JOURNAL OF ANIMAL SCIENCE
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J Anim Sci 1979. 48:271-279.

CHARACTERIZATION OF BIOLOGICAL TYPES OF CATTLE–CYCLE III: I. BIRTH AND WEANING TRAITS[1,2,5,6]

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SUMMARY

Gestation length, calving difficulty, perinatal mortality, calf crop weaned, birth weight, preweaning average daily gain (ADG), relative growth rate (RGR) and 200-day weight were examined on 1,610 calves born and 1,536 calves weaned in 1975 and 1976 from 4- to 11-year-old Hereford and Angus dams and by Hereford, Angus, Brahman, Sahiwal, Pinzgauer and Tarentaise sires.

Angus dams were superior (P<.01) to Hereford dams in preweaning ADG, RGR and 200-day weight. Hereford dams produced calves with significantly heavier birth weights and longer gestation length than Angus dams. Effects of breeding group and sex of calf were significant for all traits except perinatal mortality and percentage calf crop weaned. All breed of sire groups except Pinzgauer and Tarentaise differed significantly from each other in gestation length; Sahiwal crosses had the longest (294.2 days) and Hereford-Angus crosses had the shortest (284.2 days) gestation length. Brahman crosses exhibited a significantly higher level of calving difficulty than all other breed of sire groups which did not differ (P>.05) from each other. Differences in perinatal mortality were not significant among sire breed groups. Hereford-Angus reciprocal crosses had a significantly higher percentage calf crop weaned than Brahman and Sahiwal crosses. Differences in percentage calf crop weaned were not significant among all other breed of sire groups. Birth weight was heaviest in Brahman crosses (40.6 kg) and lightest in Hereford-Angus (35.4 kg) crosses. All sire breed groups except Sahiwal and Tarentaise crosses differend significantly from each other in birth weight. Brahman crosses had significantly heavier 200-day weight than all other sire breed groups and had significantly higher preweaning ADG than all other breed of sire groups except Tarentaise. Sahiwal and Hereford-Angus crosses were similar (P>.05) in 200-day weight as were Pinzgauer and Tarentaise crosses. All other sire breed groups except Sahiwal and Pinzgauer differed significantly from each other in 200-day weight. Sahiwal and Pinzgauer crosses did not differ significantly from each other or from Hereford-Angus reciprocal crosses in preweaning ADG.

(**Key Words**: Cattle, Breeds, Birth and Weaning Traits.)

INTRODUCTION

This paper is the first in a third and final series reporting results from a research program aimed at the life cycle characterization of biological types of cattle as represented by different breeds. Breeds have been sampled to represent a wide range of performance characteristics for traits such as mature size, growth rate, maturing rate, milk production and body composition. This paper reports breed differences in gestation length, calving difficulty, perinatal mortality, calf crop weaned, birth weight, preweaning average daily gain (ADG), relative growth rate (RGR) and 200-day weight

[1] Published as Paper No. 5463 Journal Series, Nebraska Agricultural Experiment Station, Lincoln.

[2] This paper was prepared while the senior author was in residence as a Visiting Professor on the faculty of the Department of Animal Science, Texas A&M University, College Station, 77843, through an assignment of the Intergovernmental Personnel Act.

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[5] Contribution from Regional Project NC-1, Improvement of Beef Cattle Through Breeding Methods.

[6] Authors express appreciation to L. Beerwinkle, G. Hays, J. Stark, M. Sukup and R. DeGunia for data collection, and to W. Hinerman and B. Knapp, Jr. for statistical analysis.

for the progeny of Hereford, Polled Hereford, Angus, Brahman, Sahiwal, Pinzgauer and Tarentaise sires bred to Hereford and Angus dams. In addition to Hereford and Angus sires, which were used in all three cycles of this program, sires of the Jersey, South Devon, Limousin, Simmental and Charolais breeds were used in Cycle I; and sires of Red Poll, Brown Swiss (domestic and European), Gelbvieh, Maine-Anjou and Chianina breeds were used in Cycle II. Results from Cycle I have been reported by Smith *et al.* (1976a,b), Laster *et al.* (1976), Koch *et al.* (1976), Koch and Dikeman (1977), Young *et al.* (1978) and Notter *et al.* (1978a,b). Results from Cycle II have been reported by Gregory *et al.* (1978) and Laster *et al.* (1978).

