Carbon Neutral Agriculture
Methods, Trading, Markets and Tools

Richard Eckard

Primary Industries Climate Challenges Centre

THE UNIVERSITY OF MELBOURNE

Carbon Neutral Agriculture

Industry and policy drivers

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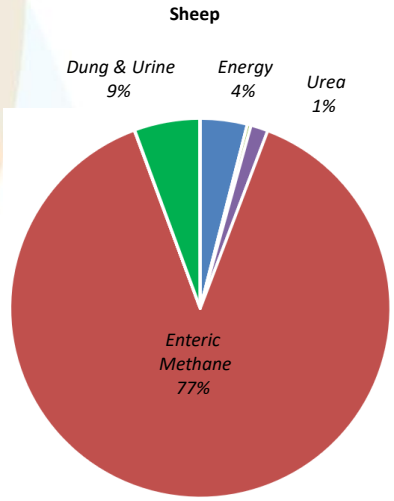
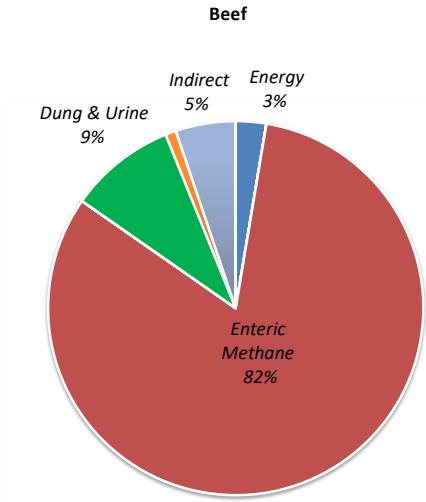
Why Carbon Neutral?
Agricultural emissions

- Methane (10%)
  - Ruminants, waste management
- Nitrous Oxide (3%)
  - Fertilizer, excreta, waste, legumes etc
- Carbon Dioxide
  - Energy, lime, urea application and fertilizer production
- But agricultural land also has the capacity to sequester CO_2 in the soil and into trees

