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Wimmera Broadacre Farming Net Zero Emissions Project

Craig Hurley

Future Regions Research Centre

Research Summary Presentations

27 February 2024

Australian Government | National Landcare Programme

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Acknowledgement of Country

Federation University Australia acknowledge the Traditional Owners of the lands on which our campuses, centres, and field stations are located, and pay our respects to their Elders past, present and emerging. Federation University Australia also acknowledges the continuing and unceded sovereignty of all Aboriginal and Torres Strait Islander Nations.

Our Campuses

Ballarat: Wadawurrung

Berwick: Boon Wurrung

Gippsland: Gunai Kurnai

Nanya Station: Mutthi Mutthi and Barkindji

Wimmera: Wotjobaluk, Jaadwa, Jadawadjali, Wergaia, Jupagulk

CRICOS 00103D | RTO 4909
| TESQA PRV12151 (Aust University)

Agenda

12:00 pm	Welcome & apologies	*Craig Hurley*
12:02 pm	Acknowledgement of Country	
12:05 pm	Wimmera Broadacre farming Net Zero emissions project: • Using Carbon Calculators • Results – GHG emissions (Farms B, D, L & W)	
12:25 pm	An Input-Output Zero Greenhouse Gas Simulation *Assoc. Prof. Abdel Halabi & Dr. Paul McPhee* • Method and Results: • Hindmarsh, Yarriambiack, Horsham Rural City, and West Wimmera LGAs	
12:45 pm	Questions	*Chris Sounness*
1:00 pm	Close	

Wimmera Broadacre Farming Net Zero Emissions Project

Collaborative research project:

- Federation University
- Wimmera Southern Mallee Development (formerly WDA)
- Agticulate
- 4 Wimmera farmers (Horsham, Brim, Nhill & Edenhope areas)

WIMMERA SOUTHERN MALLEE DEVELOPMENT

This research was supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's *National Landcare Program: Smart Farms Small Grants Round 4* & WSMD.

Also aligned with WDA's *Roadmap to Zero Grampians Agriculture Project*.

Australian Government | National Landcare Programme

Wimmera Broadacre Farming Net Zero Emissions Project

Objective: To demonstrate the use of carbon calculators for the identification of carbon emissions and abatement opportunities for Wimmera farmers.

Research activities:

- Collection of carbon emissions data from 4 Wimmera farms (from 3-4 years/seasons)
- Input farm carbon emissions data into relevant carbon calculators (3-5) to identify & model the impact of various farming activities on carbon emissions.
- Model Net Zero emissions scenarios
- Model (using Input/Output software) the regional, state and national economic impacts of Net Zero Emissions activities

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Background - Australia

Australia's GHG emissions reductions targets:

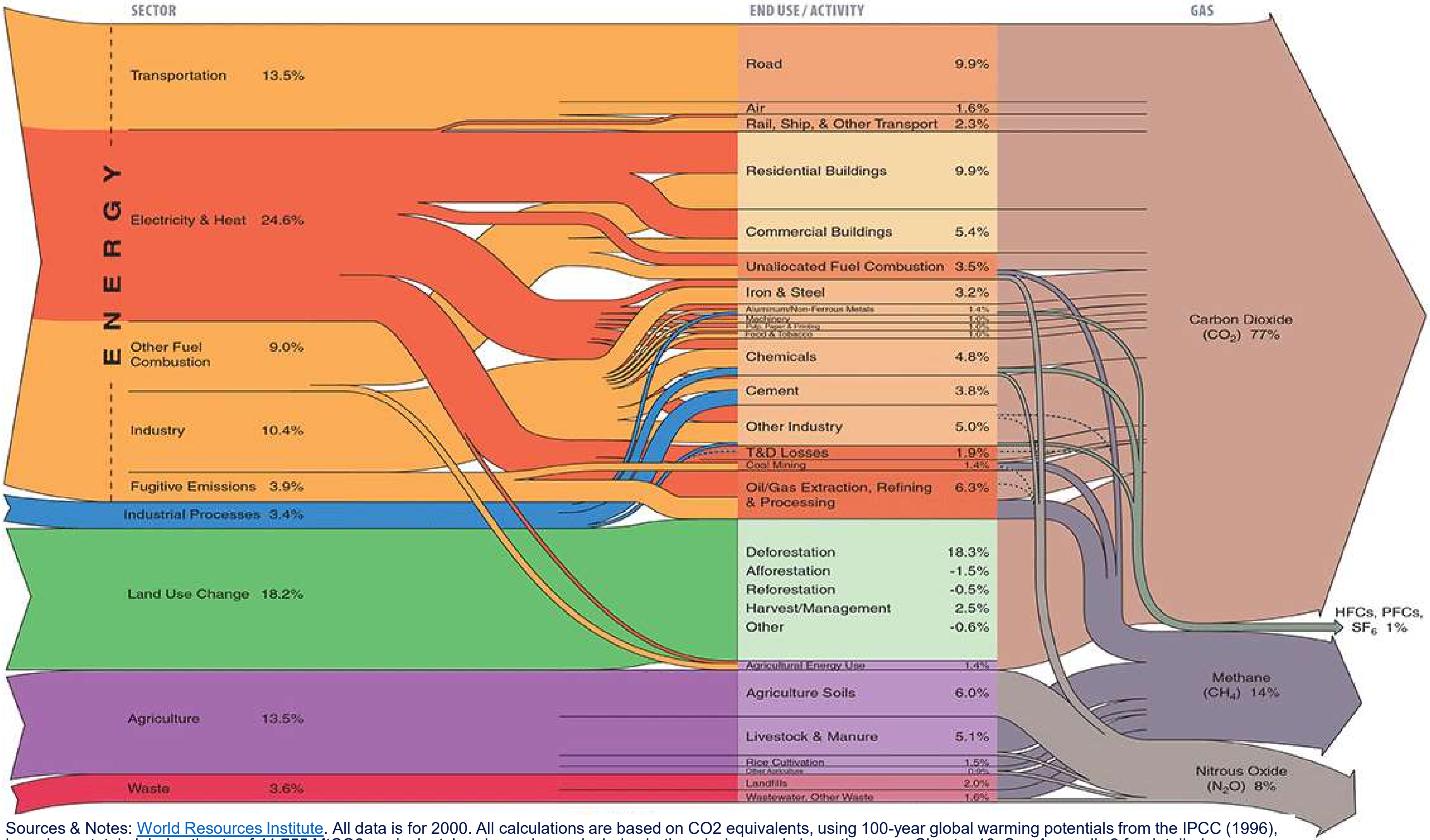
- Reduce GHG emissions to 26-28% below 2005 levels by 2030
- Reduce GHG emissions to net zero by 2050 (DISER, 2022)

Other commitments to achieve net zero by 2050 (or earlier):

- Grampians New Energy Taskforce (GNET)
- Agriculture peak bodies – NFF & MLA
- Agriculture companies - Elders (S.1 & 2, 2050), Nufarm (s.1&2)

- Local councils – 58% have net zero targets (Proudlove, Bravo & Denis Ryan, 2020)
- Federation University Australia – Net Zero 2033

World GHG Emissions Flow Chart



Sources & Notes: World Resources Institute. All data is for 2000. All calculations are based on CO2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 41,755 MtCO2 equivalent. Land use change includes both emissions and absorptions; see Chapter 16. See Appendix 2 for detailed description of sector and end use/activity definitions, as well as data sources. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

Methodologies – carbon emissions

Measurement and reporting of greenhouse gas emissions.

