Tokoroa Pastoral Ltd. – Tokoroa, South Waikato

‘Greenhouse gas and nitrogen loss mitigation in the South Waikato’

A 2019 case study on environmental performance and the effect on production and profitability

Executive Summary

This project is part of the Dairy Action for Climate Change, an industry partnership between DairyNZ and Fonterra, supported by the Ministry for the Environment (MfE) and the Ministry for Primary Industries (MPI).

The aim is to partner with commercial dairy farms to discover, demonstrate and communicate the feasibility of meeting future environmental challenges. There is a key focus on greenhouse gas emissions (GHG) and nitrate leaching.

This case study is on Tokoroa Pastoral Ltd, a 70ha farm milking 175 cows (2.6 cows/ha). The farm operates with just 7% of the annual feed supply brought onto the farm. Key strengths are the high level of home-grown feed eaten as pasture (13.9 t DM/ha) while running a relatively low stocking rate, with strong financial performance when compared with DairyBase benchmark data. To quantify the possible reductions in greenhouse gas (GHG) emissions and the likely effect on farm profitability, five scenarios were modelled using both Farmax and Overseer (ver. 6.3).

Because the farm already achieves a high level of efficiency, these scenarios delivered only small reductions in GHGs and generally tended to reduce profitability. Reducing replacement rate achieved small reductions in GHGs and small gains in profit but is a high-risk scenario for the farm and has dependencies. Reducing imported supplement is the option that reduced GHG the most, but this also reduced profitability.

Farm Overview

Tokoroa Pastoral Ltd is one of three farms owned and operated by George and Sharon Moss, just outside Tokoroa in the South Waikato district. The farm is 70ha of 'Taupo deep sand' soil type, milking 175 cows (2.6 cows/ha). A full-time farm manager is employed with part -time assistance -0.4 FTE (full time equivalent. The farm operates at System 2, with 7% of the annual feed supply brought onto the farm. The herd is wintered on the milking platform. Rising two-year-old replacements are grazed off on an adjacent support block, also owned by the Moss's. There is a strong history of high operating profits even in low milk price years. Typically, the farm produces around 1150kg MS/ha and 450kg MS/cow.

Vision and Goals of the Farm

Goals

- Farms to provide financial security in both the short and long term.
- Active involvement in developing environmental solutions as a part of a profitable dairy farm system.
- Provide a pathway for young farming couples into farm ownership in Tokoroa Pastoral Ltd and Pukerua (another Moss farm) at a later stage. Currently the commitment is to the current staff and their goals.
- George is actively involved (and keen to remain so) in industry activities and does not want to be on farm full time.

Business Principles

- George and Sharon want their three farm businesses (two dairy farms and an adjacent dry stock block) to remain as three separate entities.
- Each entity is run as a closed system with no need for purchased livestock.
- Cash losses are considered 'untenable' - the business must make a positive cash result: *"ruthless with money, gracious with people."*
- Farm with quality stock, compliant infrastructure, and good management practices.
- No more land purchases, or increases in debt per kg MS.