MATERIALS AND METHODS

In this study, data are included on 1,610 calves (830 males and 780 females) born and 1,536 calves (787 males and 749 females) weaned at the U. S. Meat Animal Research Center in 1975 and 1976 from the third and final cycle of a comprehensive Germ Plasm Evaluation Program. The calves were the result of artificial insemination (AI). With the exception of the 4-year-old dams that produced calves in 1975 and the 4- and 5-year-old dams that produced calves in 1976, the Hereford and Angus dams were purchased as calves from commercial producers in western Nebraska. The 4- and 5-year old dams noted above were produced at the U. S. Meat Animal Research Center by the females purchased as calves from commercial producers in western Nebraska. They were by Hereford and Angus sires produced at the U. S. Meat Animal Research Center. The dams that produced calves were from 4 to 10 years old in 1975 and from 4 to 11 years old in 1976. The older females had been used in Cycles I and II of this program. All dams involved in this study produced calves first as 2-year-olds.

The sires of the calves were 13 Hereford and Polled Hereford, 14 Angus, 17 Brahman (Red and Gray), six Sahiwal, nine Pinzgauer and seven Tarentaise. The Hereford, Polled Hereford and Angus sires had been used in Cycles I and II of this program and provide a basis for comparison among the sire breeds in all three cycles. Hereford-Angus reciprocal crosses provide the basis for comparison among the sire breeds included in the present study. Hereford, Polled Hereford and Angus sires were sampled from among those that had gained entry into progeny testing programs of commercial AI organizations on the basis of individual performance information. Based on inspection of the data, a difference between Hereford and Polled Hereford sires was not indicated for the traits evaluated. Brahman sires were sampled from both commercial AI organizations and from private breeders. The Sahiwal breed is classified as *Bos indicus* and originated in Pakistan. The sample of Sahiwal sires used in this study was through semen imported from Australia. The importation of the Sahiwal breed into Australia from Pakistan was described by Anderson (1972). Pinzgauer and Tarentaise sires were sampled from commercial AI organizations from sires that had been imported into Canada from Europe. No progeny test results were available on any of the sires from any breed at the time they were sampled for use in this program. All available Sahiwal, Pinzgauer and Tarentaise sires were used. The experimental design and the number of calves produced by breed of sire and breed of dam subclass are presented in table 1. The number of sires of each breed used in each year and the number repeated the second year are presented in table 2.

TABLE 1. NUMBER OF CALVES PRODUCED BY BREED OF SIRE BY BREED OF DAM SUBCLASS

	Sire breed and number of offspring													
	Hereford		Angus		Brahman		Sahiwal		Pinzgauer		Tarentaise		Total	
Dam breed	Born	Wnd.[a]	Born	Wnd.	Born	Wnd.	Born	Wnd.	Born	Wnd.	Born	Wnd.	Born	Wnd.
Hereford	...	...	138	134	139	127	126	122	148	142	69	65	620	590
Angus	220	212	...	...	210	203	199	187	228	216	133	128	990	946
Total	220	212	138	134	349	330	325	309	376	358	202	193	1610	1536

[a] Wnd. = weaned.

TABLE 2. NUMBER OF SIRES USED EACH YEAR

Sire breed	Number of sires 1975	1976[a]	Total[b]
Hereford	13	12 (12)	13
Angus	14	14 (14)	14
Brahman	17	17 (17)	17
Sahiwal	2	6 (2)	6
Pinzgauer	8	9 (8)	9
Tarentaise	1	7 (1)	7

[a]Number of sires used in 1976 that were also used in 1975 shown in parentheses.

[b]Total number of different sires used.

The cows were maintained on improved pasture (April to November) and fed legume and grass hay on pasture during the winter. Calves were born over a 50-day calving season from early March until late April. Average birth date was April 7. All calves were identified and weighed, and male calves were castrated within 24 hr of birth. Calves were creep fed a diet of whole oats (IRN 4-03-388) in 1975 and a diet of equal parts of ground sun-cured alfalfa (IRN 1-00-059) and rolled corn (IRN 4-02-931) in 1976. Creep feed was made available from mid-August until weaning on October 22 in 1975 at an average age of 198 days and from mid-August until weaning on October 17 in 1976 at an average age of 193 days. The average amount of creep feed consumed was 110 kg/calf in 1975 and 54 kg/calf in 1976.

