



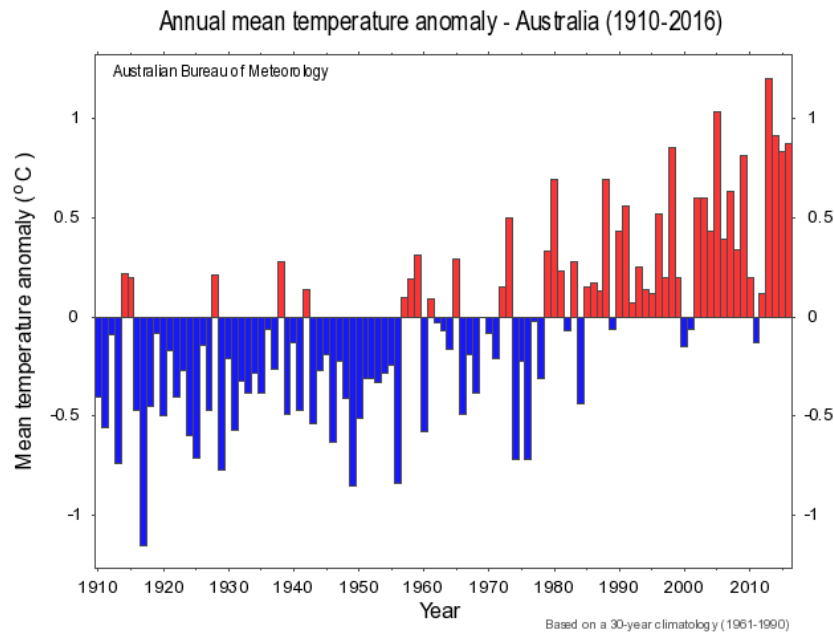
# Breeding for heat tolerance

*Jennie Pryce and Thuy Nguyen*



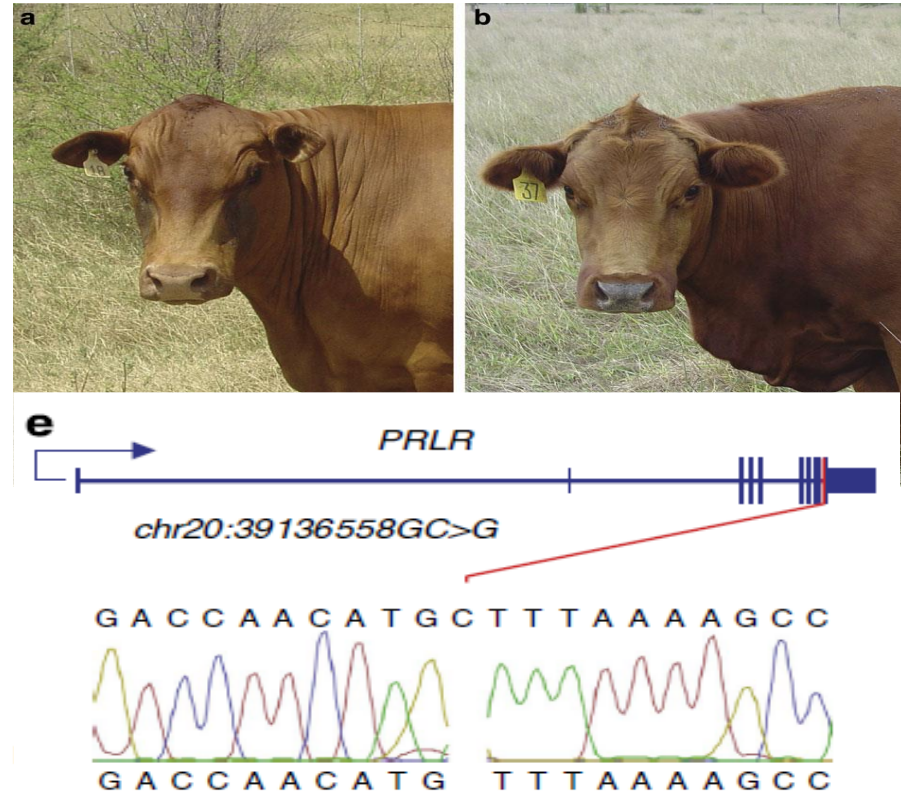
# Heat tolerance

- Heat stress: temperature & humidity above comfort zones
- Leads to:
  - Reduction in feed intake, milk yield, fertility
  - Loss of income
- Major dairying regions in Australia will experience an increase in daily average temperatures
  - And more frequent heat waves and longer duration
- Attempts: Cool Cows, cool diets, genomic selection, gene editing



