BREED EFFECTS OF COW'S SIRE AND SERVICE SIRE ON REPRODUCTION OF CROSSBRED DAMS AND PREWEANING PERFORMANCE OF THEIR CALVES

Efectos raciales del padre y abuelo materno sobre la reproducción de vacas cruzadas y el comportamiento predestete de sus becerros

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ABSTRACT

Reproductive traits and preweaning growth of progeny from crossbred cows sired by Braford, Simbrah, Senepol and Simmental bulls and from Zebu-crossbred cows were compared to Brahman x Angus F1 cows. All dams were bred to Brangus and Limousin since 1989 to 1994 varying in age from two to five years and over. The cattle were handled in accord with the usual Beef Research Unit management system where the experiment was conducted, located in North-Central Florida near Gainesville and under subtropical climate. The cattle were grazed on Bahiagrass pastures as well as fed a corn-silage soybean meal based diet. The statistical model fitted effects of calving year CY, dam age DA, sire breed of calf SBC, sire breed of dam SBD, calf sex, calf age used as a covariate and the random effect of cow within SBD. Data analyses were conducted using PROC GLM of SAS (24). Results from the evaluation of the maternal performance of crossbred dams indicated, firstly, that both cow and CY significantly influenced variation in reproduction as well as SBD affected (P<.05) pregnancy rate and calf survival to weaning. Secondly, regarding to the calf traits, all the effects significantly influenced the preweaning growth, except for SBC, CY and DA which did not affect (P>.20) birth wt of the calf. Brahman x Angus F_1 cows performed the greatest for survival rate, 205-d wt and ADG; however, Simmental-sired crossbred dams were the highest (P<.05) for calving, pregnancy and weaning rates per cow exposed to breeding. Both Simmental- and Brahman-sired cows performed the same on the kg of calf weaned per cow exposed. Contrasts of Brahman-derivative (Brangus, Braford, Simbrah) sired cows exceeded (P<.05) *Bos taurus* (Senepol, Simmental) sired cows for weaning rate (2%), weaning wt (20 kg), 205-d wt (15 kg), ADG (100 g/d); nevertheless, the opposite ocurred for calving (-33%), pregnancy (-44%) and survival (-32%) rates. This study suggests that there is evidence of higher maternal heterosis in calf growth than in reproductive characters, and also that breed selection is important when planning a continuous crossbreeding program to obtain maximum benefit from heterosis in Florida's cow-calf operations.

Key words: Crossbreeding, beef cattle, reproduction, kg of calf weaned, growth.

RESUMEN

Tanto caracteres reproductivos como de crecimiento predestete de progenie de vacas cruzadas hijas de toros Braford, Simbrah, Senepol y Simmental fueron comparadas con vacas Brahman x Angus F_1. Todas las madres fueron servidas con toros Brangus y Limousin desde 1989 hasta 1994, variando en edad de 2 a 5 y más años. El ganado fue manejado de acuerdo al sistema de producción de la Unidad de Investigación de Carne de la Universidad de Florida, localizada en Gainesville y bajo un clima subtropical. Los animales pastorearon sobre potreros de pasto Bahía y fueron suplementados con harina de soya y silaje de maíz como dieta base. El modelo estadístico ajustó los efectos del año de parto (AP), edad de la vaca (EV), raza del padre del becerro (RPB), sexo del becerro (SB), edad del becerro (EB) usada como covariable y el efecto aleatorio de la vaca dentro de (RPV). Los datos fueron analizados por PROC GLM del SAS (1988). Los resultados indicaron que el efecto vaca y el AP influenciaron significativamente la variación reproductiva, y RPV afectó (P< 0,05) la tasa de preñez y la sobrevivencia del becerro al destete. Con relación a los caracteres del becerro, todos los efectos influenciaron significativamente al crecimiento predestete, a excepción de RPB, AP y EV que no afectaron (P> 0,20) el peso del becerro al nacer. Las vacas F_1 Brahman x Angus fueron las mejores

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para la tasa de sobrevivencia, el peso a los 205 días y la ganancia diaria de peso (GDP) del becerro; sin embargo, las vacas de toros Simmental alcanzaron las mayores (P> 0,05) tasas de parto, preñez y destete por vaca expuerta a servicio. Las vacas hijas de Simmental y Brahman produjeron los mismos kg de becerro destetado por vaca expuesta. Los contrastes entre las razas derivadas del Brahman (Brangus, Braford y Simbrah) excedieron (P< 0,05) a las *Bos taurus* (Senepol y Simmental) para la tasa al destete (2%), peso al destete (20 kg), peso a los 205-d (15 kg) y GDP (100 g/d); sin embargo, lo contrario ocurrió para la tasa de parto (-33%), preñez (-44%) y sobrevivencia del becerro (-32%). Este estudio sugiere ciertas evidencias por una mayor heterosis materna en el crecimiento del becerro que en los caracteres reproductivos, y también que la selección racial es importante cuando se planifica un programa de cruzamiento continuo para obtener el máximo beneficio de heterosis en las operaciones comerciales de vaca-becerro en la Florida.

