Birth traits of pure Holstein calves versus Montbeliarde-sired crossbred calves

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ABSTRACT

Pure Holstein calves and Montbeliarde-sired crossbred calves from multiparous Holstein dams were compared for gestation length, calf weight at birth, calving difficulty, and stillbirth in 2 research herds of the University of Minnesota. The Montbeliarde-sired calves from multiparous Holstein dams had significantly longer gestation lengths (283.2 d) than Holstein-sired calves from Holstein dams (278.4 d), and Montbeliarde-sired calves from multiparous Holstein dams had significantly greater calf weight at birth (48.3 kg) compared with Holstein-sired calves from Holstein dams (43.3 kg). However, calves sired by Montbeliarde bulls were not significantly different from calves sired by Holstein bulls for calving difficulty and stillbirth. In addition, Jersey × Holstein crossbred cows mated to Montbeliarde artificial insemination (AI) bulls were compared with pure Holstein cows mated to Holstein AI bulls for gestation length, calf weight at birth, calving difficulty, and stillbirth at their first 3 calvings. Gestation length was significantly longer for Jersey × Holstein cows bred to Montbeliarde bulls than for pure Holstein cows bred to Holstein bulls at first calving (280.3 versus 277.7 d) and second and third calving (282.2 versus 278.6 d); however, Jersey × Holstein cows bred to Montbeliarde AI bulls were not significantly different from pure Holstein cows bred to Holstein AI bulls for calf weight at birth, calving difficulty, and stillbirth at the first 3 calvings.

Key words: crossbreeding, gestation length, calving difficulty, stillbirth

INTRODUCTION

Dairy producers around the world have turned to mating pure Holstein (HO) heifers and cows to AI bulls from breeds of dairy cattle other than HO, especially Jersey (JE) and the Scandinavian Red breeds, to reduce calving difficulty (CD) of cows and stillbirth (SB) of

calves. In a survey conducted by Weigel and Barlass (2003), dairy producers indicated pure HO cows had less CD and SB when bred to AI bulls that were non-HO compared with HO. Loss of production, reduced fertility, increased health problems, and decreased survival of cows are some of the consequences of increased CD and SB (Zaborski et al., 2008). Furthermore, HO cows that deliver SB calves have reduced fertility and a greater risk of being culled (Bicalho et al., 2007).

Meyer et al. (2001) reported 29% of first-calf HO heifers and 11% of multiparous HO cows had CD, and Lombard et al. (2007) reported 19% of first-calf HO heifers and 7% of multiparous HO cows had CD when bred to HO bulls. The SB rate in Minnesota DHI herds was reported to be 11.3% by Silva del Río et al. (2007), and SB rates have increased 3.7 percentage units from 1985 to 1996 in the United States for HO (Meyer et al., 2001). Those HO cows with CD are more likely to deliver calves with SB, digestive problems, and greater mortality after birth (Mee, 2008).

Many studies have reported less CD and fewer SB when mating HO heifers and cows with bulls from other breeds (Hollon and Branton, 1975; Vesely et al., 1986; Touchberry, 1992; Olson et al., 2009). Vesely et al. (1986) reported pure HO calves (15.1%) had a greater SB rate than did Ayrshire-sired calves (10.7%) from HO dams at first calving, and pure HO cows (14.5%) had significantly more SB than Ayrshire × HO crossbred cows (6.4%) at first calving. Touchberry (1992) found Guernsey and HO crossbred calves had fewer SB (6.2%) than the mean of pure Guernsey and pure HO calves (9.0%). In addition, JE × HO calves had significantly less CD than, but similar SB to, pure HO calves, as reported by Olson et al. (2009).

Heins et al. (2006) reported CD and SB from a crossbreeding study of 7 large commercial dairies in California, and calves sired by Montbeliarde (MO) AI bulls were not significantly different for CD (11.6% for MO versus 16.4% for HO) or SB (12.7% for MO versus 15.1% for HO) from pure HO calves from pure HO dams at first calving. For multiparous pure HO dams in the same study, Brown Swiss- (4.9%), Normande- (8.7%), and MO-sired (5.4%) calves were not significantly different from HO-sired (8.4%) calves for

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CD; however, Brown Swiss- (5.6%), Normande- (7.3%), and MO-sired (5.0%) calves had significantly lower SB rates than HO-sired (12.7%) calves from multiparous pure HO cows.

