BIRTH CHARACTERISTICS OF BRAHMAN AND BRAHMAN CROSSES COMPARED TO OTHER BREED TYPES

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ABSTRACT

The idea has been advanced that Brahman dams produce calves of lower birthweights regardless of sire breed type. Birth records on 3595 individuals were collected between 1950 and 1970 at the Texas Agricultural Experiment Station at McGregor, Texas. These data were analyzed to determine the validity and extent of this restriction in birthweight. Raw means and variances were used to evaluate the data. Hereford sires showed more uniform birthweights than the Brahman and Brahman X Hereford sires. Brahman dams tended to produce calves of lower birth weight although the variance within the three mating types using Brahman dams were relatively dispersed.

A least squares model was designed to correct the raw data for any extraneous sources of variation. An analysis of variance was performed and the following effects were found to be highly significanct ($P < .01$):

Dam breed

Dam age

Year of calf birth

Season of calf birth

Calf sex

Sire breed x dam breed interaction

Parity and Sire breed approached significance at $P = .05$.

No adequate explanation of the mechanism by which Brahman cows mediate birth weight was found. The research did add evidence to the hypothesis that Brahman cows tend to produce smaller calves, but they are capable of producing extremely large calves at times.

CONTENTS

LIST OF TABLES

INTRODUCTION

Birth is the first opportunity that is available to evaluate an animal. At this time measurements can be taken to predict future performance. Birthweight can be extremely important in determining whether or not calves will be born without assistance or cause calving difficulty (dystocia). Bellows et al. (1971) found that birthweight ranked first in importance of factors affecting dystocia. For this reason, it is obvious that some understanding of the factors affecting birthweight is important to control calving difficulty. Wythes et al. (1976) reported the incidence of dystocia to be greater than 10% in 35% of herds, and greater than 30% in 10% of herds located in Australia. This amount of dystocia can be an extremely important economic problem.

It is generally accepted that calf survival rate is influenced by the relationship between calf birthweight and cow size (Peacock et al., 1977). Calves that are born with extremely low birthweight sometimes have low vigor at birth, and in a range situation a high percentage will be lost. On the other extreme, calves of high birthweight relative to small cow size, will probably require assistance to be delivered. This will cause calves as well as cows to be lost. The idea has been proposed that calves of high birthweight are necessary to achieve high rates of growth in later life. This is in disagreement with work done by Dowling (1979) who found postnatal growth of lower birthweight *Bos indicus* hybrids to be superior to that of higher birthweight *Bos taurus* calves. Ideally, birthweight need be no higher than that necessary to retain calf vigor.

This paper attempts to describe some of the factors affecting birthweight. Particularly, Brahman cattle and their crosses will be studied. Nelsen et al. (1980) reported that Brahman cows tend to bear calves of lower birthweight from a variety of different sire breed types. This paper will try to extend this idea and determine which parameters are causing this reduction.

LITERATURE REVIEW

Birthweight in cattle is affected by many different variables, some of which are difficult, if not impossible to measure. The following will be a discussion of some of these variables.

Sex of Calf

Sex of calf has been shown to have a large influence on birthweight. Touchberry and Bereskin (1966) reported an average adjusted difference between male and female calves of 2.48 kg. Koch and Clark (1955) reported a 2.55 kg difference, Gregory et al. (1979) 4 kg, Rönningen et al. (1972) 2.2 kg, and Alim (1964) 1.68 kg. This is generally the source of large variations in birthweight and dystocia. Prior and Laster (1979) attributed the difference in fetal size of males to a greater growth potential of the male fetus.

Age of Dam

Dam age can affect birthweight. Koch and Clark (1955) observed that most of the variation in birthweight due to dam age occurs at dam ages of three, four and ten years. These were the youngest and oldest cows in their study. Harricharan et al. (1976) reported a 5.9 kg increase in birthweight as the age of the dam increased from 2.5 to 8 years in Brahman cows. He reports the largest relative increase to occur between dam ages of 30 and 48 months. In general, the largest difference due to dam age is between first calf heifers and second calf cows. Srivastava et al. (1978) concluded that heifers have lighter weight calves at birth because the maternal tissues are not fully developed and competition for available nutrients in the blood occurs between maternal and fetal tissues.

