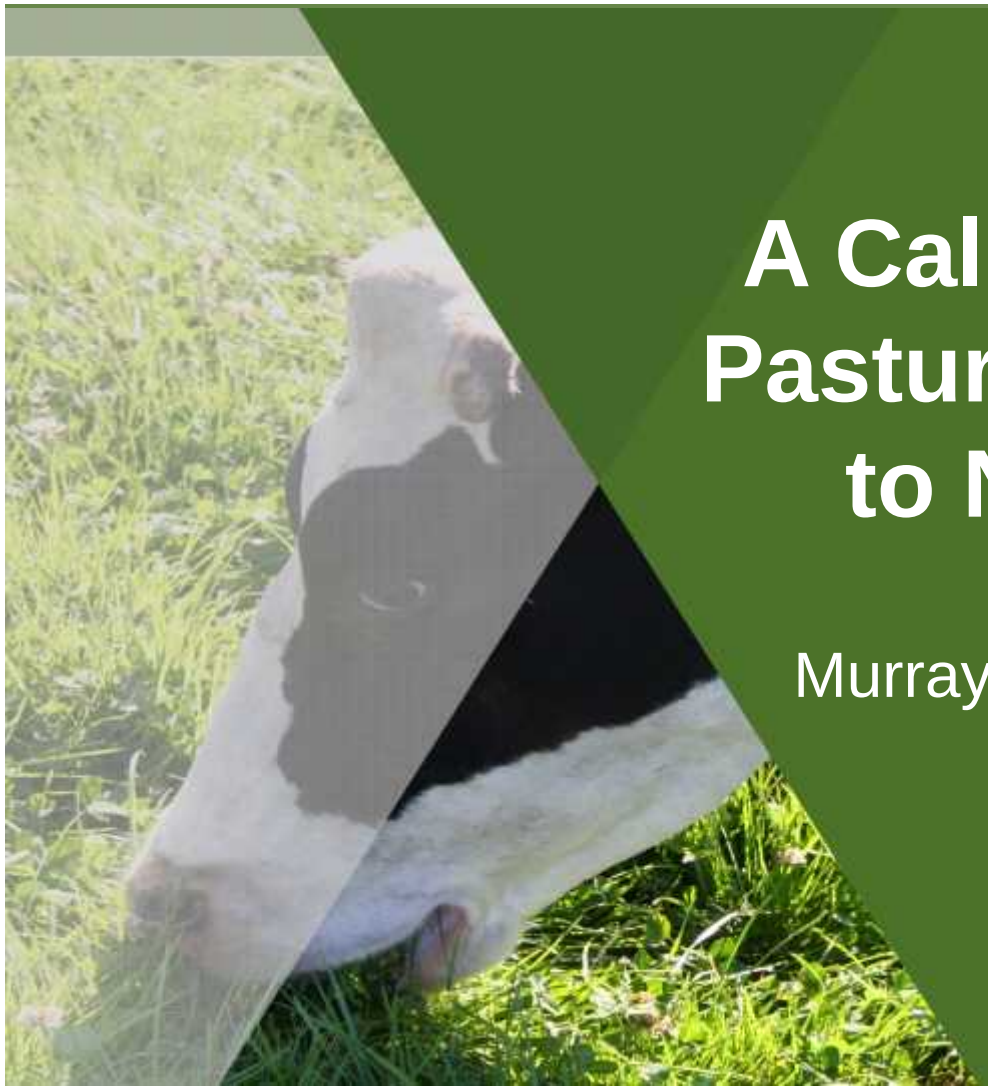

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A Calibrated Model for Pasture Yield Response to Nitrogen Fertiliser

