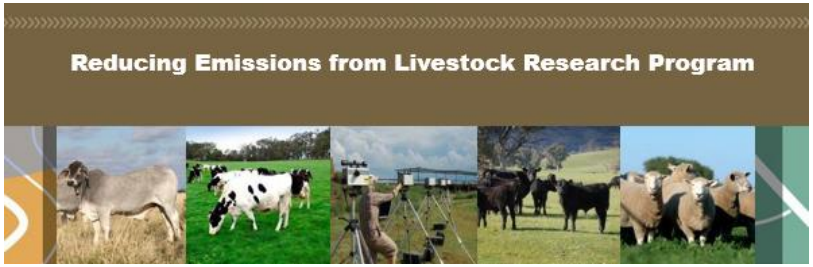
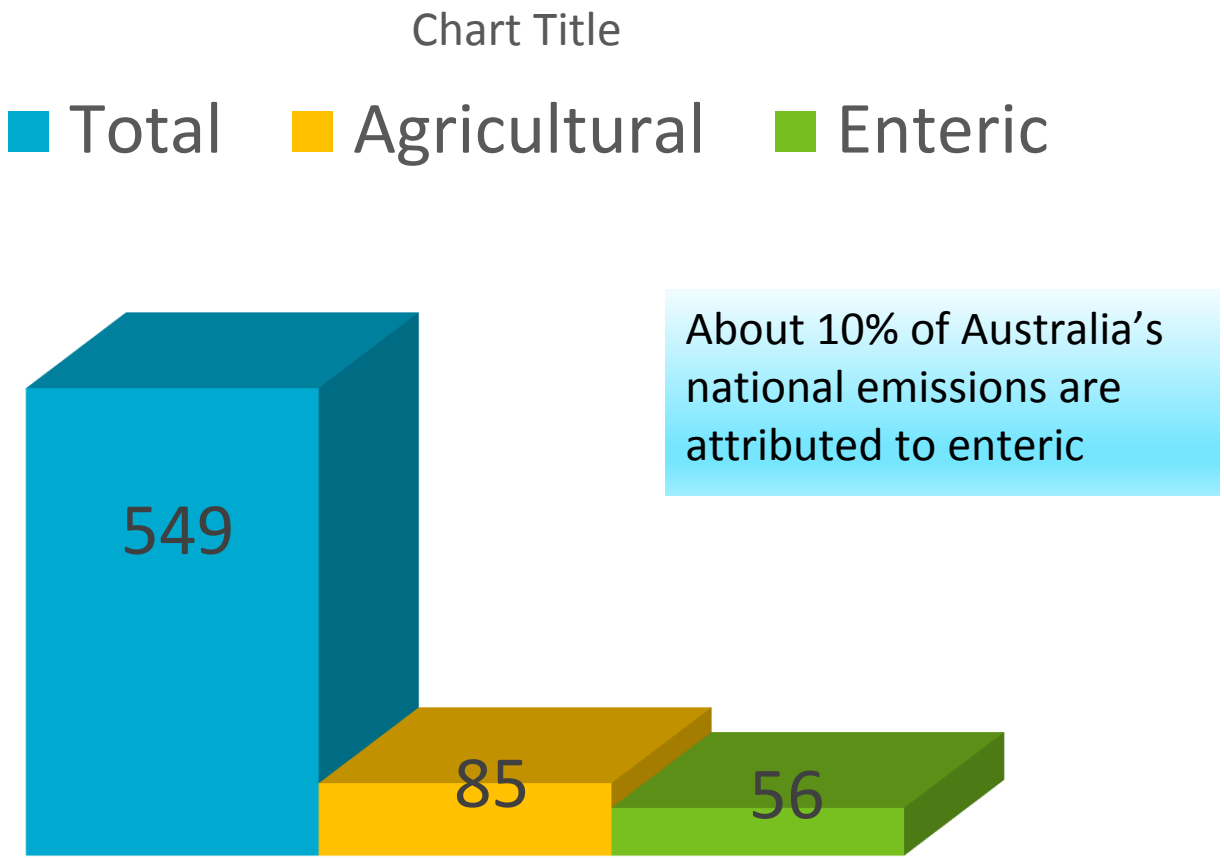
A universal equation to predict methane production of forage-fed cattle in Australia