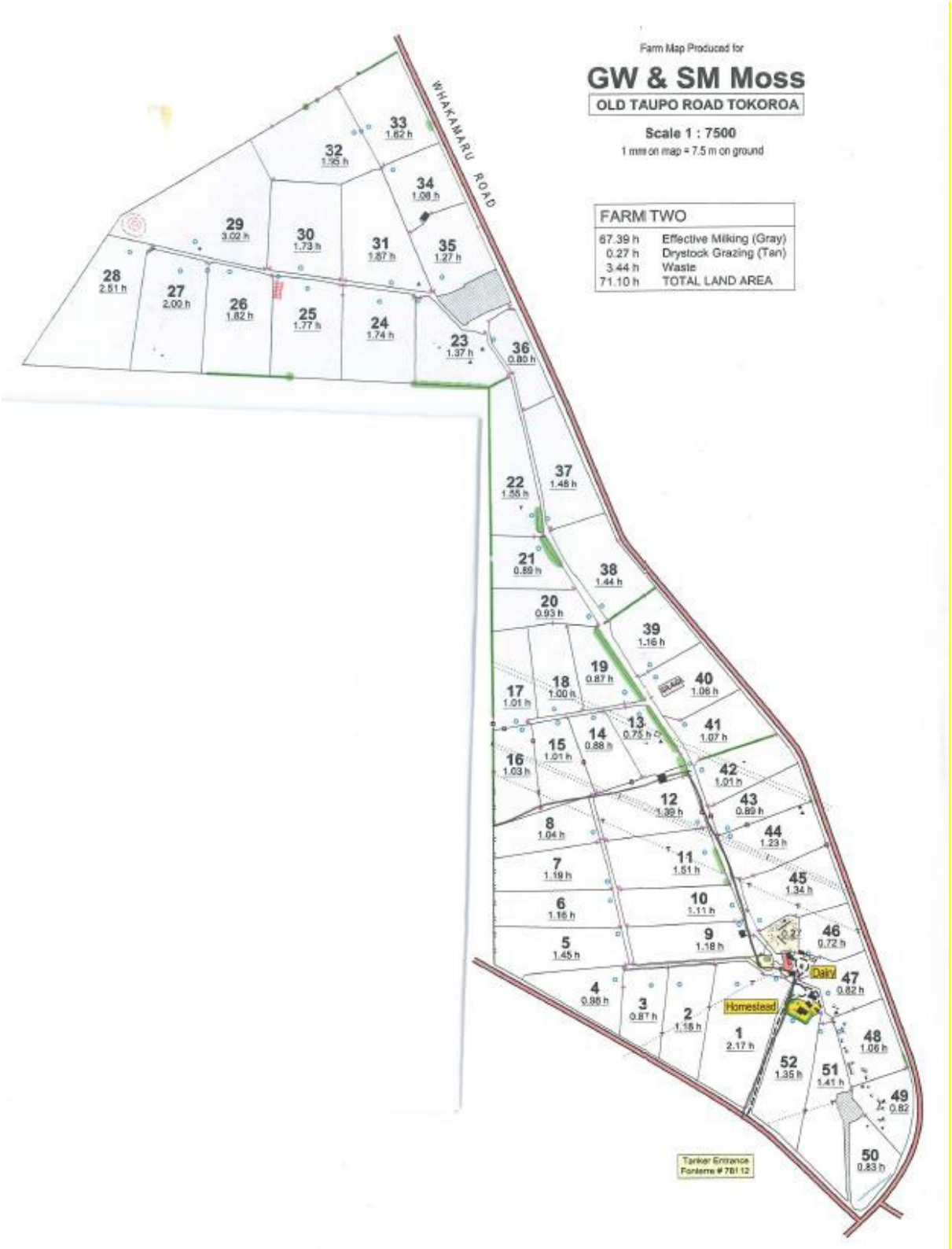
- Not keen to be absentee owners.

"*We own enough dairy farms already but might consider purchase of other non-farm assets"*

Values

- Provide a good workplace for employees.
- Farm in an environmentally sustainable way, meeting all best practice standards regarding the 'five key contaminants' (N loss, P Loss, E. coli, sediment loss and emissions).

