Modernizing Canada's Lifetime Performance Index (LPI)

B. J. Van Doormaal[1], C. Jaton[1], H. Sweett[1], P. G. Sullivan[1], A. Fleming[1], F. Miglior[1,2] and C. M. Richardson[3]

[1] Lactanet Canada, Guelph, Ontario, Canada

[2] Centre for the Genetic Improvement of Livestock, Department of Animal Biosciences, University of Guelph, Guelph, Ontario, Canada

[3] AbacusBio International, Roslin Innovation Centre Easter Bush, Edinburgh, United Kingdom

Corresponding author: bvandoormaal@lactanet.ca

Abstract

National selection indexes combining important traits are frequently used by dairy farmers, breeders, and A.I. companies to achieve their breeding goals. The Canadian dairy industry has made significant genetic progress with two national selection indexes, the Lifetime Performance Index (LPI) and Pro$, which are now double the rate compared to the pre-genomics era. Since its introduction in 1991 the LPI formula has changed alongside the expansion of national breeding objectives. With the introduction in recent years of genetic evaluations for its portfolio of traits related to sustainability, the timing was right for Lactanet to modernize several aspects of Canada's LPI, effective April 2025. A key strategic change is the creation of six subindexes, which are each published on their own using a standardized scale with an average of 500 and standard deviation of 100. Subindexes include the Production Index (PI), Longevity & Type Index (LTI), Health & Welfare Index (HWI), Reproduction Index (RI), Milkability Index (MI), and Environmental Impact Index (EI). For the Holstein breed, the relative weights placed on these subindexes are 40% PI, 32% LTI, 8% HWI, 10% RI, 5% MI, and 5% EI. The six other dairy breeds evaluated have differing relative weights in accordance with the respective breed objectives. A second important change is an increased focus on presenting the genetic response over the next five years that can be expected for each trait based on the average level of selection gain realized for LPI. While this approach recognizes the impact of direct inclusion of a trait in one of the six LPI subindexes, it also reflects the expected response for correlated traits. Defining six subindexes that contribute to LPI demonstrates the increased diversity of traits currently evaluated and acknowledges the continued expansion of Canada's overall breeding goal for dairy cattle breeds.

Key words: Lifetime Performance Index, subindexes, expected response

Introduction

Given the vast number of traits evaluated in dairy cattle breeding, most countries use at least one national genetic selection index to identify superior males and females in each breed. In Canada, the Lifetime Performance Index (LPI) was introduced in 1991 as the official ranking index for all seven dairy breeds, namely Ayrshire, Brown Swiss, Canadienne, Guernsey, Holstein, Jersey and Milking Shorthorn. A second national genetic selection index, named Pro$, was introduced in 2015 (Van Doormaal et al., 2015). With the relatively small population size of the Brown Swiss, Canadienne, Guernsey and Milking Shorthorn breeds in Canada, combined with the very high correlation (i.e.: over 85%) between the two national indexes, Pro$ values are only published for the three other breeds, Ayrshire, Holstein and Jersey.

Since the introduction of LPI in 1991, the traits included, and their relative weights, were previously reviewed and modified seven times with the latest being in 2019. While the original LPI formula included only production (60%) and type (40%) traits, herd life and somatic cell

score were included in 2001, and a Health & Fertility component was first introduced with the addition of daughter fertility in 2005. The formula changes in 2008, 2015 and 2019 all increased the relative emphasis on the Health & Fertility component compared to the Production and Durability components, which have been 20:40:40, respectively, since 2019.

Canada was among the first countries globally to introduce national genetic evaluations for Feed Efficiency in 2021 (Jamrozik et al. 2021), which was then included in the Holstein LPI formula as an add-on trait starting in April 2022. In April 2023, two more traits related to environmental sustainability were launched by Lactanet Canada. Body weight data, converted to metabolic body weight, is used as the input phenotype to produce single-step genetic evaluations for Body Maintenance Requirements (Fleming et al., 2023). Together with Feed Efficiency, selection aims to reduce on-farm feed costs. Lactanet Canada was the first country to use milk mid-infrared (MIR) spectral predictions of methane yield as input phenotypes for its single-step genetic evaluation for Methane Efficiency (Van Doormaal et al., 2023; Oliveira et al., 2024). With this portfolio of traits available to help farmers genetically select to reduce the carbon footprint of their herd, the timing was right to modernize the LPI formula to allow for the inclusion of traits related to environmental sustainability.

