Réseau laitier canadien
Canadian Dairy Network

The DNA Evolution and Revolution!

The word “genomics” is the talk of the industry but what is it? What are SNPs (“snips”)? Who understands what genes, alleles, loci and chromosomes really are? Answers to these questions can be found in other articles and the focus here is to describe how this new technology will affect Canadian dairy producers and the industry in general.

DNA Profiles Contributing to Genetic Evaluations

Since the genetic information of every animal is contained in its DNA, it was inevitable that DNA technology would one day become an integral part of our breed improvement programs. Ever since frozen semen became commercially available more than sixty years ago, the evaluation of daughter records, such as production and conformation, has been the fundamental component of genetic evaluation calculations. Due to the establishment of a North American DNA repository that started more than 15 years ago, combined with recent major developments in DNA technology, Canadian Dairy Network (CDN) is working to include DNA information in official genetic evaluations of genotyped Holsteins starting April 2009.

For bulls, this means that genotyped calves will have information from their DNA profile combined with their Parent Average to produce a more accurate genetic evaluation for use as an unproven young sire. For females, traditional Parent Averages can also be enhanced in terms of accuracy for heifers and cows that have their DNA genotyped. As shown below, this means that females will soon have four sources of information contributing to the calculation of their genetic evaluation, namely their Parent Average known at birth, the information from DNA when genotyped, their own performance data, which basically begins at first calving, and the performance recorded on their daughters.

Sources of Genetic Evaluation Contributions for DNA Genotyped Females

EBV = PA + DNA + Performance + Progeny

Heifer

Genotyped Calf

Milking Cow

“Mature” Milking Cow

(4+ yrs old, 3rd+ lactation, 1+ daughter(s) in milk)

(Minimum 7 yrs old to have a proven son)

New Genetic Selection Strategies

With the inclusion of information from an animal's DNA profile, preliminary research conducted jointly between the University of Guelph and CDN shows that the average Reliability of genetic evaluations for young bulls and heifers is expected to increase to a range between 50% and 60%, depending on the specific trait. This represents a significant increase in accuracy compared to current levels of Reliability values for heifers and young sires, which average from 20% to 40% across all traits.

With the higher level of accuracy available for young sires via DNA genotyping, it is evident that A.I. organizations will soon require the analysis of a DNA sample for every young bull of potential interest for purchase, especially when a team of full-brothers is available to select from. Some A.I. companies may also offer semen from a team of higher-Reliability sires that do not yet have daughters born as a different product line compared to the usual young sires on a testing program or to proven sires with roughly 100 daughters in milk.

Genetic selection schemes involving heifers and cows will also be revolutionized in this new era with DNA information contributing to genetic evaluations. Perhaps the most important single point is the fact that DNA genotypes are essentially unbiased whereas Parent Averages, an animal's own performance data and that of their progeny are all susceptible to possible biases due to preferential treatment that cannot be totally removed within the current genetic evaluation calculation systems. Genotyped cows will have more accurate genetic evaluations for all traits including LPI, which means there may be some re-ranking among the top cows and A.I. will make more accurate decisions when selecting dams of future young sires. For heifers, those that are genotyped and found to be superior can be selected as herd replacements and/or as donors for embryo transfer flushing programs.

Genotyping Procedures

On behalf of the Canadian dairy cattle industry, Holstein Canada is currently developing the required guidelines and procedures for herd owners to collect and submit tail hair samples from the heifers and cows they want to have genotyped. This national DNA genotyping service will start in November 2008. Hair samples will be sent to Holstein Canada, who will then forward them to an authorized genotyping laboratory where the DNA will be extracted and genotyped. Each animal's DNA profile will be sent via data exchange procedures to CDN for calculation of a Genomic Breeding Value (i.e.: GBV) for each trait, which will be combined with the animal's Parent Average into a Genotype-Enhanced Parent Average (GPA) or, for cows, with their official genetic index into a Genotype-Enhanced Estimated Breeding Value (GEBV). For bulls, DNA genotyping must be done via one of the A.I. organizations that contributed to the development of the new technology in order to lead to the computation of a Genotype-Enhanced Parent Average (GPA) for each trait.

Summary and Future Developments

The use of information from DNA profiles for calculating genetic evaluations for all animals and traits is going through a very important and rapid evolution. In view of the CDN plans to incorporate DNA genotype information into official Holstein genetic evaluations starting in April 2009, Holstein Canada is developing the necessary

procedures for herd owners to have any desired heifers and/or cows genotyped, with the introduction of a national service planned before the end of 2008. The inclusion of information from DNA profiles for males and females will revolutionize current genetic selection and breed improvement strategies. Detailed results of the joint research and development that is ongoing between CDN and the University of Guelph, in collaboration with the USDA-AIPL in the United States, will be the topic of an upcoming CDN article in this column.

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