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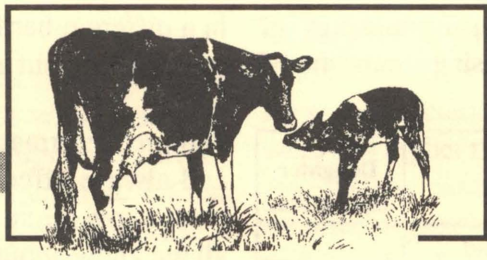

Dairy

PUBLICATION 404-082

PTA's for Cows:
Calculation and Use

*Bennet Cassell **

PTA (predicted transmitting ability) is the term given to estimates of genetic merit for a number of traits in dairy cattle including milk, protein, fat, and type traits. PTA's are calculated for bulls and cows by USDA and breed associations using a procedure called the animal model. This publication covers female PTA's, factors affecting PTA's for individual cows, and how to use the estimates for within herd management.

PTA's have two purposes: to rank animals for genetic merit and to estimate genetic differences between animals. A cow with a PTA of 1500 for milk is expected to produce daughters averaging 500 lbs/lactation higher production as mature cows than daughters of a cow with a PTA of 1000. The cow with a 1500 lb PTA would rank higher than the cow with the PTA of 1000. Only animals of the same breed can be compared.

Procedures used to calculate PTA's account for environmental conditions under which traits are expressed, relative amounts of information from records, pedigree and progeny, and heritability, among other factors. PTA's are compared to a genetic base or zero point, determined by average genetic merit of cows born in a given year. In 1994, a cow with a PTA for milk of 1500 lbs would be genetically superior to an average cow born in 1985 (the current genetic base) by 1500 lbs. In 1995, the genetic base will be updated by five years, making the average PTA of cows born in 1990 zero for each trait in each breed. PTA's for bulls can be compared to PTA's of cows. Both estimates are produced at the same time by animal model procedures.

Information Used In Cow PTA's

Genetic evaluations on cows use three sources of information: pedigree, own performance, and progeny. Details of the animal model are in other publications. VCE Publication 404-086 explains the basics of the animal model. Fact Sheet H-2 of the National Cooperative Dairy Herd Improvement Program Handbook, *USDA-DHIA Animal Model Genetic Evaluations*, is an excellent reference. This publication will not address procedures, but how cow PTA's differ from bull PTA's in information used, accuracy, and use.

Table 1 shows importance of different sources of information, with information expressed in "daughter equivalents." A daughter equivalent is the amount of information about a parent's genetic merit available from a single lactation of a single daughter in a herd. Daughter equivalents can be converted to Reliability of a PTA for milk using the formula REL $= n / (n + 14)$ where n is the number of daughter equivalents. See VCE Publication 404-092 for details.

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Table 1. Importance of different sources of information to genetic evaluations using animal model procedures.

Relative	Information available	Daughter equivalents
Parents	Sire with70% REL[1] and dam with 30% REL	4.7
	Sire with 99% REL and dam with 50% REL	8.3
	Sire with 99% REL and dam[2] with 99% REL	14.0
Self	1 lactation record	4.7
	3 lactation records	7.8
	5 lactation records	9.0
Daughter	1 lactation record	1.0
	3 lactation records	1.5
	5 lactation records	1.7
Son	10 daughters, 10 herds, 1 record each	1.8
	50 daughters, 50 herds, 1 record each	4.4
	Sons evaluation is 99% REL	7.0

[1]REL is Reliability, a measure of accuracy of a genetic evaluation that ranges from 0 (least accurate) to 99 (most accurate). See VCE Publication 404-089 for more details on Reliability.

[2]In practice, REL for females seldom exceed 80%.

A cow by an AI bull would have pedigree information worth 6 to 8 daughters and 1 to 3 lactations of performance data worth 5 to 9 daughters. For the typical cow, 13 to 16 daughter equivalents would produce a REL of around 50 percent. A "typical" progeny tested bull with 50 to 60 daughters distributed one per herd would have a first crop REL of about 80 percent. Genetic evaluations on an individual bull would be more accurate than for a cow and would be expected to be closer to actual genetic merit.

