B.GBP.0026 - Feeding Leucaena to manage the rumen for maximum beef profit

Leucaena leucocephala

A legume fodder tree which has

- high levels of protein - approx. 27%;
- good palatability for cattle as browse feed;
- and the potential to reduce rumen methane emissions up to 20%*.

Cultivar name	Australian release	Origin	Positive attributes	Negative attributes
Redlands	2017	hybrid	tolerance to psyllids suitable for coastal planting	some seed production
Wondergraze	2011	hybrid	early seedling vigour good foliage growth some cold tolerance	susceptible to psyllids single seed provider
Tarramba	1994	hybrid	produces less seed early seedling vigour some cold tolerance some psyllid tolerance	taller growth habit may require trimming single seed provider
Cunningham	1976	Guatemala (hybrid)	shrubby growth habit prolific seeder	susceptible to psyllids frost sensitive
Peru	1962	Peru	shrubby growth prolific seeder	susceptible to psyllids

Table adapted from Leucaena Network fact sheet, https://www.leucaena.net/fact-sheets

*Stifkens A et al. (2022) Animal Production Science, 62(7), 622–632

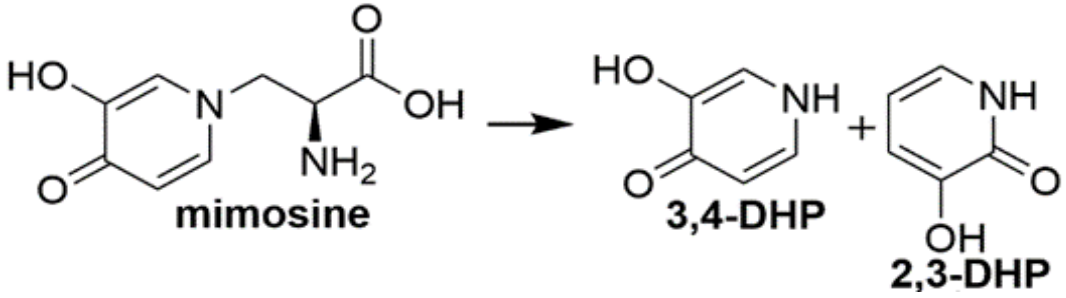
Leucaena toxicity

- Mimosine - non-protein amino acid
- Mimosine is broken down to 3,4-dihydroxypyridine (3,4-DHP) then to 2,3-dihydroxypyridine (2,3-DHP).
- Many rumen bacteria can break down mimosine to 3,4-DHP.
- Toxicity in cattle can range from sub-clinical to acute and chronic.
- The toxins interfere with the way the thyroid gland uses iodine resulting in goitre.
- DHP in blood inhibits metal-chelating enzymes.
- Clinical signs of Leucaena poisoning in cattle include
  - hair loss, profuse salivation, listlessness, appetite loss, loss of fertility, poor growth and death.

Steer with typical symptoms of mimosine poisoning

[Photo: CSIRO – Rob Megarrity and Ray Jones]

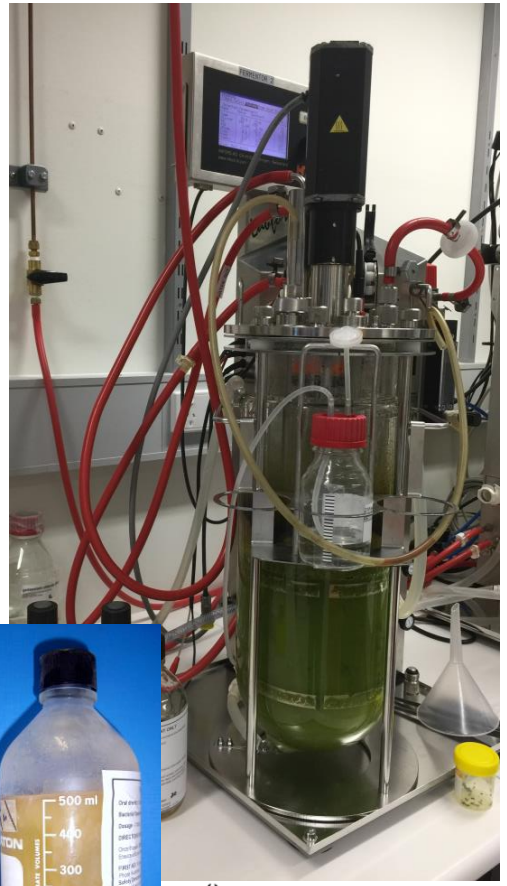
Leucaena toxicity solution Colin Ward, 2011



Adapted from **Toxin degradation by rumen microorganisms: a review.** Loh *et al.* 2020

