Technical Bulletin

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Igenity® Select Genomic Predicted Transmitting Abilities (PTAs) an Effective Estimate of Key Dairy Economic Traits

Key Points

- This study was conducted on 1,618 first lactation Holstein cows beyond 60 days in milk, located on a commercial dairy in the Midwestern United States. All animals were genomically tested with Igenity® Select.
- On-farm data was analyzed to assess the risks and rewards of using the sire's genetic information vs. Igenity Select as an effective selection tool to predict individual cow performance.
- Igenity Select consistently identified the best performing Holstein cows more accurately than alternative selection tools. When selecting on lifetime net merit (NM$), Igenity Select identified an average economic difference of $294.81 per head and $477,002.58 across the entire group of cows in the study.

Introduction

Powered by Neogen®'s custom 65,000 SNP panel and supported by the Council of Dairy Cattle Breeding (CDCB), Igenity® Select provides the progressive dairy producer with highly reliable and cost-effective genomic results. A comprehensive DNA profile designed for confident replacement heifer selection, Igenity Select is a streamlined product offering insight into an animal's genetic merit for over 50 traits, and is available for Holstein, Jersey, Ayrshire, Guernsey, and Brown Swiss cattle.

Igenity Select leverages the CDCB's existing genetic evaluation. As the largest dairy animal database in the world, the CDCB houses over 138 million phenotypic records and six million genotypes with over 59,000 males receiving genetic evaluations or genomic predictions. Combining genomic information from Igenity Select with pedigree, progeny information, and production records provide results in the form of genomic-enhanced predicted transmitting abilities (PTAs). These PTAs predict the performance of an animal's progeny from average and are expressed in the units used to measure the trait.

The innovative technology of Igenity Select includes genomic parent verification and an estimate of genetic merit for 12 key traits and economic indexes, seven health traits, six yield traits, eight fertility traits, 20 type traits, 15 genetic conditions, breed composition, and more than four available add-on traits such as A2 Beta Casein.

The objective of this report is to highlight the genetic variability produced in progeny compared to a sire's PTA and outline the efficacy of Igenity Select when used to predict the individual genetic merit of a replacement heifer for key dairy traits. Using genomic data and production records on Holstein cows, this report demonstrates the superiority of the genomic predictions of Igenity Select and their relationship to real-world performance.

Materials and Methods

The data utilized in this study originated from 1,618 first lactation Holstein cows beyond 60 days in milk located on a progressive commercial dairy in the Midwestern United States. Purebred Holstein cows were milked three times per day and subject to an environment with moderate humidity. Herd management data was collected from Valley Ag Service's DairyComp software program.

Tissue samples were collected on all female calves within two days of birth before they were moved and developed off-site. Samples were processed on Neogen's Igenity Select profile and results submitted to the CDCB for incorporation into their genetic evaluation. Prior to statistical analysis, parentage was confirmed using genomics on all animals with misidentification errors of 18% discovered and corrected.

Economic assumptions used for analysis were based on 12 month rolling averages from the United States Department of Agriculture's (USDA) Agricultural Marketing Service (AMS) and were summarized as of August 31, 2022[1] (Table 1).

This study examined the risks and rewards of utilizing two different genetic selection tools to predict individual cow performance and increase gross profits. The first selection tool leveraged the sire of the female candidate for selection, where the sire's PTA for the respective trait served as the proxy data to inform the selection decision. The second selection method leveraged the female's actual genetic merit reported by Igenity Select. To determine the efficacy of each selection method, individual animal performance data standardized to a 305-day mature equivalent (ME 305-Day) served as the realized performance that both selection methods aimed to predict.

The respective selection methods were compared by partitioning the 1,618 Holstein first lactation animals into four quartiles. Animals were assigned to quartiles based on the genetic variation described by the sire's PTA or the Igenity Select PTA for milk yield, protein yield, and days open, separately. The top 25% of animals represent the expected best performing first lactation females and the bottom 25% represent the least performing. Published performance values per quartile represent the respective average of animals within quartile.

