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DESCRIPTION OF NATIONAL GENETIC EVALUATION SYSTEMS

Country (or countries)	United States of America
Main trait group[1]	Female Fertility Trait 1: Maiden heifer's ability to conceive (heifer conception rate) Trait 3: Lactating cow's ability to conceive 1 (cow conception rate) Trait 5: Lactating cow's interval calving-conception (daughter pregnancy rate)
Breed(s)	Holstein, Jersey, Brown Swiss, Guernsey, Ayrshire, Milking Shorthorn
Trait definition(s) and unit(s) of measurement[2] Attach an appendix if needed	Trait 1: Heifer conception rate is defined as the percentage of inseminated heifers that become pregnant at each service. A heifer CR of 1 implies that daughters from this bull are 1% more likely to become pregnant as a heifer than a bull with an evaluation of 0. Trait 3: Cow conception rate is defined as the percentage of inseminated cows that become pregnant at each service. A Cow CR of 1 implies that daughters from this bull are 1% more likely to become pregnant during that lactation than a bull with an evaluation of 0. Trait 5: Daughter pregnancy rate is defined as the percentage of nonpregnant cows that become pregnant during each 21-day period. A DPR of 1 implies that daughters from this bull are 1% more likely to become pregnant during that estrus cycle than a bull with an evaluation of 0. Each increase of 1% in PTA DPR equals a decrease of 4 days in PTA days open
Method of measuring and collecting data	Collected by Dairy Herd Improvement Associations using ICAR approved methods.
Time period for data inclusion	Trait 1: 2003 and later. Trait 3: 2003 and later for first calving. Trait 5: 1960 and later for first calving.
Age groups (e.g. parities) included	Trait 1: Only breedings where the heifer is at least 1 year old but less than 2.2 years old are included. Trait 3: First 5 parities are included; only breedings where the cow is at least 2 years old are included. Trait 5: First 5 parities are included.

Other criteria (data edits) for inclusion of records	Trait 1: All confirmed (failure or success) breedings* up to the 7th are included. Herd-year conception rate must be between 10 and 90%. A known sire is required, and known ET heifers are excluded. Heifers must be 97% purebred to have an evaluation, and within-breed matings are required. Trait 3: All confirmed (failure or success) breedings* up to the 7th are included. Herd-year must report at least 1 breeding for at least 50% of milking cows, and conception rate must be between 10 and 90%. A known sire is required, and known ET cows are excluded. Cows must be 97% purebred to have an evaluation, and within-breed matings are required. Trait 5: Records for pregnancy rate are considered to be complete at 250 days in milk (DIM); pregnancy status after 250 DIM is used, but records are set to the maximum 250 DO. Date pregnant is set equal to 50 for any cows that become pregnant before 50 DIM. Some extremely early pregnancy dates obtained by calculation from date of next calving are inaccurate because of short gestation lengths or unreported abortions. The lower and upper limits of 50 and 250 are applied after adjusting days open for season effects and affect 5% and 14% of the records, respectively. *A service is coded as a failure if another reproductive event (breeding–AI or natural service, heat, or diagnosis of "not pregnant") is subsequently reported or as a success if validated with a pregnancy check or from a resulting calving date recorded.
Criteria for extension of records (if applicable)	Trait 5: DIM ≥130 days and <250 days are predicted.
Sire categories	All sires (AI and natural service) are evaluated together.
Environmental effects[3], pre-adjustments	Trait 5: Season adjustments based on month fresh; heterogeneous variance adjustments using the same procedures developed for yield traits.
Method (model) of genetic evaluation[3]	Traits 1, 3: ST BLUP repeatability animal model within each breed. Trait 5: All breeds and crossbred cows are evaluated together in a multibreed BLUP animal model
Environmental effects[3] in the genetic evaluation model	Trait 1: Fixed: management group (flexible herd-year-season-registry), year-state-month of breeding, service number, heifer age at breeding, short cycle, mating type; random: permanent environment. Trait 3: Fixed: management group (flexible herd-year-season-parity-registry), parity, year-state-month of breeding, service number, cow age, short cycle, mating type; random: permanent environment Trait 5: Fixed: management group (flexible herd-year-seasons), parity × age, regression on inbreeding; random: permanent environment, and herd × sire interaction. HOL management group definition includes registry status. Published PTA includes the expected future inbreeding (EFI) and coefficients of heterosis when mated to purebreds multiplied by the regression coefficients as a post-processing step.

