so on. After several generations of mating crossbred to crossbred, most of the hybrid vigor will have dissipated.

It is more beneficial to have hybrid vigor in the cow herd because of the substantial hybrid advantage in fertility and mothering ability, as shown in Table 2. Many benefits of a hybrid cow are expressed in increased pounds of calf produced at weaning time because of the cow's mothering ability. A hybrid mother's calf is necessarily a crossbred of some type, so it is difficult to completely separate the hybrid benefit from the dam's mothering ability and calf's own ability.

Table 2. **An example of the advantage of hybrid vigor in the dam**

Breed or Cross Dam	Sire	Percent Calf Crop Weaned	Weaning Wt. Lbs.	Lifetime Prod. No. Calves/Cow
BH	H	80.1	438	7.6
H	BH	72.3	391	4.6
Difference in favor of F_1 dams		7.8	47	3.0

Source: Cartwright, 1964, Texas

A successful crossbreeding program must take advantage of hybrid vigor in traits most responsive to hybrid vigor, but also must take advantage of selection for those traits most responsive to selection. Selection is less predictable and less effective in crossbreds than in purebreds. Since the amount of selection possible in a systematic crossbreeding plan is limited, the major selection benefits for high heritability traits such as meatiness and carcass value constantly must be brought into the breeding program by purebred animals.

MEASURES OF PRODUCTION EFFICIENCY AND PRODUCT QUALITY

In order to effectively study crossbreeding programs, one needs sufficient information to determine the amount of change expected in the following production and quality traits: (1) weaning weights, (2) percent calf crop, (3) length of productive life, (4) cow size, (5) rate of gain after weaning, (6) cutability grade and (7) quality grade. Since this publication is developed for the cow and calf industry, let's consider the first four points--cow size, length of productive life, percent calf crop and weaning weight as ways of measuring production efficiency and the last three--rate of gain after weaning, carcass quality grade and yield grade as measures of product quality.

PRODUCTION EFFICIENCY

Sixty percent of the cost of producing a calf is in feeding the cow and calf. About 65 percent of the feed required to produce the 1,000 pound slaughter steer is fed to the calf and its dam before the calf is marketed at about 450 pounds as a weaned calf. Feed efficiency in a cow and calf operation is defined as the pounds of feed, feed nutrients or forage required to produce 100 pounds of weaned calf at 7 to 8 months of age. To design the most profitable operation for each producer, basic causes of efficiency or inefficiency must be understood and measured in each proposed crossbreeding program.

When the feed required for a weaning calf does not include feed necessary for the dam's maintenance and activity, the feed required for each 100 pounds of weaned calf increases as calf weight increases because of the increase in feed required for additional milk production. As calf weight increases without changes in cow weights (1,000 pounds in figure 1), the feed required for maintenance of cow weights can be divided by the larger calf weights thus reducing the pounds of feed required to produce each 100 pounds of weaned calf.

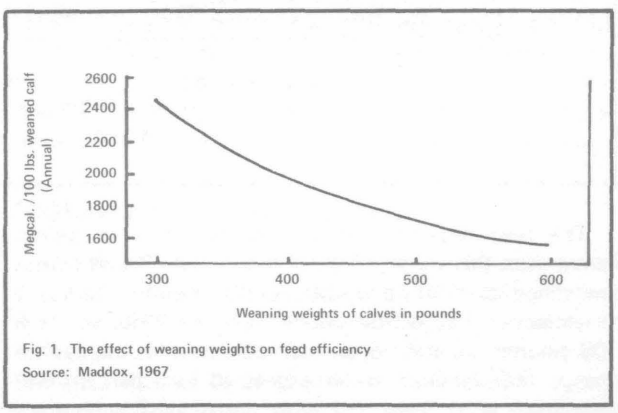

Fig. 1. The effect of weaning weights on feed efficiency
Source: Maddox, 1967

Low percent calf crop weaned causes poor feed efficiency even though production levels on producing cows are as high as 500-pound calves produced by 1000-pound cows, as illustrated in figure 2. When 10,

20 or 30 percent of the cows fail to calve, the feed they have consumed for the past 12 months must be charged to the claves weaned and will increase proportionally the feed required to produce each 100 pounds of calf. Cows that calve every 18 months will have the same effect as reducing percent calf crop one-third.

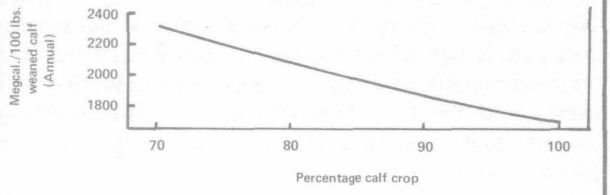

Fig. 2. The effect of percentage calf crop on feed efficiency
Source: Maddox, 1967, Texas

A study of the total productive life of breeding cows shows that feed efficiency changes rapidly during the first three or four calves, and tends to level out if the cows stay in production for six or eight calves. This change occurs with reasonably high production levels such as 1,000-pound cows producing 500-pound calves. Figure 3 indicates that the real feed saving occurs when replacement heifers are selected that can stay in production for a long time over those that are culled after producing the first or second calf.

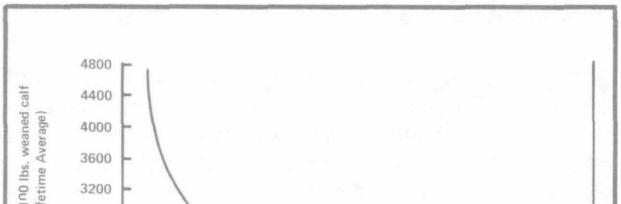

Fig. 3. The effect of number of calves produced on feed efficiency
Source: Maddox, 1967, Texas

The feed required for maintenance of cow weight increases as the weight of the cow increases. Cows within the range of 800 to 1,400 pounds requires about 1 megacalorie of digestible energy (DE) each day for each 100 pounds of additional cow weight. This increase in energy requirements when expressed as a percent will vary from 6 to 9 percent with the highest percentage increase at the lower weights. Effects of changes in cow weight when calf weight remains constant (500 lbs.) on megacalories of DE required to produce 100 pounds of weaned calf is shown graphically in figure 4.