In Australia:

- must comply with the National Greenhouse and Energy Reporting Scheme (NGER Act, 2007, aka NGERS) – references & emission factors derived from IPCC Guidelines for National GHG Inventories and the GHG Protocol
- only large energy consumers or GHG emitters are currently *obligated* to report on their emissions.

Source: Clean Energy Regulator

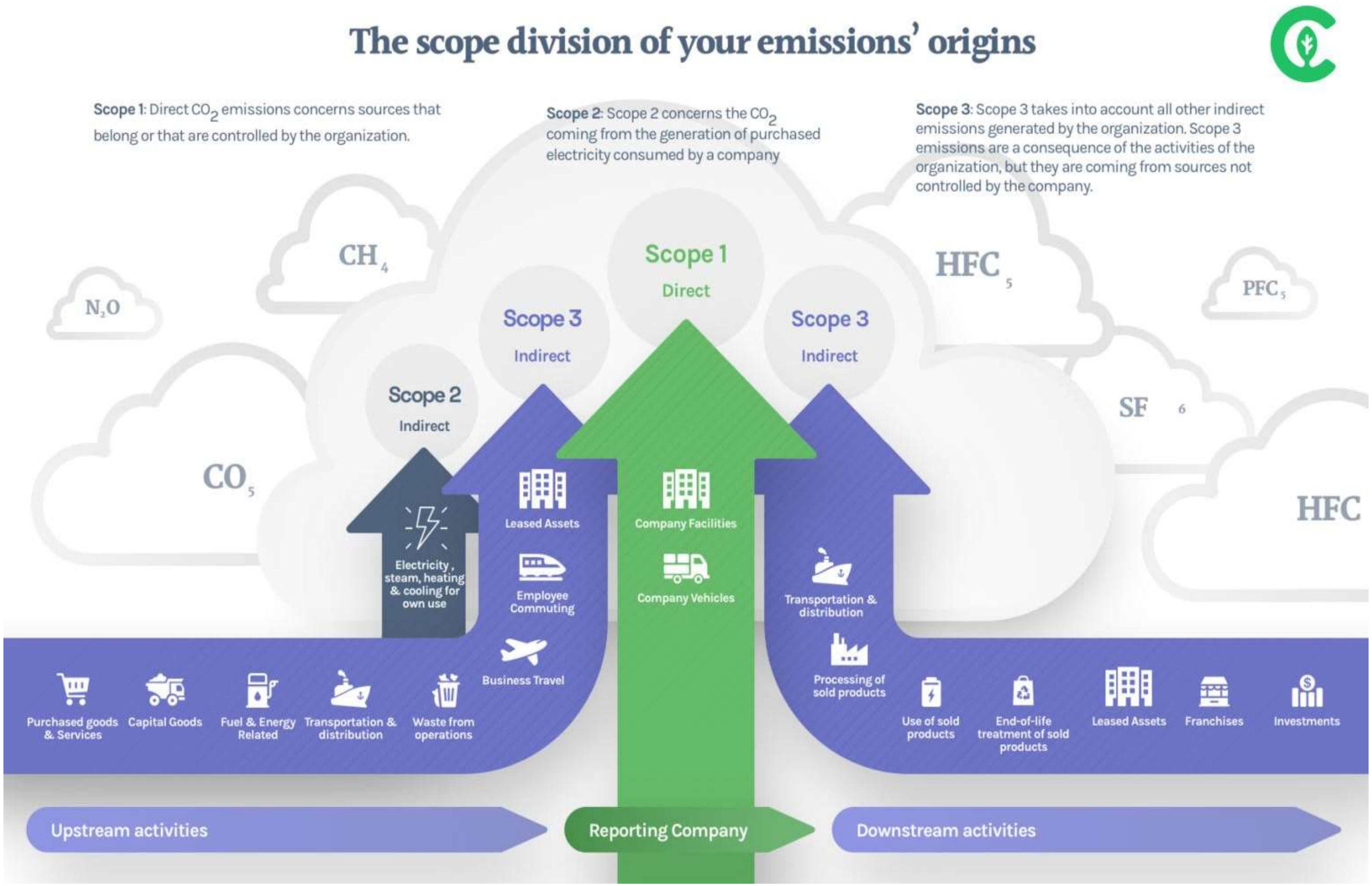
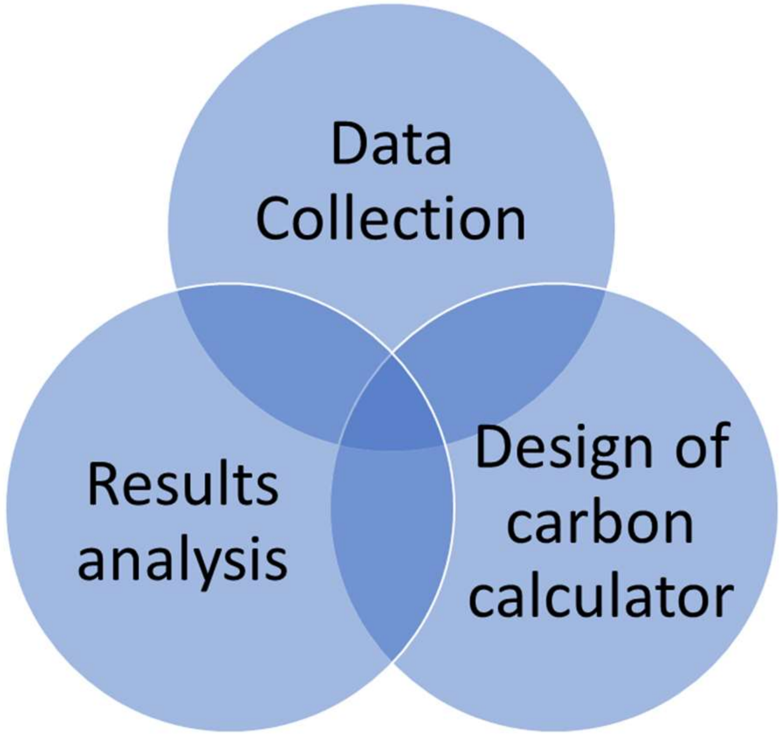


Image: [ClimateSeed]

Carbon Calculators

- computer programs that calculate the approximate amount of carbon dioxide produced by a business, organization, etc. (Cambridge Business English Dictionary)
- Typically an online tool or MS Excel spreadsheet requiring input of data relating to business activities, inputs, production, energy & fuel consumption etc.
- Provides results as a ‘carbon footprint’ – usually as tCO2-e – tonnes of CO_2 equivalent



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Carbon Calculators

- NGER Threshold Calculator
- AFI FarmGas
- Farm Carbon Calculator (UK)
- Greenhouse Accounting Framework – Primary Industries Climate Challenges Centre (Melb. Uni)
- FarmPrint (CSIRO) – not yet available

Data collection

- Identify 4 Wimmera farm case studies
- Develop data collection template for multiple calculators
- Work with growers to source data
- ‘Clean’ data
- Identify data gaps

WIMMERA SOUTHERN MALLEE DEVELOPMENT

AGTICULATE

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Where is the data?

