Breed of Sire Effect on Fertility of First Generation Crossbred Heifers

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Introduction

Inbreeding and selection for milk yield have reduced the reproductive performance of mature cows in several dairy breeds. Crossbreeding has improved reproductive performance signifying heterosis likely has a significant effect on fertility traits, especially when crossing to the Holstein breed (Lin et al. (1984); Heins et al. (2006)). Fertility traits are lowly heritable indicating heterosis may result in greater improvement to these traits than direct selection. The TwoPlus project was initiated in Canada in 2004 to investigate crossbreeding on Canadian dairy operations, importing Norwegian Red semen to breed Holstein dams. The Norwegian Red breed was chosen for its broad breeding goal that includes emphasis on functional traits. To further assess the potential for crossbreeding in Canada, additional dairy breeds crossed to Holstein dams were included beyond the Norwegian Red breed. The objectives of this study were to investigate the reproductive performance of the first generation TwoPlus crossbred heifers for eight reproductive traits. Secondly, the reproductive performance of all first generation crossbred heifers was investigated.

Material and methods

Data. Data on reproductive traits were obtained from the Canadian Dairy Network (CDN) for all animals. Data were combined with pedigree information from the CDN and breed associations, as well as herd information. The crossbred analysis was conducted using first generation crossbred yearling heifers out of Holstein dams and by non-Holstein sires. Purebred Holstein heifers within the herds containing crossbred heifers were included for comparison. Heifers from crossbreeding herds were included in the analysis if they were born after 2003. All animals involved in analysis were required to have a purebred Holstein dam and known parentage. At least five heifers had to be born to a sire breed for the breed to be considered for analysis. The traits included in this study were age at first service (AFS) measured in days, 56 day non-return rate (NRR) recorded as a binary trait per individual heifer, number of services per pregnancy (NS), days from first service to conception (FSTC), gestation length (GL) measured in days, calving ease (CE) measured on a four point scale, stillbirth (SB) recorded as a binary trait, and calf size (CZ) measured on a four point scale.

Models. The traits were analyzed by single trait linear sire models, adapted from the linear animal models published by Jamrozik et al. (2005) with an additional fixed breed of sire effect. All eight models included region-year-season of birth and breed of sire as fixed effects, as well as herd within region-year-season of birth, sire, and residual error as random

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effects. The model for non-return rate included month of first insemination as a fixed effect, and service sire by year of insemination and technician as random effects. The models for number of services and first service to concpetion interval included month of first insemination as a fixed effect. The gestation length model included month of first insemination by sex of calf as a fixed effect and sire of calf as a random effect. The models for calving ease, stillbirth and calf size included age of calving by month of calving by sex of calf as a fixed effect and sire of calf as a random effect. Age classes were defined on a monthly scale for the fixed age of calving by month of calving by sex of calf. Birth seasons were defined as December to February, March to June, July to September, and October to November.

Methods. Models were analyzed using ASREML 3.0 (Gilmour et al. (2009)). Estimates of variances published by Jamrozik et al. (2005) for heifer fertility traits for the Canadian Holstein population were used as prior values in the analysis of current data. Breeds were compared using pair wise t-tests, with *p* adjusted for multiple comparisons using the Bonferroni correction (Shaffer (1995)). Six comparisons were conducted for each of the eight traits, as each non-Holstein sire breed was contrasted to the Holstein sire breed.

Results and discussion

Breed of Sire Effects. Breed differences for reproductive traits, as well as heterosis, were expected to contribute to differences between crossbred and purebred animals. A limited number of crossbred records were available for some sire breeds, and Holstein sire records greatly outnumbered all other sire breeds (Table1). The data set was comprised of two components, the Norwegian Red (NR) sired heifers and their Holstein (HO) herdmates which resulted from the TwoPlus trial, and the data on other crosses of Holstein cows to Ayrshire (AY), Brown Swiss, (BS), Guernsey (GU), Jersey (JE), and Swedish Red (SR) sires which were found in Canadian herds over the same time period as the trial.

