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Calf birth weight, gestation length, calving ease, and neonatal calf mortality in Holstein, Jersey, and crossbred cows in a pasture system

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ABSTRACT

Holstein (HH), Jersey (JJ), and crosses of these breeds were mated to HH or JJ bulls to form purebreds, reciprocal crosses, backcrosses, and other crosses in a rotational mating system. The herd was located at the Center for Environmental Farming Systems in Goldsboro, North Carolina. Data for calf birth weight (CBW), calving ease (0 for unassisted, n = 1,135, and 1 for assisted, n = 96), and neonatal calf mortality (0 for alive, n = 1,150, and 1 for abortions recorded after mid-gestation, stillborn, and dead within 48 h, n = 81) of calves (n = 1,231) were recorded over 9 calving seasons from 2003 through 2011. Gestation length (GL) was calculated as the number of days from last insemination to calving. Linear mixed models for CBW and GL included fixed effects of sex, parity (first vs. later parities), twin status, and 6 genetic groups: HH, JJ, reciprocal F_1 crosses (HJ, JH), crosses >50% Holsteins (HX) and crosses >50% Jerseys (JX), where sire breed is listed first. The CBW model also included GL as a covariate. Logistic regression for calving ease and neonatal calf mortality included fixed effects of sex, parity, and genetic group. Genetic groups were replaced by linear regression using percentage of HH genes as coefficients on the above models and included as covariates to determine various genetic effects. Year and dam were included as random effects in all models. Female calves (27.57 ± 0.54 kg), twins (26.39 ± 1.0 kg), and calves born to first-parity cows (27.67 ± 0.56 kg) had lower CBW than respective male calves (29.53 ± 0.53 kg), single births (30.71 ± 0.19 kg), or calves born to multiparous cows (29.43 ± 0.52 kg). Differences in genetic groups were observed for CBW and GL. Increased HH percentage in the calf increased CBW (+9.3 ± 0.57 kg for HH vs. JJ calves), and increased HH percentage in the dams increased CBW (+1.71 ± 0.53 kg for calves from HH dams vs. JJ dams); JH calves weighed 1.33 kg more than reciprocal HJ calves. Shorter GL was observed for twin births (272.6 ± 1.1 d), female calves (273.9 ± 0.6 d), and for first-parity dams (273.8 ± 0.6 d). Direct genetic effects of HH alleles shortened GL (−3.5 ± 0.7 d), whereas maternal HH alleles increased GL (2.7 ± 0.6 d). Female calves had lower odds ratio (0.32, confidence interval = 0.10–0.99) for neonatal calf mortality in second and later parities than did male calves. Maternal heterosis in crossbred primiparous dams was associated with reduced calf mortality.
Key words: crossbreeding, genetic group, Holstein, Jersey

INTRODUCTION

Calving ease and neonatal calf mortality are economically important traits in the dairy business. Calving is a stressful event for the cow. The amount of stress is often affected by high calf birth weight (**CBW**), calving difficulty, and calf mortality (Olson et al., 2009). Calving difficulty has been associated with reduced survival of both cow and calf, as well as lower production, fertility, and longevity for the cow. Calving difficulty can lead to increased rates of neonatal calf mortality, lower milk production, and overall reduced health of cows (Heins et al., 2006a). Stillbirth, abortion, and death of calves after parturition are an immediate economic loss. In addition, loss of female calves increases the number of pregnant females needed to produce replacement females to maintain cow numbers in a herd. For births that require assistance during calving, additional cost estimates range from $96.48 to $397.61, depending on the type of assistance needed (Dematawewa and Berger, 1997).

Holsteins have dominated the dairy industry in the United States due to their high milk production. Jerseys are the second most popular cow breed in the United States and account for 7% of the US dairy population. Over the past several decades, average milk production per cow has increased. In contrast, health and fertility traits have declined (Bjelland et al., 2011). Numerous studies have evaluated crossbreeding Holsteins with other breeds to improve production, fertility, surviv-

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ability, and calving ease (Heins et al., 2006a, b, 2008; Sørensen et al., 2008; Prendiville et al., 2010). Interest in crossbreeding has grown over the past decade among both dairy producers and researchers especially to improve calving ease (Weigel and Barlass, 2003; Heins et al., 2006b). Many studies have shown benefits in reducing calving difficulties in a crossbreeding system with various breeds (Touchberry, 1992; Heins et al., 2006a,b; Maltecca et al., 2006).

