Agricultural Greenhouse Gases (GHGs)

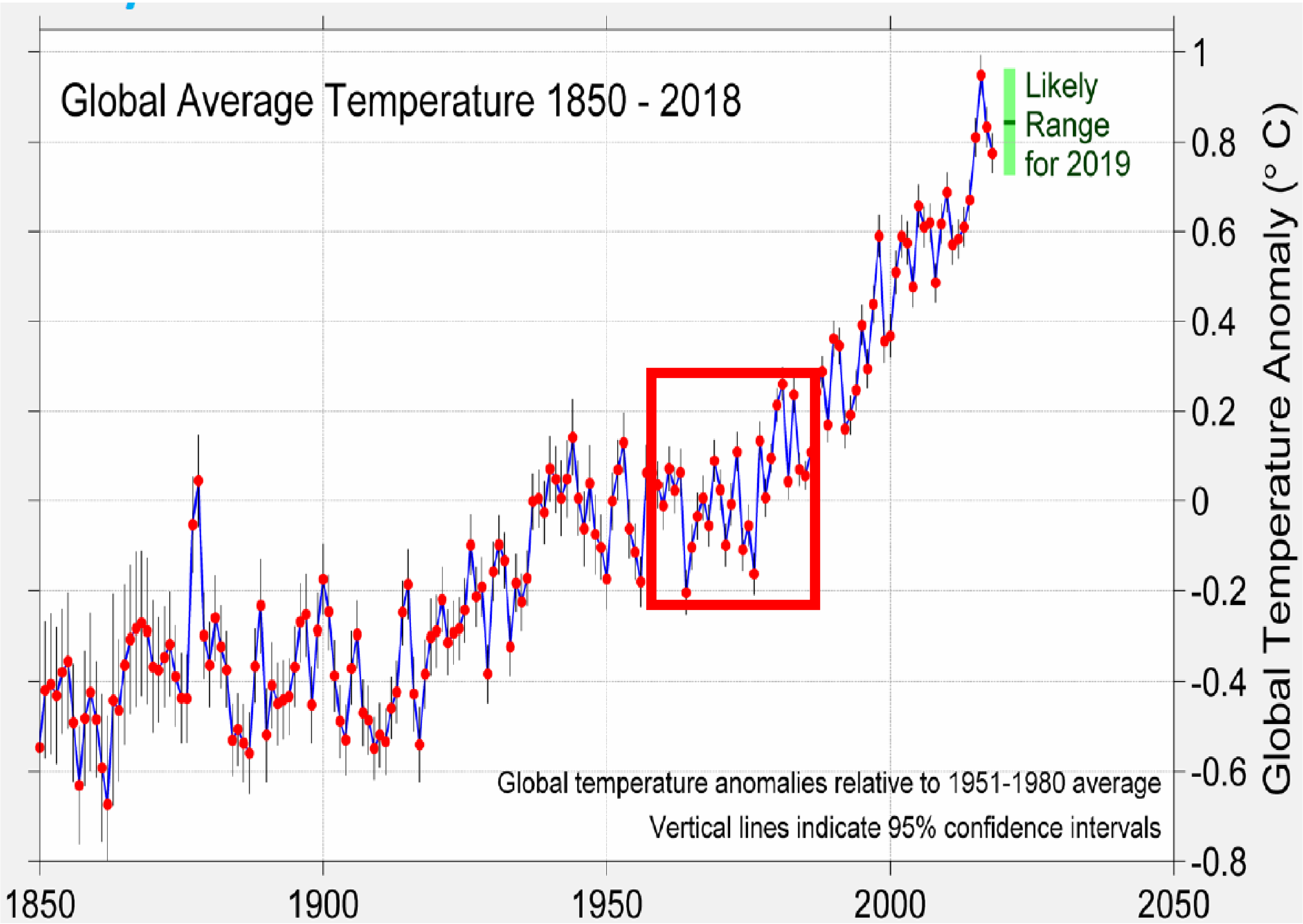
Thriving Southland Workshops

March 2023

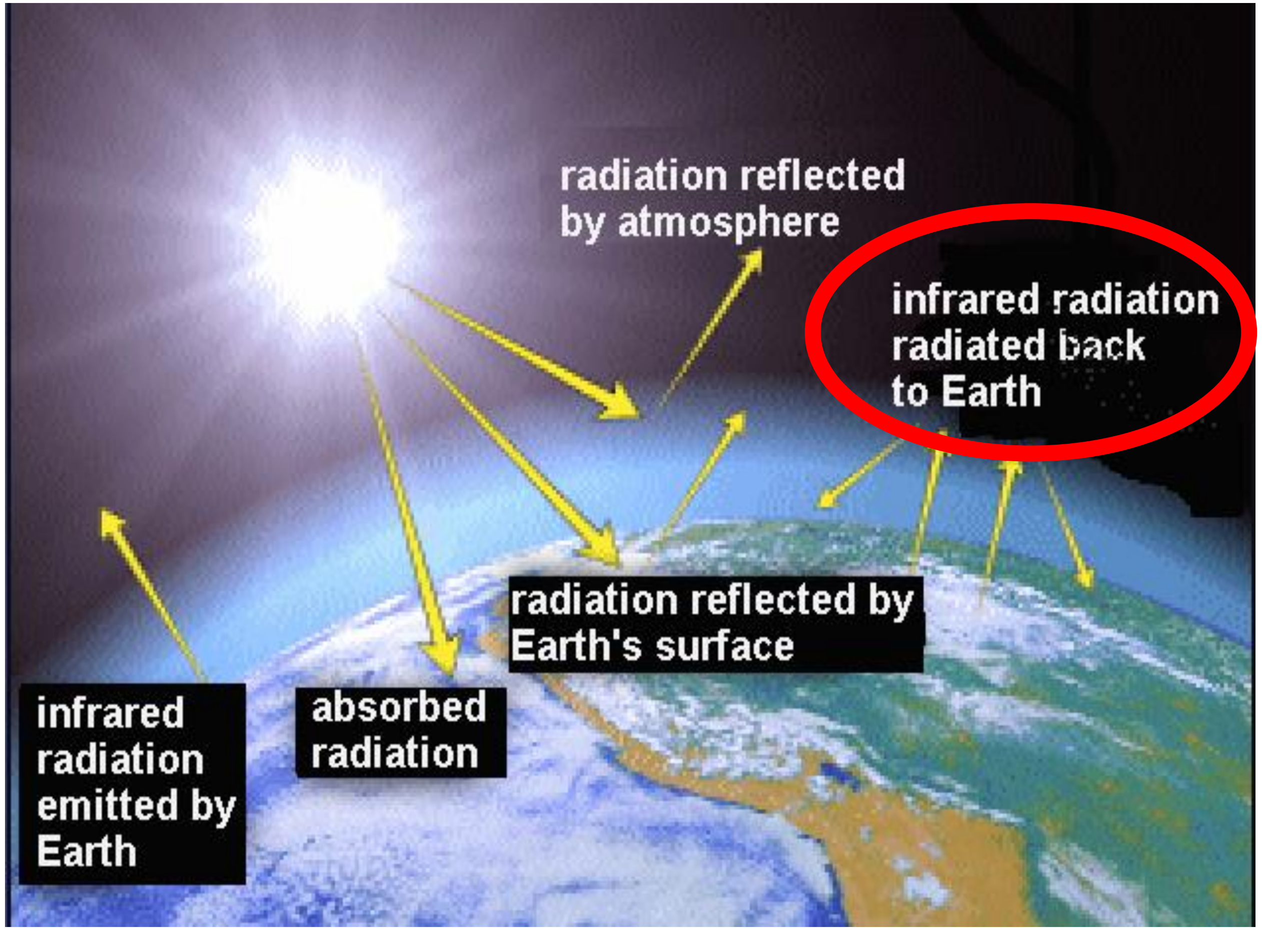
ravensdown

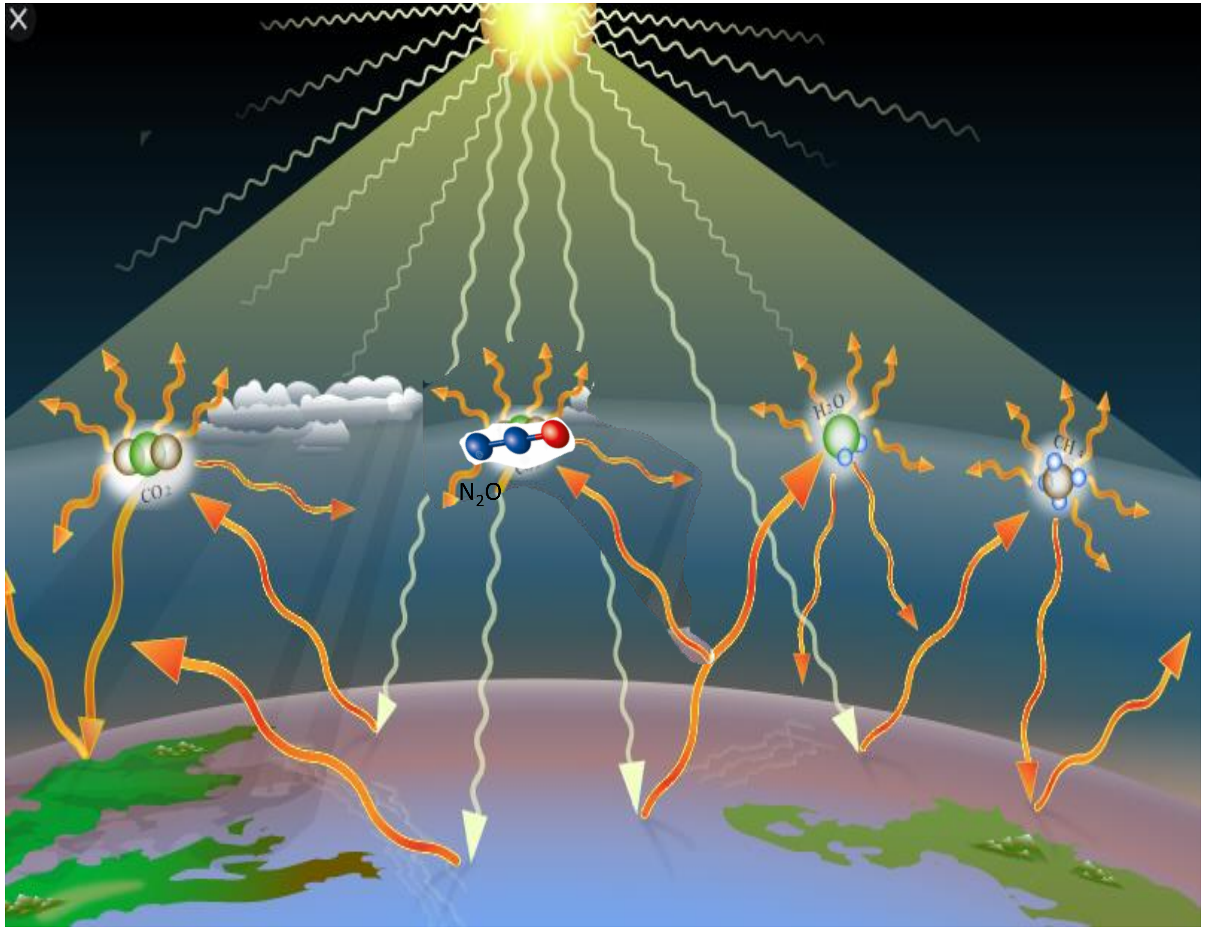
