AB Lime Ltd

‘Greenhouse gases and nitrogen loss mitigation in Southland’

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

Executive summary

The Partnership Farm Project has been set up as 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 and practicality of applying principles and practices developed through research to meet future environmental challenges. There is a key focus on nitrate leaching and greenhouse gas emissions (GHG).

This case study is on **AB Lime Dairy Farm,** a partner farm for the project. The options chosen are specific to the farm and the owners' farming aspirations, philosophies, and business strategy. Changes to the system have been modelled in Overseer and Farmax to estimate the reduction in nitrogen (N) leached, changes in GHG emissions and profit.

This case study details the management of the 373ha (effective) dairy platform and the land that supports it (young stock and winter grazing). Three mitigation options have been explored for this partnership farm:

- Short term – achievable in one year:
    - Increase the effluent area from 50% to 65% of the effective dairy area.
    - Increase use of the feed pad to two hours a day in March, three hours in April and four hours in May.
    - Cull in April rather than in May and milk the remaining herd for an extra four days.
    - Reduce nitrogen fertiliser so total nitrogen applied as effluent and fertiliser is 160kg N/ha/yr.
- Medium term – achievable in three years:
    - Plant out steep portions of the property with native plants – approximately 23ha.
- Long term – achievable in ten years:
    - Improve genetic merit of the herd by not breeding from the bottom 15%.

A further mitigation, increased use of plantain, was also discussed. The use of plantain was not modelled however, as research around its effectiveness as a mitigation under different climates, farm systems and pasture compositions is still ongoing.

Modelling outputs indicate the short- and medium-term mitigations create a reduction in profit. Following the implementation of the long-term mitigations, modelling of the entire farm system (dairy platform combined with young stock and winter grazing) predicts the following:

- Profitability to increase by $19,000 annually or $51/effective dairy ha, which is an 8% increase.
- N Leaching reduced from 34kg N/ha to 30kg N/ha, which is a 15% reduction.
- GHG emissions reduced from 9.3t/ha to 9.1t/ha CO_2e, which is a 5% reduction.

Overseer does not account for the value of carbon sequestration from planting (financially or environmentally). Assuming a carbon unit price of $25.05 and carbon sequestration rates based on the MPI default values, the tradeable carbon would be valued at $23,000 in ten years, and $92,000 and $150,000 in 20 and 30 years respectively. However, if the area is deforested, the landowner will be liable to cover the cost of the lost carbon at the present-day carbon price.

Regulations

Water quality and nutrient losses are regulated at a regional level, as directed by Government through the National Policy Statement for Freshwater Management. On the other hand, it appears that regulations and policies to reduce GHG emissions will be developed at a national level. At the time of writing, there were no nutrient loss limits or GHG emission limits applicable to the AB Lime Dairy Farm.

Farm goals, values, and principles

From the whole farm assessment, the farmer identified goals are to be:

- a good employer; have happy, well trained staff and a low turnover
- environmental custodians and environmental leaders in the dairy sector
- the best across all aspects of dairying.

"My passion is for people and innovation. Whether it is people's health and safety, or their personal skills and development, I try to be all over it. There is no better reward than seeing an innovative solution or taking a staff member's passion and making it a reality for them. With operations such as a quarry, a fertiliser store, and a landfill, your job is all about environmental protection. A dairy operation is no different. It's just another operation that can have a major effect on the environment. Positive environmental outcomes don't just happen, you need to target them. It's tough minimising environmental impacts, it's a lot of work. If we can help find some solutions that can help the industry, then that's a win for everyone." Steve Smith, AB Lime manager.

