ABV scales, adjustments & expression

Genetics Backgrounder # 3 Updated December 2020

HIGHLIGHTS

- DataGene publishes ABVs for 50 different traits and aims to express the traits in a practical format that is easy for farmers to understand.

- The data, models and application of each trait group varies. It is helpful to understand how raw data is transformed into the published ABV, especially for some research activities.

- This document provides a single reference in the data scaling, adjustments and expression.

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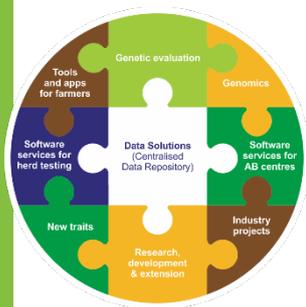
About DataGene

DataGene is an independent and industry-owned organisation responsible for driving genetic gain and herd improvement in the Australian dairy industry. DataGene performs pre-competitive herd improvement functions such as genetic evaluation, herd testing and herd improvement software development and data systems. DataGene is a Dairy Australia and industry collaboration.

Australian Breeding Values (ABVs) are the terms used in Australia to describe the estimated breeding values or genetic merit of dairy bulls and cows. ABVs are the additive genetic value and represent the average additive effects that an individual receives from both parents.

The models employed during genetic evaluations are designed to separate genetics from environmental and management effects using the best available statistical approaches.

This document describes the expression of ABVs and how the outputs from statistical models are treated to calculate a published ABV. For more information about the models themselves, refer to links in the More Information section.

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│       Genetic evaluation engine       │
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│          Solutions scale              │
│        units of measurement           │
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│         Base adjusted scale           │
│  units of measurement, base animals   │
│        have average of 0              │
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┌─────────────────────────────────────┐
│             ABV scale                 │
│  scale and units that are meaningful  │
│            to farmers                 │
│ (also known as the relative scale or  │
│         published scale)              │
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ABV scales

ABVs are computed for each animal for every trait. There are three different scales that Australian Breeding Values (ABVs) may be stored, or used in:

1. Solutions scale

2. Base adjusted scale

3. ABV scale.

1. Solutions scale

The statistical engines of the genetic evaluation system (Solver & Random Regression) generate data in a solutions scale. This scale is generally in the units in which the traits are measured with statistical normalization in some cases. This scale is used in the statistical processes and when blending data from Interbull. For example, Temperament is scored on a 1 to 5 scale (1= placid, 5=aggressive). Note that the original values are integers (whole numbers); the ABVs are real numbers on a similar scale but ranging either side of zero.

2. Base adjusted scale

Indices and ABVs are relative measures, meaning they make more sense when compared to each other or compared to an average. The average, also known as the 'base' is a clearly defined group of animals to which all others are compared.

In Australia the average is defined for a group of cows or bulls of the same breed born over a recent 5-year period. It is updated periodically so it reflects the cows that are milking in today's herds. Base animals are currently a fixed set of animals defined as daughters of NASIS bulls with at least one record for the trait and born in 2009 through 2013 for yield and conformation traits, and NASIS bulls born 2002 through 2006 with Publishable ABVs for the trait group. This group was created in August 2015. From November 2020 crossbred animals are excluded from the base group.

The base adjusted scale is calculated by subtracting the average of the base animals' solutions from all solutions, so that base animals have an average of 0.