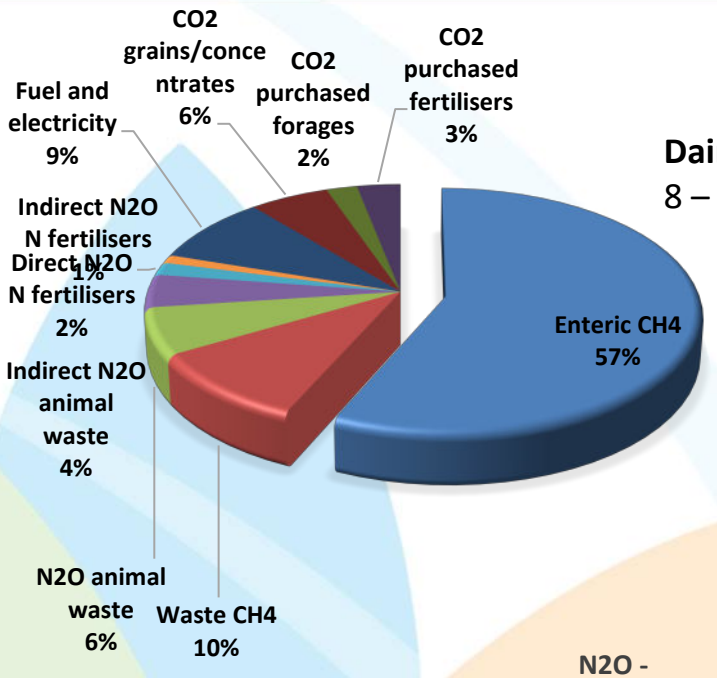


7-9 kg CO_2e/kg CFW+LWT
28-32 kg CO_2e/kg CFW

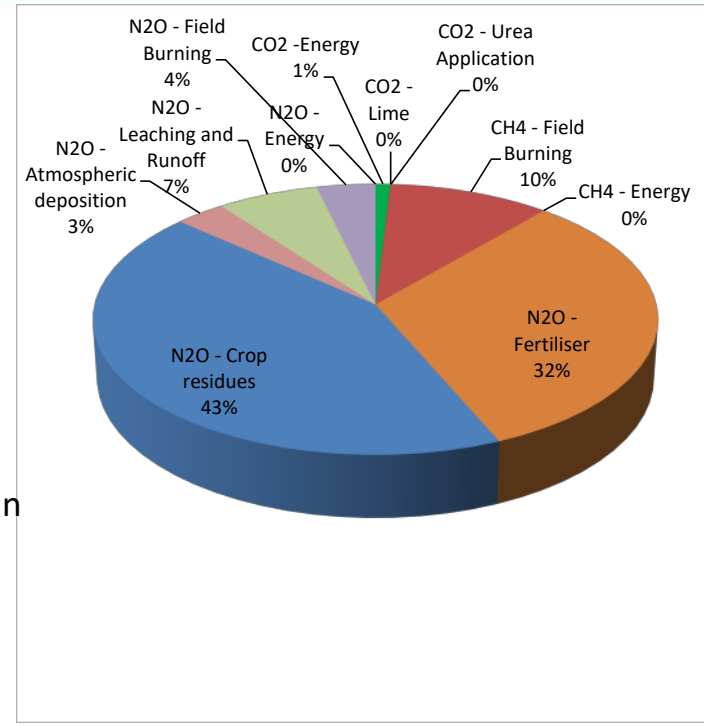


9 - 15 kg CO_2e/kg LWT

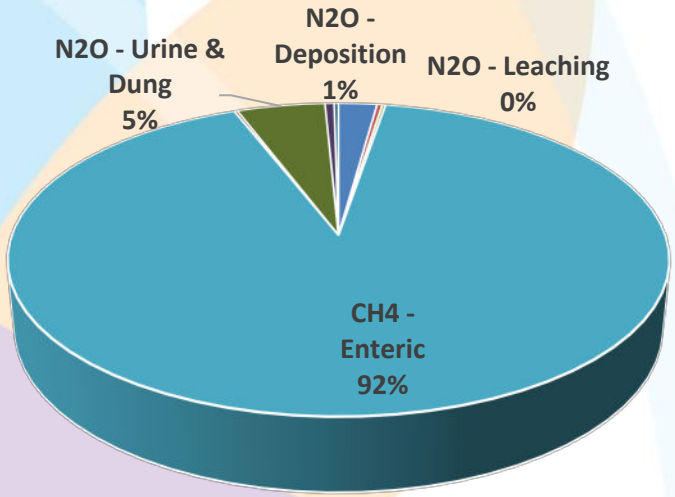
Why Carbon Neutral?
Typical Farm GHG profiles



Dairy
8 – 21 t CO_2 e/t MS



Grains / pulses
0.04 t/CO_2e/t grain

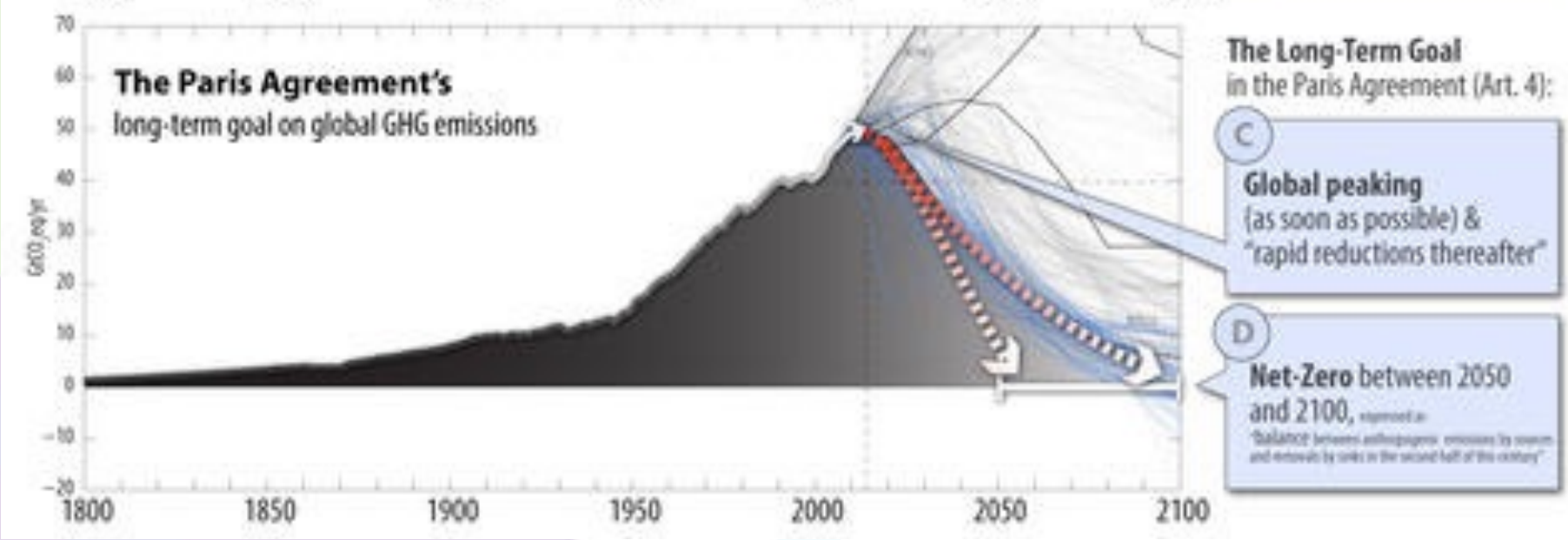


Rangeland Beef
14 t CO_2e/t LWT

Christie *et al*. 2016

International Policy Drivers
COP21 Paris Agreement

- Reach global peaking GHG emissions as soon as possible
  - Achieve a **climate neutral** world by 2050
    - Assumed as net zero GHG, but not required
      - e.g. NZ methane target



COP21 - Paris Agreement
Investors responses

FAIRR | FARM ANIMAL INVESTMENT RISK & RETURN
A COLLER INITIATIVE

Coller FAIRR Protein Producer Index Report

Benchmarking intensive livestock and fish farming on environmental, social and governance issues

FAIRR - an index to analyse livestock production against the Sustainable Development Goals (SDGs).

