Genetic Base Changes for February 2005

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Genetic and phenotypic progress || DPR and SCS genetic bases || Calving ease and PL evaluations || Model changes || Genetic trend validation

Genetic bases were updated previously in the United States in 1965, 1974, 1984, 1989, 1995, and 2000, and the next is scheduled for February 2005. Base changes for yield, health, and fertility traits in February 2005 are reported below; estimates of base changes for final score and individual type traits of non-Holstein breeds are reported separately (Wright, 2004). Stepwise genetic bases allow predicted transmitting abilities (**PTA**'s) from new evaluations to be easily compared with previous evaluations except at base changes, when accumulated genetic gain is subtracted so that all animals are compared with a more recent cow population. A particular animal's PTA is supposed to decrease when the base is changed and remain fairly constant between base changes. Interbull survey forms indicate that 19 of 25 countries plan to update their genetic bases for yield traits on the recommended 5-year schedule; the other 6 countries update every year or at each evaluation. A new PTA history query makes comparisons easier by adjusting previous PTA's to the current base and displaying all evaluations released by USDA since 1974.

Base changes provide an opportunity to review genetic progress and are a logical time to revise trait definitions and evaluation procedures. Several improvements to genetic evaluation models will be introduced with the February 2005 base change. These include adjustments for inbreeding depression and for differing standard deviations (**SD**'s) across lactations, expression of yield PTA's to a 36-month age base instead of a mature equivalent, and a heritability of .12 instead of .10 for somatic cell score (**SCS**). Also, calving ease evaluations will be introduced for Brown Swiss.

Genetic and phenotypic progress

Genetic and phenotypic trends comparing cows born in 2000 with cows born in 1995 are equal to or slightly less than the trends for the preceding 5 years reported at the previous base change in August 2000. For the February 2005 base change, the differences in PTA's are provided for Holstein, Jersey, Brown Swiss, Guernsey, Ayrshire, and Milking Shorthorn cows along with the phenotypic differences for standardized first-lactation traits of Holsteins:

Trait	Unit	Phenotypic progress (Holstein)	PTA progress (2000 - 1995 birth years)					
			Holstein	Jersey	Brown Swiss	Guernsey	Ayrshire	Milking Shorthorn
Net Merit	Lifetime $	…	155	128	146	100	76	57
Protein	Pounds	69	19	16	16	12	8	6
Fat	Pounds	78	18	16	19	16	9	6
Milk	Pounds	1982	592	442	479	420	259	225
Productive life	Months	.9	.3	.4	.4	.2	.2	.6
SCS	Log (base 2)	-.01	.01	.01	-.04	.02	-.01	.02
Udder	Composite	…	.36	.25	.30	.15	.25	.10
Feet/legs	Composite	…	.31	.15	.25	.10	.20	.00
Body size	Composite	…	.24	.45	.55	.25	.30	.20
Daughter pregnancy rate	%	-1.0	-.1	-.1	-.2	-.2	.0	.0

Service sire calving difficulty	%	-.2	.4	…	…	…	…	…
Daughter calving difficulty	%		-.4	…	…	…	…	…

Multiplication of the PTA progress by 2 indicates that genetic progress (or breeding value progress) again accounts for slightly more than half of the phenotypic progress for protein and milk, but not quite half of the progress for fat. For SCS, genetic trends were small and unfavorable (positive) except for slight improvement for Ayrshires and moderate improvement for Brown Swiss. For daughter pregnancy rate (**DPR**), all breeds had either no genetic improvement or slight declines.

DPR and SCS genetic bases

The PTA for DPR will be expressed on a cow base instead of a bull base to be consistent with the other traits. The DPR base change for each breed will then include the difference between bull and cow averages for 1995 and also the PTA progress from 1995 to 2000 birth years:

PTA DPR	Holstein	Jersey	Brown Swiss	Guernsey	Ayrshire	Milking Shorthorn
Cow average (1995)	.4	.2	.6	-.3	-.1	.5
Progress	-.1	-.1	-.2	-.2	.0	.0
Base change	-.3	-.1	-.4	.5	.1	-.5

For Holsteins, PTA DPR will decrease by .3 because average cow PTA was .4 higher than bull PTA in 1995, and a slight decline of -.1 has occurred since then.

