1988

INTERACTION OF MATERNAL GRANDSIRE WITH REGION OF UNITED STATES AND HERD FOR CALVING EASE, BIRTH WEIGHT AND 205-DAY WEIGHT

K. J. Hanford
Montana State University-Bozeman, kathy.hanford@unl.edu

P. J. Burfening
Montana State University-Bozeman

D. D. Kress
Montana State University-Bozeman

Stephen D. Kachman
University of Nebraska-Lincoln, steve.kachman@unl.edu

INTERACTION OF MATERNAL GRANDSIRE WITH REGION OF UNITED STATES AND HERD FOR CALVING EASE, BIRTH WEIGHT AND 205-DAY WEIGHT[1]

K. J. Hanford, P. J. Burfening, D. D. Kress and S. D. Kachman[2]

Montana State University, Bozeman 59717

ABSTRACT

Field records supplied by the American Simmental Association from 2-yr-old dams were used to study maternal grandsire X region of the U.S. and maternal grandsire X herd within region (herd/region) interactions. Regions were 1) Montana, North Dakota and South Dakota, 2) Kansas and Nebraska, 3) Texas and Oklahoma and 4) Alabama, Florida, Georgia, Louisiana and Mississippi. Analyses were conducted pairwise with respect to region with the following number of animals in each comparison: 1 (3,964) vs 2 (2,239), 1 (3,996) vs 3 (1,660), 1 (3,418) vs 4 (474), 2 (2,033) vs 3 (1,709), 2 (1,666) vs 4 (443) and 3 (1,372) vs 4 (430). Independent variables were the fixed effects of region, sex of calf, Simmental percentage of the calf (75 to 88%) and the random effects of herd/region, maternal grandsire, maternal grandsire X region and maternal grandsire X herd/region. Records were adjusted to account for the direct effect of maternal grandsire in the maternal grandsire component. Dependent variables were calving ease score, birth weight and 205-d weight. Region was significant in all analyses except for 1 vs 2, 1 vs 3 and 2 vs 3 for calving ease score and 2 vs 3 for birth weight and 205-d weight. Herd/region was significant in all analyses. Maternal grandsire was significant in all analyses for calving ease score and birth weight and for 1 vs 2 for 205-d weight. Maternal grandsire X region was not significant in any analysis. Maternal grandsire X herd/region was significant in four of six analyses for birth weight and 205-d weight, but was not significant in any analysis for calving ease score. Maternal grandsire, maternal grandsire X region interaction and maternal grandsire X herd/region interaction accounted for an average of 4, 0 and 1%; 3, 0 and 5%; and 0, 0 and 3% of the total variation for calving ease, birth weight and 205-d weight, respectively. Genetic correlations of maternal grandsires' progeny performance in different herds ranged from .20 to .74 for birth weight and from .05 to .34 for 205-d weight, indicating significant changes in rank from herd to herd.

(Key Words: Interactions, Regions, Calving, Growth Rate, Maternal Effects.)

Introduction

The effect of genotype X environment interactions on the estimation of breeding values for direct effects in growth rate and calving ease in bulls used widely in artificial insemination has been studied. Nunn et al. (1978) and Buchanan and Nielsen (1979) reported significant sire X region of the U.S. interactions for weaning weight. However, when Tess et al. (1979) included sire X herd within region (herd/region) along with sire X region in the model, sire X region no longer was important, but sire X herd/region was a significant source of variation for weaning weight. Burfening et al. (1982) also observed that sire X region was not a significant source of variation for calving ease score or birth weight, but sire X herd/region was significant when both interactions were included in the model. Sire X herd interaction (Legates et al., 1956; Mao and Burnside, 1969) and sire X region interaction (Lytton and Legates, 1966) have been studied in dairy cattle for milk production traits of sire's daughters. Those interactions reported were essentially zero. In beef cattle, no information is available on genotype X environment interactions involving breeding values for maternal effects (growth rates and calving ease of sire's daughter's calves) and how these may influence the ranking of sires for these maternally influenced traits. One approach to evaluating the sire ranking for maternal effect is by evaluating the maternal grandsire of the calf

[1] Published with the approval of the Director of the Montana Agric. Exp. Sta., Journal Series No. J-1966.