Season and Year of Birth

Many researchers have reported season and year of calf birth to be a significant source of variation. In a review of the literature, Andersen and Mogens (1965) reported one study of 414 Hereford calves born between February 7 and June 23 at the U. S. Range Livestock Experiment Station, Miles City, Montana. Those calves born between March 1 and March 15 were 6.8 kg heavier than those born in other periods. Effect of year of birth has also caused large differences apparently due to differing environmental conditions from year to year. Skivastava *et al*. (1978) reports that year effects may be due to variations in managemental conditions, nutrition, and climate factors to which pregnant dams are exposed. Bonsma (1965) observed "miniature" calves of 8.6 to 18.2 kg from low heat tolerant dams pregnant throughout the summer in South Africa.

Breed Effects

Different breeds can affect birthweight, usually due to differences in mature size of the different breeds. Bhat and Singh (1978) reported large differences at birth due to genetic groups on height at wither and height at pin bone measurements. Holstein and Brown Swiss sired calves out of Hariana cows were not significantly different from each other, while Jersey sired calves showed large differences. Arora *et al*. (1971) reported significant differences in the birthweight of Hariana crossbred calves by Brown Swiss, Holstein and Danish Red bulls when compared to purebred Hariana calves. Bailey and Moore (1980) report Brahman X Hereford calves were heavier than straightbred Herefords, Red Poll X Hereford, and Angus X Hereford calves. Reynolds et al. (1959) observed that purebred Brahman and Shorthorn X Brahman calves were lighter at birth than calves produced from crosses of Angus, Hereford, and Santa Gertrudis. Ellis et al. (1965) reported Brahman calves to be lighter than Herefords at birth and suggested that genotype of dam exerted a larger influence on birthweight than genotype of sire. Singh et al. (1978), Peters and Slen (1967), Rao et al. (1975), Kennedy and Chirchir (1971), Touchberry and Bereskin (1966) and Cartwright et al. (1964) have all reported significant breed effects in studies of many different types of cattle.

Nutrition

The nutritional regime of the dam can affect fetus weight if nutritional levels are extreme. Prior and Laster (1979) fed heifers three dietary energy levels to provide for gains of 0 to .22 (low), 1.1 to 1.3 (medium) and 2.2 to 2.4 (high) lb./day from 35 to 42 days of gestation until slaughtered. The most advanced stage of pregnancy studied was 255 days. Fetal weight or composition was not affected ($P > .10$) by level of dietary energy. Olaloku et al. (1971) stated that birthweight differences could be attributed to environmental factors, especially the nutritional conpoment. He reports that some of the breed variation in birth weight observed in the White Fulani breed may be due to seasonal variation in quantity and quality of forage available. Frisch (1973) observed the mean birthweight of calves from Shorthorn X

Hereford cows during a period of drowth in Australia. All these researchers seem to indicate that dietary protein restriction may influence calf birthweight while energy levels may not.

Sires Within Breed

Different sires within a particular breed types may produce calves of differing birthweight. Singh and Tyage (1970) indicated 10.59% of the observed variation in birthweight to be due to the effect of individual sires within a breed. Sharma and Prabhu (1968) found genetic variation for gestation period due to individual sires in the Indian breeds of cattle to be small. This may or may not be the case in birthweight.

Weight of Dam

Weight of dam at calving can affect calf birthweight. Gregory et al. (1950) reports that weight of dam had a significant influence on the birthweight of her offspring. Donald *et al*. (1962) reported differences in the birthweight of reciprocally crossbred calves. He suggested that reciprocally crossbred calves deviate from the mean birthweight of the parental types in the direction of the maternal breed. He reports that the birthweight average of two reciprocal crossbred calves of widely divergent mature size breeds is often lower than the midparent value because the small dams may suppress fetal development more than the large dams can enhance it.

