

# A climate of change: Smart farming innovation and technology will help farmers take the front foot with climate change.

New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC),  
Palmerston North

27 March 2019



# Presentation Outline

1.The Global Picture

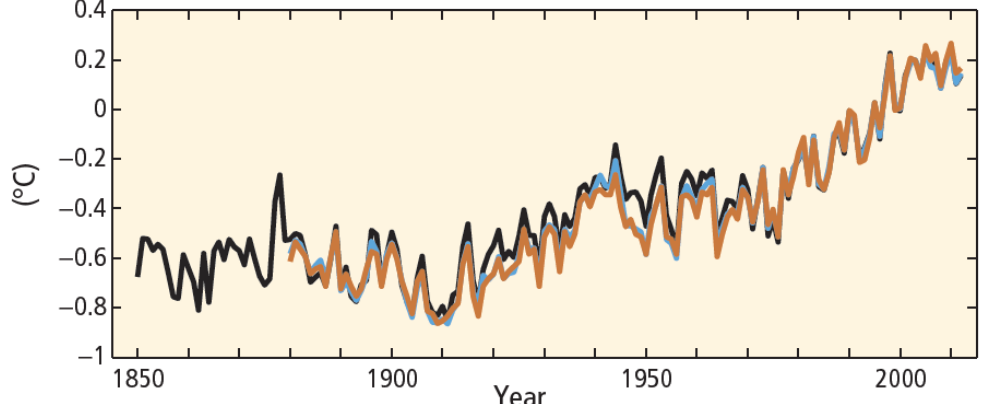
2.The New Zealand Situation

3.The Science

# The Global Picture



# Climate change – What is the science is telling us

- The earth's climate is warming. (a) Globally averaged combined land and ocean surface temperature anomaly
- 
- Scientists agree its happening and its because of us.
  - Increased atmospheric concentrations of anthropogenic greenhouse gases such as carbon dioxide, methane, nitrous oxide and fluorinated gases are the dominant cause

**Reference:** Information taken from the IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)

# What is the world doing about this?

## Paris agreement

- The deal unites 185/197 countries in a single agreement on tackling climate change

### *Key element*

- To keep global temperatures "well below" 2.0C above pre-industrial times and "endeavour to limit" them even more, to 1.5C



# Agriculture is necessary to meet the 2°C climate target.

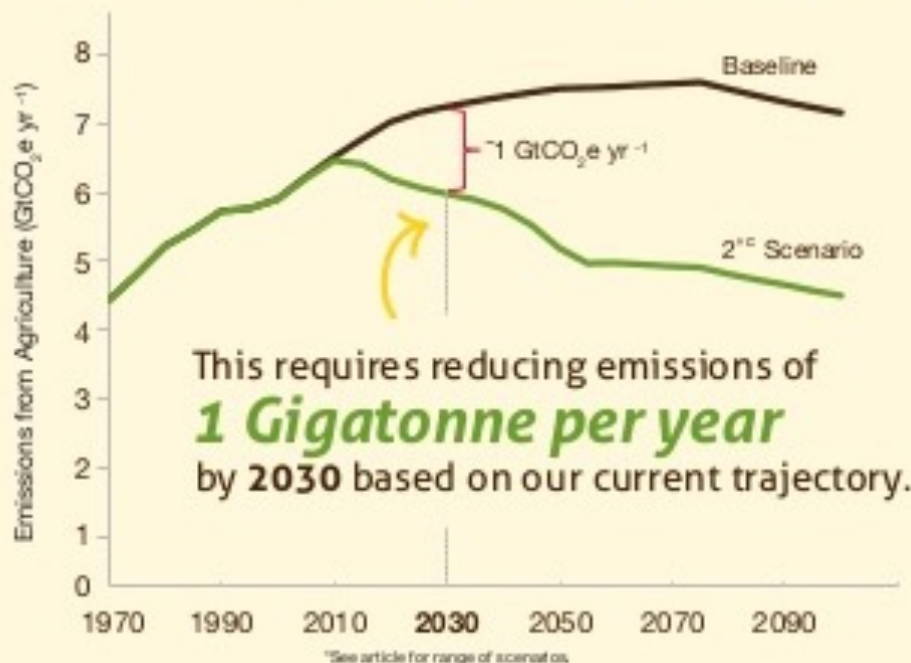
At the Paris climate conference,  
**119 countries**  
committed to mitigation in agriculture,  
(but few set quantitative targets).



Richard et al. 2016. <https://ccafz.cgi-ar.org/agricultures-prominence-indcs-data-and-maps>

# The challenge

Agriculture will need to **limit its greenhouse emissions** to only **6–8 Gigatonnes** by **2030** while also increasing production.



However, known practices could deliver just **21-40% of the needed reduction**, even if implemented fully at scale.



Top line: Estimated business-as-usual emissions from agriculture  
Bottom line: Maximum amount of emissions from agriculture in a 2°C world

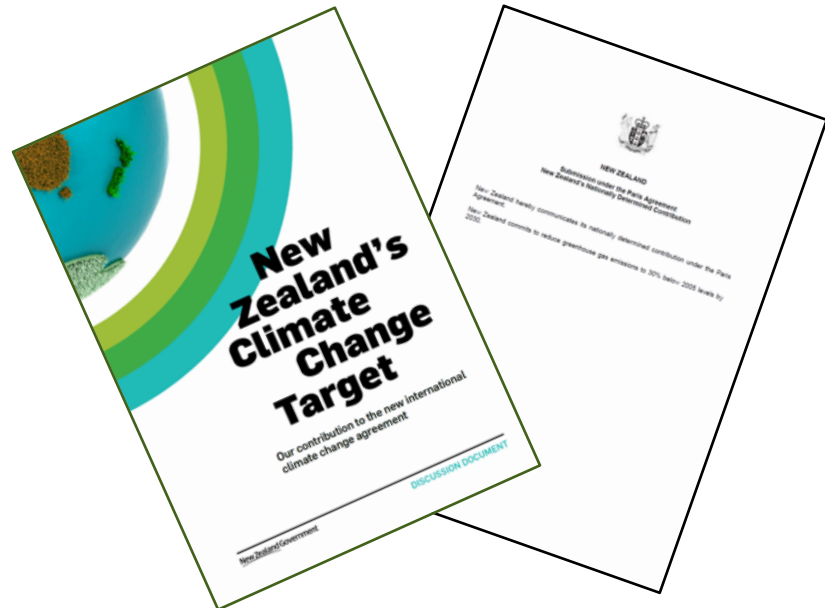
Source: <http://dx.doi.org/10.1111/gcb.13340>