GHGs: Is it all just

?

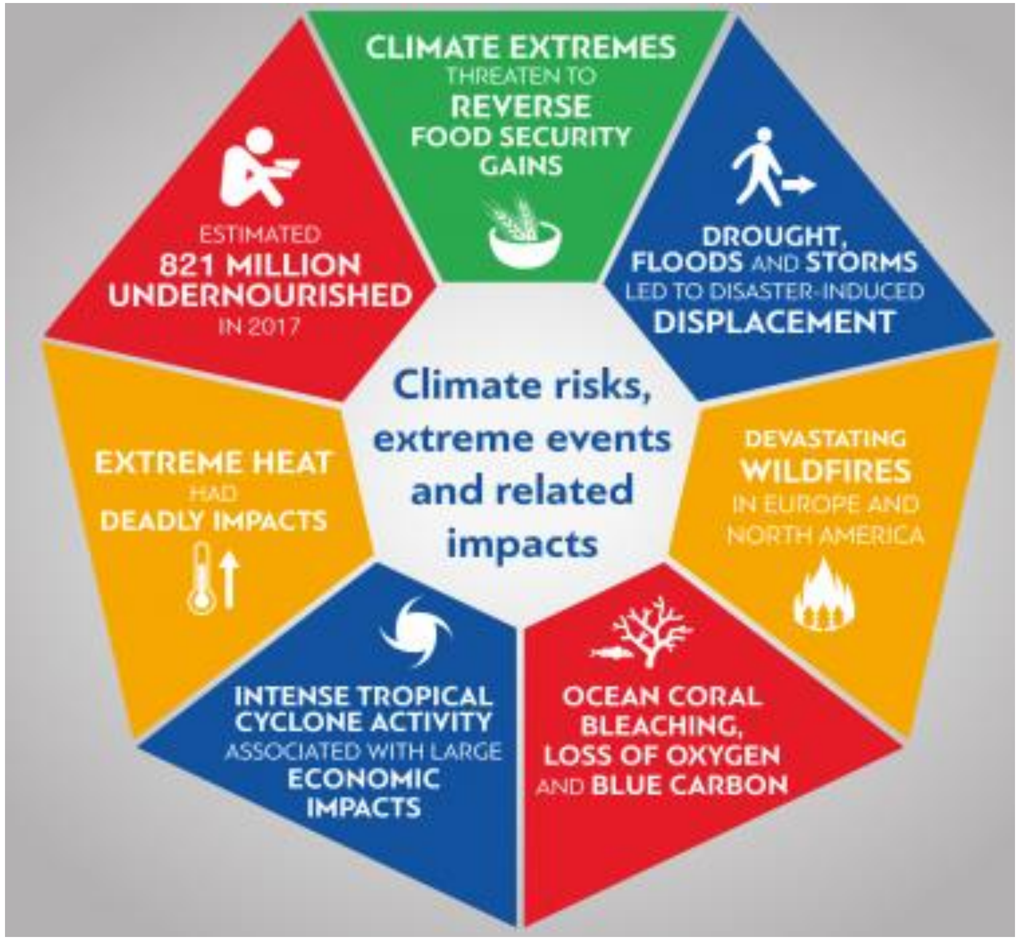


The so called "Greenhouse Effect"

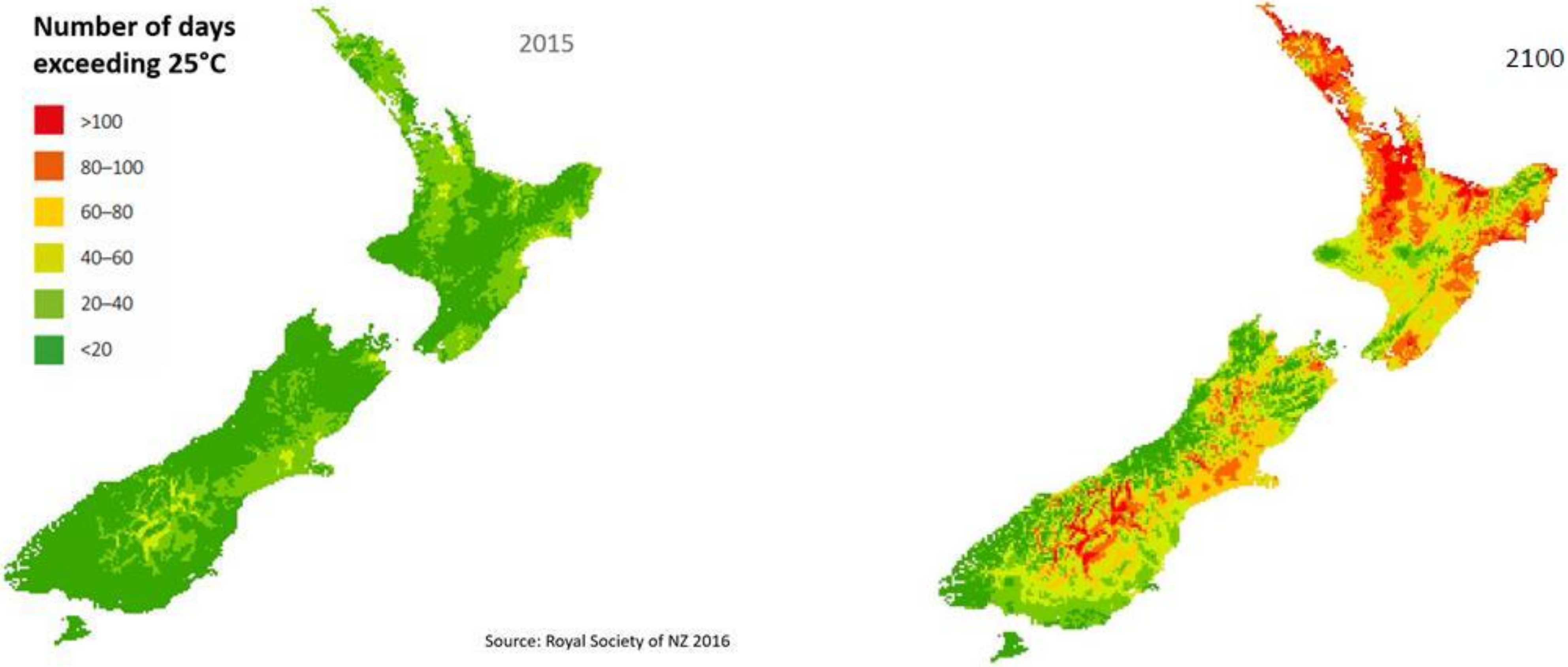




What can we expect with climate change?