Overview

The AB Lime Dairy Farm is approximately 5km from the rural town of Winton, Southland. The farm was converted to dairy in 2014 and has excellent infrastructure. The farm operates over a total of 661ha consisting of the following:

- The 466ha dairy platform – of which 373ha is effective and a further 73ha is in native bush.
  The farm peak-milks 935 Kiwi-cross cows (500kg LWT) producing 439kg MS/cow. All calves (240) are grazed on the platform until May 1. The property is 60% flat with the remaining 40% rolling to steep. All cows are wintered off. Young stock is grazed off farm for 15 months from the May 1 until their return as in-calf heifers. The property has a 500-cow feed pad, currently used sparingly in late summer (February) and late Autumn (May).
- A 63ha young stock block at Browns – 55ha effective.
  This block is owned by AB Lime Dairy Farms. It grazes 145 heifers for 12 months from May 1 to April 30. R1 heifers are wintered on kale and baleage.
- A 42ha young stock grazier business block at Springhills – 37ha is effective.
  This block grazes the remaining 95 heifers for 12 months from May 1 to April 30 using the same system as the Brown's block.
- A 90ha winter grazier business block at Dunrobin – all land area is effective.
- The herd including in calf heifers are wintered on a silage and grass system.

Table 1: Physical key performance indicators (KPIs) for AB Lime Dairy Farm platform

	Status quo system
Peak cows	935
Effective farm area (ha)	373
Stocking rate (cows/ha)	2.5
Comparative stocking rate (kg LWT/t DM offered)	79
Production (kg MS)	412,209
Per cow production (kg MS)	439
Per hectare production (kg MS)	1105
Days in milk	270
6-week in-calf rate (%)	74%
Not-in-calf rate (%)	13% (10-week mating)
Supplementary feed (t DM/ha)	1.6
Pasture eaten (t DM/ha)	10.8
Nitrogen fertiliser use (kg N/ha)	163

Environmental achievements

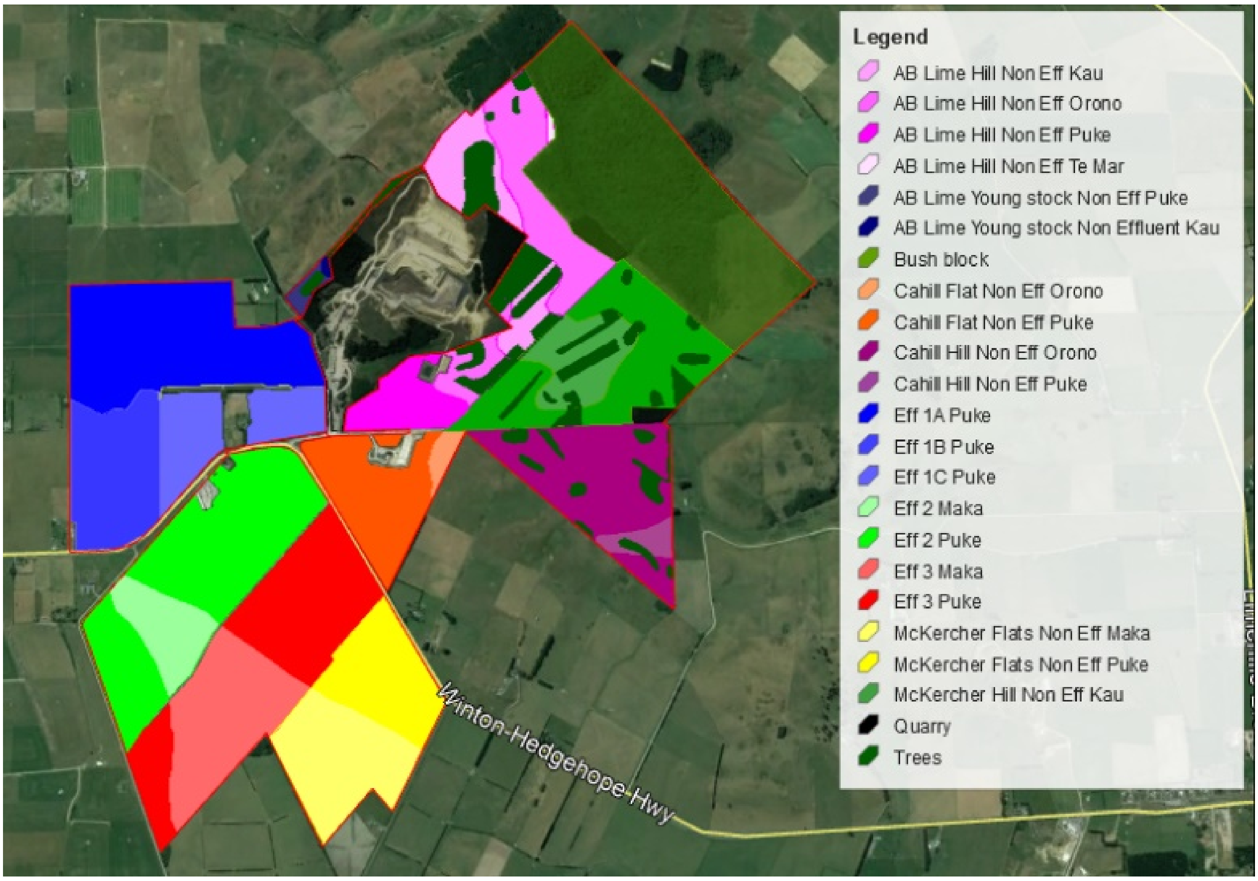
The AB Lime Dairy Farm has made significant investment in environmental initiatives each year since its conversion. The owners are driven by their strong desire to be exemplary environmental custodians and environmental leaders within the dairy sector. Investment initiatives to date include:

- Regularly water testing tile drains and roadside ditches for nitrogen and phosphate concentration, sediment loss and *E. coli*.
- Planting 10,000 trees on-farm.
- Fencing off waterways.
- Putting a plan in place to protect and improve 73ha of native bush.
- Working with consultants and Environment Southland on risks and mitigations.
- The employment of a full-time environmental manager by the wider AB Lime company.
- Completing predictive and retrospective nutrient budgets for the property each season.

Farm maps

Farm location of AB Lime Ltd in Central Southland.

Farm map of AB Lime Ltd in Overseer.



Whole farm assessment and modelling of the farm

Whole farm assessment, Overseer, and Farmax modelling has been undertaken to assess the efficiency of the farm system on the AB Lime Dairy Farm and the supporting grazier business blocks with the results summarised in Table 2 below.

Table 2: AB Lime Dairy Farm Status quo system

	Dairy farm	Owned young stock block	Young stock grazier business block	Winter grazier business block	Overall
Farm parameters					
Hectares (whole system)	466.0	63.2	43.9	90.0	663.1
Production (kg MS)	412,209				
N Fertiliser (kg N/ha)	163				
Nitrogen loss					
Total Annual Farm N Loss (kg N)	15,639	1666	1157	4258	22,720
N Loss kg N/ha/yr	34	26	26	47	34
N Surplus/ha/yr	169	90	90	164	156
Greenhouse gases (GHGs)					
Total GHGs (CO_2e kg/ha/yr)	10,601	5604	5604	6681	9262
Methane (CO_2e kg/ha/yr)	6512	3181	3181	3745	5598
Nitrous Oxide – N_2O (CO_2e kg/ha/yr)	2546	1334	1334	1826	2253
CO_2 (CO_2e kg/ha/yr)	1543	1089	1089	1110	1414
Pasture Grown (t DM/ha/yr)	12.4	9.1	9.1	9.7	
Profitability ($6.00/kg MS milk price)					

Total Operating Profit					**$250,543**
Operating Profit (per effective dairy ha)					**$672**
Operating Profit/kg N Leached ($)					**$11.03**
Operating Profit/t CO_2e ($)					**$40.79**

Environmental mitigations

Mitigations to reduce N leaching and GHG emissions were developed with the AB Lime Dairy Farm team and a Southland Community of Interest group. The chosen mitigations target the following areas:

- Farm nitrogen surplus – a reduction in farm nitrogen surplus reduces nitrogen leaching losses and nitrous oxide emissions.
- Farm system feed intake – reductions in feed intake result in a reduction in biological methane emissions.

The mitigation strategies were split into three groups, depending on the timeframe required to achieve them. Key assumptions of the modelling are as follows:

- Whole system scenario modelling – the modelling looks at the entire farm system, including young stock and winter grazing. Where there has been a decrease in the requirement for feed, it has been assumed that less area is grazed by AB Lime Dairy Farm at its two grazier business blocks. Total land area required for the farm system is shown in the summary outputs. There has been no adjustment made to show how this land could be used differently.
- Status quo system – it has been assumed that the farm system is in a steady state. Milk price was assumed to be $6.00/kg MS. Input prices were assumed to be in line with average prices over the last five years.
- Capital investments – to achieve the mitigations, capital investment was required for the effluent system, feed pad and for tree planting (fences, trees and maintenance). It is assumed that the capital required will all be borrowed at a 7.5% interest rate. The capital item is expected to depreciate in line with the life expectancy of the investment.
- The mitigations are cumulative – each set of mitigations builds on the system before it. For example, the long-term mitigation scenario uses the status quo farm as the base and includes all the mitigations within the short-term scenario, medium-term scenario and the long-term scenario.