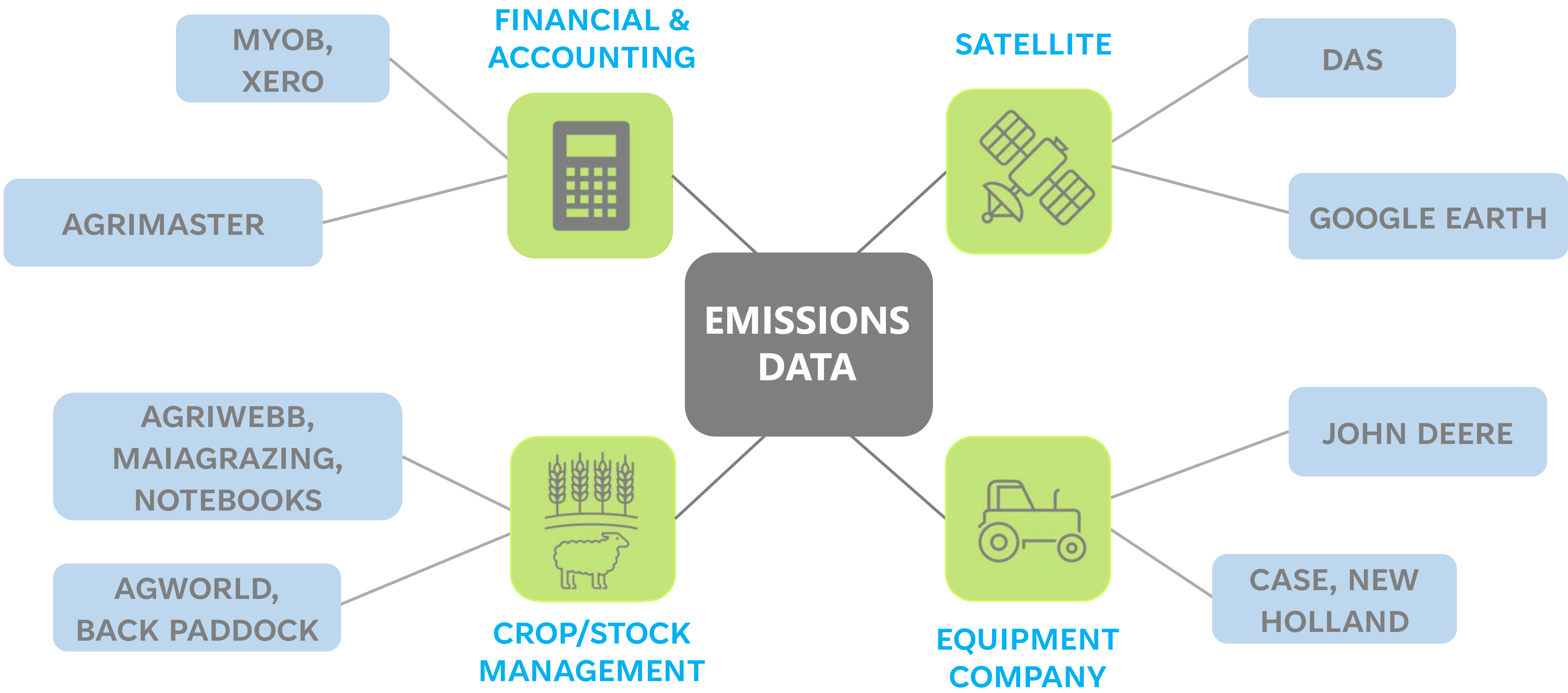


FIGURE: AGTICULATE

THE COMPANIES REFERRED TO ARE EXAMPLES ONLY & THE LISTS ARE NOT EXHAUSTIVE

Part 2 – Results & Scenario Modelling

Participating Wimmera Farms

Farm L

- Horsham RCC
- 885 ha
- 764 ha cropped (wheat, barley, canola, lentils, chickpeas, faba beans, vetch)
- 1,480 sheep
- 140 cattle
- 28 ha forest
- 25 ha sparse woody

Farm D

- Yarriambiack SC
- 1,878 ha
- 1624 ha cropped (wheat, barley, canola, peas, vetch)
- 660 sheep
- 3 ha forest
- 35 ha sparse woody
- (128 ha trees)

Farm B

- Hindmarsh SC
- 10,668 ha
- 3,000 ha (wheat, barley, oats, canola, faba beans, vetch, lucerne)
- 19,500 sheep
- 639 ha forest
- 223 ha sparse woody

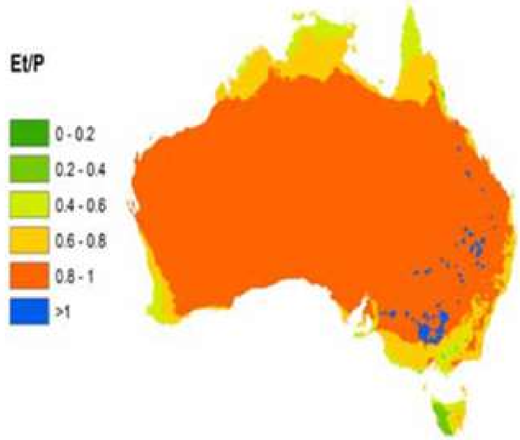
Farm W

- West Wimmera SC
- 1,117 ha
- No cropping
- 8,840 sheep
- 30 cattle
- 20 ha forest*
- Sparse woody?

GrainsGreenhouseV10.3 - Farm D 2019

	B	C	D	E	F	G	H
1	**Enter your farm data**	Farm Name	**Farm D - 2019**				
2	Choose your region in Australia	Vic 6					
3	Electriticy Source	State Grid					
4	**Farm cropping details**	Wheat	Barley	Oilseeds	Pulses	Forage Crops	
5	Production System	Non-Irrigated Crop	Non-Irrigated Crop	Non-Irrigated Crop	Non-Irrigated Crop	Non-Irrigated Crop	
6	Is the crop in orange zone? (Ref Map. 1)	No	No	No	No	No	
7	Average grain yield	3.80	4.20	1.90	2.20	1.35	t/ha
8	Area sown	264	796	282	124	280	ha/farm
9	MAP Application	50	50	60	50	23	kg product/ha
10	DAP Application						kg product/ha
11	SOA Application						kg product/ha
12	Urea Application	50	50	140			kg product/ha
13	Single Superphosphate						kg product/ha
14	Mass of Lime Applied						kg/ha
15	Fraction of Lime as limestone vs dolomite						Limestone/dolomite
16	Fraction of the annual production of crop that is burnt (F)						ha/total crop ha
17	Annual Diesel Consumption	3036	9154	3271	1438	3248	litres/year
18	Annual LPG Use						litres/year
19	Annual Electricity Use	42	127.65	45.22	19.89	44.90	KWh
20	Allocation to crop	15%	46%	16%	7%	16%	
21	Herbicide/Pesticide use	3274.7	34589.384	3265.278	1160.764	2524.99	kg total

The question is really - does your farm get enough rainfall or irrigation t



Data summary | Data input - crops | Data input - vegetation | Fertiliser | Urea Application | Leaching and runoff | Crop Residues | Atmospher ...