3. ABV scale

The ABV scale is based on an expression of each trait which is meaningful to farmers. This is the scale published on DataVat, Good Bulls Guide/App, breed organisation websites and bull company catalogues.
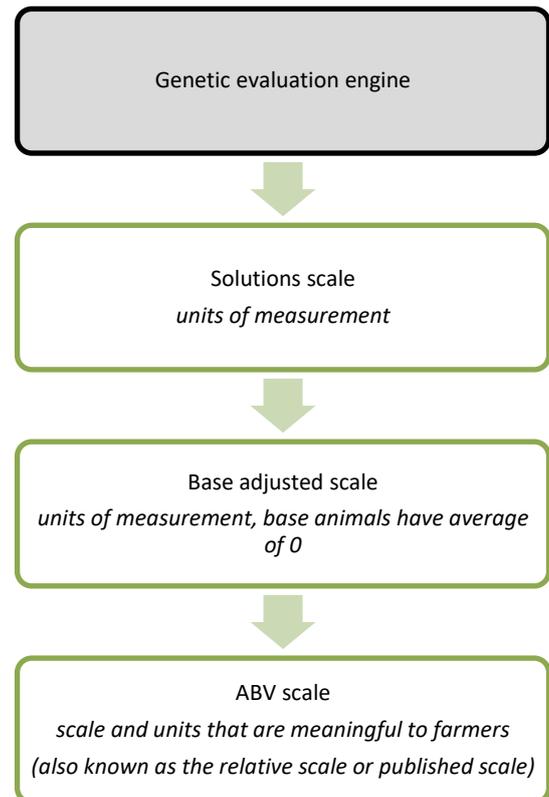
There are three types of ABV scale, depending on the type of trait:

a. Units of measure (e.g. production traits)

b. Average of 100 with a % deviation of phenotypic mean (e.g. fertility)

c. Average of 100 with a fixed 5 point standard deviation (e.g. conformation traits)

Units of measure

ABVs that are expressed in units of measurement have a base adjusted scale, i.e. 0 represents breed average for base group and the trait has not undergone transformation to another scale. This applies to yield (kg or litre), feed saved (kg) and gestation length (days).

% deviation of phenotypic mean

For some traits, base-adjusted solutions are adjusted and expressed as % deviation of the phenotypic mean. This applies to all other traits except conformation. For example, Daughter Fertility ABV is expressed as percent more/less of the phenotypic mean. A Holstein bull with an ABV of 105 is 5% higher than the phenotypic mean of 55.7% non-return rate.

Average of 100

For conformation traits, base adjusted solutions are transformed to have an average of 100 and a standard deviation of 5 for NASIS bulls born in the past 15 years.

Appendix 1 lists the published expression, breed average, unit of measure and breeding direction for each trait.

Adjusting from base to ABV scale

There are two steps to transform the base adjusted scale to an ABV relative scale:

Step 1   Adjustment from base-adjusted solutions to ABV

Step 2   Calculation of the published ABV

Step 1 Adjustment from base-adjusted solutions to ABV

The published ABV is an Estimated Breeding Value (EBV) expressed on the scale that is agreed to for publication. To calculate the ABV from the base adjusted solutions, a further step is required because the base-adjusted solutions aren't meaningful to the end user. The adjustment is a linear (or, for some traits, quadratic) transformation, applied with one simple formula using constants that depend on the breed and trait of the ABV.

The adjustment formula is:

$$adjustedBV = FL * SBV + FQ * SBV^2$$

where

SBV   = Base adjusted Solution Scale Breeding Value

FL   = linear factor

FQ   = quadratic factor (0 for all traits except workability)

There is a special adjustment formula for Calving Ease:

$$adjustedBV = 100 - FL * SBV$$

Appendix 2 contains the values used for FL, FQ and Phenotypic Means.

Step 2 Calculation of the published ABV

The published ABV is produced on a relative scale but the treatment varies between trait group.

Health and Management Traits

For Milking Speed, Temperament, Likeability, Daughter Fertility, Somatic Cell Count, Survival, Calving Ease, Liveweight, Heat Tolerance, the general formula is

$$ABVScaleBV = 100 * (adjustedBV * directionMultiplier + phenotypicMean) / phenotypicMean$$

These ABVs are expressed as a percentage of the phenotypic mean of the trait.

A direction multiplier is applied to ensure animals with desirable characteristics get the highest ABVs. The direction Multiplier is normally 1. However, it is -1 for Somatic Cell Count and Mastitis to convert a lower score (lower SCC or lower mastitis incidence) to a higher ABV. The direction Multiplier is included with the linear factor and quadratic factor in Appendix 2.