Gestation Length

The length of time a cow carries a fetus may affect the calf's weight at birth. Reynolds *et al*. (1980) reported that gestation length affected ($P < .01$) birth weight of the calf. His regression analysis showed a .25 to .30 kg increase in birthweight for each additional day of gestation. McDowell *et al*. (1959) as well as Everett and Magee (1965) indicated high correlations between gestation length and calf birthweight.

Calving Interval

Whether or not a cow calves every year may influence birthweight. Andersen and Plum (1965) in a review of the literature report disagreement among researchers on the effect of calving interval on birthweight. Some researchers suggest the observed effect may actually be due to increased dam weight if a cow fails to produce a calf one year. Others claim birthweight to be more strongly influenced by the dam's physiological age than by her weight. Still other researchers have observed no relationship between calf birthweight and calving interval.

Level of Inbreeding

Krishna et al. (1971) reports a depressed birthweight with increasing levels of inbreeding. In his research with purebred Hariana cattle, all calves averaged 26.8 ± 0.2 kg. Thirty-three calves with 25% inbreeding averaged 24.9 ± 0.6 kg. Twenty-five calves with 12.5% inbreeding had an average birthweight of 25.9 ± .5 kg. Willham (1970) defines heterosis as the difference between the mean of the reciprocal crosses and the average of the parents. He also suggests that to maximize heterosis in the offspring of a cross between breeds, the breeds crossed should be as genetically divergent as possible and the favorable genes must exhibit some dominance. Inbreeding causes an increase in homozygosity, so clearly these type animals would show decreased birthweight.

MATERIALS AND METHODS

The birthweight data used in this study involved 3595 records taken from the Texas Agricultural Experiment Station located at McGregor, Texas, from 1950 to 1970. Both native and cultivated pastures were used to maintain the cow herd, and supplemental hay and protein were fed when needed. All cattle were handled as nearly alike as possible with the various cow herds being separated only during the breeding season. Weaning weight and feedlot gain were the principal traits for which selection was practiced.

The data were analyzed by general least squares procedures, using a model incorporating those main effects and interactions thought to be important. A more detailed discussion of these methods follows.

RESULTS AND DISCUSSION

Raw Means

The first step in analyzing the data was to compute raw means for birthweight for each of the three dam breeds (Hereford, Brahman, and Brahman X Hereford) when crossed with each of the same three sire breeds. These raw means are means that have not been corrected for different effects, but instead just reflect the observed average for each type of calf produced. This computation resulted in an individual mean for each of the nine types of calves produced. In addition, a raw mean was computed for each sire breed type and for each dam breed type. It would appear from these results (Table 1) that considerable birthweight differences exist. Care must be exercised in interpreting these results because no correction has been made for extraneous sources of variation in the means.

Variance

In addition to raw means, variances were calculated. Variance is a measure of how the data is distributed about the mean. A low variance value would indicate data (calf birthweight) that were closely distributed around the mean. A high variance value would indicate data that is widely dispersed around the mean. Inspection of the variance values for the different dam breeds (Table 2) would indicate less variability for the Brahman cows (25.54) than for either Hereford (32.13) or Brahman X Hereford (31.64). This is misleading because it should be noted that the

Table 1. Raw Means for Calf Birthweight

RAW MEANS

Calf BW (Kg)

Dam	Sire			
	H	B	BH	Mean
H	31.97	36.68	38.34	33.41
B	30.27	29.61	31.61	29.79
BH	31.07	34.53	33.18	33.09
Mean	31.85	34.13	35.37	

Table 2. Computation of Variance, Dam Breed by Sire Breed

RAW MEANS, DAM BREED

	Variable	N	Mean	Variance
Hereford dams				
	Calf BW	2643	33.41	32.13
H Sires	Calf BW	1856	31.97	24.01
B Sires	Calf BW	727	36.68	34.86
BH Sires	Calf BW	60	38.34	33.20
Brahman dams				
	Calf BW	523	29.79	25.54
H Sires	Calf BW	64	30.27	17.92
B Sires	Calf BW	432	29.61	25.88
BH Sires	Calf BW	27	31.61	35.88
BH dams				
	Calf BW	429	33.09	31.64
H Sires	Calf BW	165	31.07	21.62
B Sires	Calf BW	229	34.53	31.36
BH Sires	Calf BW	35	33.18	49.90

Brahman cows do have quite a bit of variability when the components that make up the Brahman dam average are noted. It is valuable to note that the Brahman X Hereford dam mated to the Brahman X Hereford sire showed the most variability. This is to be expected when crossing two highly heterozygous types like the F_1's.