Compared to single trait selection, economic indexes such as lifetime net merit (NM$) are the preferred selection criteria to drive genetic improvement in dairy herds. Therefore, this study also evaluated how selection on NM$ from Igenity Select or the sire's NM$ resulted in different economic outcomes. Utilizing the same approach, cows were ranked and placed into quartiles based on either their own NM$ value, or that of their sire. Economic differences were calculated using the phenotypic records which correspond to influential traits included in NM$.

Table 1. Relative Economic Assumptions.

Trait	Dollar Value
Milk (cwt)	$21.07
Fat (lb)	$2.89
Protein (lb)	$2.84
Cost per Day Open	-$4.00

Results and Discussion

To demonstrate the relationship between the genomic predictions of Igenity Select and corresponding animal performance, figures one through five have been provided. Figures one through three collectively illustrate the effectiveness of genomic technology to predict ME 305-Day performance outcomes for milk, protein, and days open in first lactation. Figures four and five reveal Igenity Select's ability to precisely characterize genetic variation of feed saved (FSAV) and the economic variation of NM$.

ME 305-Day Performance

The difference between the top and bottom quartiles in actual 305-day milk yield when cows were sorted by sire PTA is 2,070 lbs per lactation, whereas this difference is 5,977 lbs when cows were sorted with Igenity Select (Figure 1a). More precisely, the difference between the top 25% in actual 305-day milk yield when cows were sorted by sire PTA vs. Igenity Select resulted in an average per head dollar difference of $366 per lactation (Figure 1b). Assuming a lifetime equivalent of 2.75 lactations, this equates to $1,007 over a lifetime of milk production.

The difference between the top and bottom quartiles in actual 305-day protein yield when cows were sorted by sire PTA is 18 lbs per lactation, whereas this difference is 95 lbs when cows were sorted with Igenity Select (Figure 2a). The gross profit difference between top quartiles in actual 305-day protein yield when cows were sorted by sire PTA vs. Igenity Select resulted in an average per head dollar difference of $99 per lactation (Figure 2b) and $272 over a lifetime of protein production.

Finally, when sorted based on daughter pregnancy rate (DPR) PTA, the difference between the top and bottom quartile in actual days open of first lactation cows when sorted based on sire is 47 days, whereas this difference is 62 days when cows were sorted with Igenity Select (Figure 3a). Specifically, Figure 3b illustrates the actual days open of animals in the top 25% sorted by the sire's DPR PTA vs. Igenity Select's DPR PTA. At an industry average of $4.00 per additional day a cow is open, Igenity Select reduces the average additional days open by $32 per cow per lactation and $88 over a lifetime.

Feed Efficiency

The FSAV PTA predicts the expected pounds of feed saved per lactation. Expressed in pounds of dry matter intake, FSAV allows for the selection of more feed-efficient cows, reducing volatile feed costs and improving profitability. Of the 1,618 first lactation Holstein cows tested with Igenity Select in this study, there is substantial opportunity to reduce the environmental footprint of dairy production by improving the amount of feed saved. As shown in Figure 4, there is an average difference of 342 lbs of feed consumed per cow per lactation between animals in the top and bottom quartile. This equates to 941 lbs of reduced consumption over a lifetime.

