Research Findings on Agricultural Emissions Mitigation

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Outline

Background

GHG emissions from Agriculture in New Zealand & Australia

What we know and have targeted
  • Methane
  • Nitrous Oxide
  • Soil carbon

Challenges
Partnership & Collaboration

New Zealand Livestock Industry

Joint science programme
Agriculture emissions in New Zealand

globally, agriculture directly contributes only 10-12% of gross emissions
Australian GHG Inventory

Emissions by sector, Australia, annual, year to September 2003-2013

Source: Department of the Environment estimates.
Australian- NZ context

Main differences:
NZ 47% of total vs Australia 17%

• Scale – larger and more extensive
• Feedlot and grain farming play a bigger role
• Climatically different
• BUT fundamentally similar farming practice based on free range grazing
Agricultural GHG’s

Methane: Nitrous Oxide: Carbon sinks
Methane 101

- Methane – CH₄ emitted (belched) by livestock as a consequence of digestion in the rumen where it is formed by methanogens
- GWP = 25 (CO₂= 1)
- A loss of feed energy eaten by livestock
- Currently developing Strategies to lower but mindful of other impacts
- 70% of AG emissions
Nitrous Oxide 101

- Nitrous Oxide – $\text{N}_2\text{O}$ lost mainly from urine spots of free grazing animals on pasture when conditions favourable
- GWP = 298

- Linked to Nitrate form of N and therefore practices that lower nitrate losses will also lower Nitrous Oxide

- 30% of Ag emissions
Carbon Sinks 101

- Trees – well understood and recognised
- Soil Carbon – some opportunity but NZ soils generally have high carbon status
- Plant and microbe carbon based material that is bound to the soil aggregates.
- High risk as very labile; accumulates very slowly but can be lost rapidly
- Challenging to measure and account.
Warming is proportional to cumulative CO$_2$ emissions.
Emissions intensity reduced ~1% per year due to increased efficiency/productivity

Absolute emissions increased ~15% due to even greater increase in total production.
Where greenhouse gas emissions would be now, based on New Zealand’s increased production, but if there were no on-farm efficiency gains.

Where greenhouse gas emissions are right now, thanks to on-farm efficiency gains.
PGGRC goal is to reduce agricultural emission intensity by 2.5% pa from 2020:

1% through increased efficiency (continuing historical trend, relying on industry drivers)

1.5% through additional direct mitigation options
Summary of Options

Pilot Studies

- Low-methane feeds
- Low-nitrogen feeds

1. Identification and selective breeding of low greenhouse gas animals
2. Testing and improving methane inhibitors
3. Enhanced low-N plant growth (e.g. gibberellins)
4. Optimisation of grazing/housing options
5. Biochar on pasture
Animal selection

- Have confirmed that there is a genetic basis that can be exploited in sheep & likely in other ruminants.
- Established a flock of high & low methane sheep with heritability 0.13 and able to make genetic progress.
- The genetic gains are positive but moderate for methane and when considered amongst other traits, GHG reduction progress will not be rapid but...
- Genetic change is extremely low cost, permanent and cumulative.
- Cattle & Deer will also be targeted over the next few years.
- Delivery 2-3 years for sheep, other species longer.

IMPACT – 1-2 % per year and dependent on genetic selection criteria.
Low GHG Feeds

• Pasture quality offers no advantage
• Brassica crops have shown potential:
  Rape – 25-30% lower methane when 100% diet.
• However: only small percentage of total diet in NZ farm systems
  • 300,000ha / 10m ha
  • Farm systems - use of crops vary
• Supplements: Maize silage / PKE
  • No impact on CH4
  • Some benefit on N₂O through lower N in diet
• Focus is to package this information and get it included in the national Inventory
• 2-3 Years to delivery: IMPACT <1 % nationally
Yield per unit of DMI

Yield per unit of digestible OMI
Methanogen inhibitors

- Target essential enzymes with small animal safe compounds
- Targeting a methane impact of 20% or greater
- Screened >100,000’s compounds using a pipeline approach
- We have confirmed compounds that in animal trials have reduced methane by 30%
- A positive first step with many barriers to be overcome
- Cost and mode of delivery, productivity impact, food safety and regulatory issues will need to be evaluated over the long term
- 7+ years to delivery
- IMPACT Targeted: > 20% reduction CH4
Warming is proportional to cumulative CO$_2$ emissions.
Vaccine

• This offers an opportunity to impact all ruminants
• Blue sky science that is making steady progress, utilising the animals own immune response to inhibit methanogens.
  • Ruminants create antibodies to Methanogens
  • These antibodies inhibit pure cultures
  • Antibodies are delivered to the rumen via saliva and survive through digestion
  • Animal trials with lead antigens currently in development
• Aim to have it proven in animal trials and engage a commercial partner.
• 5-7 years to delivery
• IMPACT Targeted: > 20% reduction CH4
Nitrous Oxide

- Our grazing animals receive more protein than they need from pasture and this leads to N hotspots – urine patches
- Nitrification inhibitors block the transforming of ammonium-N to Nitrate – N and can significantly reduce emissions by 60%. DCD is an example but there may be others
- This is a recognised mitigation in the National Inventory
- Tight management of N inputs to farm systems
- Increase support from industry in benchmarking N use and efficiency & losses
- Plants that can deliver lower N levels into the diet are also options being investigated
Soil Carbon

• Despite a wealth of theories and research there are not yet any robust general rules about how to enhance NZ soil carbon stocks.
• But we do understand that soils can lose carbon quickly and only recover it slowly so we need to firstly protect existing stocks.

Current Research is focused on:
• Nitrogen and Carbon interactions
• Optimisation of Irrigation
• Increase roots inputs of carbon
• Biochar
Challenges — to name a few…

- Ensuring that options are scientifically valid and that they can count in national GHG inventories.
  - Technically fully developed
  - No unexpected circumstances
  - Works in existing farm business settings
  - Carbon impacts fully understood eg, footprint LCA
- Linking any options for mitigation to productivity and thereby enhancing adoption
- Engaging third parties who will need to be involved to deliver to sector
- Consumer and community acceptance
- Building capacity to adopt new practices and behaviour.
Thank You
Goal is to reduce emission intensity by 2.5% pa

- 1% through Increased efficiency
- 1.5 % through Direct mitigation (this investment)

While enhancing productivity and farm business profitability

The impact of these approaches will depend upon effective uptake and adoption
Animal genetics

A heritable trait but low, in sheep 0.13 heritability

Low Methane sheep have:
- ~18% smaller rumen
- different microbial communities
- No difference in productivity as measured in SIL

Difference is consistently 6-8% this is expected to stand on pasture diet but likely to reduce in magnitude

The genetic gains are positive but moderate for methane and when considered amongst other traits GHG reduction progress will not be rapid. But Genetic change is extremely low cost, permanent and cumulative

No reason that Cattle and Deer won’t be similar

Challenges
Measurement for selection in all species.
NZ and Australian ruminants eat mainly pasture >90% on an annual diet basis.
A diet where grain is > 66% of the ration will impact methane emissions and lower N excreted so leading to lower N$_2$O emissions.

In NZ Brassica Rape has shown 25% advantage over pasture when 100% diet. This difference appears linear in proportion of the Brassica in the diet. Swede are similar 20-22% but kale and turnips have shown around a 12-15% impact. Analysis does not indicate that any specific plant compound is involved rather the effect is an outcome of the highly digestible nature and rapid rumen outflow of the brassica diet.

The way forward for this is through the inventory reflecting the national ruminant diet rather than at a farm level.