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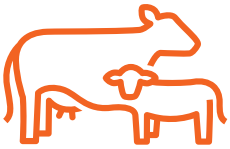

BUILDING A HEALTHIER HERD WITH CLARIFIDE® PLUS

Dairy producers can use CLARIFIDE Plus to select animals based on calf wellness and other important traits with a goal of a healthier, more productive herd. Reducing calf disease and improving livability through genomic testing now can favorably impact your heifer-raising costs and pay dividends down the road.

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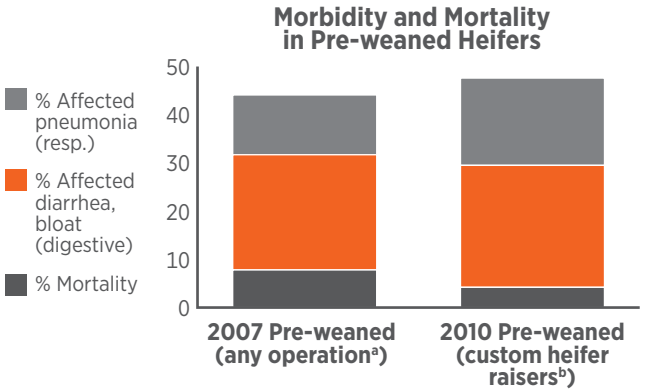
KEY POINTS

- CLARIFIDE Plus is the first commercially available dairy genetic evaluation specifically designed for cow and calf wellness traits in U.S. dairy cattle.
- CLARIFIDE Plus genomic predictions for calf wellness traits provide reliable assessments of genetic risk factors for economically relevant health challenges in Holstein youngstock.
- Producing calves that are robust and able to thrive in modern dairy operations will improve both financial sustainability of the dairy industry and animal welfare.
- CLARIFIDE Plus provides an expanded suite of genetic selection tools that provide highly relevant information to dairy producers that seek to continue to improve the health, productivity and profitability of the dairy cattle they care for.
- The use of Dairy Wellness Profit Index® (DWP$®) offers similar selection emphasis to that achieved by Net Merit (NM$) on primary traits, but would apply additional selection emphasis and improvement on cow and calf wellness traits.

INTRODUCTION

One of the largest contributors to the cost of production for commercial dairies is the replacement heifer rearing expenses. These replacement costs are usually the second-highest expense on dairy farms. Costs of raising a calf from birth to first calving have been estimated at $1,200 to over $2,000[1] A data report from California Department of Food and Agriculture for the 2006-2015 period establishes that replacement costs for Holstein dairy herds average 8.6% of total production cost for the dairies, ranging from 6.1% to 11.8%.[2] Importantly, these replacement costs are influenced by many factors including morbidity and mortality risks, rate of weight gain, nutritional management, housing, labor and reproductive performance.[2] Therefore, keeping calves healthy and minimizing mortality and morbidity are key investments with real future returns that may mean the difference between profit or loss in tight margin years. Pre-weaning death loss in dairy calves ranges from 4.2 to 12%;[3-5] 53% of those losses are due to digestive problems (scours), and 21% to respiratory diseases.[3] National Animal Health Monitoring System (NAHMS) studies show similar pre-weaning death losses of 7.8% and the reasons for those losses: 56.5% due to scours, and 22.5% due to respiratory diseases.[5] In post-weaned calves, death loss was 1.8% overall, with the primary reason being respiratory diseases, which accounted for 46.5% of the losses. Even if the calf survives and recovers from the disease, its performance as a mature cow will be negatively affected.



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Producing calves that are robust and able to thrive in modern dairy operations will improve both financial sustainability of the dairy industry and animal welfare. Genetic improvement programs that incorporate differences in risk of calf disease and calf livability have the potential to improve the profitability of dairy production. The improvement in profitability is due to improved prevention and control of economically relevant calf diseases as well as enhanced animal productivity.

Improving calf health and livability through genetic selection presents a compelling opportunity for dairy producers to help manage herd replacement cost, calf disease incidence and improve profitability when coupled with sound management practices. To date, direct predictors for Holstein wellness traits related to common calf diseases and calf livability have not been readily available in the U.S. CLARIFIDE® Plus represents the first commercially available dairy genetic evaluation specifically designed for cow and calf wellness traits in U.S. dairy cattle, providing predictions describing the risk for calf livability, calf respiratory disease and calf scours.

DEVELOPMENT OF DAIRY CALF WELLNESS PREDICTIONS

Genomic predictions for calf wellness traits were developed by Zoetis based on an independent database of pedigrees, genotypes and production records assembled from commercial dairies. Calf health events were assembled from the same on-farm dairy production records as the cow wellness traits that had been provided with the consent of commercial dairy producers. Data editing procedures to condense recorded disease incidence to a common format were developed based on a review of event codes in on-farm software and consultation with dairy production and veterinary experts.