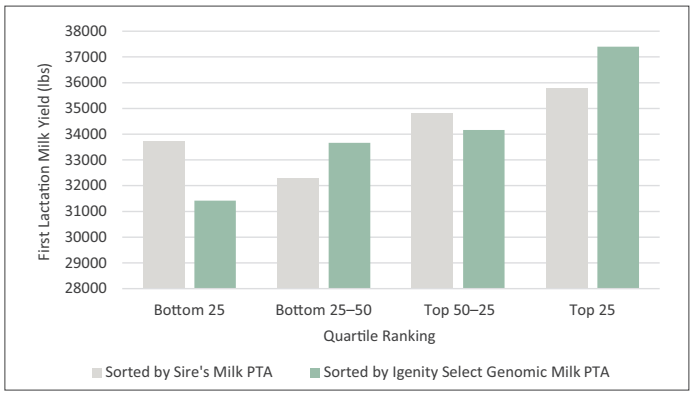
Selection on NM$

The NM$ index estimates the amount of profit an animal will transmit to its progeny over its lifetime. This index drives a herd's genetic progress by promoting an optimum balance of over 40 economically important traits into a single value[3]. Selection strategies which focus on NM$ and implement individual animal genomics (Igenity Select) are shown to reliably predict cows with higher milk, fat, and protein production, as illustrated in Table 2. When sorting with Igenity Select NM$ index, the top 25% of cows returned $385.09 more on a per head basis than the bottom 25%. When sorting with the sire's NM$ index, the top 25% of cows only returned $90.28 more on a per head basis than the bottom 25%. This results in a total dollar difference of $294.81 per head and $477,002.58 across the entire first lactation group of 1,618 cows. Igenity Select successfully identifies more economic variation when selecting on NM$, as observed in Figure 5.

In summary, this analysis highlights how the significant variation in cow performance across traits was more effectively predicted with Igenity Select. This indicates that genomically testing young calves and heifers with Igenity Select more accurately predicts future lactation performance. It is also concluded that selection with genomic data on individual animals return higher gross profits than selection on pedigree information, or the genetic merit of the sire.

Figure 1. First lactation ME 305-Day milk yield for 1,618 Holstein cows when sorted into quartiles based on Igenity Select PTA compared to sire PTA.

1a. Comparison of actual ME 305-Day milk yield performance when broken into quartiles.



1b. Average gross profit per head in top quartile for ME 305-Day milk yield.

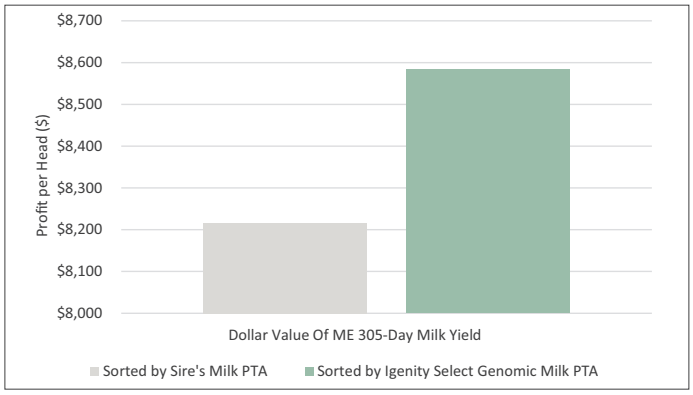
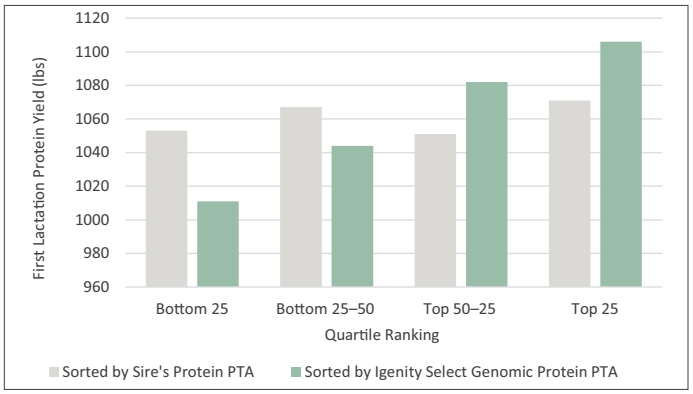


Figure 2. Average first lactation ME 305-Day protein yield for 1,618 Holstein cows when sorted into quartiles based on Igenity Select PTA compared to sire PTA.

2a. Comparison of actual ME 305-Day protein yield.



2b. Average gross profit per head in top quartile for ME 305-Day protein yield.