Ed Charmley
Richard Williams
Peter Moate
Murray Hannah
Roger Hegarty
Robert Herd
Hutton Oddy
Penny Reyenga
Kyran Staunton
Angela Anderson

Australian Government
Department of the Environment

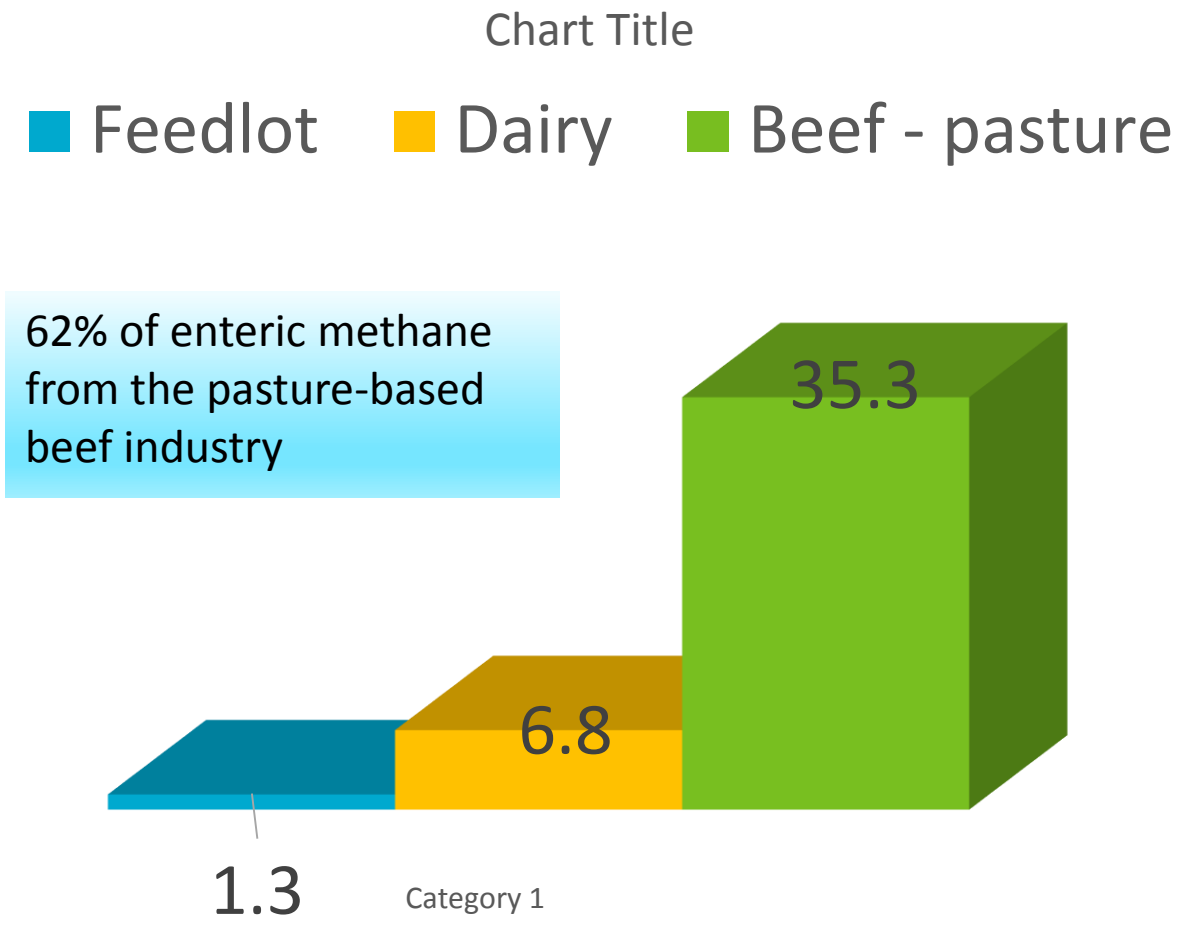


GHG emissions in Australia (million tonnes CO_2 equiv. - 2013)



