LA TROBE UNIVERSITY

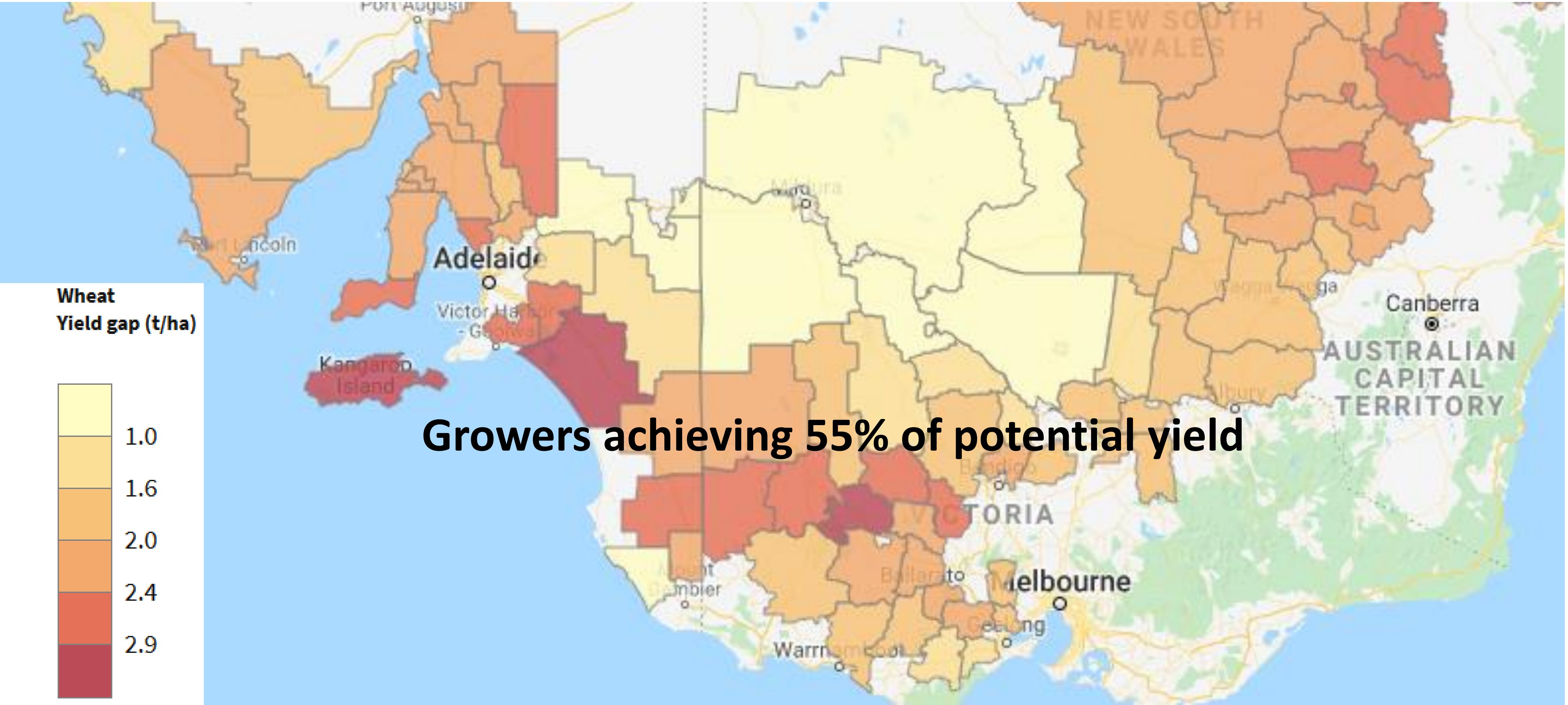
All kinds of clever

Nitrogen management in continuous cropping – high rainfall zones

James Hunt

Incitec-Pivot Agronomy Community 20 July 2018

Yield gaps in south east Australia (yieldgapaustralia.com.au)



Yield gaps & N deficiency

- N deficiency is the single biggest contributor to the current Australian wheat yield gap
  - 40% - Hochman & Horan 2018 *in review*
  - GrainCorp report 15/16 (28% ASW)
  - Roger Armstrong et al. reported in GroundCover™ Issue: 135 July - August 2018