[2] The authors wish to thank the American Simmental Association for supplying the records used in this study.

Received September 21, 1987.

Accepted January 12, 1988.

and the maternal grandsire X environment interactions.

The objectives of this study were to evaluate the importance of maternal grandsire, maternal grandsire X region interaction and maternal grandsire X herd/region interaction for calving ease, birth weight and 205-d weight.

Materials and Methods

Records supplied by the American Simmental Association from 2-yr-old dams were used in these analyses. Only records from 2-yr-old (1 yr, 9 mo to 2 yr, 9 mo of age) dams were used because when calving ease was studied as a trait of the calf, variation of age of dam groups was heterogeneous (Burfening et al., 1979) and because selection of dams may have been practiced based on their calving and weaning performance as 2-yr-olds. Contemporary groups or herds were classified according to the procedure outlined by Burfening et al. (1982). Calves within a breeder's herd were sorted on the basis of birth date, and calves born within 90 d of the first birth date were assigned to the same contemporary group. Calves with consecutive birth dates with more than 45 d between their birth dates were assigned to different contemporary groups. Regions, representing a broad cross-section of environments, were formed on the basis of geographic location and number of records in a region. The regions were 1) Montana, North Dakota and South Dakota, 2) Kansas and Nebraska, 3) Texas and Oklahoma and 4) Alabama, Florida, Georgia, Louisiana and Mississippi.

Analyses were conducted pairwise with respect to region due to the limited capacity of the least squares mixed-model program (Harvey, 1977). This was necessary in order to fit both maternal grandsire and maternal grandsire X region interaction effects.

Each herd was required to have grandprogeny of at least two maternal grandsires. Further restrictions on number of progeny per maternal grandsire X region subclass were made for each of the comparisons in order to reduce the number of maternal grandsires to the capacity of the program. The number of records, minimum progeny per maternal grandsire X region subclass, number of maternal grandsires and number of herds for each pair of analyses are shown in Table 1. Each maternal grandsire was required to have records in both regions for the pairwise analyses.

Traits such as calving ease, birth weight and 205-d weight are influenced by both the genes the cow transmits and by the maternal environment she provides (Koch and Clark, 1955). Half the genes that influence the direct effect associated with the maternal traits are contributed by the cow's sire (the offspring's maternal grandsire). These genes also may influence the maternal environment. In order to ensure that the maternal grandsire variance component more precisely estimated the maternal environmental component, each record was adjusted to account for the maternal grandsire's influence on the direct effect associated with the maternal traits. This adjustment was accomplished by calculating a correction factor (CF) for each trait for

TABLE 1. NUMBER OF PROGENY, NUMBER OF MATERNAL GRANDSIRES (MGSIRE), NUMBER OF HERDS AND *K*-VALUES FOR EACH ANALYSIS

Item	Regional comparisons[a]					
	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4
Total progeny	6,203	5,656	3,892	3,742	2,109	1,802
Region A	3,964	3,996	3,418	2,033	1,666	1,372
Region B	2,239	1,660	474	1,709	443	430
No. of MGSire	39	35	30	39	29	28
No. of herds	800	737	468	605	388	315
Min. no. of progeny/MGSire X region subclass	15	10	5	8	5	5
K-values						
MGSire (k_8)	95.8	99.3	76.0	60.0	42.1	40.3
MGSire X region (k_5)	46.6	52.1	31.4	30.6	28.2	20.2
MGSire X herd/region (k_3)	2.2	2.2	2.3	1.8	1.8	1.8

[a]Region 1 = MT, ND, SD; region 2 = KS, NE; region 3 = TX, OK; region 4 = AL, FL, GA, LA, MS.