About 10% of Australia's national emissions are attributed to enteric

Enteric GHG emissions by sector (million tonnes CO_2 equiv. - 2013)



Inventory Methods – Enteric Fermentation

- IPCC Tier 2 method based on gross energy intake (GEI) and a fixed CH_4 conversion rate

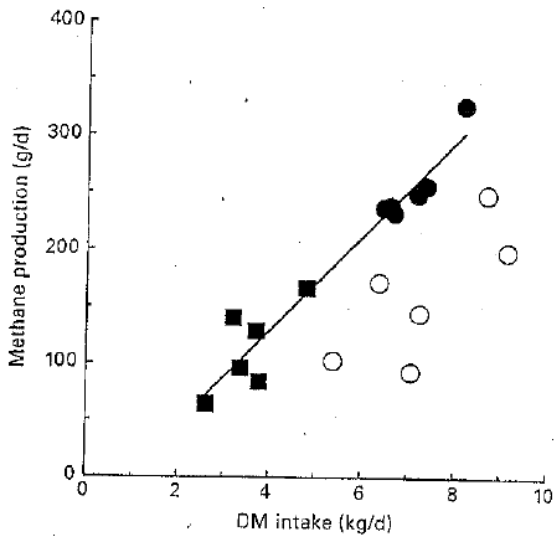
2006 IPCC Guidelines	
All other cattle	6.5% ±1.0

- The Australian methods produced ~ 20% higher conversion rates
  - Tropical cattle – Kurihara et al. (1999 amended by Hunter 2007)
  - Temperate cattle – Blaxter and Clapperton (1965, corrected by Wilkerson et al. 1995)

Australian Methods	Range
Tropical cattle	7.4-9.6%
Temperate cattle	6.1-8.5%

Tropical Cattle method

- Inventory calculation for northern cattle was based on a very small data set of 12 measurements on two forages (Kurihara et al 1999)
  - Angleton grass (*Dicanthium aristatum*), DMD 41%
  - Rhodes grass (*Chloris gayana*), DMD 60%
- Modified by Hunter (2007)
  - MP (g/d) = 34.9 x DMI -30.8



Tropical Cattle – New Empirical Data

- Kennedy and Charmley (2012) studied effects of tropical forage diets on CH_4 emissions from Brahman cattle
- Unable to replicate high rates found by Kurihara et al. (1999).
  - Emission rates more comparable with IPCC defaults

Kennedy and Charmley (2012)	
Methane production (g/d)	19.6 x DMI
Methane production (% of GE)	6.1 %

- Highlighted need to review and revise National Greenhouse Gas Inventory (NGGI) methods. Decision made to :
  - review all forage-fed cattle methods rather than just replace Kurihara et al.
  - develop new method based on Australian measurement data

Developing a New Cattle Method

- Substantial CH_4 dataset available for dairy and beef cattle through recent research programs
  - Reducing Emissions from Livestock Research Program
  - National Livestock Methane Program.

