Interpreting Sire Proofs for Linear Type Traits

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Conformation has been an important element of genetic improvement and selection programs in dairy cattle since its outset. Although linear type traits may not be the primary focus of selection programs, their consideration is important in bull selection to ensure a well-balanced cow and avoid or correct any specific issues in the herd. Linear type traits can differ widely in the amount of variation they exhibit and in heritability, which represents the proportion of the variation attributable to genetics. These differences have implications on how much change we expect to observe phenotypically by selecting sires with various proofs. To aid in the understanding of what bull proofs for these traits actually mean, Lactanet has created interpretation tables to relate sire proofs to the expected average daughter performance in terms of first lactation classification.

The Basics of Type Evaluations

Genetic evaluations for conformation traits express the relative superiority

of bulls and cows for type traits as expressed in first lactation females. Genetic evaluations are calculated using data from Holstein Canada's classification program where the various descriptive type traits are scored on a linear scale from 1 to 9. For all type traits, the published evaluations are standardized and expressed relative to the genetic base, which is defined for the Holstein breed as proven bulls born in the most recent complete 10-year period. The average sire proof for this base group is set to be zero and the standard deviation is set to 5 points. This creates a typical range of proofs of roughly -15 to +15. Genetic evaluations for type traits that are considered to have an intermediate optimum are published with a letter code instead of positive or negative signs. Since evaluations are standardized to the base definition it is important to recognize that a sire proof of zero is representative of the average bull. This is true for all type traits including those intermediate optimum traits. The average sire may be different from the trait ideals defined by the classification program. For this reason, knowledge of both where the breed population and the potential female mate stands is important for selecting the direction for selection and effectively the use of genetic evaluations for type traits in a breeding program.

A Recent Analysis Update

An analysis was recently performed by Lactanet to determine the relationship between sire proofs for each descriptive type trait and the average daughter phenotype or linear classification score expected in first lactation. This analysis was conducted separately for each breed. Sires with an official type proof and born in the last 7 years for Holstein, 12 years for Jersey and Ayrshire, and all birth years for the remaining breeds were used. The definition of linear scores may change periodically between rounds and therefore a recent time frame was sought, the length of time being dependent on the breed population size. Based on the selected sires, the linear scores, or measurements, of the daughters classified in first lactation were averaged and a regression analysis was performed.

Interpretation Tables

Appended to this article are the interpretation tables relating sire proofs to expected average daughter first lactation linear score for type traits for all seven breeds. For each breed and each descriptive type trait, the table contains values for the average linear score of daughters in first lactation of the average sire having a proof of zero, as well as the expected gain in score with each 5-point positive difference in sire proof. For traits with an actual measurement recorded during classification, which is then transformed to a linear score, the interpretation in terms of the measure is given below its respective linear trait and denoted by the units of measure following the trait name. For those proofs published with a letter code, a 'proof increase' for the purpose of this table is representative of movement in the direction of the descriptor of the higher linear score.

Understanding the Values

The 'Average for Proof=0' column represents the calculated average linear score of daughters in first lactation for a sire with a proof of zero, which represents the average bull for the breed. This average value would be an approximation for an average herd in average conditions and may not be representative for many herds that will differ in current genetics and management environments. It does give an indication of about where the average daughter will score for these sires. As is observed in reality for these sires, daughters will have a distribution of scores around this average linear score.

The 'Per 5-pt Proof Increase' column presents how much of an increase in daughter performance is expected on average when comparing daughters of two sires whose proofs differ by 5 points. A linear relationship exists between sire proofs for descriptive type traits and daughter performance in classification and therefore this value is applicable for any 5-point proof difference in sire proof and can be extrapolated to any size difference in proofs being considered. As well, since this value does not take into consideration an average score and is simply a difference, it is relevant for

the majority of herds no matter where the herd's average classification performance is. The difference in daughter performance between sires will be the same, irrespective of the average.