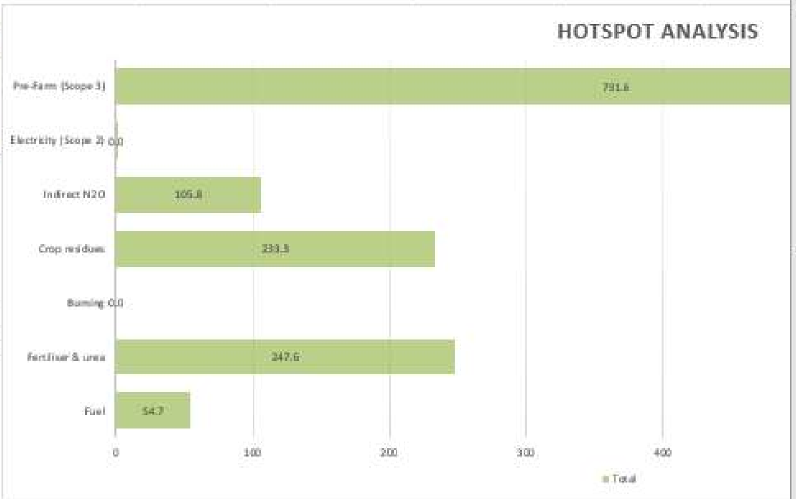
GrainsGreenhouseV10.3 - Farm D 2019

G35 =G33/('Data input - crops'!G7*'Data input - crops'!G8)

Grains Greenhouse Accounting Tool

Crop	Wheat	Barley	Oilseeds	Pulses	Forage Crops	
Outputs	t CO_2e/farm	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	8.19	24.70	8.83	3.88	8.76	54.36
CO_2 - Lime	0.00	0.00	0.00	0.00	0.00	0.00
CO_2 - Urea	9.68	29.19	28.95	0.00	0.00	67.82
CH_4 - Field burning	0.00	0.00	0.00	0.00	0.00	0.00
CH_4 - Fuel	0.01	0.04	0.01	0.01	0.01	0.08
N_2O - Fertiliser	26.17	78.89	70.27	2.19	2.24	179.76
N_2O - Atmospheric Deposition	2.88	8.68	7.73	0.24	0.25	19.77
N_2O - Field Burning	0.00	0.00	0.00	0.00	0.00	0.00
N_2O - Crop Residues	39.81	125.18	43.57	15.68	9.10	233.34
N_2O - Leaching and Runoff	14.07	43.78	21.06	4.44	2.71	86.06
N_2O - Fuel	0.04	0.12	0.04	0.02	0.04	0.27
Scope 1 Total	**101**	**311**	**180**	**26**	**23**	**641**
Scope 2 Emissions (off-farm)						
Electricity	0.006477526	0.019864412	0.006909361	0.003022845	0.006909361	0.043183505
Scope 2 Total	**0.006477526**	**0.019864412**	**0.006909361**	**0.003022845**	**0.006909361**	**0.043183505**
Scope 3 Emissions (pre-farm)						
Fertiliser	10.95	33.03	32.76	0.00	0.00	76.75
Herbicides/pesticides	47.65	503.30	47.51	16.89	36.74	652.09
Electricity	0.000635052	0.001947491	0.000677388	0.000296357	0.000677388	0.004233677
Fuel	0.42	1.27	0.45	0.20	0.45	2.80
Lime	0	0.00	0.00	0.00	0.00	0.00
Scope 3 Total	**59**	**538**	**81**	**17**	**37**	**732**
Carbon Sequestration						
Carbon sequestration in trees	-3.29	-11.51	-4.93	-1.64	-11.51	-32.88
Net Farm Emissions	**157**	**837**	**256**	**42**	**49**	**1,340**
Emissions intensity	**0.16**	**0.25**	**0.48**	**0.08**	**0.13**	**t CO2-e/t crop**

Summary	CO2e/farm
CO_2	888
CH_4	36
N_2O	524



Citation:
Ekonomou A., Eckard R.J. (2022). A Greenhouse Accounting Framework for crop production (G-GAF) based on the Australian National Greenhouse Gas Inventory methodology. Updated Febrary 2022 http://www.piccc.org.au/resources/Tools

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piccc Primary Industries Climate Challenges Centre

Data summary | Data input - crops | Data input - vegetation | Fertiliser | Urea Application | Leaching and runoff | Crop Residues | Atmospher ...

Greenhouse Accounting Framework (GAF)

Example 1:

Farm D – 2019

- Yarriambiack Shire area
- 1878 ha
- 1624 ha cropped (wheat, barley, canola, peas, vetch)
- 660 sheep
- 128 ha (sparse woody & forest)

Image: Weekly Times

[FARM D – 2019]

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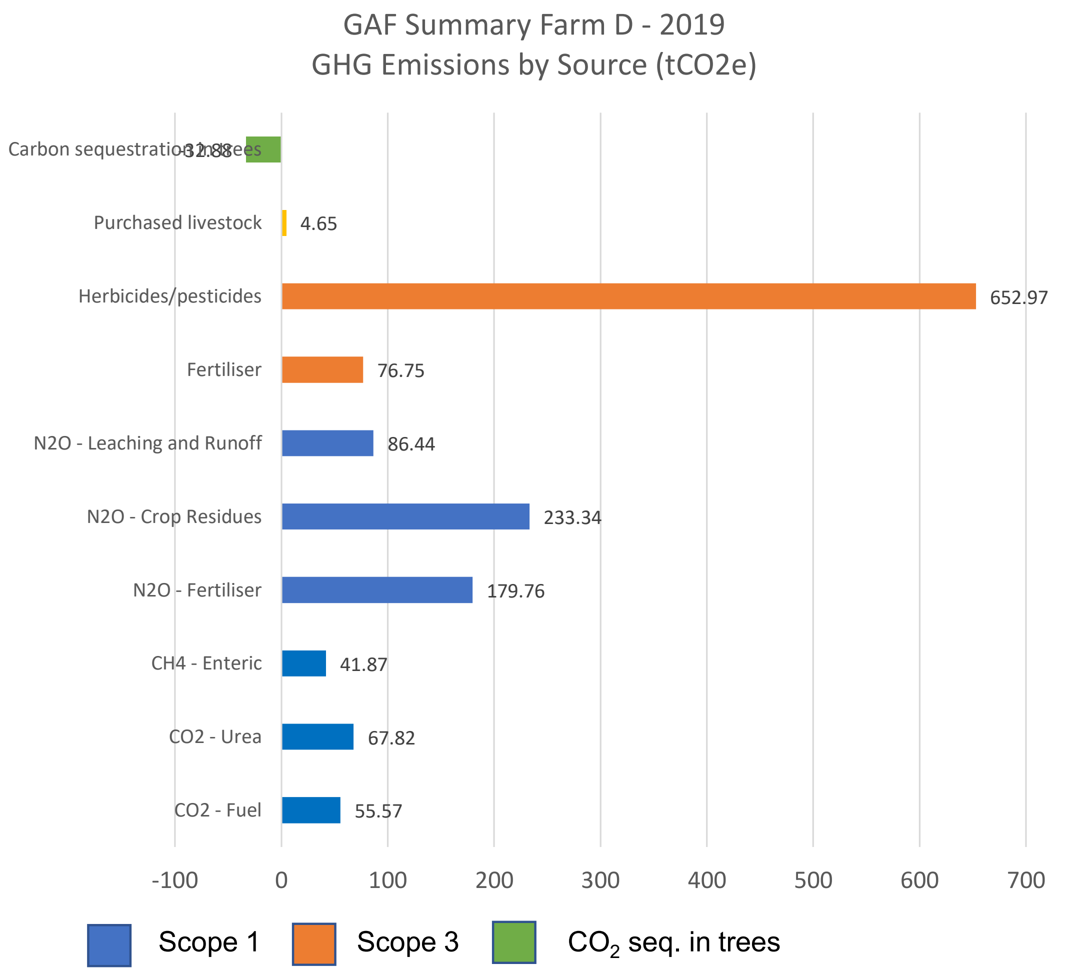
Greenhouse Accounting Framework (GAF)