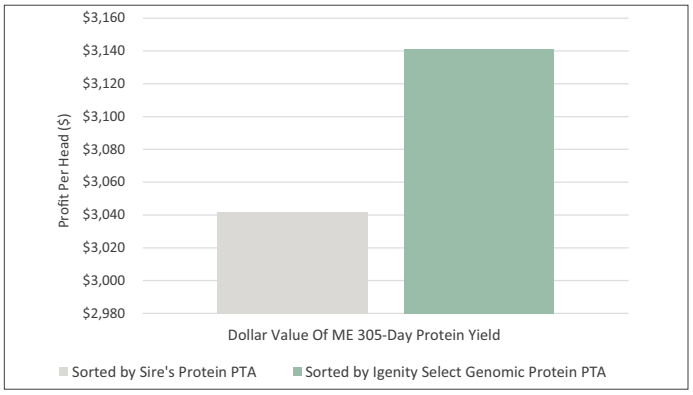
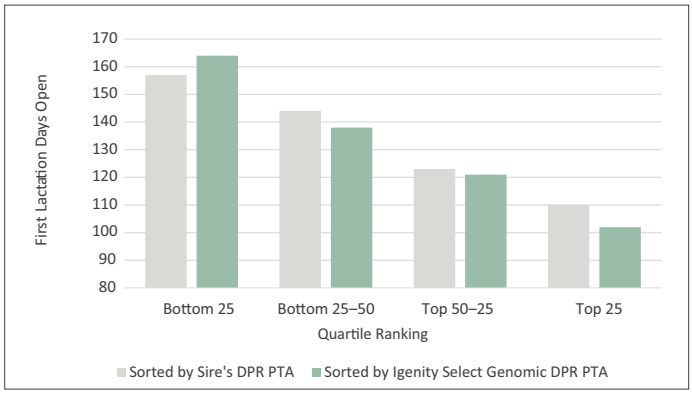


Figure 3. Average days open in first lactation for 1,618 Holstein cows when sorted into quartiles based on Igenity Select PTA compared to sire PTA for DPR.

3a. Comparison of actual days open when broken into quartiles.



3b. Average days open cow cost in top quartile for DPR.

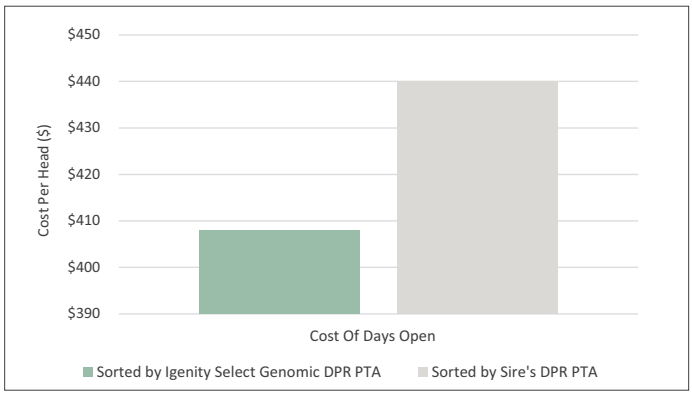


Figure 4. Genomic variation of FSAV in 1,618 first lactation Holstein cows, sorted by quartile using Igenity Select.

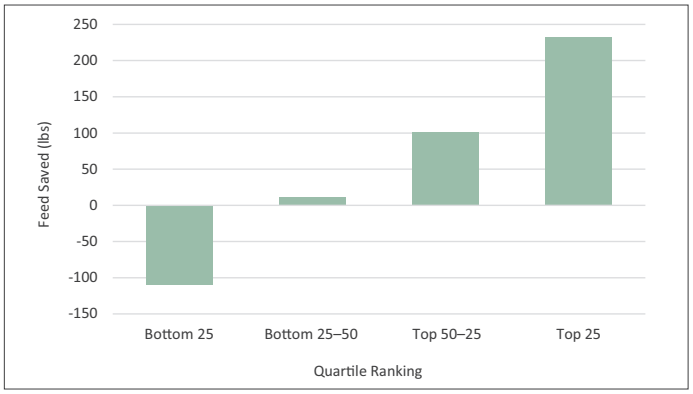


Figure 5. Economic variation between the top and bottom quartiles for NM$ in 1,618 first lactation Holstein cows, sorted by Igenity Select NM$ compared to sire NM$.