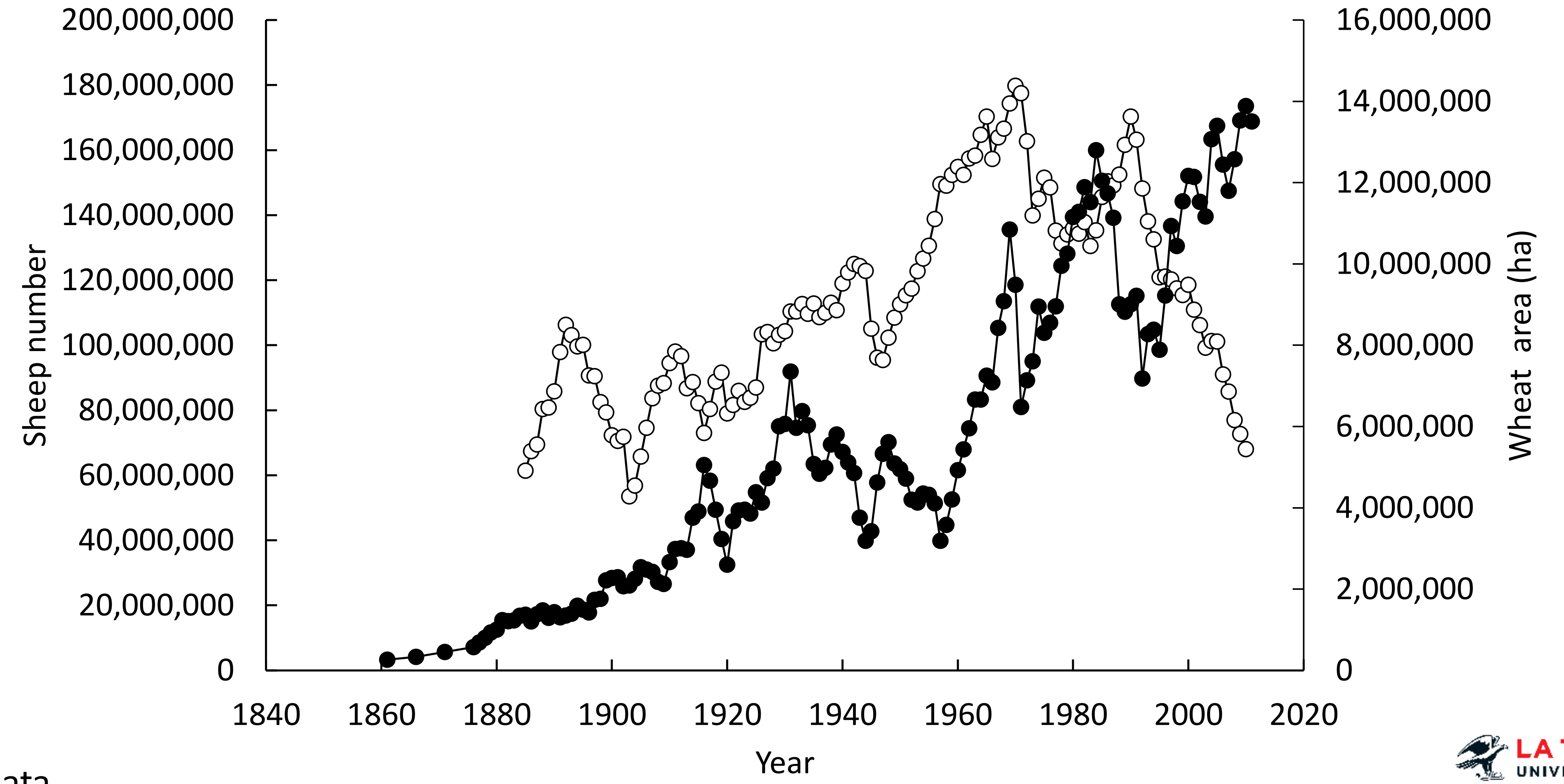
Agriculture Victoria senior scientist Roger Armstrong says a study of wheat's water use efficiency in western Victoria highlighted the importance of soil testing to guide fertiliser application rates. PHOTO: Agriculture Victoria

Top 10 factors influencing wheat WUE

Research co-funded by the GRDC and Agriculture Victoria ranked the top 10 factors influencing wheat WUE.

