

# Maternal Effects on Reproduction and Production

## Traits of Reciprocal F<sub>1</sub> Dams of Angus, Brahman, and Charolais Breeds

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Agricultural Experiment Stations  
Institute of Food and Agricultural Sciences  
University of Florida, Gainesville  
F.A. Wood, Dean for Research

### AUTHORS

**F. M. Peacock and M. Koger**

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### INTRODUCTION

Interest in increasing beef production from crossbreeding has focused attention on the F<sub>1</sub> female because of the high productivity associated with maternal heterosis. Comparisons among F<sub>1</sub> reciprocal crossbred cows are desirable in order to determine if differences in their producing ability can be attributed to the breed of their dam. The purpose of this paper is to compare the performance of reciprocal F<sub>1</sub> crossbred females as to dam breed for both reproduction and production traits. The F<sub>1</sub> females represented all combinations of the Angus, Brahman, and Charolais breeds. These breeds represent three divergent breed types with respect to size and adaptation to the Florida environment (Peacock et al., 6).

## METHODS AND PROCEDURES

The data reported here were obtained at the ARC, Ona, over a 7-year period from a project in which Angus (A), Brahman (B), and Charolais (C) bulls were each bred to F<sub>1</sub> (AB, BA\*), F<sub>1</sub> (AC, CA\*), and F<sub>1</sub> (BC, CB\*) cows of Angus, Brahman, and Charolais breeds. Bulls were put out March 1 and removed from the herd June 1 each year. The nutritional plane of herds varied among years, but the average could be considered fair to good. Herds were grazed on bahiagrass and Pangola digitgrass year-round, with molasses supplement or a cottonseed meal-citrus pulp mixture (1:4 ratio) at 5 pounds per head daily for approximately 90 days during late winter and early spring. Weaning data on calves and data on pregnancy status of cows were collected the latter part of August each year. A total of 21 sires were used (7 of each breed) during the 7-year period. Heifers were first exposed to bulls at 2 years of age.

The data analyzed, utilizing least-squares procedures as outlined by Harvey (1), were the individual records for pregnancy, calf survival, calf age at weaning, weaning weight, estimated 205-day weight, and cow weight.

\*Sire breed is written first in F<sub>1</sub> combinations.

## RESULTS AND DISCUSSION

The variance analyses for traits measured are presented in Table 1. Effects such as year, sex, dam age, and in this particular study, sire breeds, were included in the analysis to adjust for F<sub>1</sub> dams effects.

Source of variance	d.f.	Pregnancy	Survival	Calf weaning age	Calf weaning weight	205-day weight
Years	6	0.442**	0.016	2856**	3032**	3389**
Sex	1 <sup>†</sup>	-	-	1352	15661**	17908**
Dam age	2	0.446*	0.173*	3036*	960	824*
Sire breed	2	0.302*	0.164	3392*	9212**	5868**
F1 dam breed <sup>††</sup>	2	0.476**	0.048	656	1495*	2358
R-AB dams <sup>‡</sup>	1	0.000	0.041	1433	226	54
R-AC	1	0.015	0.024	456	130	482

dams						
R-BC dams	1	0.112	0.038	2194	392	50
Remainder	571 <sup>††</sup>	0.098	0.056	833	493	249
†d.f. only for production traits.						
†† F <sub>1</sub> dam reciprocals combination.						
‡Reciprocal F <sub>1</sub>						
†††Remainder d.f. for survival is 500 and for calf data 468.						
* P<0.05						
** P<0.01						

Least-squares means and standard error for traits measured are presented in Table 2.

## Reproduction

There were highly significant differences for the F<sub>1</sub> dam breeds (reciprocals combined) for pregnancy, with no differences observed for survival rate of calves. Pregnancy rates were 91.2% for AB + BA, 81.2% for AC + CA, and 89.4% for BC + CB F<sub>1</sub> dam breeds. Pregnancy rates for the Brahman cross dams were similar, and higher than those of the Angus-Charolais crosses.

No significant differences in pregnancy or calf survival were observed among the reciprocals (Table 1). The only reciprocals showing any degree of possible maternal superiority in the performance of their F<sub>1</sub> female progeny were the Charolais x Brahman (CB) at 92.0% over the Brahman x Charolais (BC) at 86.9% (Table 2). The reciprocals, whether CB (Charolais bull x Brahman cow) or BC (Brahman bull x Charolais cow), should be the same genetically. The possibility exists that differences could be due to the maternal environment provided by the Brahman to their F<sub>1</sub> female progeny in utero or during the period from birth to weaning.

