Re-Examination of Service-Sire Conception Rates in the United States

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Abstract

Until recently sire conception rates (SCRs) in the United States had been published only for bulls from artificial-insemination (AI) organizations that paid dairy records processing centers a fee for editing the data and forwarding it to the national dairy database of the Council on Dairy Cattle Breeding (CDCB). In April 2015, the published list expanded because CDCB agreed to cover the fees; now SCRs are published for all AI bulls that exceed the minimum requirements for number of inseminations and herds. The number of bulls across all breeds with published SCRs in April 2015 was 2 799 compared with 1 939 in December 2014. Mean SCR is set to zero for all AI bulls within each breed, whether published or not. The mean of published AI Holstein bulls was 0.36 in December 2014 and 0.00 in April 2015. The standard deviation for Holsteins increased slightly from 2.04% in December 2014 to 2.08% in April 2015 because the additional bulls had lower SCRs than those included before. The SCRs generally increased with bull age as fixed effects for Holsteins in April 2015 were –0.58, –0.37, –0.21, 0.05, 0.06 and 0.63% for ages <1.3, 1.4–1.5, 1.6–1.7, 1.8–2.0, 2.1–4.5 and 4.6–5.5 years, respectively, but declined thereafter. Age effects for SCR are not intended to facilitate comparisons of bull ranking at a common age as is done for yield traits. An SCR is a phenotypic assessment of the bull's prospective fertility and not a genetic evaluation. It represents a bull's expected conception rate in the current environment and timeframe in contrast to a reflection of his lifetime success. Correlations between December 2014 and April 2015 SCRs were 0.96 for both Holsteins and Jerseys, 0.82 and 0.87 between April 2013 and April 2015 SCRs and 0.50 and 0.53 between April 2011 and April 2015 SCRs. The April 2015 Holstein and Jersey SCRs were based on a mean of 4 410 and 2 053 inseminations per bull with a mean reliability of 85 and 74%, respectively. Of particular interest was whether including an AI organization-year effect in the model was effective in improving the prediction of fertility. Results revealed that alternative models ignoring AI organization-year effect were still less effective in prediction of future conception rates, the same as in the past.

Key words: conception rate, fertility, service sire

Introduction

Research was initiated at North Carolina Dairy Records Processing Center in 1986 to predict service-sire fertility (70-day non-return rate) from Dairy Herd Improvement Association data. The process was labeled estimated relative conception rate (ERCR) and was published routinely. In 2006, USDA's Animal Improvement Programs Laboratory took charge of the calculations while Dr. Melvin Kuhn developed new methodology. In 2008, the revised service sire prediction was labeled SCR (Norman *et al.*, 2008). Over time, organizations relied more on SCR as inseminations by AI technicians declined and on-farm service grew. Demand by producers for more reproductive assistance increased. Synchronized estrus flourished. Genetic traits were introduced: daughter pregnancy rate in 2003 and cow and heifer conception rates in 2009. An SCR is considered to be phenotypic because the genetic component was estimated to be only 0.1% (Kuhn and Hutchison, 2008).

The AI organizations that compensated dairy records processing centers for breeding data had SCRs published for their bulls from 2008 to 2014. The CDCB agreed to pay the fees, and in April 2015, SCRs were published for bulls from all AI organizations if the bull had the required minimum number of herds (10 for Holsteins and Jerseys; 5 for other breeds) and number of services (300 for Holsteins; 200 for other breeds). Because more bulls are published now and the situation might have changed over 7 years, the Sire Fertility Committee of the National Association of Animal Breeders (NAAB) asked that the procedure be re-examined. The objective was to determine if an alternative model would predict future fertility more accurately than the model currently in use. Of particular concern was whether the AI organization-year effect was a helpful addition to the model.

Material and Methods

Fixed effects included in the current SCR model were herd-year-season × registry status (2), parity (5), service number (7), year-state-month, standardized milk yield level (6), cow age grouping (7), length of breeding interval (2) and service bull's age group (up to 12, depending on breed). Random effects in the model were AI organization-mating year, service bull, cow (both permanent environment and genetic) and residual. Covariances included were inbreeding coefficients of the service bull and the embryo from the mating (Kuhn *et al.*, 2008).