# NZ's obligations under the agreement

**New Zealand commits to reduce GHG emissions to 30% below 2005 levels by 2030**

**All sectors and all GHGs**





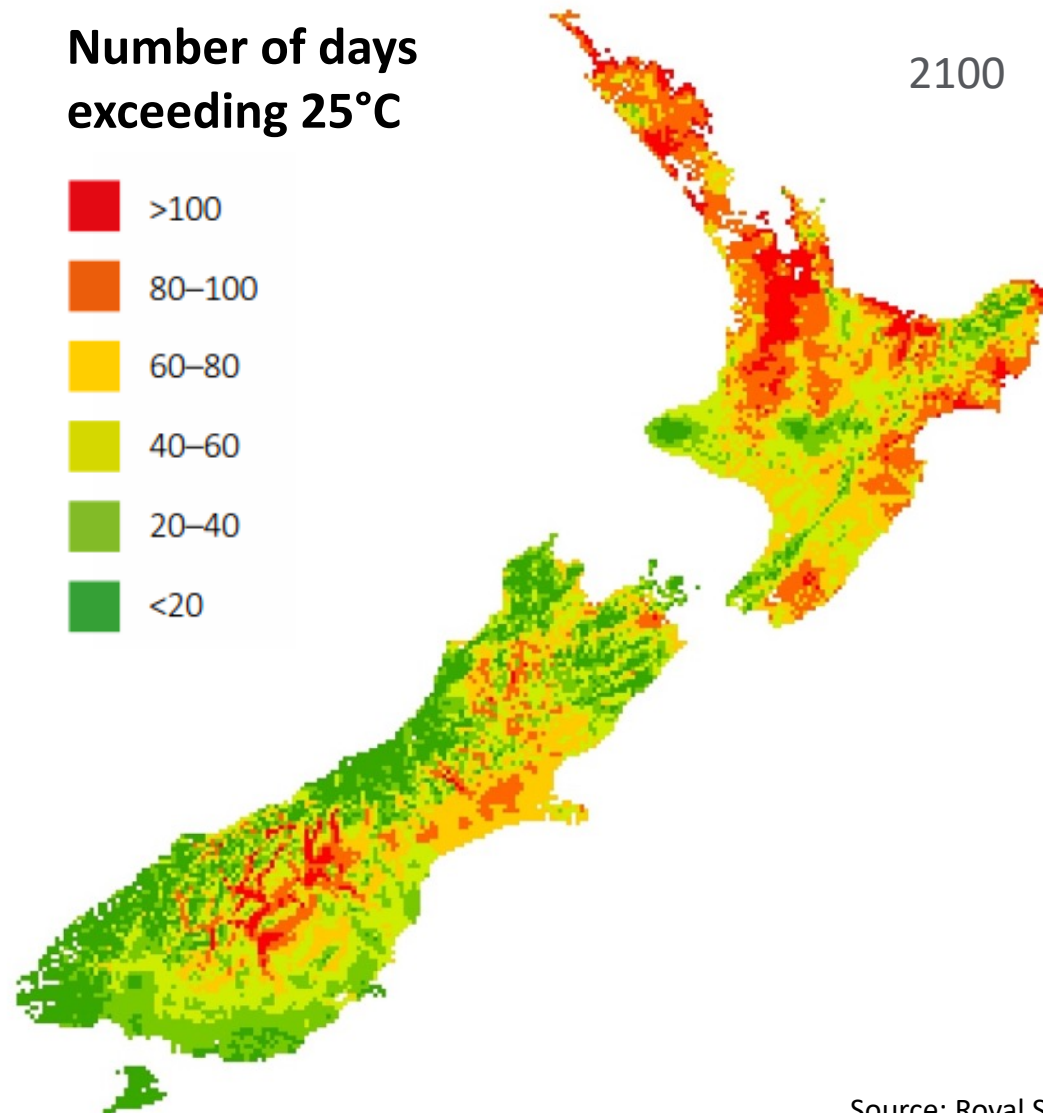
# Key points – The Global Picture

- The earth's climate is warming
- Man made GHGs are the cause
- Country commitments have been made to reduce GHGs
- Agriculture's contribution will be needed to meet the 2°C climate target
- NZ has made its commitment and it includes all sectors and all GHGs