Farm Map


Farm Map Produced for
GW & SM Moss
OLD TAUPO ROAD TOKOROA
Scale 1 : 7500
1 mm on map = 7.5 m on ground
FARM TWO
67.39 h Effective Milking (Gray)
0.27 h Drystock Grazing (Tan)
3.44 h Waste
71.10 h TOTAL LAND AREA
WHAKAMARU ROAD
Dairy
Homestead
Tanker Entrance
Fonterra # 781 12

Physical Performance

Table 1: Key features of Tokoroa Pastoral Ltd

Farm Details	
Nearest town and catchment	Tokoroa
2016/17 on farm total rainfall 20 years of recorded on farm data shows an annual average rainfall NIWA long term average	2092 mm 1598 mm 1240 mm
Soil type(s)	Taupo deep sand (Taupo 32a.1)
Terrain	Rolling
Total farm size Effective area	70.7ha 67.5ha
Support block	40ha owned and shared with another farm
Labour (FTE)	1.4
Irrigation area (ha)	0
Effluent irrigation area (ha)	15.0
Irrigation type	Travelling rotating irrigator
Stand-off pad/herd home infrastructure	Uncovered rock pad on hill paddock
Shed type	17 ASHB with Duo vac
Current Farm System Details	
Herd size	175 cows
Breed Average live weight (weighed average) BW (2016/17 season) PW (2016/17 season)	Cross-bred 482kg/cow 99/45 125/57
Farm system (% feed brought in)	System 2, 7% Imported
Stocking rate (cows/eff. ha)	2.6
Comparative stocking rate (kg LWT/ha/tDM/ha)	67kg LWT/tDM 1252kg LWT/ha/18.5 tDM
Planned start of calving	20 July
Calving spread	12 weeks
Per cow production kg MS/cow 2016/17	446
Per hectare production (3-year average)	1146kg MS/ha
Young stock (grazed off farm from 1 May each year for 12 months)	R2 Grazed on owned dry stock block adjacent to farm
All cows are wintered on milking platform with pasture and grass silage and PKE as required	Wintering on pasture
Supplements imported kgDM/ha 2016/17	1100

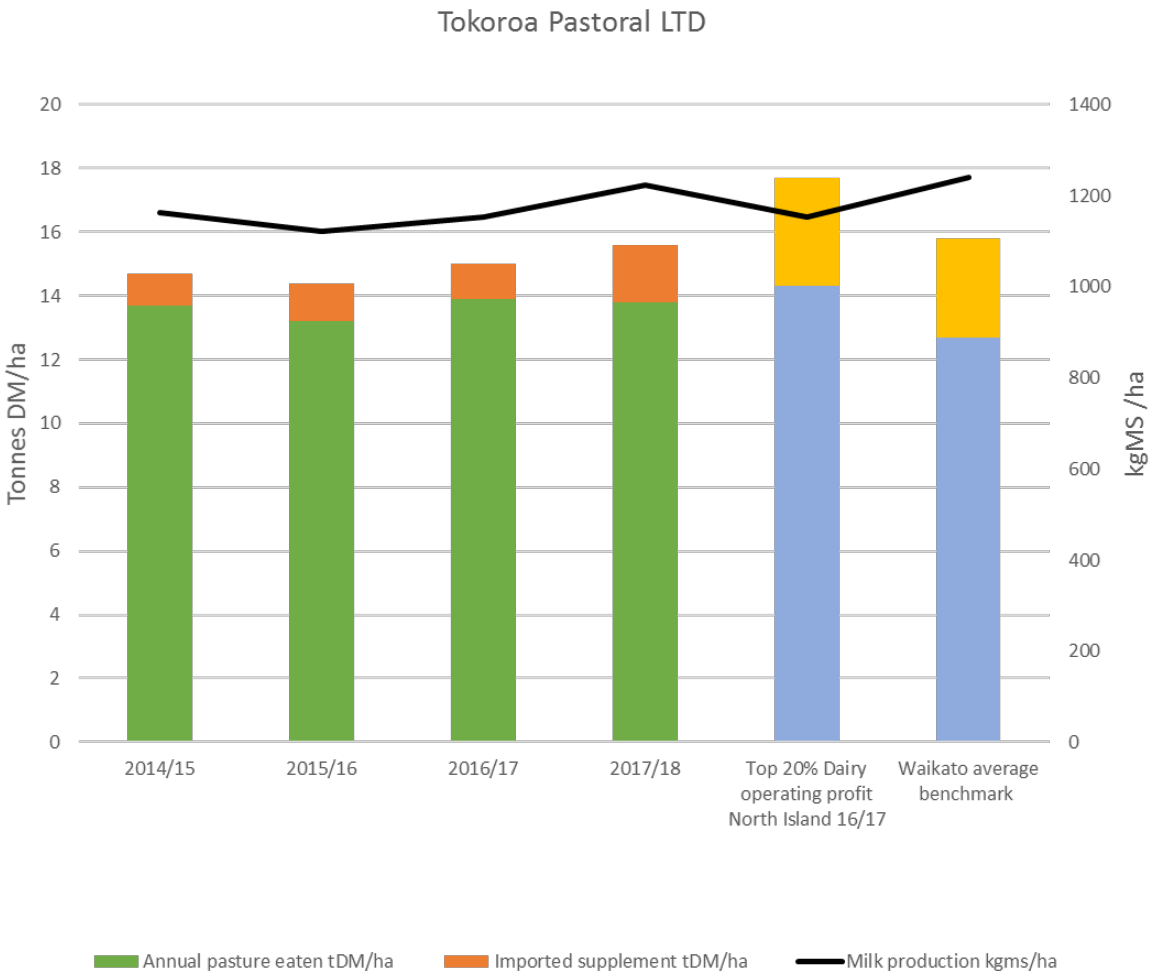
Table 2: Key Performance Indicators; Current farm system