## Production Traits

There were no differences observed for weaning age of calves among the F<sub>1</sub> dams (reciprocals combined). This indicates that all F<sub>1</sub> dams that conceived did so during the same time period (Table 1). There were also no significant differences among the F<sub>1</sub> reciprocals for weaning age of their calves.

Weaning weights and 205-day weights of calves from the three F<sub>1</sub> crossbred combinations (reciprocals combined) were significantly different (Table 1). The weights for calves from F<sub>1</sub> AB + BA and F<sub>1</sub> BC + CB cows were similar and were higher (P \* 0.01) than calves produced by F<sub>1</sub> AC + CA cows (Table 2).

Even though variations were real between breed combinations, there were no observed differences between F<sub>1</sub> breed reciprocals (Table 2). There was, however, a tendency for F<sub>1</sub> dams produced from Brahman dams to wean heavier calves, but when adjusted for calf age, these small variations were minimized. Turner et al. (8) reported no differences in the weaning weight of calves between F<sub>1</sub> Angus x Brahman vs Brahman x Angus reciprocal dams in Louisiana, but they did suggest a tendency for F<sub>1</sub> dams from Brahman cows to be superior. Results from the Charolais-Angus combinations (Table 2) showed that F<sub>1</sub> cows from Charolais dams (AC) appeared to have a slight advantage for 205-day calf weight (450 vs 438 lb [204 vs 199 kg]) These variations suggest the possibility that reciprocal differences are related to dam size, as the Charolais cows weighed 1076 lb (488 kg) vs 855 lb (388 kg) for the Angus (Table 4). Montana research (Pahnish et al., 4) on the same breed combination did not find differences in 205-day weight of calves from F<sub>1</sub> reciprocal Charolais-Angus crossbred dams, even though the Charolais were 10% heavier than Angus dams.

<b>Table 2. Reproduction and production traits of reciprocal F<sub>1</sub> dams of the Angus (A), Brahman (B), and Charolais (C) breeds.</b>								
Breed Group	Number of observations	Pregnancy (%)	Number of observations	Calf survival (%)	Number of observations	Calf age (days)	Weaning weight (lb)t	205-day weight (lb)t
F <sub>1</sub> dams <sup>††, ‡</sup>								
AB, BA	218	91.2 ± 2.7	202	95.6 ± 2.1	193	224.3 ± 2.7	503.3 ± 6.4	467.5 ± 4.6
AC, CA	185	81.2 ± 2.5	149	91.9 ± 2.1	138	228.4 ± 2.7	484.0 ± 6.4	443.6 ± 4.6
BC, CB	184	89.4 ± 2.5	165	92.9 ± 2.0	154	224.7 ± 2.5	501.7 ± 6.0	466.3 ± 4.3
Reciprocal F1 Dams								
AB	171	91.4 ± 2.6	159	93.8 ± 2.1	151	227.6 ± 2.6	507.5 ± 6.2	465.5 ± 4.4
BA	47	91.1 ± 4.6	43	97.3 ± 3.7	42	220.9 ± 4.5	499.1 ± 11.0	469.6 ± 7.8
AC	113	82.1 ± 3.0	92	93.2 ± 2.5	86	226.5 ± 3.2	487.1 ± 7.8	449.8 ± 5.5
CA	72	80.2 ± 3.8	57	90.5 ±	52	230.3	480.8 ±	437.5 ±

				3.2		± 5.1	10.0	7.1
BC	78	86.9 ± 3.7	67	94.5 ± 3.0	64	220.8 ± 3.7	496.4 ± 9.0	468.1 ± 6.4
CB	106	92.0 ± 3.2	98	91.3 ± 2.5	90	228.6 ± 4.0	506.9 ± 7.7	464.4 ± 5.4
† kg = lb x 0.454								
†† Last letter of pair is dam breed, AB = Angus sire x Brahman dam, BA = Brahman sire x Angus dam.								
‡ Reciprocals combined.								