Targeted phenotypes included:

- Calf Livability
- Calf Respiratory Disease
- Calf Scours

Calf diseases were defined as a Holstein female diagnosed with the respective disease one or more times in a given period of time (Table 1) on the basis of qualifying event codes in on-farm dairy software. As of January 2018, the database used to derive CLARIFIDE Plus predictions incorporated, primarily, large commercial U.S. dairy operations from across the nation and included more than 1,935,405, 1,314,944, and 733,136 records for calf livability, calf respiratory disease, and calf scours, respectively (Table 1). Additional records are continuously added to this database on a monthly basis from producer-supplied farm records.

Genomic data was obtained from commercially tested animals with owner consent or available genotypes within Zoetis research databases. More than 451,000 genotypes were available for consideration as of January 2018. Additional commercial genotypes are added on a weekly basis. Genotypes included in the evaluation were derived from both low and medium density genotypes, all imputed to Illumina® BovineSNP50v2 using an internal imputation reference set and FImpute.[6]

Calf wellness predictions are derived from a weekly Zoetis genetic evaluation. The evaluation employs single-step statistical methods to estimate genomic breeding values. This is the same method that was used to develop the Zoetis cow wellness traits described by Vukasinovic.[7] This method for genetic evaluation derives a joint relationship matrix based on pedigree and genomic relationships and provides a unified framework that eliminates several assumptions and parameters, thus enabling more accurate genomic evaluations.[8]

Table 1: Number of records, incidence, and heritability for Calf Wellness Traits.

Trait	Phenotype time period	Incidence (%)	Number of records	h^2
Zoetis Calf Livability	2 – 365 days of age	4.7	1,935,405	0.060
Zoetis Calf Respiratory Disease	0 – 365 days of age	17.3	1,314,944	0.042
Zoetis Calf Scours	2 – 50 days of age	20.8	733,136	0.045

Table 2 shows the average reliability of genomic predictions for calf wellness traits in CLARIFIDE® Plus. Among approximately 148,384 Holstein heifers less than 2 years of age within the reference dataset, the average reliability was greater than or equal to 36% to 42% depending on the trait. Notably, as direct predictions for individual calf wellness traits are not presently available, this represents a substantial increase in reliability from zero. Further, the average reliability of genomic predictions for wellness traits continues to increase as more records are added to the evaluation. Reliabilities below the average can be explained by several factors such as a lack of phenotype or pedigree information or limited relationship with the genetic evaluation population.

REPORTING OF CALF WELLNESS TRAITS IN CLARIFIDE PLUS

CLARIFIDE Plus predictions for calf wellness traits are expressed as genomic Standardized Transmitting Abilities (STA), similar to how type traits are expressed. Values are centered at 100 with a standard deviation of 5 (Table 3). For all calf wellness trait predictions, a value of 100 represents average expected risk and values of greater than 100 reflect animals with lower expected average risk relative to herdmates with lower STA values. Higher values are more desirable for all traits, thus selecting for a high STA will apply selection pressure for reduced risk of calf disease or mortality.

NEW INDEXES DEVELOPED OR MODIFIED

In addition to reporting individual calf wellness traits, there will be a new economic selection index to inform selection decisions (Calf Wellness Index,™ CW$™). CLARIFIDE PLUS also will continue providing the Dairy Wellness Profit Index® (DWP$®) and Wellness Trait Index® (WT$®). Selection indexes are a critical component of many selection strategies as they provide a path for dairy producers to select for comprehensive

Table 2: Reliabilities of genomic predictions for Dairy Wellness traits based on a subset of the reference population of approximately 148,384 Holstein heifers.

Calf Wellness Traits	Average Reliability	Standard Deviation	Minimum	Maximum
Zoetis Calf Livability	42%	6%	5%	58%
Zoetis Calf Respiratory Disease	36%	6%	1%	54%
Zoetis Calf Scours	39%	6%	2%	55%

Table 3: Genomic standardized transmitting abilities (STA) for calf wellness traits based on a reference population of approximately 449,391 head with calf wellness trait predictions, cow wellness trait predictions, and CDCB primary trait predictions.

Calf Wellness Traits	Average	Standard Deviation	Minimum	Maximum
Zoetis Calf Livability	100	5	66	116
Zoetis Calf Respiratory Disease	100	5	83	116
Zoetis Calf Scours	100	5	85	117

genetic improvement across a host of traits. The use of economic selection indexes helps to ensure that the distribution of selection pressure applied to component traits is appropriately balanced relative to the economic impact of the individual traits on dairy profitability.

