Why Genomics Matters

Applying genomic technology to commercial dairy operations

By Drs. Kent Weigel and Bennet Cassell

Let's do an exercise. Pull up all of the heifer data you have and rank the heifers four months old or younger based on their ability to be the genetic future of your herd. How confident are you with the data you have on hand that your decisions are accurate? Now imagine having genomic information on those same calves, empowering you with the ability to accurately predict future performance. You now have the tools to make more profitable management decisions earlier in those animals' lives. That's what genomic technology will soon have to offer commercial dairy operations.

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Genetics: The foundation of genomics

Traditional genetic evaluations have predicted many aspects of an animal's makeup—from how the animal will look to the animal's performance. Genetic improvement has long driven higher productivity as dairymen have continually bred their best females with the best bulls in hopes of producing offspring with the greatest genetic and production potential.

Over time improved data have reduced the risk of major mistakes in genetic selection. Sire selection has empowered phenomenal genetic progress, enabling one bull to be used as the sire for hundreds and even thousands of offspring. This allowed the industry to learn a lot about the impact of sires and their ability to pass genes to their offspring.

"... the stage is set for great opportunity within the female population to make rapid genetic progress."

Much less information is available regarding the potential genetic contributions of an individual dairy cow. Unlike A.I. sires, the commercial female has few offspring and few production records over her lifetime. Since most selection has been made on the bull side of the pedigree, there remains opportunity within the female population for faster genetic progress.

Genomics uncovered

To learn even more about the dairy cow a group of researchers worked diligently from 2003 to 2006 to sequence all of the DNA markers that make up the dairy cows' genetics, known as the bovine genome. The sequenced genome defined each DNA marker within the dairy cow's genetic makeup and began to identify which markers directly impact a cow's physical appearance and performance ability. Genomic tests are now available that use this information to:

- **Identify genetically superior animals.** With the full genomic map available, producers are now able to see which animals have markers for traits that will directly impact economically relevant outcomes—like milk production.
- **Rank animals at an earlier age.** Genomic testing can be done on young calves, which means producers can estimate an animal's true genetic potential earlier in life. Current industry methods of progeny testing take years and at least 100 daughters before providing a reliable prediction.
- **Improve selection reliability.** Genomic predictions have most recently been used to identify genetically superior animals with greater reliability. A majority of these animals have been bulls entering A.I. programs, or elite females to be considered as bull dams.
- **Combine information with known records.** Genomic results are reported as Genomic Predicted Transmitting Abilities (GPTAs), which are presented in the same units as the traditional genetic evaluations. For example, an animal's GPTA for milk production may be +1026, which means that animal is expected to produce 1,026 pounds more milk in a single lactation than an average female born in the current genetic base year of 2005. This data can be used alongside existing information within the herd record management program.

Looking ahead with genomics

Current genomic offerings have focused only on the top tier of potential A.I. sires and elite cows that are potential producers of future A.I. sires. But the next generation of genomic offerings will provide value to all dairy operations, allowing commercial producers to utilize the information for improved female selection, mating, management and profitability.

The bovine genome has approximately three billion base pairs, and researchers have identified the markers within these base

Why Genomics Matters, continued

pairs that are associated with the genes of greatest importance to the dairy producer. The newest technology is a cost-effective chip with 3,000 markers (3K), delivering the most relevant information on traits related to production, health and type. This technology is derived from the 50,000 marker panel that has been used extensively for characterization of elite sires and bull dams in the dairy industry. Now we have cost-effective genomic predictions that commercial operations can use for female selection.

For commercial dairy producers this revolutionary new technology will dramatically enhance female selection. Having more information than ever before available at a young age means:

- **Enhanced genetic improvement and productivity.** Genomic testing a group of young heifers will help identify potential outliers—both those that are above the herd average and those below it—allowing you to make selection decisions with a greater sense of comfort. With this information in hand, you can select and mate heifers to drive more rapid genetic improvement.

- **Additional information available.** Previously, commercial dairy producers have waited until a cow reaches the milking herd to evaluate her genetic potential in action. Since the average cost to rear a heifer is $2,150[1] that means a significant investment must be made into an animal before anything is known about how she will perform as a cow. 3K technology allows you to access this critical information on young females and make a more informed investment by only developing heifers that exceed minimum thresholds of genetic potential for productivity.

One especially important index offered with the 3K chip is Net Merit, which directly measures the potential profit contribution an individual animal generates for your dairy. In a commercial dairy population, animals tested with the 3K chip showed an extreme range in Net Merit dollars generated over the animal's lifetime.

Example Net Merit values from one commercial dairy operation are provided in the following table, and highlight the range of values seen within a typical heifer population. These Net Merit index results illustrate a difference between the most extreme animals of $419 over their lifetime. Having this information allows you to select the best females to generate the greatest profits, and cull or correctively mate lower-end females.

	Minimum	Maximum	Difference
Net Merit $	-224	+195	+419

"A female calf born today that is genotyped with the 3,000-marker panel will have more reliable information than previously attainable with current progeny testing methods."

- **More reliable decision-making.** The reliability values that accompany genomic predictions help to further explain how closely genomic information relates to an animal's true genetic potential. A female calf born today that is genotyped with the 3K chip will have more reliable information than previously attainable with current progeny testing methods. This means more information is available within months of birth with greater reliability than ever before.

The example below compares three heifers that have very similar pedigree information and expected Net Merit based on genes they might have inherited. The 3K chip can help identify genetic merit actually possessed by these females, such that those with the most potential to generate the greatest profits are retained with more confidence. Based on the example below, heifer 2 can be expected to generate an additional $649 return ($124 + $525) over her lifetime compared to heifer 1, who is expected to be less profitable.

Heifer	Net Merit $	Reliability %
1	-124	62
2	525	63
3	48	62

The decisions you make today in your calf and heifer pens will have a direct impact on the future of your herd. Utilizing the latest genomic technology allows you to look into the future of these young animals and use the information to confidently make important selection, mating and breeding decisions, leading to greater herd productivity and profitability.

1 Zwald A, Kohlman TL, Gunderson SL, Hoffman PC, Kriegl T. Economic Costs and Labor Efficiencies Associated with Raising Dairy Herd Replacements on Wisconsin Dairy Farms and Custom Heifer Raising Operations. University of Wisconsin. 2007. Available at: http://www.sheboygan.uwex.edu/ag/dairy/documents/CostofRaisingHeifers-2007ICPAReport.pdf. Accessed July 22, 2010. PAG10027