Murray Hannah, Cameron Gourley, Kohleth Chia and Ivor Awty

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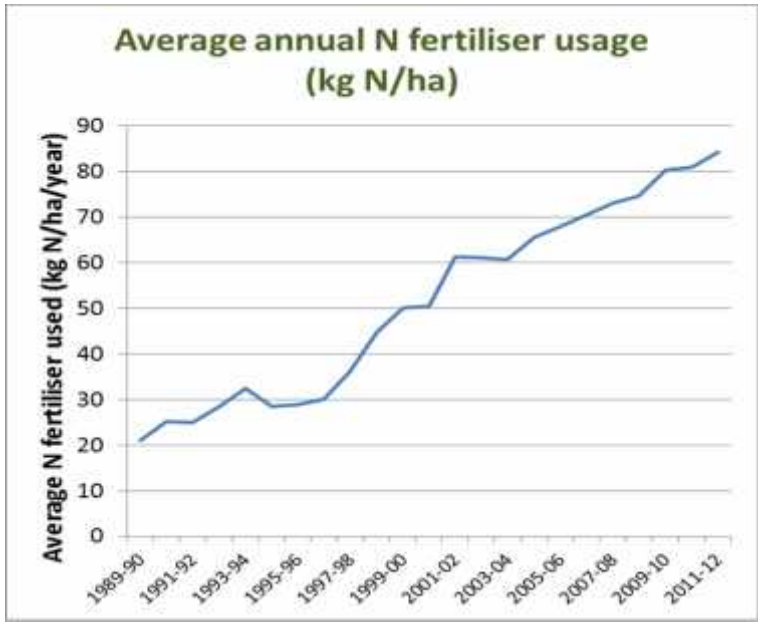
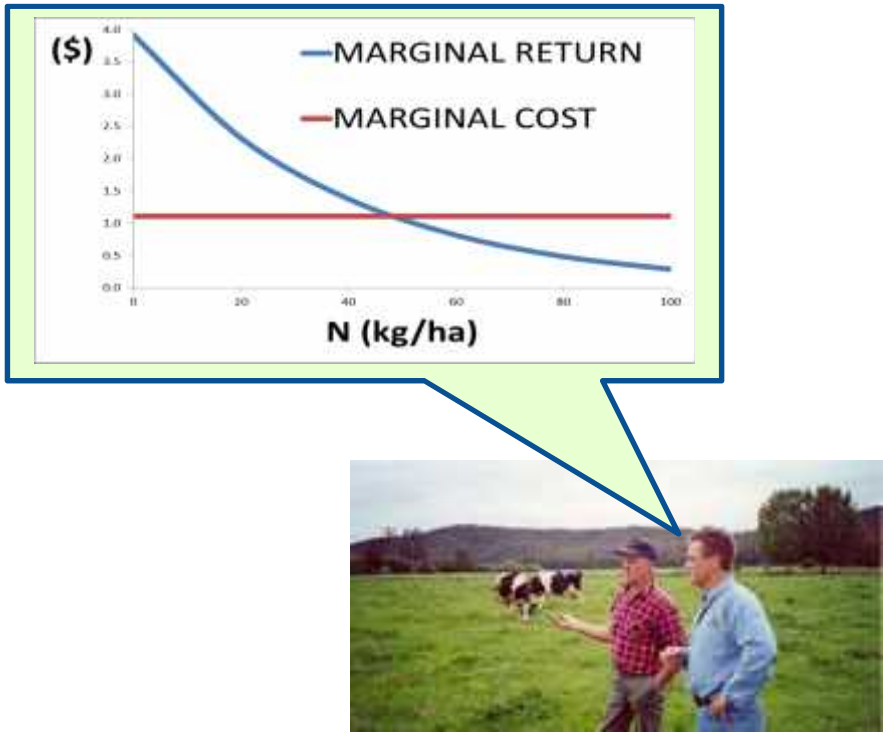
Trend in dairy nitrogen fertiliser use



Sources: ABARE, ABS, DA

An economic and environmental question



How much N to apply?

