HIGHLIGHTS

- Breeding is one of many of tools dairy farmers can use to reduce greenhouse gas emissions on-farm. Other management practices continue to play an important role.
- The Sustainability Index is a standalone index that allows farmer to fast-track breeding for reduced greenhouse gas emissions intensity. The higher an animal's Sustainability Index, the more efficient it is for emissions intensity.
- To fast-track genetic gain for sustainability, breed replacements from animals that rank highly for Sustainability Index.

Sustainability Index

Technote 29

Reducing dairy farm emissions

Australian dairy farmers use a combination of management practices to reduce greenhouse gas emissions (GHG). These practices include

- Managing herd life and number of replacements bred
- Nutrition and additives
- Pasture management and utilisation
- Fertiliser strategies
- Irrigation and water use strategies
- On-farm energy generation and energy savings
- Animal health
- Waste management.

Click here for more information on Australian dairy environmental programs.

Breeding tool

Within a herd, some cows emit less greenhouse gas per unit of milk produced than others. This variation is captured in the Sustainability Index. Introduced in August 2022 it enables dairy farmers to add breeding to their toolkit for reducing greenhouse gas emissions.

While other management practices will continue to play an important role, overseas research has found that increasing genetic merit is one of the most cost-effective strategies to reduce emissions (Teagasc 2019). Breeding is a relatively low-cost tool with the advantage of the impact being both permanent and compounding.

The Sustainability Index is in line with the Australian dairy industry's Sustainability Goal which is to reduce Emissions Intensity across the whole industry by 30% by 2030, based on 2015/16 levels (calculated as 1.03 kg

CO_2 equivalent/kg Fat and Protein Corrected Milk).

Sustainability Index

The Sustainability Index is a standalone breeding index that allows farmers to fast-track genetic gain for reduced greenhouse gas emissions (GHG) intensity. Refer to the Appendix for an explanation of different greenhouse gas emissions measures and why the Sustainability Index is based on emissions intensity rather than gross emissions.

As with any index, animals with similar Sustainability Index values may have different Australian Breeding Values (ABVs) for individual traits. This creates the opportunity to fine-tune selection, for instance by picking those with the highest fertility ABVs among the highest ranked animals for Sustainability Index animals.

Base and units

The Sustainability Index is a relative ranking of animals expressed as a unit against a base of 0.

The higher the Sustainability Index number, the more efficient the animal for emissions intensity.

The unit of emissions intensity used in the Sustainability Index is kilograms of carbon dioxide equivalent per kilogram of protein equivalent produced (kg CO_2-eq/ kg protein-eq).

Carbon dioxide equivalent is a standard measure of greenhouse gas emissions (see the Appendix).

Protein-equivalent is used as the production unit as protein has the highest economic value under the Australian payment system.

The Sustainability Index is a desired gains index and cannot be directly compared to the Balanced Performance Index (BPI) or Health Weighted Index (HWI).

Index trait weightings

Like the Balanced Performance Index (BPI) and Health Weighted Index (HWI), the Sustainability

Index (SI) combines production, health and fertility, feed saved, type and workability traits.

But the Sustainability Index fast tracks genetic gain for reducing greenhouse gas emissions intensity by placing greater emphasis on the traits that contribute to reducing emissions intensity (production, survival and feed saved).

Trait relative weightings in indices are breed-specific and summarised in Figure 1.

The differences in weightings between breeds is due to the differences in genetic variation within each breed.