# Possible measures: Use adapted breeds

- *SLICK* – mutation of large effect
- Senepol cattle – heat tolerant *Bos taurus* with slick coat
- Mutation in prolactin receptor
  - Littlejohn et al. 2014, Nat Comms, 5:5861
- Introgressed into Holsteins – less drop in milk production in summer
  - Dikmen et al. J Dairy Sci. 2014 97:5508.
- Gene editing target



# Genomic selection for heat tolerance

- Exploit within breed variation
- Genome wide DNA markers







**Development**



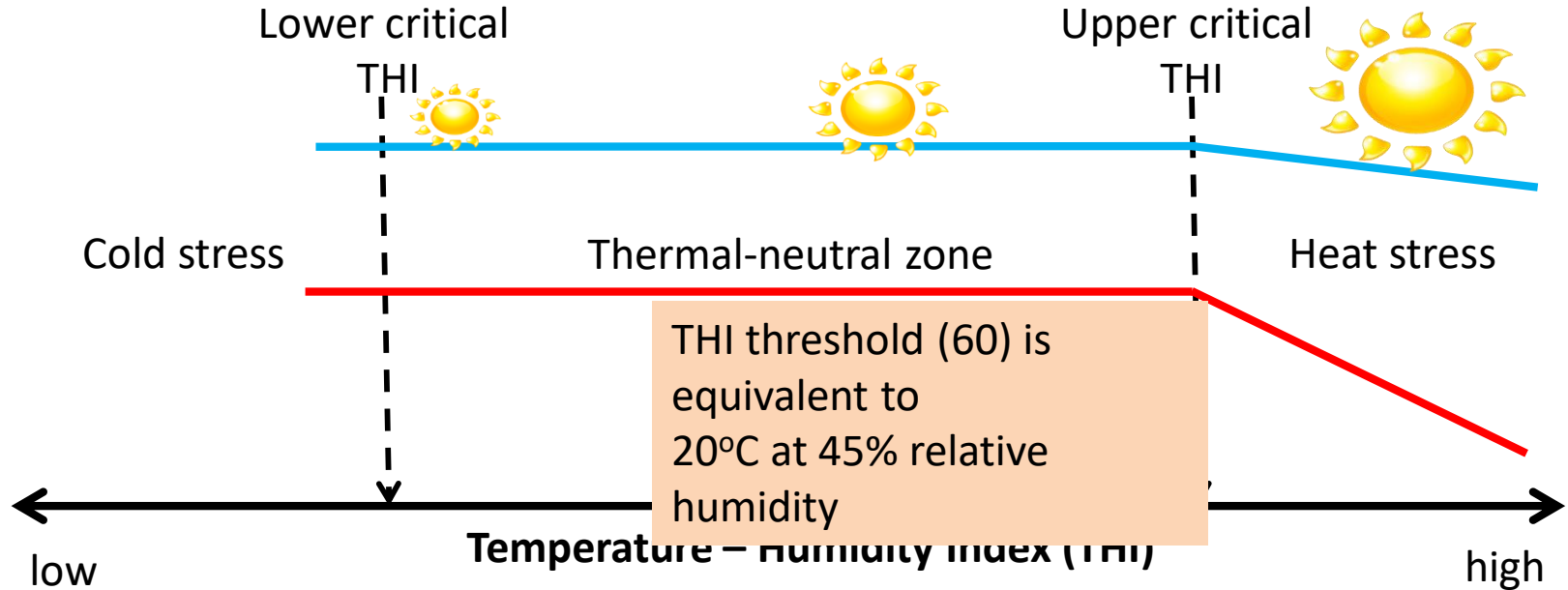
**Validation**



**Implementation**

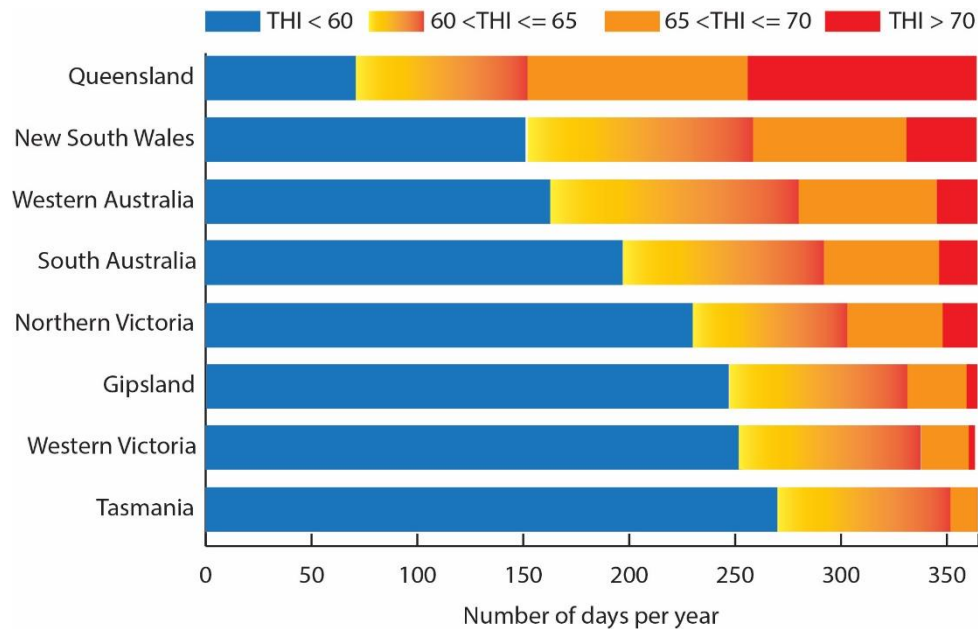
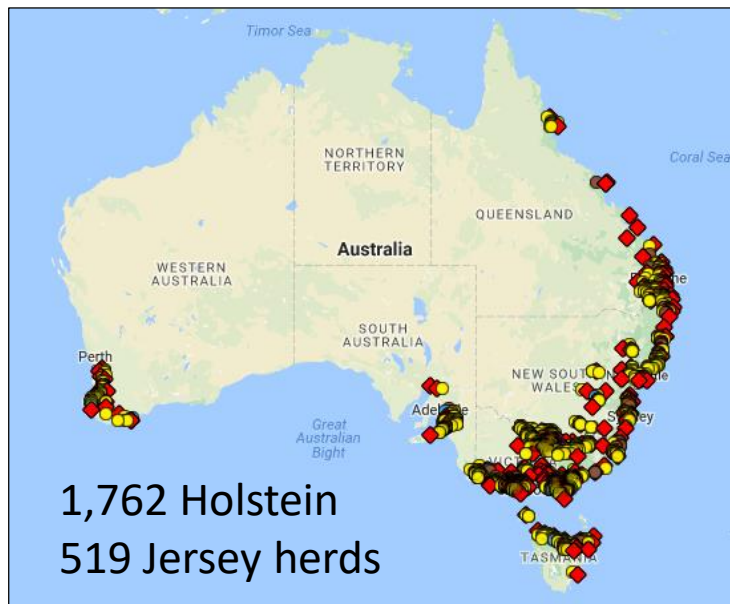
What trait to  
measure?