# The New Zealand situation

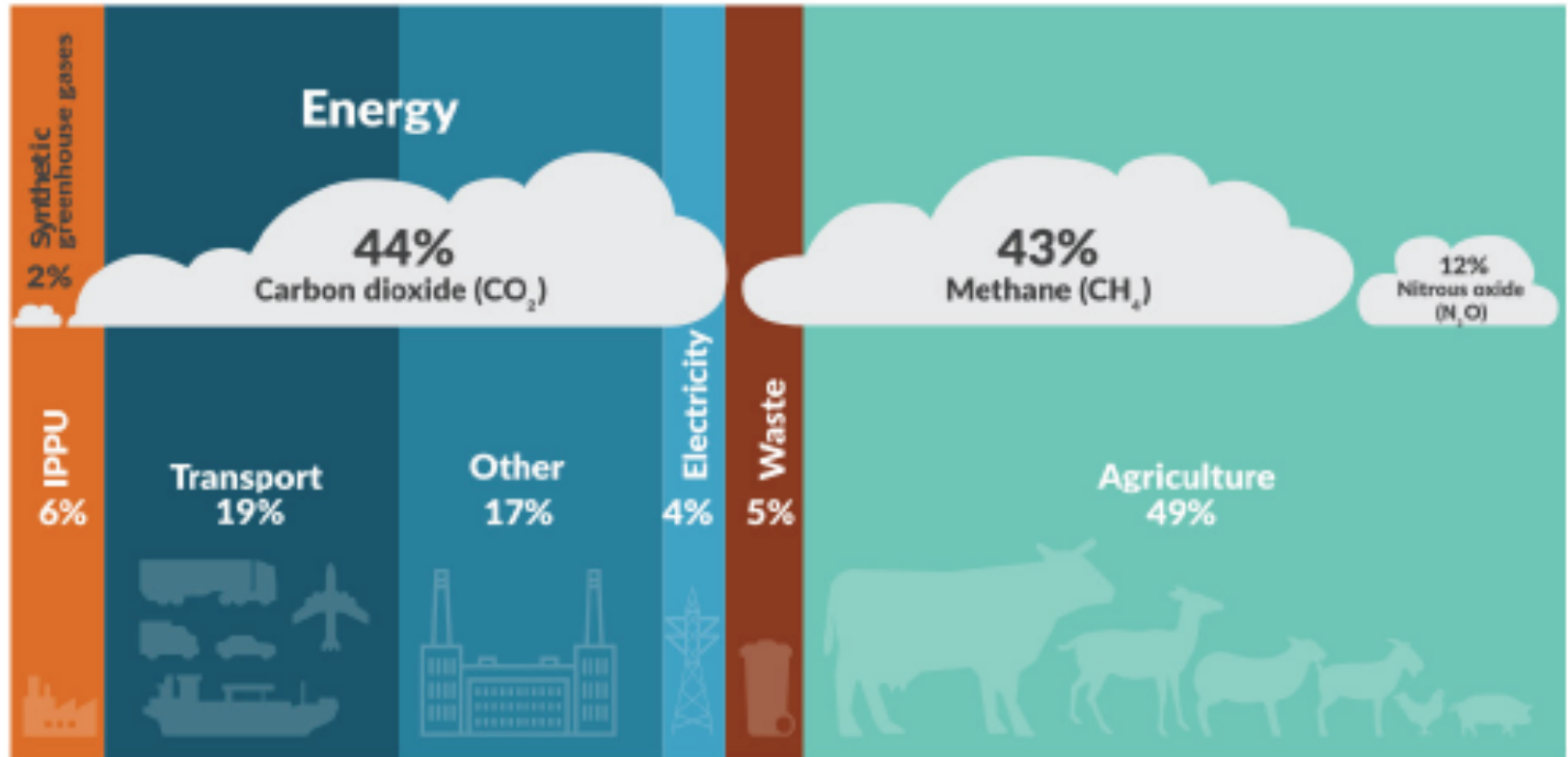


# Climate change matters to New Zealand



Source: Royal Society of NZ 2016

# Agriculture accounts for half of NZ's gross emissions



Source: Ministry for the Environment

# Where do livestock emissions come from?

## Methane

Enteric fermentation

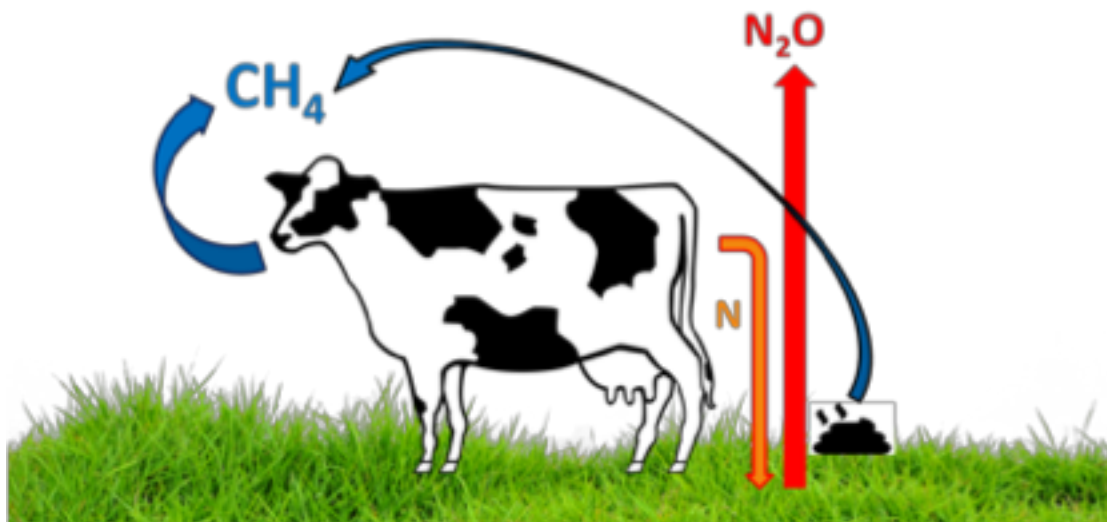
Stored and deposited animal wastes

## Nitrous Oxide

Pasture deposited animal wastes

Manure management

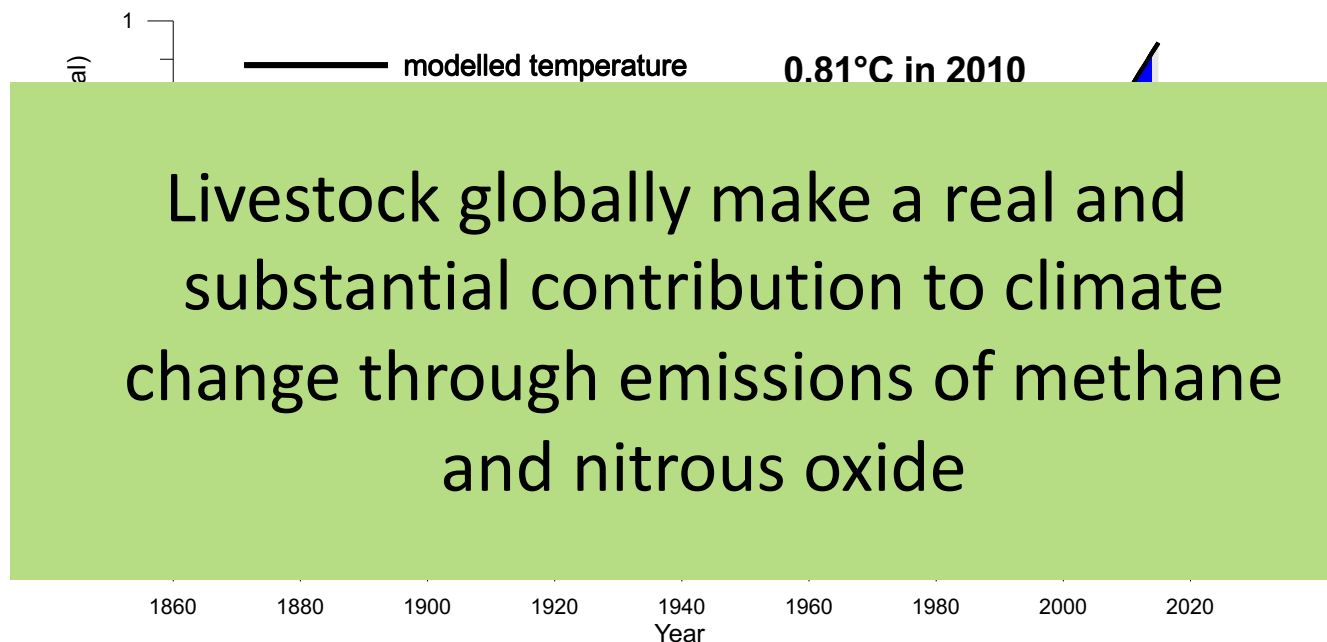
N fertiliser



<u>Ruminant</u>	<u>Number (2017)</u>
Sheep	27,370,000
Beef	3,610,000
Dairy	6,470,000
Deer	850,000

