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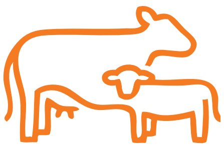

Building a Healthier Herd with CLARIFIDE® PLUS

Dairy producers can use CLARIFIDE Plus to select animals based on wellness traits with a goal of a healthier, more productive herd.

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Summary

- CLARIFIDE® Plus represents the first commercially available dairy genetic evaluation specifically designed for cow and calf wellness traits in U.S. Jersey dairy cattle.
- 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 genomic predictions for wellness traits provide reliable assessments of genetic risk factors for economically relevant diseases in Jersey cattle.
- The use of Dairy Wellness Profit Index (DWP$) would be expected to offer very similar selection emphasis to that achieved by Cheese Merit (CM$) making it a practical consideration for producers that have historically used CM$, but would like to apply additional selection emphasis on cow and calf wellness traits
- 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 Jersey dairy cattle they care for

Genetic evaluation and selection in dairy cattle has largely focused on production traits such as milk and protein production. Indirect predictors of health and fertility (e.g., somatic cell score, productive life, daughter pregnancy rate) are available and there is evidence to support some genetic improvement for these traits (Council on Dairy Cattle Breeding, Bovine Genetic Trends 2015)[1]. However, due to genetic antagonisms between production and health traits as well as changes in management practices, data supports increased incidence of many common diseases in contemporary dairy production systems (Jones et al., 1994[2]; Lucy, 2001[3]; Veerkamp et al 2009[4])[4]. Consequently, dairy cows are considered to be less 'robust' than previous generations which has serious implications for the health and fertility of the modern day dairy cow (McParland et al 2012[5]; USDA 2008)[6]. Profitable dairy cows are fertile, productive, and require minimal extraneous inputs to maintain their health through all phases of production. They generally require fewer veterinary treatments or interventions, without compromising the health or economic efficiency of the cow, and are less likely to be prematurely culled (Ten-Napel et al., 2009[7]; Egger-Danner et al 2014[8]).

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 (Rossini, 2004)[9]. Importantly, the replacement costs are influenced by many factors including morbidity and mortality risks, rate of weight gain, nutritional management, housing, labor and reproductive performance (Overton and Dhuyvetter 2017)[10]. 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. Even if the calf survives and recovers from the disease, its performance as a mature cow will be affected. 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 cow and 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 diseases as well as enhanced animal productivity.

In the recent years, the Jersey breed has been gaining popularity in the US dairy industry, primarily due to their smaller size and feed efficiency. In 2015, there were more than 320,000 Jersey cows enrolled in the production testing programs (www.usjersey.com)[11]. Under intense selection pressure aimed at increasing production and milk components, health and wellness of Jersey cows may deteriorate.
Improving cow and calf health traits through genetic selection presents a compelling opportunity for dairy producers to help manage disease incidence and improve profitability when coupled with sound management practices. To date, direct predictors for wellness traits in Jerseys related to common disease conditions in dairy production have not been readily available in the US. CLARIFIDE® Plus represents the first commercially available dairy genetic evaluation specifically designed for wellness traits in US Jersey cattle, providing predictions describing the risk for 10 common health events in dairy cattle.

Development of Jersey Wellness Predictions

Genomic predictions for Jersey wellness traits were developed by Zoetis based on an independent database of pedigrees, genotypes and production records assembled from commercial dairies. Cow and calf health events were assembled from the same on-farm dairy production records with consent by commercial dairy producers. Data editing procedures to condense recorded disease incidence to a common format were developed based on review of event codes in on-farm software and consultation with dairy production and veterinary experts (Vukasinovic et al., 2017)[12].

Targeted phenotypes included:

- Mastitis (MAST)
- Metritis (METR)
- Retained placenta (RETP)
- Displaced abomasum (DA)
- Ketosis (KETO)
- Lameness (LAME)
- Milk Fever (MFEV)
- Calf Scours (Calf_Scours)
- Calf Livability (Calf_Liv)
- Calf Respiratory Disease (Calf_Resp)

All diseases were defined as a Jersey female diagnosed with the respective disease one or more times in a given lactation or time period (calf wellness) on the basis of qualifying event codes in on-farm dairy software in the case of commercial data, or clinical research records in the case of internal research assets. Table 1 shows the approximate number of phenotypic records in the database used to derive CLARIFIDE

Plus for Jersey predictions as of July 2018. 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 45,000 genotypes were available for consideration as of July 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 (Sargolzaei et al., 2014)[13].

