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Changes in USDA-DHIA genetic evaluations (August 1997)

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Heritability increased to .30

Heritability is the proportion of variation among records that results from genetics. Since 1989, a heritability of .25 has been used by the Animal Improvement Programs Laboratory (AIPL) when calculating USDA-DHIA genetic evaluations for yield traits. Prior to 1989, a heritability of .20 was used. Recently, many researchers have estimated higher heritabilities for yield traits, and most countries now assume a heritability higher than .25.

To determine if a heritability of .25 was appropriate for U.S. evaluations, new estimates were developed by AIPL for the complete national data set using a model analogous to the one used for computing USDA-DHIA genetic evaluations. Because of limitations of current computing algorithms, only first-lactation records could be analyzed. Use of Method R, a relatively new statistical tool, allowed inclusion of all first-lactation milk, fat, and protein yields of cows born since 1980 in separate analyses by breed. Pedigree information was included for all animals born since 1970.

Heritability estimates for first-lactation milk yield were considerably higher than .25; estimates for fat and protein yields were slightly lower than those for milk yield but still generally higher than .25. Based on these results, the heritability used in calculation of USDA-DHIA genetic evaluations for milk, fat, and protein yields has been increased to .30.

Heterogeneous variance adjustment since 1991 had allowed heritability to range from .20 to .30 with a midpoint of .25 for each birth year (and region). Heritability now ranges from .25 to .35, with a midpoint of .30. Use of wider heritability ranges and midpoints that varied by birth year were tested with Holstein data but resulted in less accurate evaluations.

Estimates of repeatability (the correlation between repeated records of the same cow) did not support any increase from its current value of .55. However, repeatability is the sum of heritability, the proportion of variation due to the interaction of sire and herd (environmental correlation between daughters of a sire in the same herd), and the proportion of variation due to permanent environment. To allow heritability to increase to .30 while repeatability remained at .55, the proportion of overall variation was reduced from .14 to .10 for herd-sire interaction and from .16 to .15 for permanent environment. Changing the relative proportions of variation assigned to heritability, herd-sire interaction, and permanent environment results in larger differences in evaluations for bulls with small numbers of daughters or proven in only a few herds. Additional research on estimation of heritability and other variance components will be conducted.

Deviations limited

The increase in heritability for yield traits also increased the emphasis on an animal's performance relative to information from relatives. This increased emphasis on performance was expected to cause large deviations from management group averages to have a greater impact on genetic evaluations. To limit this impact, deviations were restricted to within ±4 herd-year standard deviations from management group average while continuing the previous practice of imposing a lower limit for deviations of half of the management group average. These limits on large deviations were not intended to preempt research on determining appropriate limits for deviations, which was designated as an area in need of additional research at the January 1997 meeting of the Council on Dairy Cattle Breeding.

Impact of changes examined

As a research test, evaluations for May 1997 were recalculated using the new heritability estimates and yield deviation limitations. A comparison of results from the new and previous systems indicated that the impact of these changes was not dramatic. Predicted transmitting abilities (PTA's) from the two systems were similar for most artificial-insemination (AI) bulls. Correlations of evaluations exceeded .99 for all birth years, and the correlation was .998 across birth years.

The effect of the system changes on bull evaluations as they progress to include second-crop daughter data also was examined. Changes in PTA's for protein based on Holstein data used for May 1997 evaluations from PTA's based on data from cows that freshened before January 1, 1993, were compared for the new and previous evaluation systems. Evaluations based on first-crop daughters had to include data from at least 10 but not more than 500 daughters; evaluations based on first- and second-crop daughters had to have an increase in reliability of at least .09 between the two evaluations. A total of 263 Holstein bulls met these criteria. Correlations between first-crop PTA's and PTA's that also included second-crop daughter data were larger for the new system than for the previous system.

Evaluations for Holstein AI bulls in August 1997 were compared with May 1997 evaluations for those bulls. The increase in heritability caused the average reliability to increase by .04. The increase in heritability also resulted in an increase in variation among evaluations. For bulls born in 1990 or later, the standard deviations of milk, fat, and protein PTA's for bulls with 100 daughters or fewer in August were 5% larger than the standard deviations for bulls with 100 daughters or fewer in May. For 543 bulls in active AI service after May 1997, their average PTA's in August declined slightly from their May averages: 7.8 lb of milk, .62 lb of fat, and .51 lb of protein.

Fat-protein release requirement

Although AIPL calculates an evaluation for all bulls with at least 10 daughters with lactation records that pass edits, not all evaluations are released to the dairy industry. To lower distribution costs, release of updated evaluations for bulls that are not likely to be still alive has been restricted. For a bull with daughters in only one herd to have an updated evaluation released, the sum of PTA's for fat and protein has been required to change by more than 10 lb since the last released evaluation. Beginning in August 1997, this requirement was increased to 15 lb. The release requirement of a change of more than 5 lb for bulls with daughters in more than one herd remains the same.

Evaluations for Netherlands bulls

Data for August 1997 USDA-DHIA genetic evaluations included milk records from 10 U.S. daughters or more of each of five Netherlands Holstein bulls (Celsius, Graton, Jabot, Jimtown, and Labelle-BL). Because the International Bull Evaluation Service (INTERBULL) requires second-country Holstein evaluations to have data from at least 75 daughters in 50 herds, U.S. evaluations for these Netherlands bulls were not included in the August 1997 INTERBULL evaluations. This INTERBULL edit removes potential bias that could occur if the bull's first daughters in the second country were imported or resulted from embryo transfer instead of random matings. The USDA-DHIA evaluations for these bulls have low reliability (51 to 66%), are unofficial, and should not be used in advertisements. For these bulls, evaluations on a U.S. scale from INTERBULL have much higher reliability (at least 81% in February 1997) and, therefore, are official.

For all five Netherlands bulls, the February 1997 INTERBULL PTA's for milk, fat, and protein were higher than the unofficial August 1997 USDA-DHIA PTA's for all traits. The daughter yield deviation (DYD's) of each bull received only partial weight for USDA-DHIA evaluations because so few (10 to 31) daughters were in U.S. herds, and the remaining weight was placed on the bull's parent average. If pedigree data are incomplete, which often is the case for non-U.S. bulls, parent averages can be lower than anticipated because the average genetic merit of U.S. unknown parents for that birth year is used for the missing information. Also, previous selection outside the United States is not available for calculation of USDA-DHIA evaluations, and imported bulls are assumed to be unselected progeny-test bulls.

Bull daughters within and outside the United States can be compared without the biases caused by incorrect parent averages or improper accounting for selection outside the United States by focusing on USDA-DHIA DYD's instead of PTA's. The DYD's for the five Netherlands bulls were highly variable, however, because records from so few daughters were included. Average DYD's of the five bulls, weighted by number of daughters, were 1,245 lb of milk, 42 lb of fat, and 65 lb of protein. Corresponding weighted averages of PTA's on the U.S. scale from February 1997 INTERBULL evaluations were 1,865 lb of milk, 74 lb of fat, and 73 lb of protein. Because the DYD's were based on early records in progress of only 85 cows, any assessment of how well INTERBULL evaluations of Netherlands bulls predict daughter performance in the United States should be considered preliminary. Future USDA-DHIA evaluations will include additional U.S. daughters of more non-U.S. bulls and lead to more accurate global rankings and conversion assessments.