For NZ, no. days > 25°C will increase…



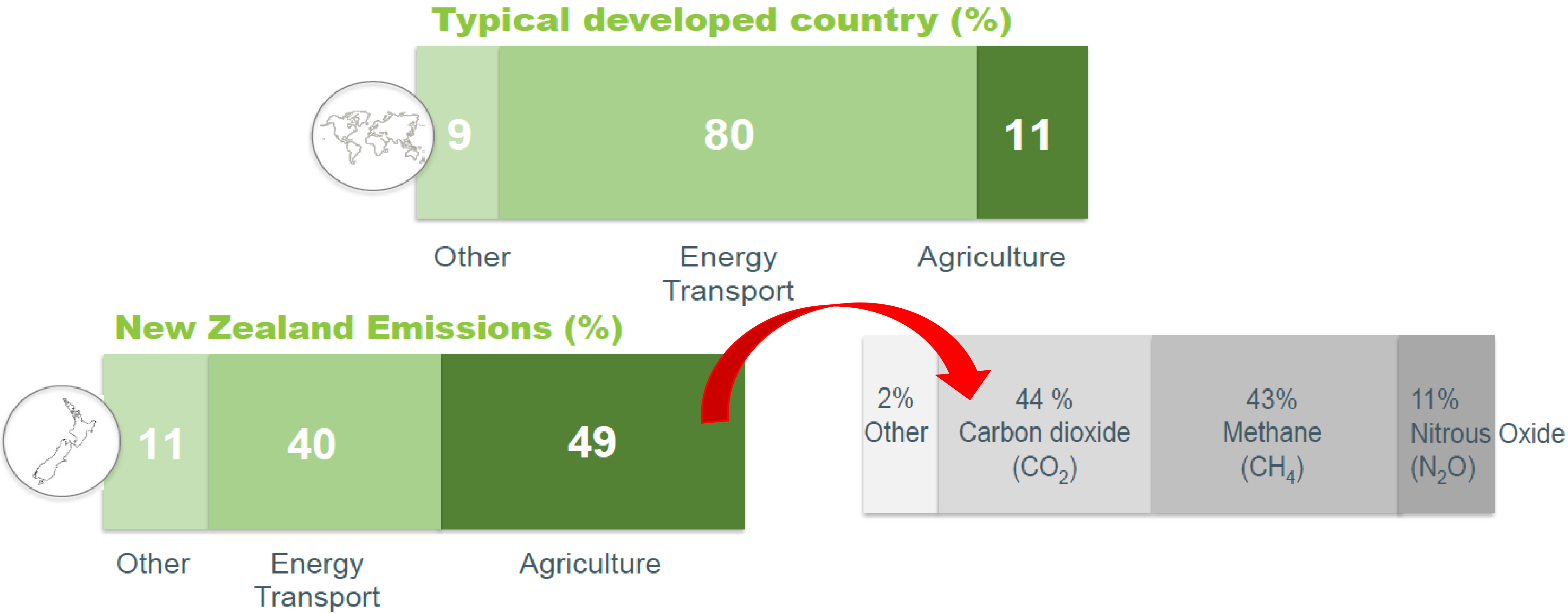
New Zealand’s international GHG commitments

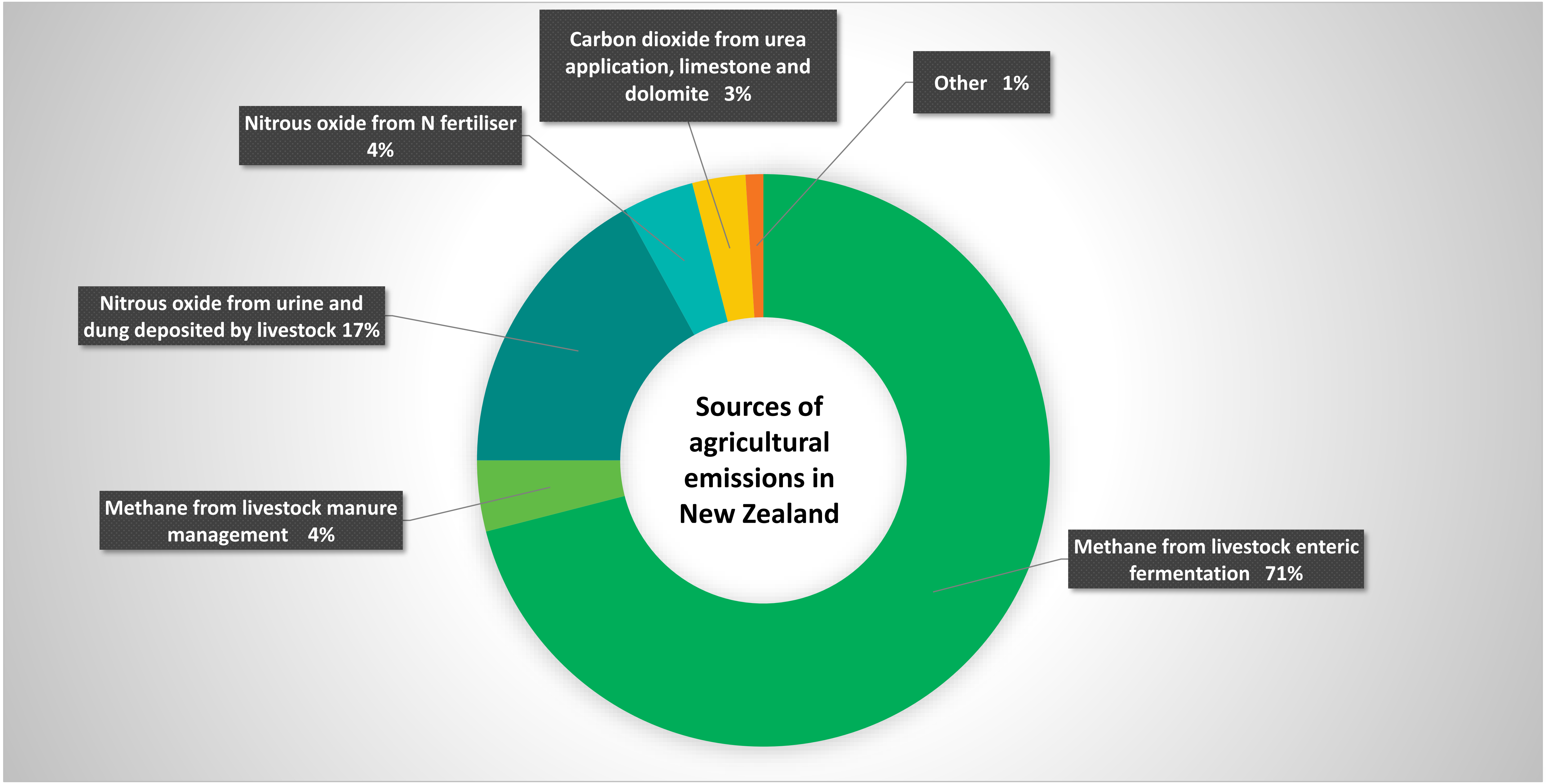
- Paris Agreement (185/197 countries) to reduce emissions to 30% below 2005 levels: by 2030

- NZ‘s target to reduce emissions to 50% below 1990 levels: by 2050

- Zero Carbon Bill
  - CO_2 and N_2O to zero: by 2050
  - CH_4 reduced 10% below 2017 levels: by 2030
  - CH_4 reduced 24-47% below 2017 levels: by 2050

New Zealand's emissions profile is unique




Carbon dioxide from urea application, limestone and dolomite 3%
Other 1%
Nitrous oxide from N fertiliser 4%
Nitrous oxide from urine and dung deposited by livestock 17%
Sources of agricultural emissions in New Zealand
Methane from livestock manure management 4%
Methane from livestock enteric fermentation 71%

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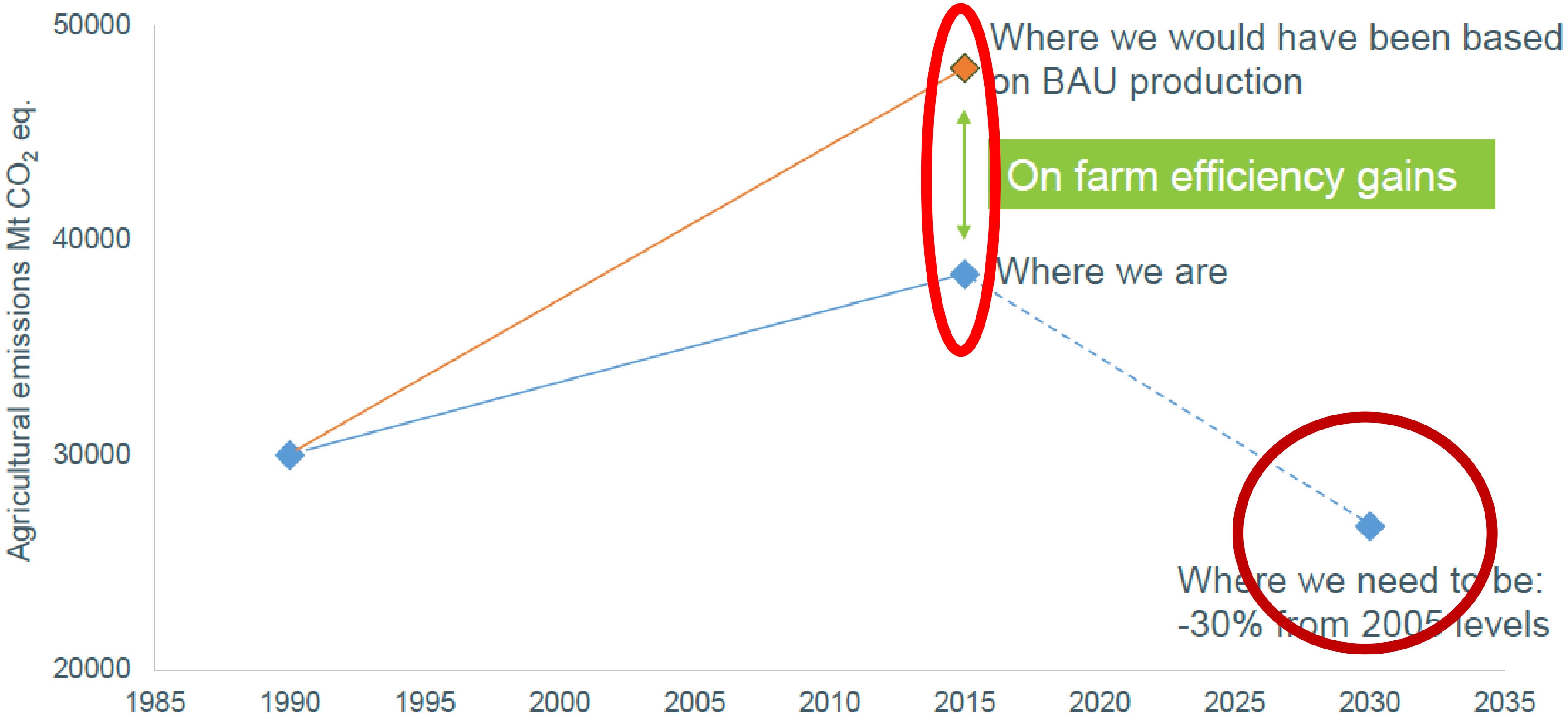
New Zealand’s Target

