Beef Production of Brahman, Shorthorn, and their Crosses on Different Pasture Programs

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Introduction

Beef production is the result of a combination of both genetic and environmental factors. Genetic factors may be masked by induced or natural environmental influences which hinder expression of hereditary traits. Environmental influences either complement or limit the genetic potential of the animal. Thus, it is important to assess the productivity of various breed groups in alternative production systems in order to develop the most efficient production programs. Limited information is available on the comparative productive behavior of Brahman, European origin and crossbred cattle under variable environmental conditions.

The purpose of this study was to evaluate the performance of Brahman, Shorthorn and crossbred cattle involving those two breeds on three pasture-management programs in the semi-tropical environment of south central Florida.

Materials and Methods

The study was designed to evaluate the comparative production of Brahman, Shorthorn, and various crosses of these two breeds when maintained on native, or a combination of native, and all-improved pasture. The design of the trial is shown in Table 1

Table 1. Design of Trial

	Phase 1, 1957 to 1961				Phase 2, 1962 to 1966			
	Breed	Pasture program			Breed	Pasture program		
Breed of cow	of sire	1	2	3	of sire	1	2	3
		Matings per year				Matings per year		
Brahman (B)	**B**	10	10	10	**S**	10	10	10
¾ B ¼ S (B_3)	**B**	10	10	10	**S**	10	10	10
½ B ½ S (F_1)	**B**	10	10	10	**S**	10	10	10
½ B ½ S (F_1)	**S**	10	10	10	**B**	10	10	10
¼ B ¾ S (B_1)	**S**	10	10	10	**B**	10	10	10
Shorthorn (S)	**S**	10	10	10	**B**	10	10	10

Breed Groups

The herds on each of the forage programs included approximately 60 cows. Each herd included five breed groups as follows: ten Brahman (B), ten 3/4 Brahman-1/4 Shorthorn (B_3S_1), twenty Brahman-Shorthorn first crosses (F_1), ten 3/4 Shorthorn-1/4 Brahman ($S_3 B_1$) and ten Shorthorn (S). The trial was conducted in two 5-year phases. During the first phase the B, the $B_3 S_1$, and one-half of the F_1 cows were mated to Brahman bulls while the remaining groups were mated to Shorthorn bulls. This procedure resulted in a balanced design considering breed of calf but resulted in confounding of breed of bull with breed of cow since only one-half of the possible breed combinations were included during one phase. The procedure was dictated, however, by the availability of replacement females for the study and the decision to maintain 10 animals per breed group x year sub-cell rather than five, which would have resulted had breed of cow and breed of sire been used annually in all possible combinations. During the second phase, breed of sire for the different cow groups was reversed from that of the first phase. Thus, including both phases each breed of cow was mated to bulls of both breeds. By including two mating groups (30 F_1 cows mated each to B and S bulls) across all years it was possible to remove year effects and obtain a satisfactory comparison of all breed combinations.

Pasture-Management Programs -

Program 1 - This program involved native grasses, mainly Aristida and *Andropogon* spp. (wiregrass and broomsedge) During the first 5-year period, the 60 cows and their calves grazed 812 acres of native range divided into five fields. Eighty acres of each of these five fields were burned on alternate years. A reduction to 772 acres in the program was made during the second phase.

Supplemental feed was provided on native range only to the extent necessary to prevent extreme weight loss in the cows. Cows were supplemented during the winter months with 41% cottonseed pellets and a limited amount of hay in the first phase. In phase 2 an average of 555 pounds of hay, 52 pounds cottonseed meal (41%), and 52 pounds of citrus meal were fed over a period averaging 109 days annually beginning in December.

Program 2 - This program included a combination of 73 acres of improved pasture plus 315 acres of native grasses for the 60 cow herd. The improved pasture included 40 acres of Pensacola bahiagrass *(Paspalum notatum* Flugge.) 15 acres of Coastal bermudagrass *(Cynodon daclylon* (L.) Pers.) and 18 acres of Pangola digitgrass *(Digitaria decumbens* Stent.) during the first phase. For the second phase the bermudagrass was replaced by digitgrass. Approximately 20 acres of the bahiagrass was grown in conjunction with Hairy Indigo *(Indigof era hirsuta* Linn.) with the remaining 20 acres being in combination with non-irrigated white clover *(Trifolium repens* L.) and Hubam sweetclover *(Melilotus alba* Desv.). The cattle had access to the native grasses continuously and generally to one field of improved pasture.

