CARBON NEUTRAL DIPTON

PROJECT REPORT

GREATER DIPTON CATCHMENT GROUP

NOVEMBER 2022 TO JULY 2023

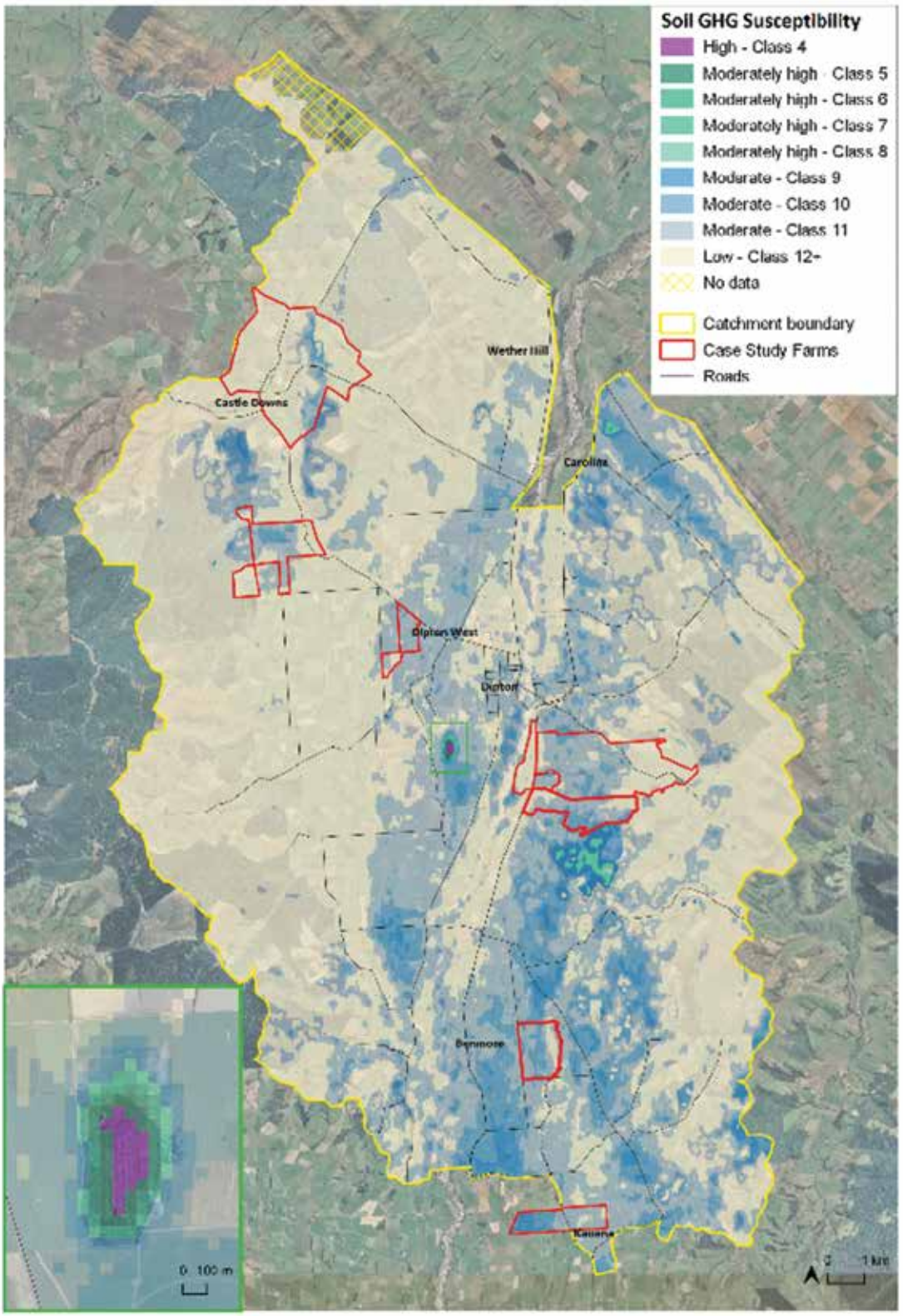
GREATER DIPTON CATCHMENT GROUP

Carbon Neutral Dipton

THRIVING SOUTHLAND

Tōnui ana te whenua. Tōnui ana te takata.

A thriving, prosperous land. A thriving, prosperous people



Greater Dipton Catchment map reflecting landscape susceptibility to soil Greenhouse Gases (GHG), (Case study farms highlighted). Map prepared by Land & Water Science

INTRODUCTION

The Greater Dipton Catchment Group is made up of local farmers and community members who 'came together to turn ideas into action'. They decided that although Dipton might be small, it is mighty - and they wanted to set an aspirational goal – to see how they could become CARBON NEUTRAL DIPTON.

This project is all about doing the hard yards to make fellow catchment farmers' lives easy.

Carbon Neutral Dipton Project involved working with five farmers, each with some buddies (neighbours and community members) to brainstorm exciting ways to reduce GHG emissions on their farms. They are from all types of farming backgrounds so there was something for everyone.

In early 2023, the farmers and their buddies worked with consultants to model and evaluate each farm's baseline numbers alongside several different scenario's for each farm. This report outlines the findings of these evaluations.

Thank you to the thousands of people that engaged with this project, who joined our field days, attended the stakeholder breakfast, followed us on facebook, listened to us on the radio and at conferences, read stories in the media and offered their support.

