Case Study of Greenhouse Gas Emissions from Four Deer Farms

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Introduction

The Climate Change Response (Zero Carbon) Amendment Bill proposes that New Zealand agriculture is required to reduce its greenhouse gas emissions. Farmers do not have readily available information of their farm's i) greenhouse gas emissions; ii) possible mitigation measures and their effectiveness (how much reduction of emissions is possible); iii) existing carbon storage level (from woodlots, riparian plantings, shelterbelts, spaced-planted poplars and willows, retired native vegetation, etc.).

DINZ commissioned AgFirst in August 2019 to visit and interview four deer farms of varying sizes, production focus, climate and topography to assess their emissions, mitigation options and existing carbon storage. Results are summarised below.

Side note:
A Greenhouse Gas (GHG) is a gas that traps heat in the earth's atmosphere. GHGs have differing residence times in the atmosphere (years to thousands of years) and some GHGs are more effective than others at trapping heat in the atmosphere. To allow for comparison of the effect of different GHGs it is common practice to convert all GHG emissions to carbon dioxide (CO_2) equivalent Global Warming Potential at 100 years. Using this conversion 1 kg of methane (CH_4) is equivalent to 25kg of CO_2 while 1 kg of nitrous oxide (N_2O) is equivalent to 298 kg of CO_2.

New Zealand livestock farming results in biological emissions of methane and nitrous oxide. The main source of methane is rumen digestion with a small amount coming from manure. Nitrous oxide is mainly sourced from nitrogen applied to the soil via animal urine, dung deposits and fertiliser.

Case Study Farm Information

Farm Information	Farm 1	Farm 2	Farm 3	Farm 4
Description	East Coast North Island moderate hill	East Coast North Island flat to steep hill	South Island high country	South Island flat to rolling
Focus of farm system	Velvet	Breeding and finishing	Breeding and finishing	Venison
Total farm area	332.1 ha	740 ha	4374 ha	796.7 ha
Stock units/grazed ha	10.9 SU/ha	8.7 SU/ha	3.0 SU/ha	18.7 SU/ha
Deer:cattle:sheep	79:16:5	29:31:40	22:25:53	78:19:3
Crop area	25 ha	9.5 ha	98.5 ha	120 ha
N fertiliser use	49 kg/ha/yr	1 kg/ha/yr	3 kg/ha/yr	55 kg/ha/yr

Current Biological GHG Emissions (tonnes CO_2-e per farm per year)

	Farm 1	Farm 2	Farm 3	Farm 4
Annual Emissions (t CO_2-e/yr)	1365.3	1920.3	5034.5	4309.4

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Current Biological GHG Emissions (kg CO_2-e per hectare per year)

GHG	Source	Farm 1	Farm 2	Farm 3	Farm 4
Methane	Enteric	3047	2021	873	4258
	Dung	42	22	12	45
	Total methane	**3090**	**2043**	**885**	**4303**
Nitrous oxide	Excreta Paddock	666	442	202	772
	N fertiliser	175	3	10	169
	Crops	2	0	0	7
	Indirect	178	107	54	156
	Total Nitrous oxide	**1021**	**552**	**266**	**1104**
Total Biological GHG emissions		**4111**	**2595**	**1151**	**5407**

Current Emissions per Animal Enterprise (kg CO_2-e per stock unit)

Enterprise	Farm 1	Farm 2	Farm 3	Farm 4
Deer	440	391	404	399
Beef	432	384	422	412
Sheep	401	368	390	391

What influences how much methane is produced by an individual animal?

- Approximately 21g methane produced per 1kg DM feed eaten. This ratio is relatively consistent between different species and stock classes.
- Emissions per unit of intake for different diets are relatively constant. Certain feeds can result in lower emissions however large changes in diet are needed. Examples of lower emission feeds are cereals, forage rape and fodder beet. The percentage of the diet comprised by these feeds needs to be significant e.g. >30% cereal or >60% fodder beet.
- Variation between animals is linked to rumen size, rate of passage and microbial community structure.

Carbon Sequestration by Trees

There is not an ability to directly offset farm GHG emissions with carbon sequestered by trees under current regulations. However, carbon sequestered by trees on the farms has been quantified to demonstrate the potential offset. The carbon sequestration by trees has been estimated with the use of the Carbon Look-up Tables for Forestry in the Emissions Trading Scheme (ETS). All notable tree areas on the farms have been accounted for, including shelter belts. To allow for comparison with annual farm emissions, the current carbon stock of trees has been annualised.

Impact of trees	Farm 1	Farm 2	Farm 3	Farm 4
Annualised carbon sequestration by trees kg CO_2/ha/yr	288	1602	82.3	1107
Offset of annual biological emissions	7%	61.7%	7.2%	20.5%

The above table outlines the carbon sequestration if all trees were able to be used to offset emissions, however a more realistic scenario is that only trees that meet the definition for inclusion in the ETS or were established post 1989 could be considered. If this were the case, offset by trees on these farms would instead range from no offset to a 46.5% offset at their current age.