Palabras clave: Cruzamiento, ganado de carne, reproducción, kg becerro destetado, crecimiento.

INTRODUCTION

The beef cattle industry has increasingly turned to crossbreeding as a tool for improving productivity through heterosis and for combining traits from different breeds to match cattle to varying environments and markets. Beef cattle production will be at biological and economical levels when cattle are matched to the environment over time; however, resources will be wasted if cattle do not have the genetic potential to utilize available resources.

The maternal heterosis using crossbred cows is usually greater than individual hybrid vigor for maternally influenced traits; however, crossbreeding will not compensate for poor management and some programs require several breeding pastures as well as cows be identified by year of birth and breed of sire.

In Florida, lower prices received for calves showing characteristics of Brahman type cattle have led breeders to investigate alternative crossbreeding systems to those traditionally used. On crossbred Zebu-*taurus* cows, this study involved the use of purebred Brahman, Brahman-derivative (Braford, Simbrah) and *Bos taurus* (Senepol and Simmental) bulls to represent two mature sizes and rapid growth to a large mature size in the case of dams sired by Simbrah and Simmental, and a more moderate growth rate and mature size in the case of the Senepol and Braford-sired dams. In addition, Brahman X Angus F_1 cows were utilized each year to produce the control crossbreds. Out of these cow groups, crossbred calves sired by Brangus and Limousin were produced from 1989 to 1994.

The objectives of this study were 1) to evaluate alternative crossbreeding plans designed to produce both feeder steers and replacement heifers that are productive under North-Florida conditions, while avoiding the production of animals with excesive Zebu characteristics, 2) to evaluate the maternal performance of crossbred dams sired by Brahman-derivative and unrelated *Bos taurus* breeds in comparison with Brahman X Angus F_1 cows, and 3) to evaluate reproduction of the cow and calf weight data on the preweaning responses of calves varying in genetic potential for growth.

MATERIALS AND METHODS

Description of data

The cows used in this long-term project were firstly *Bos indicus X Bos taurus* crossbreds from Brahman and Romana Red sires and reciprocals Brown Swiss X Angus F_1 and F_2 mothers. Both Romana Red- and Brahman-sired females were born from 1981 to 1985 [17] for then initiate a new study in 1985 at the Beef Research Unit of The University of Florida, near Gainesville. Cows were artificially inseminated to three to four bulls of each of the Braford, Simbrah, Senepol and Simmental breeds. Brahman X Angus F_1 cows served as controls annualy for comparison over a four-year period. Finally, from 1988 to 1993 dams have been bred to both Limousin and Brangus sires to continue the rotational crossbreeding program. The design of this study on the number of observations from each breed of sire X breed of dam combination are shown in TABLE I.

TABLE I
REPRODUCTIVE RECORDS BY SERVICE SIRE AND CROSSBRED GROUP OF DAM

Crossbred group of dam	Service sire	
	Limousin	Brangus
F1 Brahman (BR) x Angus (AN)	61	58
4/8 Braford x 2/8 BR or Romana Red (RR) x[b]	72	67
4/8 Simbrah x 2/8 BR or RR x[b]	61	49
4/8 Senepol x 2/8 BR or RR x[b]	71	61
4/8 Simmental x 2/8 BR or RR x[b]	73	57
	338 (53.7%)	292 (46.3%)

[a]Breed of sirelisted first. [b]1/8 Brown Swiss (BS): 1/8 AN or 1/8 BR:1/16 BS: 1/16 AN.

TABLE II
LEAST-SQUARES ANALYSIS OF VARIANCE FOR DAM'S REPRODUCTIVE TRAITS (n=630)

Source of Variation	Degrees of Freedom	Mean Squares Rates			
		Calving	Weaning	Pregnancy	Survival
Sire breed of dam (SBOD)	4	.372	.107	.476[c]	.326[c]
Dam (SBOD)[a]	237	.217[b]	.265[b]	.213[b]	.112[b]
Service sire	1	.049	.013	.041	.000
Year of calving	5	.409[b]	.445[b]	.233[b]	.058
Age of dam	3	.079	.017	.089	.026
Residual	379	.052	.097	.044	.049

[a]Error term for SBOD. [b]P < .001. [c]P < .05.

The climate in North-Central Florida is considered semi-tropical, with an annual average temperature of 21°C and rainfall of 140 cm concentrated during the winter and summer months. Cattle were managed in accord with the usual management system of the ranch, which is grazing on Bahiagrass *Paspalum notatum* and some White Clover *Trifolium repens* pastures, during a 60-d breeding season, starting in April 1 and ending in May 30 of each year. Multiple sires were used in nearly all cases and artificial insemination for only one estrus cycle was followed by about 40 days of natural service. Both pregnant cows and heifers were maintained on Bahiagrass until November 30 of each year, and fed a corn silage-soybean meal based diet during the remaining of the year. Cows were culled on the basis of both age and reproductive failure and palpated for pregnancy aproximately 90 days after the end of the breeding season. Calves were weighed at birth and at weaning time in late August of every year. Male calves were castrated within 24-h of birth. All the cows were sold after weaning their 1994 calves.