The annual fertilizer program per acre for improved grass pastures was approximately 400 pounds of 8-8-8 (N-P_2O_5-K_2O) plus 150 pounds of ammonium nitrate (33.3% N) for pangolagrass, or a like amount of complete fertilizer plus 100 pounds of ammonium nitrate for bahiagrass pastures. The legume pastures received 250 pounds per acre of 0-8-24 fertilizer annually with an extra application of muriate of potash averaging 32 pounds K_2O per acre on the white clover.

Cattle were given suplemental feed only in the winter of 1957-58 during phase 1. During the last 5-year period the cattle on Program 2 received supplemental feed (43 pounds hay, 65 pounds cottonseed meal and 31 pounds citrus meal per cow) for an average of 72 days annually from January to April.

Program 3 - This program included only improved pastures. During the first phase it included 76 acres of pangolagrass, 20 acres of which were irrigated and over-planted with white clover. Due to pasture becoming less productive the area was increased to 107 acres for the second phase. This change resulted in 70 acres of all pangola digitgrass, 27 acres of digitgrass overplanted with white clover, and 10 acres of bahiagrass. Pasture fertilization in Program 3 followed the same pattern as described for Program 2.

Cattle in Program 3 were maintained in a high nutritional status at all times. For the most part, the cattle maintained good weights from pasture, as only an average of 280 pounds of hay per cow was fed for each of the five winters.

General Management

The cattle on all programs were bred in a restricted season of 105 days extending from March 15 to July 1. All the calves were weaned at one time in early September.

Replacement heifers were grown together from weaning until being placed in their respective herds just prior to the breeding season at two years of age.

Cows were culled on the basis of repeated reproductive failure or failure to raise a calf.

Data Analyses

Individual performance data were recorded annually for pregnancy status, calf survival, weaning rate, age of calf at weaning, weaning weight, 205-day weight, and market grade of calf. The research was conducted in two phases, five years each. The separate analyses for both reproduction and production traits are discussed.

The observed data for pregnancy status, calf survival, and weaning rate were recorded as 1 or 0 (zero). These individual data were processed initially in separate analyses for each phase. Least squares techniques as outlined by Harvey (4) were followed, employing the same model for all analyses. All effects were assumed to be fixed. Since subclass numbers were approximately proportional the above analyses yielded efficient estimates of effects.

A third analysis was performed by pooling data for the two phases. The least squares means for the breed x pasture program subclasses from the above analyses were adjusted for differences between phase and combined in a singled analysis. The adjustments required were small for pregnancy and weaning rates and nil for calf survival. The adjustment for combining the two phases into a single analysis was made on the basis of differences between phases for the two breed groups of F_1 cows which were included during both periods of the study. These breed groups represented a total of approximately 300 matings per phase. There were no indications of interactions between the two phases. Thus, it was concluded that the combined analyses yielded unbiased estimates of effects. The error mean square used in testing significance was the pooled error term for the two phases coded by the harmonic mean of subclass numbers. The model for the combined analyses for reproduction traits included breed of dam (D), breed of sire (S), pasture program (P) and their interactions (Table 2).

Table 2. Means Squares from Analysis of Breed x Pasture Program Subclass Means of Adjusted Record.

Source	**d.f.**	**Pregnancy Rate**	**Weaning Rate**	**Survival Rate**
Breed of dam (D)	4	226.97**	247.16**	17.70
Breed of sire (S)	1	144.00*	1.78	128.50**
Pasture program (P)	2	896.70**	751.03**	12.15
D x S	4	42.00	69.58	9.57
D x P	8	97.26*	93.51*	4.26
S x P	2	33.59	17.86	5.40
D x S x P	8	45.67	56.18	8.63
Error				
	1632	40.02	43.07	-

Pregnancy and wean				
Survival	1188	-	-	10.32
* Significantly different at P (.05).				
** Significantly different at P (.01).				