each maternal grandsire. Expected progeny differences (American Simmental Association, 1983) were reported in ratios. Because low scores for calving ease and low birth weights were considered to be desirable, ratios for values of calving ease scores and birth weights below the breed average were above 100. Whereas heavy 205-d weights were considered to be desirable, ratios for values of 205-d weights above the breed average were above 100. The following equation was used to convert the ratios to the units of measure used in these analyses and to calculate CF:

$$CF = ((100 - BVR) \cdot EPDU)/2$$

where CF = the correction factor to adjust each calf's record for its maternal grandsire's direct effect for the traits under consideration, BVR = the breeding value ratio for the direct effect of calving ease score, birth weight or 205-d weight for the calf's maternal grandsire and EPDU = the value in the units of measure for a one percentage point change in ratio for that trait (.016 for calving ease score for first calf, .38 kg for age of dam adjusted birth weight and 2.33 kg for 205-d weight).

All analyses were conducted by the mixed-model least squares procedure (Harvey, 1977; W. R. Harvey, personal communication). Dependent variables were calving ease, birth weight and 205-d weight. Calving ease was scored as follows: 1 = no assistance; 2 = easy pull; 3 = hard pull (usually with a mechanical puller), and 4 = Caesarean. The model included the fixed effects of region, Simmental percentage of calf (75 or 88%) and sex of calf. Random effects were herd/region, maternal grandsire, maternal grandsire × region interaction, maternal grandsire × herd/region interaction and residual. The variance-covariance matrix for maternal grandsire effects was assumed to be $I\sigma^2$. The expected mean squares for the model with unequal subclass numbers are shown in Table 2. As can be seen from Table 2, there was no appropriate mean square for testing the statistical significance of region. However, estimates of the maternal grandsire × region variance component were either close to zero or negative for all analyses. Therefore, the maternal grandsire × region variance component was assumed to be zero, and the herd/region mean square was used for testing region because the maternal grandsire × region variance component was the only additional variance component present in the expected mean squares for region. If the maternal grandsire × region variance component actually was not zero, then the test conducted would cause region to test significant more often than if an exact test were possible, due to the underestimation of the error term used. Herd/region and maternal grandsire × region were tested over maternal grandsire × herd/region. Maternal grandsire was tested over maternal grandsire × herd/region. Maternal grandsire × herd/region, sex of calf and Simmental percentage of calf were tested over residual.

Variance components and their coefficients were estimated for each random effect (Harvey,

TABLE 2. EXPECTED MEAN SQUARES (EMS)

Source	EMS
Region	$\sigma_e^2 + k_{11}\sigma^2_{MH/R} + k_{12}\sigma^2_{MR} + k_{13}\sigma^2_{H/R} + k_{14}\sigma^2_R$
Herd/region	$\sigma_e^2 + k_9\sigma^2_{MH/R} + k_{10}\sigma^2_{H/R}$
MGSire[b]	$\sigma_e^2 + k_6\sigma^2_{MH/R} + k_7\sigma^{2\,a}_{MR} + k_8\sigma^2_M$
MGSire × region	$\sigma_e^2 + k_4\sigma^2_{MH/R} + k_5\sigma^2_{MR}$
MGSire × herd/region	$\sigma_e^2 + k_3\sigma^2_{MH/R}$
Sex of calf	$\sigma_e^2 + k_2\sigma_x^2$
Simmental percentage of calf	$\sigma_e^2 + k_1\sigma_p^2$
Residual	σ_e^2

[a]Not in expectation with equal subclass numbers.

[b]Maternal grandsire.

1977; W. R. Harvey, personal communication). Total variance was estimated as the sum of the variance components for maternal grandsire, herd/region, maternal grandsire X region interaction, maternal grandsire X herd/region interaction and residual. Percentage of the total variation attributed to these different variance components was calculated using a weighted average based on the total number of progeny in each analysis presented in Table 1. Genetic correlations (Yamada, 1962) between maternal grandsire's progeny performance in different herds within region were calculated according to:

$$r_{g_{MH/R}} = \frac{\hat{\sigma}^2_M}{\hat{\sigma}^2_M + \hat{\sigma}^2_{MH/R}}$$

which assumes that the maternal grandsire by region variance component is zero.