Analysis of data

192-crossbred beef cows at comparable ages of 2, 3, 4 and 5 years and over were evaluated for reproductive performance from 1989 to 1994. The traits of interest in this study were calving rate, calf survival, weaning rate and pregnancy rate. A binary coding (i.e., 1 or 0) was used to indicate whether or not the proportion of cows exposed to breeding gave birth to a live calf, which defined calving rate. Calf survival was defined as the proportion of calves born that survived to weaning. Weaning rate was the proportion of cows exposed to breeding that weaned a calf. Females that were pregnant 90-d after the breeding season were coded as 1 and those open received a 0 entry. Binary data for reproductive traits were analyzed according to Wilcox et al. method [25]. In addition, preweaning growth of the calf was analyzed for birth and weaning wt, 205-d wt and ADG adjusted and unadjusted, with calf age as a covariate indicating the time from the beginning of the breeding season until the time of conception. Calf age contains the effects of gestation length and survival, both from conception to birth and from birth until weaning [18]. Calves that died were not included in the analyses.

Statistical analyses were conducted using PROC GLM of SAS [24]. The basic model included terms for the overall mean, calving year (1989 to 1994), dam age (2, 3, 4, 5 yr and over), service sire or sire breed of calf (Limousin and Brangus), sire breed of dam (Brahman, Bradford, Simbrah, Senepol and Simmental) and the random effect of cow within sire breed of dam. Cow/sire breed of dam was utilyzed as the error term for the sire breed of dam effect. The random error associated with the dependent variable was assumed to be normally and independently distributed, with mean 0 and variance σ^2. The fixed effect of calf sex was added to the previous model in order to analyze the growth traits. Preliminary analyses indicated that first order interactions among fixed variables were unsignificant and therefore ommited from the final model. Orthogonal contrasts with the performance of control (Brahman X Angus) F_1 cows were run, which allowed comparisons to other types of crossbred cows. Contrasts of specific breed types were done by grouping Brahman-derivative (Brangus, Braford, Simbrah) crossbred cows, *Bos taurus* (Senepol, Simmental) unrelated dams, Senepol- vs Simmental-sired cows, and control F_1 Brahman X Angus dams deviated from all of the other breed groups.

RESULTS AND DISCUSSION

Reproductive traits

Least-squares analysis of variance, mean squares and significance levels for calving CR, weaning WR, pregnancy PR and survival SR rates as reproductive traits of the dam are presented in TABLE II. Neither service sire (Brangus vs Limousine) nor age of dam significantly influenced variation in reproduction; however, cow/sire breed of dam as well as year of calving affected (P<.001) most reproductive traits. Sire breed of dam only influenced significantly PR and SR to weaning. The interactions between breed type, year and age were non-significant and not included in the analyses. Effects of year and

TABLE III
LEAST-SQUARES MEANS FOR REPRODUCTIVE TRAITS ACCORDING TO SIRE BREED OF DAM

Sire Breed of Dam	Calving Rate	Weaning Rate	Pregnancy Rate	Survival Rate
Brahman	.688	.613	.685	.943
Braford	.679	.603	.677	.920
Simbrah	.736	.560	.736	.808
Senepol	.680	.548	.691	.869
Simmental	.832	.630	.855	.805
μ	.723	.591	.729	.869
SE[a]	.026	.036	.024	.025
Significance	NS[b]	NS[b]	*	*

[a]Average standard error for least-squares means. [b]Not significant. *Sire breed effect (P< .05).

TABLE IV
COMPARISON OF CROSSBRED DAMS FOR REPRODUCTIVE TRAITS (ORTHOGONAL CONTRASTS)

	BA-(BF+SB+SP+SM)[a]		(BA+BF+SB)-(SP+SM)		SP-SM		BA-(BF+SB)	
Trait[b]	Estimate	SE[c]	Estimate	SE	Estimate	SE	Estimate	SE
CRT	-.175	.112	-.332**	.138	-.152***	.034	-.039	.061
WRT	.111	.153	.018	.188	-.082	.046	.063	.083
PRT	-.220*	.103	-.441***	.127	-.164***	.031	-.043	.056
SRT	.369**	.108	-.318**	.134	.064*	.033	.158**	.059

[a]BA:Brahman ´ Angus F_1, BF:crossbred Braford,SB:crossbred Simbrah, SP:crossbred Senepol SM:crossbred Simmental. [b]CRT: calving rate, WRT: weaning rate, PRT: pregnancy rate, SRT: survival rate. [c]Standard error of estimate. *Breed type effect (P<.05). **Breed type effect (P<.01). ***Breed type effect (P<.001)

dam age are common in published data and will not be discussed.

Calving rate: The overall mean CR per cow exposed was 72.3%. Despite Simmental-sired cows had a higher CR (83.2%) as compared to other crossbred groups, this advantage was not significant, TABLE III. Contrasts of breed types presented in TABLE IV shows significant advantages of *Bos taurus*-sired dams over Brahman-derivative ones; also, between *Bos taurus*, Simmental-sired cows were higher (15.2%, P<.001) for CR than Senepol-sired cows. Brahman X Angus F_1 cows did not differ from others as controls. The lack of significant differences among dam breeds for CR agrees with the findings of Comerford et al. [3] and Newman et al. [15]; however, differences ocurred in calf crop born percentage according to Gregory et al. [9], Williams et al. [26], Bailey et al. [1, 2] which disagree with this report. There is no reasonable explanation for this result; nevertheless, the lower CR observed might be the result of increased fetal loss between pregnancy diagnosis and parturition, although CR and WR in the present study were not calculated from cows pregnant and cows calving, respectively.