The individuals records for age of calf, condition score, 205 day weight, and weaning weight were first analysed separately for the two phases, employing a model including year, mating groups (sire x dam), pasture program, sex, age of dam, and first order interactions. Secondly, the data from the two groups of F_1 cows which were included across both phases of the trial were analyzed employing a similar model. On the basis of these preliminary analyses records were adjusted for year, age of dam, and sex on a within-program basis. The adjusted data then were analyzed by least squares methods outlined by Harvey (4). The models utilized are indicated in Table 3.

Table 3. Mean Squares from Analyses of Adjusted Records.

Source	d.f.	Weaning Age	Condition Score	205-day Weight	Weaning Weight	Annual Prod/Cow
Pasture Program (P)	2	6,277**	588.1**	930,084**	1,398,182**	45,610**
Breed of Dam (D)	4	6,101**	44.8**	377,104**	402,613**	15,100**
Breed of sire (S)	1	274	42.1**	88,665**	81,920**	1,015
P x D	8	897	35.9**	14,987**	15,902**	2,165
P x S	2	2,514**	3.4	4,496	5,060	1,200
D x S	4	1,651	1.7	158,247**	263,831**	5,500
P x D x S	8	3,430**	17.4**	3,306	11,324**	890
Remainder	1209[a]	804	1.5	2,202	4,096	1,513

[a] Error df for production per cow was 120.

Individual records of calves weaned were analyzed for all traits other than annual production per cow. In order to obtain observations that approached normal distribution more closely than a combination of individual zero and weight records, annual production per cow was computed for 150 year x program x breed-of-calf subgroups. This yielded five observations in each of the 30 breed of calf x program groups. Analyses of these observations yielded lower standard errors of estimates than analysis of combined individual zero and weight records.

Results and Discussion

The results from the combined analyses for both reproduction and productive traits are given in Tables 2 and 3. Least squares means for reproduction are presented in Table 4 and for production traits in Tables 5 and 6. Observed heterosis levels (percent advantage of crossbreeds over the mean of the two purebred breeds) are shown by pasture program in Tables 5 and 6.

Pregnancy Rate

Pregnancy rate was significantly influenced by both pasture program and breed of cow as well as their interaction. The average pregnancy rates were 64%, 76%, and 81% for the native, combination, and improved programs, respectively. The rates of improvement ranked in the anticipated order. The performance on the improved area was somewhat lower than that reported by Gonzalez-Padilla et al. (3) and Crockett et al. (2) for south Florida. It is explained for the most part by the relatively low response of the purebred cows (Brahman or Shorthorn) to the improved pasture programs (Table 4). The overall averages for the five breed groups of cows were: Brahman, 71%; 3/4 Brahman, 80%; F_1, 76%; l/4, Brahman, 75%; and Shorthorn, 64%. The observation that F_1 and backcross cows did not differ significantly was noted also by Koger et al. (7) in a previous publication from the same station.

The significant (P<.05) breed of cow x pasture interaction provides an example of one form of geneotype-environment interaction. This arose principally due to differential response to improved pasture programs. The Brahman and Shorthorn cows had an average pregnancy rate of 61% on native range versus 72% on the highly improved program for a difference of 11%. For crossbred cows the averages were 67% and 86% for the same two programs for an increase of 19%.

The effect of breed of sire on pregnancy rate was significant (P<.05), 76% for the Brahman and 72% for the Shorthorn with no significant breed of sire x pasture-program interaction.

Calf Survival

Calf survival from birth to weaning is an important factor affecting net productivity. The combined analysis for reproduction shows survival rate to be affected by breed of sire. Calves sired by Brahman bulls had an average survival rate of 94% while the survival rate of Shorthorn sired calves was 98%.

The average death loss of 4% observed in this study is lower than that reported from other studies in Florida (2,6).

