Animal Sciences Dairy
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Changes to U.S. Genetic Evaluations of Dairy Cattle

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In the fast paced era of the 21st Century, frequent change is inevitable. New technologies, adapting to rapidly changing consumer preferences and tighter profit margins reinforce the need for competitiveness and efficiency. The U.S. dairy industry is no different from any other industry in this respect. Production of top-quality milk and dairy products to satisfy consumers at low cost drives down farm-gate prices thus forcing producers to become more efficient to stay competitive. The year 2000 will mark a milestone in U.S. genetic evaluations for dairy cattle. First, the genetic base will be changed as it is every five years. Second, and more importantly, there will be improvements made to the Net Merit selection index and the Type Production Index (TPI). These changes represent definite progress in providing dairy producers with tools to select more profitable cows rather than cows that simply produce more milk. This paper explains some of the changes and describes some of the benefits for producers.

Genetic Base

All dairy cattle genetic evaluations for production traits are expressed as Predicted Transmitting Ability (PTA). PTAs are expressed relative to a reference population of animals called the *genetic base*. Each breed has its own base. Currently the U.S. base is the average PTA of cows born in 1990. The average PTA of these cows is then set to zero. For example, a sire with a PTA of +2000 lbs. of milk, +50 lbs. of fat, and +45 lbs. of protein is expected to have daughters that yield on average 2000 lbs. more milk, 50 lbs. more fat, and 45 lbs. more protein than a daughter of an average cow born in 1990.

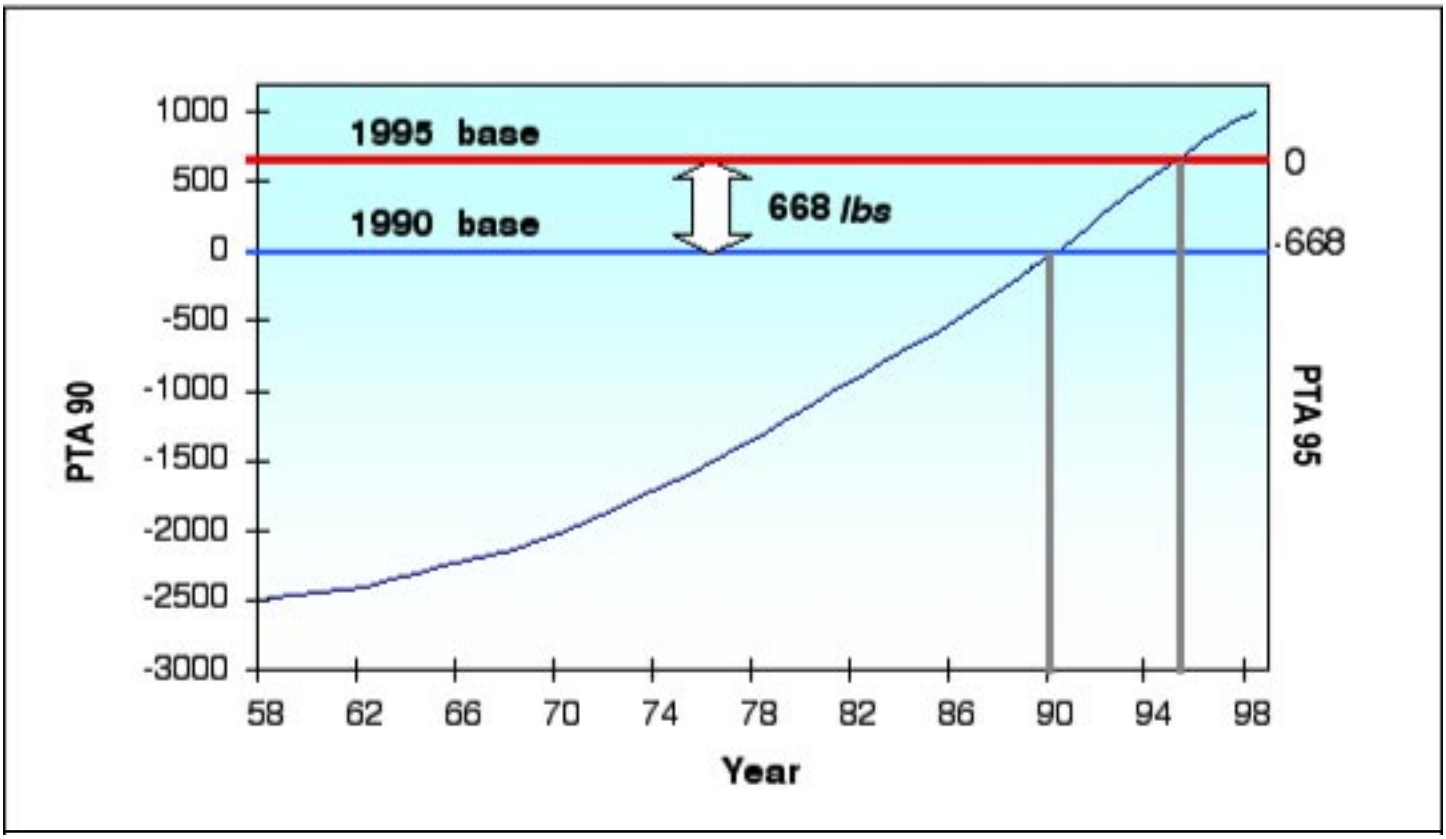
The International Bull Evaluation Service (INTERBULL) recommends updating the genetic base every five years, with the animals defining the base being cows born five years before. The five-year gap assures that the base cows have an opportunity to complete a lactation as a mature cow. The U.S. genetic base will be updated this year and the PTAs for sires and cows will be expressed relative to the average genetic merit of cows born in 1995. The difference between the average PTA's for cows born in 1990 and those born in 1995 reflects the amount of genetic progress made in those five years for each trait. This is what people call the "base change". Table 1 shows the amount of genetic progress in PTAs the various breeds have achieved over the