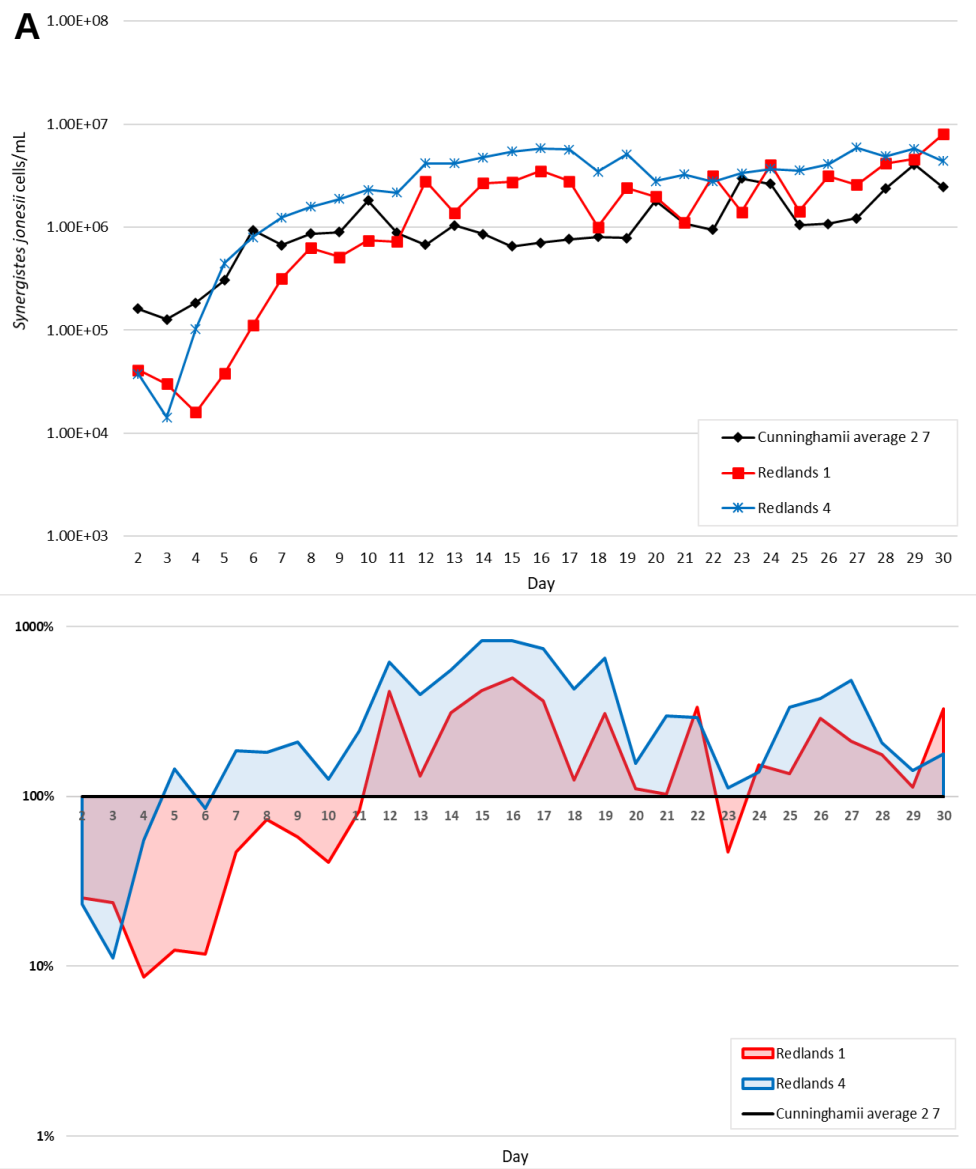
DAF Leucaena inoculum

- 1983 - A rumen-based culture from Hawaiian goats brought into Australia
- Bacteria, *Synergistes jonesii,* isolated which can break down 3,4 DHP and 2,3 DHP
- Late 80s and early 90s, the DAF Leucaena inoculum (or drench) was sourced from fistulated steers
- Mid-1990s - DAF started using an *in vitro* fermenter to produce the mixed bacterial Leucaena inoculum
- Quality control checks:
    1. Toxin degradation assays
    2. *S. jonesii* population numbers in daily samples (qPCR)
- 2018 - MLA co-funded project to determine the effect of anti-psyllid compounds in Redlands on the Leucaena inoculum's bacterial populations and ability to detoxify mimosine, 3,4-DHP and 2,3-DHP in a series *in vitro* fermentations.