Production traits, Feed Saved and Gestation Length

There is no transformation to another scale for Milk, Fat, Fat %, Protein, Protein %, Feed Saved, Gestation Length.

$$ABVScaleBV = adjustedBV$$

Conformation Traits

For conformation traits and composite conformation traits, the general formula is

$$ABVScaleBV = 100 + 5 * (adjustedBV - mean\{calculated\})/(standard\ dev\{calculated\})$$

where:

$$mean\{calculated\} = mean\ adjustedBV\ for\ the\ defined\ animals\ for\ the\ breed$$

Liveweight and Residual Survival Traits

As liveweight and residual survival are indices that are calculated from ABVs, there is no transformation required.

More information

For a detailed description of each trait, it's model, breed trait combination, reliability calculation, phenotypes, click the links below:

Interbull production   Interbull conformation

Interbull udder health   Interbull longevity

Interbull calving   Interbull female fertility

Interbull workability

Visit the DataGene website for

- Technotes related to most traits

- Type ABVs explained for a detailed summary of type traits

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Appendix 1: Published ABV expression

Trait or Index	Definition	Bull selection guide for relevant traits*	Expression unit
Balanced Performance Index BPI	The Balanced Performance Index is an economic index that blends production, type and health traits for maximum profit. It reflects most farmers' preferences.	Choose bulls from the Good Bulls Guide.	Breed average = 0 $ profit
Health Weighted Index HWI	The Health Weighted Index allows farmers to fast track traits such as fertility, mastitis resistance and feed efficiency.	Choose bulls from the Good Bulls Guide.	Breed average = 0 Units
Australian Selection Index ASI	The Australian Selection Index (ASI) is a production-based index that ranks bulls on their ability to produce daughters with the most profitable combination of protein, fat and milk production. Traits are weighted according to the way Australian dairy farmers are paid for their milk (fat + protein - volume).		Breed average = 0 $ profit from production
Milk ABV	The Milk ABV estimates an animal's ability to produce litres of milk.		Breed average = 0 Litres milk
Protein ABV	The Protein kg ABV is an estimate of an animal's ability to produce kg of protein in milk.		Breed average = 0 Kilograms protein
Protein % ABV	The Protein % ABV is an estimate of an animal's ability to produce milk with a higher or lower percentage of protein.		Breed average = 0 % protein
Fat ABV	The Fat kg ABV estimates an animal's ability to produce kg of fat in the milk.		Breed average = 0 Kilograms fat
Fat % ABV	The Fat % ABV estimates an animal's ability to produce milk with a higher or lower % of fat.		Breed average = 0 % fat
Feed Saved ABV	The Feed Saved ABV is expressed in kilograms of dry matter of feed saved per cow per year more or less than the average of zero. A positive number represents feed saved; a negative number represents extra feed consumed. In Holstein it combines liveweight and RFI ABVs, in other breeds it is based on the liveweight ABV only.	To improve feed efficiency in your herd, select Good Bulls with a Feed Saved ABV greater than zero.	Breed average = 0 Kilograms Feed Saved
Milking Speed ABV	The Milking Speed ABV estimates the percentage of daughters rated satisfactory or better for milking speed.	To improve, select Good Bulls with Milking Speed ABV, of more than 100.	Breed average = 100 % faster/slower milking speed
Temperament ABV	The Temperament ABV estimates the percentage of daughters rated satisfactory or better for temperament.	To improve, select Good Bulls with Temperament ABV of more than 100.	Breed average =100 % better/worse temperament
Likeability ABV	The Likeability ABV estimates the percentage of daughters rated satisfactory or better for likeability. I.e. farmers want more cows like this group of daughters.	To improve, select Good Bulls with Likeability ABVs of more than 100.	Breed average =100 % more/less likeability
Somatic Cell Count SCC or Cell Count ABV	An estimate of an animal's genetic merit for individual cow cell count.	To improve cell count in your herd, select Good Bulls with a Cell Count ABV of more than 100. Higher ABV indicates cows with lower somatic cell count	Breed average = 100 % higher/lower
Mastitis Resistance ABV	An estimate of an animal's genetic merit for resisting mastitis infections.	To breed for improved mastitis resistance, look for Good Bulls	Breed average = 100 % higher/lower