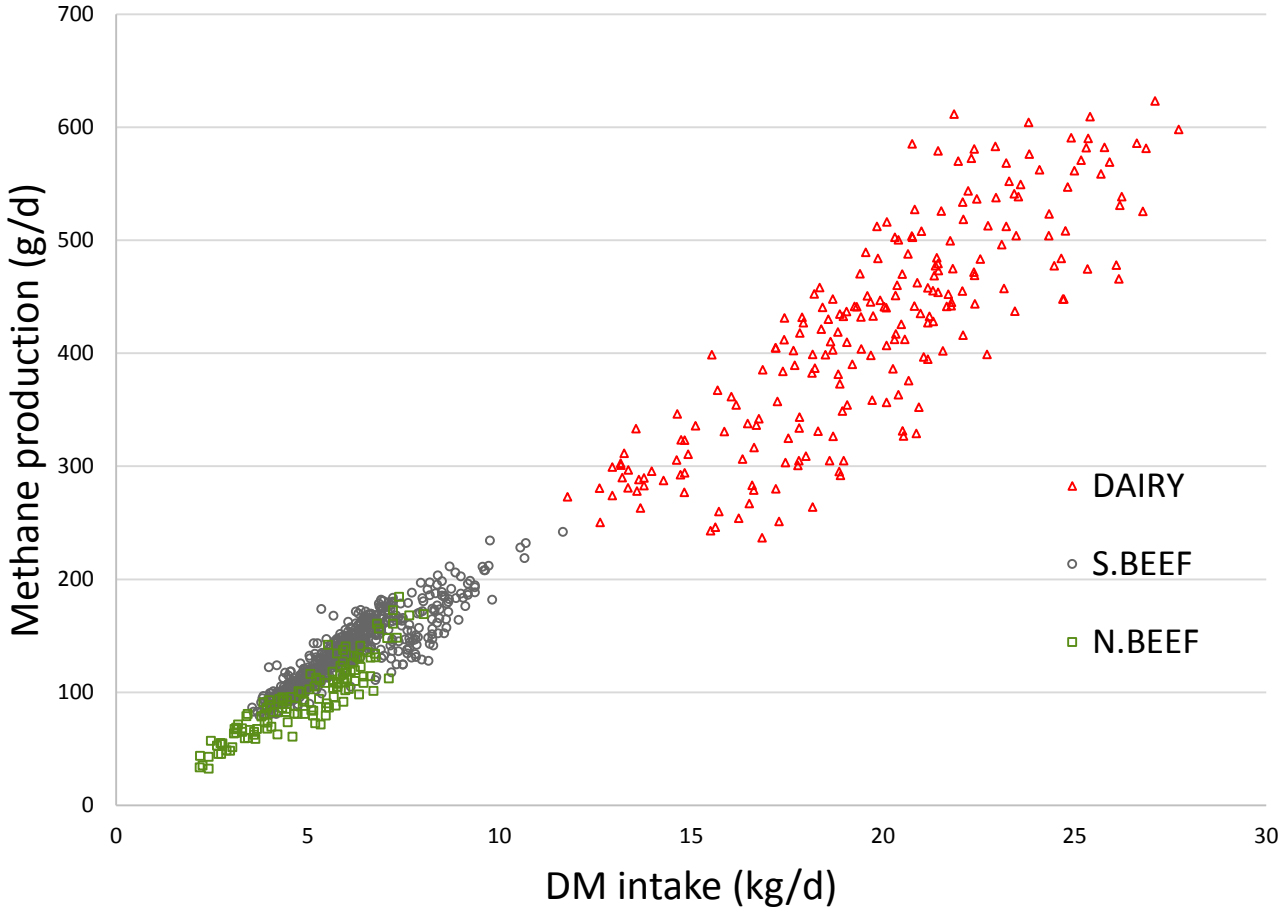
- Department of Environment convened working group to reanalyse the available measurement data and to prepare a paper for publication

- Working Group set following data boundaries:
  - Look for the simplest relationship that adequately described the data
  - Only diets with <30% concentrate
  - Only data from methane chambers
  - Only data from diets known not to inhibit methanogenesis

