To test or not to test?

by Kent A. Weigel and Ashley A. Mikshowsky

GENOMIC selection has taken the dairy genetics industry by storm over the past five-plus years. Regardless of whether you sell elite breeding stock or use young, genome-tested bulls, you've probably been affected in one way or another.

No doubt, the greatest impact of genomics has been the heavy use of young sires. By 2012, more than 50 percent of inseminations in the Holstein and Jersey breeds were to young genome-tested bulls with no progeny of their own. That percentage has more than doubled since 2007.

At the same time, the average generation interval for sires and dams of young A.I. bulls dropped to 3 years of age (and it's still dropping), while the average generation interval for sires of replacement heifers fell below 5 years of age for the first time since A.I. and frozen semen became available.

What about the so-called "females to produce females" selection pathway? In other words, are we making more rapid genetic progress by selecting better dams of our future replacement heifers now that genomic testing is possible?

Up until this point, genetic progress in females has always been the weakest link in our breeding programs, because farmers had to keep nearly every heifer calf that was born as a future herd replacement.

That "raise every heifer" paradigm has shifted, because many farms have upgraded facilities, improved calf health, reduced involuntary culling, and improved pregnancy rates (using timed A.I.). Those management changes, coupled with widespread use of sexed semen, have for the first time allowed dairy farmers to produce extra heifers and consider the possibility of culling a significant number of heifer calves.

As this has taken place, low-density chips that cost less than $50 per animal have become available. We can now identify superior or inferior calves accurately and confidently at a young age and use this information to reduce feed costs and improve the genetic level of our replacement heifers. Or can we?

Our genomic selection

The Allenstein Dairy Herd at UW-Madison has 764 cows total, including our campus, Arlington and Marshfield sites. The herd has a rolling herd average of 28,362 pounds of milk, 1,076 pounds of fat, and 894 pounds of protein on 2X milking. Since 2011, every heifer calf has been tested with a Zoetis low-density chip (CLARIFIDE) upon arrival at the Marshfield Agricultural Research Station, which is where our replacement heifers are reared. Because more than 400 of the 1,000-plus tested heifers have grown up and entered

Table 1. First lactation ME 305-day milk yield based on genomic PTA milk

Quartile	Number of cows	Average genomic PTA milk (lbs.)	Actual ME 305-day milk yield (lbs.)
Top 25%	103	1,358	31,581
Top 25-50%	103	832	30,050
Bottom 25-50%	103	482	27,864
Bottom 25%	102	-57	26,780

Table 2. First lactation ME 305-day milk yield based on sire's PTA milk

Quartile	Number of cows	Average sire PTA milk (lbs.)	Actual ME 305-day milk yield (lbs.)
Top 25%	103	1,780	29,864
Top 25-50%	103	1,168	29,673
Bottom 25-50%	103	762	29,247
Bottom 25%	102	128	27,498

the milking herd, we now have enough information to assess the accuracy of these early genomic predictions.

A total of 411 Holstein cows were beyond 60 days in milk in their first lactation, and these animals were used to compare the genomic predicted transmitting ability (PTA) for milk yield with the actual mature equivalent (ME) 305-day milk production. As a reference, we also compared each cow's actual first lactation ME 305-day production with the August 2014 PTA milk of her sire.

Was it a good investment?

The genomic PTA for milk yield at 12 months of age explained 18.8 percent of the variation in first lactation ME 305-day production, whereas sire PTA explained only 4.4 percent. Therefore, the genomic information provided a substantial improvement, but it's hard to really say whether this gain in accuracy was worth the $40 to $50 cost of carrying out a genomic test.

Let's look at it a different way, by dividing cows into quartiles based on genomic PTA for milk yield at 12 months of age and sire PTA milk. The difference in actual production between the top and bottom quartiles based on genomic PTA as a heifer was 4,801 pounds. As a comparison, the difference was less than half — 2,366 pounds — when cows were divided into quartiles based on sire PTA milk. Again, this means that genomic information on individual animals allows more accurate selection decisions than one can achieve using pedigree information alone.