Trait or Index	Definition	Bull selection guide for relevant traits*	Expression unit
		with an ABV of greater than 100.	Higher ABV indicates cows with less mastitis
Survival ABV	The Survival ABV reflects a bull's ability to produce daughters that last in the herd for many lactations.	To improve longevity in your herd, select Good Bulls with a Survival ABV of more than 100.	Breed average = 100
Residual Survival ABV	The difference between an animal's survival and its survival expected from other traits.	No longer in use	Breed average = 100
Calving Ease ABV	An indicator of how easily a bull's progeny will be born.	To breed for improved calving ease, look for Good Bulls with an ABV of less than 100.	Breed average = 100 Expressed as % of normal or easier calvings in mature cows
Gestation Length ABV	Identifies cows that have a shorter gestation length, or bulls whose daughters have a shorter gestation length.	To breed for shorter gestation length, look for Good Bulls with an ABV of less than zero.	Breed average = 0 Every 1 ABV is ~1 day more or less gestation
Daughter Fertility ABV	The Daughter Fertility ABV reflects the percentage of a bull's daughters pregnant by six weeks after the mating start date compared to the average. For year round calving herds, this is equivalent to the percentage of their daughters pregnant by 100 days after calving.	To improve fertility in your herd, select Good Bulls with a Daughter Fertility ABV of more than 105.	Breed average = 100 % higher/lower Higher ABV indicates cows with higher 6-week in-calf rate
Liveweight ABV	An estimate of an animal's genetic merit for liveweight.	To increase liveweight, select Good Bulls with a liveweight greater than 100.	Breed average = 100 % higher/lower Higher ABV indicates cows with heavier liveweight
Heat Tolerance ABV	The Heat Tolerance ABV allows you to identify animals with greater ability to tolerate hot, humid conditions with less impact on milk production.	To improve heat tolerance in your herd, select Good Bulls with a Heat Tolerance ABV of greater than 100. Allow for the lower reliability by using a team of bulls.	Breed average = 100 % higher/lower Higher ABV indicates cows with smaller decline in production in response to hot or humid conditions.
Composite Overall Type ABV	The Overall Type ABV is a reflection of a cow's overall classification score which is based on linear traits as assessed by breed associations.	To improve overall type in your herd choose Good Bulls with an Overall Type ABV of greater than 100.	Breed average = 100 Units ABV
Composite Mammary System ABV	An estimate of an animal's genetic merit for the combination of the following type traits: udder texture, fore udder attachment, rear udder attachment height and width, centre ligament and teat placement.	To improve mammary system choose Good Bulls with a Mammary System ABV of greater than 100	Breed average = 100 Units ABV
Feet & Legs ABV	An estimate of an animal's genetic merit for the combination of the following type traits: foot angle, heel depth, rear set, bone quality and rear leg view.	To breed for improved feet and legs, look for Good Bulls with an ABV of greater than 100.	Breed average = 100 Units ABV
Rump ABV	An estimate of an animal's genetic merit for the combination of the following type traits: pin set, pin width and loin strength.	To breed for improved rump, look for Good Bulls with an ABV of greater than 100.	Breed average = 100 Units ABV
Dairy Strength ABV	An estimate of an animal's genetic merit for the combination of the following type traits: stature, udder	To breed for improved dairy strength, look for Good Bulls	Breed average = 100 Units ABV

