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Production, reproduction, health, and growth traits in backcross Holstein × Jersey cows and their Holstein contemporaries[1]

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ABSTRACT

A total of 648 purebred Holstein and 319 backcross Holstein × Jersey dairy cattle were compared for production, reproduction, health, linear type, and growth traits. Animals were born between 2003 and 2009 and were housed in the University of Wisconsin–Madison Integrated Dairy Facility. All animals had Holstein dams; lactating dams were mated to unproven Holstein sires to produce purebred (control) Holsteins or to unproven F_1 Jersey × Holstein crossbred sires to produce backcross animals, whereas nulliparous dams were mated to proven Holstein sires to produce purebred (other) Holsteins. Traits were analyzed using mixed linear models with effects of season of birth, age of dam, sire, birth year of sire, days in milk, lactation, and linear type score evaluator. Control Holsteins had greater 305-d milk yield (12,645 vs. 11,456 kg), 305-d mature equivalent milk yield (13,420 vs. 12,180 kg), peak daily milk yield (49.5 vs. 46.4 kg), total lactation milk yield (11,556 vs. 10,796 kg), and daily fat-corrected milk yield (43 vs. 40 kg) compared with backcrosses. Days open and services per conception as a heifer or cow did not differ between control Holsteins, other Holsteins, or backcrosses. The proportion of first-parity births that required assistance was less in control Holsteins than in backcross cows (3.7 vs. 11.2%). The incidence of scours or respiratory problems in calves did not differ between control Holsteins, other Holsteins, and backcrosses, nor did the incidence of mastitis, injury, or feet problems. Control Holstein heifers were heavier (629 vs. 557 kg), with greater hip height (145 vs. 139 cm), body length (167 vs. 163 cm), heart girth (205 vs. 198 cm), and hip width (54 vs. 53 cm) at 22 mo of age. On a 50-point scale for linear type traits, Holsteins were larger in stature compared with backcrosses (41 vs. 28), had wider rumps (37 vs. 33), and wider rear udders (34 vs. 32). Results of this study suggest that backcross Holstein × Jersey cattle have decreased production but fail to demonstrate an advantage in health and reproduction compared with purebred Holsteins.
Key words: crossbreeding, backcross, Jersey

INTRODUCTION

Over the past several decades, the average milk production per cow has greatly increased. Although nutrition and management have helped to improve production, genetic selection has accounted for more than 55% of the phenotypic gains in yield traits (Shook, 2006). In contrast to improved milk production, health and fertility traits have decreased. From 1976 to 1999, rolling herd averages for milk yield increased from 4,753 to 6,375 kg for southeastern Holsteins. During this period, days open increased from 124 to 168 d, and services per conception increased from 1.91 to 3.00 (Washburn et al., 2002). Throughout this time period, the majority of commercial dairy farms relied on the high-producing Holsteins, with only 5% of US dairy cattle being breeds other than purebred Holstein (McAllister, 2002). Crossbreeding Holsteins with other breeds has been considered as an option to help minimize the decline of health and fertility, by introducing favorable genes, removing inbreeding depression, and taking advantage of heterosis.

Interest in crossbreeding has grown over the past decade among both dairy producers and researchers (Weigel and Barlass, 2003; Heins et al., 2006c). Many recent studies have compared Holsteins with F_1 crosses involving Jerseys (Heins et al., 2008b; Olson et al., 2009), Brown Swiss (Dechow et al., 2007), and European breeds such as Normande, Montbéliarde, and Scandinavian Red (Heins et al., 2006c). Among these breeds, Jerseys were initially thought to best complement the Holstein breed due to their advantage in milk composition and fertility. Other characteristics of the Jersey breed, such as strong within-breed selection, competitive milk yield per unit of BW, and demonstrated heterosis with Holsteins, have led to their

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inclusion in crossbreeding programs (McAllister, 2002). Previous studies involving F_1 Holstein × Jersey crossbreds have examined many economically important traits. Heins et al. (2008a) indicated a decrease in milk production and protein yield of crossbreds compared with Holsteins, but no difference was observed in fat yield. This study also noted that days open for first lactation crossbreds was lower than that of Holsteins. Olson et al. (2009) reported a significant decrease in dystocia for Jersey-sired crossbred calves compared to Holstein calves. VanRaden and Sanders (2003) reported that F_1 Holstein × Jersey crossbreds were more profitable than pure Holsteins when strong premiums were placed on fat and protein percentages. A study of the use of Holstein-Friesian, Jersey, and Ayrshire breeds in crossbreeding mating systems in New Zealand also resulted in all crossbreds being more profitable than purebreds (Lopez-Villalobos, et al., 2000).