It is important to note that, in all of our examples, the sire identification errors had already been corrected using genomic testing, and before correcting these errors the sire PTA would have been a slightly poorer predictor (we have a 5 percent sire misidentification rate in our herd, as compared with roughly 15 percent nationally).

What would have been the cost of the "selection errors" we would have made by culling the bottom 25 percent of heifer calves based on sire PTA milk rather than by genomic PTA for milk yield?

Per lactation it would yield an additional 237 pounds or 652 pounds per lifetime. (To arrive at that number, the difference would be 29,832 - 29,595 = 237 pounds of milk per lactation. The 29,832-pound figure represents average milk yield for the top 75 percent based on genomic PTA versus the top 75 percent based on sire PTA which is 29,595 pounds of milk. This difference of 237 pounds was multiplied by 2.75 lactations per cow for a total of 652 pounds of lifetime milk production.)

After accounting for the extra cost of the feed used to produce those 652 pounds of milk (43 percent of the extra milk value), and using a three-year average mailbox price of $20.39 per hundredweight, we are looking at $76 in extra net profit per cow.

Assuming that genomic testing costs about $45 per animal, we would generate $23,484 in extra revenue ($76 per cow times 309 cows kept as herd replacements). Meanwhile, the cost of genomic testing would be $18,495 ($45 per heifer times 411 heifers tested). Remember that the genetic improvement is permanent. That means we will realize additional financial gains when we milk the daughters and granddaughters of the heifers selected using genomics.

Table 3. Days open in first lactation based on genomic PTA for daughter pregnancy rate

Quartile	Number of Cows	Average genomic PTA DPR (%)	Actual first lactation days open
Top 25%	60	1.65	104.9
Top 25-50%	60	0.65	113.6
Bottom 25-50%	60	-0.06	114.9
Bottom 25%	60	-1.08	125.9

Table 4. Days open in first lactation based on sire PTA for daughter pregnancy rate

Quartile	Number of cows	Average sire PTA DPR (%)	Actual first lactation days open
Top 25%	60	2.10	113.1
Top 25-50%	60	0.85	104.9
Bottom 25-50%	60	-0.03	124.9
Bottom 25%	60	-1.70	116.5

Gains in health also important

We've talked a lot about milk yield, but what about some of the other traits? First, let's take a look at days open and see how it is related to the cow's genomic PTA for daughter pregnancy rate (DPR) and her sire's PTA for DPR.

The difference is striking. The top versus bottom quartiles based on genomic PTA at 12 months of age differed by 21 days open. The difference was only 3.4 days open when cows were divided into quartiles based on sire PTA. If we consider a cost of $2 or $3 per day open, it is clear that improvements in fertility can also help offset the cost of genomic testing.

Genomics works!

Genomic predictions are not perfect, but they are much more informative than pedigree information alone. This is not only true for the predicted genomic PTA of young bulls and elite heifers, but also for predicted future performance of replacement heifers on commercial farms. Based on data from our Allenstein Dairy Herd at UW-Madison the benefits of genomic testing can outweigh the corresponding costs.

The reason we emphasize the word "can" is that we must take management actions based on the genomic test results. In this study, we kept heifers that ranked in the bottom 25 percent based on genomic PTA for research purposes, but in the future (and in your herd) these animals should be culled in order to save feed and recoup the cost of genomic testing. Assuming a postweaning rearing cost of $2.30 per day, we could have saved approximately $147,798 in rearing costs by culling the 102 heifer calves in the lowest quartile for genomic PTA milk at 3 months of age.

It is also important to capture other benefits of genomic testing whenever possible. These include: 1) use of the top-ranking females as embryo donors and the below-average females as embryo recipients, 2) use of sexed semen to create extra heifer calves from the above-average females, and 3) use of genomic mating programs to avoid inherited defects and minimize inbreeding.

Lastly, don't underestimate the value of combining technologies, because it is clear that the benefits of genomic testing can be enhanced when used alongside embryo transfer, in vitro fertilization, sexed semen, genomic mating programs, and other reproductive and management technologies.

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