

DESCRIPTION OF NATIONAL GENETIC EVALUATION SYSTEMS

Country (or countries)	United States of America
Main trait group	Female fertility [heifer conception rate (HCR), calving to first insemination (CFI), cow conception rate (CCR), daughter pregnancy rate (DPR)]
Breed(s)	AYS (RDC), BSW, GUE, HOL (B&W, R&W), JER, MSH (RDC); single-breed evaluations for HCR and CCR; all breeds and crossbred cows evaluated together in a multibreed AM for DPR
Trait definition(s) and unit(s) of measurement	<p>HCR: Maiden heifer's ability to conceive (trait 1) defined as percentage of inseminated heifers that become pregnant at each service; an HCR of 1 implies that daughters of this bull are 1% more likely to become pregnant as a heifer than daughters of a bull with an evaluation of 0</p> <p>CFI: Lactating cow's ability to start cycling (trait 2) defined as days from calving to first insemination; estimated as a linear function of PTA for CCR and DPR instead of directly from raw data</p> <p>CCR: Lactating cow's ability to conceive (trait 3) defined as percentage of inseminated cows that become pregnant at each service; a CCR of 1 implies that daughters of this bull are 1% more likely to become pregnant during that lactation than daughters of a bull with an evaluation of 0</p> <p>DPR: Lactating cow's interval calving-conception (trait 5) defined as 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 DO</p>
Method of measuring and collecting data	Collected by Dairy Herd Improvement Affiliates using ICAR-approved methods
Time period for data inclusion	<p>HCR: Calvings from 2003 and later</p> <p>CCR: First calvings from 2003 and later</p> <p>DPR: First calvings from 1960 and later</p>
Age groups (e.g. parities) included	<p>HCR: Only breedings for which heifer is at least 1 but <2.2 years old included</p> <p>CCR: First 5 parities included; only breedings for which cow is at least 2 years old included</p> <p>DPR: First 5 parities included</p>

Other criteria (data edits) for inclusion of records	<p>HCR: All confirmed (failure or success) breedings* up to 7 included; herd-year conception rate must be between 10 and 90%; known sire required; known ET heifers excluded; heifers must be 97% purebred to be evaluated; within-breed matings required</p> <p>CCR: All confirmed (failure or success) breedings* up to 7 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%; known sire required; known ET cows excluded; cows must be 97% purebred to be evaluated; within-breed matings required</p> <p>DPR: Records for pregnancy rate considered complete at 250 DIM; pregnancy status after 250 DIM used, but records set to 250 DO; date pregnant set to 50 DIM for cows that become pregnant before 50 DIM; some extremely early pregnancy dates obtained by calculation from date of next calving inaccurate because of short gestation lengths or unreported abortions; lower (50) and upper (250) limits applied after adjusting DO for season effects and affect 5 and 14% of records, respectively</p> <p>*Service coded as failure if another reproductive event (breeding–AI or NS, heat, or diagnosis of “not pregnant”) subsequently reported or as success if validated with a pregnancy check or resulting calving date</p>
Criteria for extension of records (if applicable)	DPR: DIM \geq 130 and $<$ 250 predicted
Sire categories	All sires (AI and NS) evaluated together
Environmental effects, pre-adjustments	DPR: Season adjustments based on month fresh; heterogeneous variance adjustments use same procedures developed for yield traits
Method (model) of genetic evaluation	<p>HCR: ST BLUP RP AM within breed</p> <p>CCR: ST BLUP RP AM within breed</p> <p>DPR: Multibreed BLUP AM; all breeds and crossbreds evaluated</p>
Environmental effects³ in the genetic evaluation model	<p>HCR: Management group (flexible HYS-registry status) (F), year-State-breeding month (F), service number (F), heifer breeding age (F), short cycle (breeding \leq17 days after last service) (F), mating type (F), PE (R)</p> <p>CCR: Management group (flexible HYS-parity-registry status) (F), parity (F), year-State-breeding month (F), service number (F), cow age (F), short cycle (F), mating type (F); PE (R)</p> <p>DPR: Management group (flexible HYS, includes registry status for HOL) (F), parity \times age (F), regression on inbreeding (F), PE (R), herd \times sire interaction (R); released PTA includes regression coefficient multiplied by expected future inbreeding (EFI) and coefficient of heterosis when mated to purebred as a post-processing step</p>
Adjustment for heterogeneous variance in evaluation model	DPR: Herd-year variances adjusted to equal first-parity variance of cows calving in 2007 (base year + 2) using the same methods developed for yield traits