There were multiple other goals underlying the need to modernize Canada's LPI formula, including:

- Reduce the mathematical nature of the formula and how to communicate it to breeders.
- Replace the three LPI components with six subindexes to be published on their own as well as be combined into LPI.
- Enhance the breeder understanding and language towards expected response by trait from index-based selection, instead of focusing on the specific traits included in the index and their relative weights.

Materials and Methods

Correlation Matrix and Expected Response

Official genetic evaluations for bulls within each breed served as the basis for the analysis of correlations and expected selection response. For each breed, progeny proven sires included in the genetic base definition for each breed were combined with younger genomic bulls with at least 30 registered daughters in Canada but not progeny proven for production and type traits. A matrix of simple correlations among all traits and indexes was calculated based on the official genetic evaluations published for the group of bulls included for each breed.

As described by Van Doormaal et al. (2015) for the development of Canada's profit-based national selection index, Pro$, correlations between any given index and individual traits can be used to estimate the expected response for the trait resulting from selection for the given index. Technically speaking, this requires true genetic correlations, but the use of bull evaluation correlations leads to easier calculations and serves as an excellent proxy. Such expected selection responses are more relevant than the traditional use of relative weights on traits included in an index, which often ignore the underlying correlation matrix among all traits.

To facilitate dairy farmer understanding of the concept of expected selection response, the bull evaluation trait correlations with the LPI national selection index were converted to units of expected genetic gain in the next five years. To accomplish this, the total genetic gain realized in Canadian cows and heifers born in the most recent 5-year period was calculated and then expressed in terms of standardized units based on the standard deviation of LPI values for Canadian females. For each individual trait, the 5-year expected response from selection for LPI was estimated by multiplying the total realized standardized gain for LPI by the trait correlation with LPI and the trait standard deviation based on published cow evaluations.

Formulation of LPI Subindexes

Since 2005, the Canadian LPI formula has included three components: Production, Durability and Health & Fertility. A key goal of the new modernized LPI formula was the development of six subindexes to better reflect the diverse groups of traits currently in Canada:

- Production Index (PI)
- Longevity & Type Index (LTI)
- Health & Welfare Index (HWI)
- Reproduction Index (RI)
- Milkability Index (MI)
- Environmental Impact Index (EI)

For the development of each subindex by breed, consultations with each breed association were held to identify any specific traits for which they desired targeted gains for the future. For the Production and the Longevity & Type subindexes, breed associations and industry organizations agreed to implement only minor modifications. In addition to separating the former Health & Fertility component into the new Health & Welfare and Reproduction subindexes, there was also a desire to include new traits in each subindex based on the underlying correlation matrix.

Given the increasing adoption of robotic milking systems in Canadian herds, which now represents one-quarter of milk-recorded cows, the industry agreed to develop a new Milkability subindex of LPI. In addition, with the launch of three new traits aimed at reducing the carbon footprint of dairy farms, a new Environmental Impact subindex was developed and included in the LPI for Holsteins.

Results & Discussion

Following industry consultation including the comparison of results from various LPI scenarios, Table 1 represents the final relative weight on each of the six subindexes in the modernized LPI for the Holstein breed, as well as the resulting correlation between each subindex and LPI. Similar relative weights were used for building the LPI for the six other dairy cattle breeds evaluated by Lactanet but are not presented here.

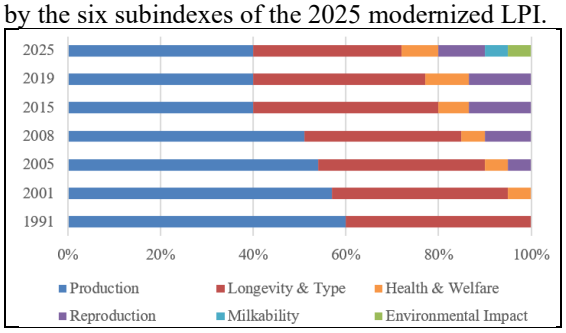
Table 1: Relative weight (%) of each subindex of the modernized LPI for Holsteins and their resulting correlation with LPI.

