Maximizing genetic progress in the new age of genomics

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Abstract

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.

Introduction

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.

Materials and methods

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

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.

Results

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

Summary of genetic traits for the current herd

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 NM$ average for cows is 127 NM$, which ranks them mid-way between the 50th and the 80th percentile cows, which is 170 NM$. Although the herd is doing well, there still is great potential for improvement. The average NM$ value of the top 80th percentile is 246 NM$, 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

	Cows					Youngstock				
		Percentile					Percentile			
	Your Herd	20th	50th	80th	Avg 80th	Your Herd	20th	50th	80th	Avg 80th
Number	2595		398010			2187		364170		
NM$	127	-67	54	170	246	273	48	175	294	370
CM$	128	-70	56	177	257	281	50	181	305	384
FM$	124	-65	49	159	231	255	40	160	272	344
PTA Milk	246	-372	34	444	722	472	-121	246	600	842
PTA Fat	12	-14	2	18	29	26	-1	14	28	38
PTA Fat %	0.01	-0.06	0.00	0.07	0.12	0.03	-0.04	0.02	0.08	0.11
PTA Pro	7	-9	2	12	20	17	0	10	20	26
PTA Pro %	0.00	-0.02	0.00	0.03	0.05	0.01	-0.02	0.01	0.04	0.05
PTA SCS	2.96	3.07	2.96	2.87	2.81	2.90	3.02	2.93	2.84	2.78
PTA PL	1.2	-0.9	0.5	2.0	2.9	2.3	-0.1	1.5	3.0	3.9
PTA DPR	0.2	-0.8	0.4	1.5	2.3	0.5	-0.4	0.6	1.7	2.5
Avg Inbred %	6.0		5.6			6.5		5.9		
Avg Fut Inbred %	6.2		6.0			6.5		6.3		

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.

Trend of genetics by year of birth

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.

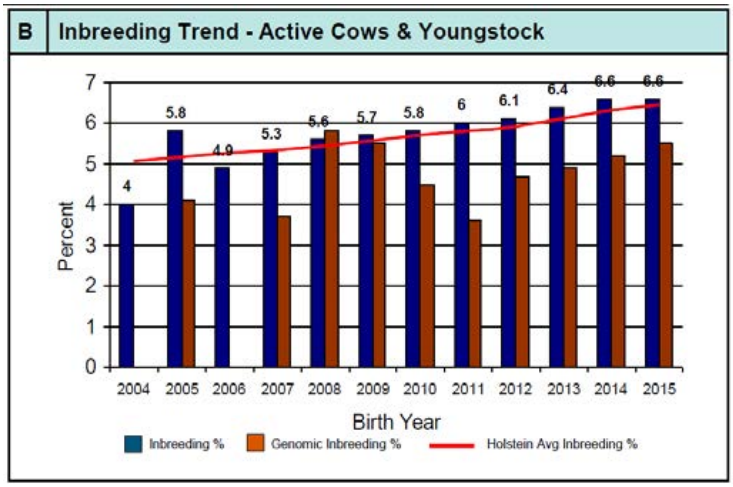


Figure 2. Inbreeding trend graph.

Trends of genetic traits for the herd by test date

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

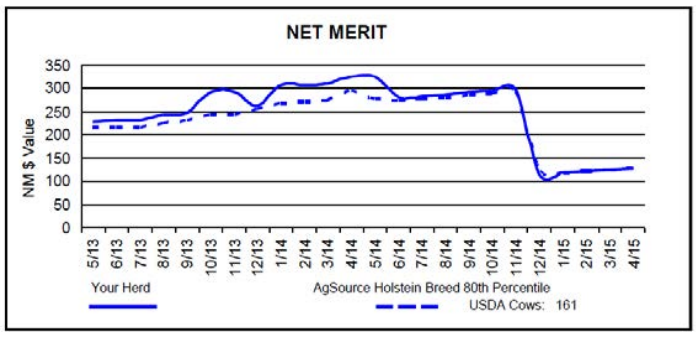


Figure 3. Net merit $ historic trend diagram.

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 at a rate comparable to the top 80th percentile herds.

Analysis of phenotypic data as it relates to genetic information

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 NM$ 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.

H Genetic and Phenotypic Trend by NM$ Quartile - Active Cows

Quartile	Num Cows	NM $	CM $	PTA Milk	PTA Fat	PTA Pro	PTA SCS	PTA DPR	ME Milk	ME Fat	ME Pro	LSSCC	Days Open	TCI©
1	627	308	313	604	30	19	2.91	0.6	33631	1321	1008	1.8	135	187
2	626	173	177	305	16	10	2.94	0.4	32974	1277	994	2.0	135	228
3	626	84	85	173	8	5	2.98	0.1	32527	1225	976	2.1	133	142
4	626	-34	-38	-40	-4	-3	3.01	-0.2	31760	1175	944	2.4	146	-12

Figure 4. Genetic and phenotypic trend.