Weaning Rate

Weaning rate is the product of pregnancy rate and survival rate. Since death losses were small in this trial, the data on weaning rate (Table 4) closely paralleled those of pregnancy. The one exception of this trend pertained to breed of sire effects, which were highly significant for pregnancy but approximately nil for wean rate. This resulted from breed of sire effects being reversed for pregnancy and survival rates.

The average weaning rate for the trial was 71%. The average for the three pasture programs was 63%, 73%, and 76%, respectively. The average weaning rates by breed of cow were: 69% for the B; 76% for the B_3S_1; 74% for the F_1; 75% for the S_3B_1; and 60% for the S.

As was the cause for pregnancy rate, the cow groups responded differently to the pasture programs for weaning rates. A good portion of the interaction effects resulted from the crossbred cows responding more to improved conditions than did the purebreds. The average weaning rates for the three groups of crossbred cows were similar, varying from 74% for the F_1 to 76% for the B_3S_1 cows.

Table 4. Average Rates for Pregnancy, Calf Survival, and Weaning Classified by Breed of Cow X Pasture Program and Breed of Sire X Program.

	Pregnancy Rate % Program				**Survival Rate % Program**				**Weaning Rate % Program**			
	1	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**
Breed of dam												
B	61	77	75	**71**	96	97	96	**97**	59	75	72	**69**
B_3	69	85	83	**80**	96	97	96	**95**	66	84	77	**76**
F_1	61	83	85	**76**	96	97	96	**96**	59	81	82	**74**
B_1	71	68	87	**75**	99	100	97	**98**	71	68	84	**75**
S	61	62	69	**64**	95	94	93	**94**	58	58	64	**60**

Breed of sire												
B	67	77	85	**76**	94	96	93	**94**	63	73	79	**72**
S	62	77	78	**72**	99	98	97	**98**	62	76	76	**71**

Age of Calf at Weaning

Where mating occurs in a restricted season and calves are weaned all at one time, age at weaning is an important production trait, influencing the weight and value of calf produced. It was analyzed as a production trait in this study in addition to using it for estimating weights at a constant age of 205 days.

Pasture program and breed composition of dam significantly ($P<.01$) influenced age of calf. Age of calf varied from 218 days for Program 1 to 226 days for Program 3 (Table 5). This trend reflected the possibility of a shorter calving interval from calving to estrus in the improved program (8,9). Age of calf varied from 214 days for the pure Brahman to 229 days for the F_1 calves out of Shorthorn cows ($P<.01$). A long gestation period for Brahman cows along with a difference in interval to first postpartum estrus likely entered into this difference (2,9,11,12). These results also suggest that the Shorthorn cows which did conceive, did so early in the breeding season.

Condition Score

This trait was included because it reflects thrift and vitality and generally is positively associated with prices received for calves. The calves were scored to the nearest one-third of a Federal market grade for slaughtered calves. Scores of 6, 7, and 8 were used to designate low, medium, and high commercial, 9 to 11 for good, 12 to 14 choice, etc.

As seen in Table 5, condition score was significantly influenced by pasture program (P), breed of dam (D), breed of sire (S), and P x D interaction effects. Progeny of Brahman dams improved by one-third of a grade in condition from Program 1 to Program 3, progeny of crossbred dams improved two-thirds of a grade, and the progeny of Shorthorn females increased by four-thirds of a grade in the improved program.

Significant heterosis in the crossbreds was obvious for condition score with estimates of 9% for F_1 calves in purebred dams, 14% for backcross calves on F_1 dams, 8% for B_5 S_3 or S_5B_3 calves on backcross cows, and 5% for S_7B_1 and B_7S_1 calves on backcross dams. Heterosis levels tended to be higher in the native pasture program than on improved pastures for condition score.

Wean Weight and 205-day weight -

Estimated 205-day weight is a measure of growth rate, while weaning weight reflects differences in both rate of growth and age at weaning. In this study, the trends shown for pasture program and breed group differences were similar for the two traits (Table 5). Due to this similarity, the two traits will be discussed in conjunction.