		%	LPI Corr
Production	PI	40	0.83
Longevity & Type	LTI	32	0.69
Health & Welfare	HWI	8	0.57
Reproduction	RI	10	0.39
Milkability	MI	5	0.01
Environmental Impact	EI	5	0.00

The Production Index has the highest relative weight of 40%, which also yields the highest correlation with LPI of 0.83. The Longevity & Type Index represents 32% of the LPI formula and has a relatively strong correlation of 0.69 with LPI. Results for the Health & Welfare and Reproduction Indexes are of particular interest since their relative weights of 8% and 10%, respectively, result in LPI correlations of 0.57 and 0.39. The lower LPI correlation for Reproduction stems from the underlying negative correlation between female fertility traits and other key traits in the LPI, especially milk yield and some key conformation traits. Both the Milkability and Environmental Impact Indexes are new subindexes of the LPI formula. Based on discussions with industry organizations, a relative weight of 5% on each was implemented. As shown in Table 1, these weights yield a correlation with LPI that is near zero at 0.01 and 0.00, respectively. In both cases, exclusion of these new subindexes of LPI would have yielded a negative correlation and expected selection response, which is not desired. In addition, for the Environment Impact Index the relative weight of 5% serves as a starting point to raise dairy farmer and industry awareness for the opportunity to genetically select for the underlying traits related to the carbon footprint of a dairy herd, even while there is no direct financial incentive to do so at the present time.

The 2025 update to the LPI formula represents the sixth significant modification since its inception in 1991. Figure 1 presents the evolution of traits that have been included by presenting them in groups aligned with the six subindexes included in the 2025 LPI formula for Holsteins.

Figure 1: Evolution of the Holstein LPI formula expressed as relative weights (%) on traits grouped by the six subindexes of the 2025 modernized LPI.



In the 1990s, the LPI formula only included production and type, with relative weights of 60:40, respectively. Herd Life and Somatic Cell Score were added in 2001. Daughter Fertility was added in 2005 and then increased in emphasis in 2008. The updates in 2015 and 2019 included higher relative weights on traits related to the current Health & Welfare and Reproduction subindexes, which therefore decreased the relative emphasis placed on the other subindexes, including production traits. Since 2015, however, the Production Index has maintained a 40% weight in the Holstein LPI, even with the addition of the new Milkability and Environmental Impact subindexes in 2025. The 2025 focus on estimates of expected response by trait resulting from LPI selection, rather than on traits included and their relative weights, slightly reduced the overall weight on traits related to the Health & Welfare and Reproduction subindexes (Figure 1).

Production Index (PI)

Figure 2 shows Fat and Protein Yields as the only two traits directly included in the Production Index, with relative weights of 60% and 40%, respectively. The inclusion of only these two traits also applies for all other breeds. When selecting for LPI, however, five other traits related to the Production subindex are monitored as correlated traits, namely Milk Yield, Fat and Protein Deviations and Lactation Persistency.

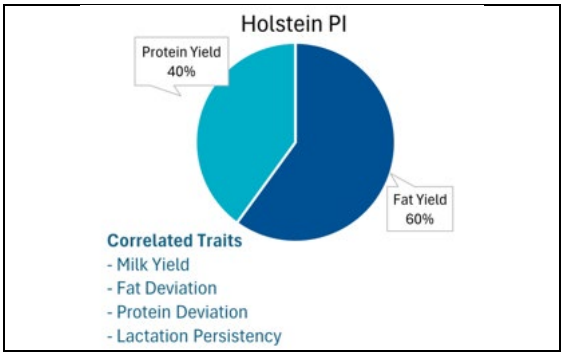


Figure 2. Traits included in the Production Index (PI) of LPI for Holsteins, with their relative weights, and key correlated traits.

In addition to the trait weights for the Production Index, Table 2 provides the resulting correlation that the direct and correlated traits have with LPI, given the relative weight of all six subindexes in Table 1. These correlations are also expressed in terms of the expected selection response (ESR) for each trait based on selection for LPI over the next five years.

Table 2: Relative weight (%) of traits included in the Production Index (PI) of LPI for Holsteins, their resulting correlation with LPI, and the expected selection response (ESR) by trait over the next 5 years resulting from selection for LPI.

