Cotton and Carbon Farming

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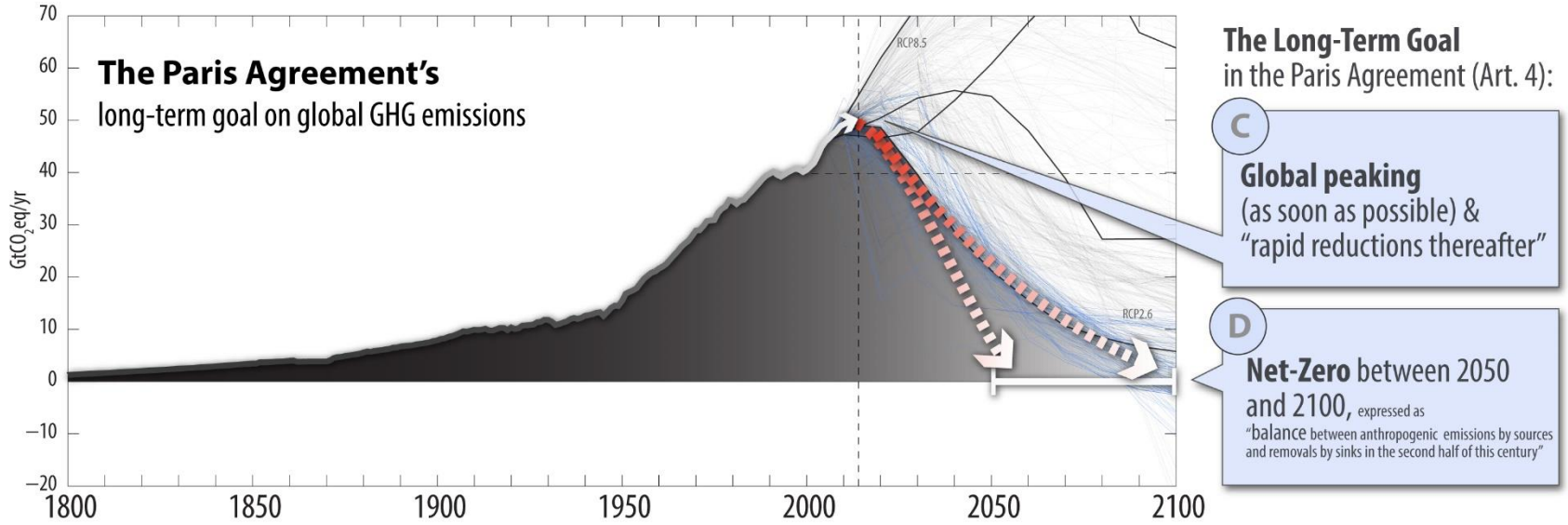
Who is asking for low emissions production?

COP21 Paris Agreement



- Reach global peaking GHG emissions as soon as possible
  - Achieve a balance between anthropogenic emissions by sources and removals by 2050
  - COP26 - Increased 2030 ambition

Source: Malte Meinshausen 2015

Supply chain responses to Paris Agreement

- Rabobank & NAB
  - Net zero financed emissions by 2050
  - Hold 50% of Australia agri-debt market
- 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
- Cargil
  - Reduce our global supply chain emissions 30% by 2030 and net zero by 2050
- etc ……

  - Of the 100 largest economies 69 are companies and 31 are countries
  - 70% of Australian farm produce is exported

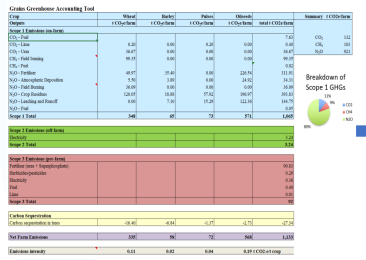
Source: Company sustainability reports https://oxfamapps.org/fp2p/the-worlds-top-100-economies-31-countries-69-corporations/

How will the supply chain achieve their targets?

- Supply chains will need to meet their targets
- All suppliers will conduct GHG audit
  - Data sent to supply chain buyer
- Purchaser starts buying at lowest GHG intensity
  - The higher GHG they purchase costs them more carbon offsets

t CO_2e/Bale

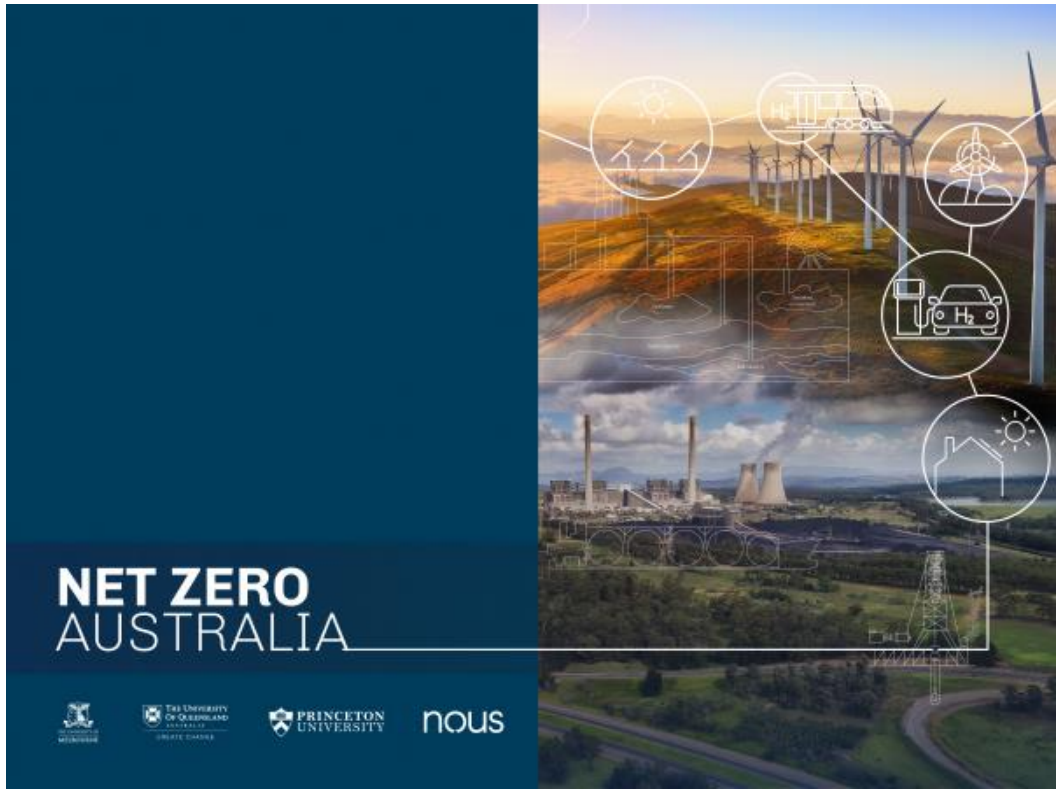
0.20 0.25 0.30 0.35 0.40 0.45 0.50



Key Conclusion from Net Zero Australia plan

- Agriculture will need to **inset** ALL their own soil and tree carbon
  - Maintain supply chain access post 2030
- There are no surplus offsets in agriculture!