Use of genetic groups and relationships	DPR: Unknown parents grouped by birth year, breed, and, for HOL, separately for U.S. and foreign animals; unknown sires and dams of cows grouped separately, but unknown parents of bulls in a combined group; separate unknown-parent groups used for R&W and B&W HOL; relationship matrix accounts for effects of inbreeding on Mendelian sampling variance
Blending of foreign/Interbull information in evaluation	Not applicable
Genetic parameters in the evaluation	See Appendix GE for h^2 /genetic variance estimates and “calculation of reliability” section below for use in calculation; HCR: PE variance, 0.025; RP, 0.12 CCR: PE variance, 0.012; RP, 0.07 DPR: PE variance, 0.12, herd \times sire interaction; 0.04, RP, 0.20
System validation	Means and SDs for all variables calculated and examined overall; means for new bulls, changes for high bulls, largest changes, and key statistics for recent AI bulls checked; genetic trends for each breed validated by methods 1, 2, and 3
Expression of genetic evaluations	PTA, % for HCR, CCR, and DPR; PTA, days for CFI HCR: PTA = within-breed PTA – breed mean CFI: PTA = 1.2(PTA CCR) – 3.6(PTA DPR) CCR: PTA = within-breed PTA – breed mean DPR: All-breed PTAs adjusted to within-breed bases as within-breed PTA = (all-breed PTA – breed mean) \times (breed SD/HOL SD)
Definition of genetic reference base	HCR: All evaluated bulls (rolling, every evaluation) CCR: All evaluated bulls (rolling, every evaluation)
Next base change	DPR: Cows born in 2005 (stepwise, 5 years) April 2015 (when base will be cows born in 2010)
Calculation of reliability	HCR: ACCF90 (Misztal, I., et al. 2002. BLUPF90 and related programs. Commun. No. 28–07 in Proc. 7th World Congr. Genet. Appl. Livest. Prod., Montpellier, France) CFI: 0.37(CCR reliability) + 0.63(DPR reliability) CCR: ACCF90 (Misztal, I., et al. 2002. BLUPF90 and related programs. Commun. No. 28–07 in Proc. 7th World Congr. Genet. Appl. Livest. Prod., Montpellier, France) DPR: Daughter equivalents from progeny, parents, and own records 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 (April, August, December)
Use in total merit index⁴	DPR: 11% of total in net merit dollars (NM\$, all breeds); 10% of total in Total Performance Index (TPI, HOL)

Anticipated changes in the near future	Additional genetic evaluations for days from first to last insemination
Key reference on methodology applied	<p>VanRaden, P.M., and G.R. Wiggans. 1991. Derivation, calculation, and use of national animal model information. J. Dairy Sci. 74:2737–2746.</p> <p>Wiggans, G.R., and P.M. VanRaden. 1991. Method and effect of adjustment for heterogeneous variance. J. Dairy Sci. 74:4350–4357.</p> <p>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 Res. Rep. DPR1(11-02).</p> <p>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.</p> <p>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.</p> <p>Wiggans, G.R., and R.C. Goodling, Jr. 2005. Accounting for pregnancy diagnosis in predicting days open. J. Dairy Sci. 88: 1873–1877.</p> <p>Kuhn, M.T., J.L. Hutchison, and G.R. Wiggans. 2006. Characterization of Holstein heifer fertility in the United States. J. Dairy Sci. 89:4907–4920.</p> <p>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.</p> <p>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.</p> <p>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.</p>
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