# How much actual warming is due to GHG emissions from livestock globally?

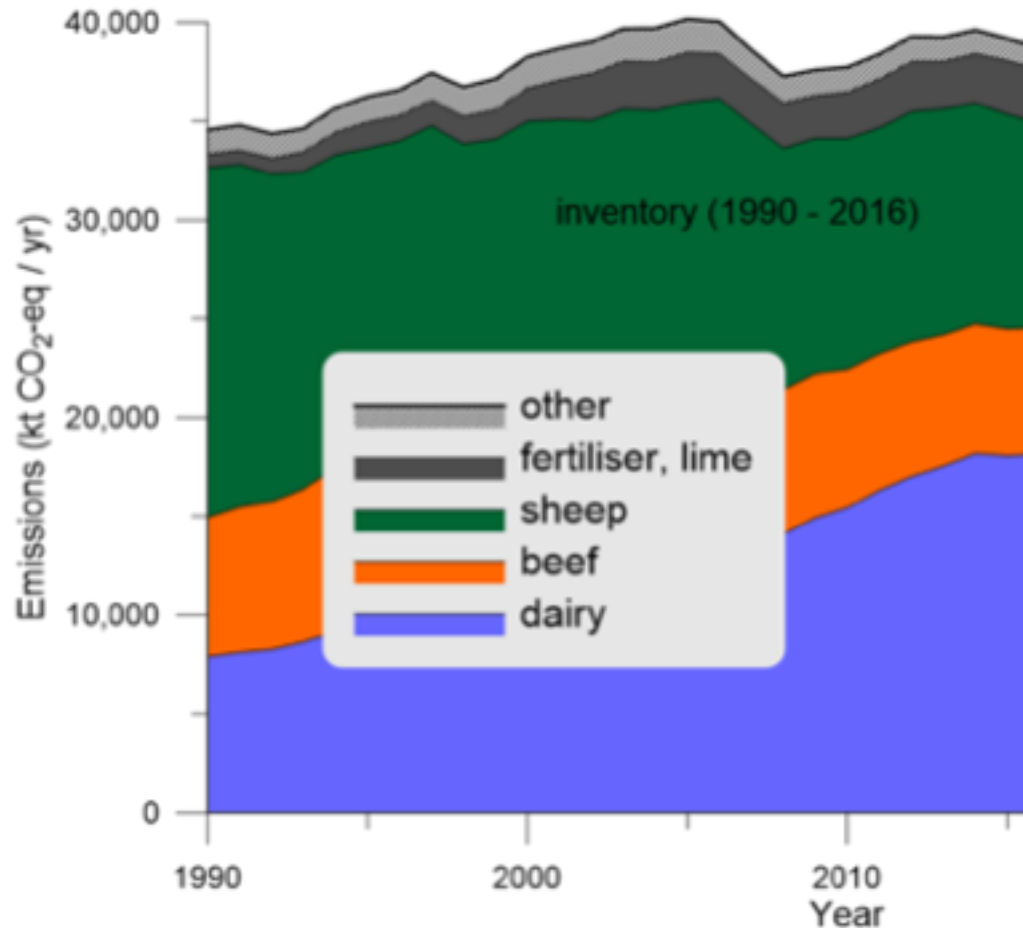
## Livestock contribution to historical warming



Reisinger and Clark (2017) <https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.13975>