Key Performance Indicator	2014/15	2015/16	2016/17	2016-2017 Waikato benchmark (owner - operators)
Peak cows	182	169	175	
Farm size (ha)	67.5	67.5	67.5	
Stocking rate (cows/ha)	2.7	2.5	2.6	3.0
Comparative stocking rate (kg LW/ha/t DM/ha)	72	68	67	
Production (Kg MS)	78,570	75,667	77,827	
Per cow production (kg)	432	448	445	390
Per hectare production (kg)	1164	1121	1153	1172
6-week in calf rate (%)	71%	71%	67%	
Not-in-calf rate (%) (12-week mating)	12%	11%	10%	
Pasture eaten (t DM/ha)	13.73	13.2	13.9	12.2
Imported feed eaten (t DM/ha)	1.0	1.2	1.1	3.4
N fertiliser applied (kg/ha/year)	127	130	128	123
Production as a % of liveweight	89%	93%	92%	81%
Feed conversion efficiency (kg MS/kg DM)	78.7	76.8	77.4	

A key strength of Tokoroa Pastoral Ltd is the high level of feed eaten as home-grown pasture (13.9 t DM/ha), while running a low stocking rate of 2.6 cows/ha (see Figure 1). This is achieved through accurate grazing management and timely decision making.

Figure 1 shows this farm has a pasture eaten/ha figure which compares well with the top 20% of farms based on operating profit in the Waikato. It also shows a relatively low reliance on imported supplement/ha compared with both the top 20% dairy operating profit group and the Waikato average farm.

Figure1: Total feed eaten, pasture eaten and MS/ha for Tokoroa Pastoral Ltd vs Benchmark (Waikato top 20% for operating profit)



Financial Performance

The financial performance of this business is strong and consistently above average when compared with DairyBase benchmark data (Waikato 2016/17 owner operator System 2).

Operating profit as outlined in Figure 2 is significantly above benchmark data, particularly during the 2015/16 season when the farm made good use of the guaranteed milk price scheme, which was offered by Fonterra at this time.