How are we tracking



Adapted from NZAGRC, 2014

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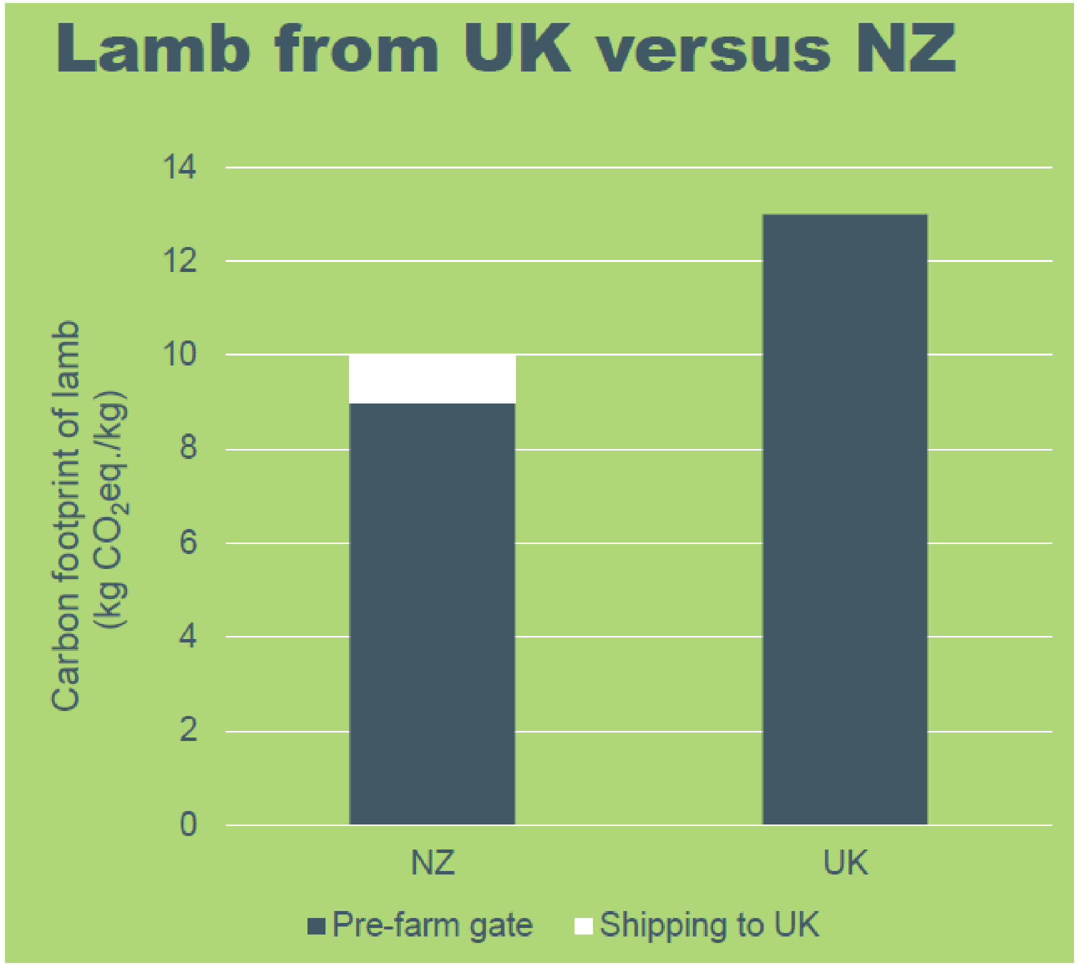
NZ farm systems are efficient by global standards



What HWEN says you should do…

Know Your Number

- By 31/12/2022

92% to date

A GHG Reduction Plan

- By 31/12/2025

25% to date

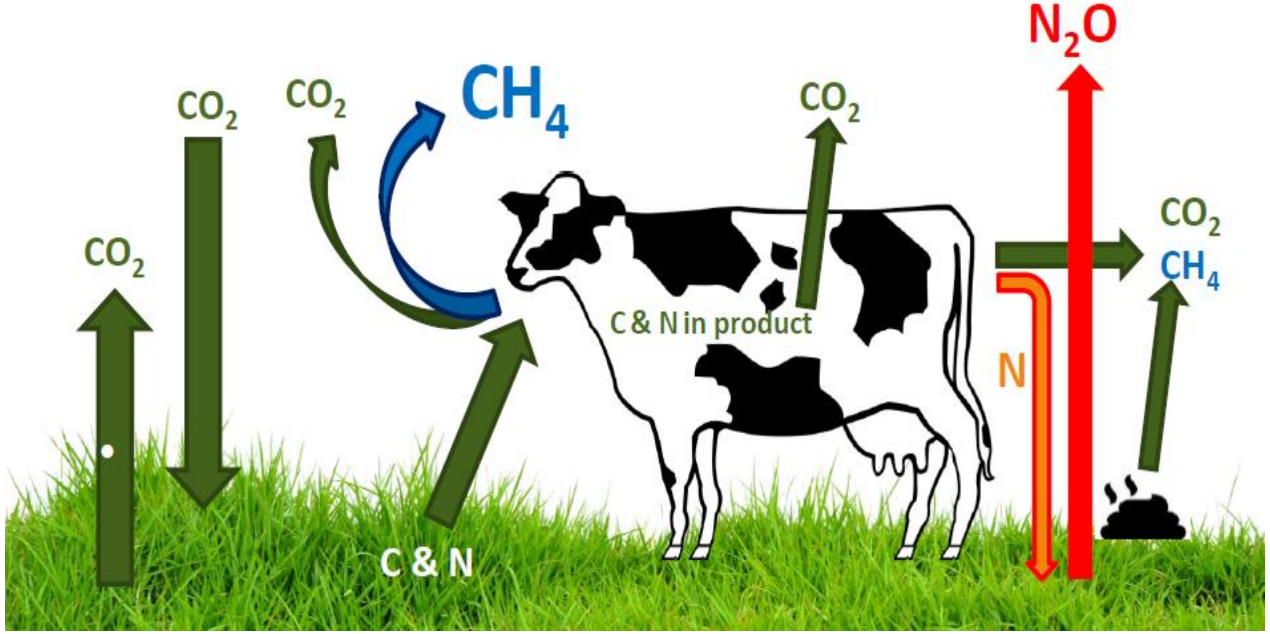
Typical farm emissions in Southland

GHG	Dairy (Winter off)	Sheep/beef Breeding/finishing	Arable (with process crops, sheep)
Carbon dioxide CO_2	2157	340	582
Methane CH_4	9136	5013	1232
Nitrous oxide N_2O	2769	1481	616

So where do these gases come from?

Livestock are:

- **Neither source nor sink for CO_2**
- **Are a source of methane (CH_4)**
- **Are a source of nitrous oxide (N_2O)**



How is the methane produced?

Enteric methane (approx. 95% of total methane)

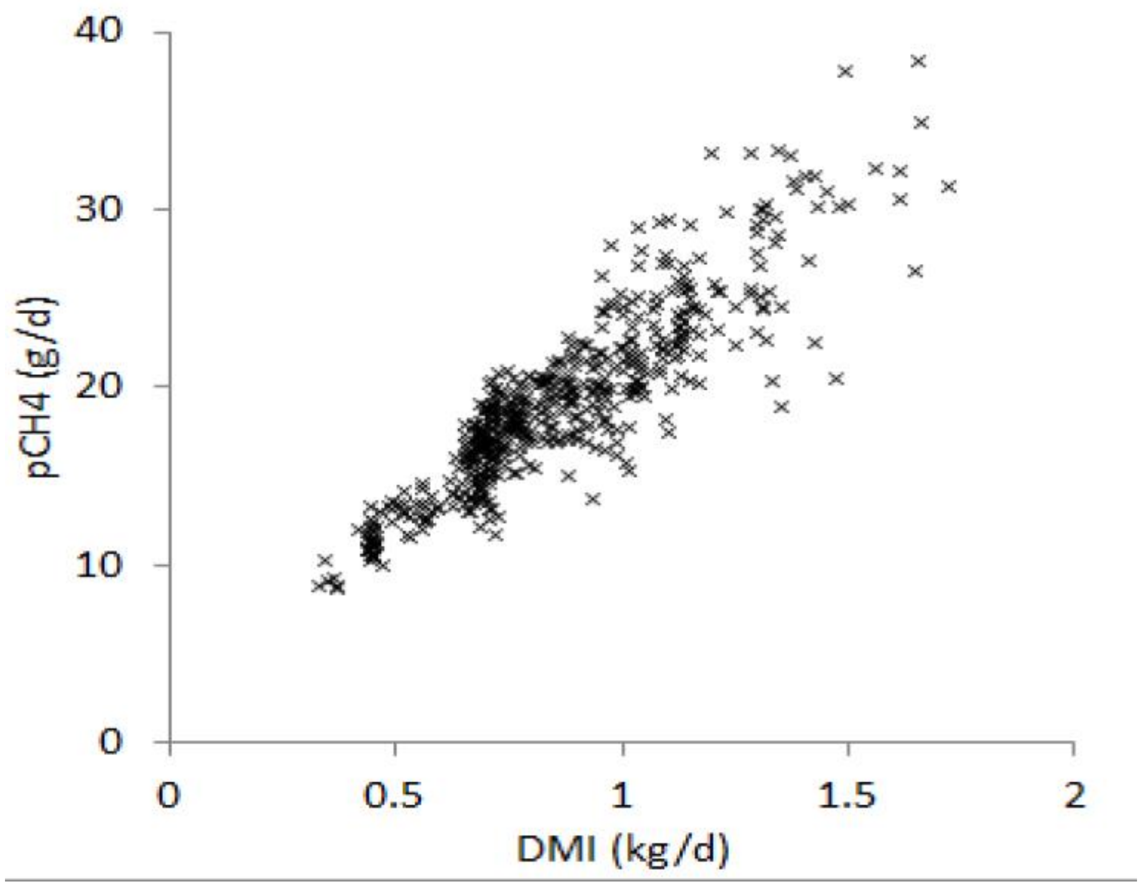
- Anaerobic decomposition of feed in the rumen
- Specialist group of microbes convert CO_2 & H_2 into CH_4
- Approx 95% lost via the mouth (rest is flatus)