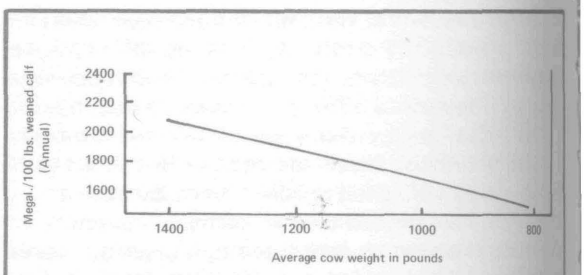

Fig. 4. The effect of weight of cows on feed efficiency
Source: Maddox, 1967, Texas

PRODUCT QUALITY

The cow and calf industry, like all other food industries, must maintain a balance between production cost and product quality. This balance is more critical in the red meat industry because of low investment returns and the necessity for a high quality product in order to maintain and improve our markets. Quality of product in a weaning calf is rate of gain after weaning, carcass quality grade and cutability grade.

The positive relationship between rate and economy of gain in beef cattle is well established. An example in terms of digestible energy using the NRC formula shows an 800-pound animal requires DE at the rate of 12.21 megacalories for each pound of gain while gaining at the rate of 2 pounds per day. If rate of gain were increased to 3 pounds per day, the DE required per pound of gain would be reduced by 15 percent to 10.35 megacalories. This change in DE requirement is illustrated in figure 5.

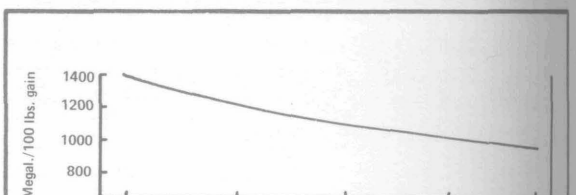

Fig. 5. The effect of rate of gain on feed efficiency (800 lb. cattle)
Source: Maddox, 1967, Texas

The high percentage of roast and steak meat in a beef carcass is just beginning to be accepted as one of the important measures of product quality in the cow and calf industry. Difference in carcass value of as much as $3.50 per hundred have been demonstrated at the retail level between adjacent USDA yield grades. Cattle fed to the choice grade that have yield grades of 1 and 2 should sell as live cattle for $1.50 to $3 more than the average grade 3. Live cattle that are mostly grades 4 and 5 will sell for about the same amount less than the average. Selecting animals within breeds or crosses that are genetically capable of producing carcasses with high yield grades in addition to other measures of quality will insure a high quality product and a higher selling price.

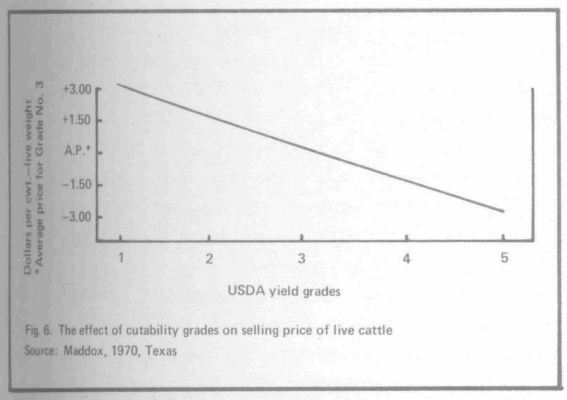

Fig. 6. The effect of cutability grades on selling price of live cattle
Source: Maddox, 1970, Texas

Previously, the principal, and many times the only, measure of product quality in the cow and calf industry, was calves that could be fed to the USDA quality grade of high choice or prime. Although there are other measures of quality of feeder calves such as rate of gain and cutability grade, the ability to reach the low choice grade still has an effect on the selling price.

Figure 7 illustrates a reduction in selling price of $2 per hundred as the quality grade is reduced from low choice to high good, a reduction of $1 per hundred when the grade is reduced from high to average and another 50 cents when the grade is lowered to the low good grade. As long as quality grades have this much effect on selling price, the cow and calf industry must consider this as one of the important traits when planning, breeding and crossbreeding programs.

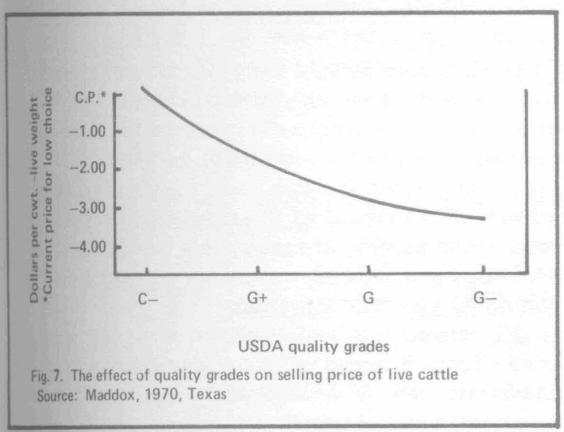

Fig. 7. The effect of quality grades on selling price of live cattle
Source: Maddox, 1970, Texas

As we try to take an industry-wide view of production efficiency, we need additional information on the effects of cow size on rate and economy of gain. Angus and Hereford weaning weights increased by an average of 6.7 pounds per 100 pounds increase in weight of the dam when age of dam was included in the analysis, and 12.5 when age of dam was not included (28). Relationships between mature cow weight and rate of gain of offspring within breeds are usually nonsignificant (25).

With present knowledge, we are not able to assign numerical values to each trait in production cost and product quality and make direct arithmetic comparisons. Table 3 suggests some goals for each trait that can be used for comparing production level and establishing your level of efficiency.

Table 3. Some suggested goals for comparison of cost of production and quality of product

Items	Goals
Production costs	
Pounds of calf weaned as a percent of mature cow weight	50-60%
Percent calf crop weaned	95-98%
Annual replacement of breeding cows	10-12%
Product quality	
Feedlot rate of gain, lbs.	3 to 3.5
Quality grade (carcass)	Low choice
Cutability grade (carcass)	1 and 2

USES OF REFERENCE MATERIAL

Research reports on the productivity of breeds and crosses come from all over the world. Even the better designed research projects are based on small numbers of animals and raise some question as to how near they represent the true breed average.