A resource for institutional investors on risk of investment in livestock.

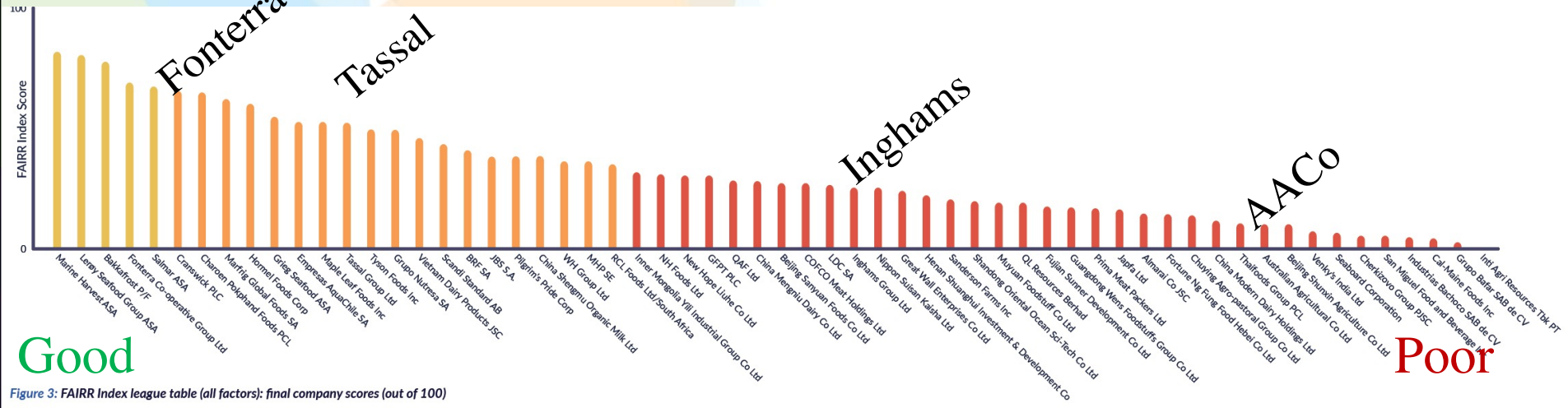


Figure 3: FAIRR Index league table (all factors): final company scores (out of 100)

Carbon Neutral Agriculture
Supply chain responses to Paris Agreement

- Fonterra
  - Climate-neutral growth to 2030 for pre-farmgate emissions from a 2015 base year
- Unilever
  - Reducing the GHG impact of their products by 50% by 2030, compared to baseline of 2010
- Mondelez
  - Reduce absolute GHG from manufacturing 15%
  - 100% renewable energy
- Nestle
  - Zero environmental impact in our operations
- **JBS**
  - Net-zero GHG by 2040 and zero deforestation across its global supply chain by 2035
- **Heineken**
  - Carbon neutral barley-malt supply chain
- **Rabobank**
  - Carbon neutral supply chains
- Mars
  - Reduce GHG across our value chain 27% by 2025 and 67% by 2050 (from 2015 levels)
- Kellogg Company
  - 65% reduction by 2050
  - 100% renewable energy
- Pfizer
  - 60 to 80% by 2050
- Wilmar international
  - 89.72% less GHG from 2013 to 2020
  - 100% renewable energy
- Olam
  - Reduce GHGs by 50% by 2030 both in our own operations and in our supply chain
  - By 2050, we aspire to be carbon positive in operations, requiring a 5% emissions reduction per year from 2031 – 2050

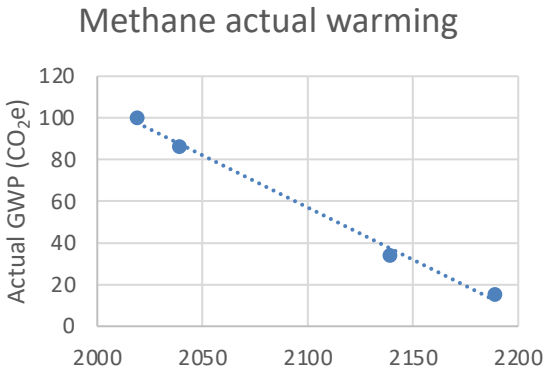
- Of the 100 largest economies 69 are companies and 31 are countries
- Government policy may now be less influential than market forces

COP21 - Paris Agreement
Livestock Industry Responses

- Meat and Livestock Australia
  - Australian beef can be carbon neutral by 2030 (CN30)
    - *Given the right industry, R&D and policy settings*
- Mato Grosso do Sul (MS), Brazil
  - "MS carbon neutral" initiative
    - Including livestock
  - Carbon neutral Brazilian Beef
- New Zealand
  - Proposed Zero Carbon Bill
    - Net zero by 2050 – long lived gasses
      - Includes agriculture
    - Livestock methane target
      - 10% by 2030 and 24% - 47% by 2050 (over 2017)