Figure 2: Operating profit/ha compared with the Waikato Benchmark (owner operators)

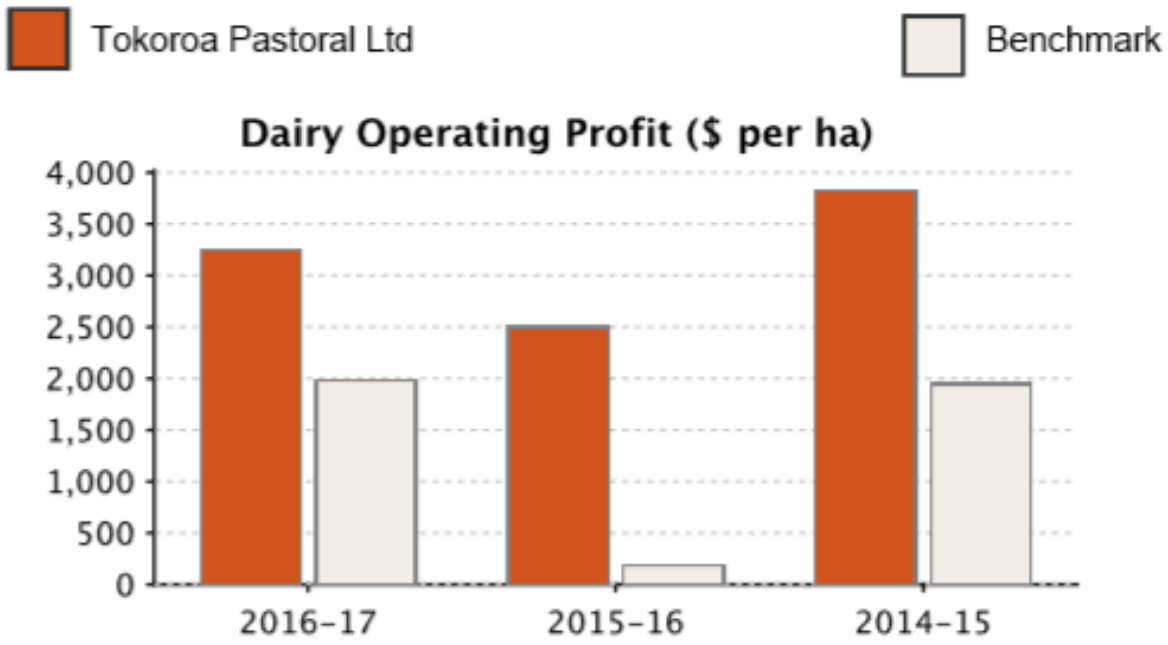
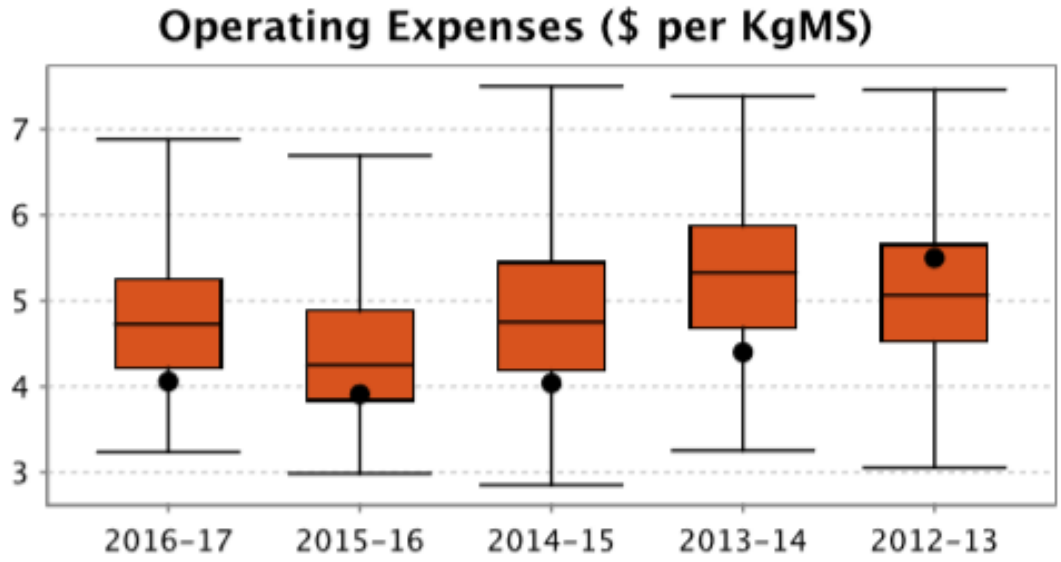