With the British crosses, we have generally reported ranges in traits in the discussion and specific percentages or pounds in the tables. Data in the tables have been referenced, and are generally an average of all references. Some data was adjusted to fit within the ranges reported for most traits included in the table.

The Brahman and Brahman/British data are mostly of Texas origin, and are based on large numbers. Most of the cow-calf data were collected at the Texas A&M University Agricultural Research center at McGregor. The advantages of Brahman and Brahman crosses will decrease in areas north and west, and increase in areas south and east of McGregor.

Much of the data on Charolais and Charolais crosses comes in bits and pieces, and were averaged in developing the tables for this section. When sufficient data were not available from one location, other data were adapted and used in the tables. When data were adapted or adjusted, they were footnoted.

CROSSING BRITISH BEEF BREEDS

The British beef breeds of great economic importance in this country are the Angus, Hereford and Shorthorn. History has not recorded the origin of cattle that were developed into these breeds. A small shorthorned ox was found in England by Roman invaders in 55 B.C. Later, cattle of other types were imported from Northern Europe. "Well known types" of cattle existed in England as early as the 17th century. These "well known types" began to resemble breeds in the 18th century with accurate records on breeding programs starting with some Shorthorn cattle in the last half of that century.

Angus, Hereford and Shorthorn cattle were developed in an area of England and Scotland about 150 miles wide (east to west) and 400 miles long (north to south). Each group of cattle that later developed into these breeds must have had a high degree of isolation for several centuries to develop the unique breed characteristic of each. This difference in genetic background seems great when considering the period of time in which the beef cattle industry has developed in the U.S., but is extremely small when comparing these breeds with the Brahman breed developed in India or the Charolais breed in France. The similarity of genetic background of Angus, Hereford and Shorthorn cattle may account for the low level of hybrid vigor that results from crossing these breeds.

Research information on Angus, Hereford and Shorthorn crosses where first cross calves were finished in feedlots and slaughtered has been available for many years. Detailed research information on these crosses, which includes lifetime production of crossbred cows, is being collected by some states at this time. Most of the information in the section is an average of production data of research projects being conducted by the Nebraska Agricultural Experiment Station as a part of North Central Regional Project NC-1, and the Virginia Agricultural Experiment Station as a part of the Southern Regional Project S-10, "Improvement of Beef Cattle Through Breeding Methods," USDA.

The first consideration when evaluating a crossbreeding program is the change in weaning weights of crossbred calves. The data in Table 4 indicates that when purebred dams are mated to bulls of other British breeds, weaning weights may be increased up to 20 pounds or 5 percent over the weaning weights of purebred calves. This increase in weaning weight can usually be more than doubled by using crossbred F_1 British dams mated with sires of one British breed. These crossbred F_1 cows increase weaning weights over weights of crossbred calves by purebred parents by 15 to 25 pounds or approximately another 5 percent. The total increase in weaning weights, using purebred cows producing purebred calves as a base, can be increased by 10 percent when British crossbred F_1 cows are mated with sires of one of the British breeds.

Table 4. Weaning weights for calves produced by Hereford, Angus and Shorthorn cows and their crosses

Breeding of Cows	Breeding of Calf	205-Day Weights, Lb.
Purebred	Purebred	412
Purebred	Crossbred (F_1)	430
Crossbred (F_1)	Crossbred (BC & 3B)	452

Adapted from Gaines, 1967, Va.; Gregory, 1965, Neb. & Cundiff, 1968, Neb.

After weaning weights, ranchers usually are concerned about the percent calf crop as resulting from a crossbreeding program. Hybrid vigor seems to increase hardiness or vigor in crossbred animals, starting with conception. In nearly all crossbreeding data, there was an increase in percent calf crop born and weaned. Among the British crosses where purebred cows were mated with bulls of another British breed, Table 5 shows an increase of 5 percent over purebred calves in percent calf crop born. When these crossbred F_1 heifers were retained as breeding cows and mated with sires of one of the parent breeds, an additional increase of 7.5 percent was observed. This gives an increase of 12.5 percent in calf crop born where crossbred F_1 dams were used over purebred dams bred to sires of the same breed.

Table 5. Percent calf crop born for Hereford, Angus and Shorthorn cows and their crosses

Breed of Cow	Breeding of Calf	Percent Calf Crop
Purebred	Purebred	81
Purebred	Crossbred (F_1)	85
Crossbred (F_1)	Crossbred (BC & 3B)	91

Adapted from Wiltbank, 1967, Neb.; Gaines, 1968, Va., & Cundiff, 1968, Neb.

There is considerable difference in length of productive life within breeds and between breeds. Hybrid vigor as a result of a crossbreeding program seems to further increase length of productive life. Length of productive life is important for two reasons: (1) it reduces the amount of feed required to produce each calf and (2) it reduces the number of replacement heifers that must be developed and returned to the breeding herd. For each additional year that cows stay in the breeding herd, 10 to 15 percent less replacement heifers must be developed. Table 6 shows purebred cows 10 years of age when last calf is weaned and a question mark for crossbred cows. Research projects crossing these three breeds have not existed long enough to yield these data. Many Texas ranches with a long history of crossbreeding believe that the crossbred dam remains in the breeding herd longer than purebred dams.

Table 6. Cow's age when last calf was weaned for Hereford, Angus and Shorthorn cows and their crosses

Breed or Cross	Age When Last Calf Weaned
Purebred	10
Crossbred (F_1)	?

Although mature weight has a high heritability level and low hybrid vigor level, crossbred cows nearly always outweigh cows of the parent breeds. In the British breed, the increase in mature weight of crossbred F_1 cows amounts to about 5 percent as shown in Table 7. Larger, mature cows require additional feed to grow to heavier weights and additional feed each day to maintain this additional weight. This increase in cow weight, if not accompanied by sufficient production increases, will increase the pounds of feed required to produce each 100 pounds of weaned calf.