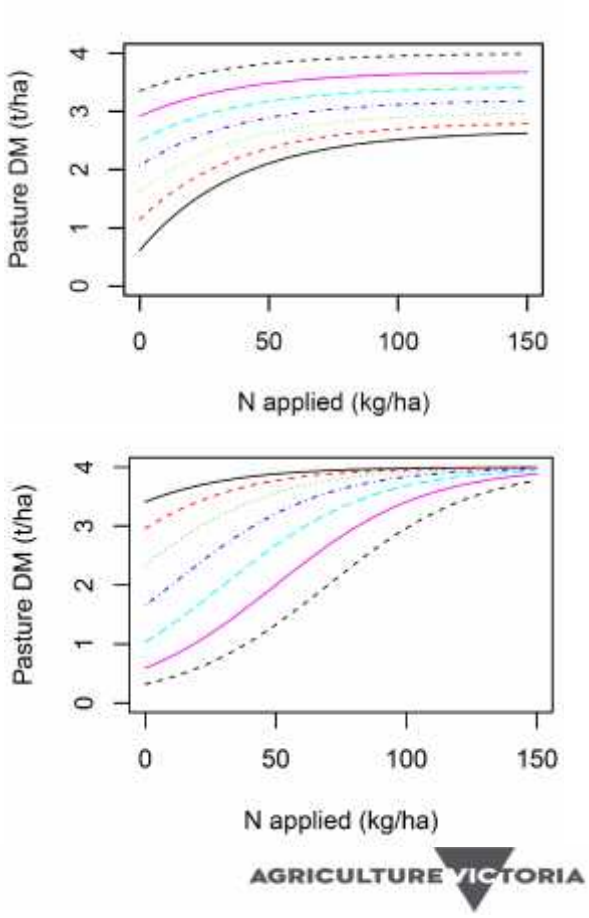
…

so that the last kilogram

- Adds to profit
- Has high NUE

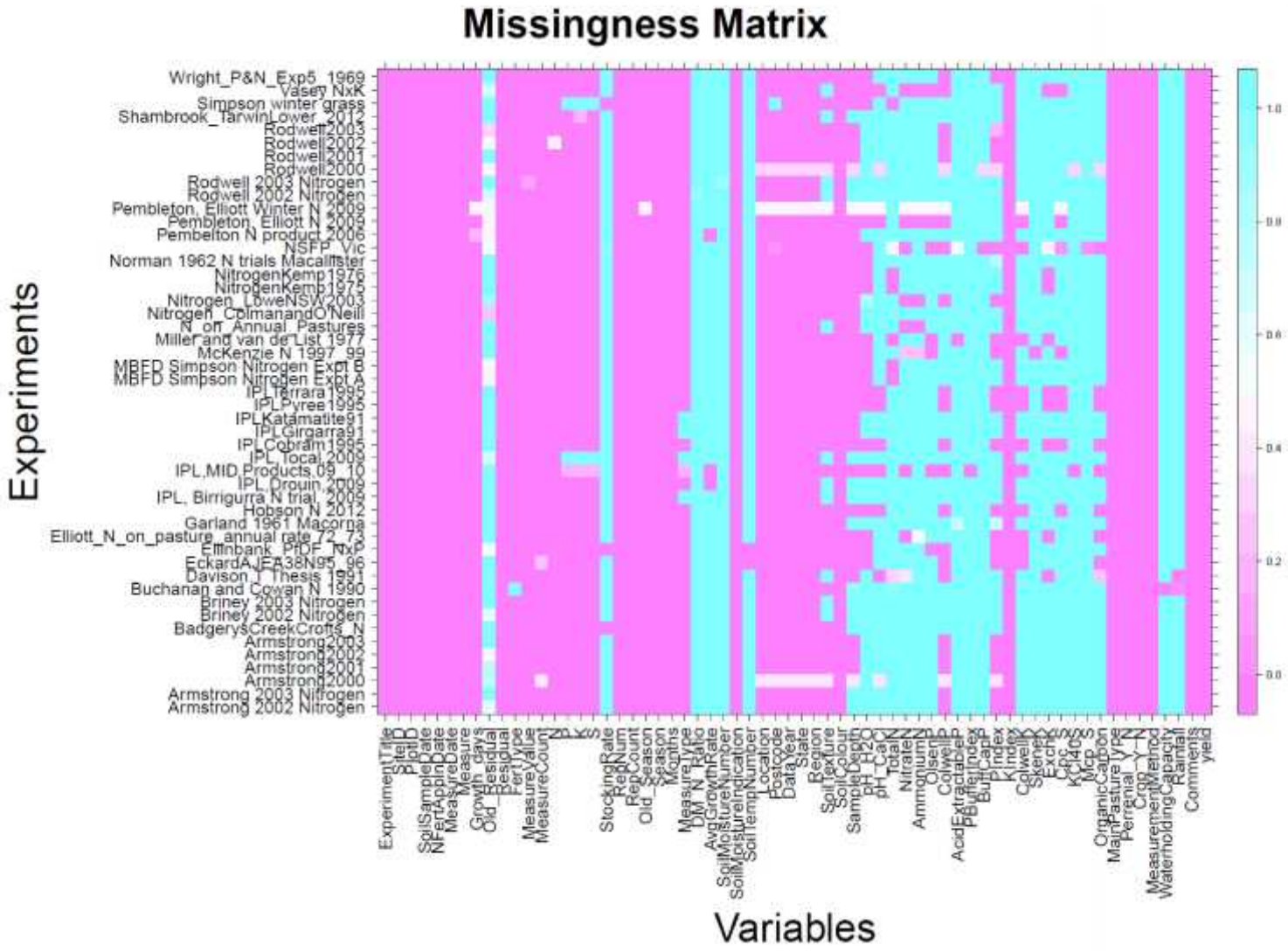
Pasture yield vs N applied?