Table 1. Estimated change in PTA for production traits for 2000 base change.

Trait	Ayrshire	Brown Swiss	Guernsey	Holstein	Jersey	Milking Shorthorn
Milk (lbs.)	367	539	515	668	549	393
Fat (lbs.)	12	22	20	20	18	13
Protein (lbs.)	10	18	18	21	20	12
P. Life (months)	.5	.3	.5	.5	.9	.6
SCS[1]	0	0	-0.01	0	0.04	0.01

[1] SCS – Somatic Cell Score

Figure 1. U.S. genetic trend for milk yield of Holsteins expressed on the 1990 and 1995 genetic bases.



five-year period. These figures represent the genetic increase in production of cows born in 1995 compared to those born in 1990.

What changes to sire PTAs can we expect as a result of updating the genetic base? The PTAs for sires will be reduced by the amount of genetic progress made between the 1990 and 1995 base years. These are the same figures contained in Table 1. Figure 1 shows the genetic progress over time, with PTAs expressed relative to both the 1990 and 1995 base. Figure 2 illustrates the changes to PTA for milk for two Holstein sires as a result of the updated base and also helps demonstrate the importance of updating the base. Relative to the 1990 base, Sire A and Sire B have PTA for milk of +500 and+1168 lbs. of milk, respectively. The 1995 base line represents the amount of genetic progress in milk yield between the two base years.