# Dairy cattle and ambient heat load

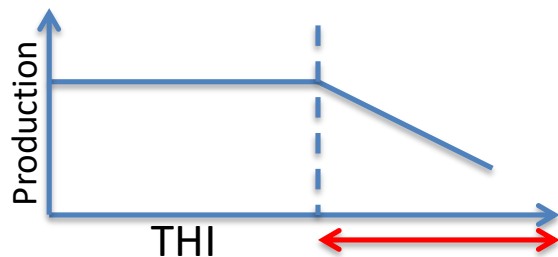


*Adapted from NRC (1981)*





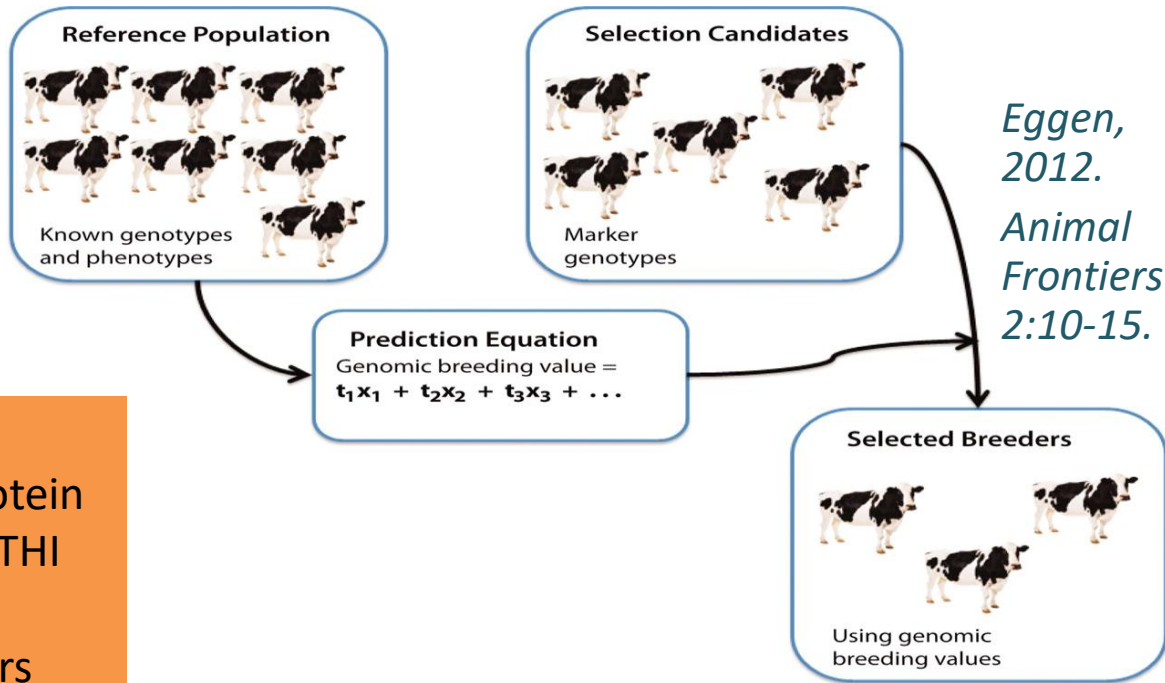
# Genomic Selection



Estimated cow slopes

Decline in milk, fat and protein yields per unit increase in THI

Sire slope = average of daughters

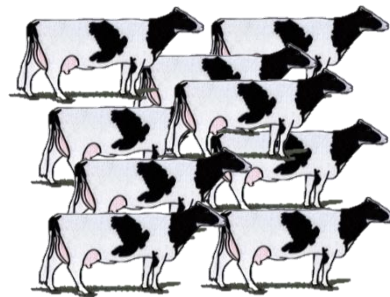




May 2017

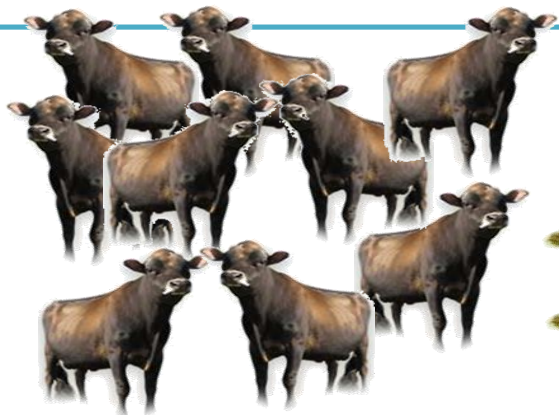


4628 bulls with  
Australian daughters

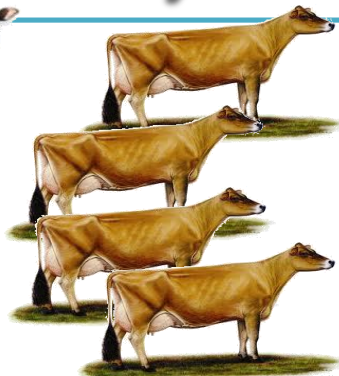


10254 cows

**10,000 cow**



1177 bulls with  
Australian daughters



**JERNOMICS**  
4232 cows



**Ginfo**  
**24,084**

# Ginfo cows improved reliability

Breed	Trait	Without Ginfo Reliability (%)	With Ginfo Reliability (%)
Holstein	Milk	19	42
	Fat	20	40
	Protein	26	38
Jersey	Milk	24	36
	Fat	25	38
	Protein	27	38

