

Updates to the Total Performance Index® (TPI®) and Type Composites

KEEPING UP WITH THE CHANGING TIMES

At the summer 2017 meeting of the Holstein Association USA board of directors, several changes were approved to the Total Performance Index (TPI) formula, as well as some of the type composites.

UDDER COMPOSITES (UDC) UPDATES

The individual weightings of traits have been updated, and two new traits have been added – Teat Length and Stature. The addition of a negative weighting on Stature is in response to concerns from the industry that the Holstein type composites have too strong of a relationship with Stature, and by selecting for high UDC and/or high FLC, you were inadvertently also selecting for taller cattle. By decoupling UDC from Stature, the index is now more accurate. Additionally, an intermediate optimum is being used for both Rear Teat Placement and Teat Length. Bulls siring cows with rear teats too close together will be penalized, as will teats that are too short or too long. The new UDC formula can be found on page 5.

FEET & LEG COMPOSITE (FLC) UPDATES

Like the UDC, the individual weightings of traits in the FLC have been updated, and a negative weighting on Stature has been added. The new FLC formula can be found on page 6.

SUMMARY OF UPDATES TO THE TPI FORMULA

- The weighting on Productive Life has been reduced from 7% to 4%. That 3% is being assigned to the new trait Cow Livability. Productive Life measures the number of months in milk, whereas Cow Livability more specifically measures a cow's ability to stay alive while on the farm. The traits are highly correlated, but there are important differences amongst some bulls.
- The weightings on Protein and Fat have been updated to 21% (down from 27%) and 17% (up from 16%), respectively, to more accurately reflect how producers are paid for milk.
- The weighting on Feed Efficiency has been increased from 3% to 8%.

The new TPI formula can be found in its entirety on page 4.

BODY SIZE COMPOSITE (BSC) NAME CHANGED TO BODY WEIGHT COMPOSITE (BWC)

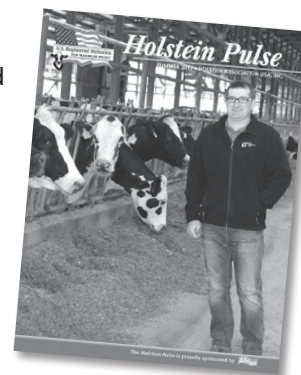
Starting in August 2017, the Body Size Composite will be re-named as the Body Weight Composite, as the new name more accurately describes what the composite is meant to predict. The change is in name only – all traits and their weightings remain the same. The BWC formula can be found on page 6.

ECONOMIC WEIGHTINGS IN FEED EFFICIENCY (FE) UPDATED

The Feed Efficiency calculations will be updated with the economic values used in the 2017 Cheese Merit (CM\$) formula. These values will be kept in synch on an ongoing basis moving forward. The FE formula can be found on page 7.

**See the Summer 2017 issue of the *Holstein Pulse*
for more details on these changes.**

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About the Holstein Association USA Total Performance Index® (TPI)

TPI® is the gold standard in ranking world-wide Holstein genetics, serving as a rudder for the genetic direction of the breed. TPI® represents HAUSA's vision for feeding the world through the improvement of the domestic and international Holstein population, encompassing animals identified in the Herdbook as well as commercial Holsteins. TPI® is not necessarily aimed at breeding individual cows, but rather to advance the entire genetic pool. HAUSA recognizes and encourages diversity in breeding philosophies to ensure the continual improvement of the Holstein breed.

The formula is evaluated periodically by Holstein Association USA's Genetic Advancement Committee to ensure it continues to meet the goals of Holstein breeders nationwide.

$$\left[\frac{21(\text{PTAP})}{19} + \frac{17(\text{PTAF})}{22.5} + \frac{8(\text{FE})}{44} + \frac{8(\text{PTAT})}{.73} - \frac{1(\text{DF})}{1.0} + \frac{11(\text{UDC})}{.8} + \frac{6(\text{FLC})}{.85} + \frac{4(\text{PL})}{1.51} + \frac{3(\text{LIV})}{1.27} - \frac{5(\text{SCS})}{.12} + \frac{13(\text{FI})}{1.25} - \frac{2(\text{DCE})}{1.0} - \frac{1(\text{DSB})}{.9} \right] 3.9 + 2187$$