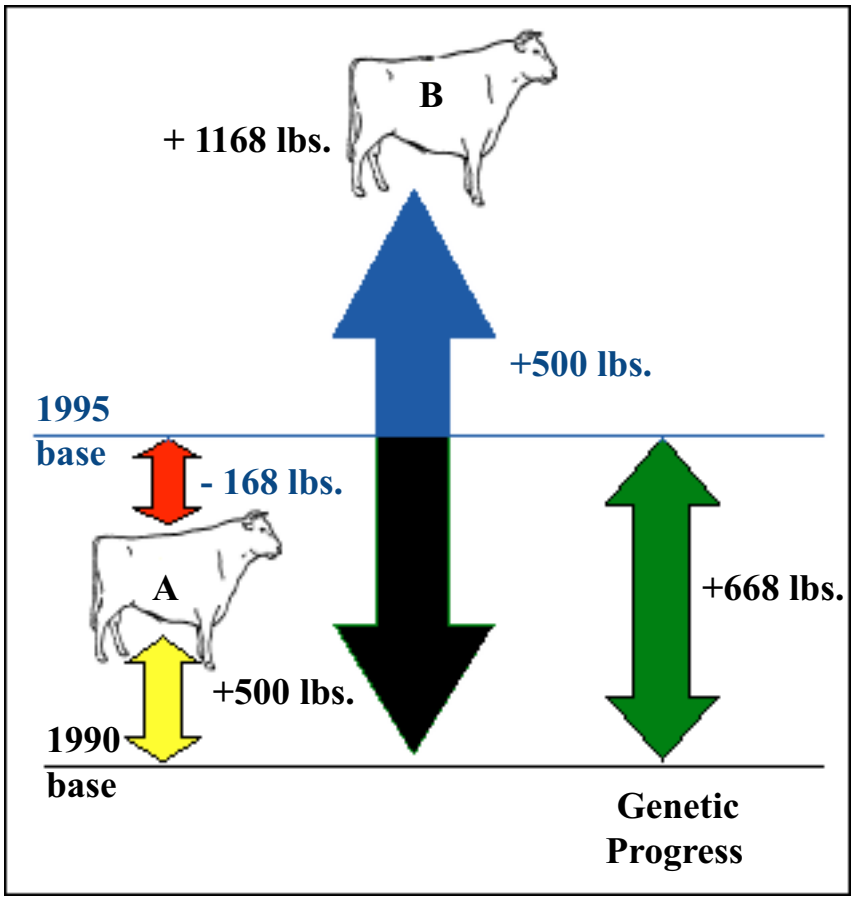


Figure 2. Genetic trend and genetic base changes from 1990 to 1995 for U.S. Holstein PTA for Milk.

That is, from 1990 to 1995, the genetic improvement in the population was 668 lbs. of milk (Table 1). Based on the 1995 base, Sire A has a PTA for milk of -168 lbs. and Sire B has a PTA of 500 lbs., a reduction of 668 lbs. in both PTAs. In other words, daughters of Sire A that produced 500 lbs. of milk more relative to cows born in 1990 will be expected to produce 168 lbs. of milk less than cows born in 1995. Daughters of Sire B that produced 1168 lbs. of milk more relative to cows born in 1990 will still produce 500 lbs. of milk more than cows born in 1995. Regardless of the base, Bull B will rank higher than Bull A, and his daughters are expected to average 668 more pounds of milk than Bull A.

Producers should not be concerned that PTAs drop as a result of the base change. It demonstrates the amount of genetic progress being made, and it allows us to continue selecting sires that will produce daughters that outperform the base cows while discouraging the use of sires that produce less superior cows, even if they have positive PTAs.

Many countries use the INTERBULL approved genetic base change that is practiced in the U.S. However, every country has the freedom to choose a base they feel is most appropriate for their evaluation system. Each country can decide to update their base either at more frequent intervals or less frequent intervals. Table 2 gives some examples of genetic base changes employed throughout the world.

Type Production Index (TPI)

The TPI has been a very popular economic index reported by the Holstein Association. TPI values have been used to evaluate and rank individual bulls for their ability to transmit production and type to their daughters. The old TPI had two components, a production component incorporating fat and protein, and a type component incorporating the Udder composite, the Feet & Legs composite, and Predicted Transmitting Ability for Type (PTAT). The formula did not, however, include any direct measure of the sire's ability to produce longer-lasting and healthier daughters. Cows that produce longer and remain healthier throughout their lifetime are an integral part of any profitable dairy, and for this reason a new Health component has been added to the new TPI. The Health component includes a measure of Productive Life and SCS. Table 3 compares the emphasis given to the production, type, and health components in both the old and the new formulas as well as the ratio of the different traits within each component.

Why change the TPI formula? The weightings for the old TPI were consistent with research on herd life regarding udders, feet and legs as well as the value of protein and fat in the milk at that time. Like the

Table 2. Examples of base changes for countries throughout the world

Country	Description of base change
Canada	Rolling base In February of each year, the genetic base is updated. The reference population of cows are those that calved for their first, second, or third lactation during the calendar year three years ago i.e. for 2000
Netherlands	All herdbook cows born in 1990 with official lactation records.
United States	Stepwise (updated every 5 years) Reference population is cows born in 1990. It will be updated to cows born in 1995 for August 2000 evaluations.
United Kingdom	Stepwise Updated February 2000. Reference population is cows born in 1995. Next change will be in 2005.

genetic base, TPI needs to be updated and redefined to reflect changes in milk pricing and also to incorporate the most recent research that allows us to better incorporate other traits and select for longer-lasting and healthier cows. The new TPI increases the emphasis on fat bringing the weighting of fat and protein closer to their multiple component prices under the Federal Milk Market Orders that were implemented January 1, 2000. PTAs for Productive and SCS are two measures that are now available to us to assess a sire's ability to produce longer lasting and healthier cows. By including Productive Life and SCS in the new TPI we are ensuring that sires that increase cow productivity are identified and selected for.

