Mamaku I Holdem Farm (2017) Limited (#1)

# Integrating Forestry for Profitable and Sustainable Land Use

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NEW ZEALAND AGRI-BUSINESS ADVISORS

With funding support from
Te Uru Rākau
Forestry New Zealand

# Case Study Summary

- Holdem Farm (2017) Limited is a 308.4 ha family-owned dairy business 15 km north west of Rotorua.
- The Holdem's are interested in trees to support goals of increasing farm efficiency, building environmental resilience, diversifying income, and enhancing property biodiversity and aesthetics.
- Scenario 1 provided the closest alignment with owner objectives, had the highest IRR and equity growth with minimal impact to cash flow.
- Timber and carbon revenues from Scenario 2 & 3 were insufficient to offset lost dairy farm profits from either scenario, even after accounting for the financial benefit of lower N loss to water.
- Reduction of GHG emissions in all scenarios highlights the potential of trees as a tool to support attainment of domestic and international emissions reduction targets.

**Table 1.** Snapshot of integrated forestry analysis.

| Performance Metrics | Base system | Scenario 1 | Scenarios 2 & 3 |
|---|---|---|---|
| Area converted to trees (ha) | - | 27.8 | 59.5 |
| Effective area (ha) | 276.2 | ▼ 10% | ▼ 21% |
| Peak cows milked | 720 | ▼ 4% | ▼ 17% |
| Total production (kg MS) | 275,000 | ▼ 3% | ▼ 15% |
| Internal rate of return (over 56 yrs) | 15.2% | ▲ 0.3% | ▼ 0.2% / ▼ 0.4% |
| Equity at Year 28 (incl. sale of carbon) | - | ▲ 11% | ▼ 5% / ▼ 14% |
| Total N leaching loss (kg N/yr) | 20,184 | ▼ 4% | ▼ 16% |
| Biological GHG (t $CO_2$ eq./ha/yr) | 9.8 | ▼ 4% | ▼ 16% |

# Take Home Messages

- Productivity differences between pasture and trees on various land classes highlight opportunities to retire poor quality land and achieve improvements through alternative land use.
- The planning and analysis provided demonstrates integration of Right Tree, Right Place to achieve the Right Purpose: optimising land use while meeting environmental obligations.
- The long term nature of tree planting means planning is crucial. Key considerations include cash flow, cost of capital over time and how these align with the owner's objectives.
- Grants assumed to be available from the One Billion Trees fund or similar alleviate cash flow constraints giving farmers the option to convert marginal land.
- The cost of environmental externalities (N & P loss, bGHG emissions) is crucial for evaluating the integration of trees.

# Case Study Overview

*This case study illustrates the impact of integrating various forestry options into a pastoral dairy farm business. The options analysed are specific to their farm and farming aspirations. Financial and environmental analysis demonstrate potential returns, impact on reducing the farm's environmental footprint, and total farm business performance of the integrated options compared to the existing farm system. The full case study report with detailed analysis can be found at www.mpi.govt.nz/forestry/ and www.perrinag.net.nz/planting-trees/.*

*Sections covered in this case study include:*

## CURRENT FARM BUSINESS

This section presents a snap shot of the businesses background, goals, and current performance. The data from the 2019/20 season is utilised to form the 'status quo system' to provide a base comparison to the forestry options analysed.

**Read more on page 4**

## RIGHT TREE RIGHT PLACE RIGHT PURPOSE

Factors motivating tree plantings and land use change are outlined to understand 'why' trees are being considered. The property's three land classes (flat to rolling, gullies, and Mamaku tors) are evaluated for their physical characteristics and determining what trees are best suited. As tree planting is a generational decision it is essential to plant the right tree in the right place to achieve the right purpose.

**Read more on page 5-6**

## WHOLE BUSINESS ANALYSIS – BEST FUTURE LAND USE & FARM SYSTEM

The forestry options at an enterprise (dairy and forestry) and a whole farm business level are analysed to show the performance of each integrated forestry option compared to the status quo and identify which option best supports the attainment of the owners' objectives.