Short-term mitigations

It is expected the short-term mitigations could be implemented within one year. These mitigations included the following:

- <u>Increase the effluent area from 50% to 65% of the effective dairy area (reduce nitrogen surplus)</u>.
  The effluent area would increase in size by 59ha at an estimated cost of $21,000. This is expected to improve the efficiency of nutrient use from the effluent, thus reducing nitrogen surplus. Nitrogen applied as effluent reduced from 38kg N/ha to 31kg N/ha.
- <u>Increase use of the feed pad to two hours a day in March, three hours in April and four hours in May (reduce nitrogen surplus).</u>
  Nitrogen leaching loss risk from urine patches increases each month from January to May. The use of the feed pad reduced the deposition of urine patches in the paddock, allowing for better control and distribution of urine via the effluent system. It is assumed that $15,000 would need to be invested in the feed pad to accommodate the extra use.
- <u>Reduce nitrogen fertiliser use on the dairy farm from 163kg N/ha + effluent nitrogen, to 160kg N/ha as fertiliser and effluent (reduce nitrogen surplus and methane emissions).</u>
  On the effluent area, the March application (28kg N/ha) was removed and the February application was reduced to 23kg N/ha (from 28kg N/ha). On the non-effluent area, the March application was reduced to 15kg N/ha (from 28kg N/ha). An $18,000 reduction in fertiliser nitrogen expenses is expected.
- <u>Cull earlier (reduce methane emissions).</u>

Lower nitrogen use in late season results in less feed on the milking platform, so demand was also decreased by culling earlier. This reduces feed intake and thus methane emissions.

- Reduce winter feed required by milking the core herd four days longer (reduce methane emissions).
  An extra 40 t DM was imported to allow for a later dry-off date at a cost of $12,000. As a result, 4% less area was required for wintering. Grazing expenses are expected to decrease by $12,000. The combined effect of earlier culling and milking longer is a drop in production of 3400kg MS ($20,000).

Medium-term mitigations:

The AB Lime Dairy Farm includes 23ha (6% effective area) of steep hill country. This area has relatively poor pasture production, a high weed burden and is a safety concern to the AB Lime Dairy Farm management team. A scenario was modelled where the 23ha would be planted in native bush while still maintaining peak cow numbers on farm. The mitigations modelled on the farm system are cumulative. Therefore, the changes identified have been made to the short-term mitigation Overseer and Farmax analysis. These mitigations included the following:

- Plant 23ha of steep hill country in native bush (sequester carbon).
  The cost of fencing, planting and maintaining the native bush is expected to be $184,000. This is annualised to a $14,000 expense. Overseer does not account for the value of carbon sequestration environmentally. Assuming a carbon unit price of $25.05 and carbon sequestration rates based on the MPI default values, the amount and value of the carbon stock is shown in Table 3 below. The carbon stock is a tradeable asset. However, if the area is deforested, the landowner will be liable to cover the cost of the lost carbon.
- Maintain cow numbers and production
  The steep hill country contributed 4t DM/ha of pasture. This feed was imported as Palm Kernel Expeller (PKE) at a cost of $260/t.

Table 3: Value of carbon sequestration over time

Age of trees (years)	Carbon stock (t CO_2/ha)	Value of carbon stock ($)
10	40.2	$23,363
20	158.7	$92,230
30	257.5	$149,649
40	305.1	$177,312
50	323.4	$187,947

Long-term mitigations

The following environmental mitigations modelled on the farm system are cumulative. Therefore, the changes identified have been made to the medium-term mitigations' files.