Table 7. Mature weights of Hereford, Angus, Shorthorn and F_1 cross cows

Breed or Cross	Mature Cow Weights, Lbs.
Purebred	1090
Crossbred (F_1)	+50 to 75

Adapted from Cundiff, 1967, Neb.

Product quality in the cow and calf industry must include rate and efficiency of gain after weaning. The average rate of gain of stocker calves, some on pasture and some fed a growing ration, was 0.10 of a pound a day faster for the crossbred F_1 steer calves than for purebred calves. When three-way cross and backcross calves were compared to the F_1, the stocker gains were reduced slightly as shown in Table 8. Gains in feedlot also showed a slight increase for the crossbred F_1 calves of 0.03 pounds per day. When three-way cross and backcross calves were compared to the crossbred F_1's, feedlot gain decreased slightly, but not significantly.

Table 8. Daily gain after weaning for Hereford, Angus, Shorthorn and their crosses (steers)

Breeding of Cows	Breeding of Calves	Stocker Gain, Lbs.	Feedlot Gain, Lbs.
Purebred	Purebred	1.24	2.09
Purebred	Crossbred (F_1)	1.34	2.12
Three-breed cross and back cross calves		1.27	2.09

Adapted from Vogt, 1967, Va.; Gregory, 1966, Neb. & Cundiff, 1968, Neb.

Carcass cutabily in cattle of British breeding has changed considerably in the last 15 years. The average grade is impossible to predict with a high degree of accuracy without specifying age, weight, days on feed, ration and many other things. In two tests where steer cattle were handled uniformly, they reached the low choice grade at near 1,000 pounds with a yield grade of 3. In both tests, there were little or no changes in the percent of boneless, closely-trimmed, chuck, loin, rib and round in purebred, first cross, backcross and three-way cross steers.

Table 9. Yield grade for Hereford, Angus, Shorthorn and their crosses (steers)

Breeding of Cows	Breeding of Calves	Yield Grade
Purebred	Purebred	3.2
Purebred	Crossbred (F_1)	3.1
Three-breed cross and backcross calves		3.1

Adapted from Gregory, 1966a, Neb. & Gaines, 1967a, Va.

Crossing British breeds has very little effect on carcass quality grade. This was shown in Table 10 in work from Nebraska and Virginia, which showed purebred calves averaging low choice, while the first cross, backcross and three-way crosses were higher in the grade but not in the average choice grade. These results support Kincaid's (20) conclusions that carcass traits not related directly to growth show little evidence of heterosis.

Table 10. Quality grade for the Hereford, Angus, Shorthorn and their Crosses (steers)

Breeding of Cows	Breeding of Calves	Quality Grade
Purebred	Purebred	Low choice
Purebred	Crossbred (F_1)	Low choice
Three-breed cross and back cross calves		Low choice

Adapted from Gregory, 1966a, Neb., & Gaines, 1967a, Va.

A summary of the production of Hereford, Angus, Shorthorn and their crosses is shown in Table 11. The advantage to the cow and calf producer of the produc-

Table 11. Production summary of Hereford, Angus, Shorthorn and their crosses

	Purebred Calves	Crossbred F_1 Calves	Three-Breed & Backcross Calves
Production efficiency			
Weaning weights	412	+5%	+10%
Percent calf crop born	81	+5%	+10%
Length of productive life	10	N.A.	?
Cow size	1,090	N.A.	+5%
Product quality			
Rate of gain	2.09	+5%	- 0 -
Yield grade	3.02	- 0 -	- 0 -
Quality grade	Low choice	- 0 -	- 0 -

tion of crossbred F_1 calves is an expected increase of approximately 5 percent in the number of calves born and 5 percent in weaning weights. The F_1 cross calf, when placed in a feedlot, is expected to gain 5 percent more per day without any significant change in carcass yield or quality grades.

The use of crossbred dams of British breeding bred back to a British bull results in an average increase in weaning weight of 10 percent and up to 10 percent increase in percent calf crop born. There is no good evidence on length of productive life on these crossbred cows, but it seems reasonable to assume that it will be longer than purebreds. Crossbred cows will be about 5 percent larger than the purebreds. When all three breeds and crosses are averaged, there is no significant change in rate of gain, yield grade and carcass grade.

CROSSING BRAHMAN AND BRITISH BREEDS

The infusion of Brahman of Zebu breeding into cattle in the Gulf Coast region had considerable economic impact on the area. The American Brahman represents the blending of several Indian breeds or varieties imported into this country and selected for beef conformation and adaptability to the Gulf Coast region.

Any genetic relationship between British breeds and the Brahman breed is lost in the unrecorded history during the cattle evolution. This wide variation in genetic background causes large increases in productivity due to hybrid vigor when crossbreeding is practiced.

Research work on Brahman/British crosses was initiated in Texas in a co-operative project between the Texas Agricultural Experiment Station and the USDA in 1918. Research information on Brahman/British crosses used in this section was collected at the East Texas Pasture Station at Lufkin, the Livestock and Forage Research Center at McGregor and the Animal Science Department, Texas A&M University.

A study of research from many southern states concerning crosses of different British breeds with Brahman and Brahman-crossed cows allows identification of superiority of certain British breeds in different states. This superiority of a British breed in crossing with Brahman is not constant between states. We must assume that most differences are within breeds, and that differences between British breeds for crossbreeding with Brahman are small and probably insignificant. In work cited in this section, comparisons are made with the Hereford and Brahman breeds and Brahman/Hereford crosses. It is reasonable to assume that other crosses of British breeds such as Angus and Shorthorn would produce about the same results.

There is a question of adaptability of breeds that must be considered in applicating these data to the entire state. The productivity of breeding herds of the British breeds in Texas areas below 1,000 feet in elevation and up to 300 miles from the Gulf Coast shown in figure 8 usually has lower productivity as measured in percent calf crop weaned, weaning weights and length of productive life when compared to the remainder of the state. Productivity of breeds and rosses as a result of the adaptability or lack of adaptability will have considerable influence on the production figure found in these data.