# NZ Agricultural GHG emission trends

+12% in 2016 compared to 1990

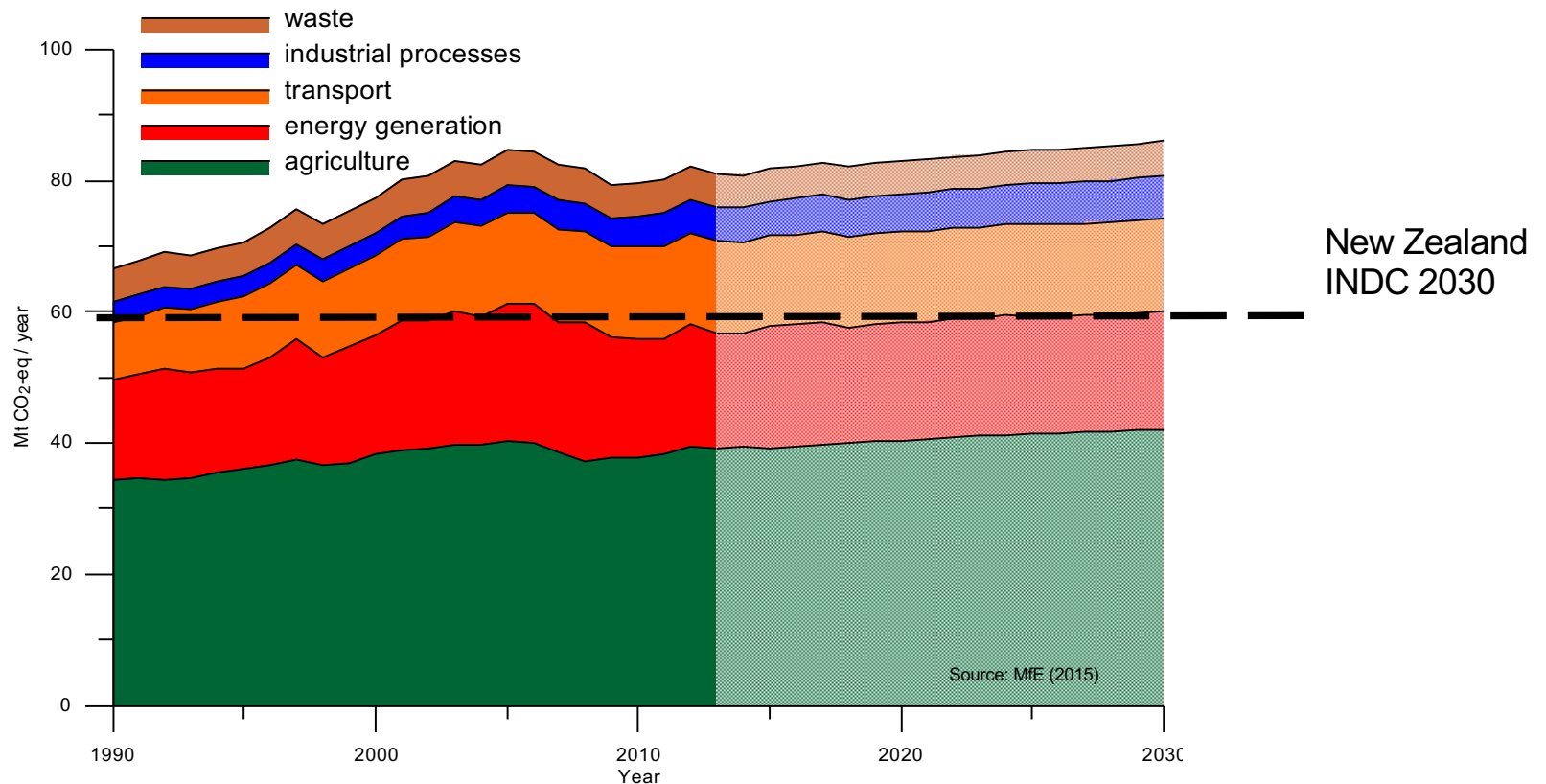


**Dairy dominates New Zealand emissions:  
Enteric CH<sub>4</sub> emissions 1990 & 2016 (kt/year)**

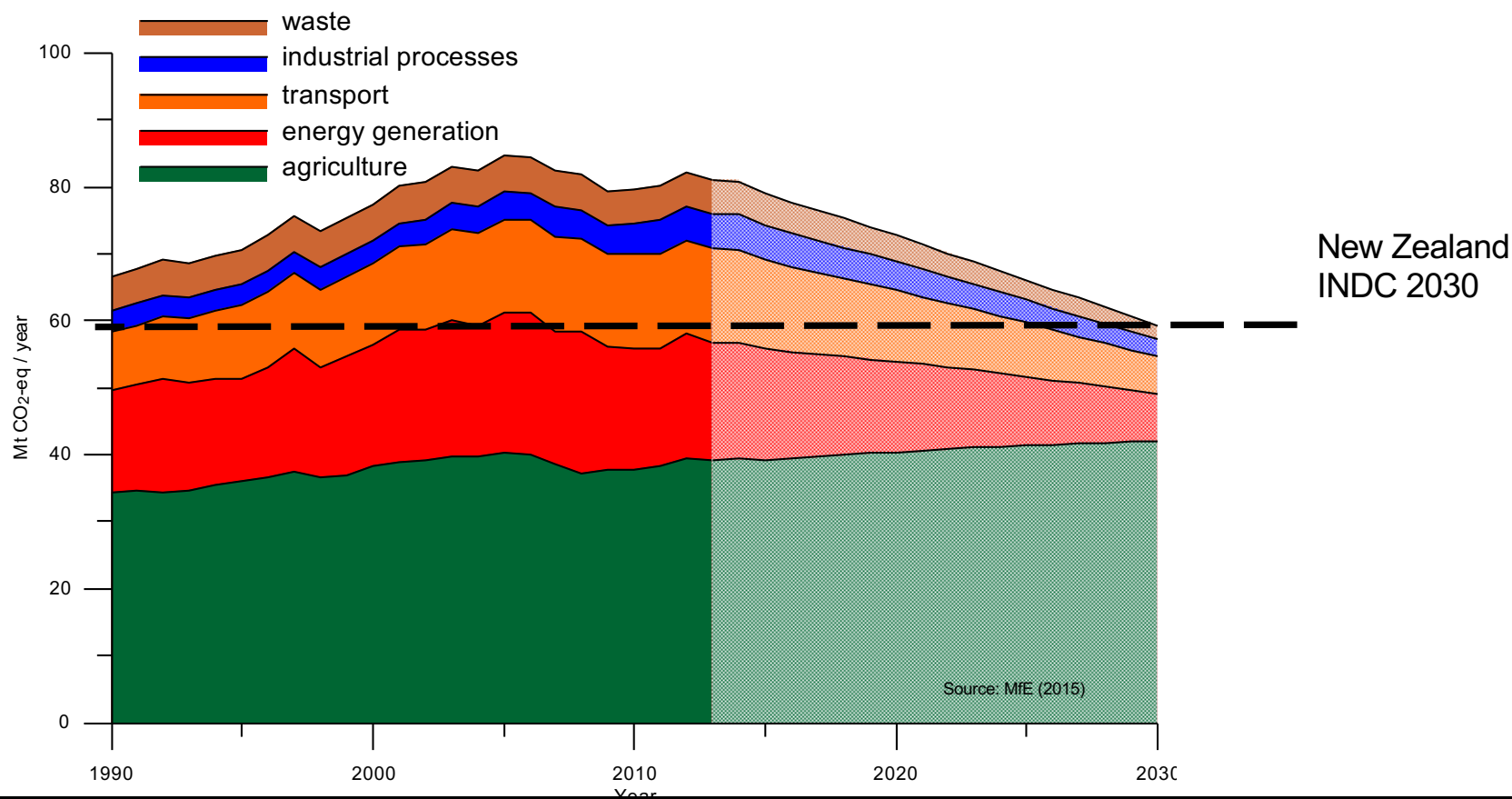
	1990		2016	
Dairy cattle	5,951.6	22.3%	13,623.63	49.0%
Non-dairy cattle	5,737.5	21.5%	5,228.69	18.8%
Sheep	14,361.30	53.8%	8,412.57	30.3%
Total dairy, beef & sheep	26,050.4	97.5%	27,267.89	98.1%
Total NZ	26,718.21		27,782.94	



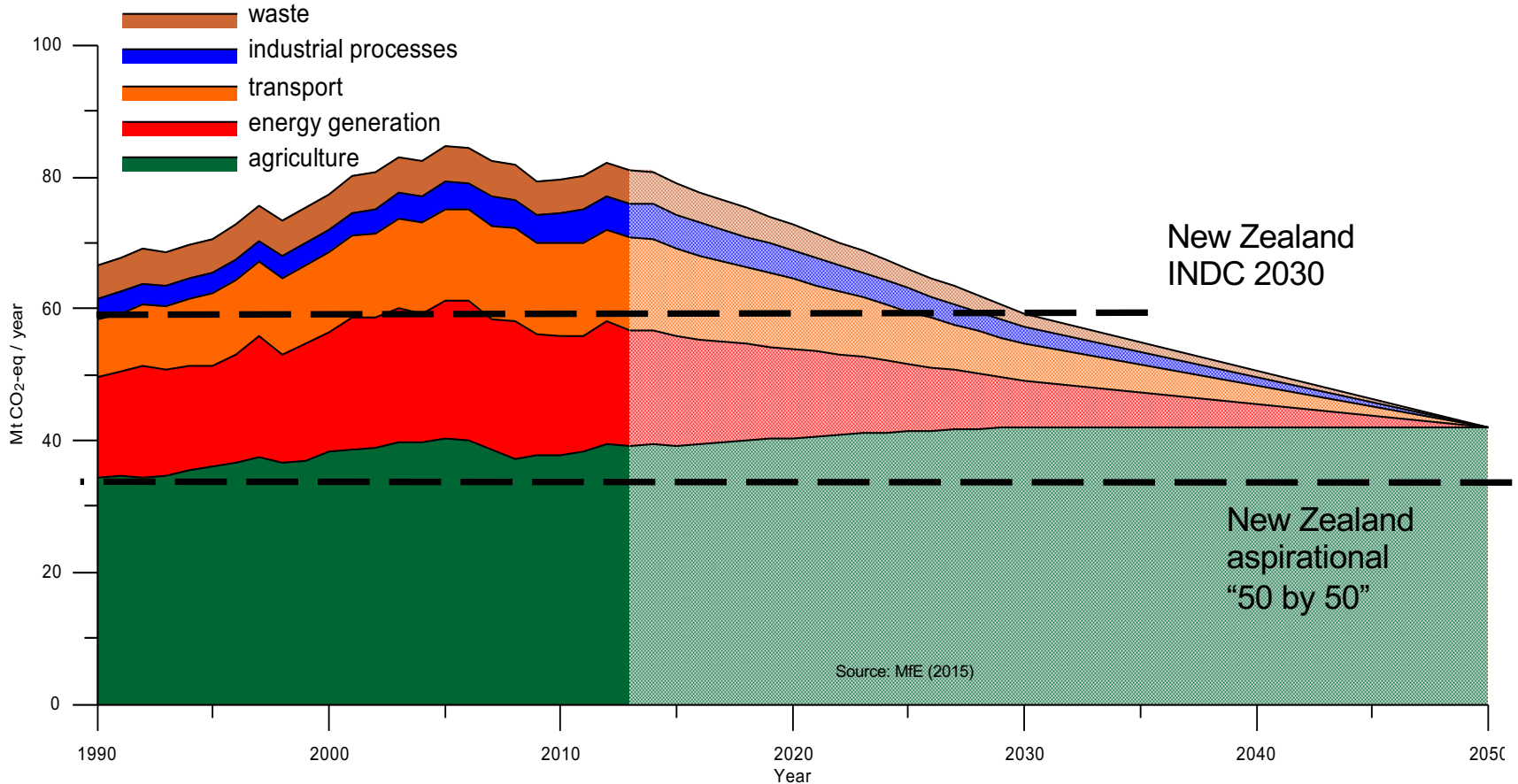
# NZ emissions are expected to increase on the back of growing economy and global demand