Methane from animal manure (stored & deposited directly onto pastures)

- Essentially the same process– the anaerobic decomposition of organic material by the same group of organisms

What influences methane production?

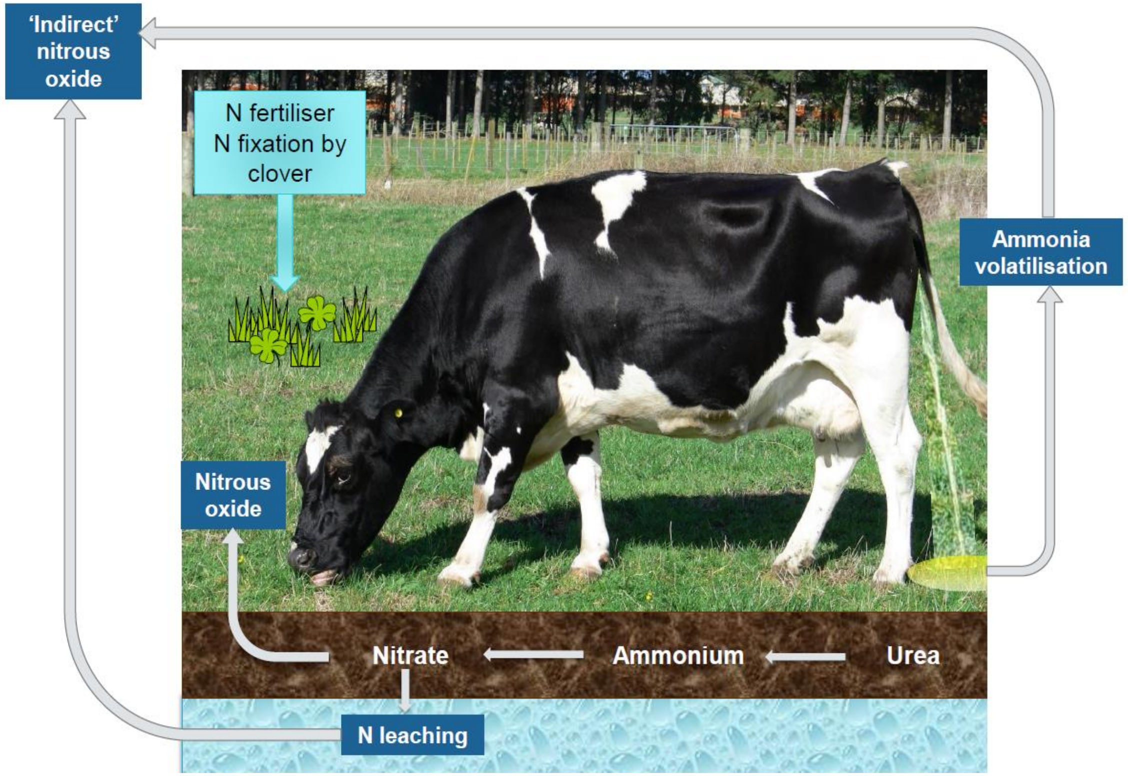
- **Feed intake: ~21 g CH_4/kg feed eaten**
- **Strongly correlated @ 15-20 kg DMI/day**
- **Feed quality affects emissions**
- **Animal factors include:**
  - **genetic merit**
  - **liveweight**
  - **milk production**



How is the nitrous oxide produced?

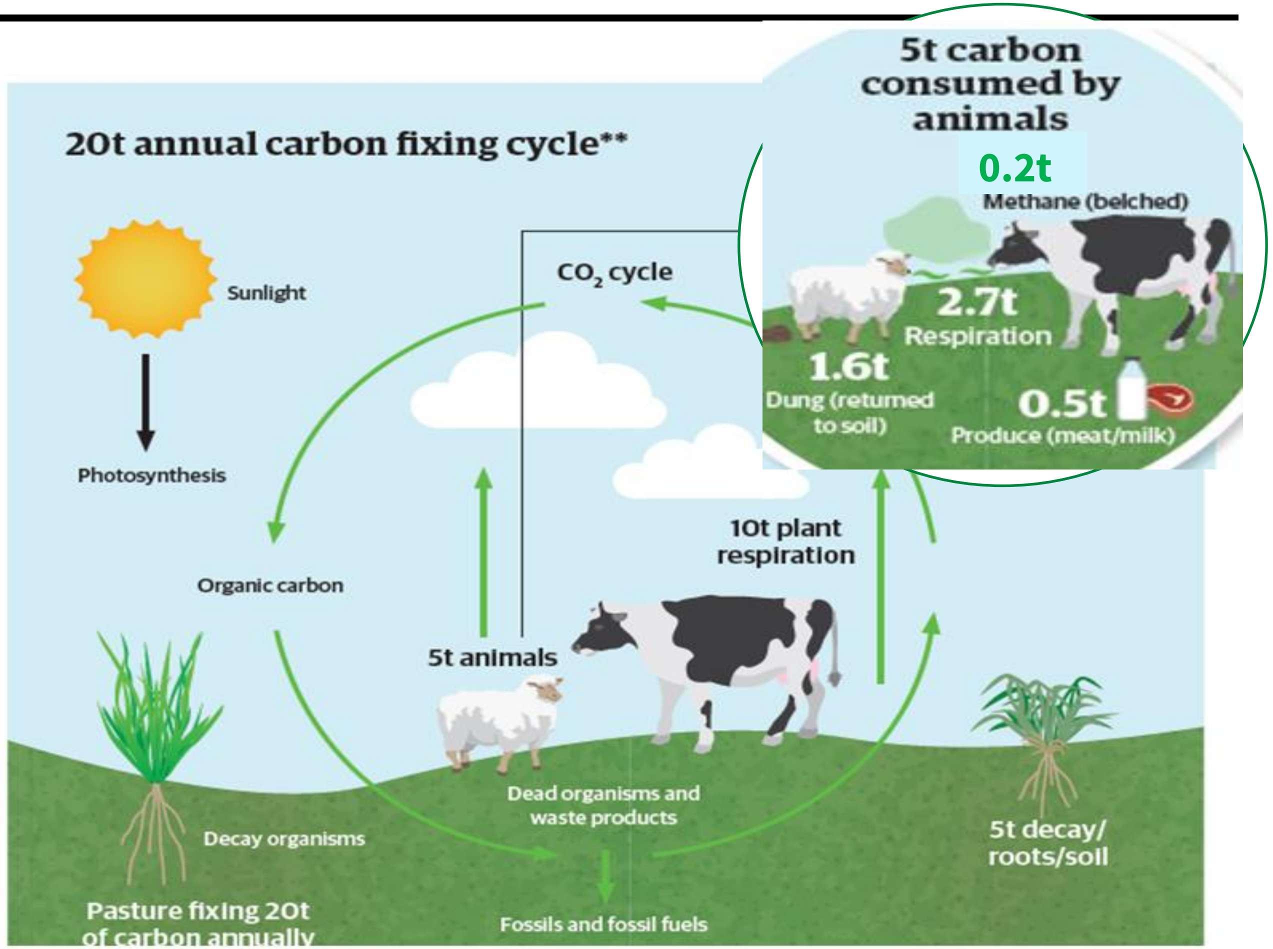
- **Indirectly from dung and urine deposition**
  - **Denitrification**
  - **Ammonia volatilisation**

- **Indirectly from soil N sources**



Popular misconceptions?

- **Pastures use carbon dioxide so why can't we count that?**



Popular misconceptions?