If variances are observed for the size breeds (Table 3), it appears that the Hereford sires produced calves of similar raw mean birthweight and variance. The Brahman sires and Brahman X Hereford sires produced calves of differing variance. It may be postulated that the Hereford sired calves had a lower variance because of the high degree of genetic homogeneity ~~genes~~ among the Hereford population.

Least Squares Procedures

After computing raw means and variances it was informative to employ least squares procedures to allow a better comparison of the parameters being investigated. Least squares procedure is a method that attempts to minimize the squared deviation of the distance the data points are from the line of best fit. In other words, this is a method to correct raw data for any source(s) of variation not wanted in a study and thereby achieve a more meaningful comparison. The product of this least squares analysis was a set of least square means and an ANOVA. The model included sire breed, dam breed, sire breed by dam breed interaction, dam age in years, year of calf birth, season of calf birth, calf sex, parity (number of calves born), and the error term. (See Table 4).

Table 3. Computation of Variance, Sire Breed by Dam Breed

RAW MEANS, SIRE BREED

	Variable	N	Mean	Variance
Hereford Sires				
	Calf BW	2085	31.85	23.75
H Dams	Calf BW	1856	31.97	24.01
B Dams	Calf BW	64	30.27	17.92
BH Dams	Calf BW	165	31.07	21.62
Brahman Sires				
	Calf BW	1388	34.13	41.25
H Dams	Calf BW	727	36.68	34.86
B Dams	Calf BW	432	29.61	25.88
BH Dams	Calf BW	229	34.53	31.36
BH Sires				
	Calf BW	122	35.37	46.81
H Dams	Calf BW	60	38.33	33.20
B Dams	Calf BW	27	31.61	35.88
BH Dams	Calf BW	35	33.18	49.90

Table 4. Model Statement for Least Squares Procedure

MODEL STATEMENT

$$Y_{ijklmnop} = \mu + BS_i + BD_j + (BSXBD)_{ij} + A_k + YR_l + S_m + SX_n + P_o + E_p$$

Where:

μ = average birth weight

BS = breed of sire

BD = breed of dam

(BSxBD) = breed of sire x breed of dam interaction

A = age of dam

YR = year

S = season

SX = Sex

P = parity

E = error

ANOVA

An analysis of variance was performed (Table 5) to determine if the main effects and the interaction were significant sources of variation. This means that each variable in the model is tested at differeing levels of confidence to determine the probability that the variable could be significant due to chance. Dam breed, sire breed by dam breed interaction, dam age, year of calf birth, season of calf birth, and calf sex were all highly significant ($P < .01$). Sire breed and parity were approaching significance ($P < .10$).

Least Square Means

The statistical analysis resulted in a table of least square means (Table 6) that can be more meaningfully compared since they have been corrected for unwanted sources of variation. This table shows that Brahman dams tended to produce calves of about the same weight (30.83, 30.56, 30.15 kg) regardless of which of the three sire breed types they were mated to. It appears that Hereford sires depressed birthweight sl slightly, although it is not a significant difference. It is interesting to note the difference in birthweight between the reciprocal Brahman Hereford crosses. When Hereford is the sire breed and Brahman the dam breed a birthweight of 30.83 kg results. The reciprocal cross yields a 38.06 kg calf. These calves should be very similar genetically. This suggests the Brahman cow has some type of mechanism to control birthweight.