**Read more on page 7-13**

# Farm Overview (Status Quo Farm System)

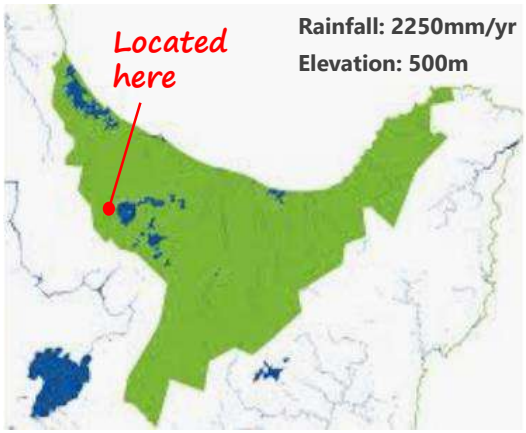
Holdem Farm (2017) Limited is a 308.4 ha multigenerational family-owned business based in Mamaku, 15 km North West of Rotorua. The property includes 276.2 ha of effective pasture, 27.2 ha of native bush (predominately rimu, tawa, tawari, mahoe, and kamahi), and 1.4 ha of newly planted riparian margin. The farm's topography is mostly flat to rolling with some steep gullies and Rhyolite mounds or tors.

The Holdem's are interested in how trees can support their goals, including increasing farm system efficiency and 'enjoy the business". Integration of forestry offers the opportunity to build environmental resilience, diversify income, enhance the property's biodiversity and aesthetics, and support the dairy operation (shade and shelter plus land optimisation).

Other farm business goals are to:

- Become more efficient, optimizing the farm financially while meeting environmental obligations.
- To operate within surplus nitrogen discharge allowance (NDA) by adopting new technology/management practices and/or secure more NDA to lift the feeling of "doing wrong".

## Location




## Farm Details

| | |
|---|---|
| Home farm (ha) | **308.4** |
| Effective pasture (ha) | **276.2** |
| Soil type | **Mamaku & Oraka Sandy loam** |
| Total milk production (kg MS) | **275,000** |
| % imported feed | **25** |
| Est. pasture eaten (per effective ha/yr) | **10.0** |

## Livestock Details

| | |
|---|---|
| Breed type | **Crossbred** |
| Herd size | **720** |
| Production per cow (kgMS) | **382** |
| Liveweight per cow (kg) | **470** |
| Stocking rate (cows/ha) | **2.61** |
| Planned start of calving | **27 Jul** |

## Performance Indicators

| | |
|---|---|
| Production per hectare (kg MS/ha) | **996** |
| Operating profit ($/ha) | **1,581** |
| Return on asset (ROA%) | **5.5** |
| N leaching (kg N/ha/yr) | **65** |
| kg MS/kg N leached | **13.6** |
| Biological GHG emissions (t $CO_2$ eq./ha) | **9.8** |

# Factors Motivating Tree Planting and Land Use Change

***Physical Constraints***

- Factors such as climate, variable topography and pasture species constrain management and physical productivity and lead to the question: **"If the less productive areas were retired and planted in trees what would the overall impact be to the business"?**
- Pasture management is challenging due to the low stocking rate and farm contour. The Mamaku tors and gullies contain unimproved pastures, produce poor quality feed, and this constrains herd performance.
- The local climate can be harsh for livestock during winter and spring. Cows historically have rapid condition loss post calving, leading to high rates of metabolic disease, and high mortality rates compared to 'best practice'. Approximately 3,000 pine trees were planted in shelterbelts during the 2019 winter to lessen climate stress for livestock. However, further tree planting opportunities exist to provide shade and shelter and moderate climate impact.

***Environmental Constraints***

- The farm operates under the Lake Rotorua Catchment Proposed Plan Change 10 (PPC10). **Annual N loss** needs to reduce by 29% by 2032 - from the current nitrogen discharge allowance (NDA) of 69 kg N/ha/year to 49 kg N/ha/yr. Current leaching levels range from 65-69 kg N/ha/year. Dairy farm N leaching losses for the catchment range between 60-100 kg N/ha, exacerbated by high rainfall. In the absence of land use change, modelling indicates the farm will need to reduce peak cows milked from 720 to 600 cows by 2032 and N fertiliser use minimised.
- While **Greenhouse Gas (GHG) reduction targets** – except nitrogen fertiliser, fuel and electricity – are not yet explicitly in the Emissions Trading Scheme (ETS), all farmers under the **Zero Carbon Act 2019** will need to reduce biogenic methane emissions by 10% by 2030 (December 2017 baseline).
- The **integration of trees** may provide a valuable tool to reduce environmental losses. For example, retiring low quality land into a low N land use while also sequestering carbon over time.