And mostly **thank you** to our farmers and their buddies who came on a crazy journey and learnt some pretty incredible things about their farms and the possibilities for the future.

THE NUTS AND BOLTS OF THE PROJECT

PROJECT ORGANISERS: **Greater Dipton Catchment Group**

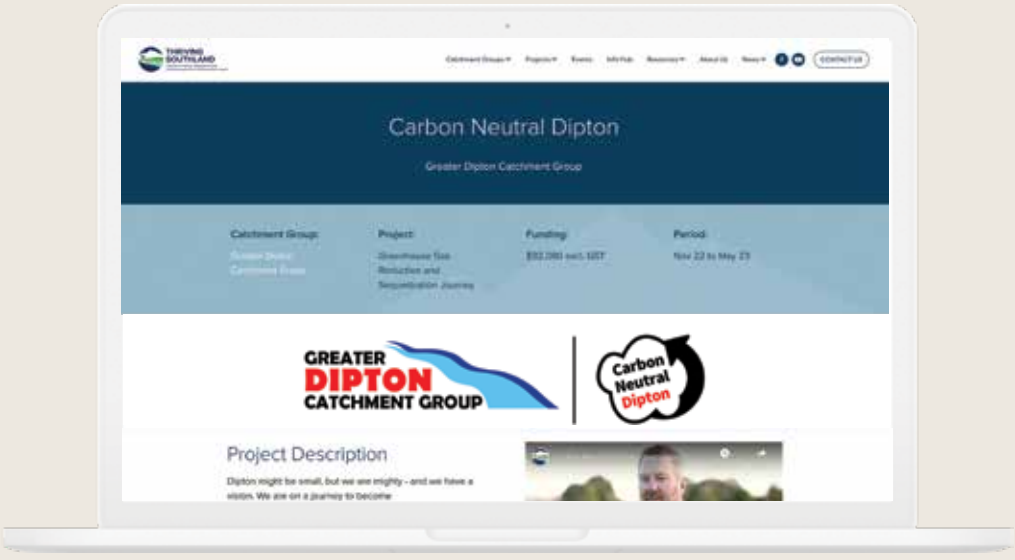
PROJECT: **Greenhouse Gas Reduction and Sequestration Journey**

FUNDING: **$92,080 excl GST** (funded via Thriving Southland by MPI)

PERIOD: **November 2022 to July 2023**

WHERE TO FIND THE FULL REPORTS

You can find the full reports at **www.thrivingsouthland.co.nz/carbon-neutral-dipton**



SUMMARY FROM FARM CONSULTANT CHRIS BEATSON: FARM SYSTEMS MODELLING

The farm system modelling within the Carbon Neutral Dipton project investigated the environmental and financial implications of possible farm system changes with the aim of reducing biogenic greenhouse gas losses on five case study farms (three sheep and beef and two dairy farms).

Four to five scenarios were investigated per farm based on ideas generated with the case study farmers and their buddy groups. These scenarios are outlined in more depth in this booklet but ranged from reduced pastural areas to grow forestry, changes in stock types, growing of arable crops to swap out pastural land, and reductions in supplement feed imported.

The farm system changes were modelled in both OverseerFM and Farmax. OverseerFM was used to establish biogenic greenhouse gas emissions and nutrient losses. Farmax was used to ensure farm system feasibility and to quantify the effects of the farm system changes on profitability. Comparisons were then made to the base steady state farm system.

Biogenic emissions were reported in this study to align with the definition used by the He Waka Eke Noa (HWEN) Programme team. It includes methane and nitrous oxide emissions associated with livestock production plus nitrous oxide and carbon dioxide associated with the dissolution of nitrogen fertiliser and lime (HWEN, 2022).

- Methane emissions are driven predominantly by animal Dry Matter Intake (DMI). For every kgDM that passes through the rumen an amount of methane is produced.
- Nitrous oxide emissions are associated with soil processes such as volatilisation of nitrogen in urine, dung and fertiliser or nitrous oxide emissions from the conversion of ammonia to nitrate by soil microbes. Both sources are weather dependent.
- Biogenic carbon dioxide is associated with dissolution of lime and nitrogen fertiliser.

Forestry areas modelled in the scenarios were not included as a carbon offset under the biogenic GHG calculations because if included in the ETS it will not be available for off-setting under HWEN. Income was added to EBIT for these areas based on selling carbon on the Emissions Trading Scheme and timber. The estimation of income has been sourced utilising information from Don Frengley's reports.

KEY FINDINGS:

- Any farm system change reducing the total kilograms of feed eaten on farm should reduce bGHG emissions. Most of the wholesale system changes investigated didn't significantly improve the farm profitability suggesting the systems currently being run are suitable to the case study farms.
- The conversion of low performing pasture to production forestry improved short to medium term financial returns for that area of the property, and in some cases reduced bGHG emission depending on the pasture eaten by ruminants from those areas.
- The crop options modelled also reduced bGHG emissions because they substituted the area in pasture harvested by ruminants. Introducing these crops significantly increased nitrogen losses. Consideration of the broader environmental effects farm system changes have, must also be factored in to ensure any system change to reduce bGHG emissions does not adversely affect other environmental aspects, specifically water quality.
- Without additional technologies not yet commercially available, there is no one "silver bullet" that can be applied to reduce total biogenic greenhouse gas emissions. Farm system changes will need to be layered to achieve additive reductions in bGHG emissions while maintaining or improving both nitrogen losses and profitability. Whilst there was no silver bullet to reduce emissions, each of the case study farms have options for reducing bGHG emissions which can be implemented or investigated further.
- Further investigation into the broader practicality of these options is recommended before significant changes are adopted by farmers.