	%	LPI Corr	ESR
Milk Yield		0.43	534
Fat Yield	60	0.81	42.1
Protein Yield	40	0.74	28.0
Fat Deviation		0.56	0.29
Protein Deviation		0.54	0.13
Lactation Persistency		0.10	0.5

The results in Table 2 clearly demonstrate the importance of concentrating on expected response versus trait emphasis in any index. For example, although Milk Yield has no direct weight in the Production Index, selection for LPI is still expected to result in over 500 kg of genetic gain for milk production in the Canadian Holstein population over the next five

years, in addition to 42.1 kg and 28.0 kg for Fat and Protein Yields, respectively. In a similar manner, selection for the yields of milk components, without any direct weight on milk production also results in relatively strong expected gains for Fat and Protein Deviations (Table 2). Without direct inclusion of Lactation Persistency in the Production Index for Holsteins, the resulting correlation with LPI of 0.10 translates to little expected selection response but the ESR value is in the desired direction.

Longevity & Type Index (LTI)

The main goal of the Longevity & Type Index is to provide a subindex that allows dairy farmers the opportunity to select for increased longevity and functional conformation. For this reason, Mammary System, Feet & Legs and Herd Life have the highest direct emphasis in this subindex, with relative weights of 37% 33% and 20%, respectively (Figure 3).

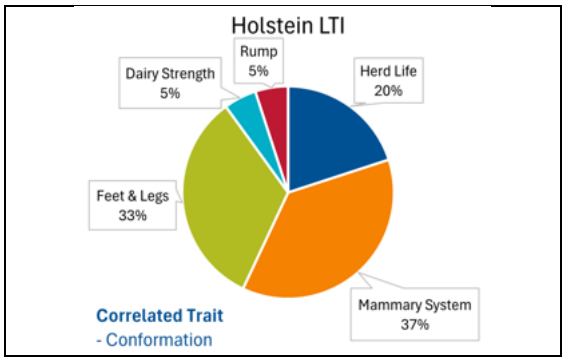


Figure 3. Traits included in the Longevity & Type Index (LTI) of LPI for Holsteins, with their relative weights, and key correlated traits.

Rump and Dairy Strength both have relative weights of 5% for Holsteins to maintain the current genetic level of their underlying traits without targeting further genetic gain per se. Given the fact that overall Conformation is a composite index of the four major scorecard traits, it is monitored only as a correlated trait of this subindex.

Given the relative weights of each trait in the Longevity & Type Index and the relative weights of each subindex in LPI presented in Table 1, the resulting correlations with LPI and the expected selection response (ESR) by trait are presented in Table 3. These results clearly show that applying a relative weight of only 20% on Herd Life still yields the highest LPI correlation and an ESR of 3.4 units of Relative Breeding Value (RBV) for the next five years. Similar to the result discussed for Milk Yield under the Production Index, having no direct weight on Conformation still yields a correlation with LPI of 0.51 and also a relatively strong 5-year ESR of 3.2 EBV units. The key composite traits of Mammary System and Feet & Legs also show moderate correlations with LPI of 0.47 and 0.46, respectively, and associated levels of 5-year ESR.

Table 3: Relative weight (%) of traits included in the Longevity & Type Index (LTI) of LPI for Holsteins, their resulting correlation with LPI, and the expected selection response (ESR) by trait over the next 5 years resulting from selection for LPI.

	%	LPI Corr	ESR
Herd Life	20	0.64	3.4
Conformation		0.51	3.2
Mammary System	37	0.47	2.9
Feet & Legs	33	0.46	2.7
Dairy Strength	5	0.07	0.5
Rump	5	0.09	0.6

Health & Welfare Index (HWI)

Compared to the previous Health & Fertility component of the LPI formula in Canada, the new Health & Welfare Index was separated out to facilitate the genetic selection and improvement for multiple traits related to disease resistance and animal welfare. With the goal of reducing the incidence of important dairy cattle diseases, Mastitis Resistance and Metabolic Disease Resistance are directly included in the new Health & Welfare subindex with relative weights of 47% and 27%, respectively (Bjelland et al. 2025), as shown in Figure 4. Hoof Health is currently the only family of traits evaluated in Canada related to animal welfare but has a relative weight of 21% in this LPI subindex. While Somatic Cell Score, Metritis and Retained Placenta are correlated traits not directly included in the Health & Welfare Index, Cystic Ovaries is included with

a weight of 5% to achieve a desired selection outcome.