Planting ALL wheat land in WA, will provide the NW-WA mining industry with max 50% offset for 25 years – but the wheat industry is gone

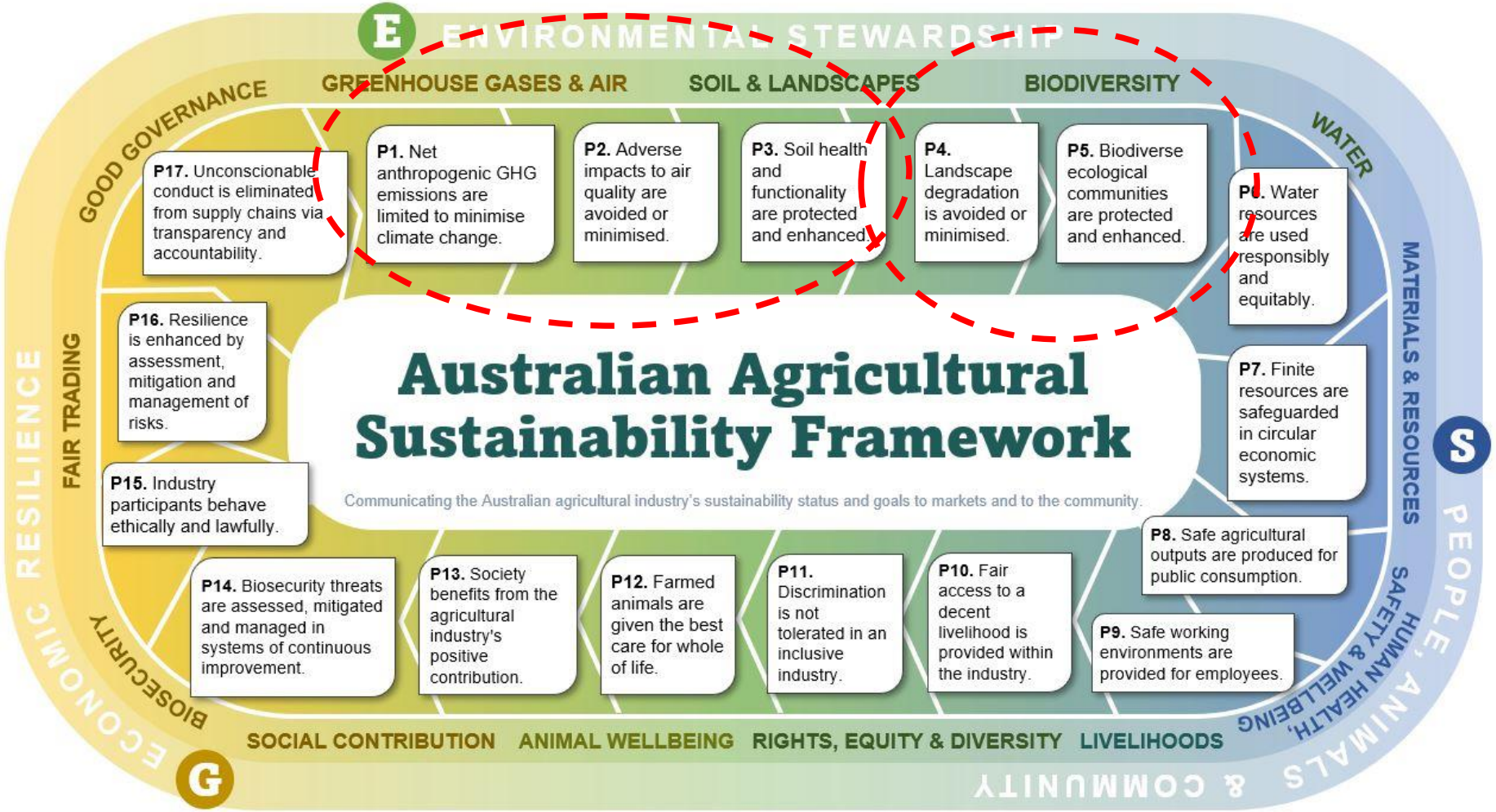


Marketing Carbon Neutral or Carbon Credits

- To 2030
  - Access to premium markets
    - e.g. carbon neutral wine
- Post 2030
  - Future compliance with supply chain targets
    - **Insetting** not offsetting

- Fundamental difference between
  - Carbon sequestration offset
    - Finite accumulating stock
    - Will need these stocks as an INSET
  - Emissions avoidance offset = flux
    - e.g. Inhibitor coated urea
    - Could sell these up to 2030 then inset

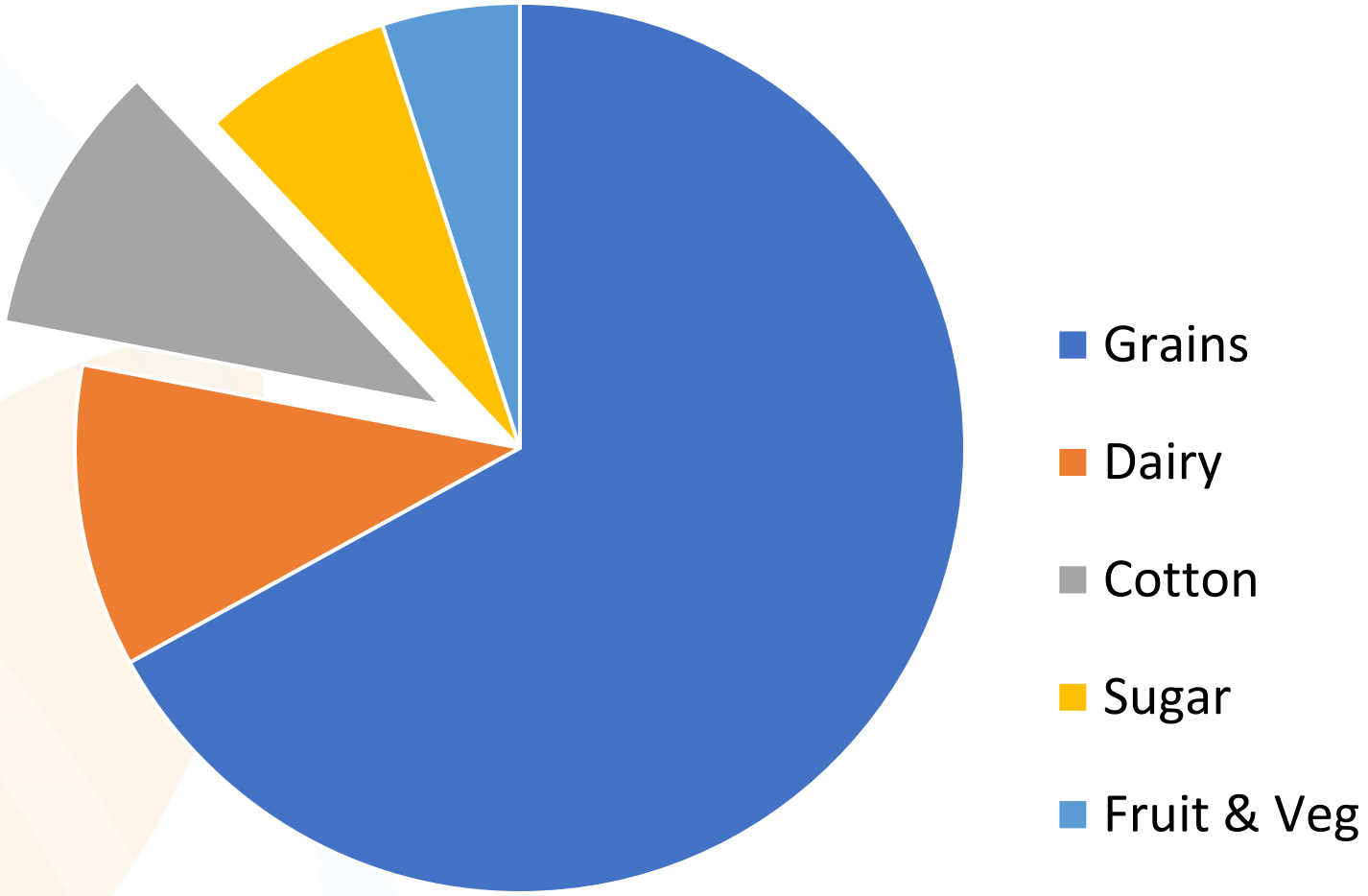
The Australian Agricultural Sustainability Framework



