Increased Rates of Genetic Gain with Genomics

The application of genomics for dairy cattle improvement became a reality in 2009 when Canadian Dairy Network (CDN) published the first official genomic evaluations for Holsteins in Canada. The promotion and adoption rate of this new technology stemmed heavily from the potential to significantly increase the rates of genetic progress for traits of importance contributing to dairy cattle profitability.

Factors Affecting Rates of Genetic Gain

The annual rate of genetic progress achieved in a breed and/or in a herd is affected by four specific parameters. These include (a) controlling the loss of genetic variation that exists in the breed, (b) increasing the intensity of selection applied, (c) increasing the accuracy of selection, and (d) decreasing the generation interval between parents and progeny. In addition, there are four specific selection pathways that contribute to the rate of annual genetic progress achieved in the breed. In general, the A.I. companies are responsible for two of the four pathways, namely the selection of sires and dams of young bulls purchased for progeny testing. Herd owners are responsible for the sires they select for A.I. usage to breed their cows and heifers as well as the heifer calves they keep and raise for herd replacements.

Impact of Genomics

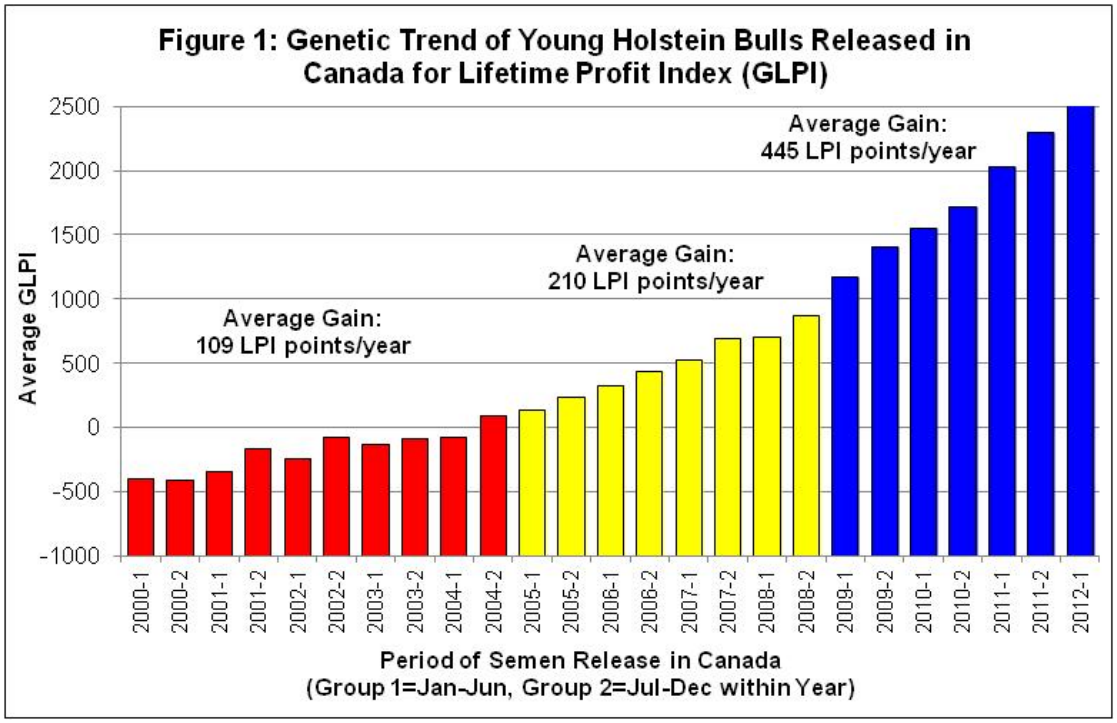
As it relates to genomics, there are three key components expected to increase the rates of genetic gain. Since genomic evaluations are significantly more accurate than traditional Parent Averages for young bulls, this translates to an important increase in the accuracy of young bull selection decisions and purchases made by A.I. organizations. In addition, DNA genotyping of thousands of candidate young bulls with interesting pedigrees has become a new selection step to ensure the highest genetic merit of the few hundred that enter A.I. service. This selection step dramatically increases the intensity of selection in the breed, which boosts genetic progress. A third key component of genetic gain that has changed significantly with genomics is the reduced generation interval. The proportion of semen from genomically tested young sires continues to grow while older progeny proven bulls are selected less often. This trend towards younger bulls leads to a decreased overall age difference between sires and their daughters. Reducing generation interval is a major factor contributing to rates of genetic progress achieved in a breed or herd.