Figure 3: Operating expenses per kg MS Tokoroa Pastoral



Farm operating expenses $/kg MS are outlined in Figure 3 (Tokoroa Pastoral Ltd is black dot) and are considerably lower than the benchmark data in all but the 2012/13 season. It is important to note that in 2012/2013 the farm was still operating as an organic system, where there was less milk production to dilute expenditure.

Environmental Performance

The soil type is 'Taupo deep sand (Taupo 32a.1)'. This is a free-draining soil with high profile available water of 169cm (0-100cm). This soil needs regular summer rain and will leach nitrogen (N) quite easily.

Table 2: Nitrogen leaching and Greenhouse Gas emissions for Tokoroa Pastoral Ltd (last 4 years)

	2016/17	2015/16	2014/15	2013/14
Total N leached (kg/year)	3978	4142	4427	2975
N Leached (kg/ha/year)	56	59	63	42
N surplus (kg)	232	211	217	180
N conversion efficiency (%)	26	30	30	34
Total emissions t CO_2e/ha	13.24	12.32	12.75	10.391
Methane t CH_4/ha	8.502	7.705	8.047	7.289
Nitrous oxide t N_2O/ha	3.236	2.982	3.204	1.600
Carbon dioxide t CO_2 /ha	1.502	1.638	1502	1.502

Environmental Obligations Waikato Regional Council

Waikato Regional Council's 'Plan Change One' means that all farms must keep accurate records of all feed and fertiliser inputs so that accurate N leaching calculations can be made each year. They will not be able to exceed N leaching above a base year of either 2014/15 or 2015/16. Farms that are deemed to be in the highest quartile will be required to drop leaching levels to a yet to be determined number, resulting from N reference calculations across the greater Waikato.

Modelling Greenhouse Gas Reductions

Five scenarios were modelled using both Farmax and Overseer version 6.3 to quantify the possible reductions in GHG emissions and the likely effect on farm profitability. All scenarios are based on a long-term milk price of $5.90/kg MS exclusive of dividend.

All scenarios are compared to the 'current system' which is based on the 2016/17 season data as this is the latest season where all data is available (see Table 3).

Current system was peak milking 179 cows at a stocking rate of 2.7 cows per hectare. There were 78 tonnes of palm kernel and 221 bales of silage imported, plus another 182 bales of silage made on farm of which all were fed. Nitrogen use was 138kg N/ha/year.

Scenarios Modelled

1. Nil imported feed. All imported supplement removed from farm system.
2. Reduce N fertiliser use from 138 kg N/ha/year to 58 kg N/ha/year.
3. Reduce N fertiliser and nil imported feed. A combination of 1&2 above
4. Rear less replacements. Currently the farm rears 32% replacements of which 22% enter the herd and 10% are sold. This scenario is based on 15% heifers reared.
5. Plant sidelings in pine trees. There is around 4ha of low producing pasture on sideling's that could be planted in forestry. Forestry sequesters carbon so that can offset some of the emissions from the dairy farm. The effective area of the farm was reduced to 63.5 hectares. Cow numbers were reduced by 11 to a peak milk of 168 cows, however stocking rate on the effective area remains the same.