https://www.farminstitute.org.au/the-australian-agricultural-sustainability-framework/

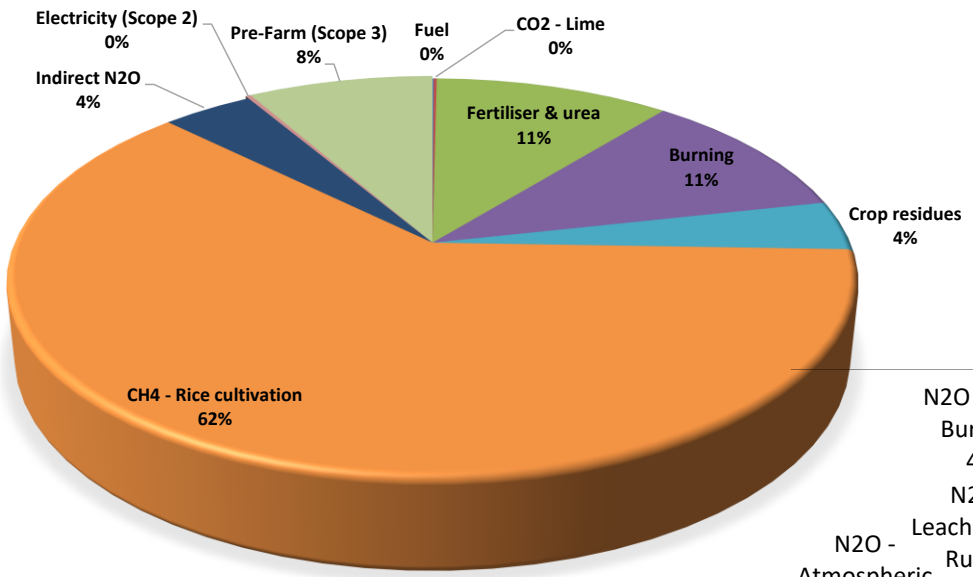
What are the emissions from various agricultural systems?

Nitrogen fertiliser use in Australia

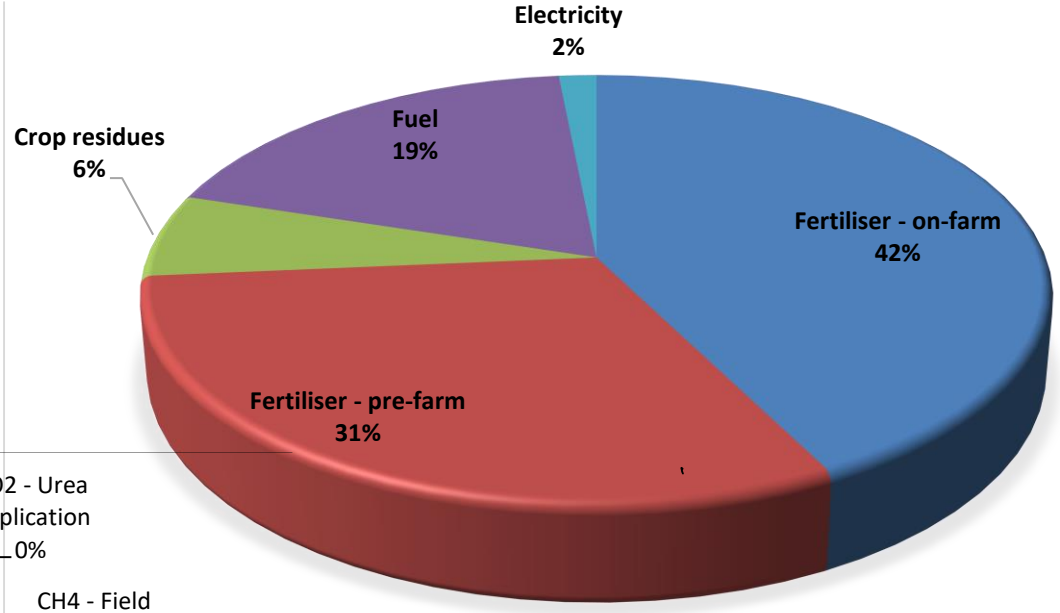


IFA (2017)

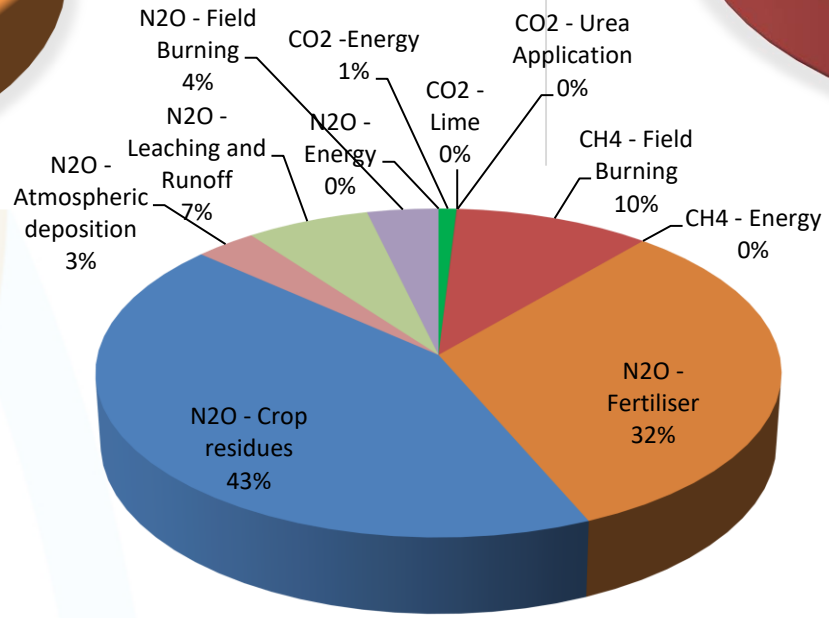
Greenhouse Gas Emissions: Typical Farm GHG Profiles



Rice



Cotton



Grains / pulses

11 Abbott et al.(2016); Eckard et al. (2022)

Potential for net zero?