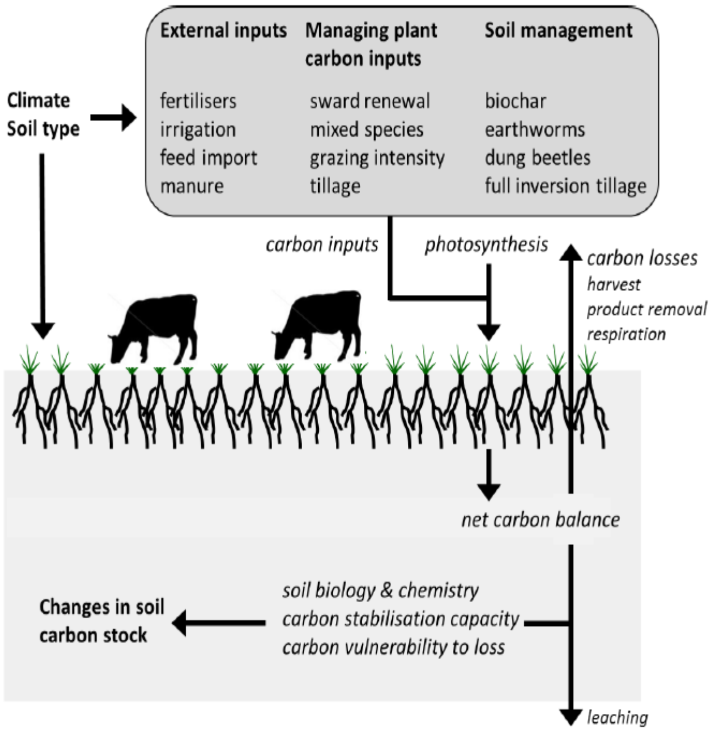
Why don't we count the carbon stored in soils?

Carbon stocks are high under NZ pastoral soils

Large uncertainty due to limited evidence base, high spatial & temporal variability

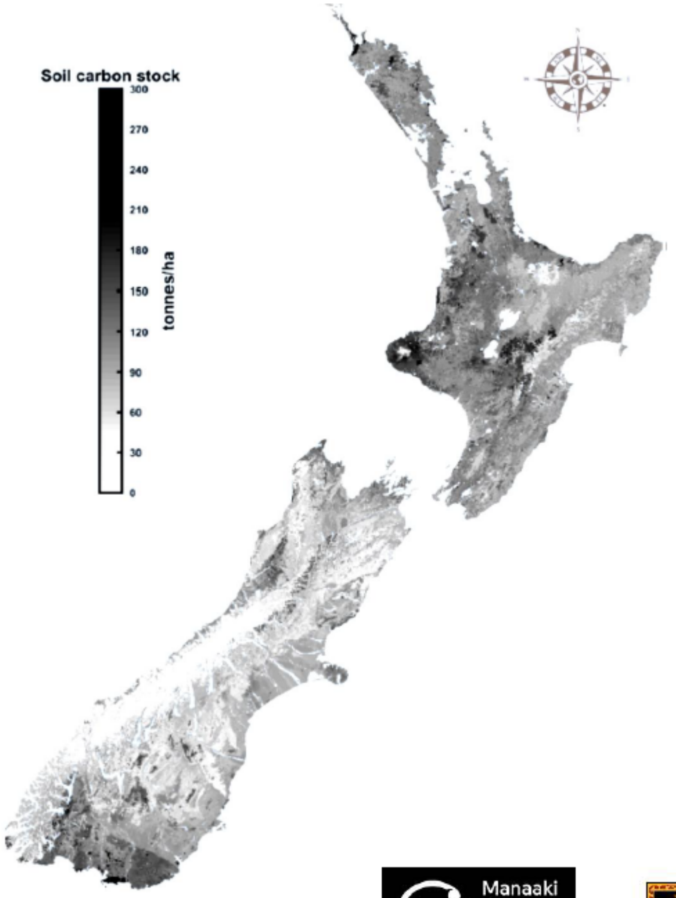
Difficult to identify specific management practices that can reliably increase rates of soil carbon accumulation

What regulates the size of the soil carbon pool?



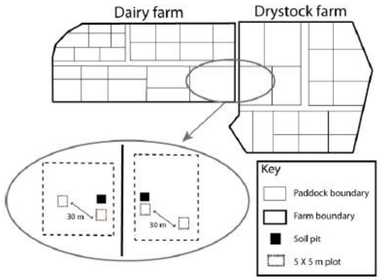
Whitehead et al. (2018) *Agriculture, Ecosystems & Environment* 265:432-443

How much soil carbon do we have in NZ?



Can we measure soil C?

- **Yes – by soil sampling!**



Grassland samples from LCDB

A proposed strategy to measure a change of 2 t C ha^{-1} between samplings

About 400 sites sampled to 0.3 m

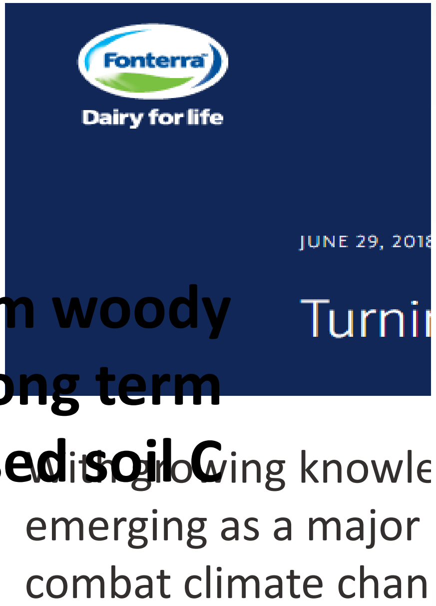
- Cropland
- Horticulture
- Dairy
- Flat-rolling drystock
- Hill-country drystock

Resampling through time

Currently developing a system for on-farm

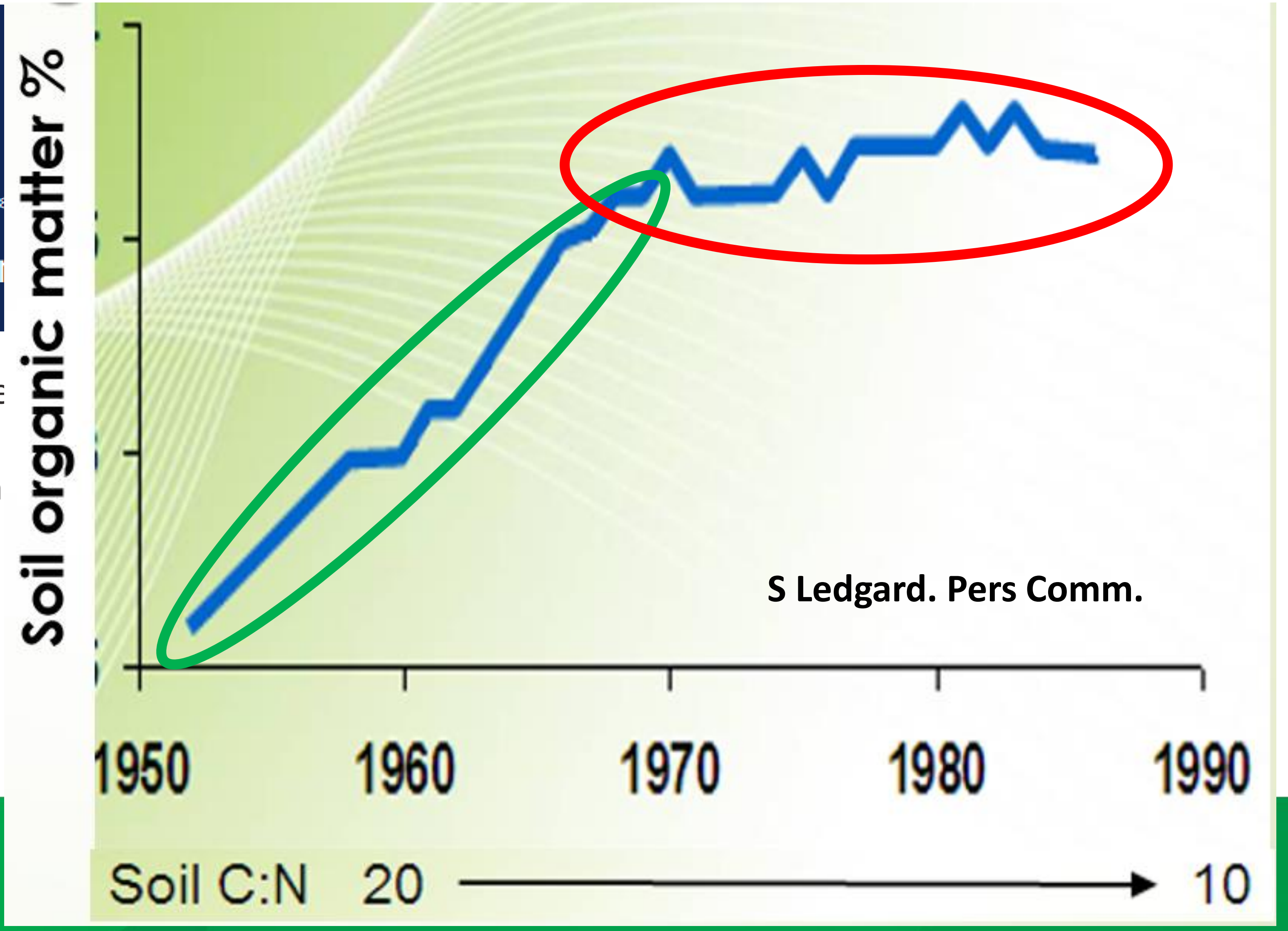
Funded by Ministry Primary Industries

Sequestering soil carbon – the answer to climate change?



Conversion from woody vegetation to long term pasture increased soil C by ~13.7 t C/ha

Schipper et al. 2017



S Ledgard. Pers Comm.

Soils under long term pastoral management

Table 1: Organic carbon (C) and organic matter (OM) contents of well developed pastoral topsoils.