Few studies have documented the effects of crossbreeding on gestation length (**GL**) and calf weight at birth (**CW**). Touchberry and Bereskin (1966) reported Guernsey-sired calves from pure HO dams had 5-d longer GL, but 1.7-kg less CW, than pure HO calves. In the same study, calves from crossbred cows had 1.2-d less GL, but greater CW, than the mean of the 2 pure breeds. Christensen et al. (1984) found pure HO calves had 2.3-d longer GL than crossbred calves of HO and Red Dane. For crossbreds of Ayrshire, Brown Swiss, and HO, McDowell (1982) reported no difference in CW of Ayrshire $\times$ HO calves and Brown Swiss $\times$ HO calves compared with pure HO calves. Although greater CW is associated with more CD and an increased SB rate (Johanson and Berger, 2003) within the HO breed, it is unclear if that association applies to crossbred calves.

The MO breed is based in the Franche-Comte region of France and was introduced to North America and other countries globally over the past decade. At this time, the breed has more than 410,000 recorded cows, and at least 120 young bulls are progeny tested annually in France. Unlike in many dairy breeds, in the MO breed, there has been selection for greater body condition instead of for more angularity. The Brown Swiss, Fleckvieh, and MO breeds of dairy cattle originate from the Alps region of Europe, and these 3 breeds share longer GL compared with the dairy breeds of northern Europe and North America. Because GL is a trait of the calf, MO-sired crossbred calves are expected to have lengthened GL compared with pure HO calves.

The objectives of this study were to investigate the GL, CW, CD, and SB of calves and their dams in 2 research herds of the University of Minnesota. Two groups of cows were compared in both herds: 1) pure HO cows at second and later calving mated to HO AI bulls versus MO AI bulls and 2) pure HO cows at first, second, and third calving mated to HO AI bulls versus JE $\times$ HO crossbred cows at first, second, and third calving mated to MO AI bulls. The GL of dairy cattle has seldom been studied, and CW is not routinely recorded by dairy producers. On the other hand, large data files are collected in the field and used to assess CD and SB within the HO breed; however, data on CD and SB of MO-sired crossbred calves are not systematically recorded in the field at this time. Therefore, data from institutional research herds, although limited in scope, are valuable to assess traits such as CD and SB for MO-sired crossbred calves.

MATERIALS AND METHODS

Experimental Design

The research dairy on the St. Paul campus of the University of Minnesota has 90 tie stalls and a compost barn that accommodates 40 animals, and the West Central Research and Outreach Center, Morris, Minnesota, has a low-input grazing system that accommodates 150 animals. The 2 research herds have shared a crossbreeding design since 2000. To initiate research on crossbreeding, pure HO heifers and cows were randomly assigned to either the pure HO or crossbred lines in both herds. The HO heifers and cows in the pure HO line were bred to HO AI bulls, and the HO heifers and cows in the crossbred line were bred to JE AI bulls. All of the resulting JE $\times$ HO crossbred heifers, which were born from 2001 to 2003, were mated to MO AI bulls during their lifetimes to initiate a 3-breed rotational system for crossbreeding.

Subsequently, beginning in 2002, some multiparous pure HO cows in both research herds were mated to MO AI bulls to provide for the comparison of pure HO and MO $\times$ HO crossbreds. Pure HO cows were randomly mated to either MO AI bulls or HO AI bulls; however, no pure HO virgin heifers were mated to MO bulls because of the crossbreeding design in the 2 research herds.

For all breeds (HO, JE, and MO), 3 AI bulls were selected annually based on ranking with the Net Merit index for HO and JE (VanRaden et al., 2006) and with the French ISU total merit index for MO (Coopex Montbeliarde, 2009). The cattle in the pure HO line at Morris that had difficulty in conception were mated to progeny-test HO AI bulls to save cost. In addition, one set of 3 MO AI bulls had repeated use for a second year. Crossbreds may benefit from heterosis for some traits, and purebreds may be negatively affected by inbreeding depression; therefore, inbreeding coefficients were not allowed to surpass 6.25% for mating of HO bulls with HO females.