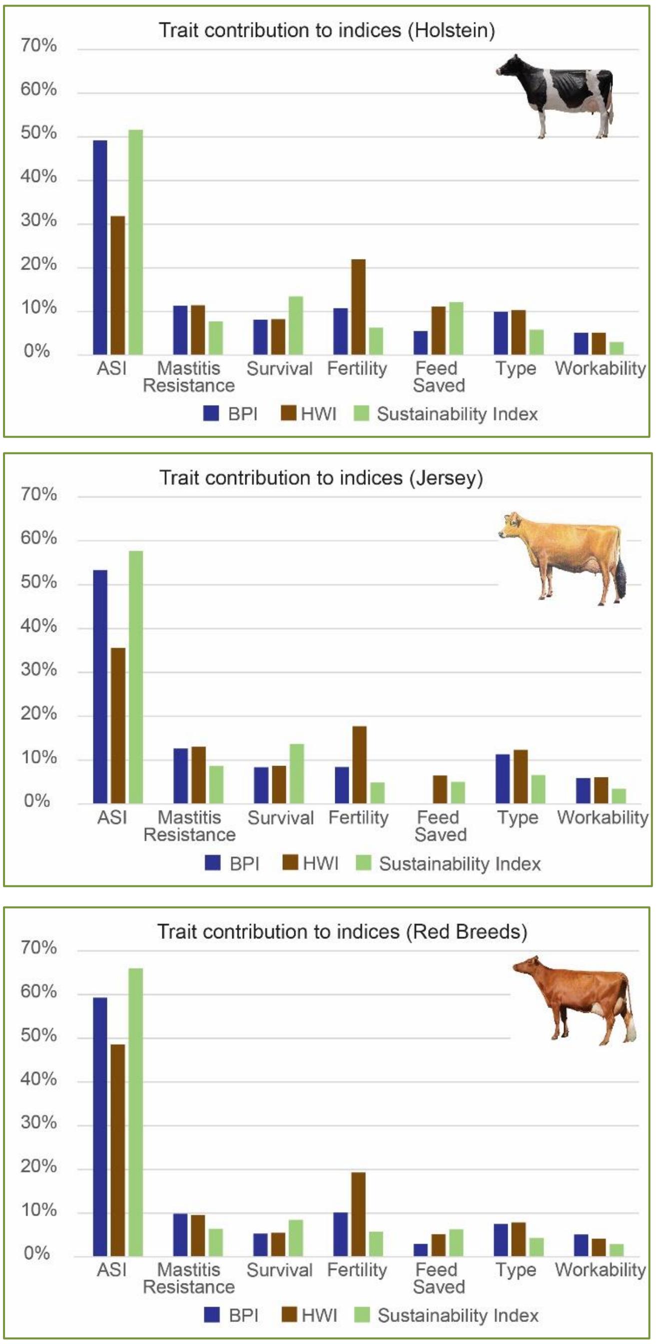

Figure 1. Trait contributions to indices

Expected impact

Table 1 shows the expected reductions in greenhouse gas emission intensity by 2050 and the relative trade-offs in BPI to achieve this.

Table 1. Expected reductions in greenhouse gas emission intensity and relative BPI trade-offs

	Holstein	Jersey	Red Breeds
Reduction in emissions intensity	6.3%	7.3%	4.4%
BPI trade-off	27 units (5.5%)	19 units (4.4%)	5 units (1.9%)

Holsteins

Compared to selecting using the BPI, the Sustainability Index in Holsteins is predicted to facilitate faster gains in reduction in greenhouse gas emissions intensity and production, and slower gains in fertility, mastitis and cell count.

Faster gain than BPI for:

- Reduction in emissions intensity
- Production

Slower gain than BPI for:

- Mastitis resistance
- Cell count
- Fertility

Jerseys

In Jerseys, the Sustainability Index is likely to result in slower gains for mastitis resistance and cell count and fertility and neutral to slightly declining udder depth compared with the BPI.

Faster gain than BPI for:

- Reduction in emissions intensity
- Production

Slower gain than BPI for:

- Mastitis resistance
- Cell count

Slightly declining for:

- Fertility
- Udder depth

However, natural genetic variation in the population means there are many Jersey bulls that have both a high Sustainability Index and Fertility ABV (as indicated by the green dots in Figure 2).