KEY: **bGHG** = biogenic greenhouse gas | **EBIT** = earnings before interest and tax | **NZU's** = New Zealand emission units

SUMMARY FROM FARM CONSULTANT DON FRENGLEY: FORESTRY MODELLING

The Carbon Neutral Dipton project is an excellent opportunity for farmers to look at the practical realities of Greenhouse Gas management on their farms. I examined Carbon Forestry options as a method of offsetting the HWEN GHGs.

Five farms were examined ranging from intensive dairy to larger scale mixed stock hill country.

Carbon forestry was not well suited to the flatter, more intensive farms, but even those had some small areas that could be afforested if desired.

		per Forest Ha/Yr		per Farm Ha/Yr	
Farm	**Operation**	**NZU's**	**$(Net)**	**NZU's**	**$(Net)**
Withy	Dairy	8.3	$728	0.3	$28
Officer	Dairy plus runoff	5.0	$1,226	0.3	$68
Dunnage	Flat land sheep	6.7	$946	0.3	$47
Stewart	East hill country sheep	5.6	$767	0.4	$58
Russell	Hill country mixed	8.7	$1,206	2.3	$316

The hill blocks all had areas of low productivity grazing that were expected to be more profitable as production forest or would give improved environmental outcomes as native forestry. Each of these areas were modelled to examine NZUs allocation and financial returns.

The model results were quite consistent across all farms with 4% to 8% modelled in forestry except the Russell's property where over a quarter of the farm was modelled into forests.

Production forest returns were roughly 50:50 NZUs and harvest (modelled at about $30K/ha for harvests and $80/NZU). Native forest returns are entirely dependent on NZUs. It is quite likely that most properties could see similar results if they use carbon forestry as an HWEN offset.

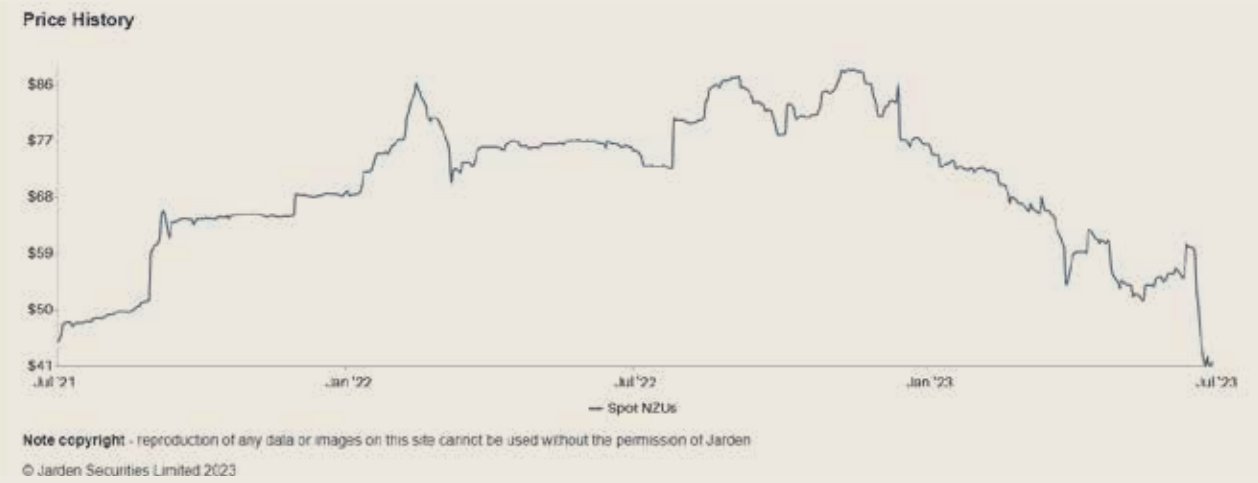
SOME IMPORTANT NOTES:

- The returns were modelled while returns from both harvest and carbon were high. At the time of writing this report, the net harvest return and NZU prices are roughly half what they were when modelled.
- Production forestry is capable of producing returns independent of the ETS. Native forestry largely is not.
- Forests only sequester carbon for a few decades. They offer a short-term GHG offset, but will not be a useful GHG solution over the longer-term. They may assist while technology solutions are developed.
- The ETS is currently under significant review. Outcomes are uncertain and this is severely depressing the market for NZUs.
- Once a forest is committed to the ETS it is likely to be very difficult to remove it. This means that it will be committed to forestry forever and this decision must be made with care. Production forests not in the ETS have a much lower cost of conversion.
- Forests may offer options with water quality management, farm ecology and environment, diversity of income, and succession planning.
- Market prices for logs, both export and domestic, have dropped about 20% over the last six months (from Nov 22 - June 22), reducing net harvest returns by 40% or more. At the same time the NZU market has had a period of low demand followed by an announcement by the Government of a significant review of the Emissions Trading Scheme. NZU prices have halved.