Table 1: Number of daughter records per sire breed by trait

Traits	AY	BS	GU	HO	JE	NR	SR
AFS	74	184	5	49690	199	366	9
NRR	74	184	5	49713	199	366	9
NS	74	184	5	49704	199	366	9
FSTC	61	139	4	41735	141	242	5
GL	64	166	4	49118	193	342	8
CE	75	189	5	51567	202	381	9
SB	75	189	5	51567	202	381	9
CZ	74	189	4	51725	201	375	9

When the Norwegian Red x Holstein heifer data was considered separately, six of the eight reproductive traits (AFS, NRR, NS, GL, CE, and SB) showed significant improvement over the Holstein breed. The sire breed effects as deviated from the Holstein breed effect are in Table 2. After comparing all the non-Holstein breeds to the Holstein breed and adjusted for multiple comparisons, the Norwegian Red sire breed effects were not significant but suggestive of improvement for the same six traits. Improvement in fertility traits when using Norwegian Red sires was expected due to the Norwegian Red breeding goal that has included fertility traits for several decades (A-Ranberg et al. (2003)) and has resulted in the genetic improvement of non-return rate and number of services. Calving performance of crossbred heifers from the Norwegian Red x Holstein cross was expected to be improved compared to purebred heifers, due to a recent crossbreeding study from the US that reported improved calving and lower stillbirth rates (Heins et al. (2006)). The Norwegian Red sire breed effect for fertility traits was not significantly different from the Holstein sire breed effect when considering all sire breeds, but showed trends suggestive of improvement.

Table 2: Breed of sire effects as differences from the Holstein sire breed effect for heifer fertility traits (standard errors in parentheses)

Traits	AY	BS	GU	JE	NR	SR
AFS (days)	-4.3	-0.2	14.2	4.4	-7.5	-0.04
	(5.6)	(3.3)	(17.4)	(3.3)	(3.3)	(13.5)
NRR (%)	1.97	1.92	-1.18	3.17	5.28	2.28
	(5.20)	(3.45)	(21.46)	(3.18)	(2.44)	(14.36)
NS	0.09	-0.06	0.06	-0.06	-0.13	-0.05
	(0.11)	(0.07)	(0.41)	(0.07)	(0.05)	(0.30)
FSTC (days)	7.7	-0.3	3.5	-1.0	-2.2	-6.0
	(4.4)	(2.9)	(16.7)	(2.8)	(2.3)	(15)
GL (days)	-2.1	**2.6**	-6.6	-0.7	-1.4	-0.6
	(1.0)	**(0.6)***	(3.2)	(0.5)	(0.6)	(2.3)
CE	-0.16	**-0.16**	-0.23	**-0.23**	-0.12	-0.09
	(0.09)	**(0.06)***	(0.31)	**(0.05)***	(0.05)	(0.24)
SB (%)	-7.29	-3.89	6.88	-2.13	-5.30	-12.8
	(4.5)	(2.61)	(15.03)	(2.58)	(2.50)	(11.29)
CZ	-0.11	-0.03	-0.30	**-0.40**	-0.07	-0.40
	(0.08)	(0.05)	(0.28)	**(0.04)***	(0.04)	(0.28)

* Significantly different from the Holstein sire breed effect at $p<0.05$ after Bonferroni correction

The Brown Swiss sire breed effect was significantly different from the Holstein sire breed effect for gestation length, with a significantly longer gestation by approximately 2.6 days. A previous study from Canada found crossbreds had longer gestation lengths than purebred animals (Lin et al. (1984)). Concerns associated with increased gestation length are increased calving difficulty (Hansen et al. (2004)). In this study, the Brown Swiss sire breed effect had significantly improved calving ease compared to the Holstein sire breed effect even with longer gestations. While longer gestation lengths may not be desirable, there does not appear to be an associated negative impact on calving ease.

The Jersey sire breed effect had significantly improved calving ease and significantly smaller calves compared to the Holstein sire breed effect. Significant improvement in calving ease is likely associated with significantly smaller calves (Hansen et al. (2004)). Calving difficulty has been reported to be less of a problem in the Jersey breed than in other breeds, and is consistent with producing smaller calves that are less likely to present difficulty in calving.

Cole et al. (2005) found Jersey dams required significantly less calving assistance than Holstein dams when bred to Holstein sires, while similar results were found in purebred Jersey births (Sewalem et al. (2008)). Sewalem et al. (2008) also reported Jersey dams produced smaller calves at a higher frequency than Holstein or Ayrshire dams.

Conclusion

Improved reproductive performance was observed in first generation crossbred heifers. The Norwegian Red breed effect was a significant improvement compared to the Holstein sire breed effect for six of the eight traits. When comparing all sire breeds used in crossbreeding in Canada, the Brown Swiss breed effect was an improvement for calving ease, but increased gestation length, which may be undesirable. The Jersey breed effect was a significant improvement for both calving ease and calf size. With more records of crossbred animals, more significant differences may become apparent with time. Improvement in calving performance and reproductive function is possible through crossbreeding.

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