The cows were observed closely for calving difficulty. Cows that calved with no assistance and those that were given minor hand assistance, but delivered their calves without the aid of a mechanical calf puller were classified as no difficulty. Cows requiring assistance with a mechanical puller or surgical removal of the calf were classified as difficult parturitions. Abnormal presentations were excluded from the analysis of calving difficulty. There were 46 abnormal presentations that were observed at about the same percentage of each breed of sire group.

Perinatal mortality, expressed as a percentage of all calves born, included stillbirths and deaths at or within 72 hr of parturition. Calf crop weaned is based on calves born. Weights were adjusted to 200 days by multiplying ADG from birth to weaning by 200 and adding birth weight.

The RGR is rate of growth relative to instantaneous size and is approximated by the difference between the natural logarithm of two weights divided by the time interval (Fitzhugh and Taylor, 1971). The RGR as used in this study is equal to the percentage of change in body weight per day from birth to weaning.

All traits were analyzed by least squares, mixed-model procedures (Harvey, 1972). The model for all traits included the fixed effects of breeding group (H × A, A × H, B × A, B × H, S × A, S × H, P × A, P × H, T × A and T × H), dam age (4-year-olds *vs* 5-year-olds and older), sex of calf and the interaction of breeding group with sex of calf. Interactions involving age of dam, of the ages included in this study, were not included in the model because the analysis of similar data showed them to be unimportant. Years nested within breeding group and sires nested within year and breeding group were included in the model as random effects. The mean square for sires within year and breeding group was used as the error term for testing significance of differences among breeding groups and as the error mean square for linear contrasts involving sire breeds. The residual mean square was used as the error term to test the significance of all other differences evaluated. Three-way interactions were assumed nonsignificant. Birth date was included as a covariate in the analysis of all traits except gestation length. In a separate analysis, birth weight was included as a covariate (linear and quadratic) in the analysis of calving difficulty, perinatal mortality and calf crop weaned. The model that was used in the analysis of data from Cycle I and Cycle II of this program included sire breed and dam breed and their interaction; however, this model was not appropriate in Cycle III because Hereford and Angus sires were not mated to produce straightbred calves. The model used in the present analysis is appropriate for providing unbiased estimates of means and standard errors of linear functions and for testing the significance of differences for all traits relating to breed of sire, breed of dam and breed of sire by breed of dam effects. Linear functions of the 10 breeding groups provide the basis for estimating differences involving sire breed, dam breed and sire breed by dam breed in this study. Breed of sire and breed of dam means were constructed from the estimates of breeding group means.

Linear functions were computed for breed of sire comparisons. More comparisons were made using these means than there are independent degrees of freedom. Therefore, all comparisons are not independent, and the error rate over the entire set of comparisons may be different from that indicated by the level of probability. However, the plan of the experiment was to examine sire breed effects on major economic traits by comparing all sire breed groups with the Hereford-Angus crosses and with each other. Tests of significance asssociated with the linear functions can at least be taken as guides as to whether the observed values could have occurred by chance.

RESULTS AND DISCUSSION

Mean squares for all traits are presented in table 3. Least-squares means and standard errors for breed of sire, breed of dam and for breed of sire by breed of dam are presented in table 4 for all traits. Differences between Hereford and Angus dams presented in table 4 does not include Angus-Hereford reciprocal crosses. Differences in HA and AH reciprocal crosses are presented separately in table 4. Information on differences for all sire breed groups are presented in table 5.

Gestation Length. The effects of breeding group and sex of calf were significant for gestation length (table 3). The overall mean for gestation length was 288.8 days; male calves averaged 2 days longer than females. This finding compares with a 1.3-day sex difference in gestation length reported by Gregory *et al.* (1978) and a 1.7-day sex difference reported by Smith *et al.* (1976b); both studies involved samples of other breeds. Gestation length was 3.6 days longer ($P<.01$) for calves with Hereford dams than for calves with Angus dams when Hereford-Angus reciprocal crosses were not included (table 4). Gestation length was shortest for Angus-Hereford reciprocal crosses (284.2 days) and longest for Sahiwal crosses (294.2 days). All sire breed groups except Pinzgauer and Tarentaise were significantly different from each other in gestation length (table 5).