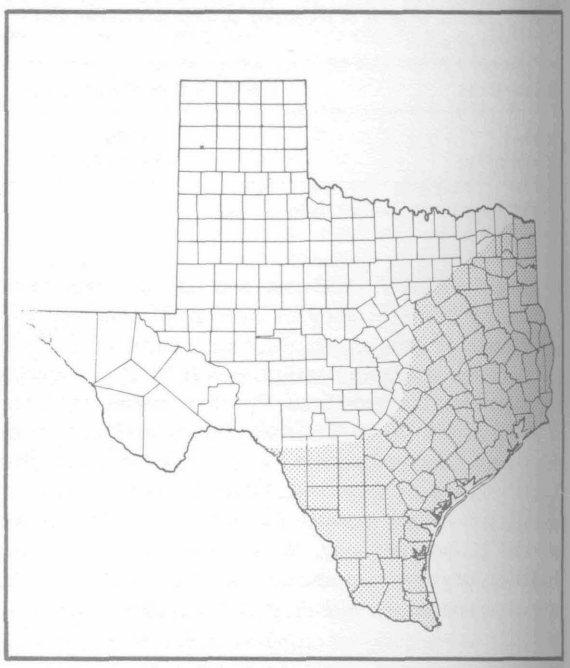

Fig. 8 **The area within 300 miles of the Gulf Coast and below 1,000 feet elevation that has a large population of Brahman cross cattle.**

A study of the 205-day calf weights from these crosses indicates that purebred Hereford calves are less than 2 percent heavier than the purebred Brahman

Table 12. Weaning weights for Brahman, Hereford and Brahman/Hereford crosses

Breeding of Cows	Breeding of Calves	205-Day, Calf Wt., Each Cross	Lbs. Average
Purebred	Purebred (British)	428	
Purebred	Purebred (Brahman)	420	424
Purebred	Crossbred(F_1)	483	483
Crossbred (F_1)	Crossbred (BC-British)	498	
Crossbred (F_1)	Crossbred (BC-Brahman)	488	493

Adapted from Brown, 1967, Texas

calves. In crossbreeding programs, the Hereford bull, when mated with a Brahman cow, produces calves nearly 5 percent heavier than the reciprocal cross. When Hereford and Brahman bulls are mated to Brahman/Hereford F_1 cows, the calves sired by the Hereford bulls are about 2 percent heavier. The advantage of the crossbreeding program where crossbred F_1 calves are produced is an increase of 14 percent in weaning weights. F_1 cows backcrossed to Hereford or Brahman bull causes increases of 16 percent in 205-day calf weights over the purebred calves. Table 12 shows the adjusted 205-day calf weight.

A weighted average of crossbreeding data from McGregor and Angleton is shown in Table 13; the percent calves born when Hereford and Brahman breeds remained pure was 5.5 percent higher than crosses between these breeds. This is contrary to most data reported on crossing British breeds. The crossbred F_1 cows backcrossed to sires of both parent breeds increased percent calves weaned by 8.7 percent over purebred cows bred to produce purebred calves. The 12-year average for 473 Brahman/Hereford crossbred cows at McGregor was 87.2 percent. Due to the low survival rate from birth to weaning of the purebred Brahman calves, the percentage of all purebred calves weaned was reduced to 68.7 percent.

Table 13. Percent calf crop born to Brahman, Hereford and Brahman/Hereford Crosses

Breeding of Cows	Breeding of Calves	% Born	
		Each Cross	Avg.
Purebred	Purebred (British)	83.9	78.7
Purebred	Purebred (Brahman)	73.5	
Purebred	Crossbred (F_1)	73.2	73.2
Crossbred (F_1)	Crossbred (BC-British)	86.8	
Crossbred (F_1)	Crossbred (BC-Brahman)	88.0	87.4

Adapted from Cartwright, 1964, Texas & Chagas, 1966, Texas

When crossbreeding Brahman and Hereford cattle, the hybrid vigor has a drastic effect on length of productive life. Information in Table 14 shows that the average Hereford cow was 7.9 years of age when she weaned her last calf, while the Brahman/Hereford crossbred cows were 10.9 years. This is an increase of 3 years or 37 percent in age of the cow when their last calf was weaned. When this increase in length of productive life is considered in conjunction with percent calf crop weaned, we find that the crossbred F_1 cow at the Lufkin Station produced three more calves, or an increase of 65 percent in number of calves weaned in the lifetime of a cow.

Table 14. Cow's age when last calf was weaned for Hereford and Brahman/Hereford Crosses

Breeding of Cows	Age When Last Calf Weaned
Hereford	7.9
Brahman/Hereford cross	10.9

Adapted from Cartwright, 1964, Texas

The increase in rates of gain resulting from hybrid vigor of crosses continues to affect growth rate, and affects the size of cows when they reach physical maturity as shown in Table 15. Where Hereford cows had an average mature weight of 997 pounds, the Brahman/Hereford-cross cows had an average weight of 1,142 pounds or an increase of 14.6 percent. This increase in cow weight must be offset by corresponding increases in calf weaning weights or other production measures to maintain the same efficiency level.

Table 15. Mature weights of Hereford and Brahman/Hereford-cross cows

Breeding of Cows	Mature Cow Weight
Hereford	997
Brahman/Hereford cross	1,142

Adapted from Cartwright, 1964, Texas

Historically, Brahman/Hereford-cross cows have been used to produce slaughter calves at weaning time. Within the last 5 years, there has been a continuing change in the feeders' attitude toward these crossbred calves. With the increase in Texas feedlots, more and more of these calves are fed for 90 days or more. This makes rate of gain after weaning important in this kind of crossbreeding program. On a growing ration, the purebred calves showed an average daily gain of 2.2 with the

Table 16. Rate of gain after weaning for Brahman, Hereford and Brahman/Hereford crosses

Breeding of Cows	Breeding of Calves	Daily Gain, Lbs.	
		Each Cross	Avg.
Purebred	Purebred (British)	2.36	2.20
Purebred	Purebred (Brahman)	2.04	
Purebred	Crossbred (F_1)	2.44	2.44
Crossbred (F_1)	Crossbred (BC-British)	2.29	
Crossbred (F_1)	Crossbred (BC-Brahman)	2.19	2.24

Adapted from Brown, 1967, Texas

Table 17. Yield grades for Brahman, British and Brahman/British crosses–approximate slaughter weight 700 to 800 lbs.