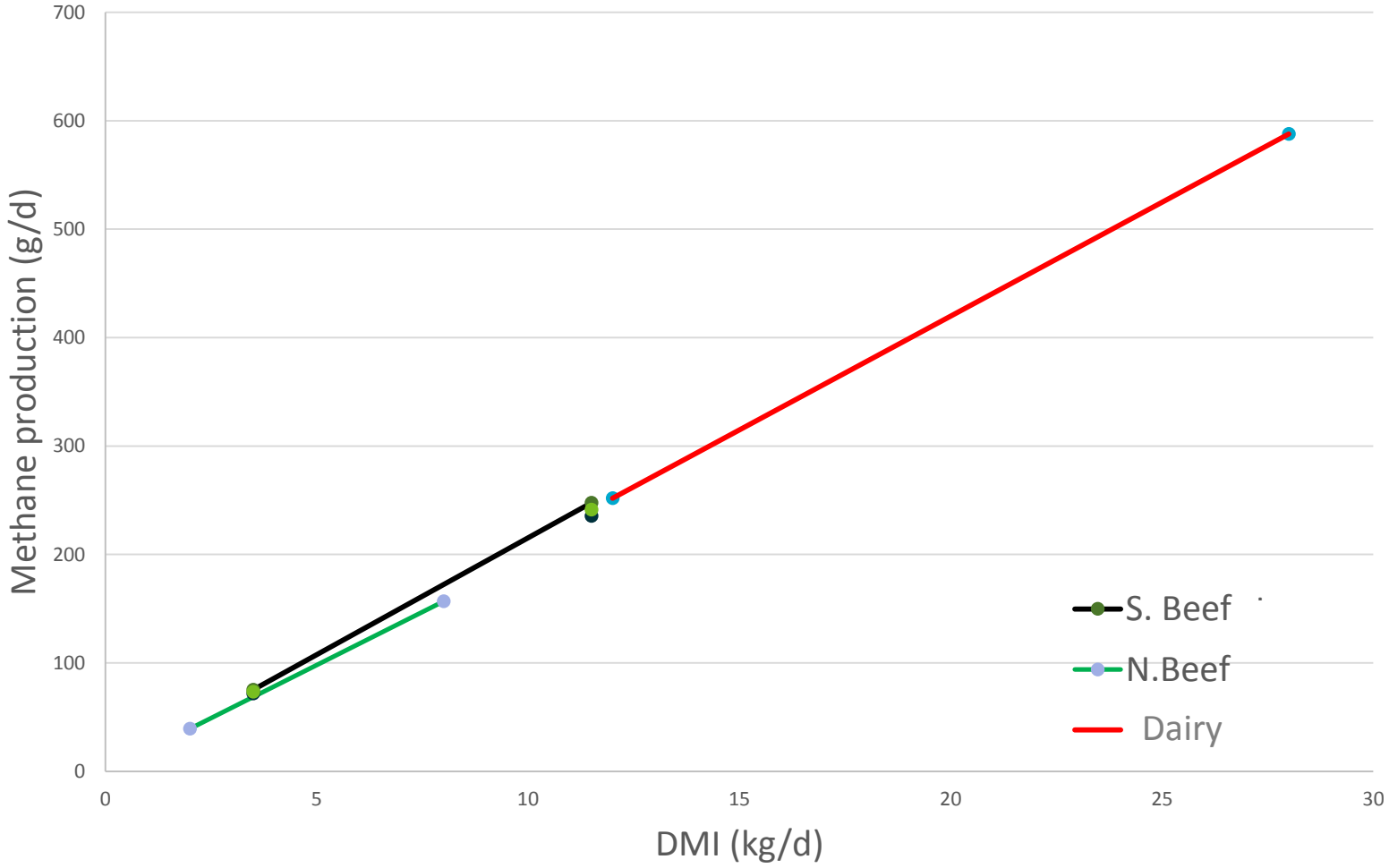
The dataset

	N. Beef	S. Beef	Dairy
Sub-species	*B. indicus*	*B. taurus*	*B. taurus*
Breed	Brahman	Angus	Holstein-Friesian
Class	Growing steers	Growing bulls & heifers	Lactating cows
n	133	680	220
BW (kg)	214 - 425	156 - 640	458 - 706
DMI (kg/d)	2.1 – 8.0	3.5 – 11.6	11.8 – 27.7
MP (g/d)	32 – 184	79 – 241	237 - 623