- Chicken meat
  - 3 to 5 kg CO_2e/kg LWT
- Pigs
  - 4 to 7 kg CO_2e/kg LWT
- Cropping
  - 0.10 to 0.75 kg CO_2e/kg grain
  - 0.20 - 0.35 t CO_2e/ cotton bale
- Dairy
  - 8 to 21 t CO_2e/t MS
- Beef
  - 11 to 18 kg CO_2e/kg LWT
- Sheep
  - 6 to 8 kg CO_2e/kg LWT
- Wool
  - 21 to 28 kg CO_2e/kg wool
- Wine
  - 0.6 to 4.7 kg CO_2e/L

- Pigs and poultry
  - Manure management
  - Renewable energy
- Wine & perennial hort
  - 100% achievable
- Extensive grazing
  - 0-20% may be possible

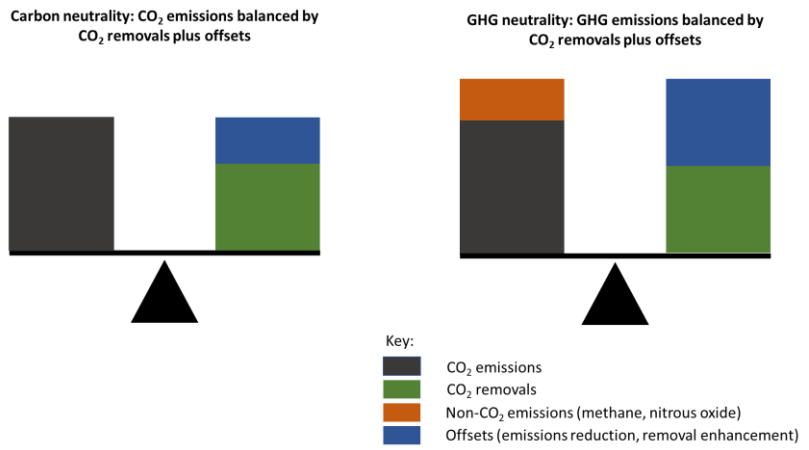
- Cotton
  - 50% possible but ….

Wiedeman *et al.* (2015); Browne *et al.* (2011); Alvarez-Hess et al. (2019); Abbott *et al.* (2016)

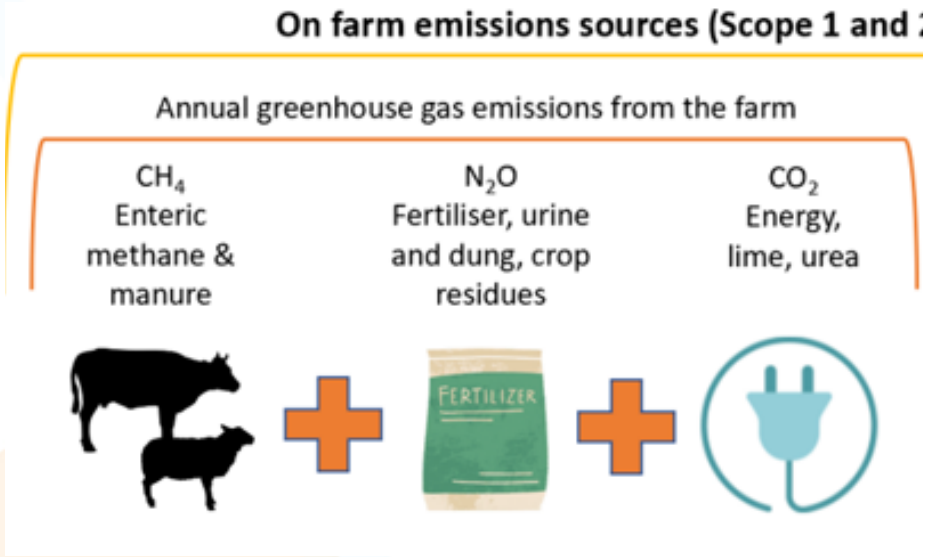
How do we account for carbon farming?

What is Carbon Farming and Carbon Neutrality?

- Net Zero
  - Management that balances GHGe against carbon sequestration (storage) in soils or vegetation (annually on a CO_2e basis)
- Carbon Neutral
  - Management that **first** minimises GHGe, and **then** balances the (small) remaining emissions through carbon sequestration in soils or vegetation (annually on a CO_2e basis)



Carbon Accounting: The concept



Source: Agriculture Victoria

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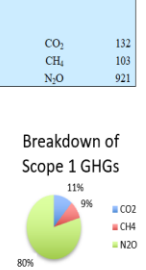
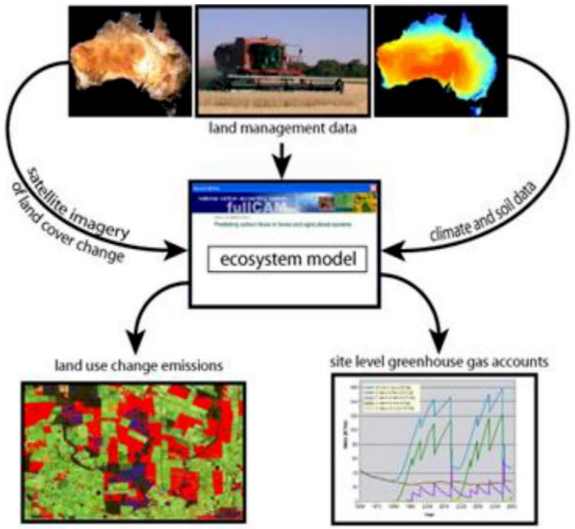
Carbon Accounting Tools

- Greenhouse Gas emissions
  - Sheep & Beef (SB-GAF)
  - Cropping (G-GAF), Rice (R-GAF)
  - Dairy (D-GAF/DGAS)
  - Feedlot, Pork, Poultry
  - Buffalo, Deer
  - **Cotton,** Sugar, Horticulture
- Carbon stocks and fluxes
  - Direct measurement and/ or
  - Model
    - Soil carbon (FullCam/ FlintPro / Socrates)
    - Vegetation carbon (FullCam / FlintPro/ Looc-C/ Cibo Labs)

