GREENHOUSE GASES: REDUCTIONS BEING ACHIEVED ON MANAWATU DAIRY FARMS

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ABSTRACT

In 2018, the Manawatu Wanganui Regional Council (Horizons) began examining natural resource management in the region in preparation for a plan review. This includes the information provided by dairy farmers as part of their land-use consent applications. In this paper the authors describe the reductions in greenhouse gas emissions (GHG) emissions being achieved by dairy farmers in the Tararua District as a co-benefit from reducing nitrogen losses to water.

The sample of 126 dairy farms came from a relatively high rainfall area (1000-2000mm/yr) and mixed soil types (mostly brown and allophanic soils). In 2012-13, the annual losses of nitrogen to water averaged 40 kgN/ha (ranging from 24-60 kgN/ha). The annual GHG emissions averaged 11.2 t/ha (ranging from 10-15 t/ha). There was a very poor relationship between individual farm nitrogen losses to water and their GHG emissions (R^2 <0.1).

To model the effect of management practices that reduce nitrogen losses to water, the farms were placed into five groups using cluster analysis. Five clusters of farms were modelled in Overseer®, to represent all the dairy farms in the catchment. Management mitigations were introduced sequentially to each cluster farm and the nitrogen losses to water calculated over an expected 20 year timeframe.

When the changes in GHG emissions were compared with the expected reductions in nitrogen losses, a possible co-benefit became apparent. Across the representative dairy farms in the catchment, after introducing the management mitigations for improving water quality, the GHG percentage reductions were estimated to be around 64% of the percentage reductions in nitrogen losses to water.

From these results, it appears likely that dairy farmers in the Tararua District will achieve significant reductions in GHG emissions from the adoption of management practices designed to reduce nitrate losses to water.

[1] The material presented in this paper does not represent any policy position of the Manawatu Wanganui Regional Council currently, or in the past, or in the future.

INTRODUCTION

In June 2018 the New Zealand Government consulted New Zealanders on three possible policy approaches for achieving zero carbon emissions by 2050. The targets varied in how many of the greenhouse gas (GHG) emissions associated with food production in New Zealand would be included (carbon dioxide, nitrous oxide, and methane). The possible targets provided by the Government were a choice between:

- Net zero carbon dioxide: Reducing net carbon dioxide emissions to zero by 2050
- Net zero long-lived gases and stabilised short-lived gases: Long-lived gases to net zero by 2050, while also stabilising short-lived gases
- Net zero emissions: Net zero emissions across all greenhouse gases by 2050

Over the period of consultation, staff from the Ministry for the Environment held public meetings throughout New Zealand (NZ Government 2018a). Discussions at these meetings included consideration of how and in what form agriculture should be included in GHG policy.

The contribution of agriculture to New Zealand's GHG inventory (in tonnes of CO_2 equivalent) has increased from 1990 until 2005 and has held approximately steady since then. The increase until 2005 reflected increased numbers of dairy cows and greater use of nitrogen fertiliser (NZ Government 2018b, p143). Modelling studies carried out by Motu, Landcare Research, AgResearch and NIWA have all indicated that until at least 2030, GHG emissions from farms can be expected to continue to increase, unless there are policy interventions introduced that have been specifically designed to reduce them.

Introducing GHG policies will mean that they become another natural resource issue alongside fresh water, for New Zealand dairy farmers to manage. Farmers have already been reducing their impact on water quality through making changes in land use, effluent systems and farm management practices and these changes are expected to continue to be introduced on farm until at least 2030 (Mcdonald et.al. 2015; Parminter 2015). This paper considers how much these changes already being put in place, could be expected to reduce GHG emissions on farm, even without further policy interventions by central government.

BACKGROUND

This topic has already been examined by Motu, Landcare Research, AgResearch Scion, Plant and Food and NIWA (Shepherd et. al. 2016). In their combined report they stated “the impacts of the NPS FM on gross GHG emissions are projected to be relatively small. This is because the area affected is not great, the required reductions in contaminants are not likely to be large and the likely (i.e. low cost) mitigation options outside of reforestation may only have a small effect on gross GHGs.” To arrive at this conclusion AgResearch focussed on the farm scale and developed four regionally specific model dairy farms and a contaminant abatement curve for mitigating contaminants lost to water. Landcare Research focussed on fresh water management units and achieving a proportion (10% and 20%) of their catchment limits by 2030.

The combined report concluded the “GHG emissions are relatively inelastic to N mitigation. For each 1% of nitrogen reduced, gross GHG emissions are on average reduced by … 0.3-0.7%”. The AgResearch results were at the lower end of this range. In this paper, these results are compared with the results of actual dairy farmers in the Manawatu Wanganui Region and the policy directions in the One Plan for the Upper Manawatu River catchment.