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Trait or Index	Definition	Bull selection guide for relevant traits*	Expression unit
	texture, muzzle width, chest width, angularity and loin strength.	with an ABV of greater than 100.	
Linear Stature ABV	An estimate of an animal's genetic merit for stature.	To breed for taller cows, select Good Bulls with a Stature ABV of more than 100 To breed for shorter cows, select Good Bulls with a Stature ABV of less than 100	Breed average = 100 Units ABV
Linear Udder Texture ABV	An estimate of an animal's genetic merit for udder texture.		Breed average = 100 Units ABV
Linear Bone Quality ABV	An estimate of an animal's genetic merit for bone quality.	To breed for flatter bone, select Good Bulls with an ABV of greater than 100 To breed for coarser bone, select Good Bulls with an ABV of less than 100	Breed average = 100 Units ABV
Linear Angularity ABV	An estimate of an animal's genetic merit for angularity.		Breed average = 100 Units ABV
Linear Muzzle Width ABV	An estimate of an animal's genetic merit for muzzle width.		Breed average = 100 Units ABV
Linear Body Depth ABV	An estimate of an animal's genetic merit for body depth.	To breed for deeper bodies at the rear rib, select Good Bulls with an ABV of greater than 100	Breed average = 100 Units ABV
Linear Loin Strength ABV	An estimate of an animal's genetic merit for loin strength.	To breed for improved Loin Strength select Good Bulls with and ABV of more than 100	Breed average = 100 Units ABV
Linear Chest Width ABV	An estimate of an animal's genetic merit for chest width.	To breed for broader chest width, select Good Bulls with an ABV of greater than 100	Breed average = 100 Units ABV
Linear Pin Width ABV	An estimate of an animal's genetic merit for pin width.		Breed average = 100 Units ABV
Linear Pin Set ABV	An estimate of an animal's genetic merit for pin set/rump angle.	To raise pins, select Good Bulls with a Pin Set ABV of less than 100. To lower pins, choose Good Bulls with a Pin Set ABV of more than 100.	Breed average = 100 Units ABV
Linear Foot Angle ABV	An estimate of an animal's genetic merit for foot angle.	To breed for steeper foot angle, select Good Bulls with an ABV of more than 100.	Breed average = 100 Units ABV
Linear Heel Depth ABV	An estimate of an animal's genetic merit for heel depth.		
Linear Rear Set of Leg ABV	An estimate of an animal's genetic merit for rear leg side view.	To breed for more curved legs when viewed from the side, select Good Bulls with an ABV of greater than 100 To breed for straighter legs, select Good Bulls with an ABV of less than 100.	Breed average = 100 Units ABV

Trait or Index	Definition	Bull selection guide for relevant traits*	Expression unit
Linear Rear leg Rear View ABV	An estimate of an animal's genetic merit for rear leg rear view.	To breed for straighter legs, select Good Bulls with an ABV of more than 100.	Breed average = 100 Units ABV
Linear Udder Depth ABV	An estimate of an animal's genetic merit for udder depth.	For shallower udders, select Good Bulls with an ABV for Udder Depth of greater than 100.	Breed average = 100 Units ABV
Linear Fore attachment ABV	An estimate of an animal's genetic merit for fore udder attachment.		Breed average = 100 Units ABV
Linear Rear attachment height ABV	An estimate of an animal's genetic merit for rear udder attachment – height.		Breed average = 100 Units ABV
Rear Attachment Width ABV	An estimate of an animal's genetic merit for rear udder attachment – height.		Breed average = 100 Units ABV
Linear Centre ligament ABV	An estimate of an animal's genetic merit for centre ligament.		Breed average = 100 Units ABV
Linear Teat placement fore ABV	An estimate of an animal's genetic merit for front teat placement.	Select Good Bulls with an ABV of greater than 100	Breed average = 100 Units ABV
Linear Teat placement rear ABV	An estimate of an animal's genetic merit for rear teat placement.	To widen rear teat placement, select Good Bulls with a Teat Placement (Rear) of less than 100	Breed average = 100 Units ABV
Linear Teat length ABV	An estimate of an animal's genetic merit for teat length.	To shorten teats, select Good Bulls with a Teat Length ABV of less than 100. To lengthen teats, choose Good Bulls with a Teat Length ABV of more than 100.	Breed average = 100 Units ABV

*For some traits, DataGene does not publish a selection guide

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Appendix 2: Sample parameters

Phenotypic Means, Linear Factor and Quadratic Factor for Holstein and Jersey breeds, extracted March 2020.