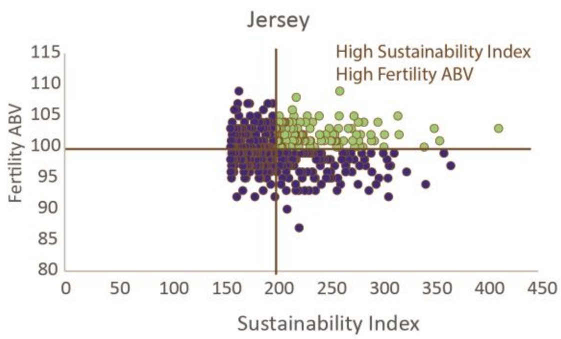

Figure 2. Look for Jersey bulls that are high in both Sustainability Index and Daughter Fertility ABV (green dots).

Similarly, there are many Jersey bulls that have both a high Sustainability Index and a high Udder Depth ABV (as indicated by the green dots in Figure 3).

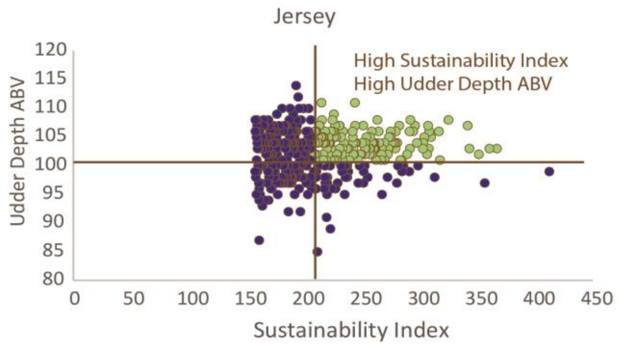

Figure 3. Look for Jersey bulls high in both Sustainability Index and Udder Depth ABV (green dots).

Red Breeds
Compared to selecting using the BPI, The Sustainability Index in Red Breeds is predicted to facilitate faster gains in reduction in greenhouse gas emissions intensity and production, and slower gains in fertility, mastitis and cell count.

Faster gain than BPI for:

- Reduction in emissions intensity
- Production

Slower gain than BPI for:

- Mastitis resistance
- Cell count
- Fertility

Other breeds
The Sustainability Index is available for all dairy breeds in Australia. Because of low numbers it is hard to predict the exact progress that can be made, but it is expected to be similar to the breed information shown above.

Reliability

Reliability is a measure of confidence in an index. The higher the reliability the closer the index is to the animal's "true" genetic merit.

Sustainability Index reliabilities are similar to BPI for each breed. Reliability improves over time as more information about an animal's performance or the performance of its progeny becomes available (see Table 2). A genotype has a major effect on the reliability, especially in young animals with limited data.

Table 2. Reliability (%) of the Sustainability Index

Trait	Reliability
Young genomic bull (no Australian daughters)	**63 (F) 57(J)**
Young heifer	
Without genomics	**29 (F) 33 (J)**
With genomics	**62 (F) 59 (J)**
Cow with >= 3 lactations	**69 (F) 65 (J)**
Bull with 100 Australian daughters	**80 (F) 79 (J)**

Using the Sustainability Index

When breeding replacements, farmers seeking to fast-track genetic gain for greenhouse gas emissions intensity reduction can select animals with a high Sustainability Index that also have high Australian Breeding Values (ABVs) for priority traits, for example fertility, cell count and mastitis resistance. With Jerseys, look for animals with a high Sustainability Index that also have high ABVs for Fertility, Udder Depth, Mastitis Resistance and Cell Count.

Many farmers are likely to create a shortlist of animals based on their BPI and within this shortlist select animals which rank highly on the Sustainability Index and for Fertility, Cell Count and Mastitis Resistance. The Good Bulls App is an easy way to do this.

Dairy breeding is on the right track

Most of the trait changes being driven by the BPI (and to a more modest extent the HWI) are already improving emissions intensity. This is because they are simultaneously improving milk yield and survival, which are both favourably associated with emissions intensity.

More info

Fun video; what is methane? And what part does livestock farming have? University of Wageningen

Australian Dairy Industry Sustainability Framework
Teagasc 2019: An Analysis of Abatement Potential of Greenhouse Gas Emissions in Irish Agriculture 2021-2030.