Recording of Data

The GL, CW, CD, and SB were recorded for calvings from August 2003 to January 2009 at both St. Paul and Morris. The GL was the date of conception subtracted from the date of calving, and CW was recorded within 48 h of birth. Body weight of dams at calving was not recorded. The CD was measured on a 5-point scale, with 1 = quick, easy birth with no assistance; 2 = over 2 h in labor, but no assistance; 3 = minimum assistance, but no calving difficulty; 4 = used obstetrical

Table 1. Number of observations, least squares means, standard errors of means, and significance from the logistical regression statistical test for gestation length, calf weight, calving difficulty, and stillbirth of calves from multiparous Holstein cows bred to Holstein versus Montbeliarde AI bulls¹

Calving trait	Pure Holstein calves (n = 277)		MO × HO ² calves (n = 138)		Statistical test of difference (<i>P</i> -value)
	Mean	SE	Mean	SE	
Gestation length (d)	278.4	0.4	283.2	0.5	***
Calf weight at birth (kg)	43.3	0.4	48.3	0.5	***
Calving difficulty (%)	5.9	1.7	9.4	2.3	0.22
Stillbirth (%)	4.1	1.3	4.3	1.7	0.90

¹Independent variables for statistical analysis were sex of calf, herd, and breed of sire.

²Montbeliarde × Holstein.

****P* < 0.001.

chains; and 5 = extremely difficult birth that required a mechanical puller. For analysis, scores of 1 to 3 were combined and represented no CD, whereas scores of 4 and 5 were combined and represented CD. The SB was recorded in a binary manner as living (1) or dead (0) within 24 h of birth.

In total, 415 calvings (Table 1) were analyzed for the comparison of GL, CD, and SB for multiparous pure HO cows bred to either HO AI bulls (277 calves sired by 32 bulls) or MO AI bulls (138 calves sired by 12 bulls), after the removal of 27 twin calvings (20 for pure HO, 7 for MO × HO). The pure HO cows calved for the second (n = 148), third (n = 117), fourth (n = 78), or fifth and greater (n = 72) time. The CW observations were missing for 11 pure HO calves and 4 MO × HO calves; therefore, 400 multiparous calvings of pure HO cows (266 bred to HO, 134 bred to MO) were analyzed for CW (Table 2).

Data for calvings of 77 pure HO heifers bred to HO AI bulls versus 78 JE × HO heifers bred to MO AI bulls were available for comparison at first calving (Table 3). After the removal of data for 8 sets of twins at first calving (3 for HO and 5 for JE × HO), 74 pure HO first-calf heifers (calves sired by 8 bulls) and 73 JE × HO first-calf heifers (calves sired by 6 bulls) were compared for GL, CD, and SB. The CW was not recorded for 2 calves at Morris; therefore, 74 pure HO versus 71 JE × HO were compared (Table 4).

For second and third calving, 86 pure HO cows bred to HO AI bulls (calves sired by 15 bulls) and 104 JE × HO cows bred to MO AI bulls (calves sired by 11 bulls) were analyzed (Table 3). Eleven twin calvings (2 for pure HO dams and 9 for JE × HO dams) and 3 late-term abortions (1 for pure HO, 2 for JE × HO dams) were removed from the data. Two pure HO calves and one crossbred calf were not recorded for CW, so 84 pure HO calves and 103 crossbred calves were compared (Table 4).

Both the St. Paul and Morris herds breed seasonally, and all virgin heifers for both locations were reared and mated at Morris. The St. Paul herd calved mostly in the fall, and the Morris herd calved mostly in the spring. Season of calving was spring (March to July) or fall (September to February). Seasons with fewer than 10 calvings and seasons containing less than 5 calvings for each genetic group were combined (fall season with following spring season) at Morris.

Statistical Analyses

Dependent variables in models for statistical analyses in all cases were GL, CW, CD, and SB. For comparison of multiparous pure HO cows bred to HO AI bulls versus MO AI bulls, independent variables were the fixed effects of sex of calf, herd, and breed of sire, along with cow as a random effect. A preliminary model included

Table 2. Number of calvings and stratification of calf weights of Holstein-sired calves and Montbeliarde-sired calves from multiparous pure Holstein dams¹

Item	Pure Holstein calves		MO × HO ² calves	
	n	%	n	%
Calf weight at birth				
≤50 kg	243	91	91	68
51–60 kg	23	9	36	27
>60 kg	0	0	7	5
Total	266	100	134	100

¹Chi-squared test for stratification of calf weight at birth versus breed of sire was significant (*P* < 0.01).

²Montbeliarde × Holstein.