Table 3: Physical and Financial KPI's from Farmax modelling of 5 Mitigation Options for reducing GHG emissions

	Current 2016/17	Nil Imported Feed	Less N Fertiliser	Less N Fertiliser & Nil Imported Feed	Rear Less Replacements	Plant Sideling's in Pines
Farm parameters						
Total area	70.7	70.7	70.7	70.7	70.7	70.7
Production (Kg MS)	77,814	73,174	74,771	69,113	78,777	72,980
Peak cows	179	169	173	155	179	168
Nitrogen						
Total Farm N Loss (kgN)	3,978	3,605	3,182	2828	3,879	3,747
N Loss/ha	56	51	45	40	55	53
N surplus/ha	232	211	192	166	227	220
Greenhouse gases						
Total GHG (tCO2e/ha/yr.)	13.24	11.7	12.142	10.612	12.792	12.431
Methane (tCO2e/ha/yr.)	8.502	7.65	8.076	7.213	8.186	7.979
N2O (tCO2e/ha/yr.)	3.236	3.01	2.707	2.486	3.139	3.036
CO2 (tCO2e/ha/yr.)	1.502	1.04	1.359	0.913	1.467	1.416
Profitability						
Operating profit ($/ha)	3254	3100	2995	2923	3402	2878
Change from current system						
N leaching (%)		-7%	-20%	-29%	-2%	-5%
GHG losses (%)		-12%	-8%	-20%	-3%	-6%
Profitability (%)		-5%	-8%	-10%	+5%	-12%

Summary

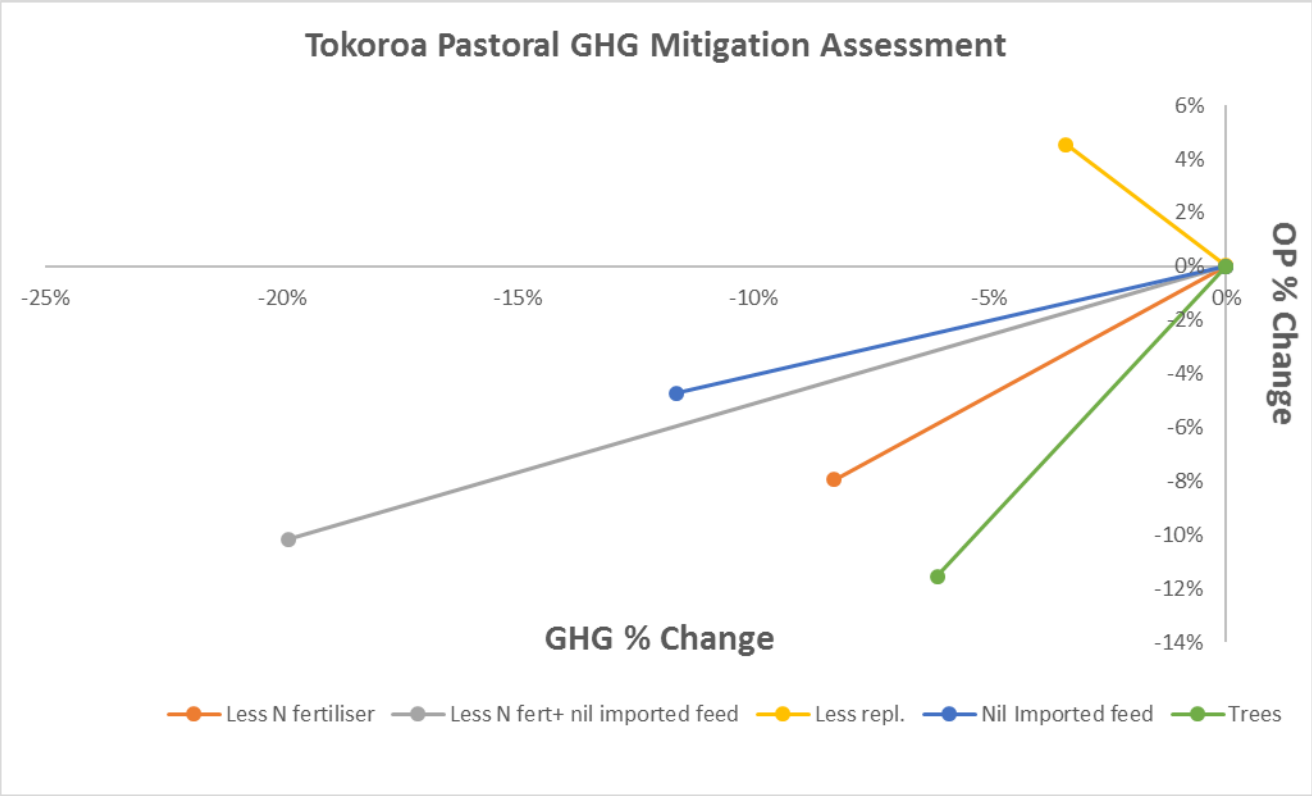
The only scenario that has positive impacts on all three outcomes (N leaching, GHG emissions and profit) is the scenario where only 15% replacements are reared. Currently the farm rears 32% replacements, of which 22% enter the herd as in-calf heifers with 10% sold as surplus stock. This provides good cash flow; however, it does increase the farm's GHG profile. The scenario modelled is based on rearing 15% replacements and reduced culling of cows. All factors other than replacement rate remain the same as the current scenario however, due to having less calves grazing on farm during summer and autumn, there is a reduced need for imported silage (188 bales). The same amount of silage is harvested on farm.