Acknowledgement

DataGene is an initiative of Dairy Australia and the herd improvement industry. DairyBio provides the research pipeline to develop and maintain Australian Breeding Values.

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Appendix: Measures of GHG emissions

Greenhouse gases

Dairy farms emit different types of greenhouse gases (GHG). The two largest sources of greenhouse gases from dairy farms are methane (CH_4) and nitrous oxide (N_2O).

Methane is generated by microbes in the rumen and belched out by the cows, contributing about 50-60% of total emissions on farm. Nitrous oxide is released from soil when soil microbes convert soil nitrogen into nitrous oxide.

Measuring contribution to global warming

Greenhouse gases differ in their potential contribution to global warming. To enable gases to be compared, the global warming potential of different gases is expressed in a common unit which is equivalents of carbon dioxide: CO_2-equivalent (abbreviated CO_2-eq).

For example, global warming potential for methane is 21 and for nitrous oxide is 310. This means that emissions of 1 tonne of methane is equivalent to emissions of 21 tonnes of carbon dioxide (and 1 tonne of nitrous oxide is equivalent to 310 tonnes of carbon dioxide).

Gross emissions vs emissions intensity

There are two philosophical approaches that can be taken to reducing greenhouse gas emissions associated with livestock production and breeding:

1. reducing *gross* emissions
2. reducing *emissions intensity*.

The Sustainability Index is based on *emissions intensity*.

Reducing *gross emission* as breeding goal

When using a gross emissions approach, the focus is on reducing greenhouse gas output per animal per day. This approach favours animals with high fertility and longer survival but at the same time penalises animals with high milk yield potential.

Reducing emissions intensity as breeding goal

When using an emissions intensity approach, the focus is on reducing greenhouse gas output per unit of productive output. Farming systems with high milk producing, long lasting animals have a low emissions intensity because the superiority in milk yield is only partly offset by the higher methane output associated with the feed required for higher milk production.