Australian Beef Sustainability Framework

carbon neutral brazilian beef



COP21 - Paris Agreement
Potential impact on dairy

- Danone purchased SILK/Whitewave (2017)
  - $12.5B Silk brands
    - Fastest growing US food and beverage company
      - 19% annual compound ground 2012 – 2015
    - Total milk sales in US declined 13% (2010-2015)
      - Plant based milks growing at 11% and organic milk at 23%

  - Danone media quotes:
    - "Accelerate our towards **sustainable** and profitable growth"
    - "Healthier and more **sustainable** eating"
      - Code for lower emissions
- Norco Co-Op & CSIRO
  - Milk from precision fermentation
  - *"Eden Brew was created to help build a sustainable food future by creating a dairy solution that is environmentally sustainable and less resource-intensive"* - Eden Milk CEO Jim Fader

COP21 - Paris Agreement
Carbon Neutral Agriculture

- Livestock
  - Arcadian Organic & Natural's Meat Co's
  - Flinders + Co Meats
  - NAPCO
- Wine
  - Ross Hill, Tulloch
  - Cullen

Border Adjustment Tariffs
Tax or be taxed!

- Around 70% of Australian Agricultural product is exported

- Border Adjustment Tariffs
  - USA: President Joe Biden
    - "Failing to curb emissions means America will tax your exports"
    - "to ensure his climate policies do not place US workers and companies at an unfair disadvantage" – Financial Times 26 April 2021
  - The EU's Carbon Border Adjustment Mechanism (CBAM)
    - "The European Parliament …approval to …start taxing imports from countries without a carbon price… by 2023" – Financial Times 11 March 2020