Results and Discussion

Region was a significant source of variation in three analyses for calving ease score and in all but one analysis for both birth weight and 205-d weight (Table 3). The least square means for the three traits for each region in each pair of analyses are shown in Table 4. Adjusting for the maternal grandsire's influence on the direct effect did not appreciably change the least square means for the effect of region for the three traits from those reported in Hanford et al. (1985) with the same data. There was a trend for calving ease, birth weight and 205-d weight to decrease from northern to southern regions; region 4 had the lowest calving ease, birth weight and 205-d weight. These results are similar to those reported by Burfening et al. (1982) in which sire X location interactions were analyzed, except that the least square means for calving ease score were larger than those shown in Table 4.

Simmental percentage of the calf (Table 3) was not a significant source of variation in any analysis for calving ease or 205-d weight. However, it was significant in three of six analyses for birth weight. These results are different from those reported earlier (Burfening et al., 1979; Burfening et al., 1982) in which Simmental percentage was significant in all comparisons for calving ease. However, the Simmental percentage of the calves in those studies was 50 and 75%, respectively. Sex was a significant source of variation in all analyses, which is similar to the findings of Burfening et al. (1982).

Herd/region was a significant source of variation in all analyses (Table 3); the variance component for herd/region (weighted average over all comparisons) accounted for 17, 28 and 51% of the total variation for calving ease score, birth weight and 205-d weight, respectively (Table 5). These results are similar to those given for calving ease score and birth weight by Burfening et al. (1982).

Maternal grandsire was significant in all analyses for calving ease score and birth weight and for 1 vs 2 for 205-d weight. These results are similar to those reported by Hanford et al. (1985) in which the maternal grandsire component was not adjusted for the direct effect. This indicates that the adjustment of the traits for the direct effect of maternal grandsire probably is not necessary in order to evaluate effectively the three traits in this study. Maternal grandsire accounted for 4, 3 and 0% of the total variation for calving ease score, birth weight and 205-d weight, respectively. These results again are similar to those reported by Hanford et al. (1985) of 4% and 0% for calving ease score and 205-d weight, respectively, but are slightly higher than the 2% for birth weight. The maternal grandsire percentage was higher for calving ease and similar for birth weight percentages reported for the sire component for 2-yr-old dams (Burfening et al., 1979; Burfening et al., 1982).

The maternal grandsire X region interaction was not significant in any analysis. Its variance components were essentially zero for all three traits, which agrees with earlier findings for the sire X region interaction variance component in which the sire X herd/region interaction effect also was in the model (Tess et al., 1979; Burfening et al., 1982).

The maternal grandsire X herd/region interaction was not a significant source of variation in any analysis for calving ease score, but it was significant in four of six analyses for birth weight and 205-d weight. This interaction accounted for 1, 5 and 3% of the total of the weighted average variance components for calving ease, birth weight and 205-d weight, respectively. The genetic correlations between maternal grandsire's progeny performance in different herds within region (Table 6) ranged from .55 to .90 for calving ease score, .20 to .74 for birth weight and from .05 to .34 for 205-d weight. The significant maternal grand-