Breeding of Cows	Breeding of Calves	Yield Grade Each Cross	Yield Grade Avg.
Purebred	Purebred (British)	3.15	2.80
Purebred	Purebred (Brahman)	2.45	
Purebred	Crossbred (F_1)	3.00	3.00
Crossbred (F_1)	Crossbred (BC-British)	3.05	
Crossbred (F_1)	Crossbred (BC-Brahman)	2.75	2.90

Adapted from Kincaid, 1962, USDA

Hereford calves gaining .32 pounds per day more than the Brahman calves. The F_1 crossbred calves shown in Table 16 gained 2.4 pounds, an increase of 10 percent, while the calves from crossbred F_1 cows backcrossed to sires of both breeds gained only 2.24 pounds a day or an increase of only 2 percent over the purebred calves.

The effect of yield grades in reducing excess fat on carcasses has been some help in increasing the desirability and packer acceptability of Brahman crosses as feeder cattle. The data used to calculate yield grades for Table 17 were based on light-weight slaughter cattle. The percent of internal fat was not reported in this project and had to be estimated in calculating these grades. The pattern of yield grades with purebred British breeds showing the least desirable yield grade and the purebred Brahman the most desirable is typical since Brahman cattle have not been selected to deposit excess fat for as many generations as the British breeds. The F_1 calves showed yield grades intermediate to the two pure breeds as expected, with three-fourths British calves with F_1 dams showing a less desirable yield grade than the calves from the same cows and Brahman bulls.

Table 18. Quality grade for Brahman, British and Brahman/British crosses–approximate slaughter weights 700 to 800 pounds.

Breeding of Cows	Breeding of Calves	Quality Grade Each Cross	Quality Grade Average
Purebred	Purebred (British)	High good	
Purebred	Purebred (Brahman)	High standard	Avg. good
Purebred	Crossbred (F_1)	Avg. good	Avg. good
Crossbred (F_1)	Crossbred (BC-British)	Avg. good	
Crossbred (F_1)	Crossbred (BC-Brahman)	Low good	Avg. good

Adapted from Kincaid, 1962, USDA

Cow and calf producers trying to market Brahman-cross calves have been told by buyers for many years that these cattle must be bought for a lesser price because they would not grade. In the data shown in Table 18 where the cattle were slaughtered between 700 and 800 pounds, there was little difference in quality grades among crossbred cattle if they contained 50 or 75 percent British breeding. Crossbred calves sired by Brahman bulls from British/Brahman cows were lower than average good, while purebred British calves graded high good. When cattle of similar breeding are fed for slaughter at 1,000 to 1,100 pounds, the group will usually increase at least one-third of a grade with the differences between breeds and crosses remaining about the same.

A general summary of using Hereford, Brahman and Brahman/Hereford crosses shows an increase in weaning weights of approximately 14 percent when the cows are F_1 Brahman/Hereford. There was a rather consistent reduction in percent calf crop of up to 12 percent. The F_1 calves are expected to gain about 10 percent more than the average of purebreds in a feedlot. This increase in gain may be as little as 5 percent more than the purebred Hereford calves. The yield grades of F_1 calves are slightly less desirable than the average of the parent breeds; this difference is probably insignificant. There is no real change in quality grades from the average of the two purebreds, but there is a reduction in grade from the purebred Hereford to the F_1 steer.

Calves from crossbred cows sired by Brahman or Hererford bulls show an increase of weaning weight up to 16 percent and calf crop of 7 percent. The length of productive life in the southeastern part of the state is increased with the crossbred cow by one-third. One disadvantage of the F_1 crossbred cow is the 15 percent increase in cow weight. Calves resulting from Hereford and Brahman bulls used on crossbred cows show only a 2 percent increase in rate of gain, with little or no change in yield or quality grade when compared to the average of the purebred parents.

Table 19. Production summary of Hereford, Brahmna and Brahman/Hereford crosses

	Purebred Calves	Crossbred F_1 Calves	Three Breed & Backcross Calves
Efficiency of production			
Weaning weights	424 lbs.	14%	16%
Percent calf crop	80%	-5%	8%
Length of productive life	8 yrs.*	N.A.	+37%
Cow size	1,000 lbs.*	N.A.	+14%
Quality of product			
Rate of gain	2.20 lbs.	10%	2%
Yield grade	2.80	.20	.10
Quality grade	Avg. good	- 0 -	- 0 -

*Purebred dams only (Hereford)

CROSSBREEDING CHAROLAIS CATTLE

Charolais, one of the oldest cattle breeds in France, is relatively new in the U.S. There is historical evidence of white cattle in France as early as 878 A.D. The establishment of a breed began in the last part of the 18th century about the same time as the British breeds.

The early development of the white cattle of France was in the Province of Charolais, but most breed development took place in the 19th century in the Province of Nievre. Genetic relationship between Charolais and Brahman or British breeds cannot be traced with our present knowledge of the evolution of cattle. This wide variation in genetic background accounts for the large amount of hybrid vigor measured in crosses with Brahman and British breeds.

Research on production traits of Charolais and Charolais-cross cattle has been conducted at many locations in the South and Midwest. Most projects involved small numbers, and results are reported in field day programs with a few in the "Journal of Animal Science." In order to compile enough data to reasonably describe percent calf crop, weaning weight, cow size, feedlot gain, yield grades and quality grades, we have averaged the results of two or more research projects. In many cases, data for a particular cross were not available in the projects averaged, and data from one state had to be adjusted to complete that table. This adjustment was generally based upon the relationship of this particular trait to one or more of the traits averaged from other locations.

Effects on weaning weights of calves from cows of British breeds sired by Charolais bulls is an increase of approximately 50 pounds. The Brahman/British dam, when mated with a Charolais bull, results in an increase of 8 to 12 percent over the F_1 calf. Purebred Charolais in Texas data show less than 10 pounds increase over Brahman/Hereford dams. The total increase in weaning weights from purebred British calves when compared to calves from Brahman/Hereford cows or Charolais cows bred to Charolais bulls is nearly 100 pounds as shown in Table 20.