Since 1994, PTA's for SCS have included individual breed averages that were near 3.0 but that changed at each base change mainly because of phenotypic change. Averages of standardized first-lactation records of cows born in 2000 are somewhat higher for Jerseys, Guernseys, and Milking Shorthorns; slightly lower for Brown Swiss and Ayrshires; and almost the same for Holsteins. For the 2005 base change, average PTA of base cows will be set to 3.0 for each breed. This practice was introduced in Canada in 1996 and also is used in Belgium. Canadian and U.S. PTA's will still not be exactly comparable because of slight genetic differences in base cows, but the two scales in 2005 will be much more similar than in previous years, and the base constant of 3.0 will be much easier to remember than breed averages:

Standardized SCS	Holstein	Jersey	Brown Swiss	Guernsey	Ayrshire	Milking Shorthorn
Cows born in 1995	3.10	3.31	3.09	3.21	2.93	3.03
Cows born in 2000	3.09	3.34	2.94	3.31	2.97	3.07
February 2005 base	3.00	3.00	3.00	3.00	3.00	3.00
PTA base change	-.11	-.32	-.05	-.23	.08	-.05

A proposal to reverse the SCS scale so that higher numbers would be favorable and to rename the trait from SCS to udder health was considered but was not unanimously approved by the Council on Dairy Cattle Breeding and, therefore, will not be implemented at this time. University researchers and the Genetic Advancement Committee of Holstein Association USA favored using a new scale, whereas National Association of Animal Breeders, American Jersey Cattle Association, and Canadian industry representatives favored continued use of the current SCS scale.

Phenotypic breed averages for SCS do not reflect genetic progress well. For example, Ayrshires had some genetic progress (a slight decrease in PTA), but their breed average SCS went up from 2.93 to 2.97; Holstein PTA's increased slightly, but the 2000 phenotypic breed average was .01 less than in 1995. A second issue is that the PTA's on different breed scales were not comparable even if SCS averages represented genetic differences, because breed differences measure the effect of all genes whereas PTA measures only half the genetic effect. To compare animals of different breeds fairly, differences within and across breeds must both have the same units (PTA or estimated breeding value). The new SCS scale that is centered on 3 within each breed does not allow across-breed comparisons, but this is consistent with evaluations for other traits that are centered on 0 within each breed.

Calving ease and PL evaluations

Calving ease evaluations for Brown Swiss will be introduced in February 2005. A combined analysis of Holstein and Brown Swiss data increases the number of contemporaries and allows crossbred calves from Brown Swiss sires to be included. The data set includes 12,000 purebred Brown Swiss calving records and 3,000 crossbred records for calves born since 1998. An evaluation of 65,000 Jersey calving records will not be implemented because nearly all Jersey sires had only 1 to 2% difficult births in heifers. Further description of the new procedures is provided by Cole, 2005.

Holstein and Brown Swiss bases report the percentage of difficult calvings expected when purebred heifers are mated to purebred bulls of the same breed. For 607 Holstein bulls with Active AI status in November 2004, average evaluation for service sire calving difficulty (SCE) decreased from 8.7 to 8.2 and for daughter calving ease (DCE) increased from 7.2 to 8.2 because of the base change. The constant values that are subtracted from SCE and DCE in the Net Merit formula will remain unchanged at 8 for Holsteins. For 55 Brown Swiss bulls in Active AI, averages were 4.8 for SCE and 4.6 for DCE. Net Merit for Brown Swiss will include SCE and DCE with the same economic value as for Holsteins, but the constant value subtracted in the Net Merit formula will be 5 for each trait.

Interbull will evaluate calving ease for Holsteins using procedures developed in Germany (Pasman et al, 2003) beginning in February 2005. A bull's Interbull evaluation will be official if it includes more progeny than the domestic evaluation. The calving ease format was extended for both the SCE and DCE traits to report source code (domestic or Interbull), percentage of domestic progeny, number of countries with progeny, and country with the most progeny. Unfortunately, Interbull will not provide DCE for any foreign bulls on the US scale or provide US data for DCE to any other country until May 2005 because of a small mistake that occurred in the September 2004 test run. Evaluations of SCE are expected in February 2005 for foreign bulls from Australia, Denmark, Finland, France, Italy, Netherlands, Sweden, and Switzerland. Net Merit for those bulls will include their Interbull evaluations instead of the pedigree indexes used previously for foreign bulls.

Productive life evaluations for foreign Jersey, Brown Swiss, Guernsey, and Ayrshire bulls will be provided and included in Net Merit using the same procedures introduced in November for Holstein bulls VanRaden and Wiggans, 2004. Genetic correlations among countries and further detail about the longevity analyses for these breeds was provided by Jakobsen et al, 2004.