# Right Tree Right Place Right Purpose

*Understanding a planting site and its effect on tree performance and future harvesting operations is essential for selecting the right tree to achieve the desired outcomes. In this section the tree options for the different land classes on the Holdem's farm are explained. The property is characterized by three distinct land types, the flat to rolling productive land, steeper gully systems and small areas of Mamaku tors (rhyolite mounds).*

## *Flat to Rolling Productive Land*

- The flat to rolling areas cover 251 ha and have a mean slope of 8.2°. The climate and deep soils provide good growing conditions for timber species. These areas are expected to produce slightly higher log yields, as well as lower harvesting costs given easy paddock access via farm races, compared to the less productive gullies.

## *Gully Systems*

- Gullies cover approximately 23.7 ha with an average slope of 20°. These areas are less productive compared to the flat to rolling slopes due to their shading, shallower topsoil and lower soil fertility. The gullies contain steep slopes, lower slopes, flats, and gully bottoms that the right tree species need to be matched to.
- Nearby farm laneways mean access and potential harvest costs are not limiting factors.
- The gullies represent an opportunity to retire marginal farmland for timber and/or carbon, biodiversity benefits and environmental protection.

## *Mamaku Tors (Rhyolite mounds)*

- Tors are a unique feature on the Mamaku plateau and cover approximate 4 ha with an estimated slope >25°.
- The mounds have limited plant rooting depth, poor fertility and low soil moisture capacity and this severely restricts the choice of tree species able to survive.
- Trees on mounds can provide biodiversity, shelter and potentially carbon income, rather than timber. Suitable species include mānuka (*Leptospermum scoparium*) and Tree Lucerne, also known as Tagasaste (*Chamaecytisus palmensis*).

# Integrated Forestry Analysis

The Holdem's are interested in ***Pinus radiata* and redwoods as timber options**. Their goals for increased efficiency and farm business resilience make radiata an obvious component of tree planting scenarios, complemented by native and riparian planting for property beautification. Radiata pine has good growth in a wide range of sites and well established log markets. Redwoods are more sensitive to site quality and weed competition and have more variable growth rates especially on windy sites, and where soils are shallow or nutrients are restricted. Redwoods provide a longer term carbon storage option and are suitable for the valley bottoms on the property.

Both species grow well at this site and have strong supporting local infrastructure and supply chains for planting, silviculture, harvest and sale of timber. **Distance to port or processor typically have the largest impact on the profitability of small woodlots** due to transport costs. The farm is within 50 km of several local processor for radiate pine, and the Port of Tauranga is 81 km away.

**Three scenarios were tested** to evaluate the value of integrating trees - timber woodlot, riparian margins or native. Woodlots were assessed for their economic potential (including carbon) while riparian and native plantings were included as costs for establishment less any grants available for planting, plus any carbon revenue that would accrue over time if identified compartments were eligible for the ETS.

For this case study both Te Uru Rākau and Bay of Plenty Regional Council **landowner grants** were assumed to be secured to support planting and fencing costs. Native plantings were included with costs based on the landowner completing planting over three years. The cost of seedlings assumed a small number of species, not pre-spaced to keep planting costs at the lower end of the range for natives. Costs for follow up weed and pest control for up to two years after planting did not include grant support.

The integrated forestry analysis that follows shows the physical, financial and environmental impact of three forestry options on the dairy and the business overall.

# Scenario Design

### *Scenario 1 – Conservative Planting Regime*

Scenario 1 targets planting only the steeper contoured and less productive land. This accounts for 27.7 ha made up of approximately 4 ha of rhyolite mounds and 23.7 ha of gully systems. A combination of woodlots (17.7 ha), native (7 ha) and riparian planting (3 ha) is used to support 'right tree, right place and right purpose'. The woodlot areas are all located in the property's gullies with the gully floors planted in permanent native to reduce soil and contaminant loss at harvest. The timber woodlots are planted in *Pinus radiata* at 800 to 850 stems per hectare, pruned in two lifts to over 5.5 m and thinned once to 370 stems per hectare.

Native and riparian plantings are targeted in areas around power lines, to protect views, areas near houses which provide beautification, and steep areas which are considered not suitable for timber woodlots due to their size and/or location. The rhyolite mounds are planted in native; Manuka covering the top two thirds where soil depth is limited, and the base planted in mixed natives where soil depth provides more species options.