TABLE 3. LEAST SQUARES ANALYSES OF VARIANCE FOR CALVING EASE (SCORES), BIRTH WEIGHT AND 205-D WEIGHT

Item	Regional comparisons: 1 vs 2 df[a]	1 vs 2 MS[b]	1 vs 3 df	1 vs 3 MS	1 vs 4 df	1 vs 4 MS	2 vs 3 df	2 vs 3 MS	2 vs 4 df	2 vs 4 MS	3 vs 4 df	3 vs 4 MS
Calving ease (score)[d]												
Region	1	.91	1	8.36	1	51.53**	1	.72	1	32.41**	1	19.43**
Herd/region	798	1.46**	735	1.72**	466	1.66**	603	1.39**	336	1.08**	313	1.39**
MGSire[c]	38	3.95**	34	3.85**	29	3.12**	38	2.29**	28	1.66**	27	1.55**
MGSire × region	38	.75	34	.56	29	.33	38	.56	28	.37	27	.48
MGSire × herd/region	1,528	.62	1,425	.64	865	.66	1,103	.54	565	.52	539	.54
Sex of calf	2	67.77**	2	42.79**	2	37.51**	2	34.52**	2	20.63**	2	6.21**
Simmental percentage	1	2.81	1	2.83	1	3.23	1	.23	1	.22	1	.04
Residual	3,796	.61	3,423	.61	2,498	.59	1,955	.59	1,147	.56	891	.52
Birth wt, kg												
Region	1	1,624.2**	1	3,152.9**	1	3,570.5**	1	49.1	1	711.0**	1	345.6**
Herd/region	798	58.7**	735	55.7**	466	58.1**	603	58.4**	336	59.1**	313	50.8**
MGSire	38	63.8**	34	70.4**	29	49.3**	38	51.9**	28	37.7**	27	54.8**
MGSire × region	38	15.7	34	19.0	29	12.7	38	15.6	28	13.6	27	11.4
MGSire × herd/region	1,528	16.6**	1,425	15.9**	865	15.1**	1,103	17.5	565	16.8**	539	15.9
Sex of calf	2	2,026.5**	2	1,904.4**	2	1,424.1**	2	1,019.7**	2	558.2**	2	443.2**
Simmental percentage	1	240.9**	1	105.7**	1	59.5	1	112.2**	1	31.6	1	14.4
Residual	3,796	14.0	3,423	14.0	2,498	13.0	1,955	15.6	1,147	14.1	891	15.3
205-d wt, kg												
Region	1	50,293.6**	1	118,776.9**	1	193,990.2**	1	3,483.0	1	117,234.7**	1	38,121.7**
Herd/region	798	4,321.1**	735	3,809.5**	466	3,528.6**	603	4,627.3**	336	5,381.3**	313	4,265.4**
MGSire	38	1,340.4**	34	1,098.2	29	1,094.4	38	943.0	28	823.9	27	734.9
MGSire × region	38	270.5	34	762.6	29	590.5	38	724.1	28	858.7	27	863.5
MGSire × herd/region	1,528	532.7**	1,425	568.2**	865	544.5**	1,103	578.8	565	572.5	539	613.8**
Sex of calf	2	73,618.3**	2	55,215.9**	2	46,611.0**	2	32,686.6**	2	26,322.7**	2	14,362.1**
Simmental percentage	1	638.8	1	1,290.8	1	77.0	1	996.2	1	9.1	1	85.1
Residual	3,796	484.3	3,423	460.8	2,498	448.7	1,955	521.7	1,147	538.1	891	510.9

[a] Degrees of freedom.

[b] Mean squares.

[c] Maternal grandsire.

[d] *Calving ease scores: 1 = no assistance; 2 = easy pull; 3 = hard pull (usually with a mechanical puller); 4 = caesarean.*

$^{**}P < .01$.

TABLE 4. LEAST SQUARES MEANS ± SE FOR THE EFFECT OF REGION OF THE UNITED STATES[a] ON CALVING EASE, BIRTH WEIGHT AND 205-D WEIGHT

