Leaping into the Genome

By Roy Wilson,
Technology Development Manager, Genex

Do you remember those genetic equations you learned back in school?

Phenotype = Genotype + Environment
Genetic Change = (Selection Intensity x Heritability) ÷ Generation Interval

These equations are the basis to animal breeding.

We have dreamed about being able to know an animal's genotype, dramatically shorten the generation interval and increase selection intensity. What if we can now say we *do* know the genotype, we *can* shave four years off the generation interval, and we *can* screen four times as many bulls? Let's just say welcome to genomic selection, and hold on tight because the world of dairy genetics is changing fast!

Most dairy animal breeding principles and practices have been routine for the past 40 years, basically since the advent of frozen semen. Within the traditional sire procurement process, an employee of an artificial insemination (A.I.) stud first identified an "elite" cow, one that was superior to her herdmates, and then visually inspected the cow to ensure she was of adequate type. Then an appropriate mating sire was negotiated with the cow's owner as well as a contract to receive a male calf of that particular breeding. This is how the dairy A.I. industry has operated for many years, and it has been successful. For instance, since 1957 the genetic progress made in milk production has been nearly 10,000 pounds! However, with the addition of genomic selection the traditional sire procurement process as well as other genetic programs will be changing.

What is genomic selection?

It is the simultaneous selection of tens of thousands of markers which cover the entire genome in a dense enough manner that all of our current traits are expected to have some linkage to these markers. Or said in a very simplistic way, we now can predict how "good" or "bad" an animal is for traits based on their actual genetic makeup.

To produce a genomic prediction a DNA sample is needed. This DNA sample is broken down into a series of nucleotides which are the genotype. Anytime there is a change in the sequence of nucleotides it is referred to as single nucleotide polymorphisms (SNP). The picture below demonstrates a DNA sequence and identifies SNPs. These SNPs are used to genetically predict how an animal will perform or to develop their genomic proof.

The Genomic Timeline

To determine if genomic data was accurate and usable, AIPL[1] investigated the reliability of the genomic predictions. The approach included using genotypes from 3,576 Holstein bulls born before 1999 to predict and compare the January 2008 daughter deviations for 1,759 bulls born between 1999 and 2002. The genotypes for these sires came from the Cooperative Dairy DNA Repository (CDDR). The contributors to the CDDR are the primary NAAB[2] member studs, such as Genex. Genomic predictions were calculated for five yield traits, five fitness traits, 16 conformation traits and Lifetime Net Merit. The genomic predictions were found to be significantly more accurate than the official parent averages for all the traits.

With this research verifying the creditability of the genomic information, the original contributing studs began genotyping their own animals in January 2008. Now eight months later genomics are still considered in the research phase, therefore no genomic proofs have yet been released to the public. To date there has been two genomic sire summaries with the expectations of three more yet to come in 2008. This information is currently being utilized by the studs to make decisions on how to implement this new technology into their dairy genetics departments and programs. AIPL is planning on making genomics part of the official January 2009 sire summary evaluations. The two equations below demonstrate how genomics will be included in the evaluations.

Proven sire evaluations = pedigree data x genomics x daughter data

Unproven sire evaluations = pedigree data x genomics

Genex Genomic Impact

We, at Genex, are planning for the future and believe genomics will play a major role in the cooperative. Therefore, Genex is ready to announce some initial changes to our genetic programs.We have already implemented a change to the sire procurement process. Prior to even being purchased from a herd owner, every young bull receives a genomic proof. This ensures only the highest qualified sire candidates are being purchased.

The cooperative's initial goals are to purchase only the top 25 percent of the bull calves screened. We anticipate screening a minimum of 1,000 bull calves annually and purchasing the 250 most qualified individuals that meet our selection goals. The number of purchased bulls is not drastically different than pre-genomic plans, approximately a 20 percent reduction. Although this is not a large reduction, it is a substantial increase in selection intensity.

By combining the increase in selection intensity with the potential of having mating sires accessible at one year of age (decreasing the generation interval), genomics will increase genetic change.

Genex is also introducing Quantum™, the new sire sampling program. Genex has always taken pride in operating what we consider one of the strongest sire sampling programs. Throughout the years, the QUEST™ program has been very successful, but now change is upon us. It is time to take full advantage of these new, exciting discoveries in animal genetics and to further build an even more successful sampling

program through Quantum. This new program will be implemented over the next six months.

Positioned for Change

Genomics are changing the landscape that has been the basis for the dairy sire industry for the past 40 years. Doug Wilson, Genex Chief Operating Officer, has been quoted multiple times saying "Change. We welcome change as long as change doesn't manage you, and you manage the change."

We believe Genex is positioning for this change appropriately. Genomics is exciting and challenges us to recreate the dairy genetics landscape. While many impacts of genomics are yet to be discovered, we are gathering data and gearing this cooperative towards a successful future. Genomics is exciting, revolutionary and without a doubt a positive change!

Author Bio **Roy Wilson** has established experience in dairy genetics and reproduction. After undergraduate work at the University of Wisconsin-River Falls, Wilson completed dual masters' degrees at the University of Wisconsin-Madison in animal breeding and reproductive physiology.

[1]*Animal Improvement Programs Laboratory*

[2]*National Association of Animal Breeders*