Table 3. Number of observations, least squares means, standard errors of means, and significance from the logistical regression statistical test for gestation length, calf weight, calving difficulty, and stillbirth of Holstein cows bred to Holstein AI bulls and Jersey × Holstein crossbred cows bred to Montbeliarde AI bulls for first calving and second and third calving¹

Calving trait	First calving					Second and third calving				
	Pure Holstein calves (n = 74)		MO × (JE × HO) ² (n = 73)		P-value from test of difference	Pure Holstein calves (n = 86)		MO × (JE × HO) ² (n = 104)		P-value from test of difference
	Mean	SE	Mean	SE		Mean	SE	Mean	SE	
Gestation length (d)	277.7	0.8	280.3	0.7	**	278.6	0.6	282.2	0.6	***
Calf weight at birth (kg)	38.9	0.6	37.6	0.6	†	42.5	0.6	41.9	0.6	0.47
Calving difficulty (%)	14.9	4.6	19.9	4.4	0.36	2.8	2.3	5.5	2.2	0.44
Stillbirth (%)	16.9	4.8	12.6	4.6	0.50	1.1	1.7	2.5	1.6	0.53

¹Independent variables for statistical analysis were sex of calf, herd, season nested within herd, and genetic group. For second and third calving, parity nested within genetic group was also included.
²Montbeliarde-sired calves from Jersey × Holstein crossbred dams.
† $P < 0.10$; ** $P < 0.01$; *** $P < 0.001$.

the effects of parity, season of calving nested within herd, interaction of sex of calf and breed of sire, and interaction of herd and breed of sire. However, none of these fixed effects significantly ($P > 0.30$) explained variation of any dependent variable; therefore, they were removed from the models. The MIXED procedure of SAS (SAS Institute, 2004) was used to obtain solutions; however, the GLIMMIX procedure of SAS was used to determine the statistical significance for CD and SB because both are binary traits. For CW, a χ^2 test (SAS Institute, 2004) was conducted for breed of sire and stratification of CW.

For the first-calf comparison of pure HO bred to HO AI bulls and JE × HO bred to MO AI bulls, independent variables were sex of calf, herd, season of calving nested within herd, and genetic group. To analyze second and third calving, independent variables were sex of calf, herd, season of calving nested within herd, genetic group, and parity nested within genetic group as fixed effects, and cow nested within genetic group as a random effect. Preliminary models included the effects of interaction of sex of calf and breed of sire and interaction of herd and genetic group; however,

interaction effects were not significant ($P > 0.20$) for any of the dependent variables and were removed from the model. The GLM procedure of SAS (SAS Institute, 2004) was used to obtain solutions for first calving, and the MIXED procedure of SAS (SAS Institute, 2004) was used to obtain solutions for second and third calving. However, the LOGISTIC procedure of SAS was used for first calving and the GLIMMIX procedure of SAS was used for second and third calving to assess the statistical significance of variables influencing CD and SB. For CW, a χ^2 test (SAS Institute, 2004) was conducted for genetic group and stratification of CW.

RESULTS AND DISCUSSION

Calvings of Multiparous Pure HO Cows Bred to HO Bulls Versus MO Bulls

Bull calves had significantly ($P < 0.05$) longer GL (1.2 d) than heifer calves and significantly ($P < 0.01$) greater CW than heifer calves (4.1 kg) for pure HO cows bred to either HO bulls or MO bulls. Norman et al. (2009) reported bull calves had longer GL than

Table 4. Number of calvings and stratification of calf weights of Holstein-sired calves from Holstein dams and Montbeliarde-sired calves from Jersey × Holstein dams for first calving versus second and third calving¹

Item	First calving		Second and third calving	
	Pure Holstein calves	MO × (JE × HO) ²	Pure Holstein calves	MO × (JE × HO) ²
Calf weight at birth				
≤50 kg	74	71	81	97
51–60 kg	0	0	3	6
>60 kg	0	0	0	0
Total	74	71	84	103

¹Chi-squared test for stratification of calf weight at birth versus genetic group was not significant ($P = 0.47$).
²Montbeliarde-sired calves from Jersey × Holstein crossbred dams.

heifer calves within breed, and Kertz et al. (1997) and Maltecca et al. (2006) found CW of bull calves is greater than CW of heifer calves within the HO breed. Furthermore, sex of calf explained a significant ($P < 0.05$) difference for CD (11.9% for bull calves and 4.3% for heifer calves) of the multiparous HO cows, but SB (3.6% for bull calves and 4.8% for heifer calves) was not significantly ($P = 0.57$) different for sex of calf.