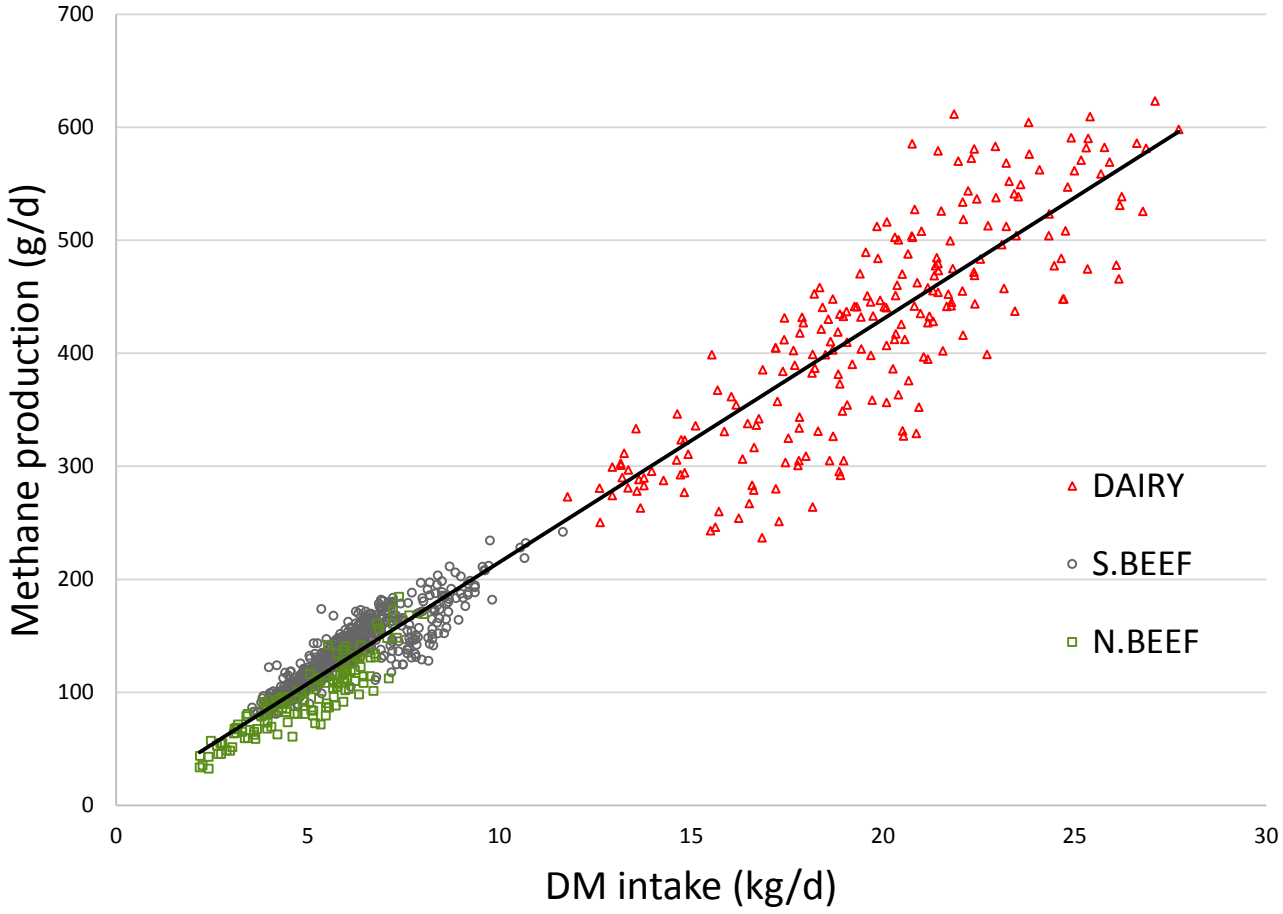
Relationship between methane emissions and DMI



Individual relationships for dairy, southern beef and northern beef cattle.