- Require a relationship
  - a realistic model
- How?
  - A bio-physical model?
  - An empirical model?
  - Data?



Better Fertiliser Decisions database

- Australian fertiliser trials,1955 - 2012.
- 920 trials with applied N
- 5,959 partitions (same site, date, treatments; a curve)
- 19,915 rows of data
- 64 data columns
  - Pasture yield measure
  - N applied
  - 62 columns of meta data (demographic, experimental, environmental)



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Rates of N applied within trials

- How many rates in each trial?
  - 150 trials had at least 3 rates

# N levels	1	2	3	4	5	6	7	8	16	24
# Trials	19	751	7	9	84	32	1	2	1	14

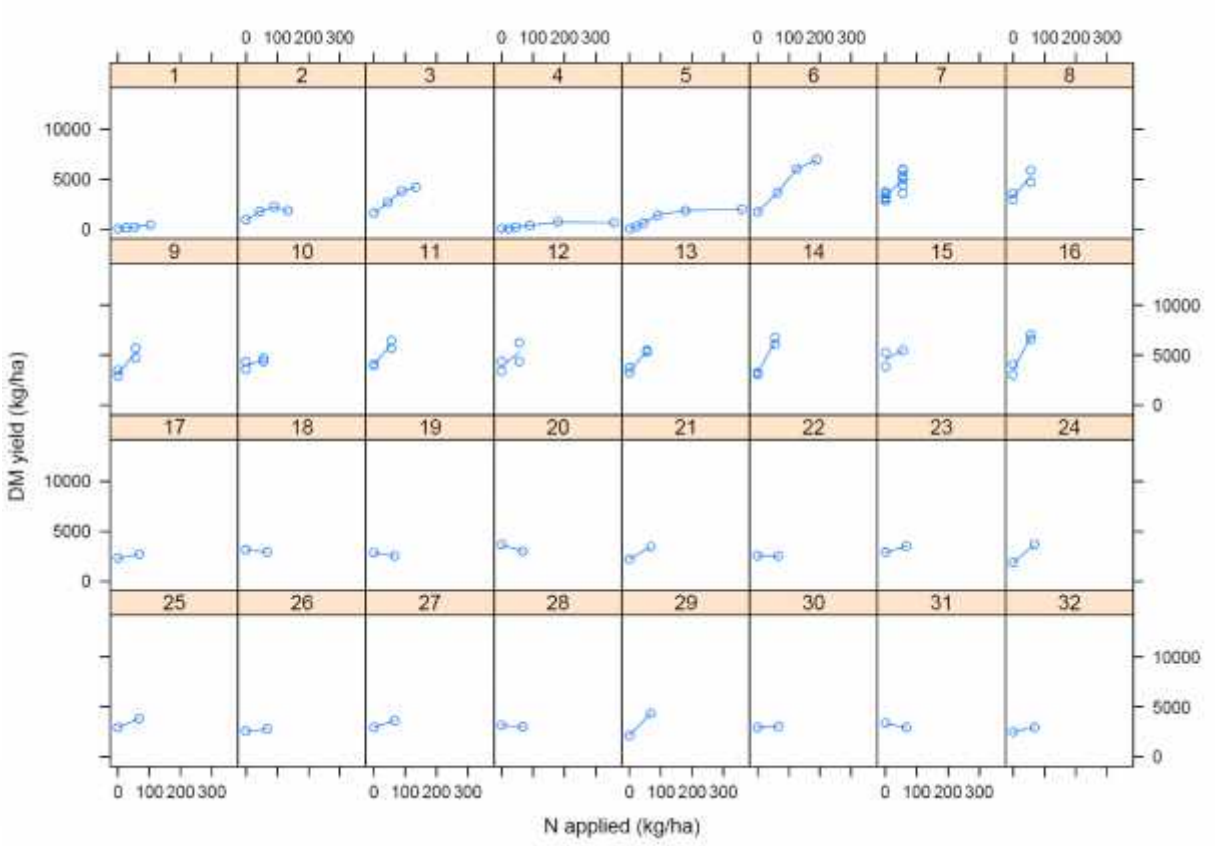
- Largest N rate in each trial?
  - 117 trials had a max rate greater than 80 kg N/ha