*The value 2187 adjusts for our periodic base change, allowing TPI® values to be comparable across time.
Formula updated August 2017.*

Where:

PTAP = PTA Protein	PL = PTA Productive Life	PTAT = PTA Type
PTAF = PTA Fat	LIV = PTA Cow Livability	UDC = Udder Composite
FE = Feed Efficiency	FI = Fertility Index	FLC = Feet & Legs Composite
BWC = Body Weight Composite	DF = STA Dairy Form	DCE = PTA Daughter Calving Ease
	SCS = PTA Somatic Cell Score	DSB = PTA Daughter Stillbirth

Weighting of Major Categories

Production	46%	(Fat, Protein, Body Weight Composite, and Feed Efficiency)
Health & Fertility	28%	(SCS, PL, LIV, FI, DCE and DSE)
Conformation	26%	(PTAT, UDC, FLC and Dairy Form)

Use of the TPI Formula will lead to:

- Additional pounds of Fat and Protein, with slightly more gain in Butterfat.
- Body Weight of the next generation of cows should be consistent with the current population.
- Production increase, and body weight staying the same, leading to an improvement in Feed Efficiency for the Breed.
- An added benefit of the better control of the size of our cattle is a lowering of the incidence of difficult births, with a slight improvement in the daughter's ability to deliver a live calf.
- Higher economic returns by lowering the incidence of on-farm deaths and improving the productive period of months-in-milk.
- Conformation of our cattle will continue to improve from genetic improvement of overall conformation (PTAT), udders and feet & legs.
- Dairy farmers using the TPI formula will be breeding a more profitable herd of cattle.

About the Linear Composite Indexes

Holstein Association USA Linear Composite Indexes combine linear trait information on several related traits into one numerical value. Composite indexes can be used as a selection tool in breeding programs to identify those bulls which are predicted to transmit a desirable combination of the traits in the Composite Index. The traits included in each Composite Index are:

Udder Composite Index

Udder Depth
Fore Udder Attachment
Udder Cleft
Rear Udder Height
Rear Udder Width
Front Teat Placement
Rear Teat Placement
Teat Length
Stature

Feet & Legs Composite Index

Foot Angle
Rear Legs - Rear View
Feet & Legs Score
Stature

Body Weight Composite Index

Stature
Body Depth
Strength
Rump Width
Dairy Form

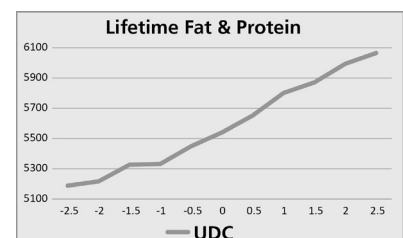
Dairy Capacity Composite Index

Dairy Form
Strength

Udder Composite and Feet & Legs Composite were developed to increase individual lactation averages, productive life, and lifetime production of fat and protein. A negative weight on stature results in the decoupling of the composites from stature, allowing breeders to improve udders and feet & legs without making their cows taller.

Udder Composite Index

Udder Composite describes a well formed capacious udder with strong attachment. Using bulls with a high UDC results in a lowering of the somatic cell score and daughters whose udders are trouble-free and capable of holding more milk.



The UDC formula is as follows:

$$UDC = -0.03 + [(.16 \times FU) + (.23 \times UH) + (.19 \times UW) + (.08 \times UC) + (.20 \times UD) + (.04 \times TP) + (.05 \times RP^*) + (.05 \times TL^*) - (.2 \times ST)] \times 1.16$$

Where RP^* and TL^* have an *intermediate optimum*. There is a penalty for rear teats that are placed too close to one another. The same goes for teat length. Teats that too long or too short are penalized.

The values -0.03 and 1.16 are used to standardize the composite with the 2010 Base Population of cows.