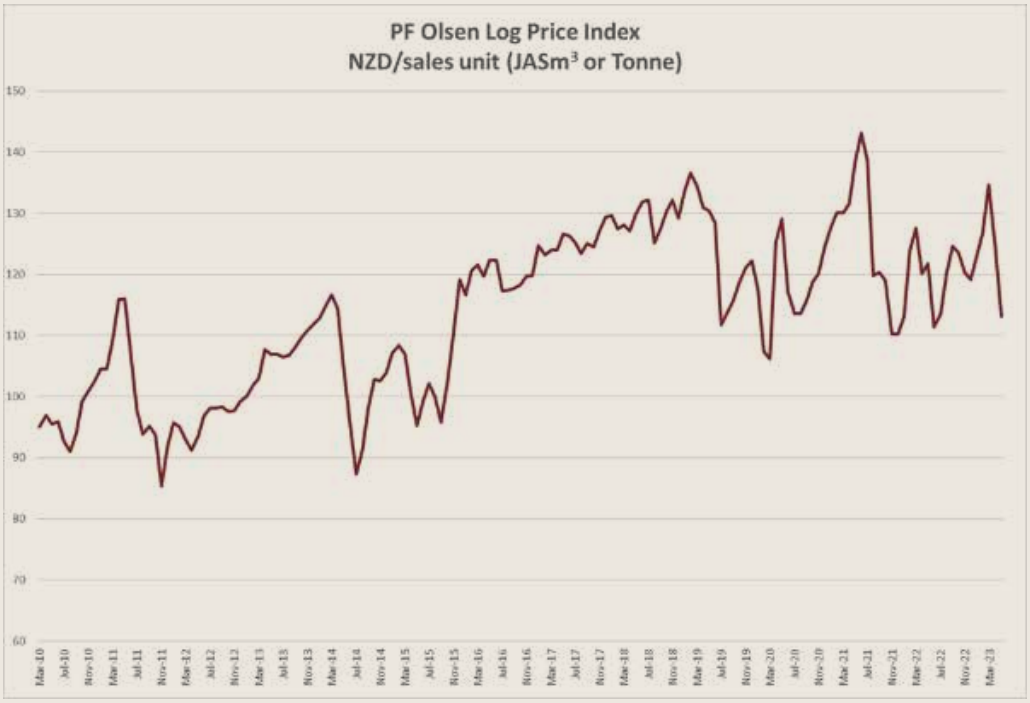
For an extended version of Don's summary, read the online version of this document available at www.thrivingsouthland.co.nz/carbon-neutral-dipton/

Scenario	Prices		Net Revenue		IRR
	Net Harvest Revenue	NZU's	$K	$/Ha/Yr	
Base	$30K/Ha	$80	$930.2	$1,022	25%
Logs Down 20%	$16K/Ha	$80	$614.8	$675	24%
NZUs Down 50%	$30K/Ha	$40	$695.3	$764	14%
Both Down	$16K/Ha	$40	$380.0	$417	13%

Sensitivity analysis prepared by Don Frengley, using Stewart's modelled scenarios, reflecting the volatility of forestry generated income on the business.



Price Volatility of NZU's since July 2021



Price volatility of log prices since March 2010

THE OFFICERS AT OFFREY FARM LTD

Offrey Farms was established as a sharemilking business in 2007 by John and Clare Officer. Ronaki is a 151ha dairy farm currently run in conjunction with two adjacent lease blocks of 100ha and 16ha respectively. They milk 460 cows on a 170ha platform, with the remainder used as an extended platform during the shoulders of the season for silage and young stock. They have a System 4 dairy operation, utilising in-shed feeding, and silage and fodderbeet feed in the shoulders of the season.

In 2018, the Officers purchased a 186ha (160ha effective) runoff block just south of Dipton known as Ben Esk. This is operated as a dairy support and beef finishing block. The Officer's finish between 100-150 beef cross heifer calves every year and approximately 60 beef cross bull calves, alongside their dairy replacements (100hd), and carry over cows. There are two small unmanaged forestry blocks on the property, native shelterbelts, and some unproductive gullies.

BUDDY FARMERS: Frazer Brown, Kody and Nyssah Hunt, Chris Reilly

Table Two: Base and Scenario biogenic greenhouse gas emissions, nitrogen losses and EBIT for Offrey Farm Ltd

	BASE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Scenario details	Base	Current steady state	Lower replacement rate	Animals finished early	9 ha of trees
Total bGHG Emissions (tCO_2E)	3,970	3,547	3,438	3,526	3,541
N Loss per ha (Kg N/ha/yr)	44	39	39	38	38
N Loss per ha (Kg N/ha/yr)	19,763	17,535	17,742	17,084	17,084
Change in EBIT	From Base	-31.7%	-30.8%	-33.0%	-30.7%
	From current steady state		+1.3%	-1.9%	+1.5%

** Please note this output includes biogenic emissions only and does not consider the sequestration of forestry as an offset.

SCENARIO 1: Current steady state; Reduced milking cows, increased beef.

Represents changes from the base, including lower milking cow numbers, importing less supplement and selling some supplement from the support block. This scenario resulted in a 10.6% reduction in bGHG emissions across the farm business. This scenario also reduced EBIT and a reduction in bGHG emissions across the farm business. This scenario reduces EBIT due to the lower modelled returns from selling beef compared with milk.