Evaluate how well your inbreeding management program is working

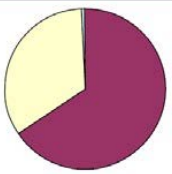
An area that is becoming of greater concern is inbreeding. As dairy cows within each breed have become more related, inbreeding has been steadily increasing. Most US dairy producers rely on mating software provided through an AI company to manage their inbreeding levels. Inbreeding levels are generally 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

I Most Prevalent Genes - Top Sires based on Cows and Youngstock

Sire Name	Sire NAAB	Total Genes	# Daughters	# PG Daughters	# MG Daughters
PLANET	007HO08081	155.25	80	314	147
SHOTTLE	029HO12209	96.75	5	368	9
O MAN	007HO06417	92.25	3	338	25
GOLDWYN	200HO03205	89.25	1	350	5
SHAMROCK	007HO10849	69.75	93	66	27
SUPER	001HO08778	69.25	25	198	29
CROWN	007HO09321	62.50	93	0	64
ROBUST	007HO10524	60.25	22	191	6
MAYFIELD	007HO11283	59.75	112	0	15
MAN-O-MAN	014HO04929	58.25	6	213	8
BOLTON	029HO11111	58.25	9	172	43
SHOT	007HO09222	49.25	80	0	37

J Inbreeding Distribution - Active Cows and Youngstock



Top Inbreed %

Name	Inb %
9704	29.8
15495	28.8
14090	28.5
14632	18.7
15832	17.5
15893	17.3
15892	17.3
13997	17.3
13916	17.1
15057	14.4

Holstein Distribution	<3.12%	3.12 - 6.25%	6.25 - 12.4%	≥12.5%
Your Herd		65.3	34.3	0.4
AgSource	2.1	71.4	26.1	0.4

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.

Trends of future genetics by evaluating genetic traits for service sires and young stock

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.

Genetic selection guide

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

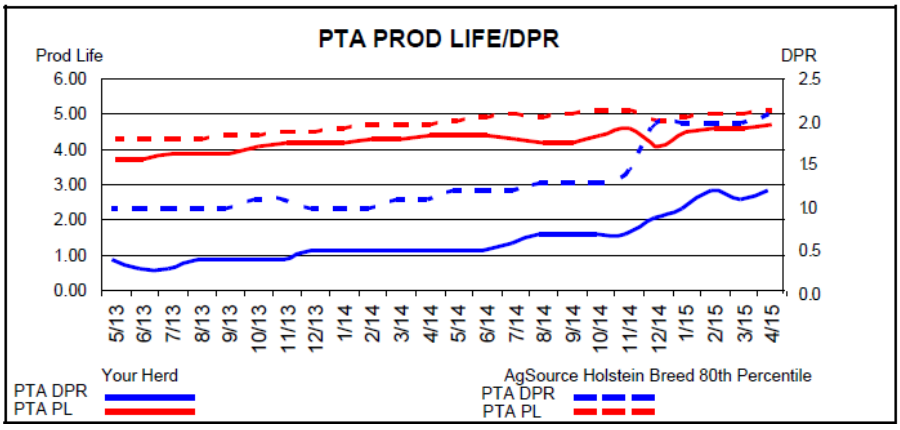
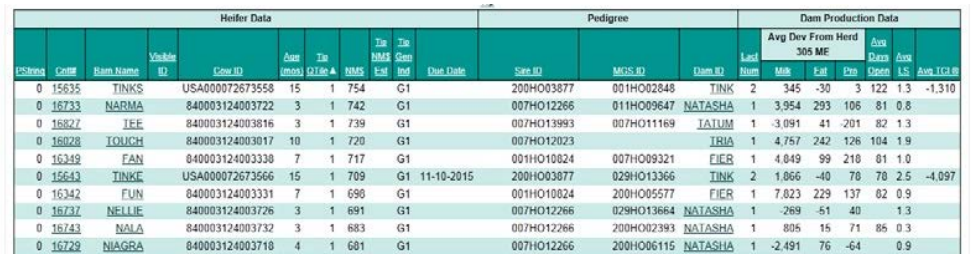


Figure 6. Future genetics in the herd.

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.



Heifer Data											Pedigree			Dam Production Data					
PString	Cntl#	Barn Name	Visible ID	Cow ID	Age (mos)	Tip QTile ▲	NMS	Tip NMS Est	Tip Gen Ind	Due Date	Sire ID	MGS ID	Dam ID	Lact Num	Avg Dev From Herd 305 ME Milk	Fat	Pro	Avg Days Open	Avg LS	Avg TCI ®
0	15635	TINKS		USA000072673558	15	1	754		G1		200HO03877	001HO02848	TINK	2	345	-30	3	122	1.3	-1,310
0	16733	NARMA		840003124003722	3	1	742		G1		007HO12266	011HO09647	NATASHA	1	3,954	293	106	81	0.8	
0	16827	TEE		840003124003816	3	1	739		G1		007HO13993	007HO11169	TATUM	1	-3,091	41	-201	82	1.3	
0	16028	TOUCH		840003124003017	10	1	720		G1		007HO12023		TRIA	1	4,757	242	126	104	1.9	
0	16349	FAN		840003124003338	7	1	717		G1		001HO10824	007HO09321	FIER	1	4,849	99	218	81	1.0	
0	15643	TINKE		USA000072673566	15	1	709		G1	11-10-2015	200HO03877	029HO13366	TINK	2	1,866	-40	78	78	2.5	-4,097
0	16342	FUN		840003124003331	7	1	698		G1		001HO10824	200HO05577	FIER	1	7,823	229	137	82	0.9	
0	16737	NELLIE		840003124003726	3	1	691		G1		007HO12266	029HO13664	NATASHA	1	-269	-51	40		1.3	
0	16743	NALA		840003124003732	3	1	683		G1		007HO12266	200HO02393	NATASHA	1	805	15	71	86	0.3	
0	16729	NIAGRA		840003124003718	4	1	681		G1		007HO12266	200HO06115	NATASHA	1	-2,491	76	-64		0.9	

Figure 7. Genetic selection guide for cows.

Conclusion

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.