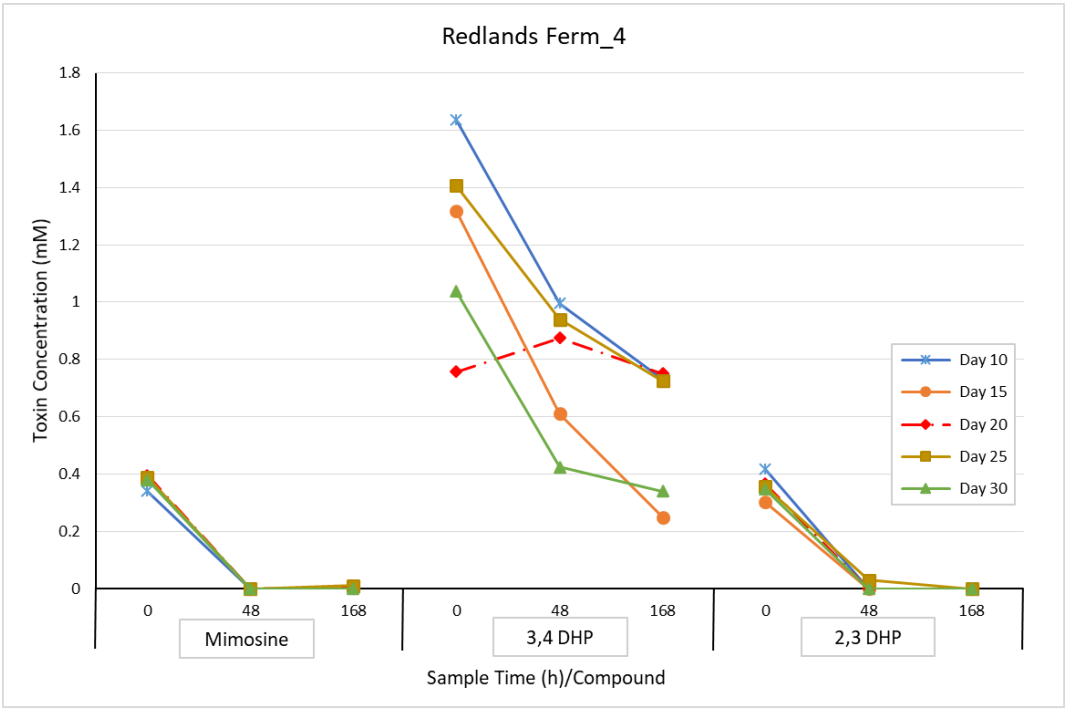


Results:

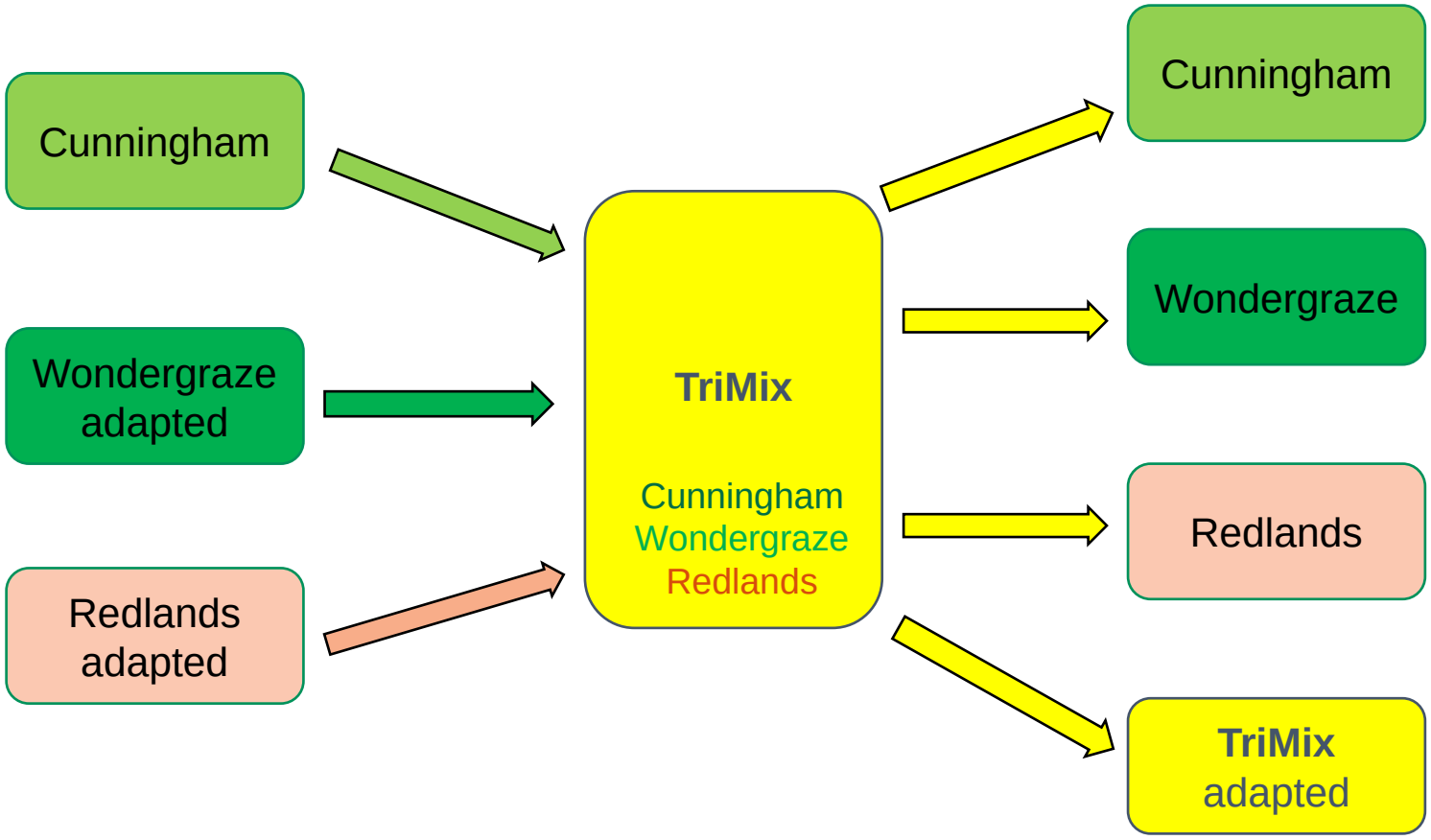
Daily populations of *S. jonesii* (cells/mL).