Pedigree Data

Pedigree information comes from breed associations for registered cows and from DHI records for grade animals. Sire and dam identification should be reported through DHI when heifers have their first calves. Table 1 shows how useful different amounts of pedigree information would be in genetic evaluations. For most cows, pedigree information would be equivalent to having 5 to 8 daughters, each in a different herd. Notice that a cow's own records contribute about an equal amount of information.

Pedigree information stays with a cow for her lifetime and always affects her PTA. Pedigree data shows what a cow might have inherited from her parents. If all we know about what she actually inherited comes from her performance rather than performance of her progeny, then performance and pedigree will remain roughly equal in determining her PTA. Large numbers of progeny, possible through embryo transfer, could make performance and pedigree relatively less influential on PTA, but they will always exert some influence.

Performance: The Importance Of Records

Table 1 shows that one record on a cow is worth about as much as 4 or 5 daughters distributed one per herd. Five production records double this number to 9 daughter equivalents. The animal model uses only the first five records produced by a cow. The cutoff at five records is for two reasons: few cows have more than five records, and for those that do, environmental and management effects tend to be more important than for earlier records. Very little useful information about genetic merit is gained from very mature records.

PTA's use production information only after adjustment for many different factors. Among these are age, days in milk, season of freshening, frequency of milking, performance of contemporaries, genetic merit of contemporaries, performance of other half-sibs in the same herd, and permanent environmental effects for cows with multiple records. All of these adjustments are made because of what scientists have learned about the relationship between phenotype (actual milk production) and genetic merit for milk yield. For instance, a cow that produces 1000 lbs more milk than other daughters of top AI sires to which she is a contemporary should receive more credit for her superiority than a cow milking 1000 lbs better than contemporaries sired by a genetically inferior heifer freshener. A 23,000 cow in a 25,000 lb herd is **NOT** as good a performer as a 20,000 cow in an 18,000 lb herd if genetic merit of contemporaries in the two herds is similar. If both of these cows were sired by the same bull, the cow with the 20,000 record would have a higher PTA than the cow with the 23,000 record!

Progeny Information

Embryo transfer technology has made progeny testing of females possible. Herds with clusters of maternal half sisters are more common than they once were with natural female reproduction. ET lets us progeny test cows, but it has major drawbacks. It is expensive. It is slow - like progeny testing bulls, so that cows are rather old before daughters produce records. Seldom are ET daughters distributed across many herds, a requirement for AI young sire sampling programs and equally necessary to accurately evaluate a donor dam. Notice in Table 1 that a well proven son is only 2 to 4 times as useful as a daughter with multiple records. Each son receives a sample half of the genes of the dam. Genetic ability is best estimated by many gene samples evaluated with moderate accuracy (milking daughters meet this criteria), not one or two samples evaluated with high accuracy as would be the case with proven sons.

Using PTA's On Dairy Cows

Most dairy cows produce 2 to 4 lactations and 1 or 2 heifer calves before they are culled. Individually, such cows contribute little, but as a group, they set the course of genetic change in a herd. Dairy farmers control PTA's through sire selection. One of the better uses of PTA's for cows in the milking string is to evaluate the results of sire selection several years earlier. In Virginia, the DHI form 202, the Herd Summary sheet, lists average PTA's for MFP$ of cows in different age categories. MFP$ is an index combining PTA's for milk, fat, and protein. Genetic evaluations of cows appear under the heading "General Management Information" in a format similar to the one in Table 2 which shows July 1994 state averages.

In July 1994, first lactation Holsteins in Virginia herds had PTA's for MFP$ that were $11 higher than for second lactation cows. The second lactation cows were $34 higher than cows in third and later lactation. Age differences between the groups were 14 and 28 months, suggesting an annual increase of between $9 and $14 for PTA's of milking cows. Notice that average PTA's for sires of these cows is always higher than the PTA's of the cows themselves. This is because of genetic superiority of sires of these cows to the dams of these cows. Flow of superior genes in the dairy industry is almost always from the sire to replacement females.