The CW was significantly ($P < 0.01$) greater (1.9 kg) for calves born at St. Paul than for calves born at Morris. In addition, CD was significantly ($P < 0.01$) greater at St. Paul (12.4%) than at Morris (2.9%), which could be due to the difference in housing (stall barn versus pasture) or to a higher rate of unobserved calvings at Morris than at St. Paul.

Table 1 has the number of observations, least squares means, and standard errors of means for GL, CW, CD, and SB from multiparous HO dams for HO-sired calves compared with MO-sired calves. The pure HO calves had significantly ($P < 0.001$) shorter GL (4.8 d) than MO $\times$ HO calves from multiparous HO dams. The GL of pure HO calves in this study is similar to the GL of 279 d reported by Norman et al. (2009), and Dillon et al. (2003) found pure MO calves had 4-d longer GL than pure HO calves across all calvings. The GL is primarily determined by breed composition of the calf, and the 4.8-d difference in GL found in this study could result in a difference in CW (Jamrozik et al., 2005). Indeed, pure HO calves had significantly ($P < 0.001$) less CW (5.0 kg) than MO $\times$ HO calves from multiparous pure HO dams.

Although the MO $\times$ HO calves had greater mean CW than the pure HO calves from multiparous HO dams, the MO $\times$ HO calves were not significantly different from the pure HO calves for CD. The least squares means for CD in this study were 5.9% for pure HO calves versus 9.4% for MO $\times$ HO crossbred calves and reflected CD for 18 of 277 pure HO calves and 13 of 138 MO $\times$ HO calves. However, this nonsignificant ($P = 0.22$) difference in percentage units for CD is in the opposite direction from the nonsignificant ($P = 0.29$) difference for CD in Heins et al. (2006) for calves from multiparous pure HO dams. For that study, 8.4% for pure HO calves and 5.4% for MO $\times$ HO crossbred calves had CD, with more observations (303 pure HO calves and 2,373 MO $\times$ HO calves) than in the present study. Furthermore, first-calving HO dams in Heins et al. (2006) had 16.4% CD for pure HO calves compared with 11.6% CD for MO $\times$ HO calves. The 5.9% rate of CD for pure HO calves from multiparous HO dams in this study is somewhat less than the 8.4% of Heins et al. (2006) and the 6.9% of Lombard et al. (2007).

For SB, pure HO calves in this study did not differ significantly ($P = 0.90$) from MO $\times$ HO calves (4.1 ver-

sus 4.3%, respectively). On the other hand, the 2,373 MO $\times$ HO calves from multiparous HO dams in Heins et al. (2006) had significantly ($P < 0.01$) fewer SB than the 303 pure HO calves (5.0 versus 12.7%, respectively). In addition, the SB rate of pure HO calves in this study (4.1%) is less than the 5.7% SB of Meyer et al. (2000) and the 14.2% SB of Maltecca et al. (2006) but greater than the 2.9% SB of Hossein-Zadeh et al. (2008).

The weighted means of genetic evaluations of the HO sires of calves in this study were 6.8% for direct CD (percentage of difficult births in heifers) and 7.6% for direct SB (January 2009 genetic evaluation of USDA-AIPL), which are both lower than the mean evaluations (CD = 7.5% and SB = 7.9%) for these traits for the HO breed in the United States (Cole, 2005; Cole, 2006). The MO sires in this study had a weighted mean of genetic evaluation for CD (percentage of births in heifers without any form of assistance) of 90.6 in France (February 2009 genetic evaluations from INRA), which is superior to the 88.7 mean for the MO breed. Evaluations for SB are not published for MO bulls in France; however, the mean for the MO breed is 4.6% in France. Therefore, the HO and MO AI bulls selected for this study tended to be among the better bulls for CD and SB within both breeds.