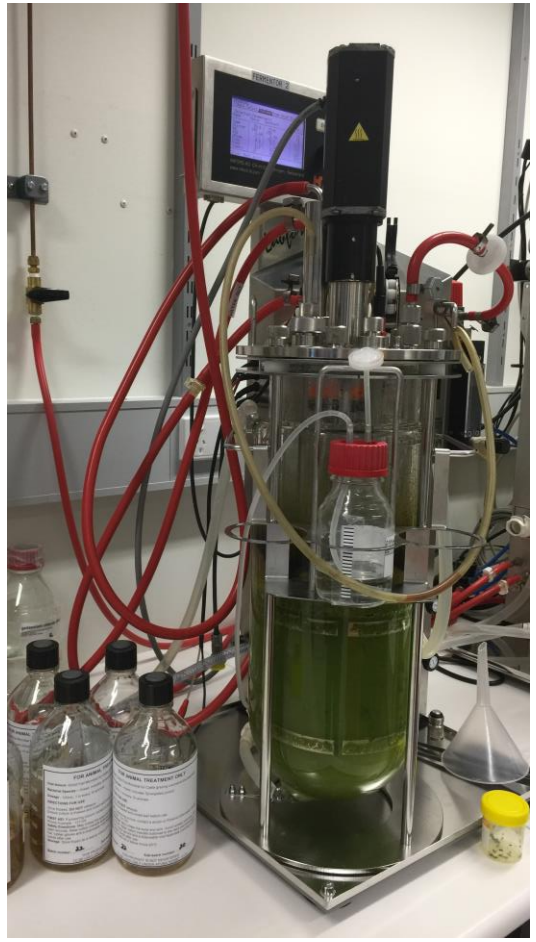


Toxin degradation assays



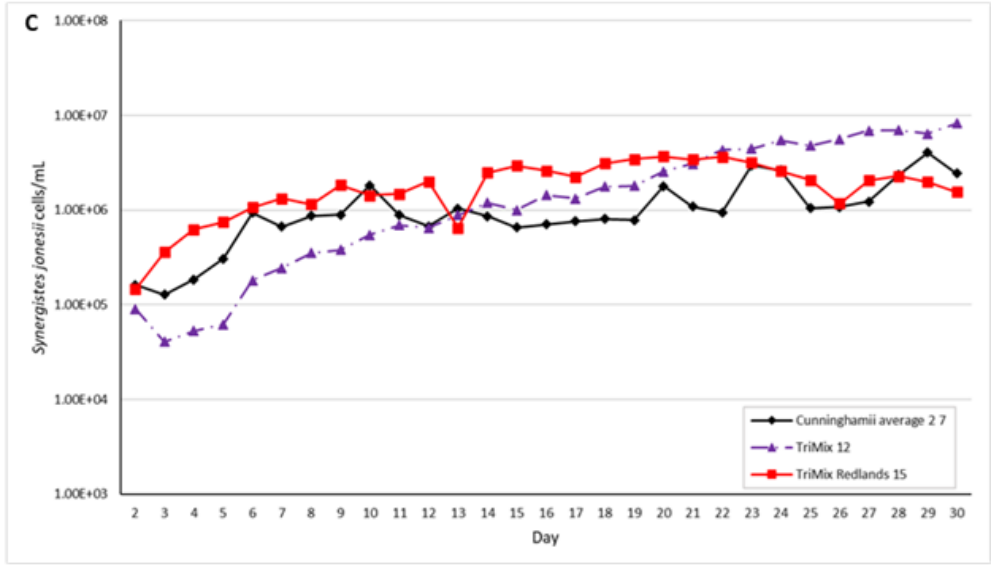