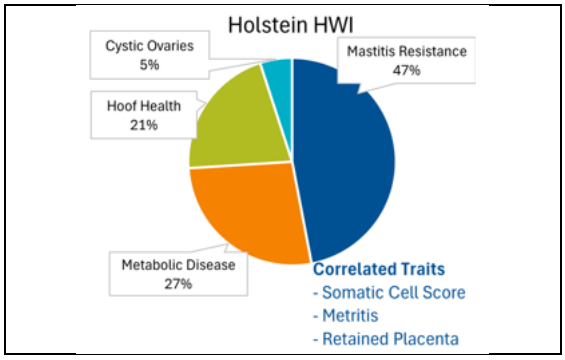


Figure 4. Traits included in the Health & Welfare Index (HWI) of LPI for Holsteins, with their relative weights, and key correlated traits.

Mastitis Resistance is an index that combines Clinical Mastitis with Somatic Cell Score, which is an indicator of sub-clinical mastitis. For this reason, the LPI correlation with these two traits are very similar at 0.44 and 0.46, respectively, and the 5-year ESR exceeds 2 RBV points for both traits (Table 4).

Table 4: Relative weight (%) of traits included in the Health & Welfare Index (HWI) of LPI for Holsteins, their resulting correlation with LPI, and the expected selection response (ESR) by trait over the next 5 years resulting from selection for LPI.

	%	LPI Corr	ESR
Mastitis Resistance	47	0.44	2.1
Somatic Cell Score		0.46	2.8
Metabolic Disease Resistance	27	0.40	2.1
Hoof Health	21	0.27	1.4
Cystic Ovaries	5	0.20	1.0
Metritis		0.37	1.9
Retained Placenta		0.19	1.0

Compared to these two traits, even though Metabolic Disease Resistance has a lower direct weight of 27% in this subindex, it has a similar LPI correlation of 0.40 and ESR of 2.1 RBV points over the next five years. With a relative weight of 21%, Hoof Health has a relatively low LPI correlation of 0.27, which translates to an ESR of 1.4 RBV points after 5 years of LPI selection.

In Canada, Lactanet provides genetic evaluations for three fertility disorders. For two of them, namely Metritis and Retained Placenta, positive correlations with LPI resulted even without direct emphasis in the Health & Welfare Index (Table 4). This stems from the positive correlations that these traits have with both Herd Life and Daughter Calving Ability, which are directly included in the modernized LPI formula. For Cystic Ovaries, however, which has a relatively low correlation of 0.34 and 0.19 with the other two fertility disorders, respectively, direct inclusion with a 5% relative weight was decided to obtain the desired 5-year ESR of 1.0 RBV points.

Reproduction Index (RI)

The Reproduction Index focuses on improvement of traits related to female fertility, calving ease and calf survival (i.e.: reverse expression of stillbirth rate). Given the major importance of female fertility, the Daughter Fertility index has a relative weight of 90% and 10% is allocated to Daughter Calving Ability (Figure 5). Calving Ability, which is an index that includes service sire traits for calving ease and calf survival, is monitored as a correlated trait to this LPI subindex.

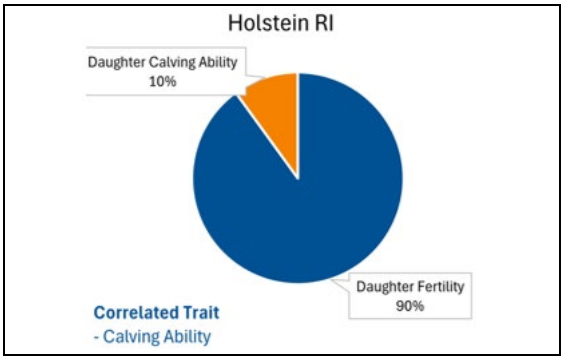


Figure 5. Traits included in the Reproduction Index (RI) of LPI for Holsteins, with their relative weights, and key correlated traits.

As shown in Table 5, even though Daughter Fertility has the highest emphasis in the Reproduction Index, Daughter Calving Ability has the highest correlation with the resulting LPI at 0.58, compared to 0.32 for Daughter Fertility. These correlations translate to 5-year ESR values of 2.8 and 1.6 RBV points, respectively. Without direct inclusion of Calving Ability in this subindex, the LPI

correlation slightly exceeds that of Daughter Fertility at 0.34 and the associated ESR is 1.9 RBV points after 5 years of selection for LPI.