PTA's cannot be calculated from DHI records unless the sire of a cow can be identified. Further, if the dam of a cow is also known and identified, relationships between the cow and maternal half sisters and other female relatives within a herd can be used in genetic evaluations. The herd summary form shows the percentage of cows in each age category identified by sire and dam. These percentages are slightly better for young animals, perhaps reflecting recent improvement in ID procedures. About 80 percent of all Virginia DHI lactation records submitted to the Animal Improvement Programs Laboratory (AIPL, the USDA group which calculates genetic evaluations) are useful for genetic evaluations under the animal model system. The column "% ID Change" gives a general indication of the quality of ID programs across the state. For most cows, ID information is most accurate when they are born. If they are correctly identified with permanent markings and appropriate records at that time, no ID change will need to be made once they freshen. The DRPC@Raleigh shows the percentage of cows changing ID after the second test day from their first calving. This gives producers two months to

Table 2. Information on cow and sire PTA's on the DHI form 202. State averages for July 1994 are shown.

	AIPL PTA $		Identification Summary			
	Cows	Sires	%Sire ID	% Dam ID	% useable by AIPL	% ID Change
1st lact.	+117	196	82	85	82	1
2nd lact.	+106	179	81	84	81	2
3+ lacts.	+72	133	79	80	79	2
All Lactations	+89	163	80	83	80	1

straighten out errors. After that date, there is the possibility that farmers may only identify those cows producing well, which would bias genetic evaluations. If such a problem exists in Virginia, the average % ID change of 1 to 2 % indicates that it is not widespread.

PTA's can be used to evaluate genetic merit of baby calves and heifers in the replacement herd. Cow PTA's can be combined with sire PTA's to produce a pedigree evaluation called "Parent Average." If a heifer calf was sired by a bull with a PTA for MFP$ of $250 and out of a cow with a PTA of $100, her Parent Average or PA would be (250+100)/2 = $175. PA's can be used to rank heifers for culling or sale. There is no better predictor of future milk production on virgin heifers than PA.

Where To Find PTA's On Individual Cows

DRPC@Raleigh prints PTA's on DHI form 203, the cow page produced at the end of lactation for a cow or whenever ID or production information is corrected. This form also includes PTA's on the sire and dam of the cow in question. **PTA's are only available on cows identified by sire. This is one of the strongest arguments for keeping good sire identification information in a herd record program.** Another source of PTA's on individual cows is a service called *Complete Herd Lists of Cow Evaluations*, distributed by the Virginia Tech Dairy Science Extension Program to herds choosing to participate. Lists are mailed to participating herds within a few days of publication of new genetic evaluations every January and July.

Elite Cows

PTA's on cows have no more important use than identifying elite cows to serve as bull mothers. However, only a few herds are affected, which is why it is mentioned last. Cows designated as "elite" rank at the top of all cows in their breeds for MFP$. PTA files are screened to locate cows apparently alive before elite lists are produced. "Elite" cows really are special. Table 3 below shows the superiority of elite cows to all living, registered cows in different breeds in the July 1994 genetic evaluations.

Notice that the MFP$ value listed for elites is the minimum value accepted for the elite designation. The best cows of each breed were quite a bit better than the minimum. In Holsteins, for instance, the top cow for PTA$ in the July 1994 genetic evaluations was $498! Cows selected as bull mothers for the next generation of AI young sires almost always are on the elite list, usually well above the minimum. With embryo transfer technology almost insuring that top cows have at least one son (and usually many more) for sampling, the elite list has become even more important in helping bull studs locate the top individuals to transmit their genes to future generations of replacement heifers.

In Virginia, owners of elite cows are notified of the distinction through Cooperative Extension and DRPC@Raleigh.

For years, cows have been ranked on MFP$ to determine elite status. In the future, the ranking procedure will be based on NET MERIT, an index which combines MFP$ with genetic evaluations for productive life and somatic cell score. Such a ranking procedure will favor cows with ability to produce at high levels for longer lifetimes and with lower somatic cell scores than a ranking based only on MFP$. As this publication is prepared, no timetable for converting elite designation to a ranking based on NET MERIT has been announced.

Table 3. Summary of the July 1994 "Elite Cow" List.

	All Cows		Elite Cows		
Breed	Number	Average	Number PTA$	Minimum PTA$ to be elite	Percent elite
Ayrshire	12.442	41	244	135	2
Guernsey	20,475	62	408	163	2
Holstein	820,839	97	8,032	257	1
Jersey	112,244	72	1,067	208	1
Brown Swiss	21,728	48	428	179	2