Gestation length accounted for 17% of the variation in birth weight on an overall basis and for 13% of the variation on a within subclass basis. Regression coefficients for birth weight (kilograms) on gestation length (days) were .42 and .36 on an overall and within subclass basis, respectively. These results are generally consistent with those reported by Gregory *et al.* (1978) from another sample of breeds.

Calving Difficulty, Perinatal Mortality and Calf Crop Weaned. In this study, calf crop weaned is based on the number of calves born and reflects differences in preweaning mortality. Effects of breeding group, age of dam (4 years old *vs* 5 years old and older), sex of calf and the interaction of breeding group with sex of calf were significant for calving difficulty. Only age of dam had a significant effect on perinatal mortality and calf crop weaned (table 3). Four-year-old dams experienced more than

TABLE 3. MEAN SQUARES FOR BIRTH AND WEANING TRAITS

Source	df	Gestation length (days)	Calving difficulty	Perinatal mortality	Calf crop weaned	Birth weight	ADG[a]	RGR[a] (%/day)	200-day weight
			(%)			kg			kg
Breed group (B)	9	2901**	1131*	306	646	728**	.439**	.2363**	16615**
Year/breed group	10	340**	531	268	358	45	.041**	.0323**	1215*
Sire/Y/B	166	43*	597	276	323	33*	.011	.0041	577
Dam age	1	17	9190**	1238**	2049**	130**	.011	.0303**	964**
Sex (S)	1	1174**	6150**	325	875	5002**	1.215**	.0345**	82381**
B × S	9	27	808*	311	318	92**	.013	.0048	929*
b_1 (birth date-linear)	1	...	772*	59	524	1352**	.152**	.2924**	2164**
Residual	...	20	384	30	392	16	.008	.0034	378
Residual df for each trait	...	1413	1366[b]	1412	1412	1412	1338	1338	1338

[a]ADG = average daily gain; RGR = relative growth rate.

[b]Abnormal presentations were excluded from the analysis of calving difficulty.

*P<.05.

**P<.01.

TABLE 4. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR BIRTH AND WEANING TRAITS FOR BREED OF SIRE, BREED OF DAM AND BREED OF SIRE BY BREED OF DAM

Item[a]	Gestation length	Calving difficulty	Perinatal[b] mortality	Calf[b] crop weaned	Birth weight	ADG[c]	RGR[c]	200-day weight
	days	(%)	(%)	(%)	kg	kg	%/day	kg
HA	283.8 ± .6	5.7 ± 2.1	3.8 ± 1.4	95.5 ± 1.5	35.0 ± .42	.875 ± .02	.912 ± .006	210 ± 2.1
AH	284.7 ± .6	6.1 ± 2.3	3.1 ± 1.7	96.5 ± 1.8	35.8 ± .46	.798 ± .02	.862 ± .006	195 ± 2.2
Mean	284.2 ± .4	5.9 ± 1.7	3.4 ± 1.2	96.0 ± 1.2	35.4 ± .40	.836 ± .01	.887 ± .005	203 ± 1.7
BH	293.9 ± .6	13.8 ± 2.3	7.8 ± 1.7	89.3 ± 1.8	41.7 ± .44	.818 ± .02	.813 ± .006	205 ± 2.2
BA	289.9 ± .6	12.3 ± 2.0	3.4 ± 1.4	95.2 ± 1.5	39.6 ± .39	.929 ± .02	.884 ± .006	226 ± 2.0
Breed of sire mean	291.9 ± .5	13.0 ± 1.8	5.6 ± 1.2	92.2 ± 1.3	40.6 ± .41	.874 ± .01	.848 ± .004	215 ± 1.8
SH	296.1 ± .6	11.3 ± 3.3	4.2 ± 1.8	94.2 ± 1.9	39.1 ± .71	.783 ± .02	.819 ± .006	196 ± 2.6
SA	292.3 ± .7	7.1 ± 3.0	6.2 ± 1.4	91.8 ± 1.6	36.3 ± .66	.880 ± .02	.898 ± .006	212 ± 2.5
Breed of sire mean	294.2 ± .5	9.2 ± 1.8	5.2 ± 1.2	93.0 ± 1.3	37.7 ± .42	.831 ± .01	.859 ± .005	204 ± 1.8
PH	287.9 ± .6	8.9 ± 2.5	4.4 ± 1.6	94.5 ± 1.7	40.1 ± .50	.786 ± .02	.809 ± .006	197 ± 2.2
PA	284.4 ± .7	9.6 ± 2.3	5.0 ± 1.4	93.4 ± 1.5	37.8 ± .49	.900 ± .02	.892 ± .006	218 ± 2.2
Breed of sire mean	286.2 ± .4	9.3 ± 1.7	4.7 ± 1.1	93.9 ± 1.2	38.9 ± .40	.843 ± .01	.851 ± .005	207 ± 1.7
TH	288.8 ± .6	10.6 ± 3.8	5.8 ± 2.2	92.2 ± 2.5	38.5 ± .79	.812 ± .02	.838 ± .006	201 ± 2.9
TA	285.8 ± .7	7.4 ± 3.4	4.1 ± 1.7	94.9 ± 1.9	36.0 ± .75	.905 ± .02	.916 ± .006	217 ± 2.8
Breed of sire mean	287.3 ± .6	9.0 ± 2.2	5.0 ± 1.4	93.5 ± 1.6	37.2 ± .50	.858 ± .01	.877 ± .006	209 ± 2.2
Hereford dams[d]	291.7 ± .3	11.1 ± 1.3	5.5 ± 1.1	92.6 ± 1.3	39.8 ± .27	.800 ± .01	.820 ± .004	200 ± 1.3
Angus dams[d]	288.1 ± .3	9.1 ± 1.1	4.7 ± .9	93.8 ± 1.1	37.4 ± .24	.904 ± .01	.898 ± .003	218 ± 1.2
Breed of dam difference	3.6** ± .3	2.0 ± 1.2	.8 ± 1.0	-1.2 ± 1.2	2.4** ± .25	-.104** ± .01	-.078** ± .004	-18** ± 1.3
HA minus AH reciprocal crosses	-.9	-.4	.6	-1.0	-.8	.077**	.050**	15**