Model changes

Several new adjustments to PTA calculation methods will be introduced in February 2005. Some of these model changes affect trait averages and SD's, and some changes were required to meet strict genetic trend validation tests required by Interbull. The main model changes are adjustments for inbreeding depression, an adjustment for differences in individual lactation SD, updated procedures for setting the base age and SD, and an increase in heritability to .12 (previously .10) for SCS. The new procedures caused very little reranking among current U.S. bulls and are not expected to change international rankings. For protein yield, correlations of official PTA's with new PTA's were .998 for current Holstein bulls and .993 for current Holstein cows. Correlations included bulls born since 1995 with August reliabilities of at least 70% and cows born since 1998 with reliabilities of 40% or greater. Cow PTA's changed somewhat more than bull PTA's because a cow's own inbreeding directly affects her performance. Yield trait PTA's of other breeds had slightly lower correlations:

Protein	Holstein	Jersey	Brown Swiss	Guernsey	Ayrshire	Milking Shorthorn
Correlations for bulls born since 1995, reliability of >70%	.998	.989	.996	.998	.994	
Correlations for cows born since 2000, reliability of >40%	.993	.943	.994	.996	.990	.981
New base SD/old base SD	1.11	1.18	1.12	1.05	1.05	1.05
Mature equivalent/36-month factor	1.10	1.10	1.15	1.05	1.10	1.15
Net change in SD of PTA	1.02	1.06	.98	1.02	.95	.88

For DPR and SCS, correlations between new model and previous model evaluations were near .999 for recent bulls within each breed.

The SD's of yield trait PTA's will change slightly in February 2005 for three reasons. The base SD will be determined from standardized yields of first-lactation cows calving in 2002, corresponding to the cows born in 2000 used to set the genetic base. The base SD was not updated since 1995, when SD were calculated from cows calving in 1992. The ratio of the new base SD to the old base SD of 1.11 for Holsteins indicates that the SD of protein yield increased by about 1% each year over the last 10 years. Jerseys had a larger increase in SD, whereas Guernseys, Ayrshires, and Milking Shorthorns had smaller increases in SD. A change in the base age from mature-equivalent yield to 36-month yield will nearly offset the increase in base SD. Division by the ratio of mature-equivalent to 36-month yield will decrease the SD by about 10% for most breeds; however, Brown Swiss and Milking Shorthorn cows mature more slowly, whereas Guernsey cows reach mature yields more quickly. Adjustments for differing SD's across lactations and for inbreeding also will cause slight changes to overall SD.

The net change in SD includes other slight increases or decreases in SD because of model changes that will be introduced. For yield traits, the SD's of genetic evaluations in the United States were larger than in many other countries for two reasons. Most countries report estimated breeding values in kilograms rather than PTA in pounds, and most use an average age instead of mature equivalent. The change to a 36-month age standard in the U.S. will give domestic and foreign evaluations more similar units. Since 1994, PTA SCS in the United States was already expressed to an average age rather than to mature equivalent. McDaniel (1973, Journal of Dairy Science 56:959-967) documented the advantages of using an earlier base age and nearly implemented this change at that time. The age-parity adjustment factors developed by Schutz (1994 research) were used to obtain comparisons of mature cows with 36-month-old cows of each breed. For SCS, the SD's of PTA's will increase slightly (from 2 to 5%) because of the increase in heritability.

Inbreeding adjustments include a regression on inbreeding in the animal model and also the regression multiplied by expected future inbreeding in the PTA. Thus, cows' records are adjusted for their own inbreeding as compared to their contemporaries, and each animal's PTA accounts for the inbreeding depression expected when mated at random to the current population. Genetic trend is reduced by about 6% for yield traits when the differences between past and future inbreeding are accounted for. Trend for DPR becomes 14% more negative, and trend for SCS changes from near 0 to slightly positive (unfavorable). The estimates of inbreeding depression (pounds per 1% F) were -65.3 for milk, -2.4 for fat, and -2.1 for protein from Wiggans et al. (1995 J. Dairy Science 78:1584) for Holsteins, with similar amounts for other breeds. For other traits, average literature estimates of +.003 for SCS and -.078 for DPR were used for all breeds. A regression of -.2 per 1% F for productive life was tested but not implemented as explained under "genetic trend validation."

When adjusted for expected future inbreeding, the PTA accounts for average relationships within breeds, but mating programs can increase profit much further by examining the individual relationships among mates. Inbreeding adjustments were described by VanRaden and Smith (1999, J. Dairy Science 82:2771; 1999, American Dairy Science Association annual meeting) and were previously submitted for October 1999 Interbull test evaluations. The result was a slight decrease of .01 for genetic correlations with most other countries, but the rankings of U.S. bulls as compared with other populations were not affected (Powell, 1999 research). Inbreeding statistics for USA bulls are compared to foreign bulls in a separate report (VanRaden et al., 2004).