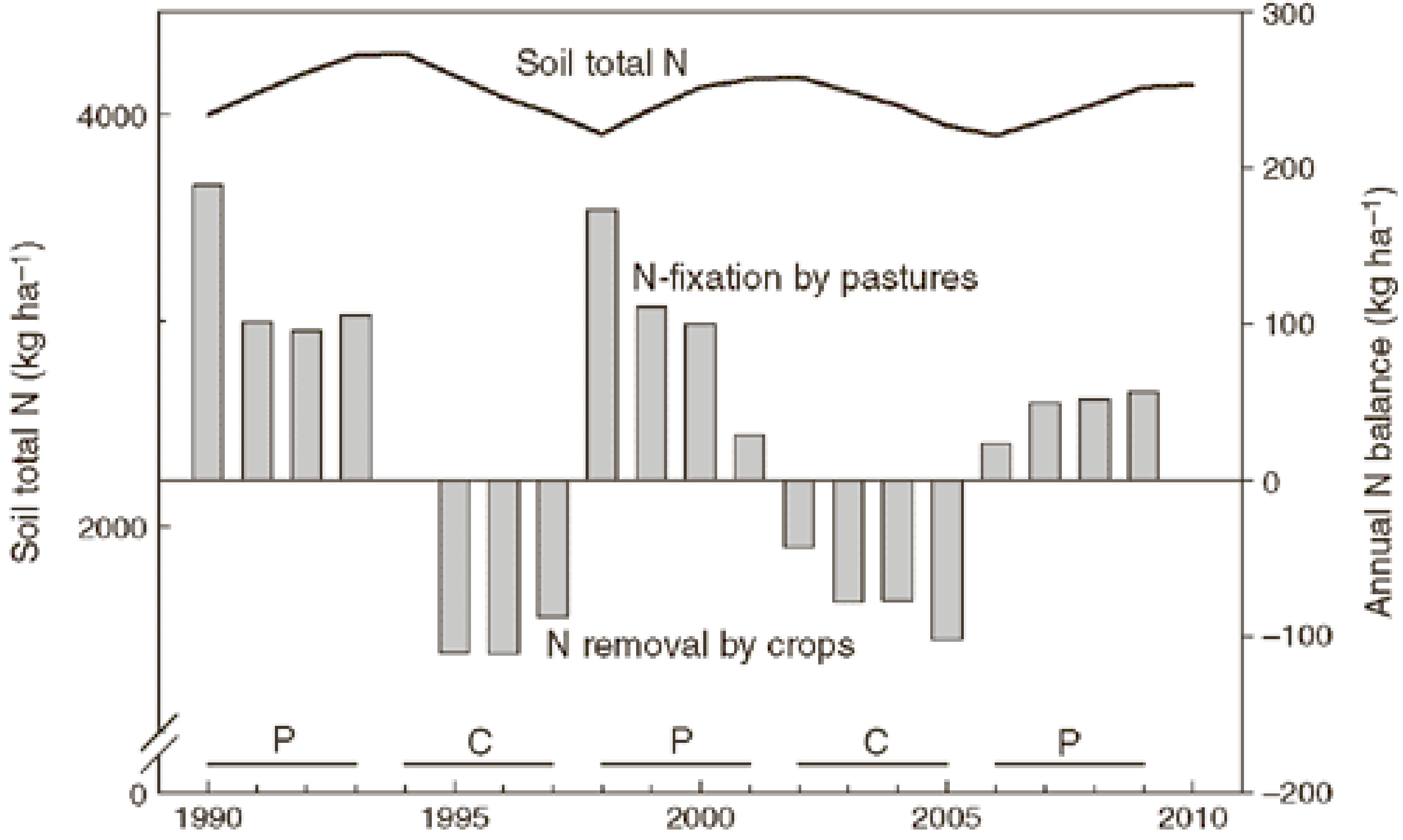
1. Nitrogen fertiliser rate
2. Crop rotation (year one)
3. Variety selection (guided by disease risk and soil type)
4. Sowing date
5. Soil manganese
6. Maturity class of variety (early maturing varieties had low WUE)
7. Soil mineral nitrogen prior to sowing
8. Phosphorus fertiliser rate
9. Crown rot and stripe rust risk
10. Colwell-P

What are the megatrends?