Table 20. Weaning weights for Hereford, Charolais and other crosses

Breeding of Cows	Breeding of Calves	205-Day Weights
British	Purebred	438
British	British/Charolais	489
Brahman/Hereford	Brahman/Hereford/Charolais	531*
Charolais	Charolais	539

*Texas data adjusted
Adapted from Brown, 1967, Texas & Pahnish, 1969, Mont.

A good source of data for percent calf crop of British and Charolais cattle under Texas conditions is not available at this time. Table 21 shows a combination of data from Montana, Ohio, Missouri and Texas. The purebred British calves showed the highest percent calf crop at 84 percent, with Charolais bulls on British cows at 81 percent, while purebred Charolais had 76 percent. The Brahman/Hereford dams bred to the same Charolais bulls had the same percent calf crop weaned.

Table 21. Percent calf crop weaned for Angus, Hereford and Charolais cows

Breeding of Cows	Breeding of Calves	Percent Weaned
British	Purebred	84
British	British/Charolais	81
Brahman/Hereford	Brahman/Hereford/Charolais	81*
Charolais	Charolais	76

*Texas data only-adjusted
Adapted from Bellows, 1966, Mont.; Klosterman, 1968, Ohio; Cundiff, 1969, Mo. & Thomas, 1971, Texas

The mature weight of cows in a commercial operation is important because of the high cost of maintaining cows with large body weights. Data for mature cow weights are limited because most research stations are not analyzing cow weights at this time. The data to some degree are unreliable because many times the cows were selected for some special reason and did not necessarily represent the breed or cross. Many of the cows called Charolais may not have been purebred. Missouri data were used in Table 22 as a base for mature weights of British and Charolais cows, and weights of Brahman/Hereford cows were approximately the same weight at slightly over 1,100 pounds, which is about 15 percent more than the British cows. With all other production characteristics British cows. With all other production characteristics equal, these larger cows must produce heavier calves to be as efficient.

Table 22. Mature weights of British, Brahman/Hereford and Charolais

Breeding of Cows	Mature Cow Weight
British	968
Brahman/Hereford	1,109*
Charolais	1,125

*Adjusted Texas data
Adapted from Cartwright, 1964, Texas, & Sagebiel, 1969, Mo.

Research data on rate of gain of cattle slaughtered at near 1,000 pounds sired by Charolais bulls on British, Brahman/Hereford and Charolais cows are limited. In

Table 23, data from Ohio, Missouri and Texas were used. The Texas data on the three-way Brahman/Hereford/Charolais cross were all that were available, and had to be adjusted to fit the averages of the other crosses. Charolais bulls crossed on British cows increase rate of gain by about .14 pounds per day or about 6 percent. Purebred Charolais calves gained .23 pounds per day more or nearly 11 percent more than purebred British calves. The Texas data on calves sired by Charolais bulls from Brahman/Hereford cows show gains of slightly more than the purebred British calves.

Table 23. Rate of gain after weaning for Hereford and Charolais crosses—approximate slaughter weight 1,000 lbs.

Breeding of Cows	Breeding of Calves	Daily Gain
British	Purebred	2.23
British	British/Charolais	2.37
Brahman/Hereford	Brahman/Hereford/Charolais	2.25*
Charolais	Charolais	2.46

*Texas data only
Adapted from Brown, 1967, Texas; Bishop, 1970, Ohio & Lasley, 1971, Mo.

Yield grades shown in Table 24 follow the expected pattern resulting from the ability of British breeds to fatten more at the present preferred slaughter weights than Brahman or Charolais. The Missouri data show that

Table 24. Yield grades for British, Brahman and various crosses with Charolais—approximate slaughter weight 1,000 lbs.

Breeding of Cows	Breeding of Calves	Yield Grade
British		3.20
British	British/Charolais	2.65
Brahman/Hereford	Brahman/Hereford/Charolais	2.40*
Charolais	Charolais	2.55

*Florida data only
Adapted from Hedrick, 1970, Mo. & Baker, 1971, Fla.

calves of British, British/Charolais and Charolais produced carcasses that ranked in yield grade according to the percent of Charolais breeding. The Florida data on one-fourth Hereford, one-fourth Brahman and one-half Charolais also show a yield grade of 2.40 at slaughter weights of approximately 1,000 pounds.

With our present quality grades based primarily on marbling, we expect to find some problems when Charolais and/or Brahman breeding are introduced in the cross if the cattle are expected to grade low choice at 1,000 to 1,050 pounds. Most of the information in Table 25 was derived from carcass studies in Missouri on heifers of British, Charolais and British/Charolais crosses. The heifers were fed an average of 190 days and slaughtered at about 1,000 pounds. These data show a consistent pattern with the purebred Charolais in the high good grade, British/Charolais crosses low choice and purebred British calves average choice. In the Florida study, the Brahman/Hereford dams bred to Charolais bulls produced calves that graded over one-third of a grade lower than cattle that were all of British breeding.

Table 25. Quality grades for British, Brahman and various crosses with Charolais—approximate slaughter weight 1,000 lbs.

Breeding of Cows	Breeding of Calves	Quality Grade
British	Purebred	Avg. choice
British	British/Charolais	Low choice
Brahman/Hereford	Brahman/Hereford/Charolais	High good*
Charolais	Charolais	High good

*Adjusted from Florida data
Adapted from Lasley, 1971, Mo. & Baker, 1971, Fla.

Sires with excellent growth rates cause calves to grow faster before they are born as well as after birth. There are considerable data available on birth rates of purebred calves, British/Charolais and purebred Charolais. Data from Brahman/Hereford cows are generally limited to Texas research. In Table 26, the combination of Texas, Ohio and Missouri data show purebred British calves with a birth weight of 70 pounds, Charolais sired on British cows at 84 pounds, while purebred Charolais weighed 89 pounds. The birth weight from Brahman/Hereford cows bred to Charolais bulls were the lowest of any Charolais or Charolais-cross probably because of the Brahman influence on calf weight. Birth weight in the past has been considered unimportant to commercial cattlemen, but with the increase in use of extremely high-gaining bulls, this information becomes important because it relates to calving difficulty.

