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Tarentaise and Hereford Breed Effects on Cow and Calf Traits and Estimates of Individual Heterosis[1,2]

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ABSTRACT: Preweaning and weaning records on 457 calves and weights and milk production of their dams were used to evaluate breed of dam effects, breed of sire effects, and individual heterosis effects. Hereford and Tarentaise dams were mated to Hereford and Tarentaise sires and calves were born from 1987 to 1991. Calf traits were birth weight, proportion calving difficulty, weaning weight, weaning height, weaning weight:height ratio, and condition score at weaning. Cow traits were milk production, four weights during the year, weight changes, height at weaning, condition score, ratio of calf weight:cow weight, proportion calved and weaned, and calf weaning weight per cow exposed to breeding. Breed of sire was nonsignificant for all traits except calf hip height, but breed of dam was significant for calf weaning weight and condition score, late milk production, change in milk production, and the cow traits of all weights, condition score, weight:height ratio, and ratio of calf weight:cow weight. Least squares means for Hereford and Tarentaise dams, respectively, were 216 and 236 kg for calf weaning weight, 6.2 and 9.3 kg for late milk production, 559 and 507 kg for cow weight at weaning, 6.0 and 4.9 for cow condition score, and .39 and .47 for ratio of calf weight at weaning:cow weight at weaning. Heterosis was significant for birth weight (1.05 kg, 3%, $P = .01$), weaning weight (11.0 kg, 5%, $P = .01$), and condition score (.13, 2%, $P = .06$). Thus, Hereford dams weighed more and had higher levels of condition, whereas Tarentaise dams produced more milk late in lactation and weaned heavier calves.

Key Words: Beef Cattle, Breed Differences, Milk Production, Heterosis

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Introduction

Crossbred calves have generally shown greater preweaning growth than straightbred calves when both were raised on straightbred dams (Long, 1980; Lawlor et al., 1984), but few experiments have included Tarentaise, a moderate-framed breed noted for easy calving, hardiness, and maternal characteristics (Briggs and Briggs, 1980). These data are from a long-term study of cow efficiency with different biological types of cows under range conditions. The present study was with foundation Hereford and Tarentaise cows raising Hereford, Tarentaise, and reciprocally crossed calves. The objectives were to compare preweaning growth of the calves, to compare milk production, reproduction, and size of the dams, to estimate individual heterosis for calf preweaning growth and dam milk production, and to decipher the usefulness of the Tarentaise breed as a possible alternative in crossing to the British breeds.

Materials and Methods

There were 457 weaning records on calves raised on Hereford or Tarentaise dams during the years 1987 to 1991. These foundation Hereford and Tarentaise dams were progeny of 30 Hereford and 20 Tarentaise sires. The 77 foundation Tarentaise were purchased or donated from 11 breeders in Montana, Oregon, Idaho, and Wyoming. They were obtained as heifers following weaning in the years 1985 and 1986, and as a result there was partial confounding of year with cow age. Within the original herds, the heifers were selected to represent herd average based primarily on their adjusted 205-d weight. The 85 foundation Herefords were selected at random from the grade Hereford herd at the research center and entered the project as young females, but not all females were heifers due to limited numbers of animals. In 1985, 31 heifers and

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29 2-, 3-, and 4-yr-olds entered the project, and in 1986 an additional 25 heifers entered the project. Foundation dams were mated to 17 Hereford and 16 Tarentaise sires selected to represent breed average for adjusted 365-d weight. All Hereford and Tarentaise sires were mated at random to both breeds of dam in a 2 × 2 design. Cows changed sire breed from year to year in a random manner. Table 1 illustrates the design and shows the number of calves weaned.

Breeding was by AI during a 45-d season starting the 1st wk of June. Calves were born from early March to late April and were weaned at 6 mo of age during the 1st wk of October. There was no creep feeding.

Cattle were located at the Northern Agricultural Research Center near Havre, MT and were managed as one experimental unit. Supplemental feeding was practiced during the winter (late December to 1st wk of May) with 9 kg of alfalfa hay or its energy equivalent fed per day per cow before calving and increased to 14 $kg \cdot d^{-1} \cdot cow^{-1}$ after calving. Cows were put on crested wheatgrass pasture the 1st wk of May and then moved to a foothill bunchgrass type of summer pasture the last week of May. The summer pasture averaged 480 mm of annual precipitation and 1,200 m in altitude. Vegetation included rough fescue, Idaho fescue, and bluebunch wheatgrass with interspersed areas of ponderosa pine. Terrain varied from level to very steep areas and the stocking rate was 1.1 ha per animal-unit-month.

