by Bennet Cassell

It takes science to turn records into proofs

TURNING production and type records into thousands of genetic evaluations is a pretty complex process which has a lot to do with why I last devoted column space to the topic in 1988! Since that was about half a human generation ago, maybe it's time to give the subject another shot. A lot of the complexity comes from the computing strategies that are needed to process very large files. Statistical issues pretty well account for the rest of the difficult parts. Fortunately, the basic biological ideas are reasonably straightforward.


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We didn't name the animal model after a true-type cow model, but the image does have some merit. An animal model is a statistical description of factors that affect trait expression in one animal that is part of a population of animals. The animal model that is used for milk production includes:

- effects common to cows in a management group
- effects due to the genetic ability of the animal
- effects that are environmental but have a permanent effect on one animal
- effects common to daughters of the same sire in one herd
- effects that don't fit in one of the above categories.

Positive tough to pinpoint . . .

Some of these effects aren't at all apparent to people who work with the cows. Try to think of the cow in your herd with the largest, positive, permanent environmental effects. It's tough.

Large, negative, permanent environmental effects are easier to see. The heifers that freshened with *E. coli* mastitis or cut two teats the second week after they calved fit this category.

Positive, permanent environmental effects usually are attributed to something else — a good mating decision, the cow family — while the effects of an excellent employee in the calf barn and the best hay year in the last 10 when a cow was a yearling are forgotten.

The biggest challenge in calculating genetic evaluations is to separate genetic effects from environmental ones. What part of a 10,000-pound contemporary deviation is due to genetic merit, and what part is due to fortunate environmental conditions?

We separate the two by comparing an animal to contemporaries treated as nearly the same as possible. The USDA animal model forms contemporary groups of cows of the same breed, same lactation number (first or later), same registry status, and same two-month calving season within each herd and year. Contemporary deviations — differences from the contemporary group mean — are then calculated for the trait being evaluated, like milk or somatic cell score. It's a little more complex than this but let's stay with the basics.

Permanent environmental and herd by sire effects are harder to visualize. Both terms help prevent too much enthusiasm for very high or low contemporary deviations. A bull should not be too harshly judged for the daughter that had pneumonia as a calf and produced 3,000 pounds less milk for the two lactations that she was in the herd than her more fortunate and much healthier contemporaries.

Herd-sire interactions act like restrictor plates on carburetors of race cars. They temper unjustified (nongenetic) optimism if daughters of one bull in a herd happened to receive favorable treatment. The term is most important if a bull has many daughters in one or two herds. If the herd of most daughters includes only two or three progeny, the herd-sire interaction component is not nearly so important.

We're after a PTA . . .

The term of greatest interest in the animal model is the PTA (predicted transmitting ability). It represents the genetic merit of the animal for whatever trait is being evaluated. Genetic effects are estimated by combining performance information such as milk records, pedigree information in the form of PTA's on sire and dam, and progeny information which amounts to PTA's on offspring. Pedigree relationships tie proofs together.

A PTA on a cow is pedigree data for her own daughter but progeny data for her sire and dam. The weight applied to pedigree, performance, or progeny depends on how much information is available from each source. The weight for performance on bulls is always zero for production and type traits. They don't express these traits themselves, and we evaluate them entirely on pedigree and progeny data.

USDA scientists developed a term called a "daughter equivalent" to serve as a measure of how much information is available from each source on individual animals. A complete lactation record on a cow, from a full-service DHI program, is worth 4.7 daughter equivalents in her PTA. The same record is worth 1.0 daughter equivalents in the evaluation of her sire.

If the cow had five lactation records, the combination is worth about 9 daughter equivalents to evaluate her and 1.7 daughter equivalents to evaluate her sire. Pedigree information reveals how good (or bad) an animal **might** be, but doesn't tell us what sample of genes that individual inherited. A sire with 99 percent reliability proof and a dam with 50 percent reliability evaluation (typical for older parents) provide equivalent information to 8.3 daughters. An A.I. progeny test with 60 daughters or more provides much more information than pedigree data on a young bull. Pedigree data becomes less important as each new daughter enters a bull's proof.

Cows and bulls differ . . .

Typical cows under commercial conditions will have about 10 daughter equivalents of information from a couple of records and normal pedigrees. Typical A.I.-proven bulls with "first crop" proofs will have about 70 to 80 daughter equivalents of information. Genetic evaluations on progeny-tested bulls are more accurate than on cows but at considerable cost. Progeny testing is a process reserved for the elite-pedigreed males of each breed and has proven to be a task best performed by a very few specialized businesses.

Less debates today . . .

It has been a while since I heard dairy cattle breeders debate the procedures used to calculate genetic evaluations. Perhaps complexity is the cause, but I'm afraid that interest (or lack thereof) in the process is a more important factor. The debates of 20 to 30 years ago arose from interest in and commitment to genetic progress that is hard to find these days.

I remain convinced that genetic improvement can make life better for dairy producers, especially for traits that reduce costs of producing milk like fertility and survival. I hope to again see the day when dairy producers think the process of genetic improvement is important enough to debate how to accomplish it most effectively.

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