[a]H = Hereford, A = Angus, B = Brahman, S = Sahiwal, P = Pinzgauer and T = Tarentaise, with breed of sire listed first.

[b]Expressed as a percentage of calves born.

[c]ADG = average daily gain; RGR = relative growth rate.

[d]Does not include AH and HA reciprocal crosses.

**P<.01.

TABLE 5. DIFFERENCES FOR BREED OF SIRE COMPARISIONS FOR BIRTH AND WEANING TRAITS

Item[a]	Gestation length (days)	Calving difficulty	Perinatal mortality	Calf crop weaned	Birth weight	ADG[b]	RGR[b]	200-day weight
		(%)			kg		%/day	kg
HA-AH-X minus								
B-X	-7.7**	-7.2**	-2.2	3.8**	-5.2**	-.037**	.039**	-13**
S-X	-9.9**	-3.3	-1.8	3.0*	-2.3**	.005	.028**	-1
P-X	-1.9**	-3.4	-1.2	2.1	-3.5**	-.006	.036**	-5**
T-X	-3.0**	-3.1	-1.5	2.5	-1.8**	-.022*	.010	-6**
B-X minus								
S-X	-2.3**	3.9*	.4	-.8	2.9**	.042**	-.010*	11**
P-X	5.7**	3.8*	.9	-1.7	1.7**	.031**	-.003	8**
T-X	4.6**	4.1*	.6	-1.3	3.4**	.015	-.029**	6**
S-X minus								
P-X	8.0**	-.1	.5	-.9	-1.2**	-.012	.008	-3
T-X	6.9**	.2	.2	-.5	.5	-.027**	-.018**	-5*
P-X minus								
T-X	-1.1	.3	-.3	.4	1.7**	-.015	-.026**	-2

[a]H = Hereford, A = Angus, B = Brahman, S = Sahiwal, P = Pinzgauer and T = Tarentaise.

[b]ADG = average daily gain; RGR = relative growth rate.

*P<.05.

