A global organization for mastitis control and milk quality

Using Genomic Selection to Improve Mastitis Resistance

Genetic studies of dairy cattle confirmed that selection for higher milk production naturally brings higher rates of mastitis. Because genetic selection to increase milk yield was highly effective prior to having genetic tools to deal with udder health, mastitis incidences in the U.S. population increased gradually over time.

In 1994, the U.S. Department of Agriculture initiated sire rankings for Predicted Transmitting Ability for somatic cell score (PTA SCS). This allowed producers to select bulls for their ability to sire daughters producing milk having lower somatic cells. In April 2018, the Council on Dairy Cattle Breeding (CDCB) initiated an evaluation for resistance to clinical mastitis for Holsteins based on producer records in their individual herds. The same was provided for Jerseys in April 2020. These developments each provide an opportunity to improve udder health and the quality of milk produced.

One point to understand is that even though higher rates of mastitis are likely in higher producing cows because the traits are correlated genetically, progress can be made in several economic traits at the same time, albeit slower. Such is the case for milk and udder health.

Measuring Mastitis

Two conditions are necessary to achieve genetic change. A trait needs a genetic component as well as sufficient variation. A larger magnitude for each indicates more progress is possible. The level of genetic control – known as heritability – for SCS is estimated to be 12 percent. The heritability of clinical mastitis using producer-recorded data is estimated to be only 3.1 percent. In contrast, the heritability for milk production is about 20 percent.

Before progress can be made in genetic selection, the trait being selected for must be measurable. The problem is that in the United States., there are no cheap or uniform methods of directly measuring mastitis.

As it turns out, however, SCS is an excellent indicator trait for mastitis. When a cow is challenged with a mastitis-causing organism, her immune system responds by sending white blood cells to the mammary system. These somatic cells attack the organism to eliminate the infection.

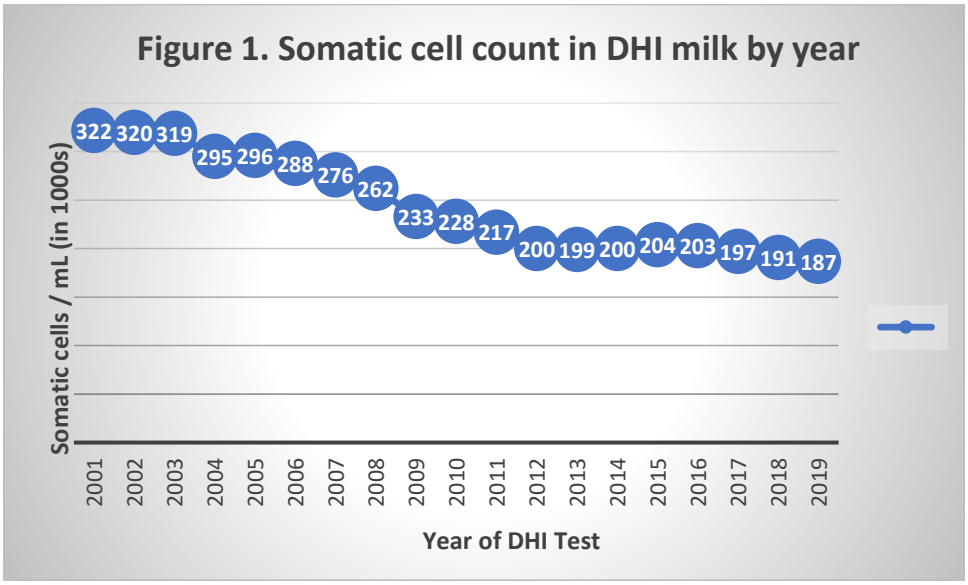
In fact, studies have shown that mastitis is the most important cause of an elevated SCS. Researchers have found that the genetic correlation between SCS and mastitis is 60 to 80 percent. This implies that daughters of sires with high PTA SCS experience a high incidence of

mastitis. Another advantage to using SCS as an indicator trait is that it is routinely collected at low cost by Dairy Herd Improvement (DHI) associations. SCS data are available from 96.4 percent of all DHI cows and from 98.4 percent of DHI herds. These data, averaged over a cow's entire lactation, are ideally suited for use in sire summaries.