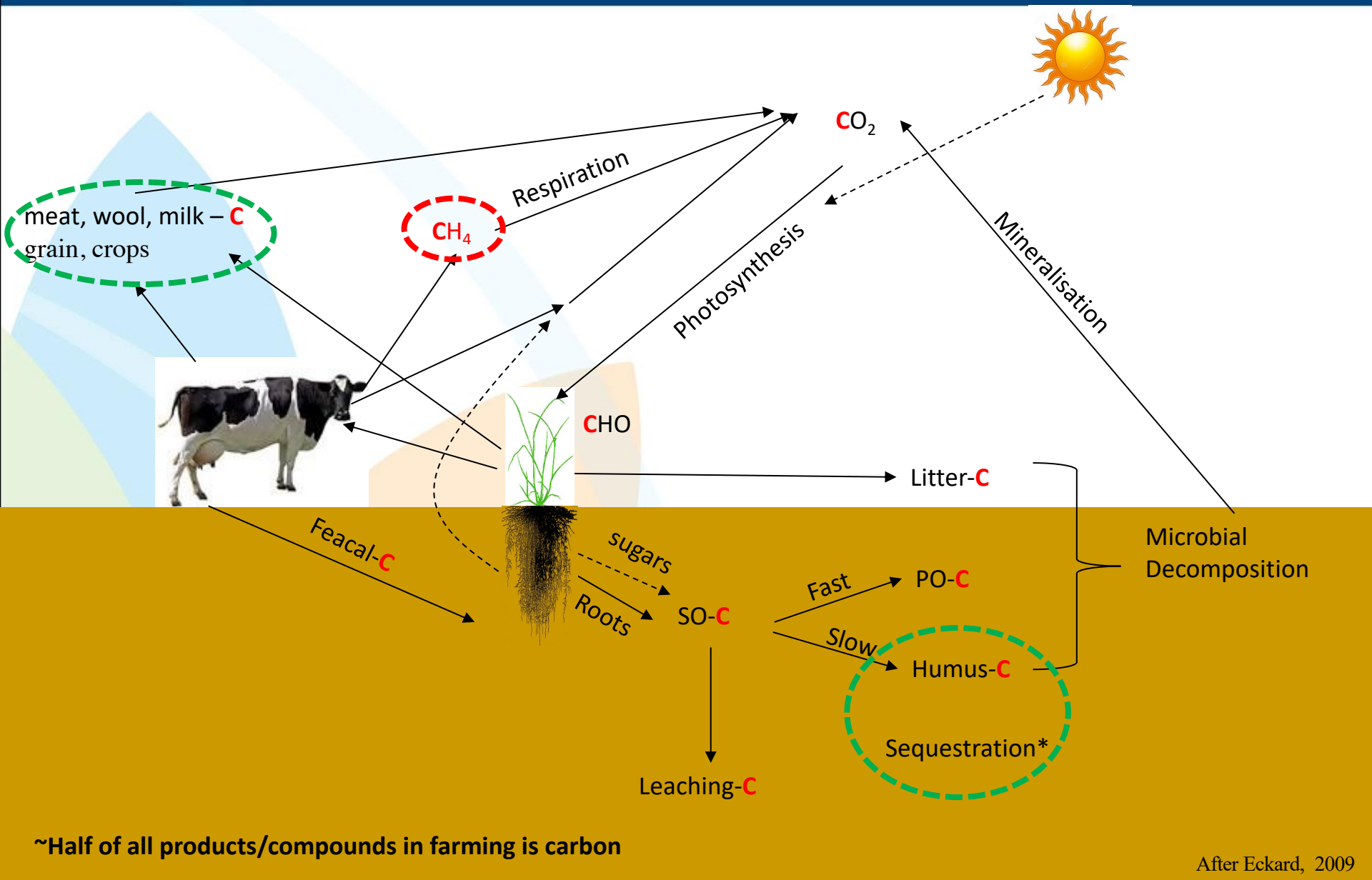
Carbon Farming, Carbon Neutral

- Carbon Farming
  - Management principles that minimise GHGe, maximise carbon sequestration in the landscape, while improving the productivity and resilience of agricultural systems
    - (Aus definition)
- Carbon Neutral (net zero)
  - Management that minimises GHGe, and offsets the balance of emissions through sequestration of an equivalent amount of carbon dioxide in soils or vegetation
    - On an year-by-year basis
    - Implied but not required under the Paris Agreement
    - Early stages of challenge to move to absolute zero
      - Using sequestration only for drawdown
- Climate Neutral
  - Too vague for IPCC glossary
  - No net change in global warming

Carbon Neutral vs Carbon Account

- Carbon account (CA)
  - Traditionally referred to as Net Emissions (NE = t CO2e / business unit)
  - All GHG emissions arising within the operational and organisational boundary of the farm enterprise.
    - Scope 1 - emissions and sources of sequestration.
    - Scope 2 - emissions from electricity
    - Scope 3 - Some pre-farm emissions
- Carbon footprint (CF)
  - Traditionally referred to as emissions intensity (EI = t CO2e/t product)
  - Life cycle of all products produced
  - Includes pre-farm emissions from purchases and livestock

The Carbon Cycle in Agriculture



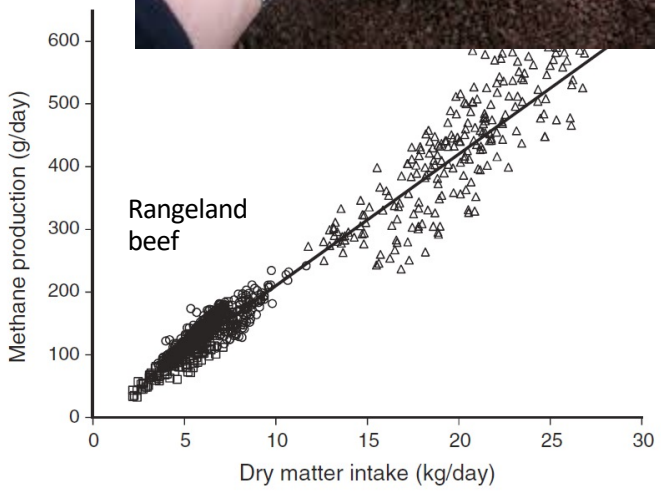
~Half of all products/compounds in farming is carbon

After Eckard, 2009

What can be done on farm now?
Methane

Factors affecting enteric methane loss

- Rumen passage rate/digestibility
  - Time producing methane
- Forage quality/ grain
  - More propionate
- Rumen pH
  - More acid = less CH_4
- Rumen O_2
- Secondary compounds
  - Tannins, saponins, nitrate, sulphate, oils



Charmley *et al.* (2016)

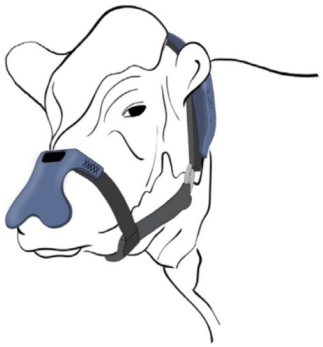
Options for reducing Enteric Methane

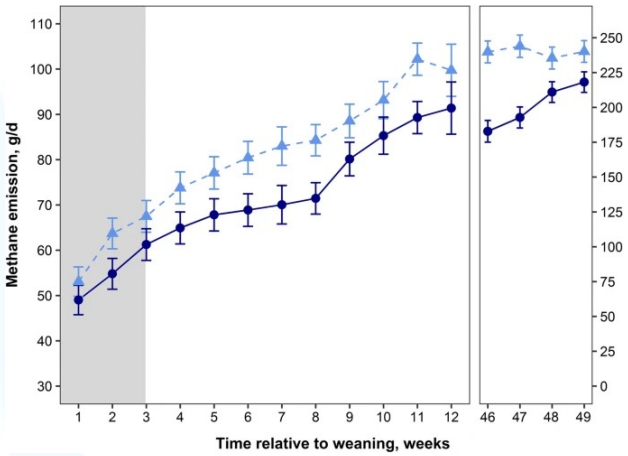
Now

- Management (10%)
  - Efficiency, health, fertility
- Forages (10-15%)
  - Digestibility / grain
  - Legumes / tannin
    - Leucaena, Lucerne, Vetch, Lotus
- Supplements (10-20%)
  - Oils, tannins
    - Grape marc
  - Nitrates, sulphates
- Breeding (1%/yr)
  - Plants
  - Animals