Table 5: Relative weight (%) of traits included in the Reproduction Index (RI) of LPI for Holsteins, their resulting correlation with LPI, and the expected selection response (ESR) by trait over the next 5 years resulting from selection for LPI.

	%	LPI Corr	ESR
Daughter Fertility	90	0.32	1.6
Daughter Calving Ability	10	0.58	2.8
Calving Ability	0	0.34	1.9

Milkability Index (MI)

With the growing adoption of robotic milking systems, the objective of creating a new Milkability Index for inclusion in the LPI was to allow dairy farmers to specifically select for a group of traits related to milking ability and efficiency. As shown in Figure 6, Milking Speed and Temperament are directly included in the subindex, with relative weights of 25% and 18%, respectively.

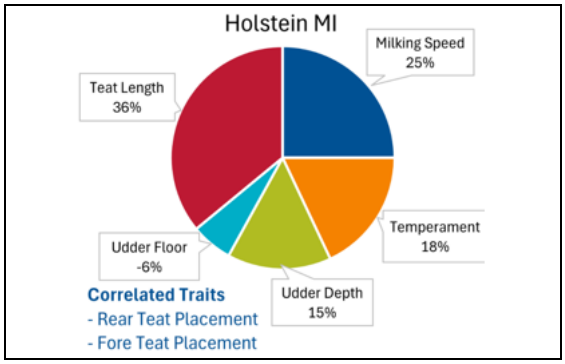


Figure 6. Traits included in the Milkability Index (MI) of LPI for Holsteins, with their relative weights, and key correlated traits.

Multiple descriptive type traits related to the udder and teats were also considered for direct inclusion. The result of various analyses led to the inclusion of Teat Length at 36%, Udder Depth at 15% and Udder Floor at -6%, with the negative value encouraging selection away from udders with a reverse tilt. Rear and Fore Teat Placement are considered as correlated traits.

The relative weights used for directly including Milking Speed and Temperament in the Milkability Index do not, however, lead to strong correlations with LPI (i.e.: 0.03 and 0.10, respectively), and therefore high levels of ESR are not expected, as shown in Table 6.

Table 6: Relative weight (%) of traits included in the Milkability Index (MI) of LPI for Holsteins, their resulting correlation with LPI, and the expected selection response (ESR) by trait over the next 5 years resulting from selection for LPI.

	%	LPI Corr	ESR	
Milking Speed	25	0.03	0.1	
Temperament	18	0.10	0.5	
Udder Depth	15	0.31	2.0	Shallow
Udder Floor	-6	-0.01	-0.1	Tilt
Teat Length	36	-0.19	-1.2	Short
Rear Teat Placement		0.03	0.2	Close
Fore Teat Placement		0.15	0.9	Close

All five of the descriptive type traits considered for inclusion in this subindex are evaluated on an intermediate optimum scale whereby bull EBVs with higher numerical values (i.e.: either above or below zero) reflect sires that will move the breed toward one extreme or the other, with both being undesired. This expression scale means that correlations with these traits need to be carefully interpreted. The 15% emphasis on Udder Depth in the Milkability subindex results in a correlation with LPI of 0.31 based on the 5% relative weight of this subindex in LPI as shown in Table 1. Based on how this trait is measured by the classifiers and designated a linear score from 1 to 9, positive EBV correlations would lead toward more shallow udders instead of deeper. The 5-year ESR for Udder Depth of 2.0 EBV units in the direction of shallow udders is the desired target to reduce problems in robotic and parlour milking systems. For Udder Floor, a negative relative weight of -6% was required to achieve a near-zero LPI correlation and ESR so that selection for LPI would not increase the frequency of reverse tilt udders, which are especially problematic with robotic milkers.