Experimental plan - Fermentations

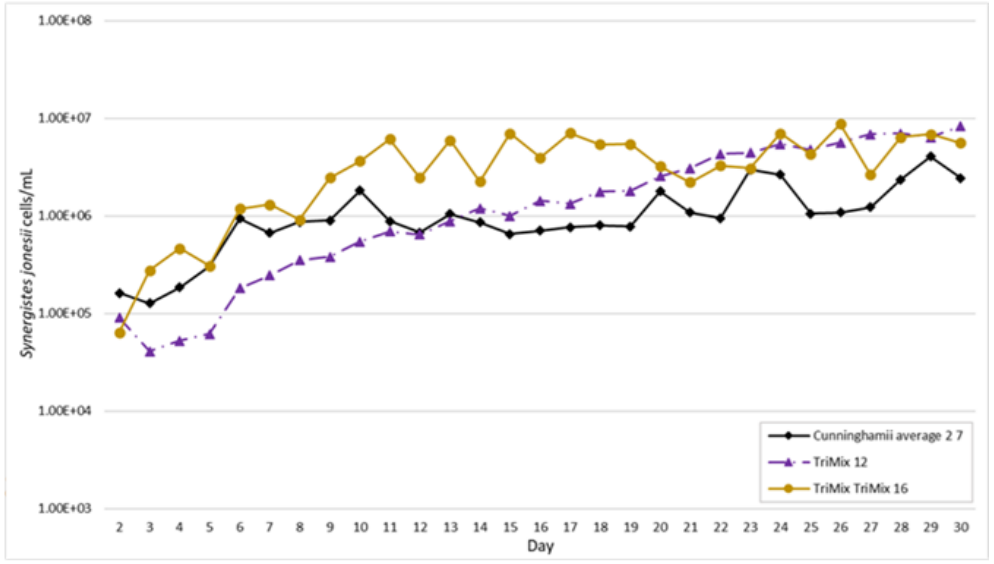




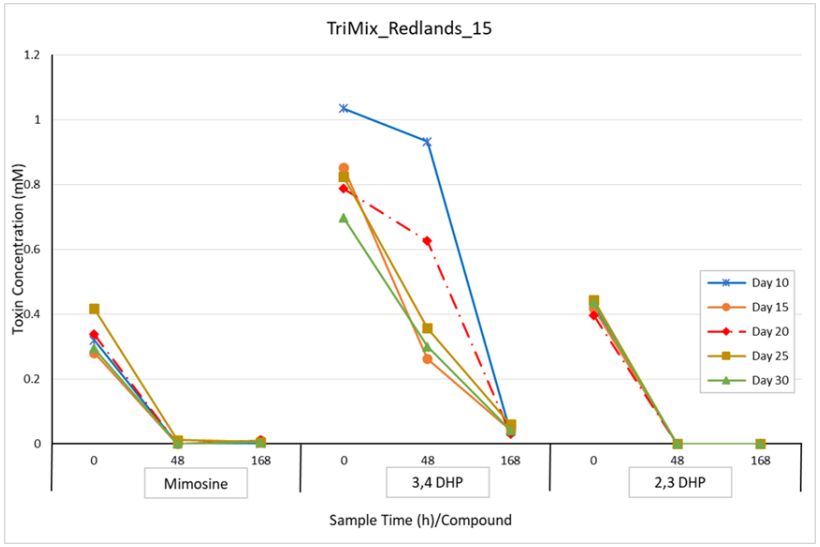
Results:

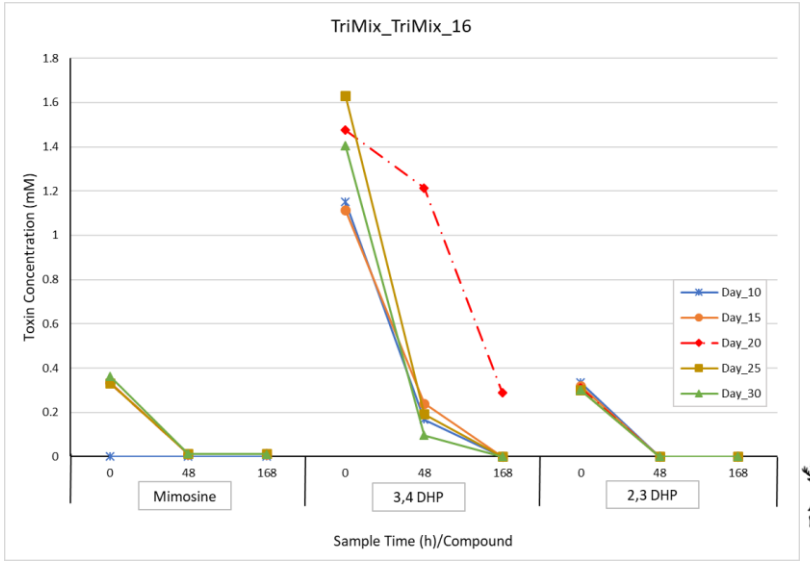
Daily populations of *S. jonesii* (cells/mL).





Toxin degradation assays





Do Qld cattle possess rumen bacteria capable of degrading Leucaena toxins?

To investigate this question, we undertook a survey of the capacity of rumen bacteria in Qld cattle to degrade Leucaena toxins

- Animal ethics approval SA 2021-08-796
- Up to 20 properties from across Qld. (sampling max. 5 animal per property).
- Four different categories
  1. Cattle have never been inoculated and graze Leucaena;
  2. Cattle have either received rumen fluid from CSIRO or DPI cattle (pre 1993) and not since;
  3. Cattle have been inoculated with DAF inoculum and graze Leucaena; and
  4. Naïve cattle never been exposed to Leucaena and never received the DAF inoculum.

Rumen fluid collection via stomach tubing

Methods

Property data collection from producers

Rumen fluid sampling

Toxin degradation assays set up crush side

Mobile lab setup

- 100Ah lithium battery
- Two 39°C capable incubators (12 volt)
- Inverter (to run centrifuge)
- Small Eppendorf mini spin centrifuge
- Portable freezer (-17°C)

Clockwise from top – Gag and stomach tube; Obtaining the rumen fluid; Processing samples; Toxin degradation assay Hungate tubes; Mobile lab set up on the ute tray