Future

- Vaccine (20%)
- Inhibitors (>80%)
  - Seaweed
  - 3-NOP
- Catalytic oxidation
  - Wearable device
- Early life programming

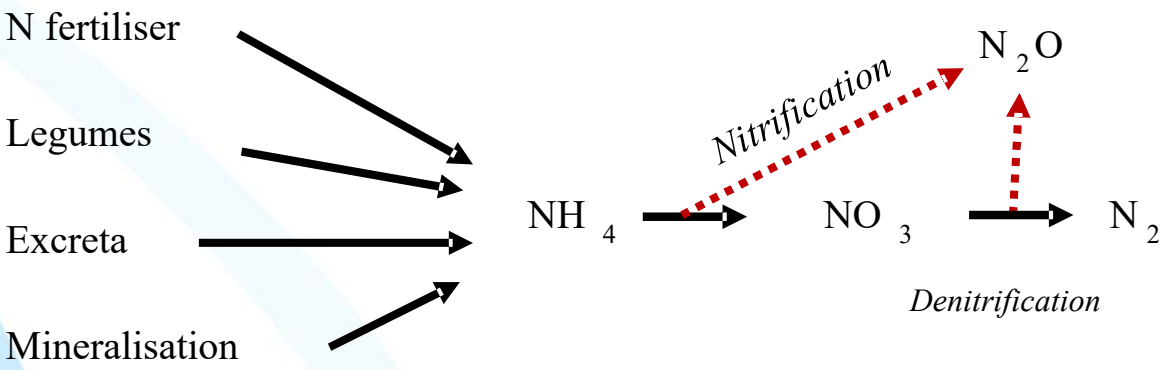




Charmley *et al.* 2016; Grainger et al. (2009); Moate et al. (2011; 2014; 2016); Williams et al. (2019); Van Nevel and Demeyer (1996); Machado et al. (2014); Li et al. (2018); Eckard and Clark (2018); Li et al. (2018), Meale *et al.* (2021)

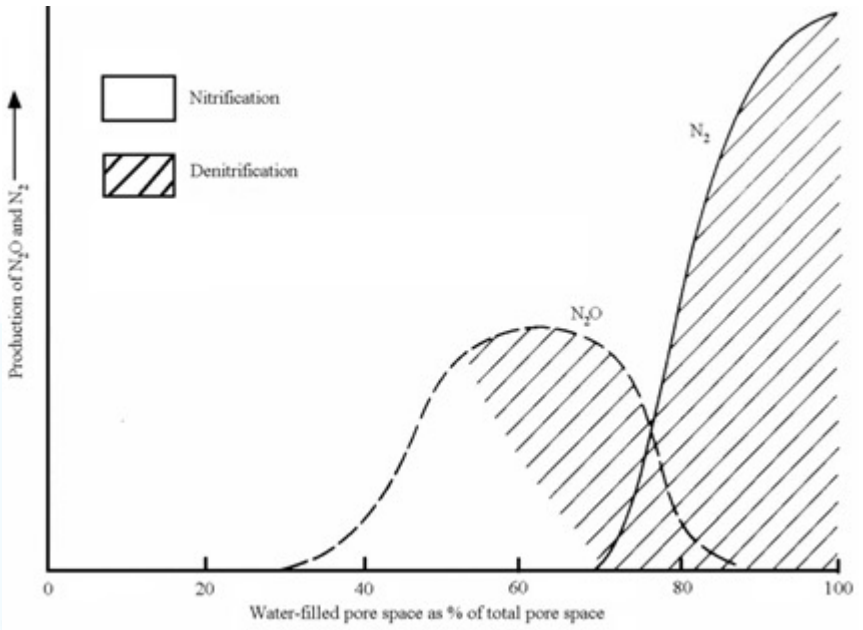
What can be done on farm now?
Nitrous oxide

Nitrous Oxide - Drivers



Factors affecting N_2O:

- Soil Nitrogen
- Soil Temperature
- Soluble C
- Soil pH
- Soil O_2
  - Saturation
  - Compaction