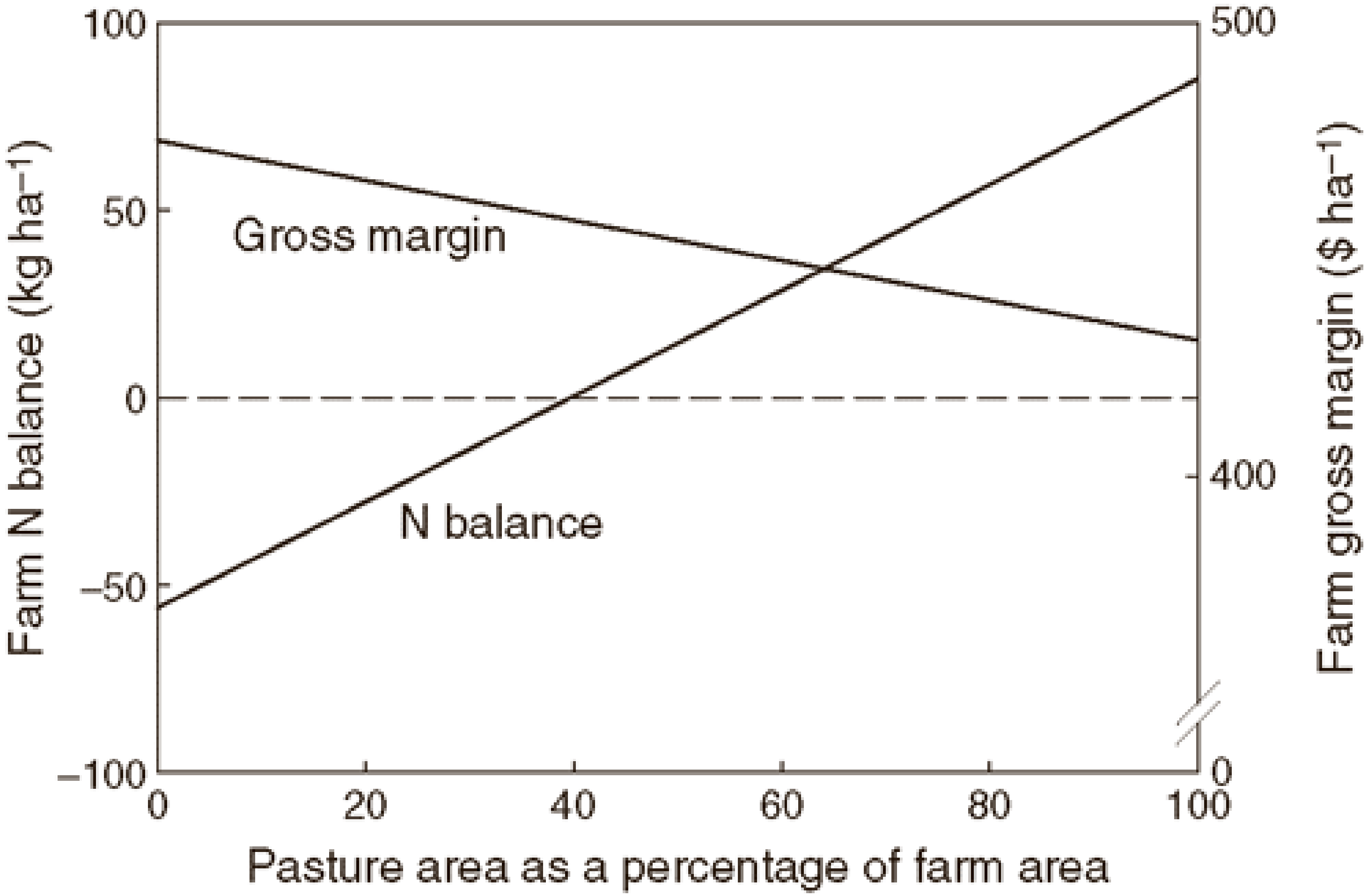
ABARE Data

Crop & pasture N dynamics



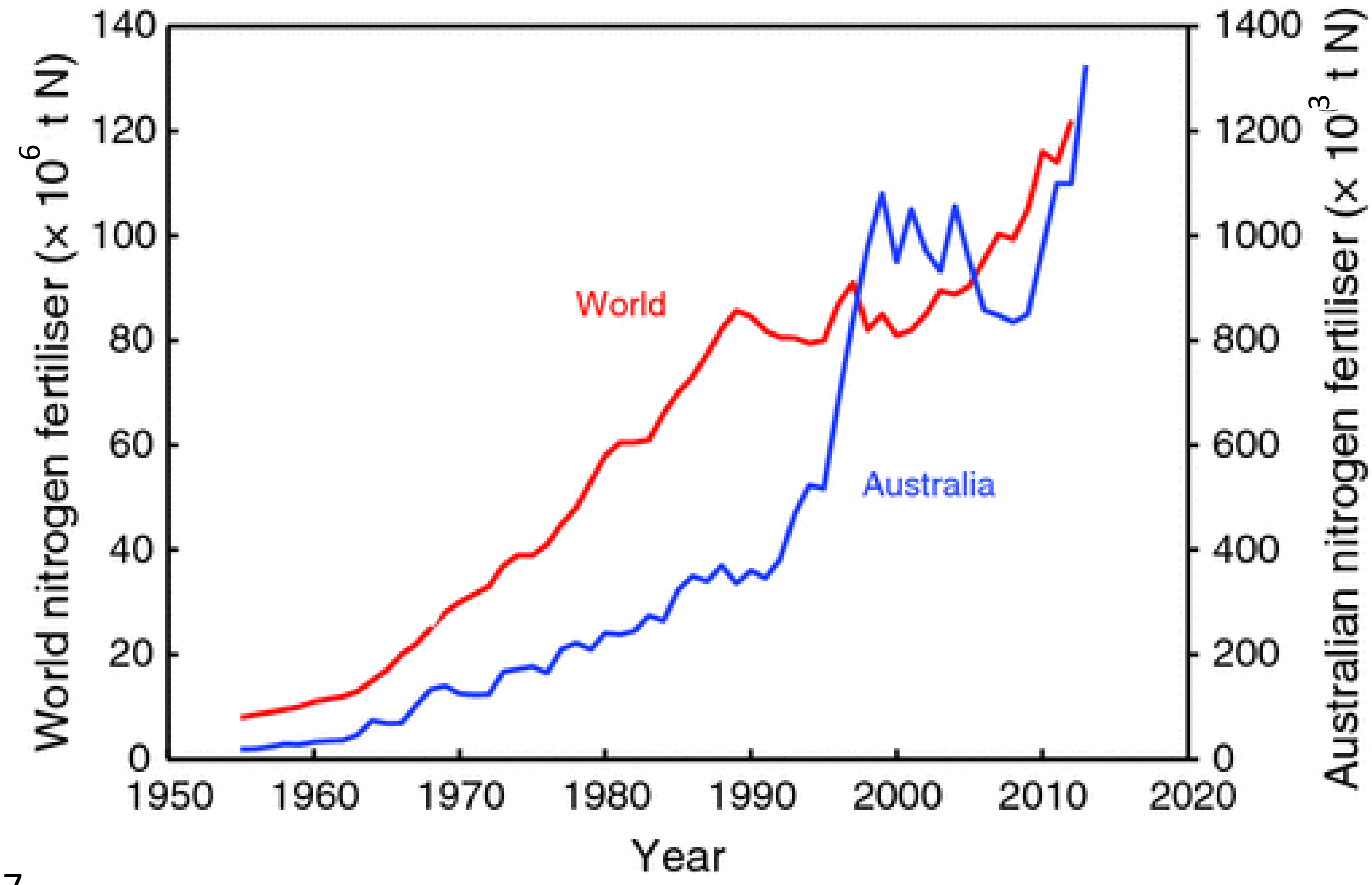
Angus and Peoples 2012

Crop & pasture N dynamics



Angus and Peoples 2012

Australian N fertiliser use



Angus & Grace 2017

A tale of two high-rainfall zones

- SE NSW
  - Crop & livestock production still very much integrated
  - Some growers who destocked during the 2000s have restocked (high returns, frost, no high value grain legume for acid soils)
  - <u>Crops still grown in sequence with legume ley pastures (lucerne, sub-clover)</u>
  - Target high protein wheat (APH, AH)