Side note:

Forestry is not a permanent solution as an additional area will need to be planted after every harvest. For example:

- Assume 100ha of forestry is sufficient for offsetting farm emissions;
- Following the first harvest (at 28 years), the initial 100ha needs to be replanted to offset carbon removed at harvesting and a further 100ha needs to be planted to continue to offset farm emissions;
- At the second harvest, replant 200ha and plant a further 100ha;
- And so on.

If considering forestry for carbon sequestration/offsetting it is important to get good advice.

Mitigation Options

The effectiveness of mitigation options is farm dependant. Common mitigation options include:

- Increase per animal performance and lower stocking rate (opportunity to maintain or improve profitability while reducing dry matter intake and therefore methane emissions).
- Reducing replacement rate (opportunity to maintain performance while reducing feed demand).
- Optimise N fertiliser use (reduce nitrous oxide emissions).
- Reduce N intake by using low N feeds e.g. fodder beet, maize silage.
- Increasing ratio of lower emitting stock classes e.g. 40% sheep to 60% sheep.
- Reducing number of breeding animals e.g. replace breeding cows with finishing bulls (increase feed efficiency, more DM to product rather than maintenance).

If changes to a farm system are proposed it is important that there is the on-farm capability to successfully manage the change e.g. pasture management with reduced stocking rate, change in crop type, change in stock classes.

Mitigation Options involving Farm System or Policy Change	Farm 1	Farm 2	Farm 3	Farm 4
Increase sheep ratio from 40% to 60%		1.2%		
Improving sheep breeding performance and lowering sheep stocking rate			5.7%	
Reducing beef from 25% to 15%			0.5%	
Halve breeding cow numbers and replace with sheep				0.5%
Change Cattle policy – finish steers earlier		0.1%		
Change Cattle policy – trade steers only	0.1%			
Remove breeding cows and replace with trade beef				0.1%
Remove carryover dairy cows				2.9%
Removing spring urea and replacing with imported feed	1.2%			
Reduced urea use replaced with imported feed				1.2%
Reduced urea use and reduced stocking rate				1.9%
Change type of imported feed	0.2%			
Change crop type				0.1%

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Offset of GHG emissions by planting trees has been determined using the Carbon Look-up Tables to identify likely carbon sequestration at 28 years. This figure has been annualised to allow for offsetting of annual emissions.

Mitigation Options involving Planting Trees	Farm 1	Farm 2	Farm 3	Farm 4
Retiring 5% of land and planting trees *Emission reduction and offset if Pinus radiata* *Emission reduction and offset if indigenous*	4.9% *38.3%* *15.1%*			
Retiring 20% of land and planting trees *Emission reduction and offset if Pinus radiata* *Emission reduction and offset if indigenous*	20% *153.5%* *60.6%*			
Retiring 13.9ha riparian area and planting trees *Emission reduction and offset if indigenous*	2.9% *8.7%*			
Retiring 20ha of low production land and planting trees *Offset if mix of indigenous and exotic trees*		0% *20%*		
Retire 200ha of low production land and planting trees (will be challenging to establish due to location) *Offset if Pinus radiata* *Offset if indigenous*			0% *73.1%* *34.4%*	
Retire 10ha of low production riparian area *Offset if indigenous trees* *Offset if exotic hardwood*				0% *2%* *5.5%*

Potential Future Mitigation Options

There is potential for a number of mitigation options to become available in the future. However, there is uncertainty around the timeframe for these options to become commercially available in New Zealand and uncertainty around the effectiveness for reducing emissions. Methane vaccines could be utilised if the effectiveness for all stock enterprises is demonstrated. Methane inhibitors such as 3-NOP may be an option, however, with farm systems where stock are not handled regularly and are predominantly fed pasture, the challenge will be supplying methane inhibitors to stock in a way that will be effective.

The effectiveness of nitrification inhibitors at reducing nitrous oxide emissions has been proven, however nitrification inhibitors are not currently available for use on New Zealand farms. There is potential for nitrification inhibitors to become commercially available again in the future. On Farm 1 the use of DCD reduced emissions by 2.8%.

Summary of findings

- Sheep consistently have the lowest emissions per stock unit. Depending on the farm, deer or beef have the highest emissions per stock unit.
- The effectiveness of mitigation options to reduce GHG emissions is farm specific.
- Only small reductions have been achieved without reducing stocking rate.
- Trees already present on farms (shelter belts, tree lots, riparian areas etc) go some way to hypothetically offsetting emissions. Up to 61.7% on these farms (however not recognised under current regulations/approach).