Weaning rate: This trait, expressed as the number of calves weaned per cow exposed is an important economic character in beef cattle production. Least-squares means are given in TABLE III. The mean WR was 60% and estimates varied from 55% in Senepol-sired cows to 63% in Simmental-sired cows. Despite this is a composite trait of CR, which in turn was quite low as mentioned earlier, and calf survival to weaning, this analysis did not indicate differences among the five breeds evaluated for WR. TABLE IV shows the contrasts for WR where Brahman X Angus F_1 dams were 11% higher than the Brahman-derivative group as well as the *Bos taurus* crossbred dams, but again, these advantages were not important (P>.10). This result is strongly in agreement with reports of Newman et al. [15] while working with F_2 and F_3 generations of Red Angus dams mated to Charolais or Tarentaise bulls, Williams et al. [26] working with three and four-breed rotation cows, Bailey et al. [2] with F_1 Angus X Charolais, Brahman X Hereford and Brahman X Angus crossbred dams, Setshwaelo et al. [23] who studied the effects of 7 breeds of cow's sire and 12 breeds of cow's maternal grandsire on preweaning performance of crossbred cows; however, significant differences were found by McCarter et al. [12] when analizing reproduction of crossbred cows containing various proportions of Brahman breeding, Reynolds et al. [21] working with Hereford, Angus, Charolais and Brown Swiss crosses, Bailey et al. [1] when evaluating maternal characteristics of young dams representing *Bos taurus* and *Bos indicus* breed types, Comerford et al. [3] in a four-breed diallel among Simmental, Limousin, Polled Hereford and

Brahman beef cattle study, and Gregory et al. [9] in the experiment of three composite populations in Nebraska, which differ with this report. In the current study, a 90% of the dams exhibited good mothering instincts shortly after parturition. Hypothesis concerning breed differences in mothering ability was not tested due to lack of variation in this trait.

Pregnancy rate: Differences among sire breed of dams as well as cow within sire breed of dam were significant in ANOVA for pregnant percentage, TABLE III. Least-squares means per cow exposed to breeding for Simmental-sired dams (85.5%) were higher (P<.05) than those for Brahman- Braford- and Senepol-sired cows (68% avg), being Simbrah-sired dams intermediate in ranking (74%). Deviations of breed group effects for PR, TABLE IV, were large and negative (-22%, P<.05) from Brahman X Angus F_1 control cows to others. On the contrary, contrasts between F_1 and Brahman-derivative (Braford and Simbrah) crossbred cows were also negative but not significant. On the other hand, deviations from Brahman-derivative to Bos taurus crossbred dams were negative and highly significant, when Senepol- and Simmental-sired cows exceeded (44%, P<.001) PR of Brangus, Simbrah and Braford crossbreds. PR of Simmental-sired cows was 16% higher (P<.001) than Senepol-sired ones. PR averaged 73% influenced by breed group of dam but the effect by breed of service sire was unsignificant. These results are in agreement with those reported by Reynolds et al. [21], McElhenney et al. [13] and Olson et al. [17].

In composite populations, individual and maternal heterosis [15] have been large and positive (P<.01) for PR. *Bos taurus X Bos indicus* and *Bos taurus X Bos taurus* crosses [19] have indicated for Zebu crossbred dams (Brahman X Angus, Brahman X Hereford, Sahiwal X Angus, Sahiwal X Hereford) to achieve higher PR as compared to those of Bt X Bt crossbred dams (Angus X Hereford reciprocals and Pinzgauer X Angus and Pinzgauer X Hereford) by 3.8 percent units. Bailey et al. [1] also reported a slightly higher PR of Brahman crossbred dams than of *Bos taurus* crossbreds in Nevada; however, those differences were not significant. In contrast, a lack of positive additive effect of *Bos taurus* (Angus) germ plasm in the Brahman crossbred females [18] indicated that any improvement in reproductive efficiency in a population of Brahman cattle upgraded from a *Bos taurus* base would arise from residual nonadditive effects. *Bos taurus* genes did not increase PR. In a more recent study, Olson et al. [20] analyzing reproductive data of rotational, three-breed and inter se crossbred cows in Florida, found similar PR of F_1, backcross and three-breed dams, but the advantage was greater for the crosses that involved Brahman. Likewise, differences among seven breeds of cow's sire were very difficult to detect [23] with limited numbers per breed group as did the policy culling all open cows.