Significant main effects ($P<.01$) were found for pasture program, breed of dam, and breed of sire. Interaction effects for pasture program x breed classifications likewise were significant.

Average weaning weight was 416 pounds, varying from 357 pounds on the native to 461 pounds on improved pasture (Table 6). Brahman-sired calves exceeded those sired by Shorthorn bulls by an average of 15 pounds. Weaning weights by breed of dam across all pasture programs by ascending order were 363, 409, 414, 432, and 463 pounds for the S, B_1S_3, B, B_3S_1 and F_1 cows, respectively. Weaning weight of calves from the F_1 cows averaged 100 pounds greater than that of the Shorthorn and 49 pounds more than that of the Brahman, indicating a high degree of heterosis. Average weaning weights across all pasture programs, relative to breed of calf, were highest for the product of the F_1 cow when sired by Brahman bulls, at 475 pounds, and lowest for purebred Shorthorn calves, at 321 pounds. Weaning weights dropped when either Shorthorn or Brahman breeding in the calf exceeded three-fourths. The backcross calves, B_5S_3 and B_3S_5 out of B_1S_3 and B_3S_1 dams, were second only to the products of the F_1 cows.

Breeding Brahman instead of Shorthorn bulls to Shorthorn cows increased weaning weights 84 pounds, and breeding Shorthorn instead of Brahman bulls to Brahman cows increased weaning weights 63 pounds. Improvements in weaning weights were also obtained when Brahman bulls instead of Shorthorn were bred to B_1S_3 cows (55 pounds) and Shorthorn instead of Brahman bulls to B_3S_1 cows (24 pounds).

Highly significant interaction of breed of calf with pasture program was observed (Table 6). This was due to a differential response of calves; the Brahman increased only 32 pounds with improvement in pastures, whereas the Shorthorn calves increased 136 pounds. Backcross calves, B_3S_1 and S_3B_1, responded similarly with increases of 119 and 118 pounds for the two breed groups, respectively. Interaction of breed of dam with pasture program was highly significant, with the response to improved pastures increasing as the proportion of Shorthorn breeding in the cow increased. An interesting feature was that the Brahman female produced as well on the intermediate program as she did on highly improved pastures.

Heterosis levels for calf weights were high. The advantage for crossbreds in weaning weights varied from 14% for B_7S_1 and S_7B_1 calves nursing 3/4 - 1/4 cows to 32% for the reciprocal backcross calves on F_1 dams (Table 6). Average heterosis levels for 205-day weight were slightly lower on the highly improved native (20%) than on native range (25%) but approximately equal (24% vs 25%) for the two programs for weaning weight.

Table 5. Breed X Program Least Squares Means for Age at Weaning, Condition Score, and 205-day Weight for Breed of Calf, Breed of Sire, Breed of Dam, and Crossbred Advantage for Different Traits.

	Weaning Age				**Condition Score**				**205-day Weight**			
	Program				**Program**				**Program**			
	1	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**
	- days -				**- score -**				**- lbs -**			
Breed of Calf												
B x B	215	222	206	**214**	7.9	9.3	8.6	**8.6**	342	381	394	**372**
B x B_3	219	223	219	**220**	7.9	9.2	10.0	**9.1**	356	409	430	**398**
B x F_1	221	225	225	**224**	8.3	9.8	10.8	**9.7**	387	453	488	**442**
B x B_1	219	214	222	**218**	8.2	8.8	10.3	**9.1**	359	418	465	**414**
B x S	223	227	238	**229**	7.2	9.2	10.7	**9.0**	307	381	411	**366**
S x B	204	219	234	**219**	9.0	9.8	10.4	**9.8**	382	444	441	**422**
S x B_3	220	225	233	**226**	8.8	9.3	10.8	**9.6**	379	418	433	**410**
S x F_1	215	227	235	**226**	8.8	10.2	11.2	**10.1**	372	435	447	**417**
S x B_1	217	218	212	**216**	7.8	9.2	10.3	**9.1**	318	380	404	**367**
S x S	224	225	223	**224**	6.2	9.0	10.9	**8.7**	230	320	356	**302**
Breed of sire												
B	219	222	222	**221**	7.9	9.3	10.1	**9.1**	350	408	438	**398**
S	216	223	227	**222**	8.1	9.5	10.7	**9.5**	336	399	416	**384**
Breed of Dam												
B	209	220	220	**217**	8.5	9.6	9.7	**9.2**	362	413	417	**397**
B_3	219	224	226	**223**	8.4	9.3	10.4	**9.3**	367	413	431	**404**
F_1	218	226	230	**225**	8.6	10.0	11.0	**9.9**	380	443	467	**430**
B_1	218	216	217	**217**	8.0	9.0	10.3	**9.1**	338	399	434	**391**
S	223	226	230	**227**	6.9	9.1	10.8	**8.9**	269	350	383	**334**
All groups	218	223	225	**222**	8.0	9.4	10.4	**9.3**	343	404	426	**391**
Advantage of crossbreds over purebreds %												
Calf Dam												