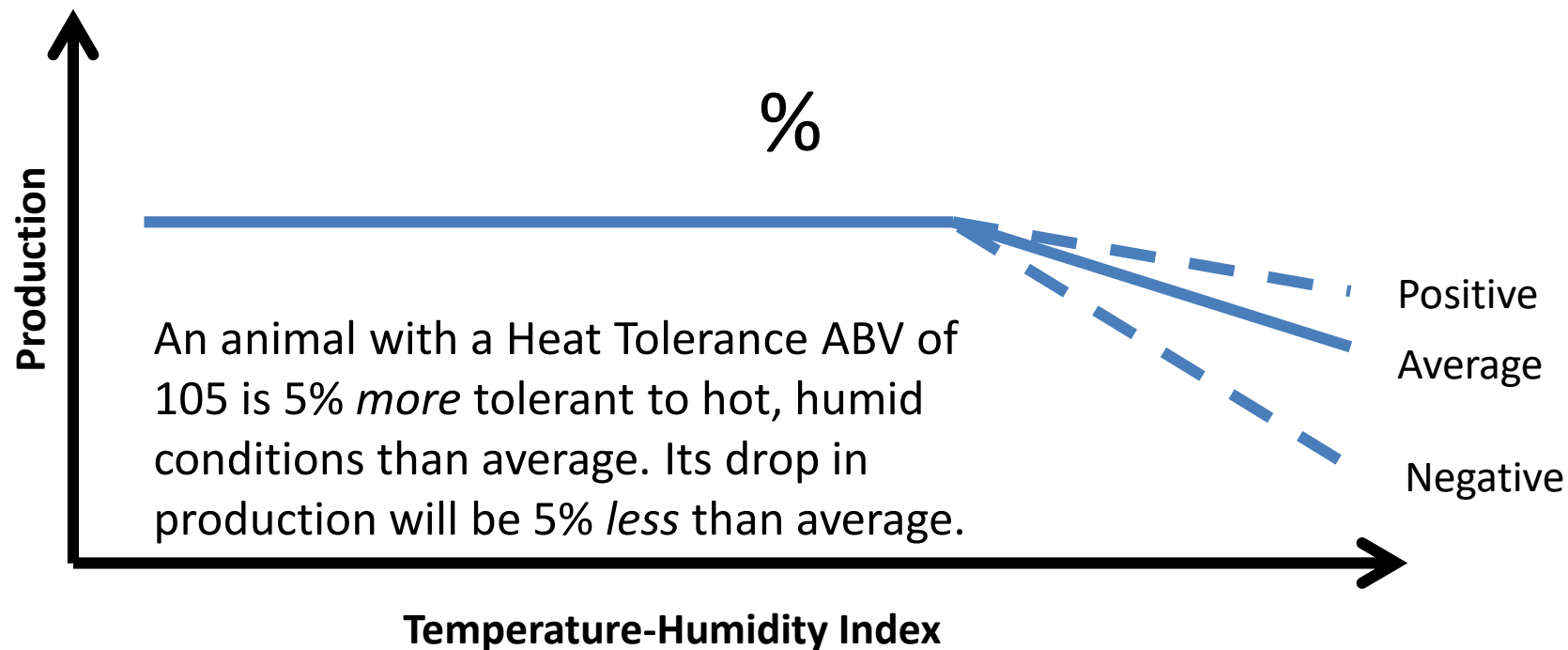
# Expression

- Decline in production (\$) per unit increase of THI

- Components 
$$\left( \begin{array}{l} EW_m * GEBV_{HTm} \\ + \\ EW_f * GEBV_{HTf} \\ + \\ EW_p * GEBV_{HTp} \end{array} \right)$$