A tale of two high-rainfall zones

- SW Victora
  - Crop & livestock disintegrated (raised beds?)
  - Crop-only paddocks vs. stock only paddocks
  - Pastures typically grass-based
  - Generally grow low protein/feed wheat
  - Naturally high soil organic matter

Cropping in the medium-high rainfall zones

- Average yields and water-use efficiency have been increasing despite negative climate trends (Hochman *et al.* 2017)
  - Better cultivars
  - Earlier sowing
  - Better crop sequences
  - Fungicides
- Leading growers can average 7 t/ha wheat, some paddock averages reported at 9 t/ha, trials have exceeded 10 t/ha
- **Supported by increasing rates of N fertiliser**
- Most farms are mining total soil N

Mining total soil N – outputs exceed inputs

Inputs

N fertiliser

Manures, compost, biosolids

Rhizobial N fixation

Rainwater, dust

Free-living microbial N fixation

Outputs

Grain (7 t/ha wheat = 140 kg/ha N)

Burning, baling stubble

Denitrification

Leaching

Volatilisation

Run-off

Total soil N

Organic N
(Plant matter in various states of decay; microbes living & in various states of decay)

mineralisation

Immobilisation

Mineral N
(NO_3+NH_4)

Consequences of mining total soil N

- Drags down stable soil organic matter (Kirkby et al. 2014, Alvarez 2005)
- Negative for soil structure & chemical properties
- Biggest negative – decline in provision of N through mineralisation (Schjønning *et al.* 2018)

What is so good about mineralisation?

- Not so useful in low rainfall environments, very useful in high rainfall environments
- Provides a buffer
- N management becomes self-correcting
  - Wet spring = higher yield potential = more mineralisation = more yield
- If you don’t have that buffer, need to be able to respond with late applications o N fertiliser
  - Fine in stable yield environments such as Europe, much more difficult in Australia

What is the future of cropping in the HRZ

Present state

Re-integration of crops & stock
More N from ley pastures

Continued separation of crops & stock
Increasing reliance on N fertiliser

N outputs exceed inputs
Soil organic matter is mined

N outputs match inputs
Soil organic matter maintained

Consequences for production & profit?

N management in the MRZ

- Easy!
- Soil sample pre-sowing
  - Less than 60 kg/ha mineral N – add some at sowing
  - More than 60 kg/ha mineral N – crop will wait until stem elongation

N management in the MRZ

- Mid-July to early August (early stem elongation)
  - calculate potential yield (best guess on stored soil water & rainfall to-date, seasonal forecast if skilful))
  - Calculate N requirement (40 kg/ha N per tonne of wheat grain – starting soil N, sowing fertiliser, mineralisation if on pulse-stubble or pasture)
  - Top-dress the balance as urea, no real need to wait for rain front

N management in the MRZ

- Early September (flag leaf emergence)
  - Review yield potential estimate
  - Put more on if you need (ideally in front of rain)
- After harvest
  - Look at yields and proteins and review the decision making process.
  - *www.farmlink.com.au/LiteratureRetrieve.aspx?ID=199299*

N fertiliser management in the HRZ

- Harder than it looks!
- High yields = large amounts of N (7 t/ha = 280 kg/ha N total supply)
- Water = losses (denitrification, run-off, leaching)
- Water = access & trafficking
- Water = water logging (acute N deficiency)
- Returns are not certain
  - Frost!
  - Drought
  - Heat

What might help?