Interaction Sire Breed X Dam Breed

Since the breed of sire by breed of dam interaction was significant, it was necessary to graph this interaction to better visualize what was

Table 5. Analysis of Variance

ANOVA

SOURCE	DF	MS	
Sire BD	2	690.97	†
Dam B	2	2072.24	**
Sire BD x Dam B	4	335.49	**
Dam Age Y	16	153.76	**
Calf BYIR	20	263.56	**
Se Cal BTH	2	479.32	**
Calf Sex	1	5803.35	**
Parity	5	45.03	†

† $(p < .10)$

* $(p < .05)$

** $(p < .01)$

Table 6. Least Square Means, Calf Birthweight

LEAST SQUARE MEANS

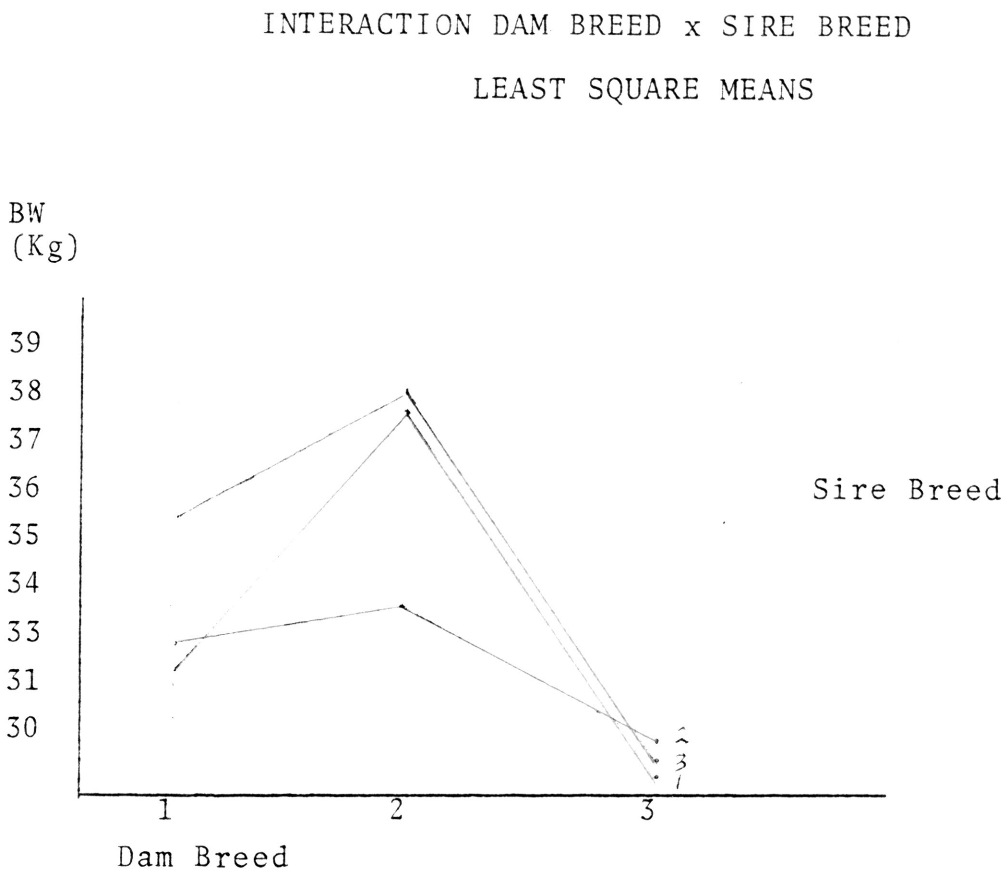
Calf BW (Kg)

	Sire			
Dam	H	B	BH	Mean
H	33.61	38.06	37.78	36.48
B	30.83	30.56	30.15	30.51
BH	32.61	35.32	32.38	33.43
Mean	32.35	34.64	33.43	

occurring.

Table 7 demonstrates well the manner in which Brahman dams tended to bear calves of lower birthweight compared to Hereford and Brahman X Hereford dams. Table 8 shows the slight reduction in birthweight and increase in uniformity apparently caused by Hereford sires.