CLARIFIDE® Plus predictions are derived from a weekly internal genetic evaluation that employs single-step statistical methods for estimating genomic breeding values. 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 (Aguilar et al 2010)[14].

Table 1 – Number of records, incidence, and heritability for Jersey Wellness Traits as of July 2018

Trait	Phenotype time period	Incidence (%)	Number of records	h^2
Mastitis	Lactation	27.6	615,674	0.0922
Metritis	Lactation	2.7	241,105	0.1167
Retained Placenta	Lactation	1.7	341,236	0.0973
Displaced Abomasum	Lactation	0.62	213,771	0.0613
Ketosis	Lactation	1.6	300,528	0.0991
Lameness	Lactation	8.7	588,470	0.1201
Milk Fever	Lactation	1.1	354,406	0.0901
Z_Calf_LIV	2-365 days of age	5.9	339,423	0.1030
Z_Calf_RESP	0-365 days of age	13.6	263,888	0.0546
Z_Calf_SCOURS	2-50 days of age	36.3	183,829	0.0843

Table 2 shows the average reliability of genomic predictions for wellness traits in CLARIFIDE® Plus. Among approximately 5,495 Jersey heifers born in 2017 and 2018 within the reference dataset, the average reliability ranged from 27% to 47% across all traits. Notably, as direct predictions for Jersey 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.

Table 2 – Reliabilities of Genomic Predictions for Dairy Wellness traits based on a subset of the reference population of approximately 5,495 Jersey heifers

Calf Wellness Traits	Average Reliability	Standard Deviation	Minimum	Maximum
Mastitis	47%	5%	27%	62%
Metritis	40%	5%	20%	57%
Retained Placenta	35%	6%	14%	53%
Displaced Abomasum	27%	5%	7%	46%
Ketosis	35%	5%	15%	54%
Lameness	42%	5%	22%	58%
Milk Fever	36%	6%	15%	53%
Zoetis Calf Livability	38%	6%	14%	53%
Zoetis Calf Scours	41%	6%	17%	57%
Zoetis Calf Respiratory Disease	44%	5%	20%	58%

Reporting of Jersey Wellness Traits in CLARIFIDE® PLUS

CLARIFIDE Plus predictions for Jersey 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 Jersey 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 cow/calf disease or calf mortality.

CLARIFIDE Plus predictions for the Polled test will reported as:

- **Tested homozygous polled**: The genotype demonstrates that the animal is homozygous polled and will always produce a polled animal regardless of the horned status of the other parent. (Coded PP)
- **Polled carrier**: The genotype reveals a heterozygous polled animal capable of producing a horned progeny. (Coded PC)
- **Tested free of polled (i.e., horned)**: The genotype is consistent with an animal that is horned. (Coded TP)
- **Indeterminate**: The polled status of the animal cannot be definitively determined. (Coded I)

Table 3 – Genomic standardized transmitting abilities (STA) for Jersey Wellness Traits based on a reference population of approximately 36,325 head with Calf Wellness Trait predictions, Cow Wellness Trait predictions, and CDCB Core trait predictions.

Calf Wellness Traits	Average Reliability	Standard Deviation	Minimum	Maximum
Mastitis	100	5	77	116
Metritis	100	5	68	114
Retained Placenta	100	5	70	117
Displaced Abomasum	100	5	70	115
Ketosis	100	5	62	114
Lameness	100	5	75	114
Milk Fever	100	5	62	115
Zoetis Calf Livability	100	5	72	116
Zoetis Calf Scours	100	5	81	115
Zoetis Calf Respiratory Disease	100	5	77	114

New Indexes

CLARIFIDE® Plus predictions for Jersey Wellness traits are expressed as genomic standardized transmitting abilities (STA),

In addition to reporting individual Jersey Wellness traits, there are new economic selection index to inform selection decisions that are specific for Jersey cattle. CLARIFIDE PLUS provides the Dairy Wellness Profit Index (DWP$), Wellness Trait Index (WT$), and Calf Wellness Index (CW$). Selection indexes are a critical component of many selection strategies as they provide a path for dairy producers to select for comprehensive 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, three economic indexes were developed for Jerseys.