The benefits of including a Health component in the new index include:

- Cows remain in the herd longer, which reduces replacement rates and costs associated with rearing those replacements.
- A larger proportion of cows are producing milk at mature levels.
- Treatment costs for mastitis are reduced and producers are paid more for milk with low somatic cell scores.

Table 4 compares the new TPI for the sires with the most sons in active AI to their old TPI values.

Change is occurring between the old and new TPI. Some sires have increased their TPI values, while at the same time there is a notable decrease in others. Part of the change reflects changing the numbers used as constant values in the formula. The change in ranks is the result of the extra weight given to fat in the index as well as the addition of Productive Life and SCS to the index. Those bulls that have poor fat to protein ratios will be deducted, as will the sires that transmit poor productive life and high SCS.

It is important for producers to focus on is the change in ranking rather than the actual decrease in TPI points. Rankings give a good indication of how bulls compare relative to one another. We can see in table 4 that there is some re-ranking among sires. Bellwood, despite dropping 73 points, is still the number one ranked sire. This is an example of why rankings are more important than the actual increase or decrease. We can see that Mascot and Luke suffered a considerable drop in rankings, again due to their unfavorable PTAs for fat. Re-ranking for other sires is less obvious, but Converse and Blackstar moved up three and four places respectively. Their PTAs indicate that good fat to protein ratios as well as favorable Productive Life and SCS are responsible for their increased TPI and ranking position.

Net Merit (NM$)

First and foremost, dairy producers want cows that produce milk. But they also want cows with sound feet and legs, cows with well-attached udders that are milked easily, cows that will stay in the herd, cows

Table 3. Relative emphasis of production, type and health components in the new and old TPI and the ratio of each trait within the components.

	New	Old	Trait	New	Old
Production	4	2	Protein	5	3
			Fat	2	1
Type			PTAT	1	1
	2	1	UDC	0.65	0.65
			FLC	0.35	0.35
Health	1	-	Productive Life	0.9	-
			SCS	0.1	-

Table 4. Change in TPI and rankings for sires with the most sons in active AI

Sire Name	Old TPI	New TPI	Change	Old Rank	New Rank
Maizefield Bellwood-ET	1544	1464	-80	1	1
Emprise Bell Elton *BL	1375	1326	-49	2	2
Lutz-Meadows E Mandel-ET	1369	1296	-73	3	4
Madawaska Aerostar	1322	1273	-50	4	5
Norrielake Cleitus Luke-Twin	1316	1185	-130	5	11
Highlight Converse-ET	1277	1324	47	6	3
Ca-Lill Belltone	1225	1262	38	7	6
Townson Lindy ET	1225	1224	-2	8	7
Bis-May S-E-L Mountain-ET	1198	1210	11	9	8
Art-Acres Ned Boy Oscar-ET	1196	1199	3	10	10
Mr Hurl-Three Momentum-Red-ET	1168	1200	32	11	9
Singing-Brook N-B Mascot-ET	1141	980	-161	12	18
Rothrock Tradition Leadman	1102	1127	26	13	12
Tesk-Holm Valiant Rockie	1099	1096	-3	14	14
Juniper Rotate Jed-ET	1090	1028	-63	15	17
Ronnybrook Prelude ET	1052	1091	39	16	15
To-Mar Blackstar-ET	1052	1104	53	17	13
Walkway Chief Mark	1045	1038	-7	18	16
Exranco Thor	951	950	-1	19	19
Hanoverhill Starbuck	892	911	20	20	20

that convert milk to feed efficiently, and cows that are resistant to disease, especially mastitis. USDA will now provide an index to help them select those cows. Net Merit is an economic index that has been reported by the USDA's Animal Improvement Programs Laboratory since 1994. Unlike the old TPI formula, NM$ included direct information on a sire's ability to produce longer lasting, healthier daughters by including Productive Life and SCS in the index as well a weighting for milk, fat, and protein dollars (MFP$). Researchers have recently proposed that yield traits, health traits, and type traits should all be combined to give an estimate of lifetime profit.