- Polymer coated products applied at sowing
  - Effective but expensive!
  - Probably more cost-effective to apply more conventional urea and wear the losses (environmentally not good!)
  - This might change as products get cheaper
- Applying N in concentrated bands (mid-row banding)
  - At sowing
  - In crop

Mid-row banding – the theory

- Poor-man’s slow release
- High concentrations of urea in a narrow band creates a high concentration of ammonium & ammonia toxic to nitrifying microbes and plant roots
- Plants can take up nitrate from the margins
- Less volatilisation
- Less immobilisation
- Potentially less leaching & denitrification
- Plant up-take when top-soil is dry
- Higher NUE
- Not much data in the HRZ

In-crop mid-row banding

Photo: Steve Larocque

N recovery mid-row banding

Data courtesy of Ash Wallace, Agriculture Victoria

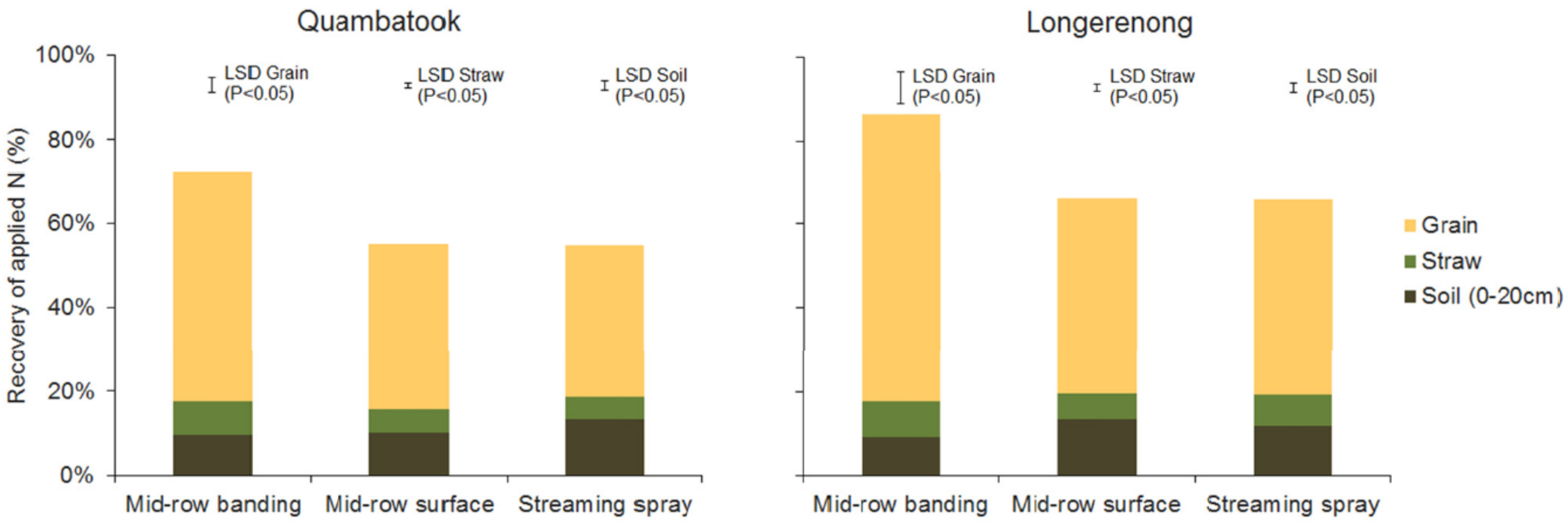


Figure 4. Recovery of applied N in above ground biomass and soil (0-20cm) at harvest for various methods of N application (average of two application times) at Quambatook and Longerenong experimental sites based on ^{15}N mass balance.

To summarise;

- N deficiency still the biggest factor contributing to the Australian wheat yield gap
- Yield potentials have increased, area of pasture has decreased - fertiliser N and soil mining have filled the gap
- We are at a crossroads;
  - Keep mining soil organic N now, become highly reliant on fertiliser N to achieve yield potentials in future
  - Maintain organic soil N by matching inputs to outputs
  - Good fertiliser N management will be critical either way
  - What role will ley pastures play?
- N management in the HRZ is tricky, but there are new technologies being adopted & studied now that can help solve some of the problems faced


The
End