An analysis was completed by the Livestock Improvement Corporation (LIC) key accounts team to estimate the possible improvement in herd genetic merit over 10 years as a result of breeding replacements from the top 85% of the herd. We have measured genetic gain using the proxy measure of herd Breeding Worth (BW). Replacements are not kept from the first-calvers. It was assumed that the herd's current performance would continue including the following:

- Death rate – 2.5%.
- Not-in-calf rate – 13%.
- Culls for age or non-BW factors – 4%.
- Not-in-calf rate in the heifers – 5%.
- Replacement rate – 25%.

The genetic merit of the herd is expected to increase by 69 BW points over this time. The LIC key accounts team modelling has shown that herd size must decrease by 0.6% for every 11-point increase in BW, to enable the genetic merit of the herd to be fully expressed. It is therefore expected that the herd would decrease in size by 3.7% to 930 cows wintered, and 906 cows at peak over this time.

The following changes were made to the Overseer and Farmax models:

- Decrease in grazier business block area required – as having fewer cows reduces the requirement for winter and young stock grazing. Winter grazing area reduced by 2.5ha (3%) and young stock area by 12ha (11%). Grazing costs are expected to fall by $19,000.
- Farmax estimated an increase in production of 7850kg MS ($45,000).
- Livestock sales are expected to drop by $9000 while 'per cow' costs on farm are expected to drop by $3000.

Summary

The analysis identifies key strengths and opportunities for the AB Lime Dairy Farm business. The AB Lime Dairy Farm owners and team have ambitious goals around environmental sustainability, work conditions and farm productivity. Mitigation strategies were modelled using Farmax and Overseer to determine environmentally effective mitigations with minimal impact on profitability.

The final outputs of the modelling are shown below in Table 4. Each mitigation modelled had a positive impact on reducing nitrogen and greenhouse gas losses. All the mitigations modelled, except for the long-term model, had a negative impact on profitability.

Table 4: Summary of mitigation modelling

	Current system	Short term	Medium term	Long term
		1 year	3 years	10 years
Farm parameters				
Hectares (whole system)	663.1	659.1	659.1	643.9
Production (kg MS)	412,209	408,804	408,804	416,651
Peak Cows	935	935	935	906
Nitrogen loss				
Total Annual Farm N Loss (kg N)	22,720	20,163	19,962	19,366
N Loss/ha	34	31	30	30
N Surplus/ha	156	148	149	150
Phosphorus loss				
Total Farm P Loss (kg P)	700	697	646	637
Average P Loss/ha	1.1	1.1	1.0	1.0
Greenhouse gases (GHGs)				
Total GHGs (CO_2e kg/ha/yr)	9262	9050	9007	9060
Methane (CO_2e kg/ha/yr)	5598	5569	5552	5599
Nitrous Oxide – N_2O (CO_2e kg/ha/yr)	2253	2111	2093	2101
CO_2 (CO_2e kg/ha/yr)	1414	1370	1362	1360
Profitability ($6.00/kg MS milk price)				
Total Operating Profit	$250,543	$243,922	$206,701	$269,528
Operating Profit/kg N Leached ($)	11.03	12.10	10.35	13.92
Operating Profit/t CO_2e ($)	40.79	40.89	34.81	46.20
Change from current system				
N Leaching		-11%	-12%	-15%
GHG Losses		-3%	-3%	-5%
Profitability		-3% ($6600)	-17% ($43,800)	8% $18,985

Conclusions

While mitigating N-loss and GHG emissions on AB Lime Dairy Farm is possible, in the short term, the mitigations modelled will reduce production and profitability. This includes costs associated with building infrastructure around effluent areas and implementing farm system changes around nitrogen and feed pad use.

Monitored changes to the farm system in the medium and long term look at planting trees on less productive steep parts of the farm and increasing in herd performance through improved genetic merit. Based on this modelling, these mitigations could reduce environmental losses and increase profitability.

The key lessons of this case study are that modelling farm system options for reducing both N loss and GHG emissions is complex and requires a high level of information from the farm to accurately represent the farm system. Understanding environmental mitigations and their effects on the farm system also requires a deep understanding of how to model this using Overseer and Farmax. Therefore to effectively reduce any farm's environmental footprint, specialist consultants would be needed to do this modelling task accurately.