- Standardised to **mean = 100, standard deviation = 5**

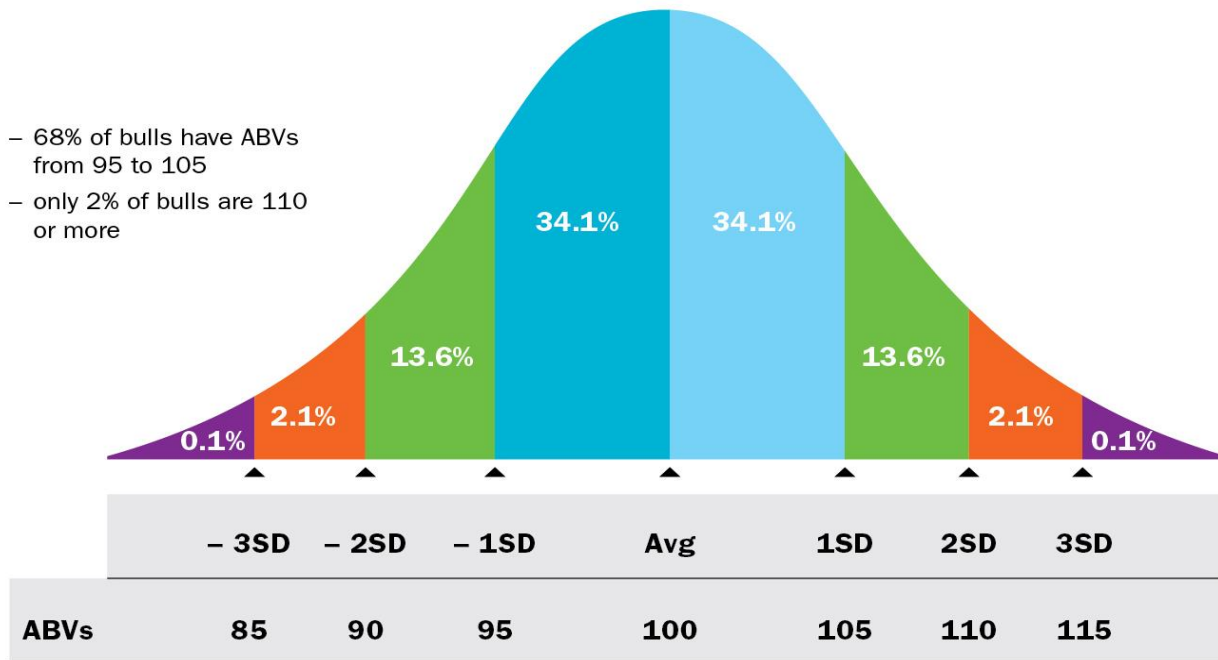
# Heat tolerance ABV





# Standardised ABVs

- 68% of bulls have ABVs from 95 to 105
- only 2% of bulls are 110 or more



# Validation study

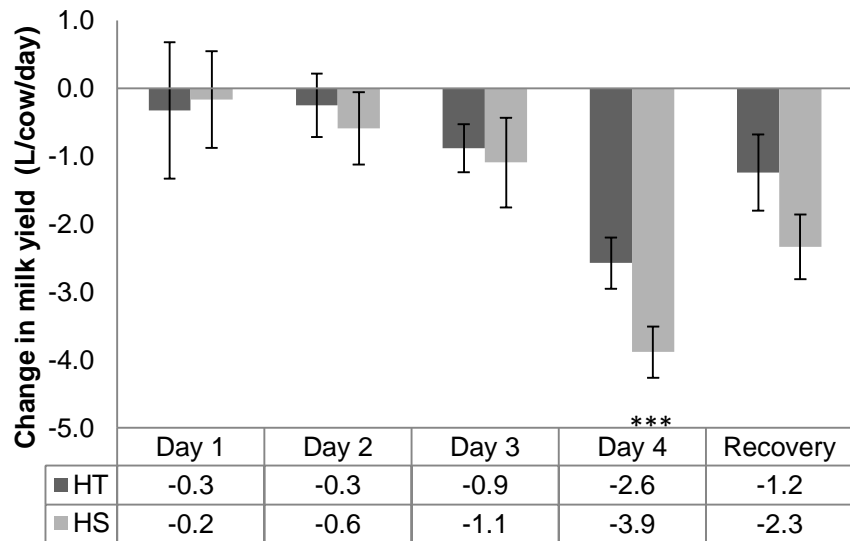
Garner et al (2016) Scientific Reports

- 400 heifers screened on genomic breeding value for heat tolerance calculated
- 24 predicted most heat tolerant, 24 predicted most heat susceptible selected
- Evaluate performance in simulated 4d heat wave event at Ellinbank
- Measure milk production, core temperature



