Dairy genomics research update: New aspects of selection for health and fertility

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AT A GLANCE

Thanks to genomic advancements, dairy producers can look forward to improving fertility and health traits without compromising milk production.

A new herd health strategy, in addition to vaccination and biosecurity, is to change the health and reproductive efficiency of the herd through genetic selection. In a recent set of presentations as part of the Minnesota Dairy Health Conference, we provided practitioners with an update on current genomic testing for health and fertility traits.

The dairy industry has based selection for many decades on milk production through the use of progeny records. We can now accelerate the improvement of the herd's traits with genomic testing that uses DNA variants to predict, when the calf is born, what their potential might be. Genomic selection accelerates the genetic improvement made with traditional genetic selection by increasing how much information we have about an animal, how much we will cull out of the bottom end and reducing the average age of the parent when its offspring are born.

Genomic selection has its highest value when selecting for traits that are difficult or expensive to measure, occur late in life or when the animal has no or few offspring. Milk production is pretty easy to select for because it is easier to measure. Traits more difficult to measure include health and fertility traits.

Selection starts with the phenotype. A phenotype is a set of observable traits. Milk production in 305 days is one phenotype – and it has a moderate heritability. Fertility can be defined as Daughter Pregnancy Rate (DPR), becoming pregnant within 21 days or defined by other means such as conception rate (CR) or calving interval. A genotype is a region of DNA used to predict a phenotype or trait. Some well-known selection indices, such as Net Merit $, have health (somatic cell score) and fertility traits (DPR) included in them. Using these indexes, the herd owner can use selection to improve the fertility of the herd.

Over the last 50 years, selection has been primarily focused on producing progeny with greater milk production without regard to fertility. Subsequently, we saw a rise in milk yield but a drop in fertility. Although fertilization rates are high, 40 to 56 percent of lactating dairy cows lose their pregnancy within the first month. To reverse this trend, in 2003, DPR was added to selection indices and, in 2010, Heifer Conception Rate (HCR) and Cow Conception Rate (CCR) were added. The result is: Fertility and milk production levels now are both improving. The rate of genetic improvement for DPR has quadrupled from 0.06 (2006-2010) to 0.28 (2011-2015). An increase in DPR of 1 percent is equivalent to a predicted (PTA) decrease of four days open and about 1 percent more calves with a lifetime average value of $150. In April of 2015, Holstein Association USA implemented both a Feed Efficiency Index and Fertility Index. The Fertility Index includes HCR, CCR and DPR. The new Fertility Index combines several reproductive components into one overall index: a maiden heifer's ability to conceive, a cow's ability to begin cycling, show heat and conceive while lactating, and her ability to maintain a pregnancy.

In addition to using selection

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indices to improve reproductive efficiency, genomic selection can be used to identify breed-specific fertility problems associated with inbreeding through haplotype testing. A haplotype is a section of DNA that tends to be inherited as an intact unit (no recombination) from a parent to its offspring. Fertility haplotype tests are used to identify autosomal recessive traits that commonly reduce fertility in different breeds.

Our current research is looking at high-fertile (100 percent CR) and sub-fertile (less than 25 percent CR) heifers and the changes along the DNA associated with CR. We are using a genome-wide association analysis to identify specific regions highly associated with fertility. About 26 loci were identified as associated with HCR with a heritability estimate of 0.46 or 46 percent. Our colleagues in Florida found areas (SNPs) that could select for fertility without impacting milk yield.

Selection for health traits also requires a specific (and, ideally, standardized) phenotype definition of health or disease to identify areas of the genome associated with health or disease. We have udder health traits, hoof health traits as well as postpartum disease traits we can select for, such as metritis, retained placenta, displaced abomasum and ketosis. Ongoing research at WSU, UC – Davis, University of Missouri, Colorado State University, New Mexico State University and Texas A&M is looking at the genetics of bovine respiratory disease in beef and dairy calves.

Many individual PTA and selection indexes are available for genomic selection for fertility and health traits, and more are in development. Genomic selection allows culling and mating to be tailored by aligning a farm's breeding objectives with indexes matching the vision for the herd. Research is ongoing to identify more loci associated with fertility and health traits that can be used for genomic selection.

Where should a producer go with this information? The value lies in making genetic progress, but there is no cookie-cutter approach to testing and use of the test results. The best place to start is with your current herd records. How are you utilizing sires now? Do you want to avoid inbreeding? Sell surplus calves and heifers? Sell genetics? Optimize your use of advanced reproductive technologies? Before doing any testing, you need to have a plan about what you will do with the results.

You can rank heifers based on available indices (NM$, Cheese Merit, Grazing Merit, Fluid Merit, etc.) depending on the market for your milk and your management. You could sell heifers not meeting farm-established cutoffs, breed bottom-end replacements to beef sires, use top-end females for sexed semen, use the top-end for ovum pick-up and in vitro fertilization, use the middle group for recipients or send the bottom end to a feedlot. Whatever you decide to do, make your plan before testing and stick to the plan. After the first round of testing, or on an annual basis, revisit your testing strategy and make a new plan after reviewing your records and goals.

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References omitted but are available upon request.

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