Calf traits (or cow/calf traits) studied were birth weight, proportion calving difficulty, weaning weight, weaning hip height, weaning weight:height ratio, weaning condition score, milk production at 40 d (early) and 130 d (late) of lactation, and change in milk production (early minus late). Proportion calving difficulty was coded 0 for no assistance and 1 for when assistance was required (varying from slight assistance required to a hard pull with mechanical calf puller). Condition was visually scored from 1 to 9 (9 = very fat) by two technicians and then averaged. The weigh-suckle-weigh technique, as described by Williams et al. (1979), was used to measure milk production. The separation interval was 6 h at 40 d and varied from 6 to 10 h at 130 d of lactation. All estimates of milk production were converted to a 24-h basis. Cow traits were weights (measured on the same day for all cows) at four times during the year (precalving, prebreeding, postbreeding, and weaning), weight changes, hip height at weaning, condition score (1 to 9) at weaning, calf weaning weight per unit of cow weight at weaning, proportion calved and weaned, and calf weaning weight per cow exposed to breeding.

Table 1. Design and number of observations

	Breed of dam	
Breed of sire	Hereford	Tarentaise
Hereford	151	73
Tarentaise	103	130

Traits were analyzed by General Linear Model procedure (SAS, 1985) assuming a model with fixed effects of year, age of dam (2, 3, 4, and 5+ yr), breed of dam, breed of sire, sex, breed of dam × breed of sire interaction, linear regression on day of birth, and random components of dam's sire within breed of dam (error term for breed of dam), calf's sire within breed of sire (error term for breed of sire), and residual. Preliminary analyses indicated that two-way interactions other than breed of dam × breed of sire were not important. Individual heterosis (average of reciprocals minus midparent average) was estimated by a linear contrast among the breed of dam × breed of sire interaction subclass least squares means. The model for proportion calved, proportion weaned, and calf weaning weight per cow exposed only included year, age of dam, breed of dam, and dam's sire within breed of dam because these traits were based on all cows that were exposed to breeding.

Table 2. Probability values from analysis of variance for calf traits and milk production

Source	df	Birth wt	Prop. calv. diff[a]	Weaning wt	Weaning hip ht	Condition score	Weaning wt:ht	MP1[b]	MP2[b]	MPD[b]
Year	4	.34	.53	.00	.25	.00	.00	.01	.00	.00
Age dam	3	.00	.00	.00	.11	.00	.00	.07	.06	.27
Breed dam (BD)	1	.64	.99	.00	.00	.03	.00	.18	.00	.03
Dam sire/BD	48	.01	.60	.00	.00	.00	.00	.04	.11	.81
Breed sire (BS)	1	.83	.18	.63	.05	.46	.23	.93	.63	.72
Calf sire/BS	31	.03	.19	.00	.01	.02	.04	.85	.57	.76
Sex	1	.00	.01	.00	.41	.00	.00	.73	.59	.85
BD × BS	1	.01	.11	.00	.00	.06	.00	.92	.80	.78
Reg. day birth	1	.01	.51	.00	.00	.00	.00	.51	.71	.85

[a]Scored 0 for no assistance and 1 for assistance.
[b]Early (MP1) and late (MP2) lactation 24-h milk production, and early minus late (MPD) milk production.

Table 3. Least squares means and individual heterosis for calf traits and milk production