Research on maternal effects for weaning weight of reciprocal F<sub>1</sub> calves was conducted in Florida by Peacock et al. (6). With the Angus-Brahman combinations, F<sub>1</sub> calves produced by Brahman dams were 5.8% heavier (P < 0.05) at weaning than those from Angus dams, but when adjusted for age, the difference (3.5%) was not significant (Table 3). The variation (P < 0.10) in weight of these reciprocals existed at 2 years of age (Peacock and Koger, 5), and also at maturity (Table 4). The positive effect of the Brahman dam on preweaning response of calves was greater in the Charolais-Brahman crosses. Calves from Brahman dams weighed 8.5% more (P < 0.01) at weaning, and 4.4% more (P < 0.05) when calf weights were adjusted for age, than the reciprocals from Charolais dams. However, this advantage diminished to 3.5% (non-significant) at 2 years of age and was completely gone at maturity. These results do not support the theory that maternal effect is caused by difference in dam breed size, since Charolais dams weighed 13.7% more than Brahman dams (Table 4). However, heterosis for growth of offspring was obtained when the Brahman and European cattle were crossed, and the hybrid vigor effects masked the maternal effects for growth.

**Table 3. Mean differences and standard errors of mean differences for calf weights between purebred, between reciprocal F<sub>1</sub> calves, and between calves of reciprocal F<sub>1</sub> cows.**

Breed groups	Calf weaning weight			Calf 205-day weight		
	lb†	Mean difference	%	lb†	Mean difference	%
<b>Purebreds</b>						
Brahman (B) - Angus (A)	(398.5 - 403.8)	-5.3 ± 12.3	1.3	(384.7 - 366.6)	18.1 ± 8.9*	4.9
Charolais (C) - Angus (A)	(491.7 - 403.8)	89.9 ± 12.1**	21.8	(465.5 - 366.6)	98.9 ± 8.8**	27.0
Charolais - Brahman	(491.7 - 398.5)	93.2 ± 11.5**	23.4	(465.5 - 384.7)	80.8 ± 8.3**	21.0

Reciprocal F <sub>1</sub> calves <sup>† †</sup>						
AB - BA	(452.9 - 428.0)	24.9 ± 12.8	5.8	(427.5 - 412.9)	14.6 ± 9.3	3.5
AC - CA	(477.6 - 449.5)	28.1 ± 13.0*	6.2	(457.1 - 406.3)	50.8 ± 9.4**	12.7
CB - BC	(503.4 - 464.0)	39.4 ± 12.0**	8.5	(474.8 - 454.7)	20.1 ± 8.8*	4.4
Reciprocal F <sub>1</sub> cows <sup>‡</sup>						
AB - BA	(507.5 - 499.1)	8.4 ± 12.6	1.7	(465.5 - 469.6)	-4.1 ± 9.0	0.8
AC - CA	(487.1 - 480.8)	6.3 ± 12.7	1.3	(449.8 - 437.5)	12.3 ± 9.0	2.8
CB - BC	(506.9 - 496.4)	10.5 ± 11.8	2.1	(464.4 - 468.1)	-3.7 ± 8.4	0.8
† kg = lb x 0.454						
†† Last letter of pair is dam breed, AB = Angus sire x Brahman dam, BA = Brahman sire x Angus dam; AB-BA = Angus sire x Brahman dam <i>minus</i> Brahman sire x Brahman dam.						
‡ Calves of reciprocal F <sub>1</sub> cows.						
* P<0.05						
** P<0.01						

Research has shown no heterosis for calf weaning weight in combined F<sub>1</sub> reciprocals from crossing the Charolais and Angus breeds (Peacock et al., 6). The Charolais and Angus are both European breeds, even though large differences existed in mature size. The Charolais cow was 25.8% heavier than the Angus 1076 vs 855 lb (488 vs 388 kg). Reciprocal crossing resulted in Charolais cows producing 13% more calf than the Angus cow, 6.2% more when the calves reached 2 years of age. At maturity this F<sub>1</sub> Angus x Charolais cow weighed 5.0% more (P < 0.01) than its reciprocal from Angus cows. Even though real differences did not occur among offspring of these reciprocal Charolais-Angus cows, additivity for dam breed size was present in F<sub>1</sub> cows, diminishing in the succeeding generation until equilibrium was reached.