N (kg/ha)	<20	20-40	40-60	60-80	80-100	>100
# Trials	8	11	62	722	29	88

Number of rows of data by State and Season

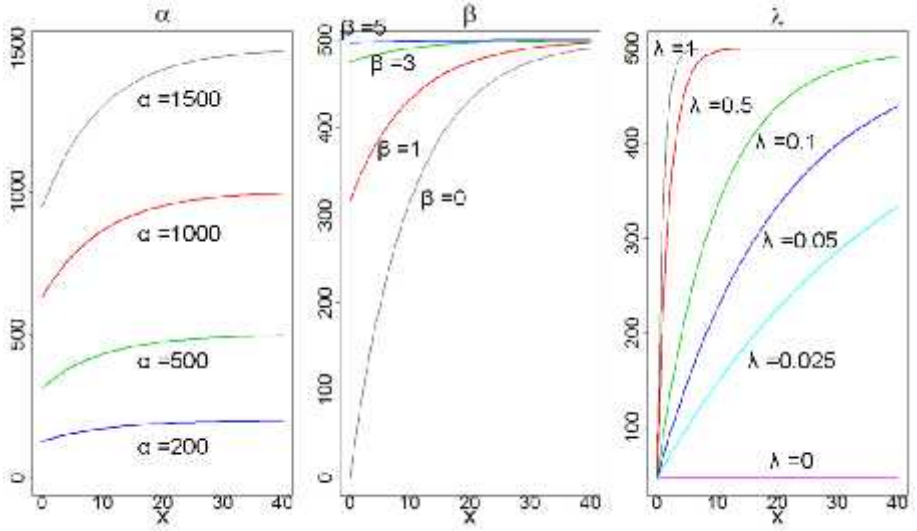
State	Spring	Summer	Autumn	Winter
NSW	83		40	40
Qld		6		
SA			352	
Tas	128		120	427
Vic	42		11,735	655
WA			396	24

The first 32 (of 5,959) partitions



Model development

- Mitscherlich, $y = \sim(1 - e^{-a x -} \quad)$
  - Simple
    - Requires few points of support
    - Can be expanded
  - Widely used
    - Often adequate
    - Interpretable parameters



Model development strategy

- Exploratory phase:
  - Fit a Mitscherlich curve to each partition
    - Graph $\hat{\sim}$, $\hat{}$, $\hat{a}$ against meta data.
    - Separate models for $\sim$, , and a
- Formal modelling phase:
  - Pool information
  - Expand Mitscherlich to non-linear mixed model
  - Test meta-data terms

Expanded model (final model)