	Regional comparisons					
Region A vs Region B	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4
	Calving ease (score)[d]					
$\hat{\mu}$	1.76 ± .02	1.79 ± .02	1.63 ± .03	1.74 ± .02	1.60 ± .03	1.54 ± .03
A	1.78 ± .02[b]	1.83 ± .02[b]	1.81 ± .02[b]	1.76 ± .03[b]	1.77 ± .03[b]	1.67 ± .04[b]
B	1.75 ± .02[b]	1.74 ± .03[c]	1.44 ± .04[c]	1.73 ± .03[b]	1.43 ± .04[c]	1.41 ± .05[c]
	Birth wt, kg					
$\hat{\mu}$	37.0 ± .1	37.0 ± .1	36.2 ± .1	36.4 ± .1	35.4 ± .2	35.2 ± .2
A	37.6 ± .1[b]	37.9 ± .1[b]	37.7 ± .1[b]	36.5 ± .2[b]	36.2 ± .2[b]	35.8 ± .2[b]
B	36.4 ± .1[c]	36.2 ± .1[c]	34.6 ± .2[c]	36.3 ± .2[b]	34.6 ± .3[c]	34.7 ± .3[c]
	205-d wt, kg					
$\hat{\mu}$	221.7 ± .6	218.8 ± .6	212.8 ± .9	216.2 ± .9	209.1 ± 1.4	205.3 ± 1.4
A	225.0 ± .7[b]	224.0 ± .7[b]	224.2 ± .8[b]	217.3 ± 1.1[b]	219.2 ± 1.5[b]	211.2 ± 1.5[b]
B	218.5 ± .8[c]	213.6 ± .9[c]	201.4 ± 1.5[c]	215.1 ± 1.2[b]	199.0 ± 2.0[c]	199.4 ± 2.0[c]

[a]Region 1 = MT, ND, SD; region 2 = KS, NE; region 3 = TX, OK; region 4 = AL, FL, GA, LA, MS.

[b,c]Means with different superscripts within each column for each dependent variable differ ($P < .05$).

[d]Calving ease scores: 1 = no assistance; 2 = easy pull; 3 = hard pull (usually with a mechanical puller); 4 = caesarean.

TABLE 5. ESTIMATED VARIANCE COMPONENTS AND PERCENTAGE OF THE TOTAL VARIATION FOR CALVING EASE, BIRTH WEIGHT AND 205-D WEIGHT

Item	Regional comparisons[a] 1 vs 2		1 vs 3		1 vs 4		2 vs 3		2 vs 4		3 vs 4		Weighted average	
	Comp	%	Comp	%	Comp	%	Comp	%	Comp	%	Comp	%	Comp	%
Calving ease (score)[c]														
Herd/region	.117	15	.150	19	.125	16	.141	19	.094	14	.165	23	.132	17
MGSire[b]	.033	4	.033	4	.038	5	.029	4	.029	4	.026	4	.032	4
MGSire X region	.003	0	−.002	0	−.011	−1	.001	0	−.005	−1	−.004	−1	−.002	0
MGSire X herd/region	.004	1	.012	2	.031	4	−.025	−3	−.023	−4	.015	2	.004	1
Residual	.607	80	.613	76	.590	76	.589	80	.560	85	.518	72	.592	79
Birth wt, kg														
Herd/region	5.67	27	5.48	26	5.48	28	7.14	29	7.39	32	6.79	29	6.07	28
MGSire	.50	2	.51	2	.48	2	.59	2	.50	2	1.07	5	.58	3
MGSire X region	−.05	0	.04	0	−.08	0	−.10	0	−.15	−1	−.24	−1	−.06	0
MGSire X herd/region	1.18	6	.86	4	.94	5	1.03	4	1.47	6	.37	2	1.00	5
Residual	13.99	66	14.03	67	12.92	66	15.57	64	14.09	60	15.26	66	14.18	65
205-d wt, kg														
Herd/region	520.03	50	448.41	47	383.12	44	711.31	56	858.92	60	709.91	55	555.70	51
MGSire	11.19	1	3.08	0	5.53	1	3.46	0	2.21	0	−4.06	0	5.07	0
MGSire X region	−6.20	−1	2.61	0	1.14	0	3.66	0	9.72	1	10.57	1	1.45	0
MGSire X herd/region	22.01	2	48.94	5	41.15	5	30.90	2	18.88	1	58.67	5	35.67	3
Residual	484.26	47	460.80	48	448.66	51	521.70	41	538.14	38	510.90	40	485.56	45

[a]Region 1 = MT, ND, SD; region 2 = KS, NE; region 3 = TX, OK; region 4 = AL, FL, GA, LA, MS.

[b]Maternal grandsire.

[c]Calving ease scores: 1 = no assistance; 2 = easy pull; 3 = hard pull (usually with a mechanical puller); 4 = caesarean.