# NZ emissions are expected to increase on the back of growing economy and global demand



# Agriculture becomes even more dominant if other sectors mitigate strongly



# The transition to a low-emissions NZ

- Reports
- Interim Climate Change Committee
- Zero Carbon Bill

## THE OPTIONS:

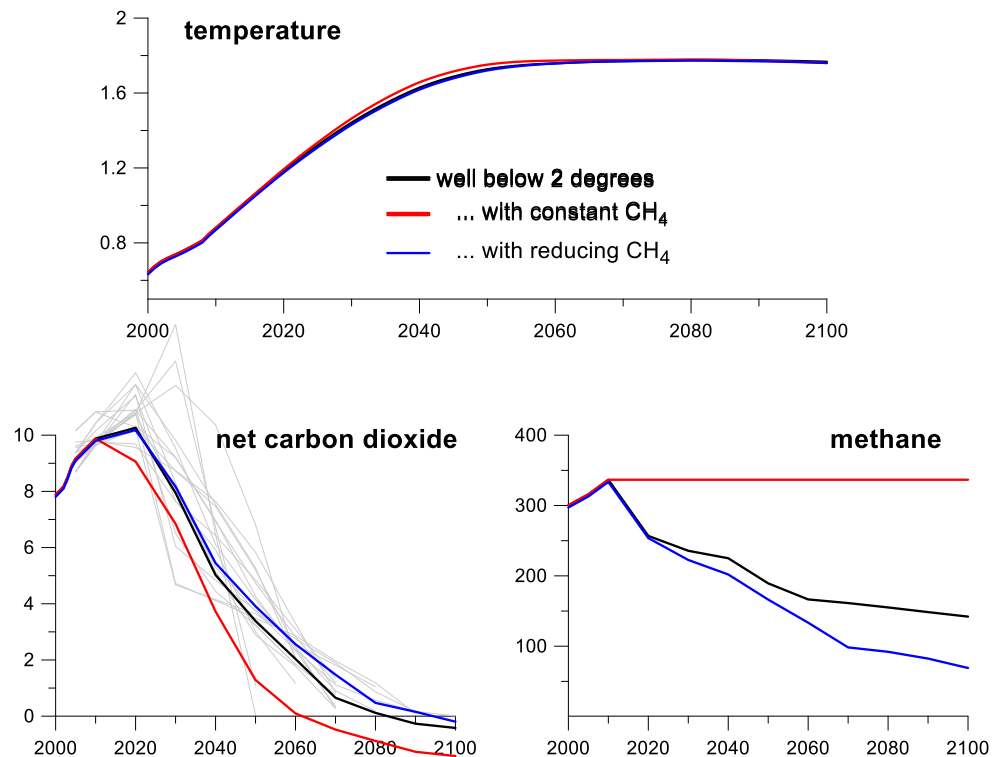
1. Net zero carbon dioxide
2. Net zero long lived gases and stabilised short-lived gases
3. Net zero emissions

<http://www.mfe.govt.nz/climate-change/what-government-doing/climate-change-programme>



# How do we get there?

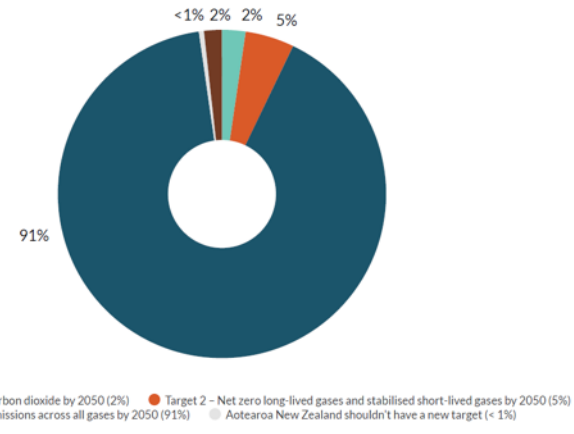
- To reach the Paris targets CO<sub>2</sub> emissions must be reduced to zero (and perhaps become negative!)
- CH<sub>4</sub> emissions do not have to be reduced to zero
- Reductions in agricultural gases allow greater time for reductions in CO<sub>2</sub> emissions



# Key points – The New Zealand Situation

- Agriculture makes up almost half of NZ's greenhouse gas emissions
- NZ GHG emissions are expected to increase on the back of a growing economy and global demand
- Agriculture's contribution will be needed if we are to meet NZ's '50 by 50' aspirational goal
- The Zero Carbon Bill

*If the Government sets a 2050 target now, which is the best target for Aotearoa? (long submissions)*