	Phenotypic Mean	Holstein		Jersey	
Trait		Linear Factor (FL)	Quadratic Factor (FQ)	Linear Factor (FL)	Quadratic Factor (FQ)
Milking speed	90.8	-11.835	-4.9275	-11.52	-4.0851
Likability	91.1	-12.366	-4.2354	-10.288	-3.0242
Temperament	90.3	-11.907	-5.3096	-11.465	-2.7807
Calving ease	94.4	59.9	0	59.9	0
Fertility	55.7	-0.32	0	-0.32	0
Survival Direct	84	70.5	0	81.6	0
Overall type	9.7	0.8832	0	0.6485	0
Mammary System	9.7	0.7807	0	0.708	0
Stature	5.9	0.4079	0	0.6442	0
Udder Texture	5.7	0.839	0	1.211	0
Bone Quality	6.4	0.6753	0	1.3762	0
Angularity	6	0.8116	0	0.9117	0
Muzzle Width	5.8	0.7602	0	1.4006	0
Body Length	n/a	n/a	n/a	1.1384	0
Body Depth	5.9	0.5641	0	0.7925	0
Chest Width	5.9	0.6267	0	1.0109	0
Rump Length	n/a	n/a	n/a	1.5468	0
Pin Width	5.8	0.5484	0	0.9513	0
Pin Set	5.2	0.4604	0	0.7711	0
Foot Angle	4.9	0.7299	0	1.1813	0
Rear Set of Leg	5.6	0.9727	0	1.8235	0
Rear Leg Rear View	5.6	0.8547	0	1.7517	0
Udder Depth	5.2	0.3563	0	0.6678	0
Fore Attachment	5.7	0.6295	0	0.7413	0
Rear Attachment Height	5.7	0.5913	0	0.7431	0
Rear Attachment Width	5.7	0.6401	0	0.861	0
Centre Ligament	5.7	0.7281	0	0.6928	0
Fore Teat Placement	5.7	0.4586	0	0.684	0
Teat Length	4.8	0.379	0	0.8538	0
Loin Strength	5.9	0.7878	0	1.0873	0
Rear Teat Placement	5.7	0.588	0	0.8527	0
RFI heifer		100	0	n/a	n/a
RFI cow		100	0	n/a	n/a
Mastitis Resistance	0.16	-0.05	0	-0.05	0
Somatic Cell Count	100	-1	0	-1	0

Appendix 3: Heritability estimates

Heritability estimates, June 2019

Trait	Heritability
Milk Volume	0.44
Fat	0.48
Protein	0.39
Milking speed	0.25
Likability	0.16
Temperament	0.2
Calving ease	0.05
Fertility	0.03
Survival Direct	0.025
Somatic Cell Count	0.11
Overall type	0.3
Mammary System	0.3
Stature	0.45
Udder Texture	0.17
Bone Quality	0.2
Angularity	0.24
Muzzle Width	0.24
Body Depth	0.24
Chest Width	0.24
Pin Width	0.24
Pin Set	0.24
Foot Angle	0.21
Rear Set of Leg	0.17
Rear Leg Rear View	0.25
Udder Depth	0.24
Fore Attachment	0.24
Rear Attachment Height	0.27
Rear Attachment Width	0.24
Centre Ligament	0.27
Fore Teat Placement	0.33
Teat Length	0.24
Loin Strength	0.17
Body condition score	0.24
Rear Teat Placement	0.3
RFI heifer	0.351
RFI cow	0.228