Operating at a low replacement rate of 15% relies heavily on meeting industry targets for herd reproductive performance and a low incidence of cow losses from diseases such as mastitis. It is a risky strategy for marginal gains in the profit and environmental outcomes. It also assumes that there is an appropriate adjustment available for the support block as there will be less stock at this block. Further, a significant contributor to the farm's profit has been the selling of surplus female stock and this, in in line with the Moss's desire to accelerate genetic gain of the herd – reducing the replacement rate will also reduce the ability to cull on PW to achieve more efficient cows for the long game. The contra position is that an older herd will produce more milk in the immediate future with reduced grazing costs to the business.

Reducing nitrogen fertiliser and nil imported feed is the scenario that is most successful for reducing GHG emissions on a tonne of CO_2 equivalent per hectare basis, with a reduction of 20% compared to the current scenario. This scenario reduces profitability by 10%, or just over $23,000 at a $5.90 milk price (grey line).

The nil supplement (continue to use N) option shows a decrease in profit (-5%) and a reduction (-12%) in GHG emissions (blue line). Total milk production is expected to drop by 5,000kg MS compared with the current scenario due to a lower stocking rate. Dropping out N fertiliser has a larger impact on profitability than dropping out supplement as N is a cheaper source of feed than the supplement.

Figure 4: Relationship between Operating profit and GHG emissions (per ha) for five scenarios modelled for Tokoroa Pastoral Ltd., compared with their current system.



Despite trees acting as a net carbon sink, there has been minimal impact on total GHG emitted due to the small area planted. For the reduction in profit associated with planting pines, there is a minimal impact on nitrate leaching and CO_2 emissions therefore is not the best option for this farm.

Conclusions

Tokoroa Pastoral already operates at a high level of efficiency regarding use of pasture. This, along with strict cost control, delivers a high level of profitability. Options explored to reduce GHG emissions and N leaching delivered small reductions and generally tended to reduce profitability. Reducing replacement rate achieved small gains in both GHG and profit and looked to be an opportunity. This option relies heavily on reducing the not in-calf -ate and finding an alternative use for additional grass grown on the support block.

Reducing imported supplement is the option most likely to reduce GHG, but this tends to reduce profitability. When this option was combined with a reduction in N fertiliser use it made the largest gains in GHG emissions, with a small drop in profitability. This scenario does require the greatest amount of skill and increases the financial and climatic risk to the farm. Achieving production of 450kg MS/cow from a solely pasture based system requires excellent pasture management skills and a strong focus on timely and decisive decisions in response to weather events.