Adjustment for heterogeneous variance in evaluation model	Trait 1: No adjustment Trait 3: No adjustment Trait 5: Herd-year variances are adjusted to equal first parity variance of cows calving in 2002 (base year + 2) using the same methods as developed for yield traits.
Use of genetic groups and relationships	Trait 5: Unknown parents are grouped by year, breed, and, for Holsteins, separately for U.S. and foreign animals. Unknown sires and dams of cows are grouped separately, but unknown parents of bulls are in a combined group. Separate unknown-parent groups are used for red-and-white or black-and-white Holsteins. The relationship matrix accounts for effects of inbreeding on Mendelian sampling variance.
Blending of foreign/Interbull information in evaluation	NA
Genetic parameters in the evaluation	Trait 1: Heritability 1%, permanent environment variance 2.5%, repeatability 12% Trait 3: Heritability 1.6%, permanent environment variance 1.2%, repeatability 7% Trait 5: Heritability 4%, permanent environment variance 12%, herd × sire interaction 4%, repeatability 20%
System validation	Means and SD for all variables are calculated and examined overall. Means for new bulls, changes for high bulls, largest changes, and key statistics for recent AI bulls are checked. Genetic trends for each breed are validated by methods 1, 2, and 3.
Expression of genetic evaluations If standardised (e.g. RBV), give standardisation formula in the appendix	Trait 1: PTAHefCR % Trait 3: PTACowCR % Trait 5: PTA DPR % [All-breed PTA DPR are adjusted to within-breed bases as follows: within-breed PTA = (all-breed PTA – breed mean)(breed SD/Holstein SD).
Definition of genetic reference base	Average of all cows born in 2000.
Next base change	February 2010 when the base will be cows born in 2005.
Calculation of reliability	Trait 1, 3: acc.f90 of Misztal Trait 5: Daughter equivalents from progeny, parents, and own records are combined using the same methods as for yield traits. Currently verified and nonverified records receive the same weight.
Criteria for official publication of evaluations	At least 10 daughters with usable fertility data.
Number of evaluations / publications per year	3 (January, April, and August).
Use in total merit index[4]	Trait 5: Net merit (all breeds): DPR receives 9% of the total emphasis. TPI (Holsteins): DPR receives 5% of the total emphasis.
Anticipated changes in the near future	Additional genetic evaluations for days from calving to first insemination and days from first to last insemination.