Edmeades, D.C. and Roberts, A.H.C. 2002.

Soil Group	Region	% C[1]	%OM[2]	OM (t/ha)[2]
Brown-grey	e.g., Central Otago	1 - 2	2 - 3	30 - 60
Pallic and brown	e.g., Canterbury	3 - 5	5 - 9	90 - 150
Allophanic, pumice	e.g., Waikato/BOP	6 - 10	10 - 17	175 - 300
Peat	e.g., Waikato	25 - 50	40 - 80	370 - 750

[1] 0 – 7.5cm; [2] 0 – 18.5cm.

Is soil carbon accumulating or being lost?

- **In the last 3-4 decades:**
  - **On flat land, soil C declined by 0.54, 0.32 and 2.9 t C/ha/yr in allophanic, gley and organic soils**
  - **On stable mid slopes of hill country, soil C increased by 0.6 t C/ha/yr**
  - **Some management practices lose soil C i.e., irrigated pasture, cropping**
  - **Soil C can be protected by minimising time soil is fallow**

Schipper et al. 2017

What about trees? – they sequester carbon

At 1st If harvesting – need to replant additional area every time at harvest

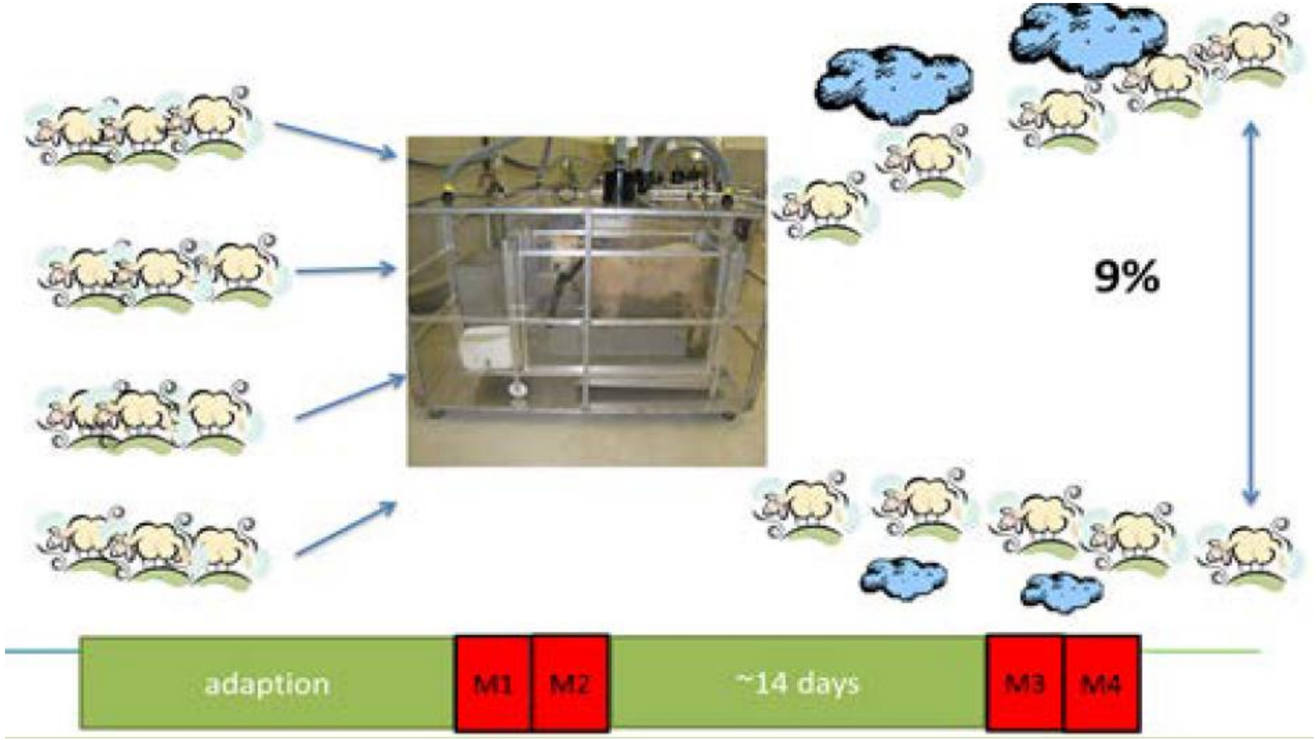
e.g.
Assume 100ha sufficient for offset

- **At 1st harvest (28 years) – replant initial 100ha, + plant further 100ha**
- **At 2nd harvest – replant 200ha, + plant further 100ha**
- **And so on**

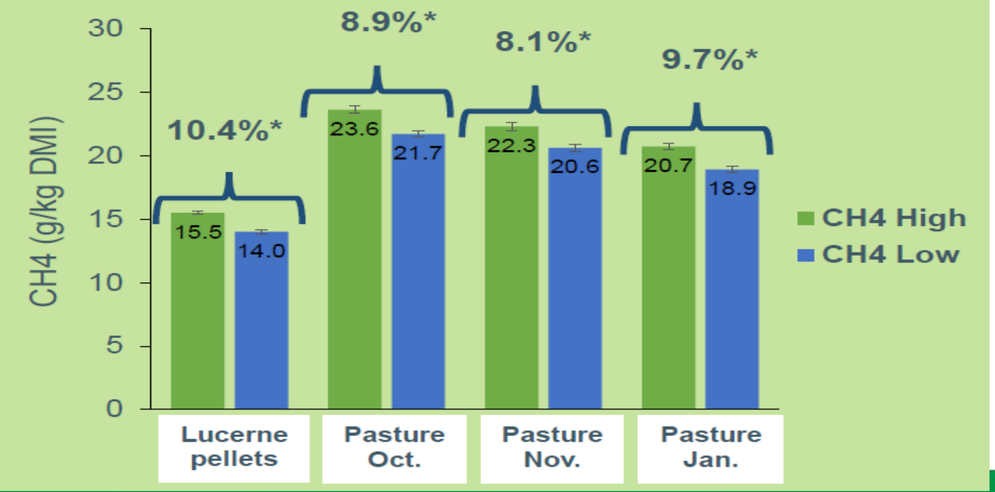
If considering forestry for carbon sequestration/offsetting – get good advice

What is being developed to help?

- Selecting low emitting ruminants



- Low vs high emitters
  - ~10% less CH_4/kg feed
  - 20% smaller rumen
  - Different fermentation
  - Different energy profile
  - More wool, less fat

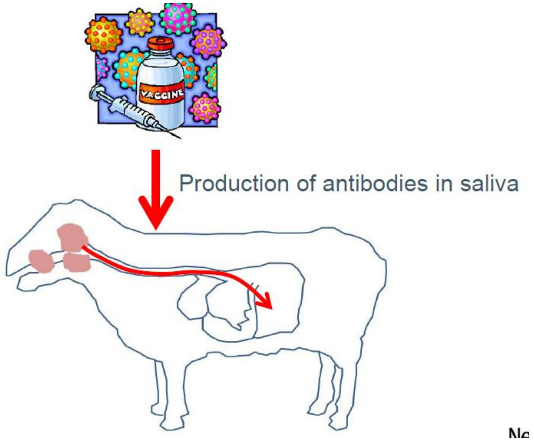


What is being developed to help?

- **Breeding for lower emissions**
  - **Heritable trait (~0.4)**
  - **No detrimental side effects**
  - **Lower absolute emissions by ~1% /yr cumulative**
- **Searching the national flock**

What is being developed to help?

- **Vaccine production**
  - **Methanogens cultured and sequenced**
  - **Genomes predict methanogen proteins for vaccine**
  - **Antibodies inhibit growth in test tubes**



Genomes from cultures

From 252 rumen samples

Methanobrevibacter gottschalkii	D5 SM9
Methanobrevibacter ruminantium	M1 YLM1
Methanomassiliicoccales Group 12	ISO4-H5
Methanosphaera sp. ISO3-F5 group	ISO3-F5

What is being developed to help?

Condensed Tannins-White Clover (Hi-CT)

Christine Voisey
Marissa Roldan

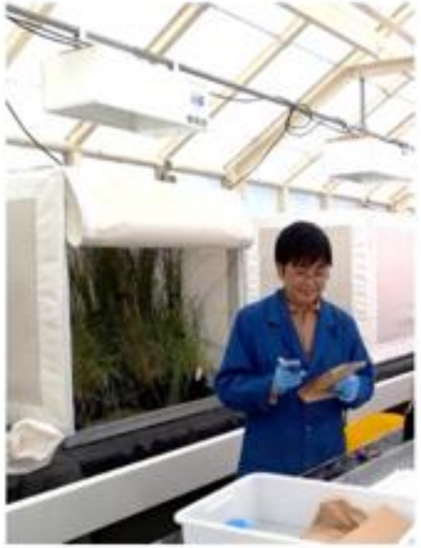
Expression of high levels of condensed tannins in leaves of white clover.

Potential to reduce methane (15%+), urinary nitrogen, bloat, internal parasite burden and improve animal productivity.

Project partners

PGG Wrightson Seeds grasslanz

High Metabolisable Energy (HME) ryegrass



Nick Roberts
Greg Bryan

Technology increases lipid content and gross energy in leaves.

Methane reductions of 10-15% are predicted but animal feeding trials are still to be undertaken.

Project partners

PGG Wrightson Seeds grasslanz DairyNZ

What is being developed to help?