Table 2 has the number of calvings and stratification of CW for pure HO calves versus MO $\times$ HO calves from multiparous pure HO dams. Calves ≤ 50 kg for CW should be born without CD, and most calves from 51 to 60 kg would not be expected to have CD when born to multiparous pure HO dams. However, calves > 60 kg would be regarded as quite large for multiparous pure HO cows by most dairy producers, and 7 of the 134 MO $\times$ HO calves (or 5% of the 134 calves) compared with zero pure HO calves were > 60 kg. The 7 MO-sired calves > 60 kg (6 bull calves and 1 heifer calf) had a mean CW of 63.0 kg; however, only 3 of the 7 calves were born with CD. The 7 MO $\times$ HO calves > 60 kg in this study could lead to concern among dairy producers regarding use of MO in a crossbreeding system. However, these large MO $\times$ HO calves did not result in a significantly ($P = 0.22$) greater mean CD or a significantly ($P = 0.90$) increased mean SB rate compared with pure HO calves. Nogalski (2003) reported body shape of calves may influence CD and SB, which could explain the lack of significant differences for CD of the pure HO calves versus MO $\times$ HO calves in this study and in Heins et al. (2006).

Calvings of Pure HO Cows Versus JE $\times$ HO Crossbred Cows

The GL was significantly ($P < 0.05$) longer (2.0 d) for bull calves than heifer calves at first calving, and CW

was significantly greater ($P < 0.01$) for bull calves than heifer calves at both first calving (2.7 kg) and second and third calving (3.7 kg) for the pure HO cows and JE $\times$ HO cows. However, sex of calf did not significantly ($P > 0.30$) affect CD or SB.

Table 3 has numbers of observations, least squares means, and standard errors of means for HO cows bred to HO bulls and JE $\times$ HO cows bred to MO bulls for first-calf heifers versus cows calving for the second and third times. The GL was significantly ($P < 0.01$) longer for MO-sired calves from JE $\times$ HO dams than for pure HO calves at first calving (2.6 d) and at second and third calving (3.6 d). However, CW tended ($P < 0.10$) to be less (1.3 kg) at first calving, and CW was not different ($P = 0.47$) at second and third calving for MO-sired calves from JE $\times$ HO dams than for pure HO calves.

Number of calvings and stratification of CW of pure HO calves versus MO-sired calves from JE $\times$ HO dams are shown in Table 4. At first calving, CW was ≤ 50 kg for all calves, both pure HO calves and crossbred calves. Similarly, at second and third calving, CW was no more than 60 kg for any calf. Therefore, JE $\times$ HO virgin heifers and cows may be mated to MO AI bulls without concern about their calves having greater CW than pure HO calves. Although MO-sired calves from JE $\times$ HO dams had longer GL than pure HO calves, the 50% JE content of the dams and the 25% JE content of the calves apparently counteract the 50% MO content of the calves; therefore, the consequences of mating cows to MO AI bulls differ in Tables 2 (MO from pure HO dams) and 4 (MO from JE $\times$ HO dams) for CW.

Least squares means for CD of pure HO calves versus MO-sired calves from JE $\times$ HO dams had no tendency to differ at first calving ($P = 0.36$) or at second and third calving ($P = 0.44$). At first calving, 10 of 74 pure HO calves compared with 14 of 73 MO-sired calves from JE $\times$ HO dams had CD. At second and third calving, 3 of 86 pure HO compared with 5 of 104 MO-sired calves from JE $\times$ HO dams had CD. Likewise, the least squares means for SB did not differ ($P \geq 0.50$) for genetic groups at first calving or at second and third calving.

CONCLUSIONS

The mean GL of MO-sired calves was longer than the mean GL of pure HO calves in this study. In addition, the mean CW of MO $\times$ HO crossbred calves was significantly greater (5 kg) than the CW of pure HO calves from multiparous HO dams; however, data were not available for calves from HO heifers bred to MO AI bulls in this study. The mean CW of MO-sired calves

from JE $\times$ HO dams were no greater than the mean CW of pure HO calves at first calving and at second and third calving.

Variation within genetic groups (pure HO calves and MO-sired crossbred calves) for CD and SB was substantial and overwhelmed any potential differences between genetic groups both in this study and in Heins et al. (2006). Based on results from this study and previous research, MO AI bulls should not be eliminated from consideration by dairy producers for crossbreeding systems because of concerns that longer GL or greater CW of their calves will result in greater CD or increased SB rates, at least for multiparous HO cows and JE $\times$ HO crossbred heifers or cows. Nonetheless, dairy producers should consider genetic evaluations for CD of potential MO service sires, just as they are urged to do when choosing among potential HO service sires, especially for mating virgin heifers.

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