Lifetime profit = milk value + salvage value + value of calves – rearing costs – feed energy – feed protein – health costs – breeding costs

This lifetime profit includes all the income and expenditures associated with production, thereby giving a good indication of a sire's net worth to the overall dairy operation. The current Net Merit expressed the advantage or disadvantage of sires in terms of dollars per 305-day lactation of their daughters. However, it was always difficult to express length of productive life on a single lactation basis.

The newly proposed Net Merit $ is calculated as the sum of three sub-indexes, YIELD$. UDDER$ and OTHER$. Table 5 shows a breakdown of the weightings of each trait in the sub-indexes as well as the overall weightings.

Table 5. Relative emphasis of YIELD$, UDDER$ and OTHER$ in the new NM$ and the ratio of each trait within each sub-index.

Sub-index	Weight	Trait	Weight in sub-index
YIELD$	67	Milk	8
		Fat	33
		Protein	59
UDDER$	16	Udder composite	44
		SCS	-56
OTHER$	17	Productive Life	64
		Feet & Leg composite	17
		Size	-19

A detailed description of each sub-index is provided in the Appendix. The sub-indexes are used for calculation only. The Council on Dairy Cattle Breeding recommended that the sub-indexes not be published routinely. YIELD$ is the value of the cow's milk, fat and protein over the cow's lifetime minus the cost of producing the milk. UDDER$ includes Udder Composite and also SCS. More emphasis is placed on SCS than in the previous NM$. The premiums paid for low SCS are included in UDDER$. OTHER$ includes the lifetime net income or loss from productive life and the remaining linear traits. Replacement costs, beef income, culling loss, maintenance costs, and mature weight are examples of some of the variables included in OTHER$. Stature receives a small negative weighting in the index because larger size increases maintenance feeding costs per lactation, and also increases housing costs. However, the use of the index will not result in smaller cows, because the small negative emphasis on size offsets the gain in size that would accompany selection emphasis on udder depth in the Udder Composite. This is because there is a strong relationship between udder depth and stature, with shallower udders occurring more frequently in taller cows.

Summary

Both TPI and Net Merit attempt to rank animals based on production, health, and length of productive life. Previously, Net Merit accounted for health and length of productive life through direct measures of somatic cell count and productive life. TPI accounted for health and productive life through type traits only. The new Net Merit index now places secondary emphasis on type traits while the new TPI index incorporates SCS and Productive Life as secondary traits. Both indexes have increased the relationship between the index and the overall breeding objective of producing healthier, longer lasting and more profitable cows. Because of this ranking of bulls on the two indexes should be much more similar than in the past.

Appendix

New TPI formula

$$45*\left(4*\left(\frac{.714\times PTAP}{19}+\frac{.286\times PTAF}{22.5}\right)+2*\left(\frac{.5\times PTAT}{.7}+\frac{.33\times UDC}{.8}+\frac{.17\times FLC}{.85}\right)+1*\left(\frac{.9\times PL}{.9}-\frac{.1\times SCS}{.13}\right)\right)+956$$

New Net Merit

NM$ = YIELD$ + UDDER$ + OTHER$

**YIELD$** = (MFP$ - Feed$) * LACTNS* actYLD
where:
MFP$ = milk fat protein dollars
Feed$ = feed cost for production
LACTNS = number of lactations
actYLD= ratio of actual yield to mature equivalent yield

UDDER$ = [12 PTA udder composite- 51(PTA SCS-breed SCS)] *LACTNS

**OTHER$** = LACTNS(profit$) - loss$ + (5 PTA f&l)LACTNS
-24PTAsize [maint$(LACTNS *actWT) + varrep$-beef$]
where:

- maint$ = increased feeding ($.18/lb.) and housing ($.03/lb.) costs for heavier cows minus net income from heavier calf weight ($.06/lb.)
- varrep$ = variable replacement cost of $.56/lb.
- beef$ = income from culling mature cows at $.35/lb.
- loss$ = loss from culling cows at a beef price lower than cost of growing replacements
- profit$ = increased profit when a cow stays for an additional lactation
- actWT = mature weight in pounds

NEW 8/00