If we look at Stature as an example, there are two relevant lines in the table: one for the linear score and one for the measurement. The table tells us that in first lactation the daughters of breed average sires with a proof of zero will score on average as 6.46 on the linear scale from 1 to 9. On the measured scale this represents a stature of 150.31 cm (59.2 inches). The table also tells that each 5-point increase in Stature proof will, on average, translate to a 0.45 increase on the linear scale in their daughters. A 0.45 increase on the linear scale is equivalent to approximately 1.15 cm (.45 inches). Daughters of a sire with a Stature proof of 10T are expected to have daughters scoring on average 0.45 linear points (1.15 cm) higher than a 5T bull. The same would be true when comparing daughters of a 2T sire to a 3S sire. If we were to consider the average provided in the table, the daughter of a 10T sire would be expected to have a score of 7.36, on average, or a measurement of 152.61 cm (60.1 inches).

Example: Sire proof interpretation for Stature in Holstein

	Average for Proof=0	Per 5-pt Proof Increase
Stature	6.46	0.45
Stature (cm)	150.31	1.15

Considerations and Limitations

As explained earlier, the average expected daughter score may differ when looking at an individual herd for a variety of reasons including the current genetics for type traits in the herd or the many non-genetic factors. Some idea of the herd's current classification will help to determine expected outcomes and the gain per 5-point increase in sire

proof can be considered with this average in mind. On a similar note, for descriptive type traits where there has been notable genetic trend in recent years the average dam which produced the daughters in the current analysis could be different genetically from those females considered for breeding today. This could result in some difference in the expected average daughter performance today. Additionally, the definition of linear type traits can change over time between rounds. For breeds with small populations and more years of data used in the analysis, depending on when the daughters were classified, their scores may not be on today's definition and this may introduce some added variability into the table estimates provided.

Summary

Lactanet has created sire proof interpretation tables for descriptive type traits to provide a resource for the industry to assist in the understanding of sire proofs for these traits and their relationship with what should be expected for average daughter classification scores. These expected values are based on averages and some deviation is expected to occur. The table values provide a guide to how the daughters of the breed average sire with a proof of zero perform in first lactation classification and how much the performance may differ between sires with proofs of different magnitudes.

Sire Proof Interpretation Table for Linear Type Traits
- December 2020 -

MAMMARY SYSTEM						
	Holstein		Jersey		Ayrshire	
Linear Trait	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase
Udder Floor	5.70	0.15	5.43	0.15	5.32	0.15
Udder Depth	5.31	0.40	4.97	0.45	5.02	0.40
Udder Depth (cm)	11.16	0.75	9.46	0.95	10.20	0.85
Udder Texture	5.57	0.30	5.64	0.30	5.22	0.30
Median Suspensory	6.29	0.25	5.79	0.30	5.64	0.40
Fore Attachment	4.99	0.45	5.46	0.60	5.10	0.35
Front Teat Placement	5.18	0.20	5.13	0.20	5.13	0.20
Rear Attachment Height	6.33	0.30	6.33	0.35	6.11	0.45
Rear Attachment Height (cm)	19.45	-0.60	17.57	-0.70	18.92	-0.60
Rear Attachment Width	5.79	0.25	6.14	0.30	5.64	0.40
Rear Attachment Width (cm)	14.95	0.45	14.62	0.50	13.48	0.55
Rear Teat Placement	6.39	0.20	5.93	0.20	6.18	0.25
Teat Length	4.66	0.30	5.40	0.25	4.85	0.25
Teat Length (cm)	3.98	0.20	4.18	0.20	3.97	0.15

FEET AND LEGS						
	Holstein		Jersey		Ayrshire	
Linear Trait	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase
Foot Angle	5.85	0.15	5.63	0.25	5.66	0.20
Heel Depth	5.33	0.15	5.44	0.25	5.15	0.20
Bone Quality	6.03	0.30	6.82	0.20	5.96	0.40
Rear Legs Side View	5.00	0.25	5.15	0.20	5.30	0.25
Rear Legs Rear View	5.29	0.20	6.09	0.30	5.34	0.30
Front Legs View	5.18	0.15	5.27	0.20	5.26	0.15
Locomotion	5.45	0.20	5.98	0.15	5.32	0.35

Sire Proof Interpretation Table for Linear Type Traits
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MAMMARY SYSTEM