Item	Birth wt, kg	Prop. calv. diff[a]	Weaning wt, kg	Weaning hip ht, cm	Cond. score	Weaning wt:ht, kg/cm	MP 1, kg[b]	MP2, kg[b]	MPD, kg[b]
Breed of dam									
Hereford	41.0 ± .80	.22 ± .06	216 ± 5.7[c]	108.5 ± .61[c]	5.45 ± .18[c]	1.96 ± .037[c]	9.3 ± .82	6.2 ± .86[c]	3.1 ± .83[c]
Tarentaise	40.6 ± .63	.22 ± .06	236 ± 4.5[d]	111.2 ± .55[d]	5.87 ± .14[d]	2.10 ± .033[d]	10.4 ± .50	9.3 ± .53[d]	1.2 ± .51[d]
Breed of sire									
Hereford	40.9 ± .84	.27 ± .07	227 ± 4.6	109.1 ± .64[c]	5.72 ± .15	2.05 ± .029	9.8 ± .49	7.6 ± .61	2.3 ± .70
Tarentaise	40.7 ± .62	.17 ± .05	224 ± 3.4	110.6 ± .45[d]	5.60 ± .11	2.01 ± .020	9.9 ± .42	7.9 ± .53	2.0 ± .60
Sex									
Heifer	39.3 ± .50[c]	.17 ± .05[c]	219 ± 2.4[c]	110.0 ± .35	5.80 ± .08[c]	1.96 ± .017[c]	9.8 ± .49	7.6 ± .54	2.2 ± .66
Bull	42.3 ± .49[d]	.27 ± .05[d]	233 ± 2.3[d]	109.7 ± .35	5.53 ± .08[d]	2.11 ± .017[d]	9.9 ± .48	7.8 ± .54	2.1 ± .66
Heterosis	1.05 ± .42	.06 ± .04	11.04 ± 2.01	1.05 ± .36	.13 ± .07	.06 ± .017	.04 ± .41	−.11 ± .45	.15 ± .55

[a]Scored 0 for no assistance and 1 for assistance.
[b]Early (MP1) and late (MP2) lactation 24-h milk production, and early minus late (MPD) milk production.
[c,d]Within classification, means with different superscripts differ ($P < .05$).

Results and Discussion

The fixed effects of year, age of dam, and sex were significant for most of the calf traits and milk production, except that sex was not significant for any measure of milk production (Table 2). Breed of sire was significant only for calf hip height at weaning. Gregory et al. (1979) reported that the difference between Hereford × Angus and Tarentaise × Angus calves was not important for birth weight but was significant for weaning weight in favor of Tarentaise × Angus calves, even though the difference was only 7 kg (210 vs 217 kg).

Breed of dam was important ($P < .05$) for calf weaning weight, weaning hip height, weaning condition score, weaning weight:height ratio, late milk production, and change in milk production (Table 2). Least squares means for Hereford and Tarentaise dams are shown in Table 3 for all traits. Tarentaise dams weaned heavier calves, taller calves, and calves with greater condition than Hereford dams. This is in agreement with Cundiff et al. (1981), who reported that Tarentaise × Hereford and Tarentaise × Angus dams weaned calves that were 21.8 kg heavier than calves from Angus × Hereford and Hereford × Angus dams. Tarentaise dams of the present study averaged 2.0 kg more milk (averaged over early and late) than the Hereford dams. Cundiff et al. (1981) reported that Tarentaise-cross dams produced 3.6 kg more milk (averaged over three milk estimates as 3-yr-olds) than Hereford × Angus and Angus × Hereford dams. Tarentaise dams of the present study maintained their milk production into later lactation better than the Hereford dams.

The breed of dam × breed of sire interaction (heterosis) was important ($P < .01$) for calf birth weight, weaning weight, weaning height, and weaning weight:height ratio and approached significance ($P = .06$) for calf condition score at weaning (Table 2). Estimates of individual heterosis for traits measured on calves and for milk production are presented in

Table 4. Breed of dam by breed of sire least squares means for calf traits

Trait	Breed of sire	Breed of dam: Hereford	Breed of dam: Tarentaise
Birth wt, kg	Hereford	40.6	41.2
	Tarentaise	41.4	40.0
Weaning wt, kg	Hereford	211	242
	Tarentaise	220	229
Weaning hip ht, cm	Hereford	107.2	110.9
	Tarentaise	109.8	111.4
Condition score	Hereford	5.45	6.00
	Tarentaise	5.46	5.74
Weaning wt:ht, kg/cm	Hereford	1.95	2.16
	Tarentaise	1.97	2.05

Table 5. Probability values from analysis of variance for cow traits[a]

Source	df	Cow weight				Cow cond score	Cow hip ht	Cow wt:ht ratio	Calf wt:cow wt ratio	Prop. calv.	Prop. wned.	Calf WW/CE
		Pre-calv.	Pre-brd.	Post-brd.	Weaning							
Year	4	.74	.02	.00	.00	.01	.00	.00	.02	.58	.79	.32
Age dam	3	.00	.00	.00	.00	.00	.02	.00	.02	.01	.05	.00
Breed dam (BD)	1	.00	.00	.00	.00	.00	.60	.00	.00	.39	.45	.38
Dam sire/BD	48	.00	.00	.00	.00	.00	.00	.00	.00	.86	.64	.38
Breed sire (BS)	1	.73	.59	.87	.79	.83	.59	.97	.59	—	—	—
Calf sire/BS	31	.33	.50	.17	.25	.17	.01	.44	.01	—	—	—
Sex	1	.95	.32	.53	.08	.12	.21	.08	.00	—	—	—
BD × BS	1	.60	.26	.49	.38	.18	.13	.08	.00	—	—	—
Reg. day birth	1	.63	.41	.21	.19	.19	.01	.63	.00	—	—	—

[a]Traits that are abbreviated are defined in Table 6.