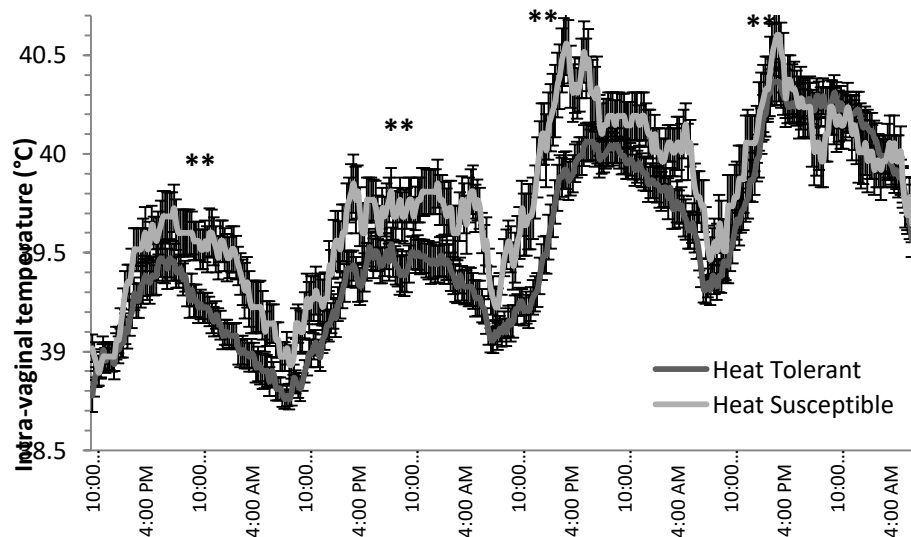
# Empirical validation

## Decline in milk production



Garner et al (2016) Scientific Reports

## Difference in intra-vaginal temperature



# What's next

- Heat tolerance in relation to health and fertility
- Genotype by environment interactions for heat tolerance
- Breeding values for more breeds and crossbreeds
- Evaluating predictors of heat tolerance





# Take home messages

- It's possible to breed for heat tolerance
- Genetic progress is permanent and cumulative
- Select bulls from Good Bulls Guide using an Aussie index (BPI, HWI or TWI)
- If farming in hot and humid conditions pick bulls with above average ABV(g)s for heat tolerance (>100)

# App available to select bulls



The screenshot shows a list of 1054 bulls. The top bar has a back arrow, the text '1054 Bulls', and three filter buttons: 'Breed', 'Index', and 'Daughter Fertility' (selected). There is also an 'Add filter +' button. Below the filters, there's a table with columns for 'BULL', 'BPI', and 'Dtr F...'. The table lists several bulls with their IDs and names, along with their BPI and Dtr F values.

BULL	BPI	Dtr F...
29HO18161 MR SEAGULL-BAY SANDAL-ET	343	108
29HO17747 COOCKIECUTTER HARPER	337	108
29HO16714 DE-SU 11236 BALISTO-ET	329	106
0200HO10220 LEOTHE DARK VADOR	329	112
7HO11395 S-S-I SHAMROCK MYSTIC	328	116
7H13264 S-S-I HEADWAY ALLTIME-ET	325	113
CBPEAKALEX COGENT PEAK ALEX	322	113

The bottom navigation bar is the same as the previous screenshot.



# Acknowledgements

- The Department of Agriculture & Water Resources
- The Australia Dairy Herd Improvement Scheme, DataGene
- Dairy Futures CRC, DairyBio ( AgVic & Dairy Australia )
- CSIRO and Bureau of Meteorology – Climate Change in Australia