SCENARIOS 2 + 4: Reducing dry matter intake.

By reducing replacement rates and growing an arable crop (Scenario Two) or substituting areas of low productivity for forestry (Scenario Four), these scenarios both had a positive impact on EBIT and reduced bGHG emissions.

The change of land use from grazed pasture to an arable barley crop reduced dry matter intake and slightly increased nitrogen loss. Consideration into the broader environmental impacts of farm system change is required to ensure that a proposed farm system change that improves one aspect (bGHG emissions in this case) does not adversely impact other aspects.

SCENARIO 3: Finishing beef cattle prior to their second winter.

Finishing beef cattle prior to their second winter whilst harvesting the same amount of home-grown feed through carrying higher stock numbers had little impact on bGHG emissions. This change reduced EBIT due to the increased price of calf rearing, finishing animals lighter and at a lower schedule price in autumn compared with spring.

SCENARIO 4: 9ha of trees added.

Focusing land use change from pasture to forestry on lower performing areas, where less dry matter is grown, is represented in this scenario. The increased profitability is due to forestry returns outweighing the returns from that 9 ha being in pasture. In practice, the harvest of timber can cause significant point source nutrient losses which are not represented in the OverseerFM model.

Property outline & soil map, Ronaki Farm

Property outline & soil map, Runoff block

"Being able to model the scenario's from both an emissions and financial perspective has been really valuable and will empower us to make smart decisions going forward"

John & Clare Officer

THE STEWART FAMILY AT GLENRANNOCH FARM

Glenrannoch Farm is a sheep and beef farm located on Bryce Road, Dipton. The farm is owned by Chris and Serra Stewart and has been in the family for around 85 years and three generations.

The farm is 625ha, 593.5ha effective, with 17.9ha of pine trees and steep scrub & gorse hill faces. Running 4900 Perendale breeding ewes and 1100 replacement hoggets. Typically, the farm is lambing 135%. 5,500 lambs are finished to works between weaning and May. Alongside the sheep flock, the Stewarts finish between 50-100 cattle, arriving as weaners in November. The farm bounds significant waterways; the Oreti River at the bottom and Winton Stream at the top. The farm has multiple different classes of land from alluvial river plains near the Oreti, through some rolling country up to steeper hill faces.

BUDDY FARMERS: Tom Day, Peter McDonald and Nick Johns

Table Three: Overseer derived Base and Future Scenario biogenic greenhouse gas emissions, and nitrogen losses for Glenrannoch Farm

	BASE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Scenario details	Base	+24.6 ha of trees	All grass wintering	Trading cattle	Finishing lambs	+84.6 ha of trees
Total bGHG Emissions (tCO_2E)	2,431	2,423	2,132	2,745	2,480	2,171
N Loss per ha (Kg N/ha/yr)	14	14	12	17	14	13
N Loss per year (Kg N/yr)	9,045	8,970	7,323	10,667	9,062	8,297
Change in EBIT		+8.3%	-14.5%	-4.7%	-7.3%	+10.3%

** Please note this output includes biogenic emissions only and does not consider the sequestration of forestry as an offset,

SCENARIO 1: The impact of converting 24.6 ha from pasture to production forestry.

The conversion of 24.6 ha pasture on areas of low productivity to production forestry improved EBIT. Production forestry on this 24.6 ha has long-term profitability of approximately $1,500 per ha (Frengley, 2023).

The conversion to forestry on this area resulted in a minor reduction in bGHG emissions (given the forestry is not used to offset) as there was little reduction in stocking rate due to the low productivity of the area planted in forestry. If more productive pasture areas are converted to forestry, a larger reduction in bGHG emissions is likely provided the remaining area of pasture is not intensified.

SCENARIO 2: Changing to all grass wintering and growing a hemp crop.

All grass wintering with a spring hemp crop also reduced bGHG emissions because it substituted the area in pasture harvested by ruminants. The removal of winter crop also reduced nitrogen losses, however the reduction in stocking rate required to align with feed supply over winter reduced EBIT.

SCENARIO 3 + 4: Swapping a sheep breeding enterprise with all trade cattle (Scenario 3), or swapping replacement hoggets with trade cattle (purchasing replacements as two-tooths – Scenario 4).

Adult cattle have been shown to produce more methane per kilogram of dry matter eaten, than with if that same kilogram of dry matter was eaten by an adult sheep. A growing lamb produces even less methane per kilogram of dry matter eaten. Swapping a sheep breeding enterprise with all trade cattle (Scenario 3), or swapping replacement hoggets with trade cattle (purchasing replacements as two-tooths – Scenario 4) and still harvesting similar amounts of dry matter will slightly increase methane emissions. The modelling indicated that these scenarios also reduced EBIT.

Reducing bGHG emissions without adversely impacting EBIT was difficult in this study without converting some of the pastoral area to production forestry. The sheep and beef enterprise currently operated achieves greater returns compared with all grass wintering, trading cattle and buying replacement lambs.

All grass wintering resulted in the greatest reductions in bGHG emissions and nitrogen losses, so combining this with the land use change to production forestry on lower performing areas, could lead to reductions while maintaining profitability.

SCENARIO 5: Conversion of 84.6 ha from pasture to production forestry.