Appendix 4: Correlation estimates

(Holstein bulls born 2011-2015 recorded in NASIS with Daughter Fertility ABV Reliability >60)

	PROT	FAT	MILK	SURV	FERT	SCC	MAS	MSPEED	TEMP	MAMM	UDDEP	OTYPE	PINSET	FOREA	LWT	FEEDEF	PROTP	FATP	OFEET_LEGS	LIKE	EASE	RUMP	DAIRY_S	HEAT_T	GEST_L
PROT	1.00	0.30	0.67	0.04	-0.16	-0.03	-0.13	-0.02	0.16	0.00	-0.19	-0.01	-0.04	-0.23	0.10	-0.21	0.18	-0.35	-0.08	0.22	0.09	-0.06	0.12	-0.53	-0.22
FAT	0.30	1.00	0.05	0.11	-0.12	0.08	-0.03	0.12	0.18	0.11	-0.05	0.08	-0.09	-0.05	0.10	-0.23	0.26	0.59	0.08	0.30	0.09	-0.04	0.12	-0.32	-0.14
MILK	0.67	0.05	1.00	0.26	-0.13	0.15	-0.05	0.00	0.18	0.22	0.06	0.17	-0.05	0.01	0.13	-0.22	-0.61	-0.78	0.09	0.33	0.04	-0.01	-0.04	-0.10	-0.20
SURV	0.04	0.11	0.26	1.00	0.52	0.67	0.33	0.13	0.29	0.41	0.73	0.33	-0.04	0.47	-0.08	-0.05	-0.30	-0.14	0.21	0.50	0.30	-0.08	-0.50	0.22	-0.28
FERT	-0.16	-0.12	-0.13	0.52	1.00	0.43	0.29	-0.04	-0.10	-0.10	0.41	-0.19	-0.08	0.08	-0.35	0.19	0.00	0.03	-0.07	-0.09	0.40	-0.24	-0.57	0.28	-0.20
SCC	-0.03	0.08	0.15	0.67	0.43	1.00	0.68	-0.15	0.11	0.23	0.55	0.18	-0.14	0.28	-0.08	-0.01	-0.22	-0.07	0.17	0.22	0.24	-0.12	-0.43	0.24	-0.20
MAS	-0.13	-0.03	-0.05	0.33	0.29	0.68	1.00	-0.21	0.00	0.03	0.29	0.03	-0.07	0.12	-0.10	0.10	-0.07	0.03	0.01	-0.01	0.13	-0.06	-0.26	0.17	-0.07
MSPEED	-0.02	0.12	0.00	0.13	-0.04	-0.15	-0.21	1.00	0.22	0.21	0.21	0.13	-0.09	0.20	0.04	-0.08	-0.03	0.07	0.02	0.35	-0.03	-0.06	-0.07	-0.09	0.08
TEMP	0.16	0.18	0.18	0.29	-0.10	0.11	0.00	0.22	1.00	0.20	0.07	0.22	0.00	0.18	0.14	-0.16	-0.06	-0.03	0.01	0.71	0.00	0.18	0.11	-0.10	-0.18
MAMM	0.00	0.11	0.22	0.41	-0.10	0.23	0.03	0.21	0.20	1.00	0.50	0.74	-0.15	0.69	0.26	-0.23	-0.28	-0.11	0.31	0.48	-0.02	0.02	-0.01	0.10	-0.05
UDDEP	-0.19	-0.05	0.06	0.73	0.41	0.55	0.29	0.21	0.07	0.50	1.00	0.38	-0.22	0.66	0.03	-0.06	-0.28	-0.08	0.31	0.30	0.17	-0.26	-0.58	0.28	-0.09
OTYPE	-0.01	0.08	0.17	0.33	-0.19	0.18	0.03	0.13	0.22	0.74	0.38	1.00	0.02	0.66	0.51	-0.37	-0.24	-0.09	0.44	0.40	-0.13	0.27	0.27	0.08	0.02