Example 1:

Farm D – 2019

- 1878 ha
- 1624 ha cropped (wheat, barley, canola, peas, vetch)
- 660 sheep
- 128 ha (sparse woody & forest)

Gross farm emissions	1,461
Carbon sequestered in trees	-33
Net Farm Emissions	**1,428**
Net Emissions (tCO2e)/ha	0.82



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Greenhouse Accounting Framework (GAF)

Example 2:

Farm B – 2019

- Hindmarsh Shire area
- 10,668 ha
- 3,000 ha (wheat, barley, oats, canola, faba beans, vetch, lucerne)
- 19,500 sheep
- 860 ha (forest or sparse woody)

Image: BCG

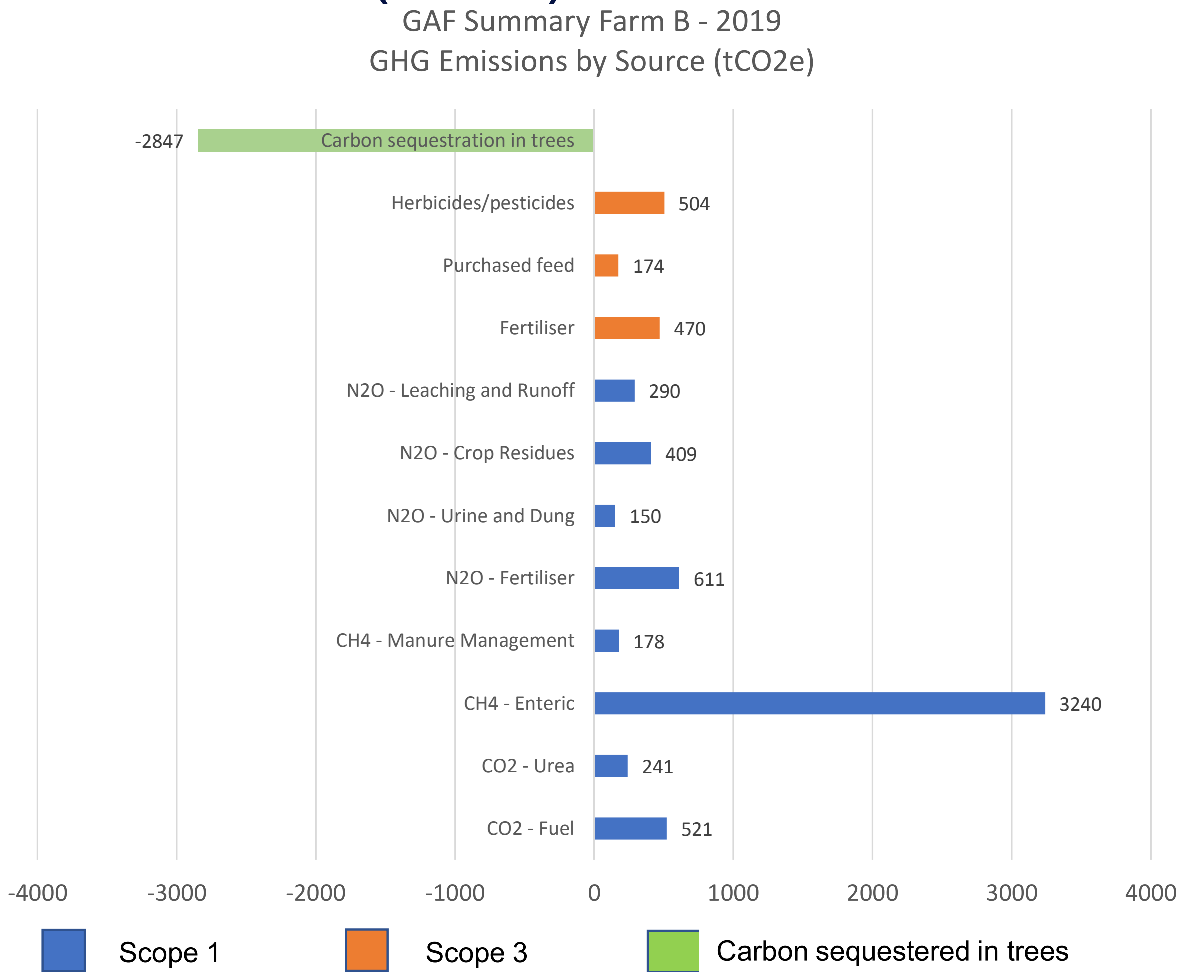
Greenhouse Accounting Framework (GAF)

Example 2:

Farm B – 2019

- 10,668 ha
- 3,000 ha (wheat, barley, oats, canola, faba beans, vetch, lucerne)
- 19,500 sheep
- 860 ha (forest or sparse woody)

Gross farm emissions	6,933
Carbon sequestered in trees	-2,847
Net Farm Emissions	4,086
Net Emissions (tCO2e)/ha	0.38



Results Summary

Main contributors to farm GHG emissions:

- Enteric emissions from livestock
- Fertilisers
- Pesticides/herbicides
- Crop residues
- Fuel

Main CO_2 management/reduction opportunities:

- Protection of existing trees and/or new plantings
- Efficient nitrogen fertiliser management
- Efficient chemical application
- Potential feed supplements for livestock

Scenario modelling – Net Zero by 2033

- Objectives:
  - To use data and carbon calculations from Wimmera farms, to model strategies to reduce farm GHG emissions.
  - Scenario actions **aiming to achieve Net Zero farm emissions by 2033**
- Scenarios based on Farm B 2019 data & GHG emissions
- Models used Greenhouse Accounting Framework calculators (GAF) – PICCC (Melb. Uni.)