Changes to the dairy enterprise include a reduced pastoral area (248.4 ha), an increased of stocking rate (+0.17 c/ha) and per cow productivity (+6kg MS/cow) associated with improved feed quality and land contour.

### *Scenario 2 – Extended Woodlot Planting*

Scenario 2 see trees planted over 59.5 ha. The woodlot area of 49.3 ha includes 9 woodlots ranging from 1.3 to 10.8 ha in size. The woodlots are all planted in *Pinus radiata* (as with Scenario 1).The riparian areas and native planting follow the same principles as Scenario 1 with planted areas covering 5.2 and 5.1 ha, respectively.

**Table 2.** Summary of farm physical parameters of the scenarios compared to the status quo system.

| Farm parameters | Status Quo | Scenario 1 | Scenarios 2 & 3 |
|---|---|---|---|
| Effective pastoral area (ha) | 278.6 | 250.8 | 219.1 |
| Timber Woodlots - Pine and/or Redwood | | 17.7 | 49.27 |
| Native (ha) | 27.2 | 34.5 | 33.3 |
| Riparian (ha) | 1.2 | 4 | 5.3 |
| Peak cows milked | 720 | 690 | 600 |
| Stocking rate (c/ha) | 2.58 | 2.75 | 2.74 |
| Production | 275,000 | 268,000 | 234,000 |
| *per hectare (kg MS/ha* | 987 | 1,068 | 1,068 |
| *per cow (kg MS/cow* | 382 | 388 | 390 |

### Scenario 3 – Extended Woodlot with Redwood Planting Regime

Scenario 3 has the same planted area as Scenario 2 but has 29 ha in redwoods (*S. sempervirens*) with the remaining 20.3 ha in *Pinus radiata*. The redwoods planted and left at 550 stems per hectare, are primarily grown for carbon, with no investment to enhance log quality. This scenario illustrates the financial performance of a carbon sequestration from alternative species.

Dairy farm system changes for Scenario 2 & 3 were modelled together as they have the same pastoral area removed but differing planting regimes. The pastoral area decreases by 60.1 ha (22%) while stocking rate and animal performance remained consistent with Scenario 1.

# Results of Forestry Scenario Analysis

Table 2 summarises the investment outcomes from two full forest rotations (plan, grow, harvest, replant, grow, harvest), both excluding and including carbon revenues. Carbon revenues from the new native and riparian plantings were not included as they were too small to qualify under the ETS (but might under the provisions of the Zero Carbon Act).

**Scenario 1** provides the second highest return per hectare planted of the three scenarios, but the lowest overall return, as measured by the Present Value (PV) from all log and carbon revenues, due to the smaller area retired. Revenue per hectare is slightly lower than Scenario 2 as the inclusion of the steeper-contoured less productive land provides slightly lower total timber yields (-5%) compared to the better-quality land included in Scenarios 2 and 3. However, **forestry represents a small decrease in productivity compared to current use in pasture** (50% less pasture yield than better land).

**Scenario 2** provides higher revenue per hectare from better-quality land but with slightly lower log quality. Lower log quality did not impact revenue as the assumed prices for lower grades reflect historical high demand. This could change in the future and can be managed by delaying harvest to improve both log quality and yield. Applying a discount rate of 6% to the whole term provided a positive PV of $152,102 ($3,085/ha) and Internal Rate of Return (IRR) of 8.48%, the highest of the three scenarios. If the safe tradeable carbon is sold, the **net pre-tax return (logs + carbon) increases to $283,173 ($4,759/ha).**

**Scenario 3** provides much lower timber revenue, as 29 ha is planted in redwoods rather than *Pinus radiata*, but derives more income from carbon. Applying a discount rate of 6% provided a positive PV of $120,362 ($2,023/planted ha). The investment's IRR was 8.9%, the lowest of the scenarios. Scenario 3 provides the greatest potential to offset the dairy farm's carbon liability, reduces exposure to log price risk, and increases exposure to carbon price risk. Considering the outlook for higher carbon prices to discourage emissions, the redwoods scenario *could* present more lucrative returns with conjecture carbon prices could go to $50/t in the mid-term. **A carbon price sensitivity analysis is important in the assessment of redwoods over radiata pine.**