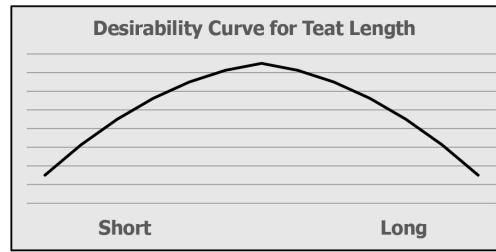
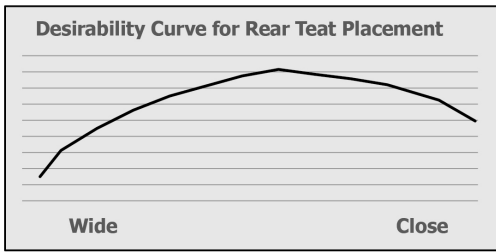
Where:

FU = Fore Udder Attachment	UH = Rear Udder Height	UW = Rear Udder Width
UC = Udder Cleft	UD = Udder Depth	TP = Front Teat Placement
RP* = Rear Teat Placement	TL** = Teat Length	ST = Stature

* If Rear Teat Position is less than or equal to 1, then $RP^* = RP$.
If Rear Teat Position is greater 1, then $RP^* = 1 - (RP \times 0.1)$.

** $TL^* = (-1 \times ABS(TL)) - (ABS(TL) \times ABS(TL) \times 0.1)$
where $ABS(TL)$ is the absolute value of Teat Length

The desirability curves for Rear Teat Placement and Teat Length are shown below:



Feet & Legs Composite Index

The Feet & Legs Composite formula utilizes a combination of the major category Feet & Legs Score along with three linear traits. The FLC formula is as follows:

Feet & Legs Quartile	Productive Life	Feed Efficiency \$
Top 25%	1.13	27
Bottom 25%	-0.64	19

$$FLC = +0.02 + [(.09 \times FA) + (.21 \times RV) + (.70 \times FLS) - (.20 \times ST)] \times 1.09$$

The values +0.02 and 1.09 are used to standardize the composite with the 2010 Base Population of cows.

Where:

FA = Foot Angle RV = Rear Legs Rear View FLS = Feet & Legs Score ST = Stature

Feet and legs are a primary concern for dairy producers worldwide. Selecting animals that transmit superior mobility, steeper foot angle, wider rear leg stance with little or no hock-in and slightly straight rear legs (side view) will result in animals capable of longer productive lives. The Feet and Legs Composite was designed to maximize within-herd lifetime production of combined Fat and Protein.

Body Weight Composite Index

The Body Weight Composite includes a measure of both body size, i.e., the dimensions of the cow, and dairy form. By including dairy form, we take into consideration how hard the cow is milking, accounting for an excess or lack of body fat. The BWC formula is as follows:

$$BWC = (.23 \times \text{Stature}) + (.72 \times \text{Strength}) + (.08 \times \text{Body Depth}) + (.17 \times \text{Rump Width}) - (.47 \times \text{Dairy Form})$$

Every 1.0 STA increase in body size correlates with a 40 pound predicted increase in mature body weight. For example, daughters of bulls that sire large cows (large positive evaluations for body size, +3.00) are predicted to weigh 240 pounds more than those that sire small cows (large negative evaluations for body size, -3.00.)

Other Composite Indexes

Feed Efficiency

Feed Efficiency is the net profit a farmer receives from an increase in production. Feed Efficiency is calculated from the following information:

$$(\text{Dollar Value of milk produced}) - (\text{Feed costs of extra milk}) - (\text{Extra maintenance costs})$$

Dollar Value of milk produced is based upon the 2017 Cheese Merit \$ information from USDA-AGIL. Feed costs are the increased cost of feed per lactation that is eaten by higher producing cows. Maintenance costs are associated with body maintenance based upon the National Research Council plus increased housing costs minus income from heavier calf weights. Body weight is predicted from HAUSA classification data. The formula was developed as a part of the USDA multi-state research project on feed efficiency and a cooperative project with researchers at the University of Wageningen in the Netherlands.

$$FE = (-.0187 \times \text{Milk}) + (1.28 \times \text{Fat}) + (1.95 \times \text{Protein}) - (12.4 \times \text{BWC})$$

Fertility Index (FI)

The Fertility Index combines several reproductive components into one overall index: ability to conceive as a maiden heifer, ability to conceive as a lactating cow, and a cow's overall ability to start cycling again, show heat, conceive, and maintain a pregnancy. The Fertility Index is derived from the formula:

$$FI = 18\% \text{ Heifer Conception Rate (HCR)} + 18\% \text{ Cow Conception Rate (CCR)} + 64\% \text{ Daughter Pregnancy Rate (DPR)}$$