Teat Length was a trait of particular interest since breeders and the industry have taken steps to mitigate the past trend towards shorter teats. For this reason, this trait receives the highest relative weight in the Milkability Index at 36%. Even with this emphasis, however, the resulting

correlation between Teat Length and LPI is -0.19, which yields a 5-year ESR of 1.2 EBV units towards shorter teats. Without the 36% emphasis on this trait in this subindex, this suboptimal selection direction would be even stronger. During the industry consultation process, various relative weights for Teat Length were tested but an ESR toward shorter teats was a consistent result. This is caused by the underlying correlation matrix between traits since Teat Length has a moderate negative correlation (i.e.: toward shorter teats) ranging from -0.20 to -0.28 with other traits directly included in the LPI, including Fat Yield, Herd Life, Udder Depth and Daughter Calving Ability. Without any direct inclusion of Rear and Fore Teat Placement in the Milkability Index, the correlation with LPI is either neutral or slightly favourable, at 0.03 and 0.15, respectively, to avoid selection towards teats that become wider apart (Table 6).

Environmental Impact Index (EI)

Since 2021, Lactanet introduced genetic evaluations for three traits directly targeting the reduction of greenhouse gas emissions produced by animals on dairy farms. These include Feed Efficiency and Body Maintenance Requirements, which reflect the volume of feed consumed, and Methane Efficiency that reflects methane yield independent of production levels. As shown in Figure 7, all three of these traits are directly included in the Environmental Impact Index with relative weights of 25%, 38% and 37%, respectively, based on analysis reported by Richardson et al. (2025).

The trait correlations with LPI and ESR based on five years of LPI selection are presented in Table 7. For Methane Efficiency and Feed Efficiency, the LPI correlations are relatively low but in the desired direction at 0.19 and 0.09, respectively. Even with only 5% weight of this subindex in the current LPI, some favourable response is expected with 5-year ESR values of 0.9 and 0.5 RBV points.

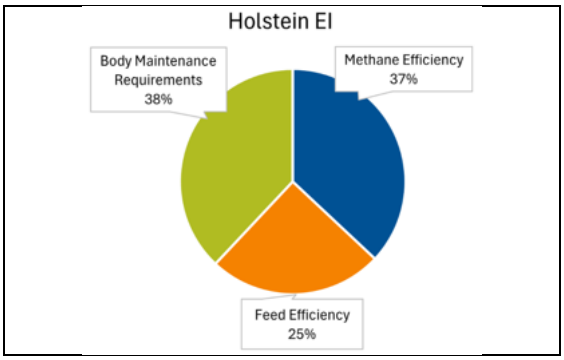


Figure 7. Traits included in the Environmental Impact Index (EI) of LPI for Holsteins, with their relative weights, and key correlated traits.

Table 7: Relative weight (%) of traits included in the Environmental Impact Index (EI) of LPI for Holsteins, their resulting correlation with LPI, and the expected selection response (ESR) by trait over the next 5 years resulting from selection for LPI.

	%	LPI Corr	ESR
Methane Efficiency	37	0.19	0.9
Feed Efficiency	25	0.09	0.5
Body Maintenance Requirements	38	-0.16	-0.8

The same result is not found for Body Maintenance Requirements, which has an LPI correlation of -0.16 and an ESR of -0.8 after five years of LPI selection (Table 7). Fleming et al. (2023) developed the single step evaluation system for this trait using metabolic body weight as the phenotypic measure. Resulting sire RBV are expressed such that higher values result in the selection of more moderately sized daughters. The genetic trend for this trait has been negative so inclusion in the Environmental Impact subindex of LPI is an important step to at least reducing the rate of the observed genetic trend. As financial incentives are introduced in the future to encourage dairy farmers to reduce the carbon footprint of their herd, it is expected that this subindex will have higher emphasis in the LPI formula.

Expression of LPI Subindexes

Lactanet currently calculates genetic evaluations for over 100 individual traits and indexes. On its LactanetGen.ca website, which provides genetic information and associated tools, over 50 traits are displayed on each animal's Genetic Evaluation Summary page.

In general, while some breeders have a keen interest in studying the detailed genetic profile of sires and the females in their herd, most dairy farmers are overwhelmed by the number of traits to consider for their selection and mating decisions. To simplify such decisions, each of the six subindexes of Canada's modernized LPI formula are expressed on a standardized scale within each breed and can therefore be used as an overall trait on their own. As presented in Figure 8, each subindex has an average of 500 and a standard deviation of 100 points based on the group of progeny proven sires that forms the genetic base within each breed. For Holsteins, this includes proven bulls born in the most recent complete 10-year period (i.e.: for 2025 includes bulls born from 2009 to 2019). The key advantages of this standardized scale include (a) easily identifies elite sires for each subindex (i.e.: 700 or higher), the higher range results in fewer animals tied at the same level, and (c) the higher average results in all animals in the active population of bulls and females have positive subindex values.