**Table 3.** Summary of individual investment performance for the forestry investments, under each scenarios.

| **Planted Area (ha)** | **Scenario 1** 30.2 | | **Scenario 2** 59.5 | | **Scenario 3** 59.5 | |
|---|---|---|---|---|---|---|
| Area in P. radiata | 17.7 | ha | 49.3 | ha | 20.3 | ha |
| Area in redwood | - | ha | - | ha | 29.0 | ha |
| Area in ETS qualifying native and riparian | 12.5 | ha | 10.2 | ha | 10.2 | ha |
| **Returns over two rotations (56 years)** | **Total** | **/ woodlot ha** | **Total** | **/ woodlot ha** | **Total** | **/ woodlot ha** |
| Net Pre-Tax Logs Undiscounted | 855,997 | 48,361 | 2,563,170 | 51,991 | 909,056 | 18,439 |
| Present Value for whole term (WACC = 6%) | 46,339 | 2,618 | 152,102 | 3,085 | - 37,957 | - 770 |
| Internal Rate of Return (IRR) | 8.2% | | 8.5% | | 5.1% | |
| | **Total** | **/ planted ha** | **Total** | **/ planted ha** | **Total** | **/ planted ha** |
| Net Pre-Tax Logs + Carbon Undiscounted | 955,658 | 31,644 | 2,851,276 | 47,921 | 1,446,640 | 24,313 |
| Present Value of free cashflow (WACC = 6%) | 91,712 | 3,037 | 283,173 | 4,759 | 120,362 | 2,023 |
| Internal Rate of Return (IRR) | 11.0% | | 11.4% | | 8.9% | |

# Impact on the Dairy Enterprise

The impacts of the proposed land use change to forestry on the dairy enterprise are summarised below.

## MILK PRODUCTION

Total milk production for **Scenario 1 only decreased 7,000 kg MS** compared to the base scenario, reflecting lower productivity land being changed to forestry (refer to Table 3). The loss of overall pasture production is partially offset by increased per cow production due to dairy consolidating onto the better land with higher feed quality. These improvements are reflected in per hectare milk production and pasture eaten increasing by 8.2% (1,068 kg MS) and 7% (+0.7 t DM), respectively.

**Table 4.** Summary of physical performance indicators for the dairy enterprise only.

| Farm Parameters | Status Quo | Scenario 1 | Scenario 2 & 3 |
|---|---|---|---|
| Effective pastoral area (ha) | 276.2 | 248.4 | 216.7 |
| Peak cows milked | 720 | 690 | 600 |
| Stocking rate (c/ effective grazing ha) | 2.58 | 2.75 | 2.74 |
| Production | 275,000 | 268,000 | 234,000 |
| *per hectare (kg MS/ha)* | 987 | 1,068 | 1,068 |
| *per cow (kg MS/cow)* | 382 | 388 | 390 |
| **Feed eaten** | | | |
| Dry Matter Intake (DMI)/ha | 15.1 | 16.3 | 16.4 |
| Imported feed eaten (t DM/ha) | 4.3 | 4.7 | 4.6 |
| Winter grazing (t DM/ha) | 0.9 | 1.0 | 1.0 |

**Scenario 2 & 3's** production per hectare and feed eaten indicators were consistent with Scenario 1. However, removal of a further 21.7 hectares reduced **total milk production by 17.5% (-41,000 kg MS) compared to the base system**. Scenarios 2 & 3 provide for the higher net returns from forestry and reduce livestock emissions and contaminant losses (GHG and water contaminants) compared to Scenario 1.

## PROFITABILITY

**Scenario 1 has 2.5% reduction in total cash operating surplus (-$12,913)** from farming but higher cash returns on a per hectare basis (refer to Table 5). The removal of the less productive land provides a higher margin per hectare. Overhead costs remain relatively unchanged due to a smaller milking platform, but variable costs relating to the land and cows proportionately decrease.

