Maximizing genetic progress in the new age of genomics

R.H. Fourdraine

AgSource Cooperative Services, 135 Enterprise Drive, Verona, WI 53593, United States

Genetics have historically played a minor role in day-to-day herd management when compared to nutrition, udder health and reproduction. Genetic progress for most US dairies consisted of selecting AI sires that might improve the herd’s main deficiencies, like production, feet and legs or udder composite. Culling low genetic merit cows was not an option because most dairies had insufficient heifer inventories to replace the low genetic value animals while maintaining herd size.

Modern technology offers a growing list of options when it comes to genetics decision making. With the introduction of genomic testing and sexed semen, managing herd genetics is no longer a minor part of the day-to-day herd management. With the variety of tools available, producers have to ask the question; am I maximizing genetic progress while managing inbreeding? AgSource provides four tools to assist producers with their genetic program decisions.

Keywords: decision aid, herd analysis, benchmarking, genetic progress, inbreeding.

Introduced in 2014, the Genetic Summary Report (GSR) is a four-page analytical tool that features 13 different analyses focused on maximizing genetic performance while minimizing inbreeding. Among the many features, the report provides a comparison of the current herd genetics against AgSource’s 80th percentile active cows and heifers, a genetic progress trend graph by year of birth, herd average genetic values by testday for cows and service sires, youngstock genetic analysis, and a performance analysis of the herd’s top 12 bulls based on number of daughters. The GSR highlights many benchmarks, allowing the producer to measure how well the herd is doing compared to other herds.

The AgSource Genetic Selection Guide (GSG) reports provide producers with the power to maximize the future genetics in the herd using both genotypic and phenotypic information to make replacement, breeding and genomic testing decisions. The Genetic Selection Guide uses Net Merit$ (NM$), which is the most widely accepted US measure of a cow or heifer’s genotypic ability to produce milk over a lifetime.

To make the most informed decisions, producers have turned to genomic testing of newborn animals and are making more use of genetic information on cows and sires today to assist in the selection of animals for sale and breeding purposes. Decision support tools provided by DHI, AI companies and providers of genomic testing are geared toward helping producers.
200

Performance recording in the genotyped world

Maximizing genetic progress in the new age of genomics

make the most profitable decisions, however to ensure the best decisions are being made, one should closely monitor the results and determine if the desired results are actually accomplished. Below, we will take a look at how the AgSource Genetic Summary Report and Genetic Selection Guide can provide dairy producers with an analysis and decision making tool to maximize genetic progress in the herd.

Although we cannot cover all the analyses provided in the Genetic Summary Report, there are six major areas to consider:

- Summary of genetic traits for the current herd
- Trends of genetics by year of birth
- Trends of genetic traits for the herd by test date
- Analysis of phenotypic data as it relates to genetic information
- Inbreeding analysis and predominant genetics in the herd
- Trends of future genetics by evaluating genetic traits for service sires and young stock

When reviewing the genetics in the herd, the first step is to review if the genetics of the cows and heifers currently in the herd are in line with other cows and heifers in the breed. To accomplish this, the GSR provides an overall snapshot of the cows and heifers in the herd and benchmarks the genetics and inbreeding values against animals of the same breed. Figure 1 shows an example of a Holstein herd with good genetics and shows that for most traits, the herd ranks between the 50th and 80th percentile compared to all other Holstein cows. For example, the NMS average for cows is 127 NMS, which ranks them mid-way between the 50th and the 80th percentile cows, which is 170 NMS. Although the herd is doing well, there still is great potential for improvement. The average NMS value of the top 80th percentile is 246 NMS, indicating there is significant room for improvement. Producers can review various traits and compare how they rank. In addition to the genetic

### A. Genetic Summary - Active Cows & Youngstock

<table>
<thead>
<tr>
<th>Year</th>
<th>Cows</th>
<th>Youngstock</th>
<th>Percentile</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2095</td>
<td>3867</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>NMS</td>
<td>127</td>
<td>175</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>CMS</td>
<td>128</td>
<td>177</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>FMS</td>
<td>124</td>
<td>159</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA Milk</td>
<td>248</td>
<td>344</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA Fat</td>
<td>12</td>
<td>18</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA Fat</td>
<td>-0.07</td>
<td>0.03</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA Protein</td>
<td>17</td>
<td>26</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA Protein</td>
<td>17</td>
<td>26</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA BCS</td>
<td>2.99</td>
<td>3.87</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA BCS</td>
<td>2.99</td>
<td>3.87</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PTA DPR</td>
<td>1.2</td>
<td>2.0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Avg Inbred %</td>
<td>6.0</td>
<td>6.0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Avg Fat Inbred %</td>
<td>6.2</td>
<td>6.2</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

Figure 1. Current herd inventory genetic summary.
values, the inbreeding percentage is listed and, in the case of this herd, the herd inbreeding percentage has been higher than the average Holstein cows and heifers (6.0% cows and 6.5% for heifers) compared to all other cows and heifers (5.5% for cows and 5.8% for heifers). The genomic inbreeding percent is close to the inbreeding percent, based on pedigree.