METHODS

The Manawatu Wanganui Regional Council (Horizons) is currently undertaking a plan review of the One Plan (2014). So named because it combines the regional policy statement and the regional plan. The Horizon’s review includes a study of the impact of possible policy options on dairy farms in the Upper Manawatu River catchment. In the study a cluster analysis has been carried out of 126 farms in the catchment, to group them into five representative clusters (Newman et. al. 2018). This was based on their farm systems, management practices, and Overseer® results.

The median results for each cluster of farms were used to compose a representative farm for further analysis. Mitigations were introduced to each representative farm sufficient for them to comply with the nitrogen caps specific to each of them obtained from Table 14.2(R). Table 14.2(R) is the existing Table 14.2 in the One Plan updated to align with a recent version of Overseer (version 6.2.3). A report has been provided to Council of the results, describing the impact on Tararua dairy farms in the Upper Manawatu River catchment (Parminter 2018).

In this paper the GHG results of the five representative farms are compared The initial results from Overseer® are for the year 2012-2013, the final results are for the same farms after 20 years.

RESULTS

The five representative farms are listed in Table 1 along with the number of farms in the catchment that they represent. Overall the catchment might be considered a relatively high rainfall catchment with mixed soil types of moderately ‘leaky’ soils. Farm sizes are a little smaller than the national average and dairy cow stocking rates are similar (LIC and DairyNZ 2017).

A summary of the changes introduced to each representative farm between their initial year (2012/13) and the final year of their consent (year 20) is shown in Table 2. The scale of the mitigations required is shown by the changes in their operational profit. All the budgets have been calculated in 2017 dollars and a long term dairy payout of $6.20. No attempt has been made to “optimise” the management on the farms. Instead the economic efficiency of the farming systems is assumed to stay constant between years. In order to be compliant, in Table 2 all the farms are modelled to reduce their number of cows, reduce milk production and as a consequence reduce expected profitability. The overall expected change in nitrogen losses from the soil profile is a reduction of 38% across all the area of dairy farmed land in the catchment. The GHG emissions for the same farms are shown in Table 3.

In Table 3 the concomitant reduction in GHG is a total of 24% across the whole of the catchment. The variation in results is considerable. The farm representing the 3rd cluster has a small increase in GHG because although the number of cows stayed very similar over the 20 years, their production has gone up. Unlike the other farms, the enterprises represented by this farm have farming systems that initially already achieved the nitrogen caps in the revised table 14.2 in the One Plan. The farm representing the 1st cluster achieved a 33% reduction because both cow numbers and production have decreased. The farm representing the 4th cluster has the most intensive dairy farm system and has been able to achieve its nitrogen cap with small reductions in cow numbers and production. The management changes that the representative farm for the 4th cluster could implement has achieved a 32% reduction in total GHG.

The highest milk producing representative farm represents the 16 farms in cluster number four. It was producing 1137 kg/ha/yr of milk solids. This is also the most efficient farm for GHG use: 12.9 kgCO_2eq/kgMS. The next highest producing cluster of farms are the 10 farms represented by farm number 2 producing 1107 kgMS/ha/yr. They are the most inefficient group of farms: 19.2 kgCO_2eq/kgMS. The representative farms for the other 100 farms have lower milk production and range between the previously described groups for GHG emissions.

In Table 3 the percentage reductions in GHG occur mainly as carbon dioxide and nitrous oxide reflecting changes in on-farm nitrogen policies and winter grazing.

Table 1. The five clusters of farms in the Upper Manawatu Catchment and median values of the attributes used to describe them

Cluster	Number of farms	Soil Order	Rainfall (mm)	Milking Platform Area (ha)	Milking Cows (Peak)	Production per Cow (kgMS/cow/yr)	Production per Hectare (kgMS/ha/yr)	Dairy System Type (I-V)	Pasture Consumption (kgDM/ha/yr)	Initial Nitrogen Loss to Water (kgN/ha/yr)	Phosphorus Loss to Water (kgP/ha/yr)
1	27	Allophanic	1,376	116	370	327	896	III	10,513	40	0.9
2	10	Recent	1,211	112	336	369	968	III	10,903	46	1.0
3	18	Gley	1,241	99	256	340	917	II	10,843	26	1.3
4	16	Brown	1,255	131	385	387	1,136	IV	10,195	47	1.0
5	55	Brown & Pallic	1,354	108	270	336	830	II	9,520	39	0.9
Medians of all farms in the catchment	126	Brown	1,298	111	309	340	902	II	10,092	39	1.0

Table 2. A comparison of the results from the five representative farms in the Upper Manawatu Catchment, comparing their performance in the initial year (2012/13) with year 20 of their consent.