F_1 PB	-3	0	10	**2**	15	4	8	**9**	20	18	14	**17**
3/4 F_1	-1	1	7	**3**	21	9	13	**14**	33	26	25	**27**
3/8 3/4	0	-2	6	**+1**	21	-1	8	**8**	29	20	20	**22**
7/8 3/4	-1	-1	1	**0**	11	1	4	**5**	18	13	11	**13**

Annual Production Per Cow -

This trait is a measure of total herd performance to weaning. It includes weaning rate times weaning weight. The average production per cow was 298 pounds, with values for pasture programs varying from a low of 224 pounds for the native range to 351 pounds for the highly improved pastures (Table 6). Breed groups ranged from 196 pounds for the pure Shorthorn to a high of 366 pounds for S_5B_3 calves on cows. Utilizing both breeds of sires, the F_1 cow produced 348 pounds compared to 329 pounds for the B_3S_l cows and 306 pounds for the S_3B_1 cows. Total production for Brahman and B_3S_1 cows on the intermediate pasture program exceeded that on highly improved pasture.

The differential response of breed groups to the three pasture programs followed the same pattern as that for calf weights. The response to improved pasture was greater for cows with a predominance of Shorthorn breeding than for dams predominately of Brahman breeding.

Heterosis levels observed for annual production per cow were high. The level of heterosis for the reciprocal 3/8 - 5/8 calves nursing 3/4 blood cows on improved pasture was 63%. The advantage of the F_1 cows over the average of the purebred increased linearly with improvements in pasture program, 37% for the native range, 48% for the intermediate program, and 58% for the improved program. Responses of this magnitude emphasize the utility of the Brahman and European crosses for improvement of production performance in environments where the improved temperate-zone breeds are not well adapted. They suggested also that Zebu-European crosses may have utility under other conditions.

In these data, calf growth was positively associated with Brahman breeding, suggesting that the additive effects of the Brahman for adaptability to this area contributed to growth of calf.

The data for breed groups probably can best be interpreted in terms of: (1) additive genetic merit of the parent breeds involved, (2) climatic adaptability of the various breed groups, and (3) level of hybrid vigor influencing performance.

Table 6. Breed X Program Least Squares Means for Weaning Weight, Weaning Rate, and Production Per Cow for Breed of Calf, Breed of Sire, Breed of Dam, and Crossbred Advantage for Different Traits.