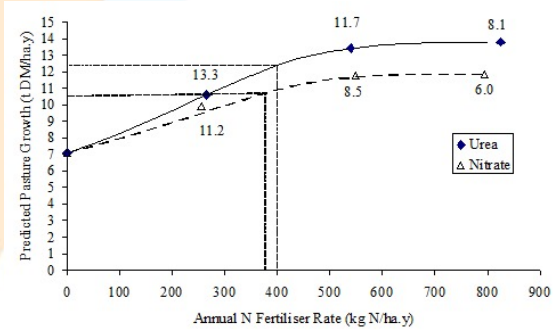
Options for reducing nitrous oxide loss

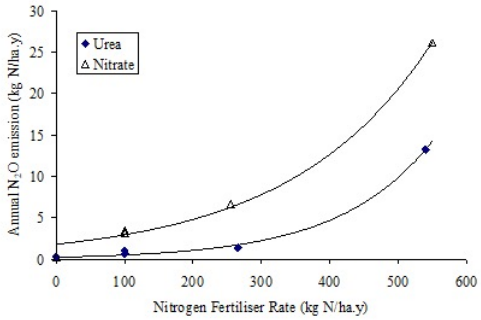
Input management

- N fertiliser & organic inputs
  - Rate, source, timing, placement
  - Formulation
    - Slow release N
    - Inhibitors (urease + nitrification)
- Legumes
  - Less urea N
  - Included in crop rotations
- Animals
  - Urine = liquid urea
  - Balance ME:CP

Soil management

- More efficient use of soil N
- Less saturation & compaction
- Less soil disturbance

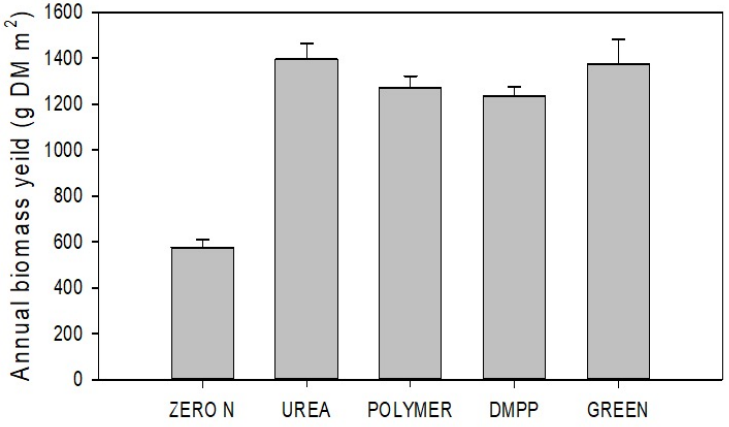




Eckard R.J. et al. (2006); Christie et al. (2018); Smith et al. (2018)

Nitrous oxide
Enhanced Efficiency Fertilisers

- Nitrification inhibitors
  - DMPP (e.g. ENTEC coated-urea)
  - DCD (e.g. Eco-N)
    - Coated-urea fertiliser
    - Pasture spray (in NZ)
- Urease inhibitors
  - e.g. green urea
- Controlled Release N
  - Polymer, oil-based coating, reduced solubility
- Limited productivity responses
    - BUT
  - Reduce the N rate by expected N loss savings

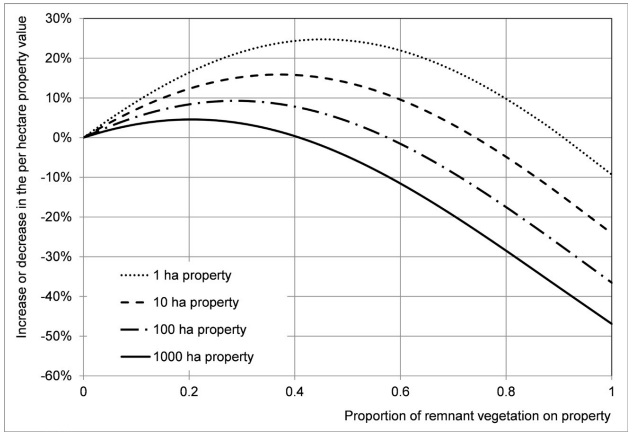


Di et al. 2010; de Klein et al. (2010); NZAGRC (2016); Dougherty et al. (2016); Rowlings et al. (2016); Suter et al. (2016); Nauer et al. (2018)

What can be done on farm now?
Trees on Farm

Rethinking trees on farm

- Trees for carbon credits
  - Struggle to match milk value of land
    - Leddin et al. (2012)
- Combining multiple benefits
  - Salinity, biodiversity, aesthetics, shade and shelter, heat and cold stress, nutrient sinks
  - Capital appreciation
    - 20% tree coverage = 4 - 8% property value