Image: Innovation for Agriculture (UK)

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Scenario modelling – Net Zero by 2023

Three scenarios:

- Farm B – Scenario B – Carbon positive – but reduce GHG emissions by 30%
- Farm B – Scenario D - Carbon negative, Climate positive
- Farm B – Scenario E - Carbon neutral, Net Zero

Strategy areas:

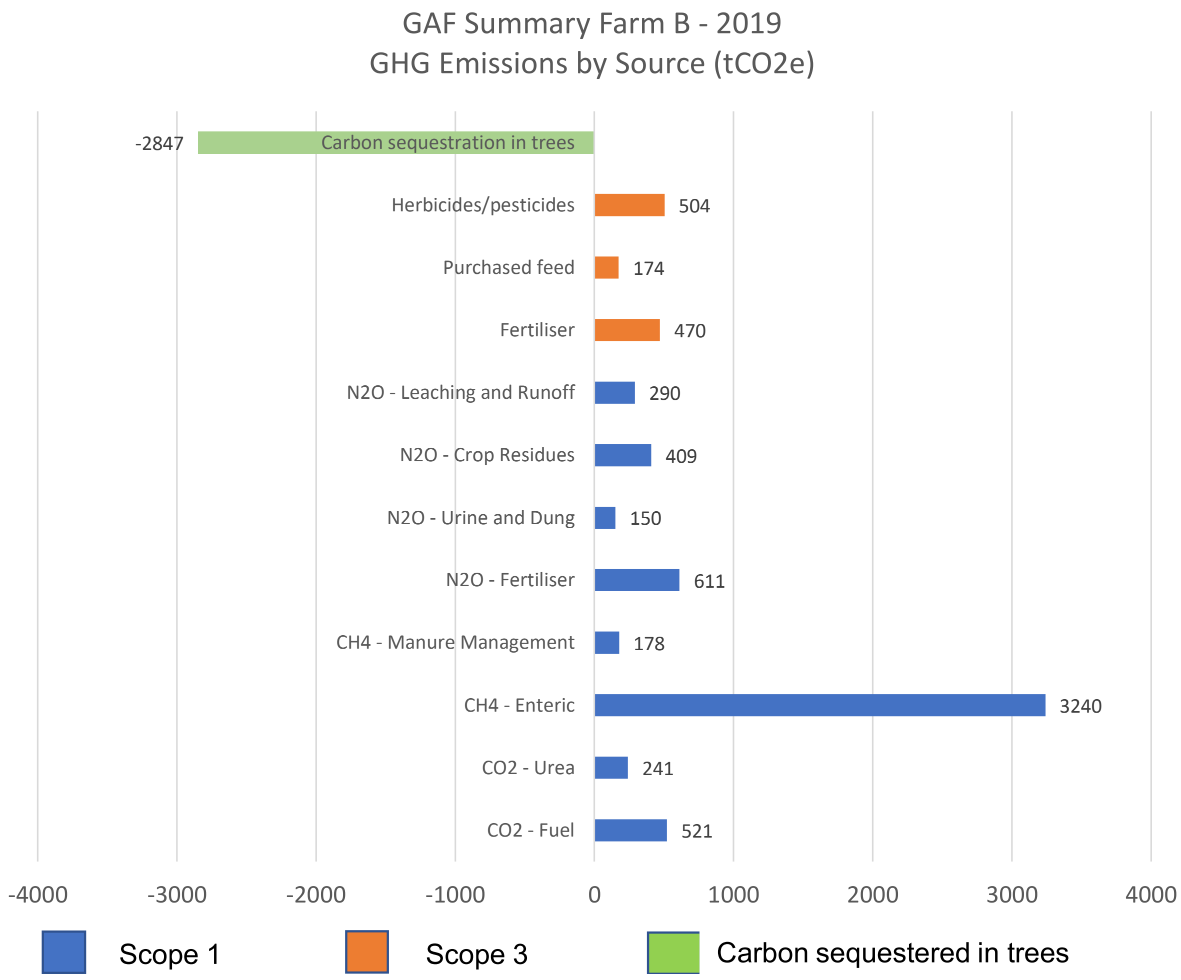
- **Herbicide/pesticide usage** – efficient application & products with reduced GHG footprint, new technologies (selective spraying – green on green, autonomous spray etc.)
- **Fertiliser usage** - efficient application (4 Rs) & products with reduced GHG footprints
- **Vegetation** – additional tree plantings
- **Livestock feed supplements** - 0.5% seaweed feed supplement for sheep - 80% reduction in enteric GHG emissions. NB – based on Future Feed (MLA, CSIRO, JCU) research in cattle, not currently in commercial production

Farm B – 2019 emissions baseline

Farm B – 2019

- 10,668 ha
- 3,000 ha (wheat, barley, oats, canola, faba beans, vetch, lucerne)
- 19,500 sheep
- 860 ha (forest or sparse woody)

Gross farm emissions	6,933
Carbon sequestered in trees	-2,847
Net Farm Emissions	4,086
Net Emissions (tCO2e)/ha	0.38



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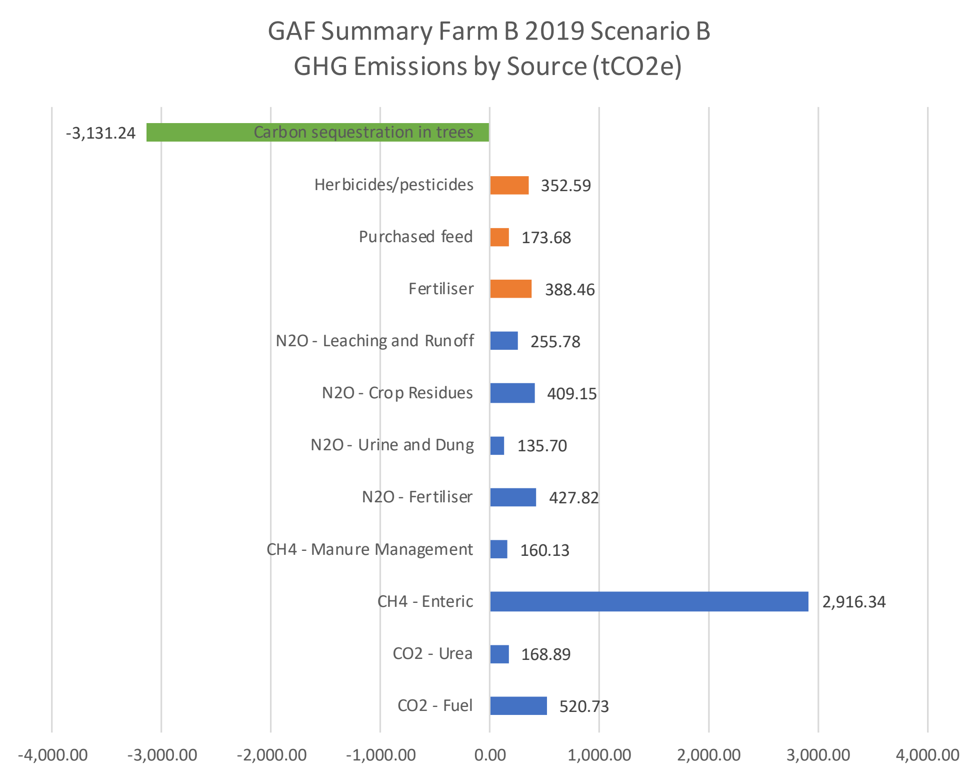
Farm B – Scenario B – Carbon Positive, GHG ↓ 30%