To support selection for reduced risk of cow and calf disease in dairy females, a new calf wellness trait economic index was developed (CW$) and DWP$ and WT$ were updated:

- *Dairy Wellness Profit Index (DWP$)*: this multi-trait selection index, the most comprehensive available, includes production, reproduction, functional type, longevity, calving ability, cow livability, milk quality, cow wellness, and new calf wellness traits plus economic value of polled test results. By combining the calf and Zoetis cow wellness traits with primary CDCB traits, DWP$ directly estimates the potential lifetime profit an individual animal will contribute to the dairy operation.
- *Calf Wellness Index (CW$)*: this multi-trait selection index exclusively focuses on the calf wellness traits (Zoetis calf livability, calf respiratory disease, calf scours) and directly estimates potential profit contribution of the calf wellness traits for an individual animal.
- *Wellness Trait Index (WT$)*: focuses on the wellness traits (mastitis, lameness, metritis, retained placenta, displaced abomasum and ketosis) in addition to polled test results and estimates the difference in expected lifetime profit associated with risk of these diseases.

The economic indexes in CLARIFIDE Plus were derived using standard selection index theory.[9-10] Economic assumptions were derived from those used in NM$[11] for the case of primary traits, and from a review of peer-reviewed literature for calf and cow wellness traits.[2, 12-22] Economic values for health traits that are considered in the derivation of NM$ were adjusted to avoid double-counting of the contributions of disease to dairy profitability. Economic values were then adjusted within the range of reported values based on the covariance among traits to achieve the final index weights.

To assess the extent to which use of CLARIFIDE Plus dairy wellness indexes would alter selection emphasis relative to use of NM$, the expected response to selection per standard deviation of genetic improvement in the index was estimated.[9] In examining the response of selection between DWP$ and NM$, it is clear that use of DWP$ will result in greater genetic improvement in wellness traits and largely the same selection response for the rest of the traits. There is some decrease in selection emphasis and expected genetic progress for genetic production traits associated with the use of DWP$ (Table 4), which is consistent with our understanding of the relationship between increased production and disease risk.[23] However, selection using DWP$ will increase milk, fat and protein production, just at a slightly lower rate than would be achieved with alternative indexes that do not consider direct selection for calf and cow wellness traits. Importantly, the use of DWP$ would be expected to offer very similar selection emphasis to that achieved by NM$ on primary traits, but would apply additional selection emphasis on calf and cow wellness traits.

Table 4: Expected response to selection expressed in units of the underlying trait associated with selection using NM$ and DWP$.®

Trait	Response to Selection	
	NM$	DWP$
Milk	305	259
Fat	18	16
Protein	12	10
PL	1.94	1.96
Cow Livability	0.67	0.78
SCS	−0.06	−0.07
Body Size	−0.06	−0.04
Udder	0.40	0.36
Feet/legs	0.25	0.24
DPR	0.51	0.57
HCR	0.55	0.52
CCR	0.85	0.89
CA$	9.73	9.31
Mastitis	0.27	1.63
Lameness	0.07	0.94
Metritis	1.58	2.01
RP	0.52	0.86
DA	0.92	1.24
Ketosis	1.82	2.00
Calf Livability	0.93	1.53
Calf Respiratory	0.02	0.50
Calf Scours	1.36	1.64

Table 5: Defines the relative values for underlying traits in each of the three wellness indexes and Net Merit.

Trait	Relative Weight (%)			
	NM$	DWP$	WT$	CW$
Milk	–1	2	0	0
Fat	24	16	0	0
Protein	18	14	0	0
PL	13	9	0	0
Cow Livability	7	4	0	0
SCS	–7	–3	0	0
Body Size	–6	–3	0	0
Udder	7	5	0	0
Feet/legs	3	2	0	0
DPR	7	4	0	0
HCR	1	1	0	0
CCR	1	1	0	0
CA$	5	3	0	0
Mastitis	0	12	47	0
Lameness	0	6	25	0
Metritis	0	4	15	0
RP	0	1	5	0
DA	0	2	7	0
Ketosis	0	<1	1	0
Calf Livability	0	4	0	43
Calf Respiratory	0	2	0	29
Calf Scours	0	2	0	28

SUMMARY

Dairy producers have enjoyed the availability of a comprehensive list of economically relevant traits and a robust genetic evaluation system to fuel their genetic improvement strategies. To date, dairy producers have been unable to improve dairy profitability and calf well-being through genetic selection for susceptibility to common diseases and livability. CLARIFIDE® Plus now provides accurate genetic predictions for calf wellness traits derived using the same proven cutting-edge genetic evaluation methodology as the cow wellness traits, and it was applied to data collected from commercial production settings. The result is an expanded suite of genetic selection tools that provides highly relevant information to dairy producers that seek to continue to improve the health, longevity, productivity and profitability of the dairy cattle they care for.

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