Olson et al. (2009) reported a significant decrease in calving difficulty for Jersey-sired crossbred calves compared with Holstein calves. Heins et al. (2003) found that Jersey-sired calves out of Holstein dams had less calving difficulty than pure Holstein. Heins et al. (2006a) also found that crossbred dams had less calving difficulty than purebred dams. Sørensen et al. (2008) reported unfavorable heterosis for direct effects in calving ease and neonatal calf mortality in heifers, and found favorable heterosis for maternal effects for both calving ease and neonatal calf mortality. Olson et al. (2009) reported unfavorable direct genetic effects in calving ease and found favorable maternal genetic effects for both calving ease and neonatal calf mortality.

The objective of this study was to evaluate differences in CBW, gestation length (**GL**), calving ease, and neonatal calf mortality among purebred Holstein, Jersey, their reciprocal crosses, backcrosses, and other crosses in a planned rotational mating program in a pasture-based production system.

MATERIALS AND METHODS

Experimental Design

A pasture-based dairy crossbreeding system using purebred Holstein (**HH**) and Jersey (**JJ**) cattle was established at the Center for Environment Farming Systems (CEFS; Goldsboro, NC). The crossbreeding system was designed so that each purebred cow or heifer was inseminated using semen from the same breed one year or from the opposite breed the next year based on odd and even eartag numbers. The same alternating breeding scheme was used for F_1 heifers and cows (**JH** and **HJ**, with sire breed first) such that any F_1 cow would have a calf that was 75% HH one year and another calf that was 75% JJ the next year or vice versa. For cows and heifers that were >50% of one breed (e.g., 75, 62.5, or 68.75%), all matings were planned to be to the opposite breed, so that 75% of one breed was theoretically the highest percentage cross. In practice, for 1.87% of cases, a mating was inadvertently made to the same breed as the sire, resulting in different percentages of crossbred offspring than planned. Six genetic groups were formed by using this crossbreeding system: purebred HH, purebred JJ, reciprocal F_1 crosses (HJ, JH), crosses >50% HH (**HX**; average = 69.25% HH), and crosses >50% JJ (**JX**; average = 29.0% HH). It should be noted that when mating virgin heifers of any breed with HH sires, calving ease sires were used with predicted difficult births at or below 7% at the time semen was purchased. This restriction was not in effect for use of HH sires for breeding lactating cows. Semen from 62 HH sires and 22 JJ sires was used for breeding, which produced 632 calves from HH sires and 599 calves from JJ sires. Approximately 40% of the dams had 1 calving observation (18% of total observations), whereas 60% of the cows calved from 2 to 9 times (82% of total observations) during the study.

Recording of Data

Data for CBW, calving ease, and neonatal calf mortality were recorded over 9 calving seasons from June 2003 through December 2011. Calf birth weights were recorded shortly after calving. Calving ease was measured on a scale from 1 to 5, where 1 = no assistance, 2 = slight problem and required some assistance, 3 = required moderate assistance, 4 = required considerable force, and 5 = extreme difficulty. The distributions of calving ease score were as follows: 1 (n = 1,135), 2 (n = 44), 3 (n = 26), 4 (n = 19), and 5 (n = 7). Calving ease scores of 1 were coded as unassisted (0) and calving scores from 2 to 5 were coded as assisted (1) because of the limited number of observations in individual categories. Neonatal calf mortality was coded as 0 for the calf born alive and surviving past 48 h, and 1 for abortions recorded after mid-gestation, stillborn, or dead within 48 h of calving. Gestation length was calculated as the days from date of last insemination to subsequent date of calving. Gestation length records for 12 cows were removed because they were greater than ±3 standard deviations (where 1 SD was 6 d) from the mean of 277 d. The data set included 1,231 total calvings with 190, 329, 113, 139, 331, and 129 births of HH, HX, HJ, JH, JX, and JJ calves, respectively (Table 1). Note that 9.8% (n = 121) of the calves (HH, HJ, JH, and JJ from planned matings from 2002 to 2006) in this study were included in the 3-state study of Olson et al. (2009) but are also included in the present study to allow for more robust contemporary comparisons among various breed groups within the pasture-based system.

Statistical Analyses

Data were analyzed using linear mixed model in SAS (version 9.2, 2008; SAS Institute Inc., Cary, NC). The model used for CBW was