Key reference on methodology applied	Kuhn, M.T., and J.L. Hutchison. 2008. Prediction of dairy bull fertility from field data: Use of multiple services and identification and utilization of factors affecting bull fertility. J. Dairy Sci. 91:2481–2492. Kuhn, M.T., J.L. Hutchison, and H.D. Norman. 2008. Modeling nuisance variables for prediction of service sire fertility. J. Dairy Sci. 91:2823–2835. Kuhn, M.T., J.L. Hutchison, and G.R. Wiggans. 2006. Characterization of Holstein heifer fertility in the United State. J. Dairy Sci. 89:4907–4920. Kuhn, M.T., and P.M. VanRaden. 2004. Use of early lactation days open records for genetic evaluation of cow fertility. J. Dairy Sci. 87:2277–2284. VanRaden, P.M., A.H. Sanders, M.E. Tooker, R.H. Miller, and H.D. Norman. 2002. Daughter pregnancy rate evaluation of cow fertility. AIPL Research Report DPR1 (11/2002). Online: http://aipl.arsusda.gov/reference/fertility/DPR_rpt.htm. VanRaden, P.M., A.H. Sanders, M.E. Tooker, R.H. Miller, H.D. Norman, M.T. Kuhn, and G.R. Wiggans. 2004. Development of a national genetic evaluation for cow fertility. J. Dairy Sci. 87:2285–2292. VanRaden, P.M., M.E. Tooker, J.B. Cole, G.R. Wiggans, and J.H. Megonigal, Jr. 2007. Genetic evaluations for mixed-breed populations. J. Dairy Sci. 90:2434–2441. VanRaden, P.M., and G.R. Wiggans. 1991. Derivation, calculation, and use of national animal model information. J. Dairy Sci. 74:2737–2746. Wiggans, G.R., and R.C. Goodling. 2005. Accounting for pregnancy diagnosis in predicting days open. J. Dairy Sci. 88:1873–1877. Wiggans, G.R., and P.M. VanRaden. 1991. Method and effect of adjustment for heterogeneous variance. J. Dairy Sci. 74:4350–4357.
Key organisation: name, address, phone, fax, e-mail, web site	Animal Improvement Programs Laboratory USDA, Agricultural Research Service Building 005, Room 306, BARC-West 10300 Baltimore Avenue Beltsville, Maryland 20705-2350, USA Tel: 301-504-8334 Fax: 301-504-8092 E-mail: paul@aipl.arsusda.gov web site: http://aipl.arsusda.gov

1) Either: Production (e.g. milk, fat, protein), Conformation, Health (e.g. mastitis resistance, milk somatic cell, resistance to diseases other than mastitis), Longevity, Calving (e.g. stillbirth, calving ease), Female fertility (e.g. non-return rate, interval between reproductive events, number of AI's, heat strength), Workability (e.g. milking speed, temperament), Beef production, Efficiency (e.g. body weight, energy balance, body conditioning score), or Other traits.
2) Indicate frequencies per category if the trait is categorical and specify transformation of data if practiced.
3) Use abbreviations for most common effects (see document with list of abbreviations at http://www-interbull.slu.se/service_documentation/General/list_of_abbreviations.rtf) and indicate random (R) or fixed (F).
4) Please give economic weights and indicate how they are expressed (preferably in genetic standard deviation units).

Parameters for national genetic evaluations for female fertility traits as provided to Interbull

Country (or countries): USA
Main trait group: Female fertility
Breed(s): Holstein, Jersey, Brown Swiss, Guernsey, Ayrshire, Milking Shorthorn

Trait name	h^2	genetic variance	official proof standardisation formula[a]
Maiden heifer's ability to conceive:	0.01	0.00231	
Lactating cow's ability to start cycling:			
Lactating cow's ability to conceive 1:	0.016	0.00338	
Lactating cow's ability to conceive 2:			
Lactating cow's interval calving-conception:	0.04	$(3.04)^2$	Conversions from the all-breed base to the within-breed bases are updated on the AIPL web site. March 2007 formulas were: BSW PTA = (all-breed PTA – 0.4)*0.990 GUE PTA = (all-breed PTA – 0.4)*0.973 HOL PTA = (all-breed PTA + 0.2)*1.000 JER PTA = (all-breed PTA – 2.6)*0.939 MSH PTA = (all-breed PTA – 2.3)*0.903 RDC PTA = (all-breed PTA – 1.1)*0.945

[a] Expressed as follows:
StandEval=((eval-a)/b)*c+d where a=mean of the base adjustment, b=standard deviation of the base, c=standard deviation of expression (include sign if scale is reversed), and d=base of expression.

Genetic and residual covariances for countries with national multiple trait evaluations. Genetic covariances on upper diagonals, residual covariances on lower diagonals.

Trait name	Trait 1:	Trait 2:	Trait 3:	Trait 4:	Trait 5:
Trait 1: Maiden heifer's ability to conceive					
Trait 2: Lactating cow's ability to start cycling					
Trait 3: Lactating cow's ability to conceive 1					
Trait 4: Lactating cow's ability to conceive 2					
Trait 5: Lactating cow's interval calving-conception					