Based on this, Scenario 5 was modelled with a further 60 ha of more productive pasture converted to forestry. This led to significant reductions in bGHG emissions due to the overall reduction in stock numbers required, and therefore the reduction in total kilograms of dry matter eaten. Consideration in utilising this area under the Emissions Trading Scheme (ETS) or as an offset under He Waka Eke Noa would be required prior to making this farm system change as the impacts on EBIT vary. The modelling showed an improvement in EBIT in the short-medium term based on higher carbon and timber prices. This increase in EBIT would not be expected based on current (July 2023) prices, or subsequent forestry rotations after carbon credits have been claimed in the first rotation.

Property outline & soil map; Glenrannoch farm

"Given current technologies, it seems like the only way to lower gross emissions significantly is to lower production. However, by utilising trees in areas that aren't productive, we can lower net emissions without negatively impacting farm profitability."

Jake Stewart

TONY AND RAYLEEN DUNNAGE

Tony and Rayleen are Sheep and Beef farmers at Dipton West. They farm a 320 ha property which is predominantly flat with 10% rolling hill. For the last 3 years the home farm has been run in conjunction with an 80 ha lease block nearby. Tony and Raylene farm the two properties themselves without staff.

The property has over 10km of mature shelterbelts with the Dipton Stream running through the property and sits on largely Pukemutu and Euraka soils. The lease farm has some areas of native tussock land. The Dunnage's run a predominantly sheep breeding operation with some finishing. Currently running 2,900 breeding ewes and 800 replacement hoggets which are mated. With a target lambing of 140%, the Dunnage's currently finish roughly 50% of lambs, adjusting the number of lambs sold store as the season dictates. 50 yearling cattle are purchased in December and finished, selling 18-20 months later. Sheep are wintered on a direct drilled kale crop. This is then second cropped before being sown into permanent pasture.

BUDDY FARMERS: Lynden Prebble, Brooke Todd and Colin Smith

Table Four: Overseer derived Base and Future Scenario biogenic greenhouse gas emissions, and nitrogen losses for Dunnage's Farm

	BASE	SCENARIO 1	SCENARIO 2		SCENARIO 3	SCENARIO 4	SCENARIO 5
Scenario details	Base	14 ha forestry	A	B	Full trading	Arable	Ewes and lamb trading
Total bGHG Emissions (tCO_2E)	1,586	1,519	1,640	1,629	1,626	1,412	1,520
N Loss per ha (Kg N/ha/yr)	12	12	12	13	14	23	11
N Loss per year (Kg N/yr)	5,148	5,016	5,234	5,370	5,792	9,793	4,463
Change in EBIT		+1.05%	-9.5%	-5.0%	+14.4%	+3.6%	+15.2%

** Please note this output includes biogenic emissions only and does not consider the sequestration of forestry as an offset,

SCENARIO 1: Considered the impact of converting 14 ha from pasture to production forestry.

The conversion of 14 ha pasture to production forestry improved long-term financial returns for that area of the property. Production forestry on this 14 ha had long-term profitability of approximately $1,250 per ha (Frengley, 2023). Other pasture areas which are profiting less than $1,250 per ha may be better suited to forestry, and if converted, would further reduce bGHG emissions provided the remaining area of pasture was not intensified.

SCENARIO 2: Changes to the stocking ratio to increase trading cattle and reduce sheep. 2A) Trade cattle purchased as yearlings and 2B) Trade cattle purchased as calves.

Scenarios 2A and 2B represent a change in the ratio of the stock enterprises. Trading cattle were increased to make up a third of all stock units with sheep numbers reduced proportionately on a SU basis. This results in an increase in both bGHG emissions and nitrogen losses. The increase in total bGHG emissions comes from an increase in methane emissions.

Buying or rearing young calves (Scenario 2B) causes a lower reduction in profitability than buying R2 cattle in the spring. The move to more trading cattle would reduce the labour requirement compared to the current farm system but is difficult to quantify in the financial modelling for both cattle trading scenarios compared with the Base. The move to spring purchased cattle in Scenario 2A also increases risk to the business of sourcing good quality animals and selling on a declining schedule in autumn.

SCENARIO 3 & 5: Moving to all trade stock; Reducing breeding ewe numbers and including a trading lamb portion to the business.

Scenario 3 represents a full trading system with no breeding stock. This scenario increases bGHG emissions by 2.5% and increases nitrogen losses by 12.5%. The increase in nitrogen losses is driven by the significant increase in cattle numbers from the Base. The resulting profitability is an estimated 14.4% increase, which is inclusive of the estimated deductions from a stock finance scheme.

Based on the findings of Scenarios 2A, 2B and 3, future Scenario 5 was modelled, which represented a reduction in breeding ewe numbers and the inclusion of trading lambs. Cattle numbers were not changed from the Base. This scenario poses similar risks as Scenario 2A and B and 3 of fluctuating stock prices, however has slightly more stability due to maintaining approximately 50% the breeding flock.

SCENARIO 4: Change of 40 ha from pasture to a spring barley crop.

The spring barley crop also reduced bGHG emissions because it substituted the area in pasture harvested by ruminants. Introducing this crop increased profitability, but also significantly increased nitrogen losses. Consideration of the broader environmental effects farm system changes have, must also be factored in to ensure any system change to reduce bGHG emissions does not adversely affect other environmental aspects, specifically water quality.