- Reduce chemical use by 30%
- Reduce fertiliser usage by 30%
- Increase tree coverage by 10%
- Reduce livestock numbers by 10%

Cropping, Sheep & Beef	
Outputs	**CO2e/farm**
Scope 1 Emissions (on-farm)	
CO_2 - Fuel	520.73
CO_2 - Lime	0.69
CO_2 - Urea	168.89
CH_4 - Field burning	0.00
CH_4 - Fuel	0.71
CH_4 - Enteric	2,916.34
CH_4 - Manure Managem	160.13
N_2O - Fertiliser	427.82
N_2O - Urine and Dung	135.70
N_2O - Atmospheric Dep	61.31
N_2O - Field Burning	0.00
N_2O - Crop Residues	409.15
N_2O - Leaching and Run	255.78
N_2O - Fuel	2.54
Scope 1 Total	**5,060**

Scope 2 Emissions (off-farm)	
Electricity	2
Scope 2 Total	**1.88**

Scope 3 Emissions (pre-farm)	
Fertiliser	388.46
Purchased feed	173.68
Herbicides/pesticides	352.59
Electricity	0.18
Fuel	26.88
Lime	0.02
Purchased livestock	27.90
Scope 3 Total	**970**



Gross farm emissions	6,031
Carbon sequestration in trees	-3,131.24
Net Farm Emissions	**2,900**
Net Emissions (tCO2e)/ha	**0.27**

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Farm B – Scenario D - Carbon negative, Climate positive

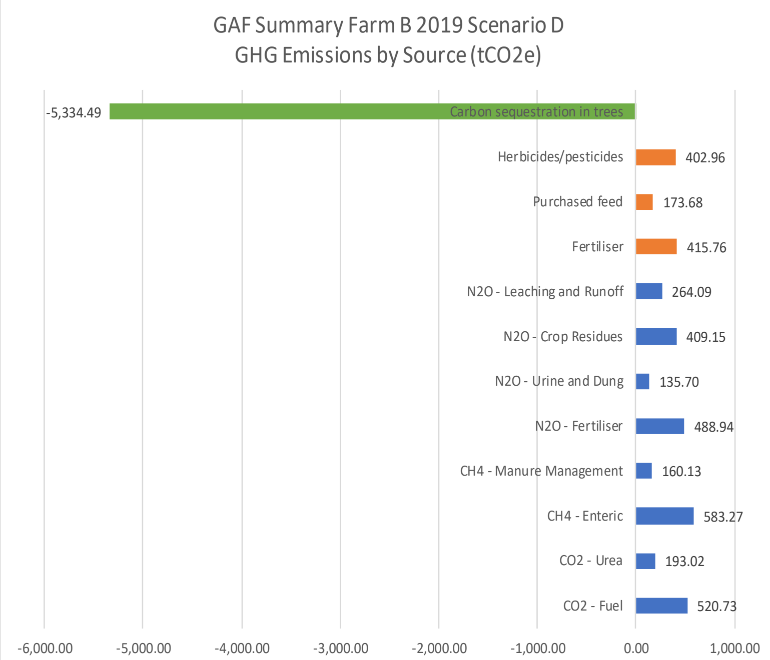
Strategies:

- Decrease emissions from **chemical use x 20%:**
- Decrease emissions from **fertiliser use x 20%:**
- Farmer convert additional **20% of non-arable land to trees** – 250ha
- Farmer convert **5% of arable land to trees** – 471ha
- Total additional tree coverage – 721ha
- Use of 0.5% **seaweed feed supplement for sheep** - NB – based on Future Feed (MLA, CSIRO, JCU) research in cattle, not currently in commercial production

Cropping, Sheep & Beef	
Outputs	**CO2e/farm**
Scope 1 Emissions (on-farm)	
CO_2 - Fuel	520.73
CO_2 - Lime	0.56
CO_2 - Urea	193.02
CH_4 - Field burning	0.00
CH_4 - Fuel	0.71
CH_4 - Enteric	583.27
CH_4 - Manure Managem	160.13
N_2O - Fertiliser	488.94
N_2O - Urine and Dung	135.70
N_2O - Atmospheric Dep	68.03
N_2O - Field Burning	0.00
N_2O - Crop Residues	409.15
N_2O - Leaching and Run	264.09
N_2O - Fuel	2.54
Scope 1 Total	**2,827**

Scope 2 Emissions (off-farm)	
Electricity	2
Scope 2 Total	**1.88**

Scope 3 Emissions (pre-farm)	
Fertiliser	415.76
Purchased feed	173.68
Herbicides/pesticides	402.96
Electricity	0.18
Fuel	26.88
Lime	0.02
Purchased livestock	27.90
Scope 3 Total	**1047**



Gross farm emissions	3,876
Carbon sequestration in trees	-5,334.49
Net Farm Emissions	**-1,458**
Net Emissions (tCO2e)/ha	**-0.14**

Farm B – Scenario E - Carbon neutral, Net Zero

- Decrease emissions from **chemical use x 20%:**
- Decrease emissions from **fertiliser use x 20%:**
- Farmer convert additional **16.5% of non-arable land to trees** – 206ha
- Farmer convert **1% of arable land to trees** – 94ha
- Total additional tree coverage – 300ha
- Use of 0.5% **seaweed feed supplement for sheep** - NB – based on Future Feed (MLA, CSIRO, JCU) research in cattle, not currently in commercial production