**P<.01.

three times (P<.01) the level of calving difficulty as dams 5 years old and older (14.5% *vs* 4.0%). Calves with 4-year-old dams weighed 1.2 kg more (P<.01) at birth (38.6 kg *vs* 37.4 kg), experienced almost three times (P<.01) the level of perinatal mortality (6.6% *vs* 2.9%) and had 4.9% smaller (P<.01) calf crop weaned (91.3% *vs* 96.2%) than calves with 5-year-old or older dams. The increased birth weight of calves with 4-year-old dams is believed to be a primary factor contributing to increased calving difficulty and perinatal mortality and reducing calf crop weaned (Laster and Gregory, 1973; Smith *et al.*, 1976b; Gregory *et al.*, 1978). The 4-year-old dams were by Hereford and Angus sires produced at the U. S. Meat Animal Research Center from populations of cattle that had been selected for growth rate for three or more generations. However, the higher level of calving difficulty, the increased perinatal mortality and the reduced percentage calf crop weaned in 4-year-old dams may have been due in part to carry-over effects resulting from late date of birth in their birth year and a low plane of nutrition in their yearling and 2-year-old winters.

Major assistance was required to deliver 9.3% of the calves. Almost twice (11.6% *vs* 7.0%) as many male as female calves required major assistance (P<.01) at birth. Male calves averaged 4.0 kg heavier (40.0 *vs* 36.0) (P<.01) at birth than female calves. This finding compares with a 3-kg difference in birth weight between male and female calves reported by Gregory *et al.* (1978) from another sample of breeds. As reflected by the significant breeding group by sex interaction on calving difficulty, the higher the average level of calving difficulty for a breeding group, the greater the difference observed between their male and female progeny in level of calving difficulty. For example, in Brahman-Angus cross calves the percentage of difficult births was 19.0 for males and 5.7 for female calves. This result is in agreement with the observations of Gregory *et al.* (1978) for another sample of breeds.

Average perinatal mortality in this study was 4.8%, with male calves averaging 1.1% higher than female calves. Percentage of calf crop weaned was 93.7% for all calves. Thus, about two-thirds of the preweaning mortality occurred at or within 72 hr of birth. Differences among sire breed groups in perinatal mortality were small (P>.05) (tables 4 and 5). Hereford-Angus reciprocal cross calves had a significantly higher percentage calf crop weaned than Brahman crosses and Sahiwal crosses, whereas other breed of sire groups did not differ (P>.05) in percentage calf crop weaned (table 5). Smith *et al.* (1976b) and Gregory *et al.* (1978) reported significant breed of sire effects for perinatal mortality and calf crop weaned from samples of other breeds.

The Brahman crosses exhibited significantly more calving difficulty than any other breed of sire group which did not differ from each other (table 5).

Hereford and Angus dams did not differ (P>.05) in calving difficulty, perinatal mortality and calf crop weaned (table 4).

In a separate analysis, calving difficulty, perinatal mortality and calf crop weaned were analyzed with birth weight as a covariate. Linear and quadratic regressions involving birth weight were important (P<.01) for all three traits. In this separate analysis, breeding group effects were not significant for calving difficulty after variation associated with linear and quadratic regressions on birth weight were removed. The linear regression coefficient was −.040262, and the quadratic regression coefficient was .000614 for calving difficulty on birth weight. Effects of breeding group on perinatal mortality and calf crop weaned were not significant in the regular analysis. Including birth weight in the analysis as a covariate on perinatal mortality and calf crop weaned had little effect on the mean squares for these traits even though both the linear and quadratic regressions involving birth weight were significant. The effects of linear and quadratic regressions of calving difficulty on birth weight in reducing the mean square for breeding group effects on calving difficulty were relatively larger in this study than in the study reported by Greogory *et al.* (1978) for breed of sire effects involving another sample of breeds. They reported relatively larger mean squares for breed of sire and breed of dam effects on calving difficulty than observed in the present study for breeding group effects. The interpretation is that this difference in magnitude of effect between the two studies is due to the different samples of breeds included.

In the analysis of calving difficulty, the regression (linear and quadratic) of calving difficulty on birth weight showed calving difficulty reaching a minimum of 8.1% at a birth weight of 32 kg and increasing linearly with birth weight at weights above the general mean of 38 kilograms. At birth weights below 32 kg, the regression reflected an increase in level of calving difficulty. The increase in calving difficulty at lighter birth weights is interpreted to be the failure of a quadratic regression to describe the effects of birth weight on calving difficulty rather than an increase in calving difficulty being caused by birth weights below a given level. Gregory *et al.* (1978) reported similar results.

Birth Weight, Preweaning Average Daily Gain, Relative Growth Rate and 200-Day Weight. In this study, the mean birth weight was 38 kg, mean ADG was .849 kg, mean RGR was .864%/day and mean 200-day weight was 208 kilograms. The main effects of breeding group and sex of calf were significant for all four traits (table 3). The interaction of breeding group with sex was significant for birth weight and for 200-day weight. The difference in birth and 200-day weight between male and female calves was greater in breeding groups having heavier birth and 200-day weights.