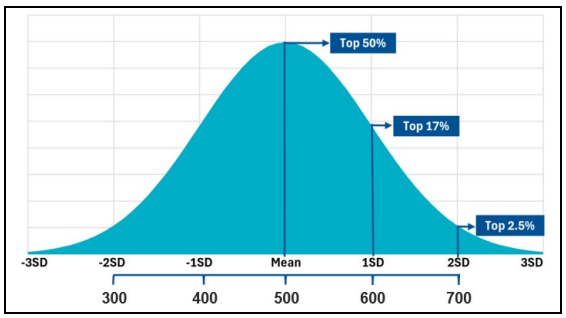


Figure 8. Scale of expression used for each LPI subindex within each breed.

Conclusions

The Lifetime Performance Index (LPI) was Canada's first national genetic selection index introduced in 1991. At that time, only six traits were included to meet the breeding goal of balancing production and type with relative weights of 40:20. Over the past 30+ years, many new traits were introduced, and breeding objectives were broadened. Most recently, the launch of genetic evaluations associated with environmental sustainability served as strong motivation to modernize the LPI formula for all seven dairy breeds evaluated in Canada.

The new modernized LPI maintains focus on production traits with its Production Index, which is followed by the Longevity & Type Index in terms of relative weight. The increased number of evaluations targeting selection for enhanced disease resistance led to the creation of a new Health & Welfare Index. The Reproduction Index was broadened to include calving performance traits in addition to female fertility. With the increase adoption of robotic milking systems, a new Milkability Index was created, which allows dairy farmers to specifically select for key traits in this area. For the Holstein breed, a new Environmental Impact Index combines the three traits currently evaluated and was introduced in the LPI formula to increase awareness and initiate genetic selection for this novel family of traits. Within each breed the subindexes are expressed on a standardized scale to facilitate producer understanding and they are published alongside LPI to give increased visibility.

An important shift with the modernized LPI is the focus towards the communication of expected selection response (ESR) achieved by selection for LPI, rather than concentrating on the list of traits included and their relative weight. This approach is more appropriate for describing the rate of genetic change that can be expected by index selection and accounts for the underlying correlations among the traits and indexes.

References

Bjelland D., Crowley, J., Richardson, C.M., Howes, N., Amer, P., Fleming, A., Jaton, C., Baes, C.F., and Miglior, F. 2025. Development of a health sub-index for genetic selection of Holstein bulls and cows in Canadian dairy operations. Journal of Dairy Science (under review).

Fleming, A., Kistemaker, G.J., Jamrozik, J., Sullivan, P.G., and Van Doormaal, B.J.

2023. Genomic evaluations for Body Maintenance Requirements in Canadian Holsteins. Interbull Bulletin 59: 164-170.

Jamrozik, J., Kistemaker, G.J., Sullivan, P.G., Van Doormaal, B.J., Chud, T.C.S., Baes, C.F., Schenkel, F.S., and Miglior, F. 2021. Genomic evaluation for Feed Efficiency in Canadian Holsteins. Interbull Bulletin. 56: 153-161.

Richardson, C.M., Amer, P., Post, M., Oliveria, T., Grant, K., Crowley, J., Quinton, C., Miglior, F., Fleming, A., Baes, C.F., and Malchiodi, F. 2025. Breeding for sustainability: Development of an index to reduce greenhouse gas in dairy cattle. Animal, 101491

Van Doormaal, B.J., Kistemaker, G.J., Beavers, L., and Sullivan, P.G. 2015. Pro$: A new profit-based genetic selection index in Canada. Interbull Bulletin No. 49: 103-110.

Van Doormaal, B.J., Oliveira, H.R., Narayana, S.G., Fleming, A., Sweett, H., Malchiodi, F., Jamrozik J., Kistemaker, G.J., Sullivan, P.G., and Miglior, F. 2023. Implementation of Methane Efficiency evaluations for Canadian Holsteins. Interbull Bulletin No. 59: 74-82.