It appears in the present study that high levels of reproductive performance (i.e., pregnancy rate) could not be obtained in beef X beef crossbred cows with some Zebu breeding in them, just because provided nutritional levels was not adequate as well as management of the cow herd was very poor to meet the higher maintenance and lactation requirements for the *Bos taurus X Bos indicus* dams. In El Reno, Oklahoma, McCarter et al. [12] suggested that reproductive rates decreased as proportion Brahman breeding increased. People who raise cattle in the Southern United States can maintain cowherds with lower percentages of Zebu breeding for not affecting PR. We consider that culling practices within this project may have also contributed to reduced reproductive rates in an effort to increase animal numbers in the various breed groups. Most of the unpregnant females, specially heifers, were retained and returned to the breeding herd the following year. Females were culled after failing to become pregnant in two succesive years.

The low pregnancy rate may have been a reflection of an accumulation of problems such as, damaged reproductive tracts from injury during parturition, repeat breeding condition and a poor body condition as a consequence of low feeding program for the cows [21].

Survival rate: Both sire breed of dam and cow within breed group affected (P<.05) calf SR to weaning. The averages SR and death loss of calves by sire breed of dam in this study were 87 and 13%, respectively, TABLE III. Least-squares means of Brahman- and Braford-sired dams were the greatest for SR. Calf mortality was higher (19%, P<.05) from Simmental- and Simbrah-sired cows as compared to the rest of cows. TABLE IV shows the specific contrasts among crossbred groups, indicating firstly a great superiority by Brahman X Angus F_1 dams (37%, P<.01) for SR in comparison with the others; secondly, predominant *Bos taurus* (Senepol or Simmental) dams were higher (P.01) than Brahman-derivative dams. Between *Bos taurus*-sired dams, crossbreds Senepol surpassed Simmental by 6.4% (P<.05). As far as Zebu breeding is concern, Brangus F_1 cows were nearly 16% greater (P<.01) than Brahman-derivative ones (either Braford or Simbrah). Breed type differences in crossbred beef cows on preweaning survival of calves have also been reported by Sacco et al. [22], Williams et al. [26], Gregory et al. [6] and McElhenney et al. [14], who indicated a significant advantage in SR of rotational or inter se crossbred calves in some generations for certain breed combinations; however, the advantage might not be consistent across breed combinations and generations. On the contrary, no differences were found in calf SR for breed of sire, breed of dam or sire X dam interaction according to reports of Reynolds et al. [21] and Setshwaelo et al. [23]. In addition, Olson et al. [17, 18, 19, 20] pointed out that the maternal heterosis was not important for SR. Of the genetic effects [18] only the maternal Brahman X Angus nonadditive group increased SR. The reduced incidence of calving difficulty by the Zebu crossbred dams was not reflected in a higher SR of their calves [19]. SR of calves to weaning have been relatively high for backcross, three-breed, rotational and inter se

TABLE V

LEAST-SQUARES ANALYSES OF VARIANCE FOR CALF TRAITS (n = 485)

Source of Variation	Degrees of Freedom	Birth Weight[a]	Weaning Weight	205-d Weight	ADG	205-d Wt ADG
Sire breed of dam (SBOD)	4	121.1[c]	10898.3[d]	9912.7[d]	.193[d]	.236[d]
Cow (SBOD)[b]	162	51.3[d]	884.0[d]	814.9[d]	.017[d]	.019[d]
Service sire	1	30.9	1623.7[d]	1336.1[c]	.022[c]	.032[c]
Calving year	5	26.0	9105.5[d]	7877.5[d]	.200[d]	.187[d]
Dam age	3	10.1	2514.8[d]	2002.0[d]	.041[d]	.047[d]
Calf sex	1	83.6[c]	18573.3[d]	16793.6[d]	.339[d]	.400[d]
Calf age	1		80211.5[d]	9.4	.000	.000
Residual	307	22.9	278.6	256.0	.005	.006

[a]n=537. [b]Error term for SBOD. [c]P < .05. [d]P < .001.

TABLE VI

LEAST-SQUARES MEANS FOR GROWTH TRAITS (KG) ACCORDING TO SIRE BREED OF DAM

Sire Breed of Dam	Birth Weight	Weaning Weight	205-d Weight	ADG	205-d ADG
Brahman	32.0	232.9	219.6	.914	1.071
Braford	30.6	205.8	194.2	.797	.947
Simbrah	33.8	231.3	218.2	.900	1.064
Senepol	32.2	211.8	200.0	.820	.975
Simmental	33.4	228.3	216.5	.887	1.056
μ	32.4	222.0	209.7	.864	1.023
SE[a]	.6	2.1	2.0	.008	.009
P<	.05	.001	.001	.001	.001

[a]Average standard error for least-squares means.

crossbred cows as compared to contemporary purebreds and no heterosis was observed [20]. No clear association was apparent in the present study on early mortality of calves associated with calving difficulty in the five crossbred groups involved.

Preweaning growth traits

Least-squares analysis of variance for calf traits are presented in TABLE V. All the effects significantly affected most characters, except for service sire (sire of calf), birth year and dam age which did not influence (P>.20) birth weight BW. Calf age used as a covariate in the model, significantly influenced both gains and weights. Many studies have reported sire breed, dam breed-type, dam within breed type, year, calf sex and dam age as important sources of variation and coincide with these results in the analyses of weaning weight WW and preweaning ADG [4, 6, 17, 19, 22, 23].