Grains Greenhouse Accounting Tool

Crop	Wheat	Barley	Pulses	Oilseeds		Summary	t CO2e/farm
Outputs	**t CO_2e/farm**	**t CO_2e/farm**	**t CO_2e/farm**	**t CO_2e/farm**	**total t CO2e/farm**		
Scope 1 Emissions (on-farm)							
CO_2 - Fuel					7.63	CO_2	132
CO_2 - Lime	0.20	0.00	0.20	0.00	0.40	CH_4	103
CO_2 - Urea	36.67	0.00	0.00	0.00	36.67	N_2O	921
CH_4 - Field burning	99.35	0.00	0.00	0.00	99.35		
CH_4 - Fuel					0.02		
N_2O - Fertiliser	49.97	35.40	0.00	226.54	311.91		
N_2O - Atmospheric Deposition	5.50	3.89	0.00	24.92	34.31		
N_2O - Field Burning	36.09	0.00	0.00	0.00	36.09		
N_2O - Crop Residues	120.05	18.88	57.92	196.97	393.83		
N_2O - Leaching and Runoff	0.00	7.10	15.29	122.36	144.75		
N_2O - Fuel					0.05		
Scope 1 Total	**348**	**65**	**73**	**571**	**1,065**		
Scope 2 Emissions (off-farm)							
Electricity					3.24		
Scope 2 Total					**3.24**		
Scope 3 Emissions (pre-farm)							
Fertiliser (urea + Superphosphate)					90.83		
Herbicides/pesticides					0.29		
Electricity					0.36		
Fuel					0.40		
Lime					0.01		
Scope 3 Total					**92**		
Carbon Sequestration							
Carbon sequestration in trees	-16.40	-6.84	-1.37	-2.73	-27.34		
Net Farm Emissions	**335**	**58**	**72**	**568**	**1,133**		
Emissions intensity	**0.11**	**0.02**	**0.04**	**0.19 t CO2-e/t crop**			

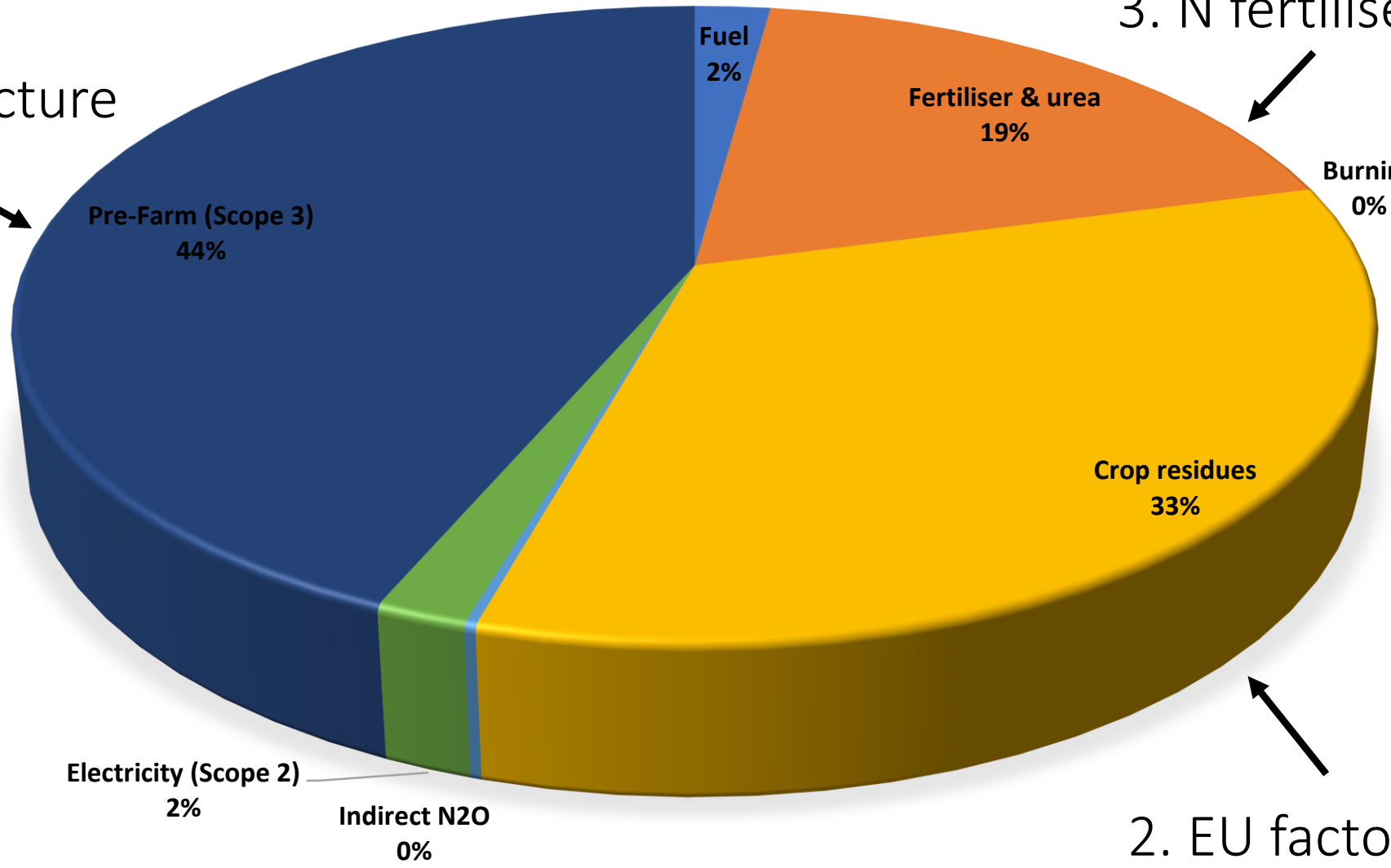




3-point plan to reduce cropping emissions

1. Urea manufacture

3. N fertiliser on farm



2. EU factors

https://piccc.org.au/resources/Tools

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3-point plan: 1. Urea manufacture in future

- Produce urea from renewable sources
  - Disconnect urea from fossil fuel price – an imperative
- Two (of 8) ARENA examples
  - H2U Eyre Peninsula Gateway Hydrogen Project
    - 100% wind and solar to power the electrolyser to split water ir
  - Yara Fertilisers
    - Seawater for electrolysis to produce green hydrogen then ammonia
- On-farm ammonia using surplus solar
  - https://jupiterionics.com/
  - https://www.nitricity.co/

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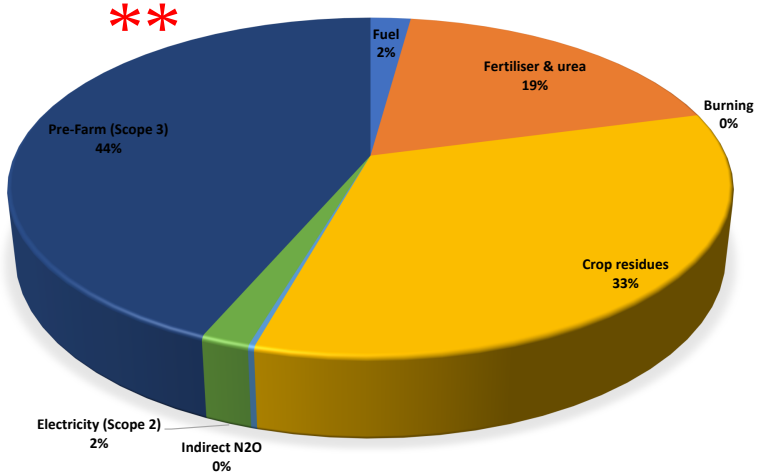