In addition to the current snapshot of the cows and heifers, the GSR provides a graphical breakdown of animals currently in the herd by year of birth. Annual averages are compared against AgSource averages by year of birth. These graphs allow the producer to look at trends for certain traits within the herd and compare these with other herds of the same breed. Figure 2 shows an example of the inbreeding trend (based on pedigree and genomic testing) within the herd compared to the inbreeding trend in US Holsteins.

As herd inventories continually change, reviewing how the genetics of the herd compare to prior months, the GSR provides graphs showing individual traits for the cows in the milking herd over a two year period. These graphs display the herd’s and the 80th percentile herds’ trend. Figure 3 shows an example of the NM$ trend. The drop in the graph was due to the US base change that took place in December of 2014. The genetics of
Performance recording in the genotyped world

Maximizing genetic progress in the new age of genomics

the current herd, coupled with the history on some of the traits, will describe the current situation, plus it will tell you if the herd has been making progress at a rate comparable to the top 80th percentile herds.

Genetics play an important role in achieving higher production levels, but also in reducing the number of cows with udder health and fertility problems. Commercial producers question how much value genetics truly bring to the table relative to other management practices in which they can invest. Taking a look at how cows of different genetic levels perform in the herd can shine a light on what the opportunities are within the herd. Figure 4 provides a GSR analysis showing a breakdown of the milking herd in four NMS quartiles. For each quartile we take a look at the phenotypic data. For the example herd, investing money in better genetics is showing a significant payoff in terms of higher production and healthier cows.

Based on both the genetic and phenotypic data, producers can make decisions as to what type of genetics they wish to invest in and monitor the payback.

Figure 4. Genetic and phenotypic trend.

An area that is becoming of greater concern is inbreeding. As dairy cows within each breed have become more related, inbreeding has been steadily increasing. Most US dairy producers rely on mating software provided through an AI company to manage their inbreeding levels. Inbreeding levels are generally taken into account as part of the mating recommendation. The one thing to consider is that a mating recommendation is just that; a 'recommendation'.

The key is that the recommended sires are actually the ones that are used. Mistakes can happen during the breeding process, but also when semen inventories are running low other bulls may get used. To make sure producers have a handle on how well the mating program and the actual breeding process is working, it is key to evaluate on a regular basis.

Figure 5, Most prevalent genes and inbreeding distribution.
basis how well the program is truly working. The GSR provides an analysis that looks at the current herd’s distribution of percent cows inbred by different categories. Figure 5 shows the inbreeding distribution and predominant sire genes of the example herd.

In the example, there are no cows with an inbreeding percent below 3.12% (low inbreeding). However, there are 34.3% of animals with medium-high inbreeding levels (6.25-12.4%). Other AgSource herds have a lower percentage (26.1%) of cows with similar inbreeding levels. Closer attention should be paid to avoid the medium-high inbreeding levels in the herd. This can be as simple as making certain mating recommendations are followed, or making a change in the mating program settings to ensure higher inbreeding levels are avoided. One other possibility is to look for the predominant lines of genetics in the herd and find some AI sires that are of equal genetic merit, but less related to the animals in the herd.

While the genetics of the cows and heifers in the herd cannot be changed, new genetics that are being brought into the herd should be selected based on their ability to improve the herd. The GSR provides graphs comparing the genetics of the service sires used against AgSource 80th percentile herds of the same breed. Figure 6 shows an example representing PTA DPR (Daughter Pregnancy Rate) and PTA PL (Productive Life) for service sires used and the comparison against 80th percentile Holstein herds for the same trait. The key for the producer is to look for those traits he considers important and make sure acceptable levels of progress are being made against each.

Evaluating the genetics of the calves and heifers in the herd is an important aspect for those producers who have low involuntary culling rates and can cull more heavily based on production or other management areas they wish to improve upon. Knowing how many heifers and what genetics are available, compared to the cows currently in the milking herd, will point at the amount of genetic progress that can be made replacing a milking cow with a heifer.

To aid in the decision making process of which cows and heifers to breed to sexed semen, conventional semen, or possibly beef semen, the AgSource Genetic Selection Guide provides a tool that allows producers to find the animals in the cow and heifer population based on their overall genetic merit. The Genetic Selection Guide is generated for cows, young stock and unborn progeny. Animals are ranked by Net Merit $ value and broken up into four NM$ quartile groups. Producers can quickly identify the animals in the herd
with the highest and lowest genetic values. Animals that were genomically tested are marked on the report. Figure 7 shows an example of a Genetic Selection Guide for cows listing top quartile animals.

The Genetic Selection Guide for progeny provides a tool that will allow producers to determine the genetic merit of calves prior to birth. Knowing a calf’s genetic merit at birth aids in the decision making process of which calves to keep and which to sell.

Figure 7. Genetic selection guide for cows.

Evaluating sire selection criteria and breeding decisions should be an annual task. The Genetic Summary Report and Genetic Selection Guide provide two tools that provide a full picture of past, current and estimation of future genetics in the herd. A successful genetic management program is based on having good analysis information available and it all starts with accurate identification of the animal itself as well as the sire and dam of the animal. Evaluating the overall genetic program allows producers to make informed decisions about the criteria by which AI sires are selected, mating decision are made, sexed and/or beef semen is used, and finally how culling decisions are made.