Birth weight: Mean BW for the study was 32.4 kg by sire breed of dam, TABLE VI. Ranking of breed groups on the basis of BW of progeny were higher for Simbrah- and Simmental-sired cows, intermediate for Senepol- and Brahman-sired ones, and lower for Braford-sired dams (P<.05). Breed group of dam deviations from Brahman X Angus F_1, from Brahman-derivative and from Senepol to Simmental were all negative and unsignificant, TABLE VII. Least-squares means of BW of calves by service sire (Limousin or Brangus) did not differ significantly, TABLE VII; however, male calves averaged 1 kg heavier than female calves at birth (P<.05). The present study supports there is a maternal X fetal genotype interaction due to differences in BW found among distinct breed groups of dams regardless of the sire breed of calf. This hypothesis was reported by Comerford et al. [3] when comparing Brahman with Hereford and Angus crossbreds, where Brahmans reduced the BW of their calves. Herein, Brahman-derivative dams calved 4 kg lighter calves than did *Bos taurus*-sired dams (P>.10). A few more reports indicating important contributions to variance in BW by breed of cow's sire which agree with this study are those of Setshwaelo et al. [23], Bailey et al. [1, 2], Gregory et al. [8], McElhenney et al. [13], Olson el at. [20] and Sacco et al. [22]. Large sex differences on

TABLE VII

COMPARISON OF CROSSBRED DAMS FOR PREWEANING GROWTH OF THE CALF (ORTHOGONAL CONTRASTS)

	BA - (BF+SB+ SP+SM)a		(BA+BF+SB) -(SP+SM)		SP-SM		BA-(BF+SB)	
Trait[b]	Estimate	SE[c]	Estimate	SE	Estimate	SE	Estimate	SE
Bwt	-1.9	2.4	-4.0	3.0	-1.2	.7	-.3	1.3
Wwt	54.4***	8.6	19.8	11.3	-16.4***	2.8	28.6***	4.8
205-d wt	49.8***	8.3	14.7	10.8	-16.4***	2.7	26.9***	4.6
ADG	.250***	.036	.102*	.048	-.068***	.012	.129***	.020
205-d ADG	.243***	.040	.072	.053	-.080***	.013	.131***	.022

[a]BA: Brahman x Angus F_1, BF:crossbred Braford, SB:crossbred Simbrah, SP:crossbred. Senepol, SM:crossbred Simmental. [b]Bwt:birth wt, Wwt:weaning wt. [c]SE: standard error of estimate. *Breed type effect (P<.05). ***Breed type effect (P<.001).

TABLE VIII

LEAST-SQUARES MEANS FOR PREWEANING GROWTH ACCORDING TO SIRE AND SEX OF CALF

	Sire of calf (semen donors)		Sex of calf	
Trait, kg	Limousin	Brangus	Male	Female
Birth wt	32.7 ± . 4	32.1 ± .4	32.9 ± .4*	31.9 ± .4
Weaning wt	224.3 ± 1.3**	219.8 ± 1.5	229.8 ± 1.3***	214.2 ± 1.5
205-d wt	211.7± 1.3*	207.6 ± 1.4	217.1 ± 1.3***	202.3 ± 1.4
ADG	.872 ±.0*	.855 ±.0	.897 ± .0***	.830 ±.0
205-d ADG	1.033 ±.0*	1.013 ±.0	1.059 ± .0***	.986 ±.0

*P< .05. **P< .01. ***P< .001.

BW which are also in agreement with this report have been found by Elzo et al. [4], Olson et al. [17], Gaertner et al. [5], Newman et al. [16] and Gregory et al. [7].

Weaning weight and 205-d weight: Effects by sire breed of dam, cow within sire breed of dam, service sire, birth year, age of dam, sex and age of calf were all large (P<.05 to P<.001) for calf weights. Overall means were 222 and 210 kg for WW and 205-d wt, respectively. TABLE VI shows the least-squares means of these weights were Brahman-, Simbrah- and Simmental-sired dams ranked the highest (P<.001), followed by Senepol- and Braford-sired cows which ranked the lowest. Breed deviations from Brahman-sired cows, TABLE VII were all significantly large and positive, averaging 52 kg advantage for WW in favor of Brahman X Angus F_1 cows. The values for Brahman may be inflated by relatively greater heterosis in maternal effects for *Bos indicus X Bos taurus* than for other breed crosses [12, 13, 19, 23]. Deviations from Brahman-derivative breeds (Brangus, Braford and Simbrah) with *Bos taurus*-sired dams (Senepol and Simmental) were also positive but smaller (P>.05) for WW. Between *Bos taurus*, Simmental-sired cows were higher (16.4 kg, P<.001) than Senepol-sired cows in weight of progeny at weaning. Calf wt of F_1 Brahman X Angus mothers were heavier (27 kg, P<.001) at weaning than as deviated from Braford and Simbrah crossbred mothers. Maternal breed effects expressed as differences among calves out of crossbred cows have been reported significant for both adjusted and unadjusted WW [1, 6, 9, 10, 11, 16] and concur with this report.

