Genomics: Advanced Measurement to Management

By George Cudoc

The Dairy Herd Improvement Association (DHIA) has always focused on how to increase milk production and cow quality. Visual appraisal of animals and production testing have long served as the basis for this system. However, more sophisticated tools are being developed to improve the chances of breeding more profitable cows. We can more accurately predict which animals will be superior foundation stock through the use of genomic testing. Genomics provides measured, scientific data that replaces the assumption that genetics are passed down equally from each parent, helping us discover what the real contribution from each may be.

What is Genomic Testing?

Genomic testing uses what is known about genes responsible for desirable traits in dairy cattle and tests individual animals to determine if they possess those genes. Results are reported as Genomic Predicted Transmitting Abilities (GPTAs) and are similar to the traditional Predicted Transmitting Abilities (PTAs). Indexing or combining a series of weighted desirable traits is still being used as well, but instead of just having a Total Production Index (TPI) for an animal, we now calculate a Genomic Total Performance Index (GTPI) based on gene contribution from each parent (Figure 1). Genomic testing is becoming a measurement tool that more and more dairy managers and owners are using to manage their breeding program, making such testing a management tool as well. This testing allows for future generations of the herd to be strategically planned through selection for certain genetic traits.

Using Genomic Data for Management

There are many different ways in which genomic testing use can benefit a management plan. A current popular use is a genomic testing plan that maximizes profits through selected culling in the heifer herd. This is of particular interest in commercial dairy herds where profits from selling excess heifers as replacement animals for other herds is less profitable than it has been in the past. Testing calves as early as possible and culling the bottom of the herd based on GTPI ranking is one approach that is often used. This eliminates the $1800 or higher cost of raising a heifer who likely will be less profitable than others ranked higher. This plan also has a secondary benefit in that now we have identification and genetic data for each tested animal that can be used to make even faster genetic progress in subsequent generations.

Animal ID	Official ID	Breed	NM$	CM$	FM$	GM$	TPI
6524	HO840EX3123587441	HO	325	335	303	335	2009
6024	HO840EX3123589441	HO	400	435	316	376	2053
6124	HO840EX3123580541	HO	342	376	262	302	1995
6242	HO840EX3123581541	HO	295	312	257	346	2019
6342	HO840EX3123582541	HO	348	372	294	275	2043
6424	HO840EX3123583541	HO	434	457	378	407	2066
6524	HO840EX3123584541	HO	274	246	337	182	1878
6642	HO840EX3123585541	HO	384	412	317	403	2074
6724	HO840EX3123586541	HO	249	233	287	202	1856

Figure 1: This report shows typical results for genome tested heifers with a number of calculated indexes.

Another way that genomic testing can add profits while accelerating genetic potential in a dairy herd is to identify the best heifers and use sexed semen at breeding to increase the odds of getting heifer calves. This increase in the heifer population from the best genetics on your farm can be accompanied by breeding the low-ranking heifers to beef bulls, possibly producing a more marketable animal sold as stocker cattle to beef producers, or kept at home for dairies that have developed a market for dairy beef.

As mentioned above, genomic testing can impact the pace of genetic change. An example of this is how bulls are selected as sires for artificial insemination. Companies can now choose a smaller selection of bulls than they have in the past, making their choices based on the bulls' genetic merit tested by genomics. While the time it takes for bulls to reach maturity has not changed, it has reduced the age of the parents of these bulls selected. Genomic proofs, produced by the Council on Dairy Cattle Breeding (CDCB) program (the overseer of the US dairy genetics evaluation program), are updated weekly for producers to make the most informed decisions possible. The CDCB currently lists more than 862,000 genomic tests conducted to date, with 739,000 in the Holstein breed alone. Of this, more than 590,000 are females.

Genomic Use on a Dairy: An Evolving Tool

Genomic testing offers many possibilities for management, depending on the needs of a farm. As an example, let's look at a farm that has been using genomics for 3 years. When the farm first started genomic testing of their calves, there was a 4 month (or longer) wait for results. The first 4 months after birth are some of the highest-cost days in raising dairy replacements, and using genomics as an early culling tool was not very practical due to the wait for the test results. Now, with the test turnaround time reduced to just a few weeks, early culling of the lowest heifers might make more sense. The cost of the technology has also decreased over the years, with current genomic testing at $42, including parentage identification, down from a cost of $250 or more as recently as 2010.[1]

Although the farm would like to test all heifer calves born on the farm, they are flexible in their management and balance affordability with progress. Because of the current economics of milk prices, they currently test 20 per month, or approximately 50% of the heifers born. They select the calves to test based on the dam's production history, or in the case of first-lactation mothers, their already-recorded genomics test numbers. The farm uses Dairy Comp 305 to generate the list of animals to sample for genomic testing. Calves can be tested through hair or tissue sample submission.

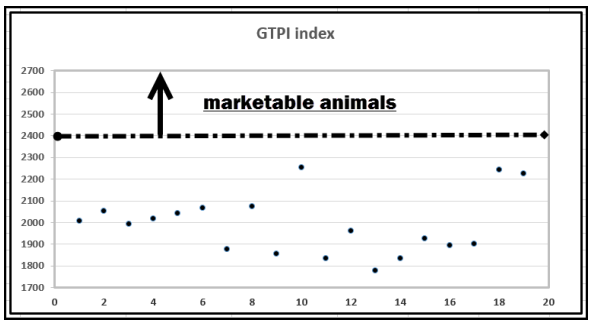

Figure 2: Processing centers help producers organize their newly generated genomic data. In this report from Dairy Records Management Systems, heifers are ranked by Net Merit (NM$). Genome-tested animals are noted by "G" and ranked nationally within their breed. The top 20% animals are designated by "N20".

Another management opportunity using genomics is animal identification confirmation. This was not a principle motivating factor for this farm to start using genomic testing, as they pride themselves as accurate record keepers. However, they were surprised to learn through the genomic test results that they had a 10% identification error rate. They have since made plans to correct those errors, which were mostly on the sire side, and then prevent such errors in the future through the use of breeding guns properly identified with animal ID.

The farm recently realized a new opportunity combining embryo transplant technology and genomic testing. They plan to use heifers on the farm as recipients of high genetic potential embryos. After birth, all of the calves will be tested, and those with the very highest results (within the range of 2400 to 2700 GTPI) will be sold (Figure 2). Eventually, there will be enough genetic progress made through selection and genomic testing to identify donor animals from within the herd. The plan calls for all mating selections to be done through genomic testing for the cows, as well as heifers whose GTPI results fall within the highest 60%. The lowest 40% will be serviced with an embryo.

Genomic testing is a tool to be used in conjunction with production, component, health, and conformation testing for profitable dairy management. Like all methods of "Measurement to Management", identification remains key in the process. Genomic testing can help correct ID errors and by doing so, allow for fully informed breeding and management decisions. Corrections in ID can also avoid setbacks caused by inbreeding or genetic recessives in a breeding program. Greater success in managing health problems with genetic ties is an exciting possibility for the future. Resources through commercial companies, breed organizations, and the CDCB are available to learn more about genomics and ways in which you can use it to make smart, informed management decisions.

1 http://www.dhia.org/dbc_articles.asp