Parity adjustments for yield SD were multipliers of 1.06, .99, .94, .89, and .85 for deviations in first through fifth lactations, respectively. These were introduced because later lactations have somewhat more variance than do earlier lactations even after the multiplicative age factors are applied. For DPR, multipliers were 1.03, 1.00, .98, .97, and .96, indicating that less adjustment was needed than for yield. For SCS, multipliers were .97, .99, 1.01, 1.02, and 1.02, indicating that the variance of standardized later lactations was slightly lower than that of first lactations. These parity SD adjustments caused little reranking for yield traits and even less for SCS and DPR; PTA correlations for recent bulls were .9998 or greater.

Genetic trend validation

Interbull requires that each country pass strict genetic trend validation tests for each trait of each breed at least every other year. Test 1 compares trend estimated from first-lactation records with trend from all lactation records; test 2 examines stability of daughter yield deviations across time within sire; and test 3 predicts the most recent 4 years of data from preceding data. Yield traits, SCS, and DPR were tested for both the new (2005) and the current (2004) USDA models:

Trend tests		Holstein	Jersey	Brown Swiss	Guernsey	Ayrshire
Protein test limits		**.37**	**.36**	**.40**	**.39**	**.30**
Test 1	New model	.06	.29	.20	.24	.09

	Current model	.20	.47	.34	.49	.22
Test 2	New model	.38	.00	.19	-.15	-.13
	Current model	.33	-.02	.24	-.05	-.19
Test 3	New model	.32	.10	.00	-.29	-.17
	Current model	.24	.02	.01	-.22	-.19
Fat test limits		**.52**	**.50**	**.52**	**.52**	**.40**
Test 1	New model	.14	.47	.17	.32	.05
	Current model	.24	.58	.39	.65	.17
Test 2	New model	.27	-.07	.16	-.21	-.23
	Current model	.26	-.06	.22	-.09	-.27
Test 3	New model	-.03	-.38	-.36	-.41	-.23
	Current model	-.07	-.48	-.47	-.43	-.30
SCS test limits		**.0044**	**.0041**	**.0042**	**.0046**	**.0043**
Test 1	New model	-.0002	-.0007	-.0051	-.0056	-.0009
	Current model	.0010	.0107	.0013	.0006	-.0026
Test 2	New model	.0010	-.0010	.0015	-.0013	.0030
	Current model	.0013	-.0005	.0014	-.0015	.0027
Test 3	New model	.0045	.0018	.0025	-.0023	.0033
	Current model	.0049	.0024	.0026	-.0017	.0033
DPR test limits		**.030**	**.030**	**.030**	**.030**	**.030**
Test 1	New model	.018	.011	.000	-.001	-.004
	Current model	.024	.017	.001	.000	-.003
Test 2	New model	.067	.049	.060	.056	.043
	Current model	.065	.041	.057	.060	.046
Test 3	New model	.004	.004	-.058	-.025	.005
	Current model	.003	-.001	-.061	-.027	.006

From official August 2004 yield evaluations, all breeds had higher all-lactation trend than first-lactation trend, with Jersey and Guernsey differences above the test 1 limits. Holstein trend was near the protein test 3 limit and also near the protein and milk test 2 limits. For SCS, Jerseys failed test 1. For DPR, all breeds failed test 2. Trend test procedures are described by Interbull (2004, Code of Practice, Appendix III) and by Boichard et al. (1995, J. Dairy Science 78:431). Interbull requires that all test values be close to 0.

Several model and parameter changes were investigated as exploratory steps using May 2004 yield trait data of Brown Swiss. Changes to heritability, herd-by-sire interaction variance, and permanent environmental variance had only small effects on all of the trend tests. Parity SD adjustments helped evaluations to meet test 1 limits and will be introduced for all breeds and also for SCS and DPR. Inbreeding adjustments decreased genetic trends but affected values for tests 2 and 3 only moderately. An earlier report of larger changes for tests 2 and 3 was incorrect because of a programming mistake in the test that was detected later. The inbreeding adjustments will not be introduced for productive life because they cause some test 3 values that currently pass to fail. Genetic trend for productive life was reduced by 25% in the model with inbreeding adjustments. Further research is in progress to revise the productive life definition and projection factors, and inbreeding adjustments may be introduced with those changes at a later date.

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