Male calves weighed 4.0 kg more (P<.01) than female calves at birth, gained .065 kg more/day (P<.01), had .011 %/day lower RGR and were 17 kg heavier (P<.01) at 200 days. Calves with Angus dams (excluding Hereford-Angus reciprocal crosses) were 2.4 kg lighter (P<.01) at birth than calves with Hereford dams, gained .104 kg more/day (P<.01), had .078 %/day higher (P<.01) RGR and weighed 18 kg more (P<.01) at 200 days (table 4). Angus dams exceeded Hereford dams by .077 in ADG (P<.01), .050 in RGR (P<.01) and by 15 kg in 200-day weight (P<.01) in reciprocal crosses (table 4).

Four-year-old dams produced calves that had 1.2 kg higher birth weight (P<.01), .013 higher ADG (P>.05), .020 higher RGR (P<.01) and were 3.4 kg heavier (P<.01) at 200 days than dams 5 years old and older. These results reflect higher genetic merit for growth rate of 4-year-old dams than dams 5 years old and older.

The RGR is a measure of increase in body weight relative to weight already attained. The RGR tended to be highest in breed of sire groups with the lowest birth weights and in calves with Angus dams. This higher RGR in calves with Angus dams reflects their higher preweaning ADG and smaller birth weight (tables 4 and 5) than calves with Hereford dams. The correlation between RGR and birth weight was −.63 on an overall basis and −.62 on a within subclass basis.

The Hereford-Angus crosses were lightest at birth and the Brahman crosses were heaviest (table 4). Cartwright *et al.* (1964) showed that the Brahman breed exhibited a high level of heterosis on birth weight, preweaning ADG and weaning weight in crosses with the Hereford breed. All sire breed groups except Sahiwal and Tarentaise differed significantly from each other in weight at birth (table 5). The Brahman crosses were significantly heavier at 200 days than all other sire breed groups (table 5). Brahman crosses had significantly higher preweaning ADG than all other breed of sire groups except Tarentaise. The Sahiwal and Pinzgauer crosses did not differ (P>.05) from the Hereford-Angus crosses in ADG, but the Tarentaise crosses gained significantly faster than the Hereford-Angus reciprocal crosses and the Sahiwal crosses during the preweaning period. The Pinzgauer and Tarentaise crosses were significantly heavier at 200 days than the Hereford-Angus reciprocal crosses and the Tarentaise crosses were significantly heavier than the Sahiwal crosses at this age. The Pinzgauer and Tarentaise crosses did not differ (P>.05) from each other in ADG or in weight at 200 days.

General. Even though differences in 200-day weight were significant among all breeding groups except the Hereford-Angus and Sahiwal crosses, the Sahiwal and Pinzgauer crosses and the Pinzgauer and Tarentaise crosses, differences among breeding groups were small except for the Brahman crosses. The *Bos indicus* breeds (Brahman and Sahiwal) included in this study had the longest gestation length in crosses (P<.01). The Sahiwal crosses did not have a significantly greater amount of calving difficulty than the Hereford-Angus, Pinzgauer and Tarentaise crosses. The Brahman crosses had a significantly higher level of calving difficulty than all other crosses. The differences among all crosses in perinatal mortality were small and nonsignificant. Hereford-Angus crosses had significantly higher percentage calf crop weaned than the Brahman and Sahiwal crosses. Perinatal mortality was highest and calf crop weaned was lowest in the Brahman crosses. Brinks *et al.* (1973), Laster and Gregory (1973), Smith *et al.* (1976b) and Gregory *et al.* (1978) have shown a higher level of perinatal mortality associated with increased calving difficulty in *Bos taurus* cattle. There is no basis for expecting a different relationship in *Bos indicus* cattle.

Conclusions on breed groups, in regard to genetic merit for net efficiency of production, are not appropriate until postweaning growth, feed efficiency, carcass composition, and meat quality have been evaluated on male progeny; and fertility and maternal traits are evaluated on female progeny. Desirably, these characterizations should be accomplished using different sets of production resources with detailed evaluations of all inputs and outputs on a life cycle basis.

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