Cropping, Sheep & Beef	
Outputs	**CO2e/farm**
Scope 1 Emissions (on-farm)	
CO_2 - Fuel	520.73
CO_2 - Lime	0.56
CO_2 - Urea	193.02
CH_4 - Field burning	0.00
CH_4 - Fuel	0.71
CH_4 - Enteric	583.27
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N_2O - Fertiliser	488.94
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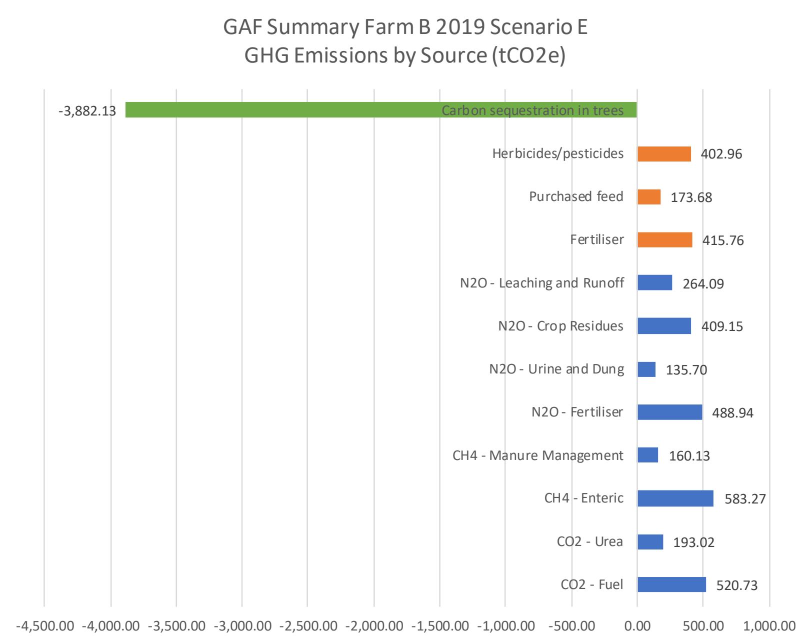
N_2O - Crop Residues	409.15
N_2O - Leaching and Run	264.09
N_2O - Fuel	2.54
Scope 1 Total	**2,827**
Scope 2 Emissions (off-farm)	
Electricity	2
Scope 2 Total	**1.88**
Scope 3 Emissions (pre-farm)	
Fertiliser	415.76
Purchased feed	173.68
Herbicides/pesticides	402.96
Electricity	0.18
Fuel	26.88
Lime	0.02
Purchased livestock	27.90
Scope 3 Total	**1047**



Gross farm emissions	3,876
Carbon sequestration in trees	-3,882.13
Net Farm Emissions	**-6**
Net Emissions (tCO2e)/ha	**0.00**

Key learnings (to date):

- CO_2 factors contested (e.g. performance of Australian soils vs European soils)
- Not all carbon calculators are equal – have variable flexibility, scope & applications
  Some very industry-specific – trade-off between accuracy & ease of use
- Carbon calculators still being developed & refined – GAF, FarmPrint
- Accuracy of results also dependent on availability and accuracy of input data

  – garbage in/garbage out
- Calculators and input data loaded with assumptions and estimations e.g. CO_2 sequestration by trees, or nitrogen fixing crops
- Must consider results holistically – Trees? Stubble burning?
- Scenarios indicate net zero broadacre farming in the Wimmera (by 2033) is 'doable'
- A future role for carbon calculators? Yes!

Impact of net zero farming on local economies

Part 3 – Key research question:

If all Wimmera farms achieve Net Zero emissions of GHG, in what ways will local economies be impacted?

To explore this question, we have:

- Assumed the farms researched in this project are broadly representative of farms in their local government area;
- Applied farm GHG emissions data from these four farms to economic data for the four LGAs in which they are located;
- Modelled the estimated economic impact of Net Zero agriculture on four Wimmera economies.

An Input-Output Zero Greenhouse Gas Simulation – Method and Results

Applied to the 'Sheep, Grains, Beef and Dairy Cattle' Sector of the Hindmarsh, Yarriambiack, Horsham Rural City, and West Wimmera LGAs (Scope 1 Emissions Only)

Dr Paul McPhee; Craig Hurley; Dr Abdel K Halabi

February, 2024

Economic and land use impacts of net zero-emission target in New Zealand

Yue Wang [a], Basil Sharp [b], Stephen Poletti [b] and Kyung-Min Nam [c]

[a]New Zealand Forest Research Institute (Scion), Rotorua, New Zealand; [b]The Energy Centre, University of Auckland, Auckland, New Zealand; [c]Department of Urban Planning and Design, the University of Hong Kong, Hong Kong

ABSTRACT

In this study, we examine the economic impacts of net zero-emission target in New Zealand, applying an integrated forest-computable general equilibrium model. The model is set to simulate equilibrium carbon permit price and sectoral output levels given the emission trading market, which is also endogenously determined within the model. When the agricultural sector is subject to a legally binding target, an equilibrium carbon permit price is estimated to be NZ$85/$tCO_2e$ (US$60/$tCO_2e$) and this results in a 1.4% loss of gross domestic product from the baseline level and a 22% reduction of greenhouse gas emissions. Exclusion of the agricultural sector, however, would reduce the permit price to NZ$68/$tCO_2e$ (US$48/$tCO_2e$) and lead to a 1.2% loss of gross domestic product and a 5% emissions reduction. This result suggests that the inclusion of the agriculture sector in the emissions trading scheme requires costs for policy compliance but can be cost-effective. It drives up compliance costs by 17%, but leads to 4.4 times the absolute emissions reduction expected when the agriculture sector is excluded.

ARTICLE HISTORY

Received 25 August 2020
Accepted 17 December 2020

KEYWORDS

CGE modelling; carbon emission units; land use; carbon dioxide emissions mechanism; zero carbon act; New Zealand

JEL Classification

Q23; Q24; Q54; Q68

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Executive Summary

- **This report provides an economic impact analysis of a net-zero Green-House Gas (GHG) emissions simulation performed on the farming areas of four Wimmera municipalities that are driving towards a net zero GHG emission production environment.**

- **The modelling uses a trend analysis which examines the changes in Scope 1 emissions alongside the changes in sector outputs.**

- **It was performed in partnership with Wimmera Southern Mallee Development (formerly Wimmera Development Association, WDA).**

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- **This modelling builds upon other research undertaken as part of their *Wimmera Broadacre Farming Net-Zero Emissions project*, which was supported by the Department of Agriculture, Water and the Environment, through funding from Australian Government's *National Landcare Program: Smart Farms Small Grants Round 4* & WSMD (formerly WDA). This research is also related to WDA's *Roadmap to Zero Grampians Agriculture Project*.**

- **The project reports the analysis of a zero GHG emissions simulation across the combined 'sheep, grains, beef and dairy cattle' sector for four Local Government Authorities (LGAs) being Hindmarsh, Yarriambiack, Horsham Rural City and West Wimmera.**

- **Findings: Under the net-zero scenario, the economies of each of these LGAs are projected to grow, and having these farms achieve a net-zero carbon emission level, is not expected to present any substantial negative impact on any of the economic sectors, nor on the overall economic activity.**

Federation University

Questions

Contact:

Craig Hurley

Federation University (Ballarat)

E: c.hurley@federation.edu.au

T: +61 3 5335 3717

Associate Professor Abdel Halabi

Federation University (Berwick)

E: abdel.halabi@federation.edu.au

T: +61 3 5122 6646

Dr Paul McPhee

Federation University (Ballarat)

E: p.mcphee@federation.edu.au

T: +61 3 5327 9415

Data collection

- **QUALITY IN = QUALITY OUT**
- Accuracy helps to reduce data output variability
- Assumptions are needed in some areas to obtain data
- Extraction is time consuming but should improve with time
- Most data existed although some extrapolation was needed ie. Ground cover % across the farm in grazing paddocks, electricity use per enterprise.
- ACCOUNTING DATA – Data form requirements can vary between accounting and carbon system inputs
- VEGETATION GROWTH & AGE – the age and density which significantly influence emissions output
- CROPPING - is potentially easier to input due to technology use than livestock due to requirement for liveweight gains and losses during the year