Table 3. Percentage heterosis was 3% for birth weight, 5% for weaning weight, 1% for weaning height, 3% for weight:height ratio, and 2% for condition score. These estimates are nearly identical to averages reported for crosses among *Bos taurus* breeds for birth weight and weaning weight (Long, 1980) and suggest that individual heterosis values for crosses with Tarentaise will be similar to those for other *Bos taurus* breeds. None of the estimates of heterosis for milk production was significant, indicating that crossbred calves did not stimulate their dams to produce more milk. Table 4 shows the least squares means for the breed of dam × breed of sire subclasses for traits that exhibited a significant breed of dam × breed of sire interaction. These subclass means were the basis for estimating individual heterosis.

Year was a significant source of variation for all cow traits except precalving weight, proportion calved, proportion weaned, and calf weaning weight per cow exposed (Table 5). Age of dam was significant for all cow traits except weight change (ANOVA for weight changes are not presented) from postbreeding to weaning. Sex of calf was significant for calf weight per unit of cow weight at weaning, cow weight changes from precalving to prebreeding, precalving to weaning, and postbreeding to weaning and approached significance for cow weight at weaning ($P = .08$), cow weight:height ratio at weaning ($P = .08$), and cow condition score ($P = .12$), indicating that cows raising bull calves gained less weight during periods after calving, had lower condition scores at weaning (5.49 vs 5.37), and had lower weights at weaning (537 vs 529 kg).

Breed of dam was significant for cow weights at precalving, prebreeding, postbreeding, and weaning (but not for weight changes), cow condition score, cow weight:height ratio, and calf weight at weaning per unit of cow weight (Table 5). Table 6 contains least squares means for each breed of dam. Hereford dams were consistently 48 to 52 kg heavier during the year and had greater condition, but were only .6 cm taller than Tarentaise dams. Cundiff et al. (1981) reported 5-yr-old cow traits for the average of Hereford × Angus and Angus × Hereford vs the average of Tarentaise × Hereford and Tarentaise × Angus of 544 vs 540 for cow weight, 123.4 vs 127.0 cm for hip height, and 7.1 vs 6.5 for condition score. Not only was breed of dam important for calf weaning weight per unit of cow weight at weaning, but individual heterosis was also significant (.024 ± .005) at 5.8%. Breed of dam

Table 6. Least squares means for cow traits by breed of dam

Trait	Hereford	Tarentaise
Cow weights, kg		
Precalving	560 ± 12.1[a]	512 ± 9.5[b]
Prebreeding	515 ± 13.0[a]	466 ± 10.3[b]
Postbreeding	562 ± 12.7[a]	510 ± 10.0[b]
Weaning	559 ± 12.8[a]	507 ± 10.1[b]
Cow hip height, cm	131.1 ± 1.04	130.5 ± .82
Body condition score	6.0 ± .20[a]	4.9 ± .15[b]
Weight:height ratio, kg/cm	4.3 ± .08[a]	3.9 ± .06[b]
Calf wt:cow wt ratio	.39 ± .008[a]	.47 ± .007[b]
Proportion calved	.820 ± .039	.781 ± .025
Proportion weaned	.810 ± .045	.771 ± .029
Calf wn wt:cow exposed, kg	171 ± 10.8	182 ± 7.0

[a,b]Means in a row with different superscripts differ ($P < .05$).

differences were not significant for proportion calved, proportion weaned, or calf weaning weight per cow exposed to breeding.

Implications

Crosses with Tarentaise cattle should yield levels of heterosis for calf preweaning growth and fatness similar to those observed from other *Bos taurus* breeds. Cow weights and heights indicate that Tarentaise cattle would work well in rotational crossbreeding systems with British breeds. In an environment that will support moderate levels of milk production and small to intermediate cow size, Tarentaise would cross particularly well with those British breeds with lower levels of milk production. Tarentaise crossed with other Continental breeds might be considered in situations in which breeders want to maintain milk production at the Continental breed level but reduce cow size.

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