Progress has also been made in recent years to utilize mastitis data directly. Research has shown that mastitis incidence reported by producers in on-farm management software can be utilized as data for genetic evaluations. CDCB currently provides genetic evaluations for clinical mastitis resistance (PTA MAST) for Holsteins and Jerseys.

As expected, PTA SCS is correlated with PTA MAST by 68 percent. Data available for direct mastitis evaluations are much more limited compared to SCS. Given this, as well as the lower heritability, reliabilities also tend to be lower, averaging about 65 percent for genotyped animals.

The value of achieving permanent improvement through genetic selection cannot be overemphasized. Still, a remarkable change in herd management practices took place at the same time that should be noted. Look at what happened to somatic cell count (SCC) since the year 2000 in herds that have been enrolled in the DHI program (Figure 1). Milk had 322,000 somatic cells per milliliter in 2001. By 2013, a phenomenal reduction had been achieved. Even though there was a slight uptick in 2014 and 2015, SCC has continued to decline in each of the last four years. Milk SCC decreased again in 2019, from 191,000 cells/milliliter to 187,000 cells. These reductions in SCC brings along improved shelf life for dairy beverages.



The speed of this improvement in milk quality wasn't predicted by anyone. Considerable credit should go to the milk processing companies who provided a premium or credit to producers for supplying low SCC milk as it increased cheese yield from the product. Also starting in 2000, pricing milk based on SCC was mandated in five of the ten federal milk marketing orders.

Using the Sire Evaluations
Producers are able to select bulls on their ability to sire daughters with lower rates of mastitis by using sire rankings for PTA SCS and PTA MAST.

SCS sire evaluations are reported in terms of a bull's predicted transmitting ability for SCS. For example, Bull A has a PTA SCS of 3.12. Bull B has a PTA SCS of 3.62. The difference is 0.5. If daughters of these bulls are housed in the same herd at the same time, the SCS of the bulls' daughters is expected to differ by 0.5.

An important fact to remember is that a lower PTA SCS is better. That's because a lower SCS means that the cow has less subclinical mastitis – and therefore is less prone to milk losses – than a cow with a high SCS.

Similarly, a bull's PTA MAST represents the expected resistance of his daughters to clinical mastitis in a herd with average management conditions. Evaluations are expressed as percentage points of resistance above or below the breed average. In this case, larger, positive values are more favorable.

It is also important to remember to not overemphasize PTA SCS or PTA MAST in your selection program. To avoid overemphasis, SCS and mastitis evaluations should be included in a selection index. Here, weights are assigned to various traits, depending on their economic importance. Over the past 50 years or so, emphasis has shifted from being primarily on production traits in order to include traits such as SCS, mastitis resistance, as well as others pertaining to longevity and reproduction.

For example, CDCB calculates a net merit index that includes weights for 38 traits currently with production receiving 45 percent emphasis. SCS receives 4 percent emphasis as of the 2018 version of lifetime net merit. Mastitis resistance is included in a Health$ sub-index, which incorporates five other health traits. The Health$ sub-index currently receives a total of 2.3 percent emphasis in lifetime net merit.

With the publication of the new CDCB evaluations for PTA MAST, sire analysts have a more direct measure of mastitis in a bull's daughters to use along with PTA SCS. Using these data will help ensure that highly unfavorable bulls are not used to sire future generations of dairy cattle.

Much of the reduction in SCS has been due to improvements in herd management; therefore, these practices need to continue if one is to maintain this performance. Traditional mastitis-control programs must be of the utmost importance in controlling the disease in dairy herds. Milking machines must be attached to clean, dry teats and equipment must be maintained for optimal milking performance.

In the future, selection for improved resistance against mastitis should play a more important role than in the past because the genetic information made available through genomics has considerably higher accuracy than what was previously available. Information from the entire dataset is updated three times per year, while information on new animals is updated monthly. Producers following sound milking practices and incorporating genetics for resistance against

mastitis will receive economic benefits while producing the quality products that consumers demand.

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