A Promising Start

Theoretical analysis by various geneticists worldwide has demonstrated that rates of genetic gain can be doubled with genomics compared to traditional young sire progeny testing programs. A recent study at CDN examined the average genetic merit of young sires that have been offered to Holstein producers in Canada from the start of 2000 to the first half of 2012. Within each year, bulls were divided into two groups, namely those with semen released between January and June (Group 1) versus those released between July and December (Group 2). Figure 1 shows the increase in average GLPI for each group of bull within year of semen release, based on current genetic evaluations. Although the plot reflects the trend for genomic LPI (GLPI) over time, only those bulls with semen released since 2009 could possibly have been selected by A.I. organizations based on knowledge of their genomic evaluations.

From Figure 1 two important facts are revealed. Firstly, the significant difference in average genetic merit (i.e.: GLPI) of young bulls offered to Canadian Holstein producers in 2012, which

averages 2500 GLPI), compared to 2000 is nothing but exceptional! This represents an absolute gain of nearly 3000 LPI points, which averages 250 LPI points per year. More importantly, however, is the increasing rate of genetic progress realized over this time period as demonstrated by the three time period shown in the graph. Between 2000 and 2004, the average genetic merit of young bulls offered in Canada increased by 109 LPI points per year. From 2005 to 2008, this rate of progress nearly doubled to an average of 210 LPI points per year. With the arrival of genomic evaluations and the ability to select young bulls with more accuracy and a higher level of selection intensity, the average GLPI of young bulls offered by A.I. in Canada between 2009 and the first half of 2012 has increased by an average of 445 LPI points per year! This remarkable trend shows great promise for the strength of young sires available for use today as well as the group of progeny proven sires that can be expected in the coming years.



The CDN analysis included many other traits in addition to LPI and each of its three components. In all cases, the rate of improvement for young bulls with semen released since the debut of genomics in 2009 has been very positive. Three traits that warrant special mention include Somatic Cell Score, Herd Life and Daughter Fertility. Although some selection emphasis has been placed on Somatic Cell Score in the past by A.I. companies purchasing young bulls, the rate of improvement in the past three years has significantly increased. This same tendency exists for Herd Life but the current gains are even more outstanding. Young bulls released in Canada between 2009 and 2012 represent an average gain of 2.0 RBV points per year in their average Herd Life evaluation whereas previous annual gains were less than 0.5 RBV points. Of particular interest is the turnaround achieved in terms of selection to improve Daughter Fertility. Young bulls offered between 2000 and 2004, which was before genetic evaluations for this trait were available, actually show a negative trend of -0.5 RBV points per year. This trend was stabilised during the period from 2004 to 2008 but since genomic evaluations have become available, young bulls offered in Canada show an average genetic gain for Daughter Fertility of nearly one RBV point per year.

Summary

Since its official adoption in 2009, “Genomics” has been promoted as a revolutionary technology able to double rates of genetic progress achievable in dairy cattle improvement programs compared to traditional young sire proving programs. Two key factors contributing to this

expected boost in rates of genetic progress include a stronger level of selection intensity combined with greater accuracy of selection when A.I. companies purchase young bulls for offering to Canadian producers. These two components will therefore shift sire usage by producers away from older progeny proven bulls and towards younger genomically tested bulls, which reduces generation intervals and increases the annual rate of genetic gain in the breed. A recent study at CDN clearly shows the outstanding gains in the average genetic merit of young sires with semen released in Canada between 2000 and 2012. Young bulls with semen released since the arrival of genomics in 2009 show an average gain of 445 LPI points per year with those made available in the first half of 2012 averaging 2500 LPI.

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