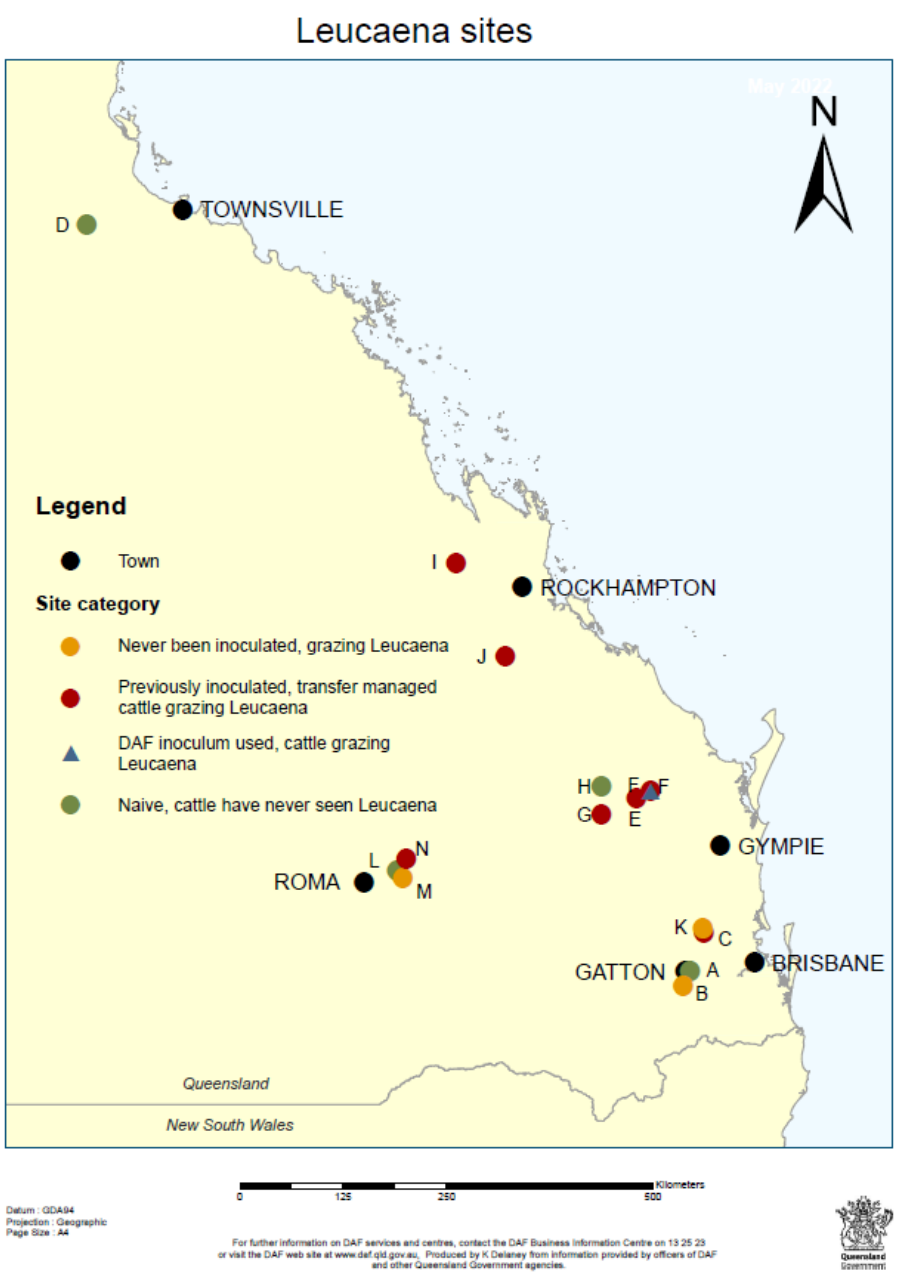
Results

- A total of 14 properties visited and based on producer information -
  - Category 1 – 3 properties
  - Category 2 – none located
  - Category 3 – 7 properties
  - Category 4 – 4 properties

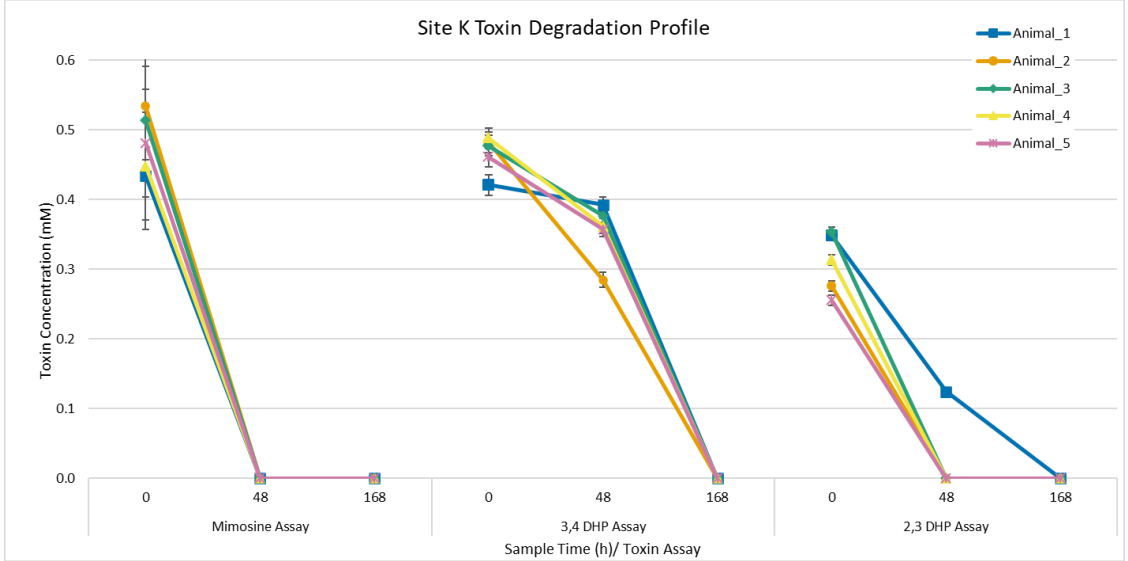
- 72 animals sampled

Property categories:

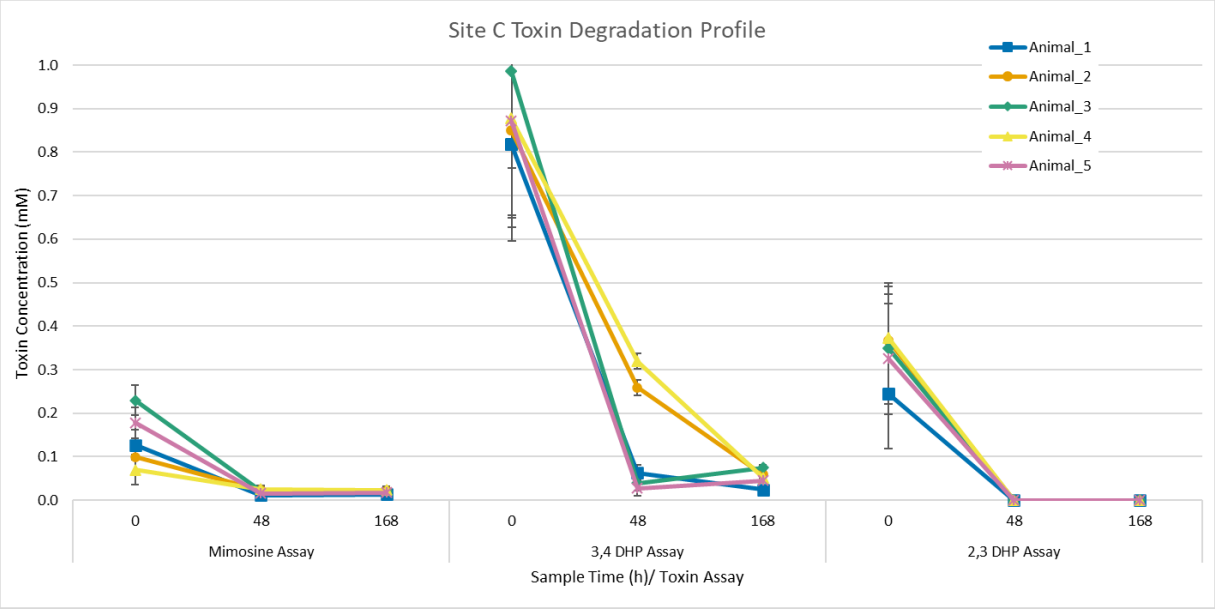
1. Cattle have never been inoculated and grazing Leucaena
2. Cattle have either received rumen fluid from CSIRO cattle or DAF cattle (pre-1993)
3. Cattle have been inoculated with DAF inoculum or managed via transfer and grazing Leucaena
4. Naïve cattle unexposed to Leucaena or inoculum



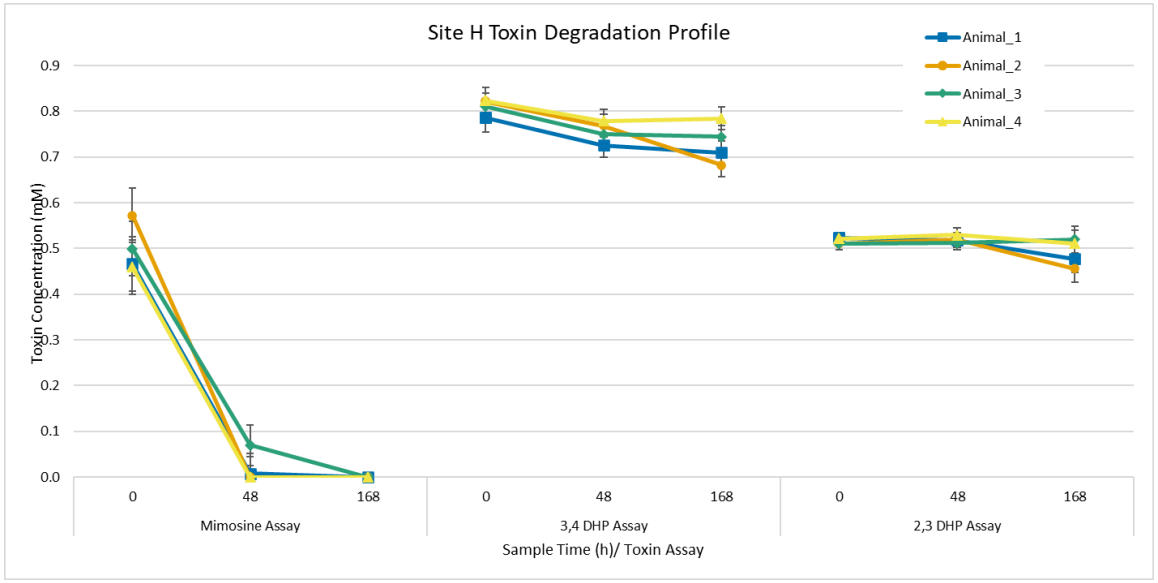
1. Cattle have never been inoculated and grazing Leucaena



3. Cattle have been inoculated with DAF inoculum



4. Naïve cattle never been exposed to Leucaena or inoculum



Conclusions

- Production of the DAF Leucaena inoculum has been modified to the TriMix fermentation
- Queensland cattle do not naturally possess rumen bacteria capable of degrading the Leucaena DHP toxins
- Un-inoculated cattle grazing Leucaena have adapted to have rumen bacteria which can partially degrade 3,4 DHP within 48 hours
- Cattle receiving the DAF Leuceana have rumen bacteria which can completely degrade 3,4 DHP within 48 hours

Our recommendation to industry will be to rumen drench with the DAF inoculum to provide cattle grazing Leucaena with rumen bacteria that can completely degrade all the toxins and ensure maximum benefits are achieved.