$$y = \sim(1 - e^{-\ -\mathrm{a}N}) + £$$

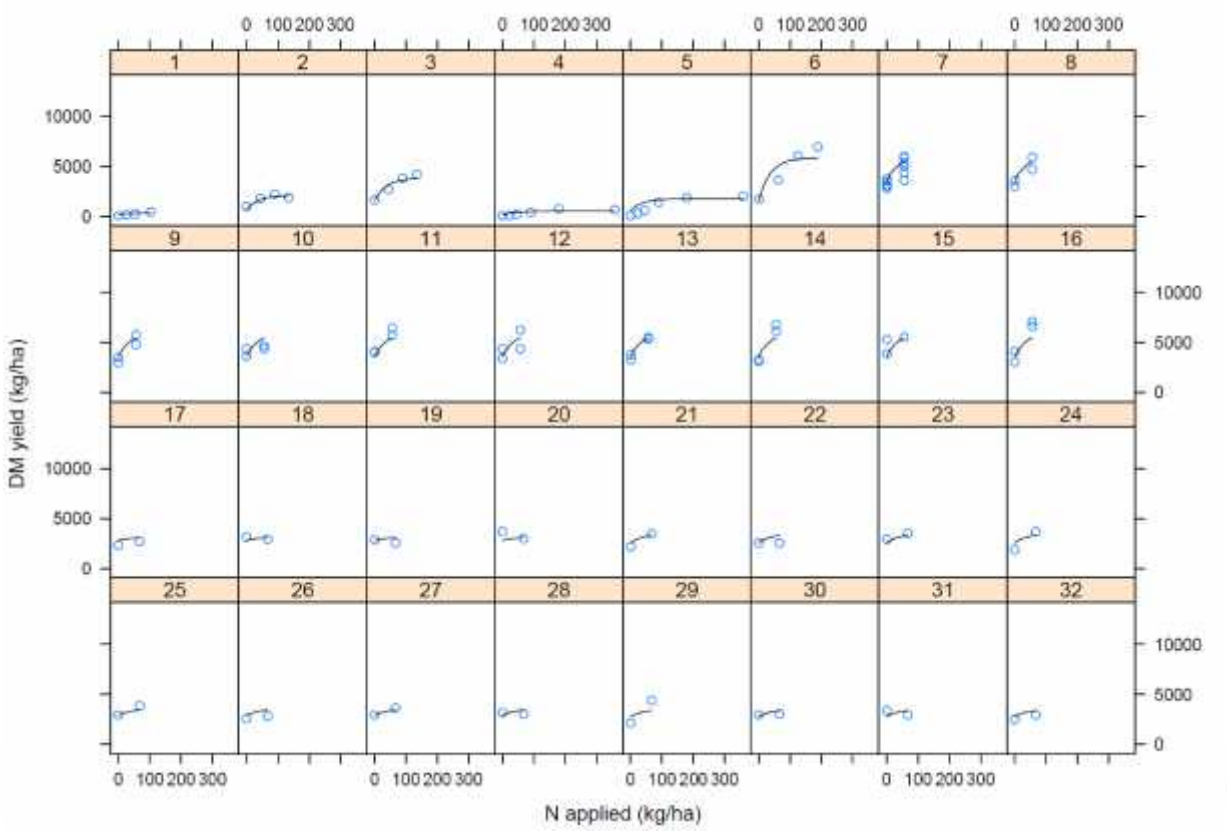
where, $\sim = «_{\sim} + ²_{\sim} + {}^{\cdot\cdot}_{P.check} + L_{\sim} + Pa_{\sim}$

$$= \exp(« \ + ² \ + {}^{\_}_{\text{state.season}} + L \ + Pa \ )$$

$$\mathrm{a} \equiv \exp(¬)$$

Fitted using nlme(), R

The first 32 (of 5,959) partitions, fitted model



Max yield α sub-model - “surprises”

- Residual harvests had greater max yield than primary harvests
- Yield decreased with growth-time
- Large SDs for max yield between sites, & between partitions,

➡ Sub-model for α (max yield) is not useful.

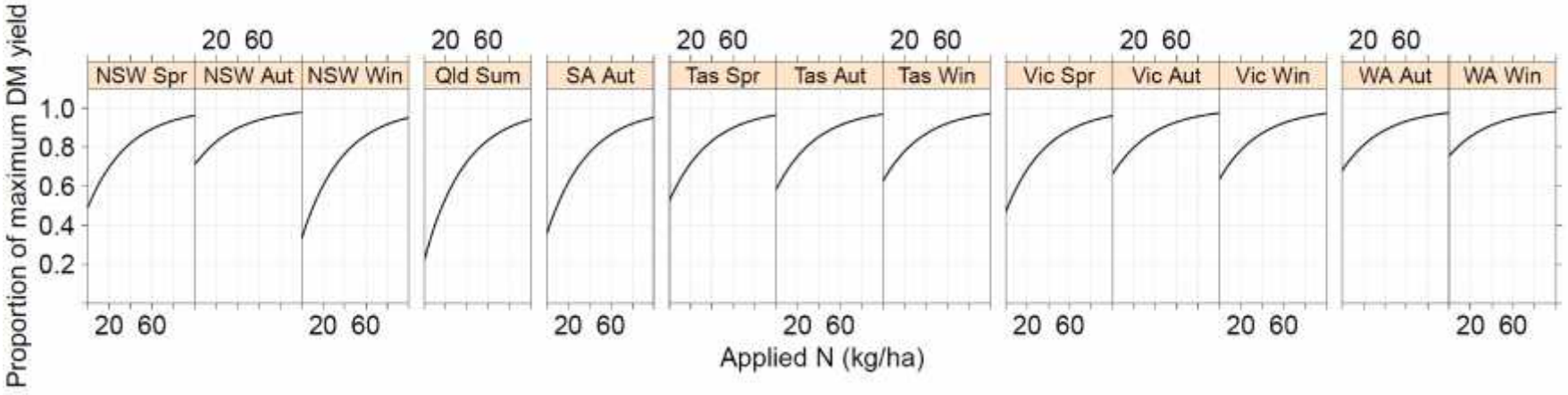
(Max yield a matter of harvest protocol)

How does applied N affect the **proportion** of max yield?