Table 26. Birth weights for Hereford, Charolais and other crosses

Breeding of Cows	Breeding of Calves	Birth Weights, lbs.
British	Purebred	69.6
British	British/Charolais	84.0
Brahman/Hereford	Brahman/Hereford/Charolais	79.5*
Charolais	Charolais	89.2

*Texas data only-adjusted
Adapted from Brown, 1967, Texas, Klosterman, 1968, Ohio & Jain, 1971, Mo.

Table 27. Calving difficulty with British, British/Brahman and Charolais when bred to Charolais bulls

Breeding of Cows	Breeding of Calves	Percent of Calves Born Unassisted
British	Purebred	92.8
British	British/Charolais	75.5
Brahman/Hereford	Brahman/Hereford/Charolais	95.0*
Charolais	Charolais	90.0**

*Author's observation
**Ohio data only adapted
Adapted from Glimp, 1971, Neb. & Klosterman, 1968, Ohio

The increase in birth weight, particularly in crossbreeding programs where large sires and small cows are used, results in additional calving difficulty. Commercial cattlemen have observed or read about calving difficulties when 2-year-old heifers are mated with fast-growing sires and have established a practice of selecting particular breeds or kinds of sires that will produce lightweight calves at birth for the first matings. Data from Nebraska show 93 percent of the births of purebred British calves were unassisted, Charolais bulls on British cows 76 percent unassisted, while the Ohio data show purebred Charolais with 3 percent more calving difficulty than Purebred Herefords. Research data are limited on the Brahman/Hereford cow bred to a Charolais bull, but Texas ranchers usually report considerably less calving difficulty with these crossbred cows.

Use of Charolais bulls on British and British/Brahman cows shows an increase of 8.5 percent in weaning weights and no change in percent calf crop when the F_1 dam is used. Here tha F_1 dam also is approximately 14 percent larger than the British dam, which will reduce part of the advantage of the crossbred cow. There is a slight reduction in rate of gain and quality grade while the yield grade improves with British/Brahman dams.

Table 28. Production summary of British, British/Brahman and Charolais cows when bred to Charolais bulls

	Dams		
	British	British/Brahman	Charolais
Production Efficiency			
Weaning weights	489 lbs.	8.5%	10.5%
Percent calf crop	81%	- 0 -	-6.0%
Cow size	968 lbs.	14%	15.0%
Product quality			
Rate of gain	2.37 lbs.	-5%	3.0%
Yield grade	2.65	-0.25	-0.10
Quality grade	Low choice	High good	High good
Miscellaneous information			
Birth weight	84 lbs.	-5%	6.0%
Calved unassisted	76%	95%	90.0%

When British dams are compared to Charolais dams, both mated to Charolais bulls, weaning weights are increased by 10 percent, calf crop reduced 6 percent and cow size increased 15 percent. Rate of gain increases in the purebred Charolais calf by about 3 percent, the yield grade improves 4 percent, while the quality grade was reduced by about one-third of a grade when compared to Hereford dams.

When the dams were half Brahman, the birth weights were reduced and unassisted calving increased. Purebred Charolais calves weighed 6 percent more than calves from Hereford dams and the Hereford cows had considerably less calving difficulties.

CROSSBREEDING USING OTHER BREEDS

Cattle breeds selected for this section are of less economic importance at this time than those previously discussed in detail. Another reason for less discussion on these cattle breeds is that less research information is available. The economic importance of these breeds in crossbreeding may change considerably in the next 10 years.

BREEDS WITH BRAHMAN/BRITISH FOUNDATIONS

There are three breeds developed after crossing Brahman with certain British breeds that are important to Texas ranchers. These breeds are the Santa Gertrudis, Brangus and Beefmaster. Research data on these breeds are limited with the most information available on Santa Gertrudis and the least on Beefmaster.

Sires of these breeds have been used on native South and East Texas cows to produce crossbred dams. These crossbred cows usually have higher mature weights than their dams, a wide variation in reproductive ability and will produce calves with heavy weaning weights for the particular area in which they are located.

Calves sired by bulls of these breeds are extremely competitive in feedlots when slaughtered at 800 to 900 pounds. Under these circumstances, they usually have excellent rates of gain, high cutability grades and, if properly fed, have a quality grade of average to high good. When fed to heavier weights, the rate of gain and cutability grade remain above average, but the quality grade tends to be lower than for purebred British breeds.

DAIRY BRITISH CROSSES

The three dairy breeds that appear to have great possibility of increasing beef productivity are Jersey,

Holstein and Brown Swiss. Research data on these breeds and crosses used in beef production are limited also.

Cows that are one-half Jersey are generally medium to small in size, high in milk production and have excellent reproductive ability. Holstein-cross cows have good milk production, are larger in size and may have some problems with reproduction under strict range conditions. The one-half Brown Swiss cow has a history of large mature size and good milk production with weaning calves with excellent weaning rates, but seems to be at a disadvantage because of her calving interval of over 12 months.

Calves from part dairy dams (large breeds) sired by bulls of beef breeding produce calves with excellent rates of gain in feedlot and excellent yield grades with slightly lower quality grades.

When purebred Holsteins or Brown Swiss sires are used, the calves have excellent rates of gain and yield grades, but are at a disadvantage in weights of 1,000 to 1,100 pounds when a choice grade is desirable.

EXOTIC BREEDS

The principal exotic breeds being used in crossbreeding programs in Texas are Limousin, Simmental and Maine Anjou. Since semem has been available for only a short period of time, and there are no purebred females in the United States, there is little or no information on production characteristics of purebred or crossbred cows in the U.S.

Extremely fast growth rates in these breeds produce calves that grow fast before birth, resulting in heavy birth weights. This has resulted in increased calving difficulties when these breeds are mated to heifers and even some calving difficulties when mated to mature cows of smaller beef breeds.

These breeds are noted for fast growth rates and large mature weights when compared to British breeds. They generally sire calves that have high weaning weights, fast and efficient gain in the feedlot with high yield grades, but are at a disadvantage when the low choice grade of 1,000 to 1,100 pounds is the goal of the feeder.

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