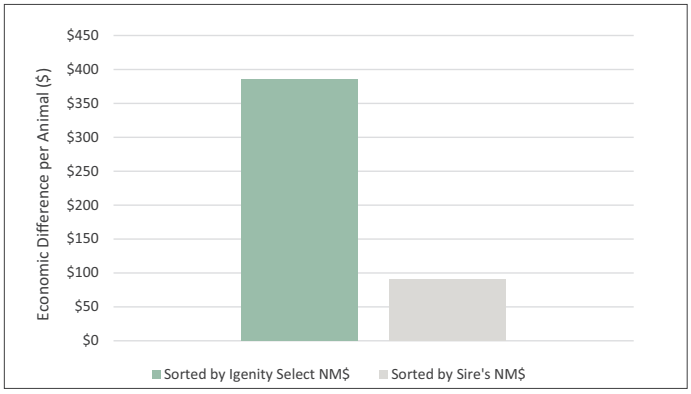


Table 2. Difference in gross profit between the top and bottom 25% of first lactation cows sorted with Igenity Select NM$ compared to sire NM$.

	Igenity Select NM$		Sire's NM$	
Observed Trait in NM$	**Top 25%[1]**	**Bottom 25%[2]**	**Top 25%[1]**	**Bottom 25%[2]**
305-Day ME Milk Yield (lb)	34,201	33,850	32,739	34,606
305-Day ME Fat Yield (lb)	1,255	1,222	1,235	1,197
305-Day ME Protein Yield (lb)	1,077	1,063	1,051	1,025
Number of Days Open	116	160	102	177
Gross Profit per Animal	$13,427.78	$13,044.10	$13,042.70	$12,953.81

[1]The top 25% (n=405) of cows based on NM$.
[2]The bottom 25% (n=404) of cows based on NM$.

Conclusion

Neogen's Igenity Select is a powerful genomic profile designed to predict the genetic potential of dairy cattle. Commercial and registered dairy producers are now equipped with a simple tool to confidently select the best animals that improve the profitability of their operation. Using only a tissue sample, Igenity Select has proven to predict future performance across economically relevant traits. In this study, Igenity Select consistently identified the best performing Holstein cows more accurately than alternative selection tools. When selecting on NM$, Igenity Select identified an average economic difference of $294.81 per head and $477,002.58 across the entire first lactation group of 1618 cows.

Faced with volatile markets and rising input costs, Igenity Select allows dairy producers to have more control over the financial future of their operation by more precisely managing the most important cash creating asset in their business, the dairy cow. Genomic data applied alongside other technology and management decisions greatly improves a dairy farm's overall efficiencies. Selecting superior animals for embryo donors and inferior animals for embryo recipients are decisions that affect long-term productivity. Furthermore, new markets such as Beef-on-Dairy require selection tools that are more accurate in determining which cows to breed to beef semen. In summary, Igenity Select provides exceptional value to the modern dairy producer as a one-time DNA test that will continually benefit the dairy for years to come.

References

[1] "Announcement of Class and Component Prices - Dairy." Agriculture Marketing Service, U.S. Department of Agriculture, 2022, https://www.ams.usda.gov/market-news/dairy-market-news-weekly-summary-and-monthly-averages.

[2] Dolecheck, Karmella, and Jeffrey Bewley. "How Much Are You Losing from Extra Days Open?" University of Kentucky Cooperative Extension Service, Food and Environment. Dept of Animal & Food Sciences, 2015, https://afs.ca.uky.edu/files/how_much_are_you_losing_from_extra_days_open.pdf.

[3] VanRaden, P M, et al. "Net Merit as a Measure of Lifetime Profit: 2021 Revision." USDA ARS, CDCB, 2021, https://www.ars.usda.gov/ARSUserFiles/80420530/Publications/ARR/nmcalc-2021_ARR-NM8.pdf