https://arena.gov.au/

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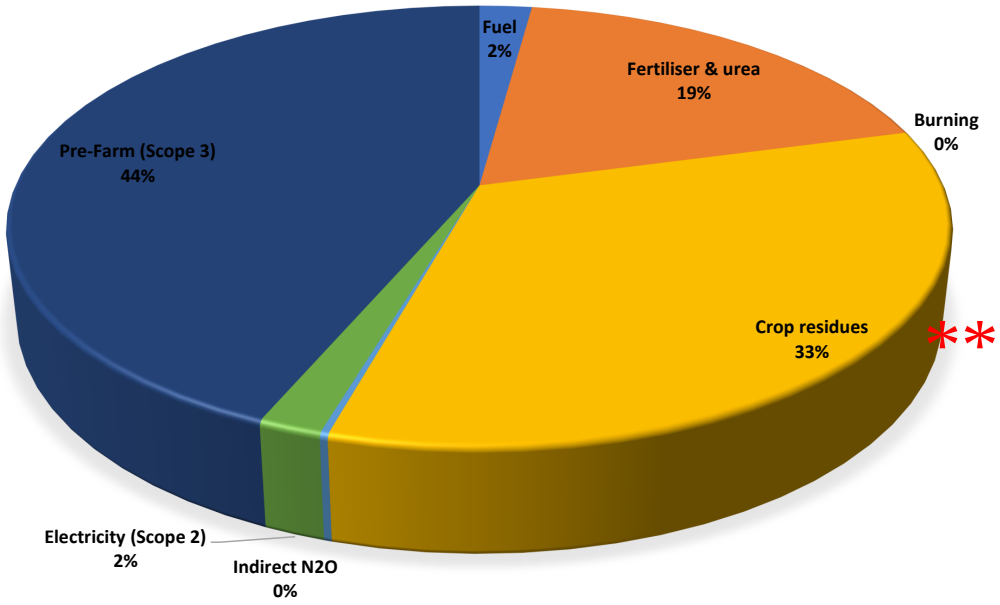
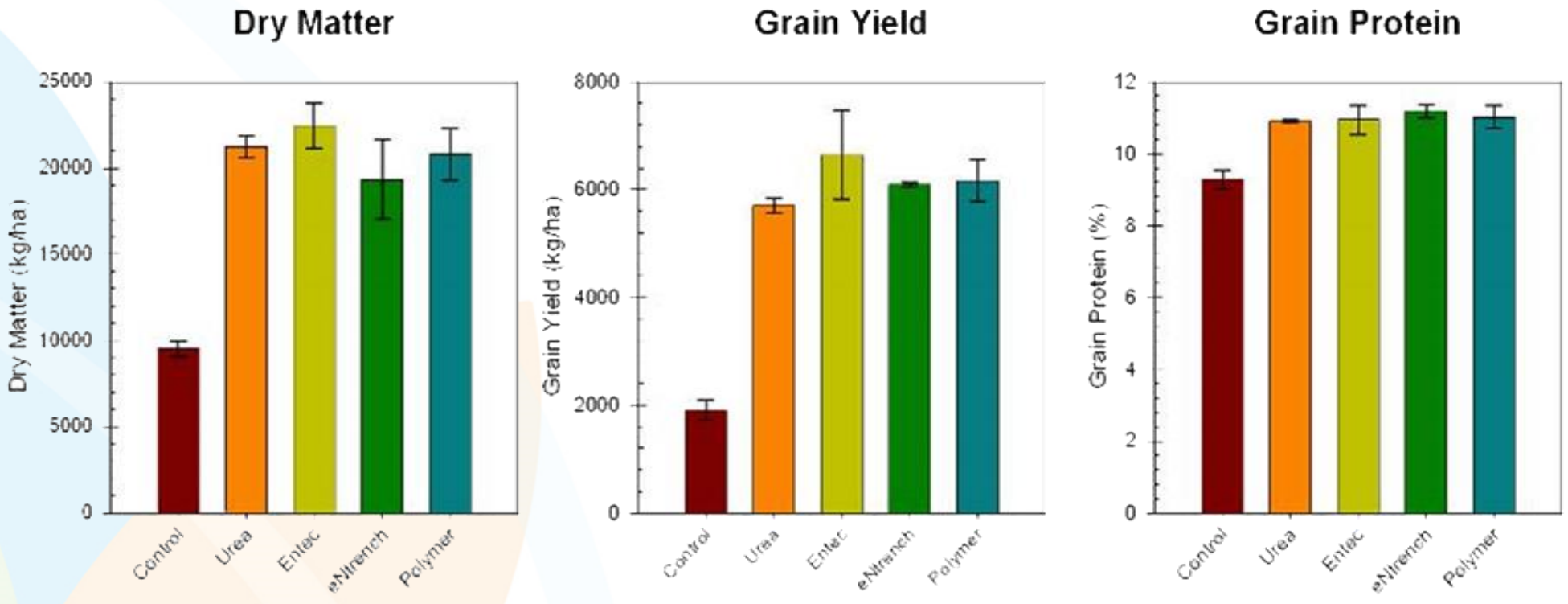
3-point plan: 2. Crop residues

- National inventory
  - Crop residues - 1.00 % of plant N
    - IPCC 2006 default
  - Inventory to adopt 0.5 % in 2023
    - New IPCC default
    - But more R&D needed



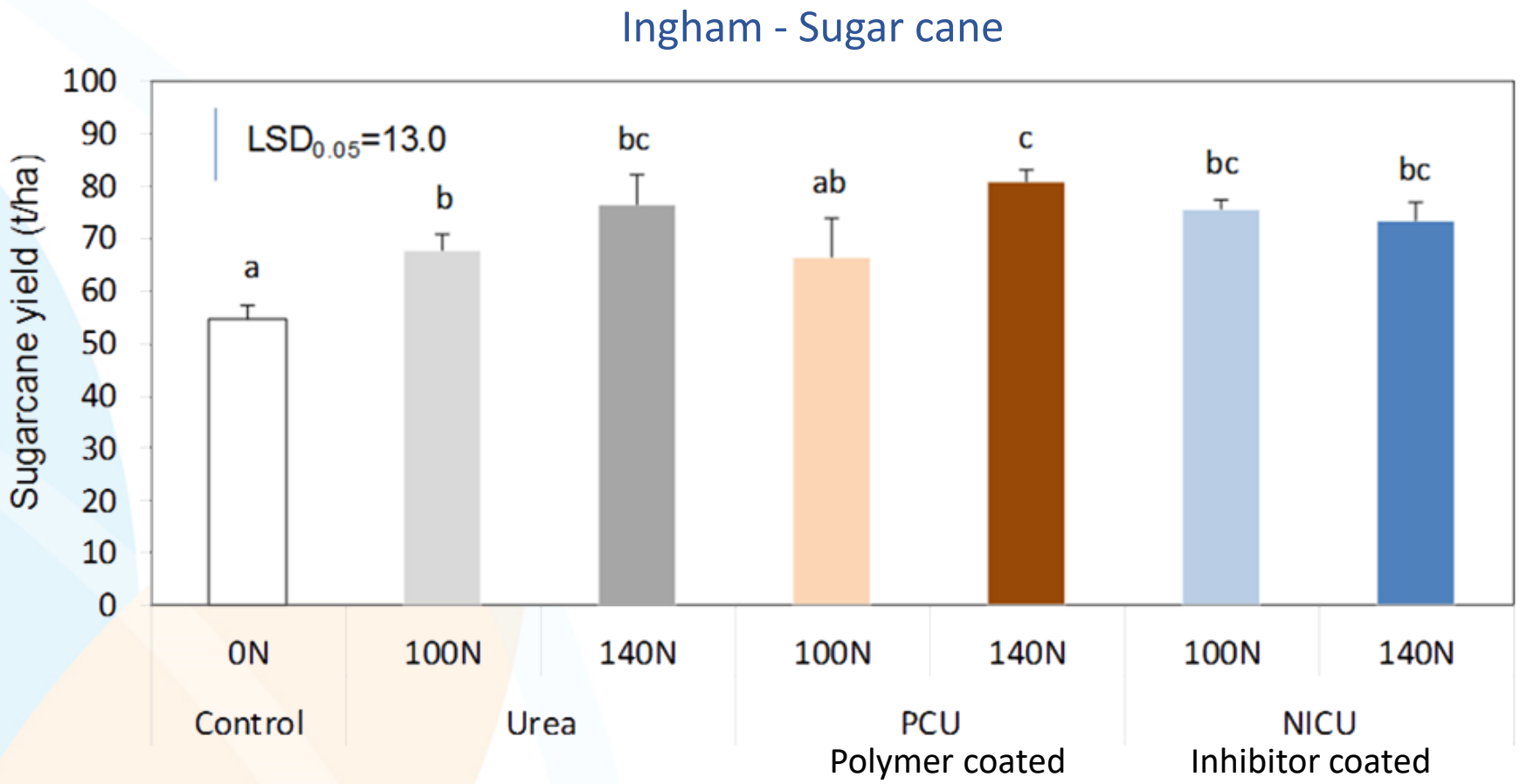
Fertiliser formulation – the market failure