To understand if a 2-breed rotational crossbreeding system involving the Holstein and Jersey breeds would be suitable, an evaluation of advanced generations of the breeding program was undertaken. The backcross animals in this study were 3/4 Holstein:1/4 Jersey, which would represent a second generation in a 2-breed rotational cross. In the long-term, a commercial 2 breed rotational cross would lead to animals that are about 2/3 one breed and 1/3 the other, in any given generation. Some theory regarding the performance of backcross animals had been reported by Rutledge (2001). The initial F_1 crossbreds are formed from gametes with no possible between-genome recombination. But when gametes are formed in the F_1 animals, recombination occurs between the chromosomes of the 2 parental breeds. This results in a breakup of ancestral coadapted gene complexes. Furthermore, backcross animals will exhibit only half of the heterosis found in F_1 animals, due to 75% of the DNA coming from just 1 of the parental breeds, instead of half from each parental breed. The combination of these 2 events theoretically results in a loss of performance of backcross animals compared with the F_1 animals.

MATERIALS AND METHODS

Data Collection

A total of 648 purebred Holstein and 319 backcross Holstein × Jersey heifers were born at the University of Wisconsin–Madison Integrated Dairy Facility (Arlington, Madison, and Marshfield, WI) between November 2003 and July 2009. The backcross animals were produced by randomly mating lactating Holstein cows to 1 of 7 unproven F_1 Holstein × Jersey sires from ABS Global (DeForest, WI), Alta Genetics Inc. (Watertown, WI), and Select Sires Inc. (Plain City, OH). Of the crossbred sires, 4 were sired by Holsteins, whereas 3 were sired by Jerseys. Information regarding the identity and parentage of these sires are presented by Maltecca et al. (2006). These matings resulted in the 3/4 Holstein:1/4 Jersey animals used in this study, which will be referred to as backcrosses throughout the remainder of this paper. The remaining lactating Holstein cows were randomly mated to unproven Holstein sires from commercial AI studs; the animals produced from these matings represented the experimental controls in this study and are referred to as control Holsteins. Nulliparous Holstein heifers were mated to proven Holstein sires; these matings were not randomized and resulted in a separate group of Holsteins, which are referred to as other Holsteins throughout this paper.

The weighted average sire genetic merit for each group is provided in Table 1. Genetic information was only available for 5 of the 7 F_1 crossbred sires used in this study. Genetic merit for all groups are presented on a Holstein base. As expected, both Holstein groups exceeded the crossbred sires in milk production, although fat and protein production were similar. The crossbred sire's genetic merit for daughter pregnancy rate exceeded those of the Holsteins, but cow and heifer conception rate did not vary greatly. Overall, the other (proven) Holsteins exceeded both the control (young) Holsteins and crossbreds for net merit ($190 vs. $17 and $77, respectively), fluid merit ($169 vs. −$12 and −$23, respectively), and cheese merit ($218 vs. −$7 and $180, respectively). Crossbred sires did have a greater genetic merit than control sires for net merit and cheese merit, but means for fluid merit were very similar.

External skeletal measurements: body length (point of the shoulders to the ischium), heart girth, and hip height, along with BW and BCS were taken on heifers at 60-d intervals from 4 to 22 mo of age, and 60-d prepartum measurements were also recorded. Prepar-

Table 1. Weighted average sire genetic merit of Holstein and backcross Holstein × Jersey cows[1]

Item	Control Holstein	Other Holstein	Backcross
Milk, kg	94	222	−345
Fat, kg	3	10	9
Protein, kg	4	10	1
Productive life, mo	−0.8	0.7	0.8
SCS	3.04	3.00	3.22
Daughter pregnancy rate, %	−0.7	−2.8	2.0
Cow conception rate, %	−0.9	0.0	−0.8
Heifer conception rate, %	0.3	0.4	0.0
Net merit, $	−16	190	77
Fluid merit, $	−23	169	−12
Cheese merit, $	−7	218	180

[1]Control (n = 41); other (n = 28); backcross (n = 5).