# What can be done?



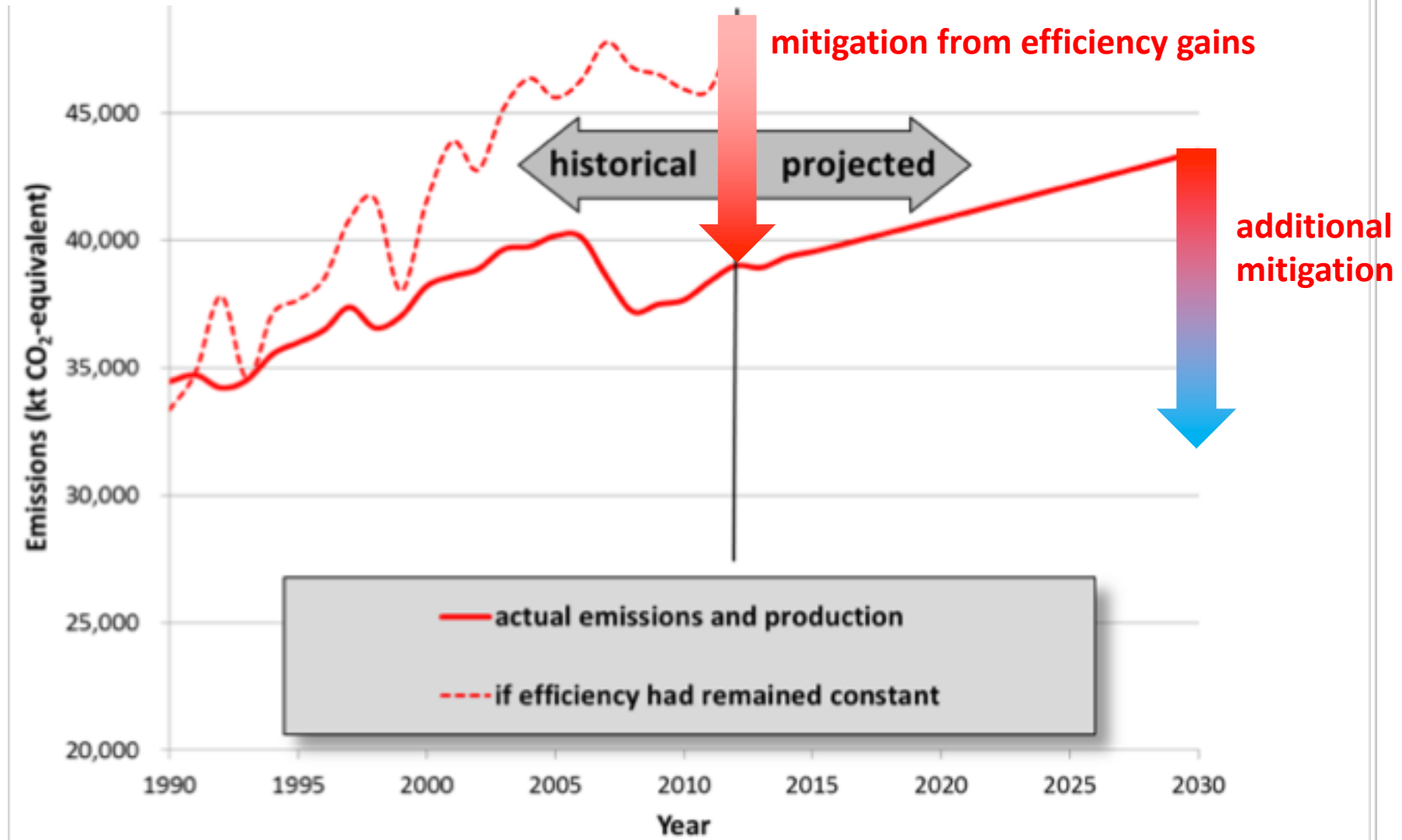


# Mitigation options for agriculture

- 1) further increases in animal productivity and farm efficiency & implementation of known technologies
- 2) additional technologies that directly seek to reduce emissions
- 3) constraints on the level and types of agricultural activity and movement towards low-emitting land uses



# Progress made but new technologies needed



# Mitigation options for agriculture

- 1) further increases in animal productivity and farm efficiency & implementation of known technologies
- 2) additional technologies that directly seek to reduce emissions
- 3) constraints on the level and types of agricultural activity and movement towards low-emitting land uses





## Under Development

### Methane

- **Low Methane Animals:** naturally low methane emitting sheep & cattle
- **Low methane feeds:** feed options that can help reduce GHG emissions
- **Methane Vaccine:** Produce a vaccine to inhibit methane production
- **Methane Inhibitors:** inhibitors against methane generating microbes

### Nitrous oxide

- **Reduce nitrous oxide and nitrate leaching:** Develop new and support existing technologies - nitrification inhibitors, low emitting plants

### Soil carbon

- **Increasing soil carbon:** Identifying ways to measure and increase the carbon content of New Zealand grassland soils; deep inversion tillage

# Methane

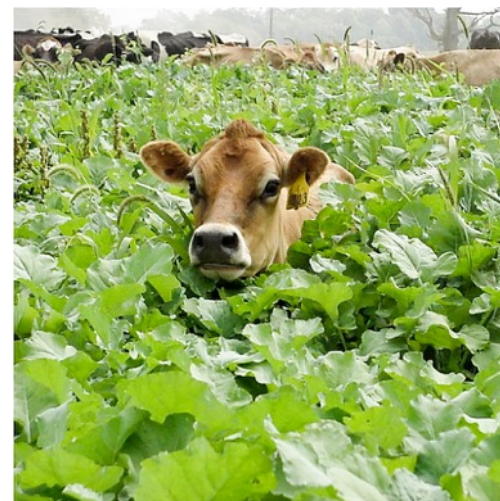
# Low CH<sub>4</sub> ruminants

- It is possible to breed low CH<sub>4</sub> emitting sheep
- Low emitting sheep approx. 5% lower CH<sub>4</sub> than average animal & trait is consistent across diets
- Production traits not affected
- Genomic selection being validated
- Engaged with genetic improvement organisation BLGNZ to transition to industry
- Work on low emitting cattle in early stages