	Weaning Weight	**Weaning Rate**	**Production Per Cow**

	Program				Program				Program			
	1	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**	**1**	**2**	**3**	**Av.**
	- lbs -				**- % -**				**- lbs -**			
Breed of Calf												
B x B	350	404	392	**382**	56	76	79	**70**	196	307	310	**271**
B x B_3	372	435	453	**420**	65	75	70	**70**	242	326	317	**295**
B x F_1	408	489	527	**475**	63	83	81	**76**	257	406	427	**363**
B x B_1	379	432	497	**436**	71	71	93	**78**	269	307	462	**346**
B x S	332	416	467	**405**	57	52	71	**60**	189	216	332	**245**
S x B	377	466	493	**445**	63	74	65	**68**	238	345	320	**301**
S x B_3	400	451	482	**444**	68	92	85	**82**	272	415	410	**366**
S x F_1	383	473	501	**452**	54	79	84	**72**	207	374	421	**334**
S x B_1	328	400	416	**381**	71	65	75	**71**	233	260	312	**268**
S x S	244	338	380	**321**	59	65	69	**61**	144	220	224	**196**
Breed of sire												
B	368	435	467	**424**	62	71	79	**71**	231	312	370	**304**
S	346	426	454	**409**	63	75	74	**71**	219	323	337	**293**
Breed of Dam												
B	363	435	442	**414**	59	75	72	**69**	214	326	318	**286**
B_3	386	443	467	**432**	66	84	77	**76**	255	372	360	**329**
F_1	396	481	514	**463**	59	81	82	**74**	234	390	421	**348**
B_1	354	416	457	**409**	71	68	84	**75**	252	283	384	**306**
S	288	377	423	**363**	58	58	64	**60**	167	219	271	**219**
All groups	357	430	461	**416**	63	73	76	**71**	224	318	351	**298**
Advantage of crossbreds over purebreds %												
Calf Dam												
F_1 PB	19	19	25	**21**	4	-11	-1	**-2**	26	6	22	**17**
3/4 F_1	33	30	33	**32**	2	15	20	**13**	37	48	58	**50**

3/8 3/4	31	19	27	**25**	21	16	29	**22**	59	37	63	**52**
7/8 3/4	18	13	13	**14**	18	-1	5	**8**	40	11	18	**21**

Summary and Conclusion

Five breed groups of dams including Brahman (B), Shorthorn (S), 3/4 B-1/4 S (B_3S_1),1/2 B-l/2 S (F_1) and 3/4 S-1/4 B (S_3B_1), each mated to both Brahman and Shorthorn sires, grazed continuously on three different pasture programs. The pastures were native (P_1) a combination of native and improved pasture (P_2,), and all improved pastures including irrigated clover-grass area (P_3).

Highly significant differences (P<.01 occurred in pregnancy rate and weaning rate for both breed of cow and pasture program. Pregnancy rates for Brahman sires were higher (P<.05) than for Shorthorn sires, but a higher survival rate (P<.01 of Shorthorn sired calves made weaning rate for sires non-significant. Average weaning rates by breed of dam were 69% 76%, 74%, 75%, and 60% for B, B_3, F_1, B_1 and S cows, respectively. Weaning rates for pasture programs were 63 63% 73% and 76% for $P_{1,}$ P_2, and P_3 programs, respectively.

Weaning age, condition score, 205-day weight, weaning weight, and production per cow variations were highly significant (P<.01) for pasture program, breed of dam, and breed of calf. Breed of sire effects resulted in higher condition scores for Shorthorn sired calves and heavier 205-day and weaning weights for Brahman sired calves. Breed of sire effects were non-significant for age at weaning and production per cow. However, mating system was highly significant (P<.01) for production per cow. Breed classifications for both calf and dam showed significant (P<.01) first order interactions for all traits except for breed of dam x pasture programs for weaning age.

Crossing the purebred Shorthorn and Brahman resulted in increased weaning weights of 26% for calves of the Shorthorn dams and 16% for the Brahman dams. Weaning weight of calves from F_1 cows exceeded the average of the purebred progeny by 35% when sired by Brahman bulls and 29 % when sired by Shorthorn bulls. The advantage of all crossbreds over the average of the purebreds was 1.5%, 9.1%, 19.8%, 22.9%, 10.1%, and 34.8%, respectively, for age at weaning, condition score, 205-day weight, weaning weight, weaning rate, and annual production per cow.

Significant interactions for breed of cow x pasture program was the result of F_1 cows responding more to improvements in nutrition than the purebred groups. These F_1 cows responded linearly in all traits with each increment of improvement in pasture programs. Brahman breeding appeared to be associated with growth, while Shorthorn breeding appeared to be related to degree of condition relative to pasture program.

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