PINSET	-0.04	-0.09	-0.05	-0.04	-0.08	-0.14	-0.07	-0.09	0.00	-0.15	-0.22	0.02	1.00	-0.19	0.06	0.02	0.02	-0.02	-0.07	-0.10	-0.07	0.69	0.12	-0.03	0.08
FOREA	-0.23	-0.05	0.01	0.47	0.08	0.28	0.12	0.20	0.18	0.69	0.66	0.66	-0.19	1.00	0.15	-0.05	-0.25	-0.03	0.37	0.39	0.00	-0.05	-0.11	0.26	0.00
LWT	0.10	0.10	0.13	-0.08	-0.35	-0.08	-0.10	0.04	0.14	0.26	0.03	0.51	0.06	0.15	1.00	-0.77	-0.07	-0.04	0.25	0.22	-0.27	0.26	0.48	-0.09	0.09
FEEDEF	-0.21	-0.23	-0.22	-0.05	0.19	-0.01	0.10	-0.08	-0.16	-0.23	-0.06	-0.37	0.02	-0.05	-0.77	1.00	0.06	0.03	-0.12	-0.27	0.12	-0.12	-0.34	0.14	0.09
PROTP	0.18	0.26	-0.61	-0.30	0.00	-0.22	-0.07	-0.03	-0.06	-0.28	-0.28	-0.24	0.02	-0.25	-0.07	0.06	1.00	0.66	-0.21	-0.20	0.04	-0.06	0.19	-0.42	0.03
FATP	-0.35	0.59	-0.78	-0.14	0.03	-0.07	0.03	0.07	-0.03	-0.11	-0.08	-0.09	-0.02	-0.03	-0.04	0.03	0.66	1.00	-0.03	-0.08	0.02	-0.02	0.11	-0.12	0.07
OFEET_LEGS	-0.08	0.08	0.09	0.21	-0.07	0.17	0.01	0.02	0.01	0.31	0.31	0.44	-0.07	0.37	0.25	-0.12	-0.21	-0.03	1.00	0.19	-0.05	-0.07	-0.03	0.12	0.11
LIKE	0.22	0.30	0.33	0.50	-0.09	0.22	-0.01	0.35	0.71	0.48	0.30	0.40	-0.10	0.39	0.22	-0.27	-0.20	-0.08	0.19	1.00	0.05	0.10	0.02	-0.06	-0.22
EASE	0.09	0.09	0.04	0.30	0.40	0.24	0.13	-0.03	0.00	-0.02	0.17	-0.13	-0.07	0.00	-0.27	0.12	0.04	0.02	-0.05	0.05	1.00	-0.18	-0.28	0.02	-0.32
RUMP	-0.06	-0.04	-0.01	-0.08	-0.24	-0.12	-0.06	-0.06	0.18	0.02	-0.26	0.27	0.69	-0.05	0.26	-0.12	-0.06	-0.02	-0.07	0.10	-0.18	1.00	0.37	0.00	0.09
DAIRY_S	0.12	0.12	-0.04	-0.50	-0.57	-0.43	-0.26	-0.07	0.11	-0.01	-0.58	0.27	0.12	-0.11	0.48	-0.34	0.19	0.11	-0.03	0.02	-0.28	0.37	1.00	-0.27	0.10
HEAT_T	-0.53	-0.32	-0.10	0.22	0.28	0.24	0.17	-0.09	-0.10	0.10	0.28	0.08	-0.03	0.26	-0.09	0.14	-0.42	-0.12	0.12	-0.06	0.02	0.00	-0.27	1.00	0.05
GEST_L	-0.22	-0.14	-0.20	-0.28	-0.20	-0.20	-0.07	0.08	-0.18	-0.05	-0.09	0.02	0.08	0.00	0.09	0.09	0.03	0.07	0.11	-0.22	-0.32	0.09	0.10	0.05	1.00