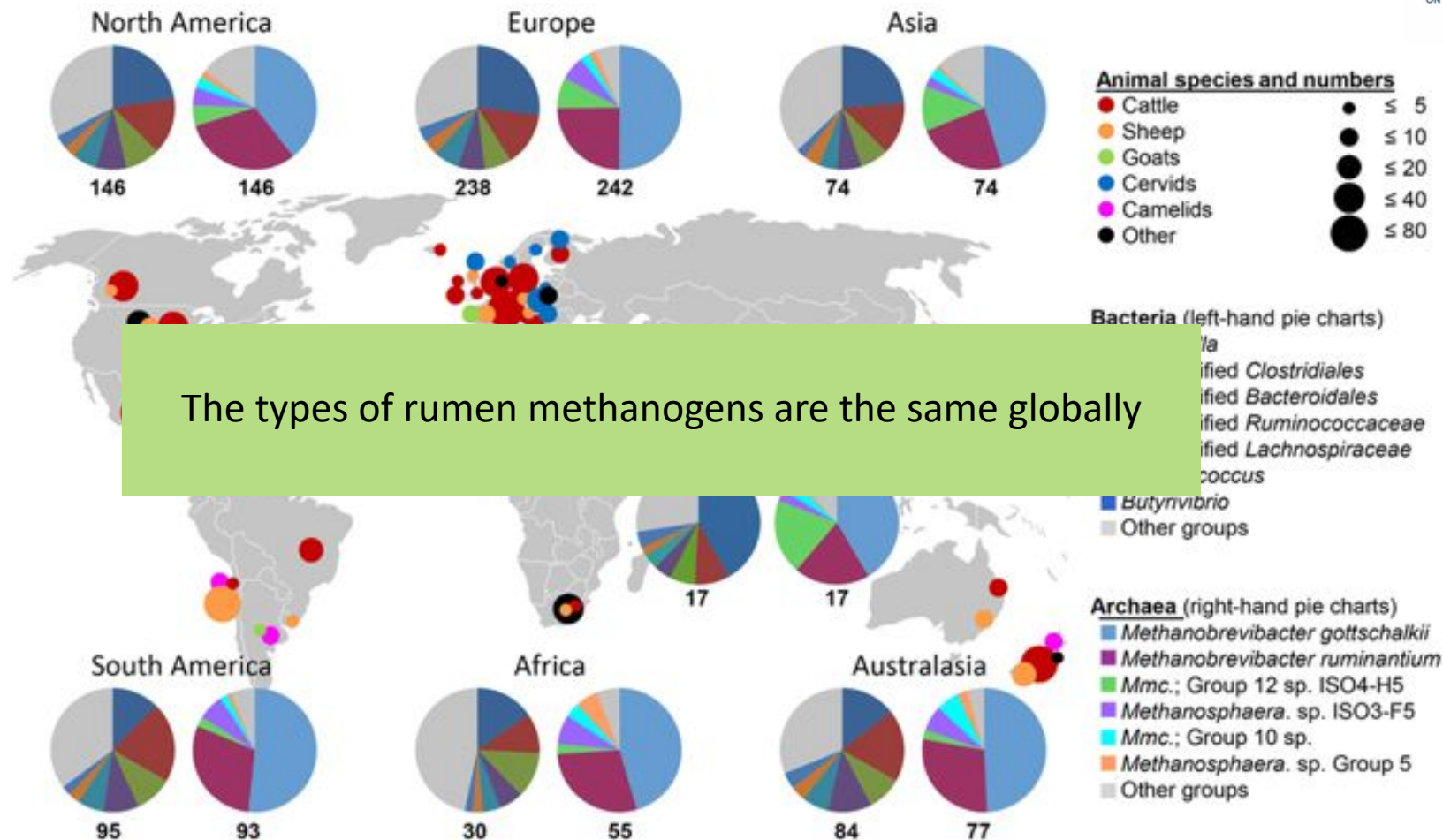
# Low CH<sub>4</sub> Feeds

- Options limited in New Zealand's year-round grazing based systems
- Most other feeds tested have no significant impact on emissions per kg feed consumed.
- Forage rape reduces emissions by 30% but small area and hence a minor component of the diet
- Unlikely to be a major mitigation option for NZ currently





# Global diversity of rumen methanogens



The types of rumen methanogens are the same globally

<https://www.nature.com/articles/srep14567>

# Methane inhibitors



## New Zealand

- Have proof of concept in animals and have identified promising compound classes
- 30% CH<sub>4</sub> reduction in 16 day animal trials – longer term trials underway
- Inhibitors currently need to be fed daily which restricts their use in grazing systems - new delivery methods being researched

## International

- A product could be on the market in 2 years (3NOP from DSM Nutritional Products). Currently aimed at intensive systems.

# Methane Vaccine



- Possible to induce the production of antibodies in saliva that suppress the growth of methanogens in pure cultures
- Antibodies produced in sufficient quantities to coat all methanogens present in the rumen
- Not yet able to reduce emissions in the animal
- Major focus on identifying and testing more effective antigens with cross species reactivity
- Once POC achieved estimated 7 years to market

# Nitrous oxide

# Nitrous oxide inhibitors

- **Nitrification inhibitors – DCD (dicyandimide) highly effective but withdrawn from the market due to residues in milk**
- **New Zealand driven changes to CODEX system could bring it back onto the market in 3 years**
- **Dairy company & market perceptions may be a bigger barrier than the regulatory system**
- **New research effort to find alternative compounds**



# Nitrous oxide mitigation - plants



- Plant species can influence  $\text{N}_2\text{O}$  emissions
- Plantain being intensively studied – lower N in leaves & some evidence of inhibitory compounds (whole system assessments)
- Challenge is to integrate alternative species into NZ farming systems



# Nitrous oxide mitigation – grazing management



- Nitrous oxide emissions influenced strongly by soil moisture
- Removing animals from pasture at critical times can reduce N<sub>2</sub>O emissions
- Risk of emissions swapping – increased CH<sub>4</sub> emissions from stored manures?
- Practicality and cost
- Reduced N fertiliser inputs – some scope

# Soil Carbon



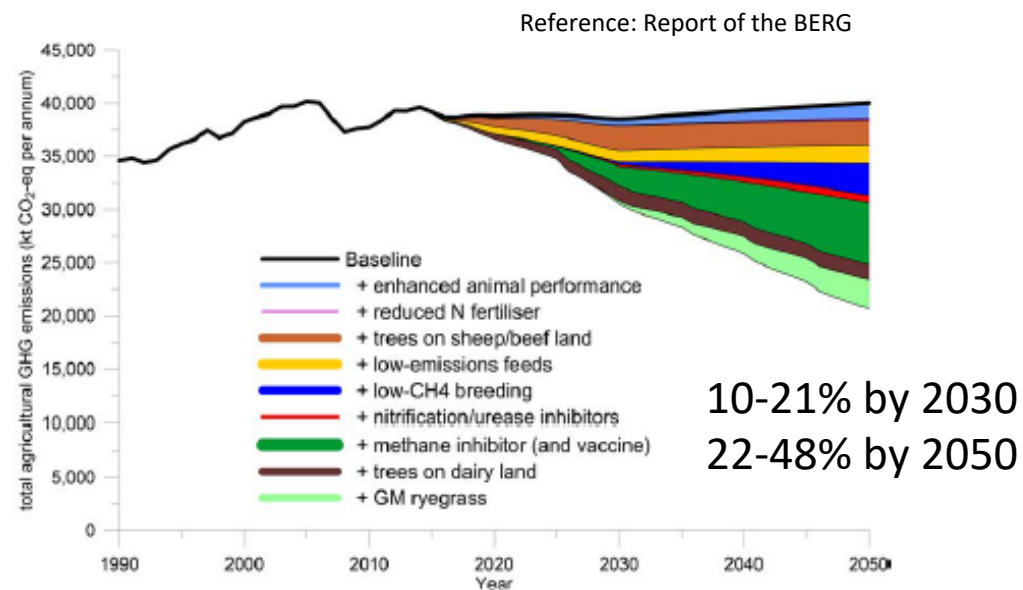
# The soil carbon conundrum



- Many farmers convinced that they are increasing stocks of soil C – basis for this difficult to pinpoint
- Scientific evidence
  - Soil stocks are high under NZ pastoral soils
  - Long-term monitoring suggests that dairy soils on flat land are losing soil C & beef/sheep farms on medium slopes are gaining soil C
  - Large uncertainty due to limited evidence base, high year spatial & temporal variability & difficulties of measuring small changes against a large stock
  - Irrigated soils have lower soil C than non-irrigated soils

# Key points – The science

- New technologies are coming
- Not one mitigation option but a package of options will be needed



Note: These numbers are based on the most ambitious assumptions about the mitigation potential relating to different options, and farmer uptake of these options.

working on it...



- The science is progressing....

# Summary

- Climate change is happening and there will be consequences for NZ
- Agriculture's contribution will be needed to meet climate targets
- Widespread adoption of currently available options (mainly farm management practices), up to 10% reduction is possible
- Science is working on it and new technologies/practices are coming



# Thank you

[www.nzagrc.org.nz](http://www.nzagrc.org.nz)

Twitter @NZAGRC

[www.pggrc.co.nz](http://www.pggrc.co.nz)

[www.globalresearchalliance.org](http://www.globalresearchalliance.org)

Twitter @GRA\_GHG

[www.livestockemissions.net](http://www.livestockemissions.net)

Twitter: @LeahySC