With regard to the effect by service sire (sire of calf), TABLE VIII indicates how Limousin-sired calves were heavier than Brangus-sired calves for WW (P<.01) as well as 205-d wt (P<.05), and also that male calves outweighed female calves by 16 kg average on both weights (P<.001). These results of significant effects by sire breed and sex of calf upon WW are in close agreement with the findings of Sacco et al. [22], Newman et al. [16] and Olson et al. [17]. Based on the results of this study as well as others [9, 22, 23], there is a large amount of variability for WW by cow within breed-groups examined. Changes in rank were observed among the five crossbred dams studied and a maternal heterosis effect was clearly noticed on the performance of the calf. The nested effect of cow in sire breed of dam includes the confounding effects of year, parity and age of the cow at calving, with a particular number of records in a crossbred group of dam. This study suggests that heterosis for WW may be greater for Brahman-derivative-sired cows than for *Bos taurus*-sired cows.

Linear regression coefficient of WW on calf age in days was .863 kg (P<.001) and this value, although a little lower, is comparable to those reported by Bailey et al. [1, 2] of .943 and 1.038 kg, respectively.

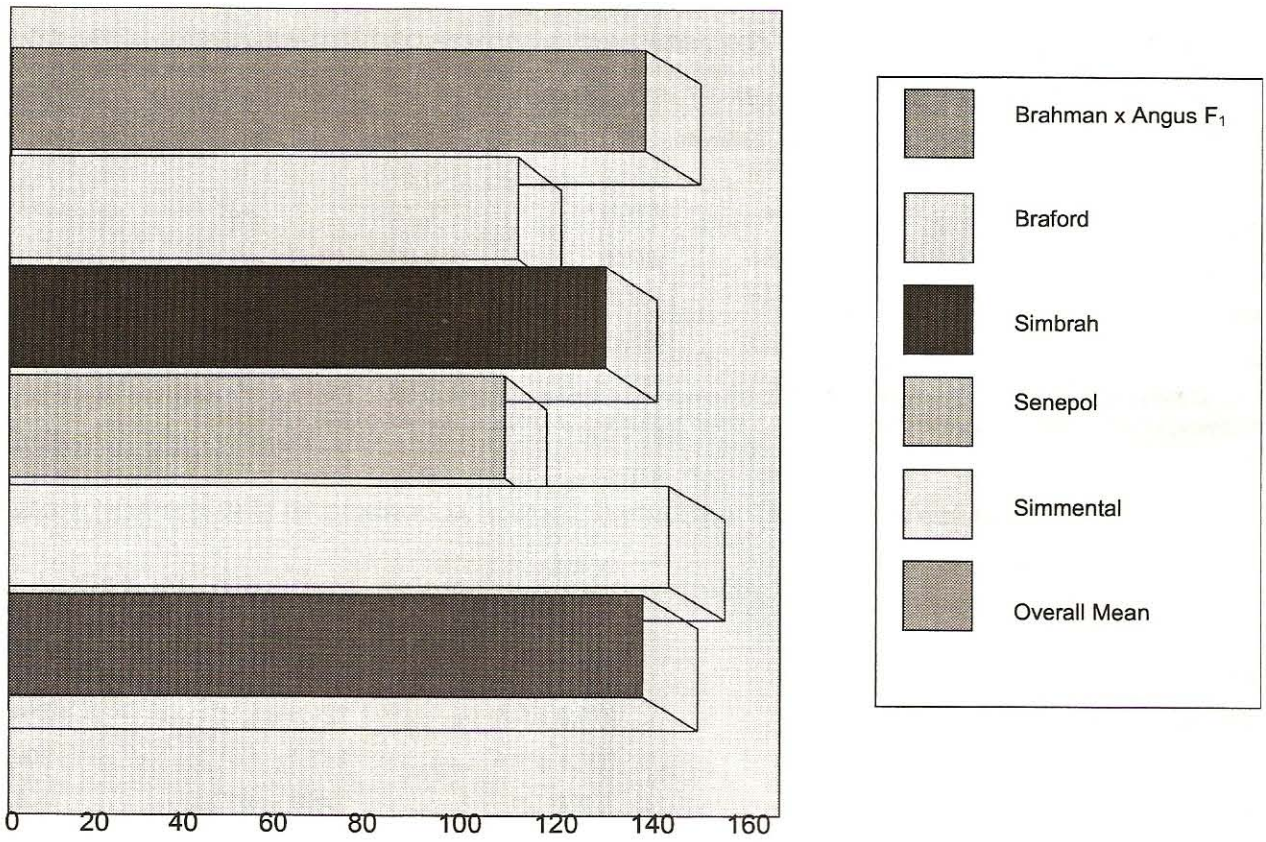

FIGURE 1. COW EFFICIENCY (KG OF CALF WEANED/COW EXPOSED) BY BREED GROUP OF DAM.