Representative Farms	Initial Farm Attributes				Final Farm Attributes			
	Nitrogen Loss to Water (kgN/ha/yr)	Peak Milking Cows (cows/ha)	Annual Milk Production (kgMS/ha)	Operating Profit ($/ha)	Nitrogen Loss to Water (kgN/ha/yr)	Peak Milking Cows (cows/ha)	Annual Milk Production (kgMS/ha)	Operating Profit ($/ha)
1	40	2.9	942	1921	24	2.0	810	1838
2	46	3.0	1107	2387	28	2.3	987	2379
3	26	2.6	880	1293	28	2.4	1008	1737
4	47	2.9	1137	2407	22	2.7	1081	1748
5	39	2.5	840	1533	24	2.5	793	1119

Table 3. A comparison of the results from the five representative farms in the Upper Manawatu Catchment, comparing their GHG emissions in the initial year (2012/13) with year 20 of their consent. The percentage change of GHG components is in brackets.

Representative Farms	Dairy System Type (I-V)	Initial Farm CO_2 equivalents (t/ha/yr)				Final Farm CO_2 equivalents (kg/ha/yr)				Reduction in GHG totals (%)
		Methane	N_2O	CO_2	Total	Methane	N_2O	CO_2	Total	
1	III	7.16	3.13	0.91	11.20	5.38 (25)	1.59 (49)	0.50 (45)	7.47	33%
2	III	6.61	2.81	0.78	10.20	5.66 (14)	1.78 (37)	0.45 (42)	7.9	23%
3	II	5.43	4.9	0.78	11.10	5.57 (-3)	4.77 (3)	0.82 (-5)	11.16	<1%
4	IV	7.43	5.81	1.45	14.68	5.92 (20)	3.02 (48)	1.04 (28)	9.97	32%
5	II	6.32	2.96	0.81	10.08	5.49 (13)	1.52 (49)	0.72 (11)	7.73	23%
Average for the catchment representative farms	III	6.58	3.65	0.92	11.15	5.55 (16)	2.19 (40)	0.71 (23)	8.45	24%

DISCUSSION AND CONCLUSIONS

Dairy farms in the Tararua District are making considerable changes to their farming systems in order to comply with the nitrogen cap in the One Plan. The changes modelled in this study will reduce their nitrogen discharges by about 38%. The One Plan does not require dairy farmers to change their management in order to reduce their GHG emissions. However, at the catchment scale and from the results modelled here, such reductions will occur concomitantly with reductions in nitrogen losses.

It is estimated that in the Tararua District, dairy farmers compliant with the One Plan will reduce their GHG emissions in the catchment by 24%. That is a reduction of 0.64% for every 1% reduction in nitrogen losses. The result is at the upper end of the reductions estimated by Shepherd et al (2016), probably reflecting differences with the farms modelled by AgResearch and the mitigations they selected. The farms used here are representative of five clusters of farms and reflect the diversity of farming systems as well as what may be considered typical for the district.

The mitigations selected for mitigating nitrogen losses are matched to the catchment outcomes required in the One Plan. The mitigations include making operational changes such as reducing nitrogen fertiliser applications and system changes such as wintering dry cows off-farm, and displacing other livestock. Taken together these changes appear to be more significant than those considered by Shepherd et al (2016). Making policy interventions additional to those required for achieving catchment limits, that require even more changes to these dairy farms over the next 20 years is likely to increase decision making complexity and the risks of farmers making poor investment choices compromising economic, social and environmental efficiencies (Bailey and Perrier 2017; Botha and Parminter 2006).

Applying the results from the Tararua District more generally may indicate that even in the absence of a policy intervention by central government, the dairy industry in this region are already making substantive changes to their farming practices. Changes that will contribute towards reducing their GHG between now and 2050. This suggests that before GHG-agricultural policies are developed perhaps detailed discussions are needed between central government ,regional government and the agricultural industries. Their purpose would be ensuring that additional regulations affecting farmers are complimentary to existing legislation and on-farm developments. Further work is needed in other catchments and regions before these results can be generalised wider afield.

ACKNOWLEDGEMENTS

There have been discussions with a number of people in the Manawatu about the subjects in this paper. Helene Anderson, Ian McNabb and Lynette Baish at Horizons have each made material inputs and their contributions were very much appreciated. The project from which these results have been drawn could not have been undertaken without the support of Adam Duker at DairyNZ, Stefan Bryant at BakerAg and Scott Ridsdale at RD Consulting. However, any mistakes or omissions remain completely the responsibility of the authors.

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