Relationship between methane emissions and DMI

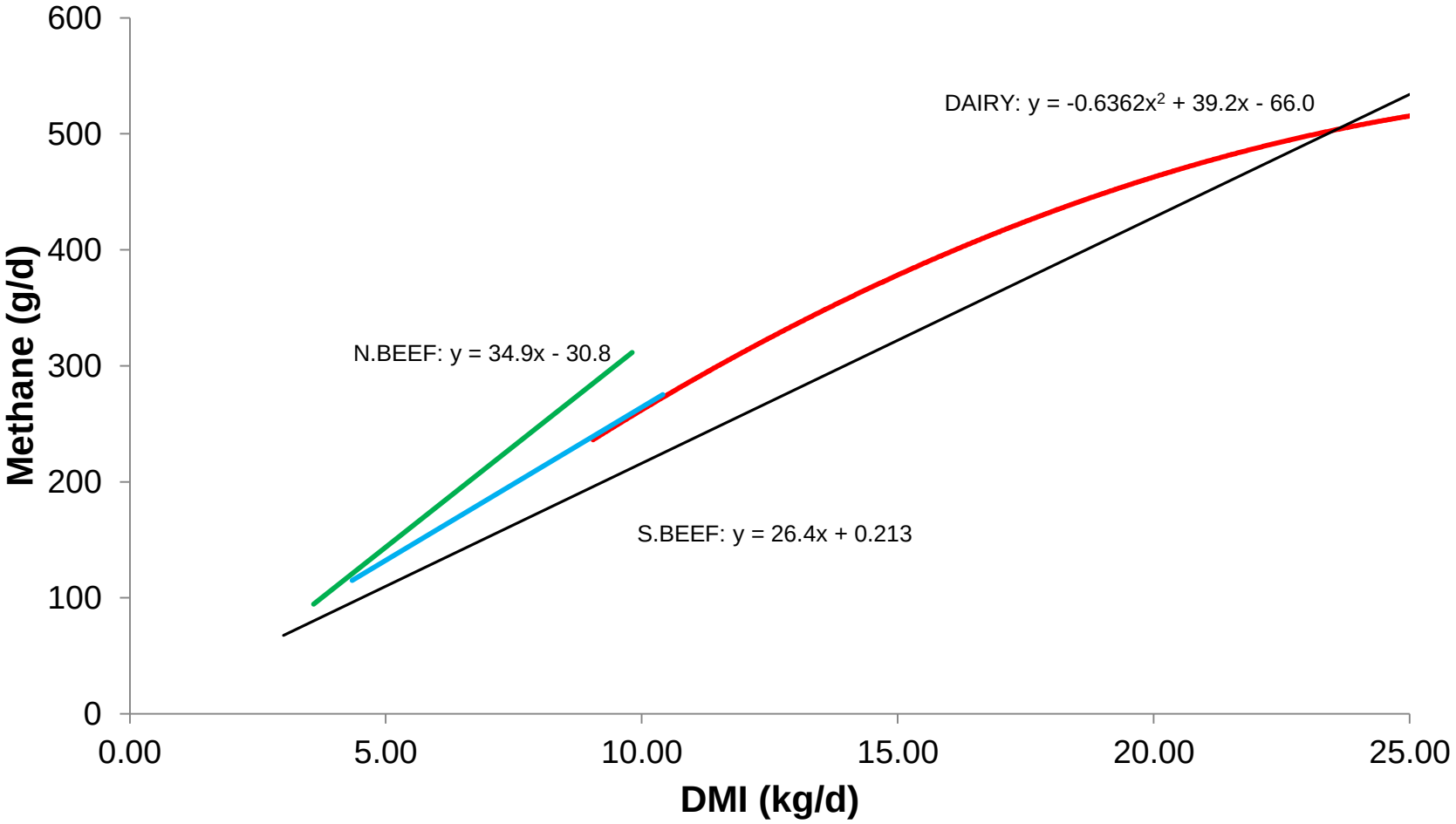


Proposed inventory equations

		95% confidence limit
DMI	MP (g/kg DMI)= 20.7±0.28 x DMI	20.2 - 21.3
GEI	MP(J/J) = 0.063±0.0008 x GEI	0.061 - 0.065

Proposed inventory values	
MP (g/kg DMI)	20.7
MCR (J/100J)	6.3

Comparison of the relationships previously used in the Australian inventory for national greenhouse gas with the new combined relationship.