Average daily gain: All the effects, fixed and random influenced significantly ADG. Sire breed of dam was a significant source of variation, TABLE VI, when Brahman-, Simbrah- and Simmental-sired cows produced the fastest-gaining calves (.900 kg/d; P<.001) as compared to Senepol (.820 kg/d) and Braford-sired cows (.797 kg/d). Ranking of dam breed groups on the basis of ADG of progeny tended to be similar to that for 205-d ADG and for WW. TABLE VII presents the contrasts for ADG, where Brahman X Angus F_1 dams exceeded (P<.001) by 250 g/d the rest of the crossbred groups, demonstrating once more the superiority of this cross over the others on the preweaning performance of their calves for rapid growth. Between Brahman-derivative- and *Bos taurus*-sired dams, the Zebu breeding group produced calves that gained faster (102 g/d; P<.05) than the *Bos taurus* group. Within *Bos taurus*-sired dams, again Simmental-sired mothers surpassed (P<.001) Senepol-sired dams for progeny gains. Within the Brahman-derivative group of crossbred cows, progeny of Brahman X Angus F_1 mothers gained a lot more (130 g/d; P<.001) than calves from Braford and Simbrah crossbred mothers.

Linear and cuadratic effects of increasing proportion Brahman [12] indicated that as proportion Brahman increased, ADG also increased. Calves from 1/2 Brahman cows gained an average of .140 kg/d faster than calves from 0 Brahman cows. Olson et al. [19] found an advantage of Zebu crossbred dams over *Bos taurus* crossbred dams for preweaning ADG in Nebraska and Florida, and is in agreement with these results. McElhenney et al. [13] also reported that preweaning ADG of calves from Brahman X Angus and Brahman X Hereford dams were greater than those of reciprocals Hereford X Angus crossbred dams in Texas; however, Bailey et al. [1] failed to show such an advantage in Nevada.

Least-squares means for preweaning ADG according to sire and sex of calf are shown in TABLE VIII. Both Limousin-sired (P<.05) and male (P<.001) calves were the fastest-gaining as compared to Brangus-sired and female calves. The advantages were about 50 and 67 g/d difference between sires and sexes, respectively. Large differences in calf gains by breed of sires utilized as well as sex of calf have been reported by Olson et al. [17] and Setshwaelo et al. [23]; nevertheless, these results differ from those found by McCarter et al. [12] and Gregory et al. [6] for the effect of sire, only.

Cow efficiency: The actual kg of calf produced per cow exposed for the crossbred groups of dams is depicted in FIG. 1. Cow efficiency values combined weaning rate/cow exposed and 205-d wt/calf weaned. Differences (P<.05) among the five crossbreds were found as Simmental-sired (136.4 kg), Brahman-sired (134.6 kg) and Simbrah-sired (122.2 kg) dams did not significantly differ from each other, but were greater (P<.05) than efficiency of Braford-sired (117.1 kg) and Senepol-sired (109.6 kg) dams. Breed of cow's sire was large enough for significance because of the large effects for wean-

ing wt observed and the approached (P=.11) for weaning rate. Overall mean of cow efficiency was 124 kg.

Crossbred dam groups have differed significantly in some other studies [1, 2, 17, 21, 23] and are in agreement with this report; however, those findings were out of different crossbred type of cows. The mean cow efficiency value reported herein is considerably lower than those found by the researchers previously mentioned, and this is true as a result of the lower fertility exhibited by this cow herd. According to Olson et al. [19], Zebu crossbred cows were superior to *Bos taurus X Bos taurus* crossbred cows by 45 kg in Florida and by 15 kg in Nebraska. These advantages however, did not occur in our study when Simmental-sired dams (*Bos taurus* crossbreds) equaled both Brahman- and Simbrah-sired cows (*Bos indicus* crossbreds) and exceeded (P<.05) Braford-sired dams for efficiency of cow.

CONCLUSIONS

Under the management program utilized in this study, crossbred beef cows had a reduced reproductive performance during a six-year term. Although Brahman X Angus F_1 were significantly greater than other crossbred types evaluated for survival rate, 205-d wt and preweaning ADG of the calf, Simmental-sired crossbred dams performed the highest (P<.05) for calving, pregnancy and weaning rates when fertility was measured for year-around cow exposed. As far as cow efficiency is concerned, Simmental- and Brahman-sired cows performed the same on the kilograms of calf weaned per cow exposed to breeding. Likewise, Brahman-derivative (Brangus, Braford, Simbrah)-sired cows exceeded *Bos taurus* (Senepol, Simmental)-sired dams for weaning rate and all the preweaning traits of the calf; the opposite occured for calving, pregnancy and survival rate. Within *Bos taurus* sire breed of dam, Senepol crossbred cows were the lowest for both reproductive and growth traits. Results from this study suggest, as well, the importance of breed and maternal effects in formulating efficient calf production systems in subtropical climates, such as North-Central Florida. There was evidence of a higher maternal heterosis in calf growth than in reproductive characters.

Significant differences found between sires of the calf (semen donors) for preweaning weights and gains, but not for reproduction, also indicated that breed selection is an important consideration when planning a crossbreeding program to obtain maximum benefit from heterosis. Breeds selected must be adapted and capable of high production within the given environment and management system. Continuous crossbreeding for using heterosis to achieve and maintain optimum additive genetic (breed) composition is something to keep in mind in the Florida's cow-calf commercial operations.

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