Proportion of yield due to applied fertiliser N

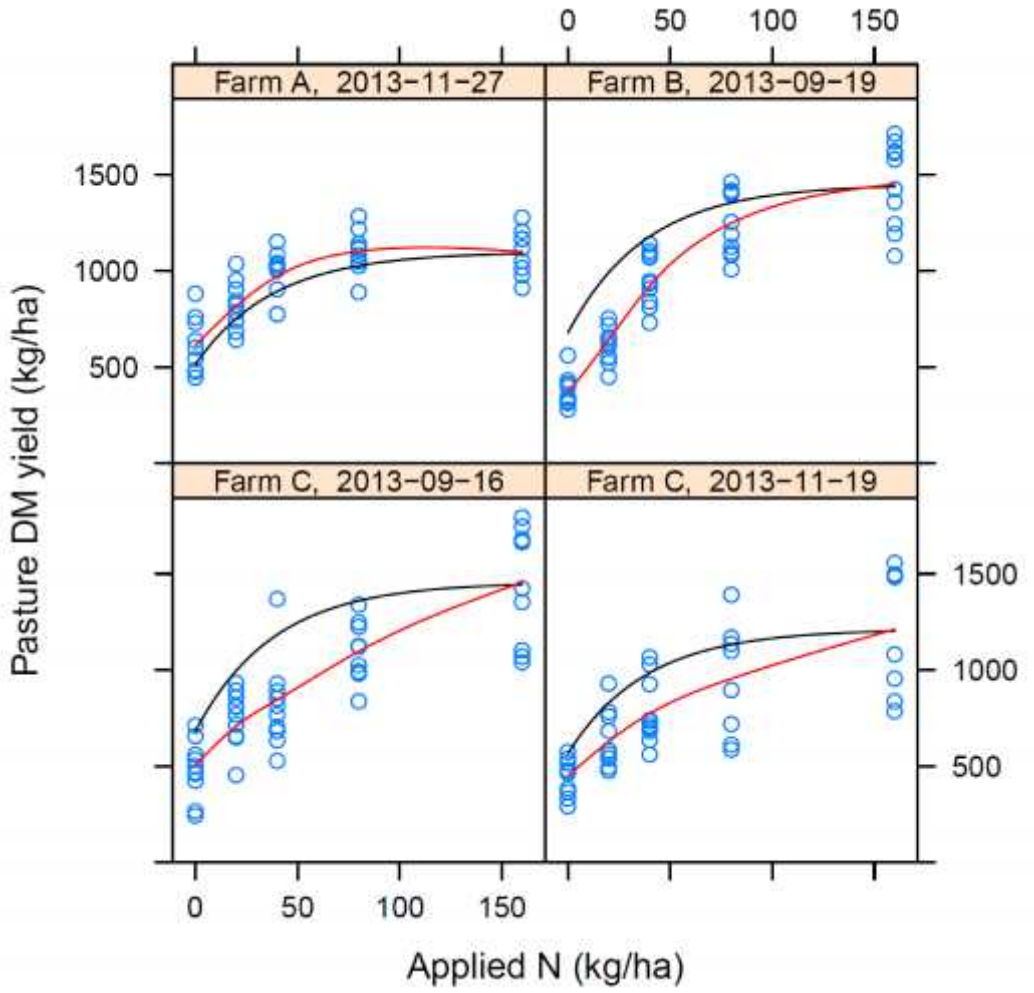
$$\text{Proportion of max DM} = 1 - e^{-a N}$$

$$= \exp(\text{«} \quad + ^{2} \quad + \overline{\quad}_{\text{state.season}} + L \quad + Pa \quad)$$



Validation

- 4 new data sets
  - 4 dates, 3 sites
- Proportional response model
  - Scaled to actual max DM yield
- Slope is critical



Conclusions

- A model for DM yield response to applied N
- Calibrated to 40 years of experimental data
- Expressed as a proportional response
- To be scaled to a maximum DM yield (target)
- Further validation/recalibration
- Assist fertiliser decision making

Kohleth Chia

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