Limitations of the dataset

- No data on reproductive beef females both temperate and tropical
- No data on growing dairy heifers
- Data limited to three breeds
- Sparse information in the intake range 7 to 12 kg DMI
- S.Beef data from genetics study on one diet
  - Genetic variation but no diet variation
- N.Beef data from small cohort of animals over many diets
  - Diet variation but no genetic variation

Impact of New Method on Inventory (million tonnes CO_2 equiv. - 2013)

Direct impact of change in method — GWP = 21

	Old Method	New Method	Change	Difference (%)
N. beef	23.2	16.4	-6.8	-29
S. beef	14.0	12.2	-1.8	-13
Dairy	6.6	5.9	-0.7	-10
Total	**43.8**	**34.5**	**-9.3**	**-21**

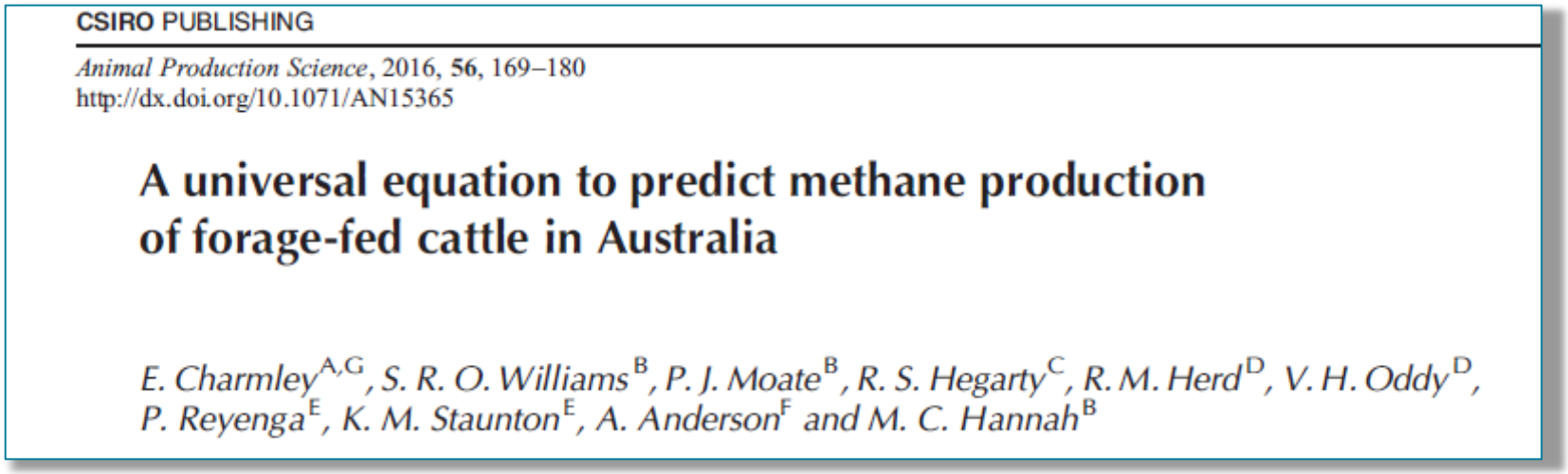
Actual impact on NGGI when new GWP of 25 applied

	Old Method	New Method	Change	Difference (%)
N. beef	23.2	19.5	-3.7	-16
S. beef	14.0	14.5	0.5	4
Dairy	6.6	7.1	0.5	7
Total	**43.8**	**41.1**	**-2.7**	**-6**

Old calculations with new GWP = 52.1

Conclusions

- There is a straight line relationship between methane production and DM intake across a wide intake range (2 to 27 kg/d)
- For forage fed animals
- Based on a dataset of over 1000 observations
- But there are important gaps in the data
- Is the simplest solution the best?



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E. Charmley[A,G], S. R. O. Williams[B], P. J. Moate[B], R. S. Hegarty[C], R. M. Herd[D], V. H. Oddy[D], P. Reyenga[E], K. M. Staunton[E], A. Anderson[F] and M. C. Hannah[B]