Table 7. Interaction of Dam Breed X Sire Breed, Least Square Means

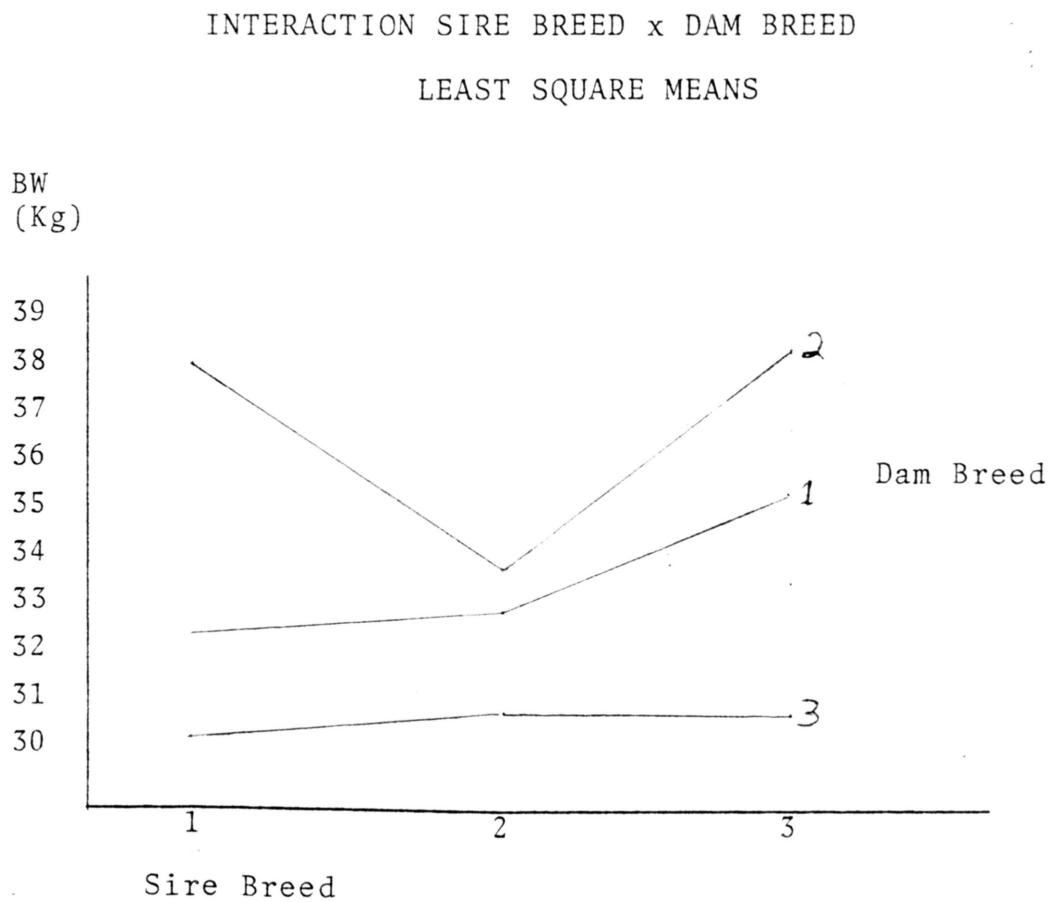


1 = 1/2 Br 1/2 He

2 = He

3 = Br

Table 8. Interaction of Sire Breed by Dam Breed, Least Square Means



1 = 1/2 Br 1/2 He

2 = He

3 = Br

CONCLUSIONS

This research indicated dam breed, dam age, year of calf birth, season of calf birth, calf sex and the interaction between sire breed and dam breed to be highly significant sources of variation in calf birth weight ($P < .01$). Sire breed and parity approached significance at $P = .05$. Since the sire breed X dam breed interaction was significant, caution must be used in comparing sire breed and dam breed least square means. This data set indicates that Brahman dams tend to have calves of more uniform and lighter birthweight than other breed types used in this study. It must be recognized that within the Brahman dams considerable variation existed and the data set did contain several calves of Brahman dams that weighed in excess of 45 kg. This data set also indicates that Hereford bulls sired calves of more uniform birthweight.

This research did not explain what type of mechanism is involved in the apparent birth weight reduction ability of the Brahman dams. It may be some type of physiological difference between Brahman cattle and European cattle. The answer may be due to the slower metabolic rate of the Brahman. It may be related to uterine environment. In summary, a maternal X fetal genotype interaction may exist. Evidence was added that Brahman cows control calf birthweight, although they are capable of producing large calves at times.

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