Technology	When available	Efficacy
Low CH_4 emitting sheep	2-3 years	10%?
Low CH_4 emitting cattle	>5 years	10%
Low N excreting cattle	Now in theory	??
CH_4 vaccine	5-10 years	30%?
CH4 inhibitors	2-5 years	30+%
Low emitting feeds e.g. GM, seaweed etc	???	???

What is being developed to help?

- **Decreases methane from ponds by >95%**
- **Kills >99% of E. coli**
- **Decrease effluent P leaching by >90%**

What can you do now?

1: Improving efficiency of pasture production

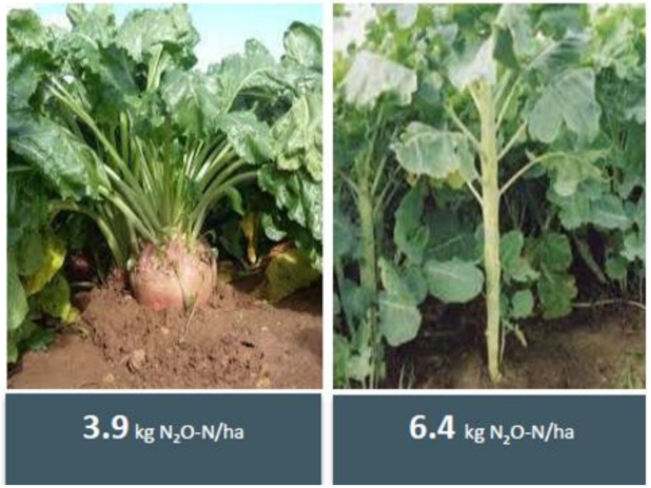
- **Manage N and N surplus**
  - **Reduce N fertiliser use**
  - **Reduce bought in supplement**
- **Use inhibitor coated N fertiliser**
- **Optimise soil pH**

What can you do now?

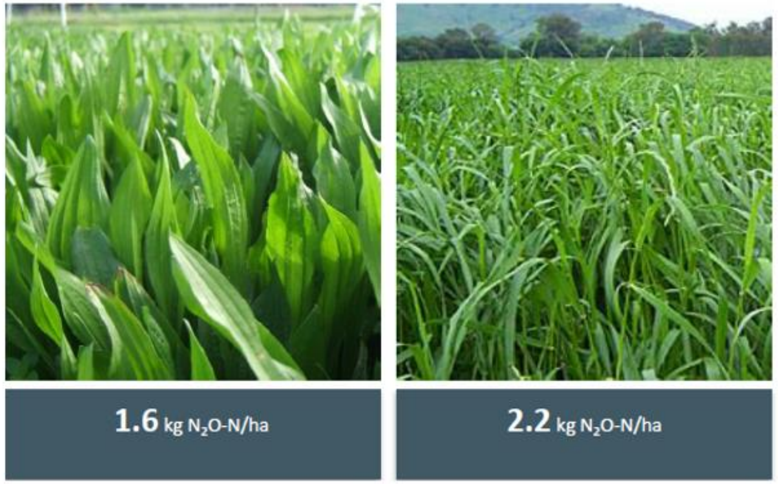
2: Matching feed demand with pasture growth

- **Optimise pasture growth and quality**
  - **Pre/post graze cover and residuals**
  - **Manage rotation lengths**
  - **Optimise soil fertility**
  - **Control pests and diseases**
- **Use lower protein feeds**
- **Reduce supplementary feed**

- **Fodder beet 39% lower emissions than kale**



- **Plantain 28% lower emissions than ryegrass**



Di et al. 2016 ; Luo et al. 2018

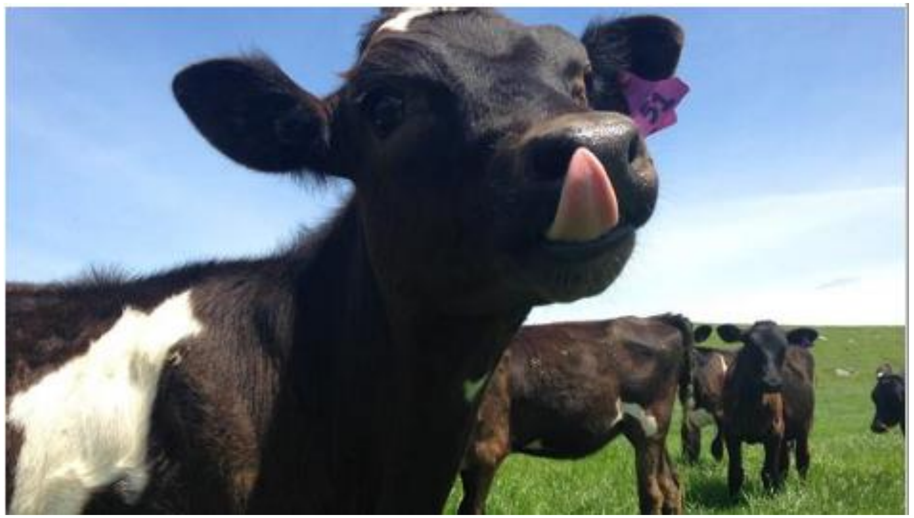
What can you do now?

3: Reducing total feed eaten

- **Increase per animal performance/reduce stocking rate**
  - **Increase genetic merit/breeding worth**
  - **Improve animal health**
  - **Improve reproduction**
  - **Cull low producers early**

- **Reduce replacements**
  - **23% to 18% reduces emissions by 2-11%**

Dairy NZ & LIC, 2016; Garnsworthy, 2004; Beukes et al. 2011, unpubl.

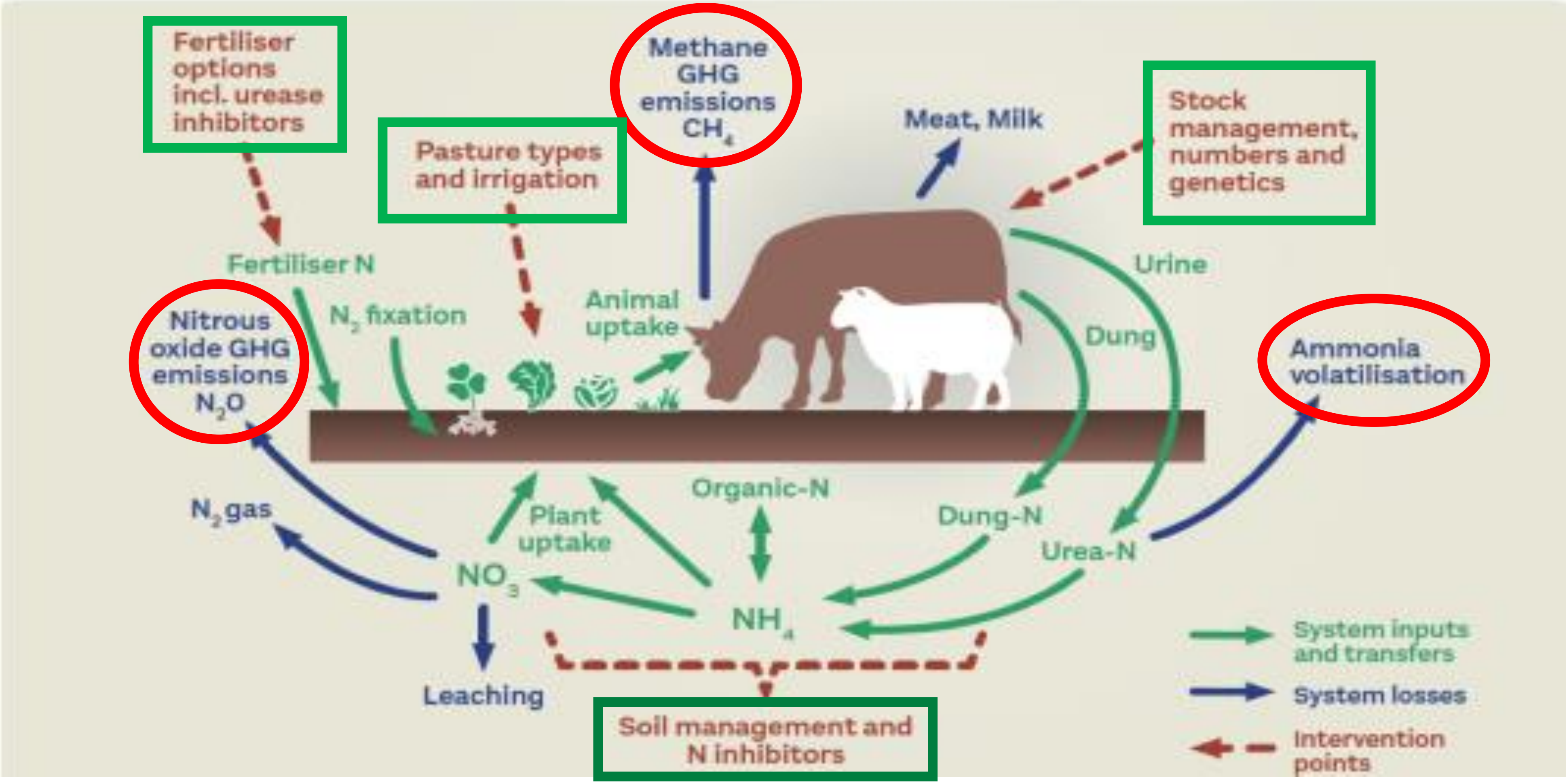


What can you do now?

4: Improving effluent (dung and urine) management

- **Minimise effluent storage in anaerobic ponds**
- **Capture effluent – stand off, barn**
- **Use all effluent as fertiliser substitute**

WORKSHOP: What will you do about GHG emissions on your farm?



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