Property outline & soil map, Dunnage farm & lease block

"Tony and Rayleen's report shows that its mostly about doing what you do as well as possible and looking for the small gains – small steps added together can help."

Lynden Prebble (Buddy Farmer).

"Our current farm system aligns well to farm potential" Tony & Rayleen Dunnage

BRIAN AND KRISTINE RUSSELL AT THE ROCK FARM

Brian and Kristine Russell, alongside their children, Adine, Hamish and Natalie own an 845 ha, (773 ha effective) sheep and beef property located at Castle Downs. Running 4450 Romney ewes with a goal of 150% lambing, 110 replacement hoggets and approximately 6200 lambs finished to 17-19kg CW. A mixed beef system of 150 beef breeding cows and 30 replacement heifers, alongside 283 steer calves destined for 5-star beef at Ashburton (at 500-550kg LW).

The property has a mix of contour and six different soil types. 565 ha is developed flat, some steep country and a further 145 ha undeveloped hill. The property also has some forestry, 40 ha existing with 75 ha planted in Douglas Fir in 2022, and a further 40 ha to be planted this year. Most of the planting has occurred in areas where gorse is difficult to control or is too steep or rocky to cultivate.

BUDDY FARMERS: Lyndon Prebble, James Duffy and Simon Saunders

Table Five: Base and Scenario biogenic greenhouse gas emissions, nitrogen losses and EBIT for the Russell's Farm.

	BASE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Scenario details	Base	72 ha forestry	Lambs sold store	Arable	All grass wintering	Forestry on >10 deg slope
Total bGHG Emissions (tCO_2E)	3,195	2,882	2,896	2,723	2,842	1.050
N Loss per ha (Kg N/ha/yr)	20	17	18	23	15	6
N Loss per year (Kg N/yr)	16,602	14,720	14,905	19,120	12,649	4,376
Change in EBIT		+7.1%	-12.8%	-2.2%	-6.0%	+49.0%

** Please note this report includes biogenic emissions only and does not consider the sequestration of forestry due to the uncertainty of how this will be managed under He Waka Eke Noa.

SCENARIOS 1 + 5: Considered the impact of converting less productive land from pasture to production forestry.

Production forestry has estimated long-term average profitability of approximately $1,500 per ha per year (Frengley, 2023) indicating other pasture areas which are profiting less than $1,500 ha/yr may be better suited to forestry. The conversion of 72 ha of lower performing pasture areas to production forestry in Scenario 1 improved modelled long-term financial returns and reduced bGHG emissions.

The conversion to a larger area of forestry in Scenario 5 further increased productivity, the financial returns are based on a short to medium-term average for the first cycle of trees. There would be significant capital requirements to fund the initial development before income started outweighing expense in year six.

The scenarios modelled in this report indicate that improvements in bGHG emissions, nitrogen losses and financial performance are possible through the inclusion of production forestry on the property. Without forestry, it is difficult to reduce bGHG emissions without adversely impacting nitrogen losses or EBIT. Focusing this change on lower performing areas of the farm where less dry matter in total is grown and harvested by animals, results in improved short to medium-term profitability as well as a reduction in bGHG emissions.

The sheep and beef enterprise, currently operated achieves greater returns compared with selling store lambs, growing maize or all grass wintering. Investigation into further forestry areas as outlined in Scenario 5 is likely to provide the best financial returns whilst also reducing modelled nitrogen losses and bGHG emissions.

SCENARIO 2: Lambs sold store

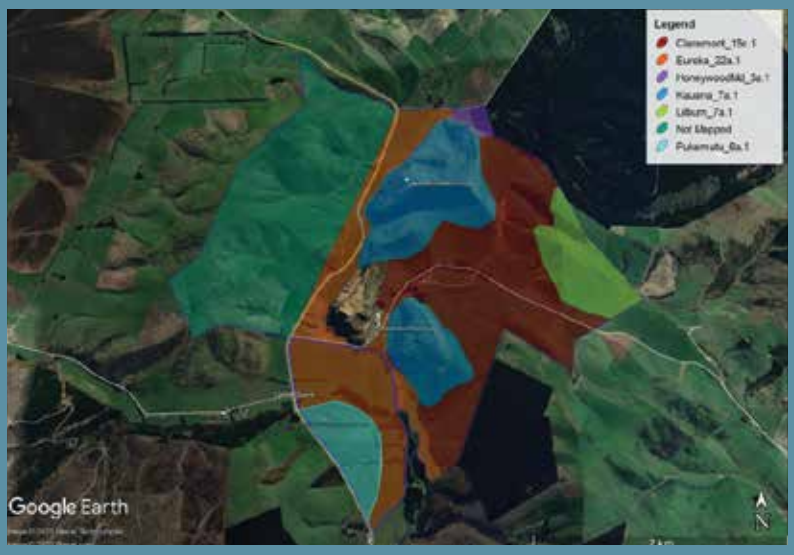
Scenario Two resulted in a minor increase in bGHG emissions and nitrogen losses relative to Scenario One. When including the improved profitability of planting forestry (Scenario One) compared to Base, the reduction in EBIT of Scenario Two is 19.8%. Selling store lambs in December and January reduces income significantly with a minimal reduction in expenses. This loss of income is not offset by the trade cattle enterprise indicating the best return per kilogram of dry matter in this study is to finish the home bred lambs through summer and autumn. To maintain similar profitability as the Base farm system, store lambs would need to be sold for approximately $155/head.