TABLE 6. GENETIC CORRELATIONS BETWEEN MATERNAL GRANDSIRES' PROGENY PERFORMANCE IN DIFFERENT HERDS WITHIN REGION FOR CALVING EASE SCORE, BIRTH WEIGHT AND 205-D WEIGHT

	Regional comparisons[a]					
Trait	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4
Calving ease score[b]	.90	.73	.55	NC[c]	NC	.64
Birth weight, kg	.30	.37	.34	.37	.20	.74
205-d weight, kg	.34	.06	.12	.10	.05	NC[c]

[a]Region 1 = MT, ND, SD; region 2 = KS, NE; region 3 = TX, OK; region 4 = AL, FL, GA, LA, MS.

[b]Calving ease scores: 1 = no assistance; 2 = easy pull; 3 = hard pull (usually with a mechanical puller); 4 = caesarean.

[c]NC = Not calculated due to negative variance component estimates.

sire X herd/region interaction and the low genetic correlations indicated that different maternal grandsire progeny did not rank the same in different herds for birth weight and 205-d weight. Differences between herds in management, nutrition and other environmental factors may account for this result. If the factors that created this interaction can be identified, it should be possible to predict more accurately the genetic worth of a potential sire in a particular herd.

In these analyses, the maternal grandsire effect was adjusted to account for half the direct effect associated with the maternal traits of calving ease score, birth weight and 205-d weight. However, these adjustments did not significantly change the results compared with analyses in which the maternal grandsire effect was not adjusted. The producer sees and evaluates unadjusted maternal traits. Because no maternal grandsire X region of the U.S. interaction was observed in the evaluation of breeding values for these maternally influenced traits, maternal grandsire rankings are not expected to differ among regional environments studied, even though differences existed among regions of the U.S.

Literature Cited

American Simmental Association. 1983. National Sire Summary. Bozeman, MT.

Buchanan, D. S. and M. K. Nielsen. 1979. Sire by environment interactions in beef cattle field data. J. Anim. Sci. 48:307.

Burfening, P. J., D. D. Kress, R. L. Friedrich and D. Vaniman. 1979. Ranking sires for calving ease. J. Anim. Sci. 48:293.

Burfening, P. J., D. D. Kress and R. L. Friedrich. 1982. Sire X region of United States and herd interactions for calving ease and birth weight. J. Anim. Sci. 55:765.

Hanford, K. J., P. J. Burfening and D. D. Kress. 1985. Interaction of maternal grandsire with region of United States and herd for calving ease, birth weight and 205-day weight. Proc. West. Sec. Am. Soc. Anim. Sci. 36:15.

Harvey, W. R. 1977. User's guide for LSML76 mixed model least-squares and maximum likelihood computer program. Ohio State Univ., Columbus (Mimeo.).

Koch, R. M. and R. T. Clark. 1955. Genetic and environmental relationships among economic characters in beef cattle. III. Evaluating maternal environment. J. Anim. Sci. 14:979.

Legates, J. E., F. J. Verlinden and J. F. Kendrick. 1956. Sire by herd interaction in production traits in dairy cattle. J. Dairy Sci. 39:1055.

Lytton, V. H. and J. E. Legates. 1966. Sires by region interaction for production traits in dairy cattle. J. Dairy Sci. 49:874.

Mao, I. L. and E. B. Burnside. 1969. Sire by herd environment interaction for milk production. J. Dairy Sci. 52:1055.

Nunn, T. R., D. D. Kress, P. J. Burfening and D. Vaniman. 1978. Region by sire interaction for production traits in beef cattle. J. Anim. Sci. 46:957.

Tess, M. W., D. D. Kress, P. J. Burfening and R. L. Friedrich. 1979. Sire by environment interactions in Simmental-sired calves. J. Anim. Sci. 49:964.

Yamada, Y. 1962. Genotype by environment interaction and genetic correlation of the same trait under different environments. Jpn. J. Genet. 37:498.