Weights of reciprocal F<sub>1</sub> females out of Brahman cows at 2 years of age slightly favored the Brahman dam over Angus and Charolais dams (nonsignificant), with the influence of the Charolais dam over the Angus diminished in the F<sub>1</sub> but still at a 6.1% advantage (P < 0.05) over the Angus (Peacock and Koger 5).

The concept of maternal effects on size and growth of beef cattle offspring was probably based on studies of growth behavior in the horse. Research in the United Kingdom (Walton and Hammond, 9) showed that crossbred foals from Shetland mares were smaller at birth and remained smaller at all subsequent stages of development than their reciprocal crosses from Shire mares. This was attributed to the fact that leg length from the knee and hock downwards increased very little after birth, and the size to which the reciprocal crosses grew was affected accordingly. However, beef cattle research (Joubert 2) showed that the knee and hock heights increased by 55.9% and 56.0% respectively from birth to maturity, which indicates that differences in size at birth may not remain permanent but might be altered by compensatory growth.

Further research on maternal influence by Joubert and Hammond (3) utilized two breeds of beef cattle of an extreme size difference, the South Devon and Dexter. The average adult South Devon female weighed 1568 lb (712 kg) and the Dexter 650 lb (295 kg), a difference of 241%. Birth weight of Dexter calves was 51.8 lb (23.5 kg), whereas for South Devon calves it was 100.3 lb (45.5 kg), a 96.3% difference. Reciprocal crossbred calves from South Devon cows weighed 12.5% more at birth than calves from Dexter cows. The difference increased to 28.6% at 7 months of age and was 16.5% at 12 months. Results from this study show that maternal effects due to dam size exist in the offspring and could continue into adult life.

Actual cow weights may not be the true genetic size of the breeds used in this study. The variations in environmental conditions existing in the United States could be involved in producing important effects of genotype-environment interaction on actual weight. In Montana (Pahnish et al., 4), Charolais cows were only 10% heavier than Angus, whereas in Missouri (Sagebiel et al., 7) the difference was 23%, and at Ona, Florida (Peacock et al., 6), the difference was 26%.

Breed groups	Purebred cow			Breeds	Reciprocal F <sub>1</sub> cow <sup>†</sup>		
	lb <sup>††</sup>	Mean difference	%		lb <sup>‡</sup>	Mean difference	%
Brahman (B) - Angus (A)	(947-855)	92 ± 11.5**	10.8	AB-BA	(987-954)	33 ± 18.6	3.5
Charolais (C) - Angus	(1076-855)	221 ± 12.1**	25.8	AC-CA	(1006-958)	48 ± 17.6**	5.0
Charolais - Brahman	(1076-947)	129 ± 12.2**	13.6	BC-CB	(1057-1048)	9 ± 15.3**	0.9

<sup>†</sup> AB-BA = Mature progeny of A x B vs. B x A.

<sup>††</sup> kg = lb x 0.454

\*\* P<0.01

The results from this study and those from the United Kingdom on crossing breeds with large variations in genetic size show that maternal effects on size are transmitted to offspring when genetic effects are additive and performance of offspring is void of heterosis. However, when crossing genetically divergent breeds where a high degree of heterosis for growth is obtained, maternal effects on size could be masked. Even though maternal effects might occur in the first cross, these effects would diminish in the next generation (offspring from F<sub>1</sub> cross females), with little grand-dam maternal effects in the offspring.

## SUMMARY AND CONCLUSIONS

Data have been presented for reproduction and production performance of reciprocal F<sub>1</sub> crossbred cows representing the Angus, Brahman, and Charolais breeds. Results of this research showed no significant differences between F<sub>1</sub> reciprocal cows for traits measured. Therefore, under the environmental conditions of this study and with the breeds utilized, the production potential of the F<sub>1</sub> cross female was not significantly affected by dam breed. Under environmental conditions similar to this study, Brahman bulls can be mated to Angus cows or Angus bulls can be mated to Brahman cows without materially affecting the performance of the resulting F<sub>1</sub> females. The same principle exists in the production of the other breed combinations represented in this study. However, under conditions where the dam breed is not adapted, and growth of offspring (F<sub>1</sub> female) is so severely retarded that its genetic potential for growth is not reached, its ultimate production could be affected. These conditions would warrant the selection of the dam breed that is most adapted to the environment to ensure that the potential of the F<sub>1</sub> female is reached.



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