- **Dairy Wellness Profit Index® (DWP$®)**: this multi-trait selection index includes production, fertility, functional type, longevity, milk quality, livability, cow wellness, and calf wellness traits plus economic value of Polled test results. By combining the Calf and Cow Wellness traits with core traits, DWP$ directly estimates the potential lifetime profit an individual animal will contribute to the dairy operation.
- **Wellness Trait Index® (WT$®)**: this multi-trait selection index exclusively focuses solely on the wellness traits (Mastitis, Metritis, Retained Placenta, Displaced Abomasum, Ketosis, Lameness, Milk Fever, and Polled) and directly estimates potential profit contribution of the wellness trait for an individual animal.
- **Calf Wellness Index® (CW$®)**: this multi-trait selection index exclusively focuses on the calf wellness traits (Z_Calf_Livability, Z_Calf_Respiratory_Disease, Z_Calf_Scours) and directly estimates potential profit contribution of the calf wellness traits for an individual animal.

The economic indexes in CLARIFIDE Plus were derived using standard selection index theory (Hazel, 194315; Schneeberger et al 1992)[16]. Economic assumptions were derived from those used in CM$® (Van Randen and Cole 2014)[17] for the case of core traits, and from a review of peer-reviewed literature for wellness traits (Bar et al., 2007[18]; Santos et al., 2004[19]; Bar et al., 2008[20]; Cha et al., 2011[21]; Cha et al., 2014[22]; Guard, 2008a[23]; Guard, 2008b[24]; Walsh et al., 2007[25]; VanRaden and Cole, 2014; Spurlock et al., 2014[26]; Widmar et al., 2013[27]; Overton and Dhuyvetter 2017; Aghakeshmiri, Azizzadeh et al. 2017[28]). Economic values for health traits that are considered in the derivation of CM$ were removed 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 multi-trait selection indexes would alter selection emphasis relative to use of CM$, the expected response to selection per standard deviation of genetic improvement in the index was estimated (Hazel, 1943). In examining the response of selection between DWP$® and CM$, it is clear that use of DWP$ 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 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 (Zwald et al., 2004)[29]. 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 wellness traits. Importantly, the use of DWP$ would be expected to offer very similar selection emphasis to that achieved by CM$ making it a practical consideration for producers that have historically used CM$, but would like to apply additional selection emphasis

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

Response to Selection		
Trait	**CM$®**	**DWP$®**
Milk	201	140
Fat	15	11
Protein	10	7
PL	0.93	0.91
Cow Livability	0.22	0.30
SCS	-0.03	-0.04
Functional Type	10.18	8.55
DPR	-0.01	0.16
HCR	0.31	0.30
CCR	0.13	0.26
Mastitis	-0.74	1.73
Lameness	-0.11	0.85
Metritis	-0.48	0.04
RP	0.36	0.91
DA	0.59	0.57
Ketosis	0.69	0.91
Milk Fever	-0.60	-0.09
Calf Livability	-0.46	0.72
Calf Respiratory	0.64	1.15
Calf Scours	-0.08	1.23

Table 5 – Defines the relative values for underlying traits in each of the three Jersey wellness indexes and Cheese Merit.

	Relative Value (%)			
Trait	CM$®	DWP$®	WT$®	CW$®
Milk	-8%	-4%	0	0
Fat	24%	21%	0	0
Protein	22%	16%	0	0
PL	11%	9%	0	0
Cow Livability	7%	4%	0	0
SCS	-5%	4%	0	0
Functional Type	14%	5%	0	0
DPR	6%	4%	0	0
HCR	1%	1%	0	0
CCR	1%	1%	0	0
Mastitis	0	14%	75%	0
Lameness	0	4%	19%	0
Metritis	0	1%	3%	0
RP	0	<1%	1%	0
DA	0	<1%	1%	0
Ketosis	0	<1%	1%	0
Milk Fever	0	<1%	1%	0
Calf Livability	0	4%	0	37%
Calf Respiratory	0	1%	0	10%
Calf Scours	0	6%	0	53%

on Jersey wellness traits.

Summary

Jersey 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, a gap has existed in the ability to improve dairy profitability and dairy cow well-being through direct genetic selection for susceptibility to common diseases.

CLARIFIDE® Plus provides accurate genetic predictions for Jersey wellness traits derived using cutting-edge genetic evaluation methodology applied to data collected from commercial production settings. The result is an expanded suite of genetic selection tools that provide highly relevant information to dairy producers that seek to continue to improve the health, longevity, productivity, and profitability of the dairy cattle in their care.

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