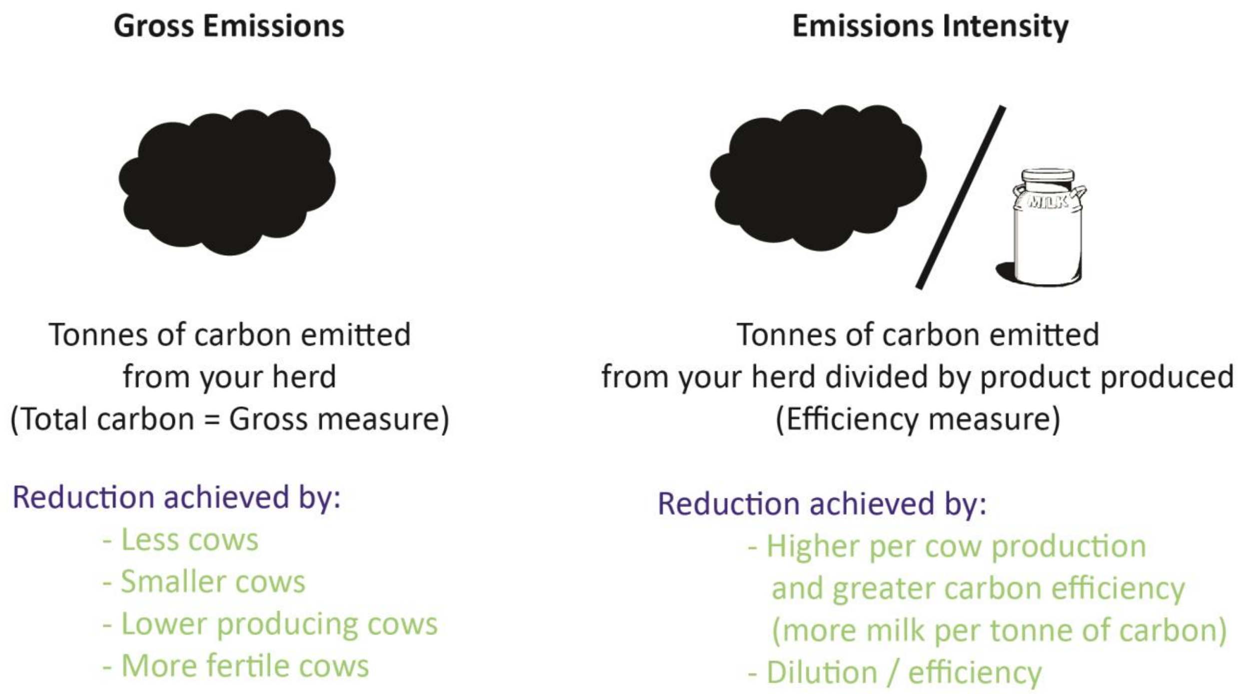

Figure 4. Gross emissions vs Emissions intensity at herd level

Within herd variation

Figure 5 illustrates that some cows in a given herd emit less greenhouse gas per unit of milk produced than others. Genomics and the Sustainability Index allows these animals to be identified.

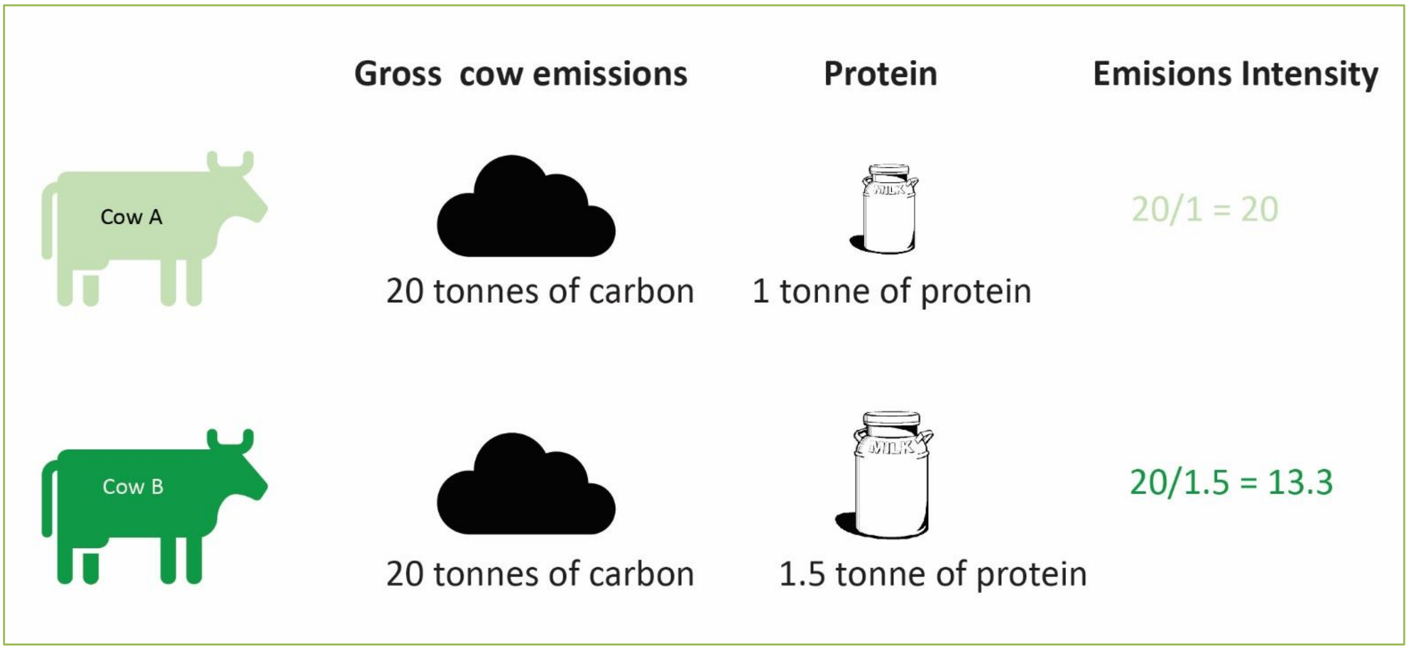

Figure 5. Emissions intensity difference between animals