Kingsthorpe (vertosol) sorghum



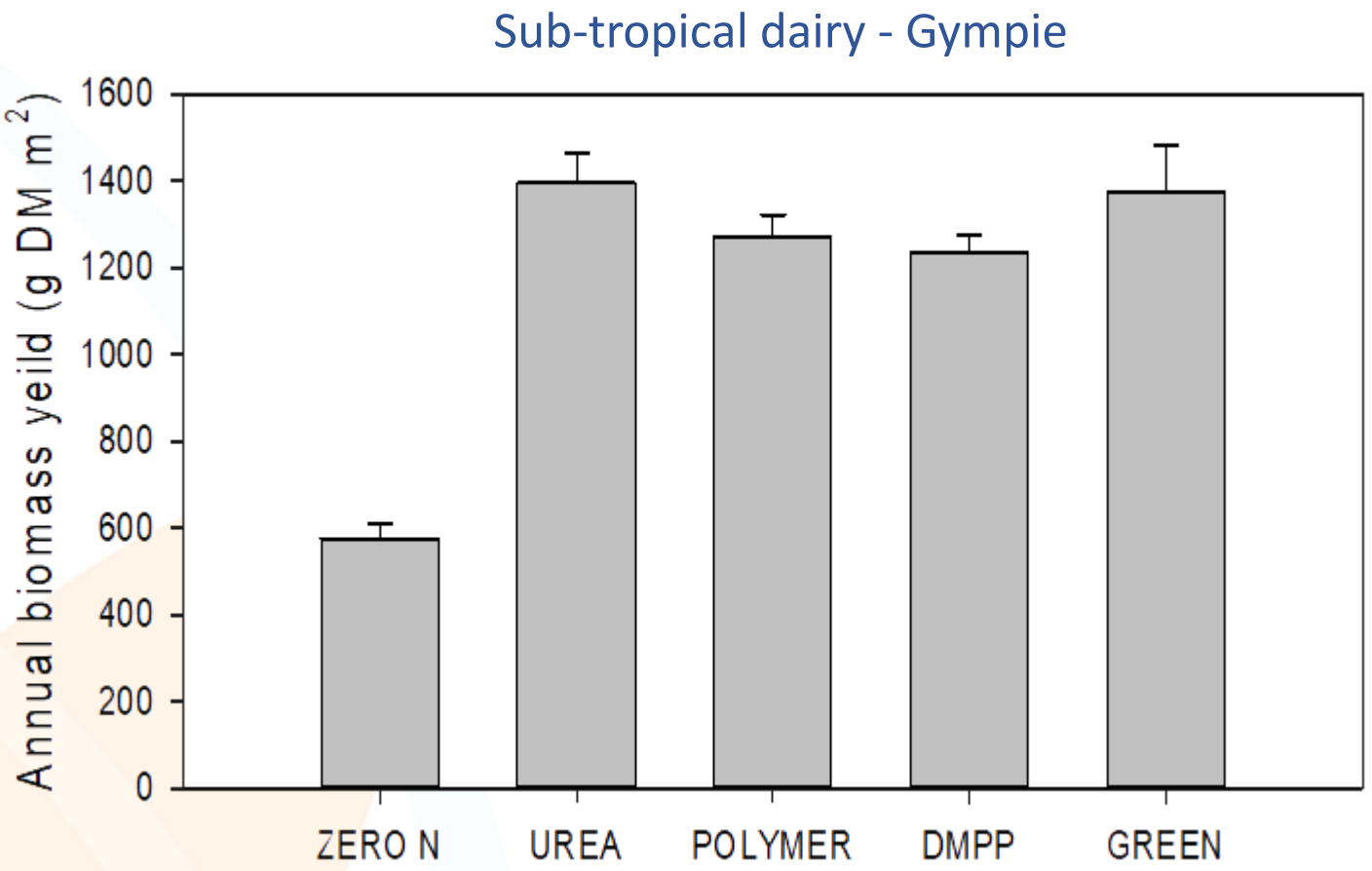
 Bell et al. 2015; Dang et al 2021

Fertiliser formulation – the market failure



 Wang et al. 2008; 2012; 2016

Fertiliser formulation – the market failure



 Dougherty et al 2016; Friedl et al. 2017

Direct Nitrous oxide - Urea versus DMPP + urea

Grace et al.. 2022

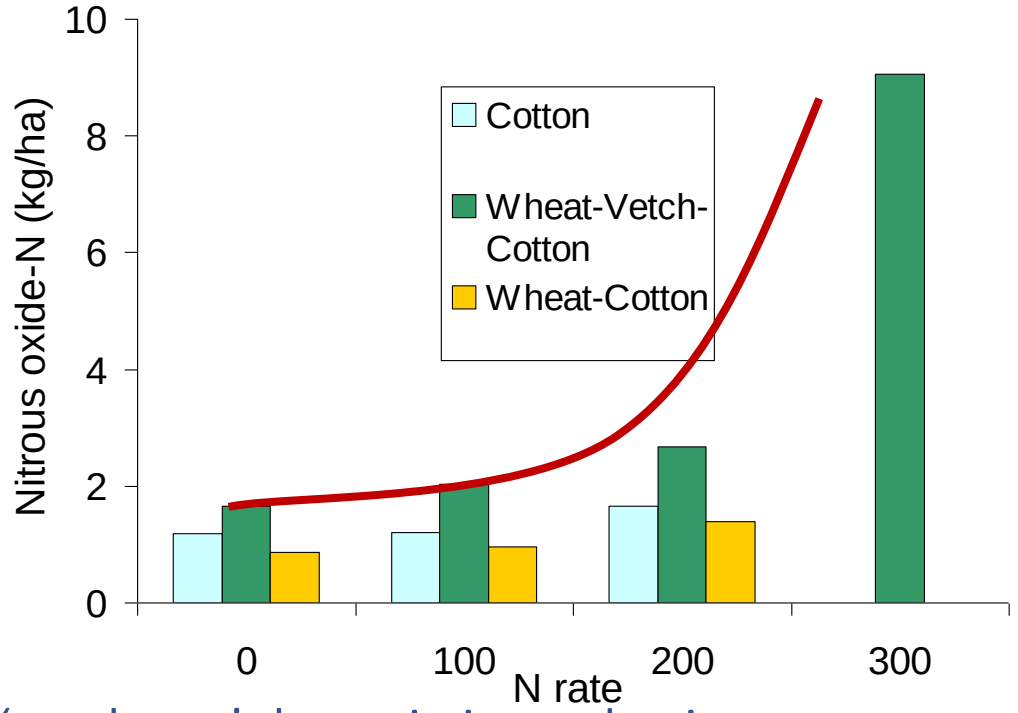
Data from:
Bell et al. (2015)
Dang et al. (2021)
Dougherty et al. (2016)
Friedl et al. (2017)
Heffer et al. (2017)
Migliorati et al. (2016)
Migliorati et al. (2014)
Scheer et al. (2016)
Schwenke et al. (2019b)
Schwenke et al. (2019a)
Suter et al. (2016)
Suter et al. (2020)
Wang et al. (2008)
Wang et al. (2012)
Wang et al. (2016)

Commodity	Inventory EF (%)	DMPP EF Reduction (%)
Grains (wet)	0.85	80
Grains	0.05/0.85	79
Horticulture	0.85	80
Pasture (Irri)	0.39	11 (?)
Pasture (dry)	0.2	22 (?)
Sugar	1.99	54
Cotton	0.55	80[a]
Average		**69**

[a] irrigated grains

3-point plan: The proposal for 50% less from cropping

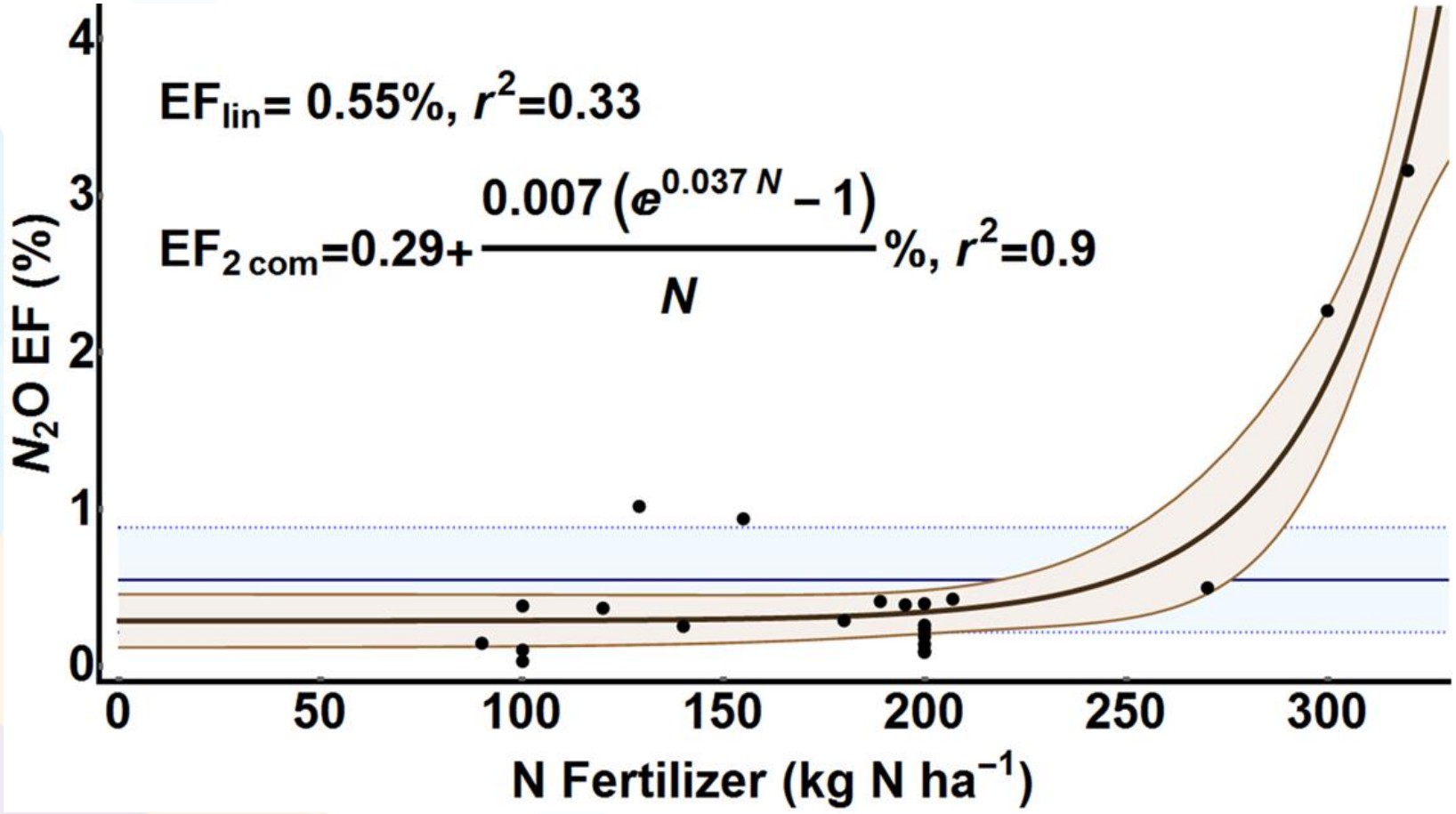
- Step 1:
  - Move to “Green” N
- Step 2:
  - Update GHG inventory crop residues factor
- Step 3:
  - Government works with 20 fertiliser companies to ‘purchases’ the emission reduction
  - Used towards Australia’s Paris COP21 commitment
- Step 4:
  - Farmers apply the 4 Rs for best NUE



 Grace, Eckard, Kraak 2022 Grace et al. 2007

Nitrous oxide reduction vs N fertiliser rate

Emissions Reduction Fund (ERF) Irrigated Cotton Methodology



https://www.cleanenergyregulator.gov.au/ERF/

Grace et al. 2016

Three important steps for industry

- Know your baseline
  - A basic farm carbon audit *(or at least know what data to keep)*
    - Supply chain targets are NOT requiring your farm to be **zero by** 2030
- Plan the first steps
  - Start with the no-regrets strategies
    - Nitrogen use efficiency, renewable energy
  - Trees and soil are only short-term carbon options
    - But the **co-benefits** are long-term!
- Carbon credits trading vs low carbon (cannot do not both!!)
  - Get independent advice
  - You may need to **INSET** all your carbon access your supply chain after 2030!

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www.piccc.org.au

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piccc.org.au/education/carbonneutraltraining

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