Linear Trait	Brown Swiss		Guernsey		Canadienne		Milking Shorthorn	
	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase
Udder Floor	5.35	0.20	5.48	0.30	4.63	0.45	5.21	0.30
Udder Depth	5.58	0.15	5.71	0.40	4.62	0.50	5.44	0.25
Udder Depth (cm)	10.79	0.75	10.25	1.05	8.49	0.95	10.38	1.20
Udder Texture	6.16	0.10	6.04	0.15	5.61	0.30	6.02	0.20
Median Suspensory	6.10	0.05	6.13	0.15	5.36	0.30	6.02	0.15
Fore Attachment	5.74	0.25	5.50	0.30	4.89	0.25	5.58	0.25
Front Teat Placement	5.32	0.20	4.77	0.25	4.63	0.20	4.68	0.30
Rear Attachment Height	5.76	0.25	6.37	0.40	5.58	0.45	5.88	0.20
Rear Attachment Height (cm)	21.67	-0.65	20.64	-0.80	21.29	-1.05	20.47	-0.75
Rear Attachment Width	5.61	0.30	5.12	0.25	5.03	0.70	5.25	0.35
Rear Attachment Width (cm)	14.14	0.55	12.55	0.65	12.20	1.00	12.86	0.55
Rear Teat Placement	5.99	0.25	5.89	0.20	5.42	0.15	5.85	0.20
Teat Length	4.67	0.25	4.83	0.40	5.67	0.25	4.59	0.30
Teat Length (cm)	4.10	0.25	4.18	0.25	4.43	0.25	4.28	0.20

FEET AND LEGS

Linear Trait	Brown Swiss		Guernsey		Canadienne		Milking Shorthorn	
	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase
Foot Angle	6.25	0.10	5.51	0.20	5.54	0.10	5.61	0.10
Heel Depth	6.15	0.05	5.49	0.15	5.30	0.10	5.59	0.15
Bone Quality	6.06	0.15	6.60	0.30	6.40	0.25	6.18	0.15
Rear Legs Side View	4.93	0.20	5.64	0.15	5.47	0.20	5.57	0.25
Rear Legs Rear View	6.11	0.15	5.55	0.25	5.50	0.40	5.48	0.30
Front Legs View	5.55	0.20	5.71	0.35	5.47	0.15	5.78	0.25
Locomotion	5.88	0.20	5.49	0.55	5.43	0.25	5.35	0.45

DAIRY STRENGTH

Linear Trait	Brown Swiss		Guernsey		Canadienne		Milking Shorthorn	
	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase
Stature	6.43	0.30	6.65	0.50	5.55	0.70	6.90	0.35
Stature (cm)	148.56	1.05	144.04	1.15	131.68	1.60	139.75	1.10
Height at Front End	4.55	0.20	5.14	0.15	5.16	0.15	5.13	0.25
Chest Width	5.85	0.05	5.75	0.25	5.58	0.20	5.81	0.05
Body Depth	5.63	0.20	6.17	0.25	5.51	0.20	5.57	0.25
Dairy Capacity	5.38	0.20	5.90	0.15	4.98	0.20	5.48	0.20

RUMP

Linear Trait	Brown Swiss		Guernsey		Canadienne		Milking Shorthorn	
	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase	Average for Proof=0	Per 5-pt Proof Increase
Loin Strength	6.01	0.25	6.23	0.20	5.72	0.20	6.08	0.25
Rump Angle	5.33	0.20	5.55	0.30	4.94	0.30	5.46	0.30
Rump Angle (cm)	-5.69	-0.40	-4.52	-0.80	-5.28	-0.45	-5.08	-0.50
Pin Width	6.08	0.20	6.32	0.35	6.19	0.40	6.60	0.30
Pin Width (cm)	18.18	0.55	17.00	0.55	16.73	0.60	17.27	0.35
Thurl Placement	5.46	0.15	5.41	0.15	5.88	0.15	5.41	0.15

Share

By Allison Fleming, Ph. D.

Allison enjoys sharing her knowledge of the dairy cattle genetic improvement landscape with all audiences from the technical to the end-user for the successful understanding and application of genetic selection tools.

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