Relationship Between Reproduction Traits and Functional Longevity in Canadian Dairy Cattle

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ABSTRACT

The aim of this study was to use survival analysis to assess the relationship between reproduction traits and functional longevity of Canadian dairy cattle. Data consisted of 1,702,857; 67,470; and 33,190 Holstein, Ayrshire, and Jersey cows, respectively. Functional longevity was defined as the number of days from first calving to culling, death, or censoring; adjusted for the effect of milk yield. The reproduction traits included calving traits (calving ease, calf size, and calf survival) and female fertility traits (number of services, days from calving to first service, days from first service to conception, and days open). The statistical model was a Weibull proportional hazards model and included the fixed effects of stage of lactation, season of production, the annual change in herd size, and type of milk recording supervision, age at first calving, effects of milk, fat, and protein yields calculated as within herd-year-parity deviations for each reproduction trait. Herd-year-season of calving and sire were included as random effects. Analysis was performed separately for each reproductive trait. Significant associations between reproduction traits and longevity were observed in all breeds. Increased risk of culling was observed for cows that required hard pull, calved small calves, or dead calves. Moreover, cows that require more services per conception, a longer interval between first service to conception, an interval between calving to first service greater than 90 d, and increased days open were at greater risk of being culled.

Key words: functional longevity, reproduction trait, female fertility, calving performance

INTRODUCTION

Longevity is a highly desirable trait that considerably affects overall profitability in the dairy industry. With increased longevity, the mean production of the herd increases for 2 reasons. First, a greater proportion of the culling decisions are based on production. Second, the proportion of mature cows, which produce more milk than young cows, is increased (Allaire and Gibson, 1992; VanRaden and Wiggans, 1995). Longevity is determined by voluntary and involuntary culling decisions of individual farmers. In the process of making decisions on culling, the farmers or producers will take into account production, health, fertility, and other functional traits such as milking speed, milking temperament, and calving ease. Generally, culling because of poor production is called voluntary culling, and culling for reasons other than poor production is called involuntary culling. Reducing the rate of involuntary culling allows a higher voluntary replacement rate, which can increase profits for a dairy farm.

Reproductive performance is another major factor affecting profitability of a dairy herd. Inadequate herd reproductive performance, manifested as prolonged calving intervals, increased involuntary culling, or both, can result in less milk and fewer calves per cow per year. Other consequences include more involuntary culling and, therefore, increased replacement costs and, ultimately, lower net returns. Until 10 to 15 yr ago, most national dairy cattle research and breeding programs were mainly oriented toward yield traits (Leitch, 1994). However, functional traits, such as reproduction, longevity, and health traits, are of increased interest to producers to improve herd profitability. Miglior et al. (2005), in their comparison of international selection indices, reported that selection indices have evolved worldwide, shifting their focus from primarily production to a more balanced breeding approach that includes longevity, udder health, conformation, and reproduction. In February 2008, a new genetic evaluation system for reproductive performance will be available to Canadian dairy farmers. The newly developed system is based on a 16-trait animal model that includes all available female fertility and calving traits collected by DHI (Jamrozik et al., 2005; Miglior et al., 2007). The availability of these traits provides an opportunity for more

Table 1. Percentage of records for calving traits[1] in each class for Holstein (HO), Ayrshire (AY), and Jersey (JE)

	CE				CZ				CS		
	HO	AY	JE		HO	AY	JE		HO	AY	JE
Unassisted	60.33	72.05	86.97	Small	9.16	10.23	10.31	Dead	5.88	4.69	5.25
Easy pull	32.82	24.27	12.62	Medium	64.17	63.66	65.74	Alive	94.12	95.31	94.75
Hard pull	6.61	3.52	0.35	Large	26.67	26.11	23.95				
Surgery	0.24	0.16	0.06								

[1]CE = calving ease, CZ = calf size, CS = calf survival.

detailed studies about the relationship of reproduction traits with other traits of economic importance.

Several reports have indicated that poor reproductive performance, manifested as prolonged calving intervals, can result in reduced milk yield and increased replacement cost (Pryce et al., 2000; Kadarmideen et al., 2003). Although there are several studies that have investigated the association between fertility and production traits, there are few studies (Beaudeau et al., 1994; Schneider et al., 2005; Perez-Cabal et al., 2006; Sewalem et al., 2006) in the literature that examined the association of reproduction traits with longevity.

Survival analysis using a Weibull proportional hazards model can offer a better fit to survival data due to its ability to properly account for censored and uncensored records. This would allow better survival estimates by accounting for differences in days of productive life between cows that survive for the same number of lactations. The methodology also accounts for the skewed distribution of survival. Time-dependent variables can be used for survival analysis to accurately model environmental effects (Ducrocq and Sölkner, 1998; Ducrocq, 2002). The objective of the present study was to analyze the relationship between various reproduction traits and functional longevity of Canadian Holstein, Ayrshire, and Jersey breeds.

MATERIALS AND METHODS

Data consisted of records of 1,702,857 cows from 12,033 herds sired by 5,090 sires for Holstein, 67,470 cows in 684 herds from 1,496 sires for Ayrshires and 33,190 cows in 800 herds from 1,288 sires for Jersey. Data were obtained from lactation and reproduction records extracted for the February 2006 genetic evaluation of the Holstein, Jersey, and Ayrshire breeds that calved from 1998 to 2005. Records with missing sire identification, incorrect calving dates, or age at first calving outside the 18 to 40 mo range were excluded from the analysis. Reproduction traits included calving traits and female fertility traits, and all cows were required to have at least one of these to be included in the analyses. Calving traits included traits such as calving ease with 4 classes (unassisted, easy pull, hard pull, and surgery), calf size with 3 classes (measured subjectively by farmers as small, medium, and large), and calf survival with 2 classes (dead or alive within 24 h after calving). Female fertility traits included traits such as number of services with 6 classes (1, 2, 3, 4, 5, and 6+), days from first service to conception with 6 classes (each class consisting of a 21-d interval), days from calving to first service with 5 classes (each class consisting of a 30-d interval), and days open with 6 classes (each class consisting of a 30-d interval). De-

Table 2. Percentage of first-parity records of calving ease by calf size (small, medium, and large) and sex in Holsteins[1]

Calving ease score	Small		Medium		Large	
	Female	Male	Female	Male	Female	Male
Unassisted	16.88		67.08		16.06	
	(62.42)	(37.58)	(54.24)	(45.76)	(42.12)	(57.88)
Easy pull	12.26		66.30		20.84	
	(61.27)	(38.73)	(52.53)	(47.47)	(40.40)	(59.60)
Hard pull	5.52		41.45		53.04	
	(58.38)	(41.62)	(48.50)	(51.50)	(36.53)	(63.47)
Surgery	6.20		37.24		50.56	
	(57.45)	(42.55)	(49.38)	(50.62)	(31.47)	(68.53)

[1]Numbers in parentheses are female and male percentage of records, respectively, in each class of calving score. CE = calving ease, CZ = calf size, CS = calf survival.