Effects are estimated each run from the latest 4 years of data. Specific effects (AI organization-mating year, service bull's age group and inbreeding coefficients for both the service bull and the embryo from the mating) are then used in the prediction model to produce each bull's SCR until the next calculation (4-month intervals). Some effects substituted into the prediction model for each bull are different from the ones in the estimation; for example, individual bulls are older each run and, therefore, older age effects are more appropriate. This study examined the effects of bull age and determined whether age effects had changed over time.

In 2008, several effects were tested in the model (Norman *et al.*, 2008) to be sure each was beneficial, including age of bull, AI organization-year, inbreeding coefficient of the bull and inbreeding coefficient of the embryo. Predictions comparing the effect of AI organization-mating year versus the effect of mating year only were compared to assess the usefulness of the effect and to observe how each impacted the predictability of future conception rate for the complete year after the April 2014 run cutoff date.

Because two AI organizations indicated they each operate with two different NAAB codes and their processing and distributing of semen for those two codes may differ, an additional comparison of predictions from having separate groupings versus a single group for each was made.

Results and Discussion

Age Effects and Changes over Time

The SCRs generally increased with bull age as fixed effects for Holsteins in April 2015 were –0.58, –0.37, –0.21, 0.05, 0.06 and 0.63% for ages <1.3, 1.4–1.5, 1.6–1.7, 1.8–2.0, 2.1–4.5 and 4.6–5.5 years, respectively, but declined thereafter. The age difference between the high and low conception rate (CR) groups was only 72% as large in April 2015 as it was in December 2011.

CR by Breed and Number of Inseminations

Mean CRs were based on inseminations following those used in April 2014 evaluations. For Holsteins, additional subsets were created using the number of inseminations in the service sire's published SCR. Mean CRs (Table 1) differed by breed, with Holsteins averaging 32.9% and Jerseys, 39.4%. The CRs for daughters of Holstein bulls with more inseminations was slightly higher than mean CR, which reflects dairy producer preference for bulls with higher SCR ratings.

Correlations between bull SCR and daughter CR the following year (Table 1) confirmed the findings from earlier work that including AI organization in the model resulted in a better prediction of future CR

Table 1. Mean CRs and SCRs based on April 2014 evaluations and weighted by number of inseminations and correlations of bull SCR with daughter CR in the following year.

Breed	Minimum inseminations (no.)	Bulls with daughters included (no.)	Mean CR (%)	Mean SCR (%)	Correlation Only year included	Correlation AI organization-year included	Gain in repeatability from including AI organization (% points)
Holstein	300	2 331	32.9	1.23	0.0217	0.0221	1.9
	1 000	1 609	32.9	1.29	0.0212	0.0215	1.6
	5 000	476	33.1	1.33	0.0226	0.0230	1.7
Jersey	300	285	39.6	0.77	0.0275	0.0300	9.1

than a model with only year effect. The percentage of improvement in correlation ranged from 1.6 to 1.9% for Holstein subsets but was considerably higher at 9.1% for Jerseys.

Separate AI Organization-Year Effects for AI Organizations with Multiple NAAB Codes

Including separate AI organization-year effects for the two AI organizations that each operate with two NAAB codes affected the AI organization group for 994 of 2 331 Holstein bulls. The NAAB codes that the two organizations have were consolidated, and the outcome was examined. Correlation between all bulls from the original and alternate approaches was >0.999 in contrast to 0.987 when no AI organization effect was included. Correlations within the four groups before versus after combining ranged from 0.991 to >0.999 (affected by number of bulls in each group and differences in AI organization–year effects). Correlations for the affected organizations between SCR from consolidating or not and future fertility were both 0.0221, which was higher than the alternative of not considering AI organization effect (0.0217). The choice of whether to consolidate across sampling groups had little effect on the results, but either was considerably more accurate than the alternative of including year effect only.

Conclusions

The CRs were lowest for bulls that were <1.3 years of age and highest when bulls were near 5 years of age. Similar to previous results (7 years ago), prediction of CR is more accurate if AI organization-year effect is in the model than when only year effect is included. Little difference was found in predicting future fertility for AI organizations with multiple NAAB codes by consolidating AI organization-year effects.

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