SCENARIO 3: Change of 50 ha from pasture to a maize crop.

The maize crop also reduced bGHG emissions because it substituted the area in pasture harvested by ruminants. Introducing this crop reduced profitability and significantly increased nitrogen losses. Consideration of the broader environmental effects farm system changes have, must also be factored in to ensure any system change to reduce bGHG emissions does not adversely affect other environmental aspects, specifically water quality.

SCENARIO 4: All grass wintering with lower stocking rates.

All grass wintering with lower stocking rates also reduced bGHG emissions through lower total feed eaten. This reduced EBIT significantly indicating the use of winter feed to maintain a higher stocking rate and maximise spring and summer growth is more profitable.



Property outline & soil map, Rock farm

"THE PROJECT GAVE US A TOOL TO BENCHMARK OUR CURRENT OPERATING SYSTEM AGAINST OTHER POTENTIAL SYSTEMS WITHIN OUR PROPERTY AND WE LEARNT THAT WE ARE BASICALLY ON THE RIGHT TRACK.

FOR US, THE PROJECT HIGHLIGHTED THE BENEFIT OF IDENTIFYING LOWER PRODUCTION AREAS AND PLANTING IN TREES AND UTILIZING THE SHELTER TO ENHANCE STOCK PERFORMANCE"

BRIAN RUSSELL

KEY: **CW** = Carcass weight | **LW** = Live weight

CHRIS & CHARLEEN WITHY AT SOUTH FIELDS FARM

South Fields Farm is an 156 ha dairy farm (143 ha effective) located at Benmore Kauana Road. The farm was purchased by the Withy's 13 years ago, having previously been involved in an equity partnership on the property alongside a 650-cow farm.

The Withy's currently peak milk 440 Friesian cross cows, producing 440 kgMS/cow. The majority of the herd are wintered off, keeping 65 MA cows back home on fodderbeet. 115 replacement heifer calves are reared each year, grazing off farm from 100kgLWT.

The farm has three different soil types, Lumsden shallow, Makarewa deep and Pukemutu. One hectare of pine trees is utilised in spring to protect soils, standing cows off in wet. Effluent is spread to 58ha from the 36-aside herringbone shed, with in-shed feeding.

BUDDY FARMERS: Stefan and Annalize Du Plessis, Louis and Angela English, Rex Kane

Any farm system change reducing the total kilograms of feed eaten on farm should reduce methane emissions and therefore total bGHG emissions. Three scenarios focused on this aspect and they had varying effects on profitability with reducing replacement numbers improving EBIT and reductions in imported supplement reducing EBIT due to the current supplement fed supporting increased milk production on South Fields Farm.

Table Six: Base and Scenario biogenic greenhouse gas emissions, nitrogen losses and EBIT for the South Field's Farm.

	BASE	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
Scenario details	Base	Herd home	Lower stocking rate	Lower replacement rate	Oat Milk
Total bGHG Emissions (tCO_2E)	2,183	2,186	2,060	2,112	1,770
N Loss per ha (Kg N/ha/yr)	65	55	54	55	67
N Loss per year (Kg N/yr)	13,168	10,598	10,151	10,151	12,374
Change in EBIT		+1.0%	-5.7%	+5.1%	-23.8%

** Please note this output includes biogenic emissions only and does not consider the sequestration of forestry as an offset,

SCENARIO 1: Herd home

Findings indicate that significant reductions in nitrogen loss can be achieved through the installation of a herd home, however this has very little effect on modelled bGHG emissions and EBIT. As methane inhibitors become commercially available, the herd home may provide opportunity to include feed additives to the feed ration over winter more easily than in grazing situations. The use of the herd home over winter may enable quicker uptake of technologies such as feed additives to reduce methane emissions as they become available in the future.

SCENARIO 2 + 3: Considered the impact of reducing stock numbers through reduced total cow numbers/ reducing replacement rates.

Reducing dry matter intake across the dairy business such as growing less replacements or reducing supplement imported should reduce bGHG emissions. The impact on profitability from these changes varies and depends on the impact on herd performance (from growing less replacements) or any reduction in milk production from feeding less supplement.

SCENARIO 4: Substituting an area of pasture that would otherwise be grazed by cows for an oat crop.

Significant reductions in bGHG emissions can be achieved through the change of land use from dairy to growing oats for oat milk. This change contributed to increased nitrogen losses (offset by the herd home) and a significant reduction in profitability and EBIT. Consideration of the broader environmental effects farm system changes have, must also be factored in to ensure any system change to reduce bGHG emissions does not adversely affect other environmental aspects, specifically water quality.

Based on the assumptions used in this study, a considerably higher bGHG emissions levy or oat milk price would be required for the conversion to oat milk to match the EBIT achieved by the dairy enterprise.

Property outline & soil map, South Fields Farm

"Being part of this project, it's highlighted for us that there is no one thing that'll greatly change our onfarm GHG's, without drastically altering our bottom line.
Going forward we'd like to investigate the option of reduced heifer replacements on our farm, ensuring it's sustainable over the years.
And the project has highlighted for us, that the herd home has been a good investment environmentally (slight reduction in GHG's & significant decrease in N losses) and financially."

Chris & Charleen

KEY: **MA** = Mixed aged | **MS** = Milk Solids | **LWT** = live weight

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