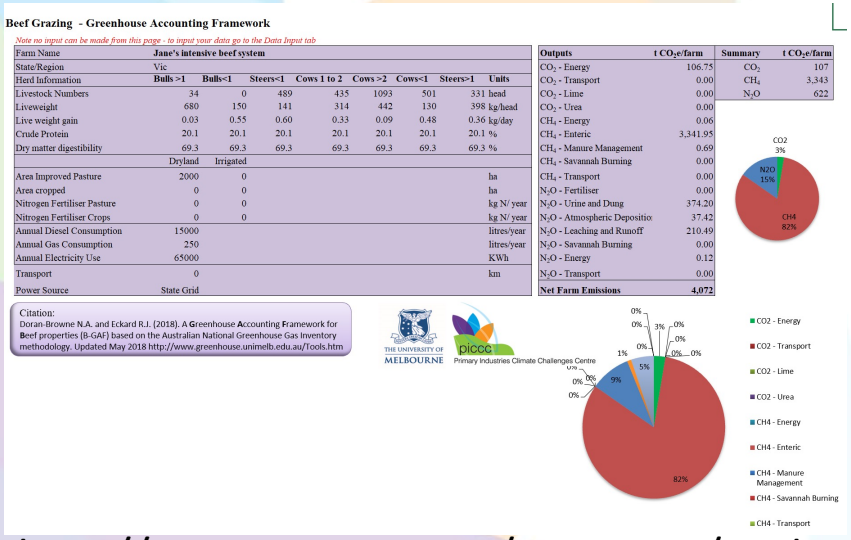
- How do we design trees on farm for these multiple objectives?

Leddin et al. (2012); Polyakov et al. (2015)

Carbon Accounting Tools

National Carbon Offset Standard => Climate Active

- Greenhouse Gas emissions
  - Consistent with NIR
  - – Sheep & Beef – GAF
  - – Grains – GAF
  - – Dairy – GAS/GAF
  - – Feedlot – GAF



Beef Grazing - Greenhouse Accounting Framework

Note no input can be made from this page - to input your data go to the Data Input tab

Farm Name	Jane's intensive beef system							
State/Region	Vic							
Herd Information	Bulls >1	Bulls<1	Steers<1	Cows 1 to 2	Cows >2	Cows<1	Steers>1	Units
Livestock Numbers	34	0	489	435	1093	501	331	head
Liveweight	680	150	141	314	442	130	398	kg/head
Live weight gain	0.03	0.55	0.60	0.33	0.09	0.48	0.36	kg/day
Crude Protein	20.1	20.1	20.1	20.1	20.1	20.1	20.1	%
Dry matter digestibility	69.3	69.3	69.3	69.3	69.3	69.3	69.3	%
	Dryland	Irrigated						
Area Improved Pasture	2000	0						ha
Area cropped	0	0						ha
Nitrogen Fertiliser Pasture	0	0						kg N/ year
Nitrogen Fertiliser Crops	0	0						kg N/ year
Annual Diesel Consumption	15000							litres/year
Annual Gas Consumption	250							litres/year
Annual Electricity Use	65000							KWh
Transport	0							km
Power Source	State Grid							

Outputs	t CO_2e/farm	Summary	t CO_2e/farm
CO_2 - Energy	106.75	CO_2	107
CO_2 - Transport	0.00	CH_4	3,343
CO_2 - Lime	0.00	N_2O	622
CO_2 - Urea	0.00		
CH_4 - Energy	0.06		
CH_4 - Enteric	3,341.95		
CH_4 - Manure Management	0.69		
CH_4 - Savannah Burning	0.00		
CH_4 - Transport	0.00		
N_2O - Fertiliser	0.00		
N_2O - Urine and Dung	374.20		
N_2O - Atmospheric Depositio	37.42		
N_2O - Leaching and Runoff	210.49		
N_2O - Savannah Burning	0.00		
N_2O - Energy	0.12		
N_2O - Transport	0.00		
Net Farm Emissions	**4,072**		

Citation:
Doran-Browne N.A. and Eckard R.J. (2018). A Greenhouse Accounting Framework for Beef properties (B-GAF) based on the Australian National Greenhouse Gas Inventory methodology. Updated May 2018 http://www.greenhouse.unimelb.edu.au/Tools.htm

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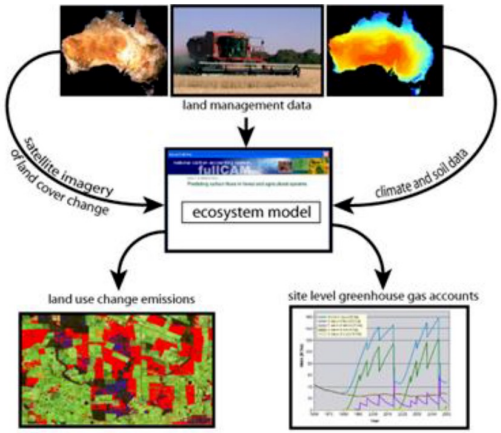
piccc Primary Industries Climate Challenges Centre

http://www.piccc.org.au/resources/Tools

- Carbon stocks and fluxes
  - – FullCam
    - Soil carbon
    - Vegetation carbon
  - – **Note – only fluxes count!**



In Short

- Agriculture is moving to lower emissions
  - Supply chain is driving this
- Perennial horticulture
  - Low N inputs and low soil disturbance
    - Perhaps easier CN target e.g. viticulture
- Cropping systems / Annual horticulture
  - Depends on tillage and N fertiliser inputs
- Livestock
  - Methane and urine-N are big issues
    - Emerging technology for 80% reduction
  - Would still need to keep our offsets/ trees

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