**Table 5.** Summary of financial performance indicators for the dairy enterprise only.

| Farm parameters | Status Quo | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| Gross farm income ($/ha) | $6,529 | $7,061 | $7,057 | $7,057 |
| Farm working expenses ($/ha) | $4,674 | $5,052 | $5,142 | $5,142 |
| Total dairy cash operating surplus | $516,674 | $503,761 | $419,540 | $419,540 |
| Change from base system | | -$12,913 | -$97,135 | -$97,135 |
| Cash operating surplus per ha | $1,855 | $2,008 | $1,915 | $1,915 |

**Scenario 2 has a large drop in dairy cash operating surplus (-$97,135 or -19%)** with more trees and a smaller dairy platform. As some of the operating expenses show little to no change (e.g. overheads, management labour) the reduction in profit is greater than the reduction in milk production (-18.8% vs -17.5%). This highlights a loss of scale and ability to dilute fixed expenses.

With less free operating cash flow available it is important to understand whether the business still generates enough cash to meet debt repayment, CAPEX requirements, and ultimately the cash the Holdem's want to draw from the business. **To remain viable the business would need to operate with less debt than either the base system or Scenario 1.**

# Environmental Performance

### *Water Contaminant Losses (Nitrogen and Phosphorus)*

**Scenario 1** demonstrated a small reduction in total N loss relating to reduced milk production (-2.5%), pasture eaten (-3.9%), and fertiliser N use (-1.5%). This scenario **achieves compliance for the farm's 2022 NDA but would require further reduction and system change by 2027 and 2032.** Assuming an N value of $200/t, this represents a capital cost to the business of approximately $1,003,400 directly by purchasing NDA (as modelled) or indirectly through the cumulative impact of implementing farm system changes. **Scenarios 2 and 3 have a much larger reduction in total N leaching due to the retirement of productive land to forestry (from 65 to 3 kg N/ha)**. These two scenarios are compliant under the farm's 2027 NDA and would not require further changes until 2032. **The current market value of the reduction in NDA liability is $657,200 (3,286 kg N x $200/kg).**

Reported **P loss** decreases by 0.4 and 0.7 kg P/ha for Scenario 1 and Scenarios 2 and 3, respectively. These reductions primarily relate to reduced P fertiliser use and exclude any reductions associated with improving land stability and providing contaminant buffers. The ecosystem service provided by the later changes are not costed in the analysis but would provide meaningful benefits to Lake Rotorua.

### *Biological Greenhouse Gas (bGHG) Emissions*

**Biological greenhouse gas emissions at a whole property level reduced by 266 t $CO_2$ eq./yr for Scenario 1 and 596 t $CO_2$ eq./yr for Scenarios 2 and 3,** mostly from lower methane emissions (less feed intake), but also less nitrous oxide emissions (less N fertiliser use). Assuming these emissions were similarly priced to carbon NZUs, this **would save the business $14,900 per annum at $25/t $CO_2$e.**

Figure 1 provides the net accumulated emissions, accounting for reduced bGHG emissions and the safe tradeable carbon if not sold, for the three forestry scenarios compared to the base system. The **safe carbon claims provide a modest short-term offset** while operating fewer livestock provides for significant long-term reductions. Scenario 3, with the inclusion of redwoods, provides the largest potential offset, almost twice as much as Scenario 2; and 5 times the amount of Scenario 1.

**Table 6.** Summary of water contaminant losses.

| Nitrogen and Phosphorus | Status Quo | Scenario1 | Scenarios2&3 |
|---|---|---|---|
| Total Farm N Loss (kg N) | 20,184 | 19,368 | 16,898 |
| N Loss/ha (kg N/ha) | 65 | 63 | 55 |
| N surplus (kg N/ha) | 182 | 178 | 154 |
| Kg MS/kg N leached | 13.6 | 13.8 | 13.9 |
| Total Farm P Loss (kgP) | 799 | 673 | 580 |
| P Loss/ha (kgP/ha) | 2.6 | 2.2 | 1.9 |

** Environmental indicators are reported from OVERSEER FM v6.3.2 and against the total farm area.*

**Table 7.** Summary of water contaminant losses.

| Greenhouse gases | Status Quo | Scenario1 | Scenario 2&3 |
|---|---|---|---|
| Total biological GHG (t CO2 eq./ha/yr) | 9.8 | 9.4 | 8.2 |
| Methane (t CO2 eq./ha/yr) | 7.7 | 7.4 | 6.4 |
| Nitrous oxide (t CO2 eq./ha/yr) | 2.1 | 2 | 1.8 |
| GHG emissions efficiency (kg CO2 eq./kg MS) | 11.6 | 11.4 | 11.3 |

*** Averaged across forests lifecycle*

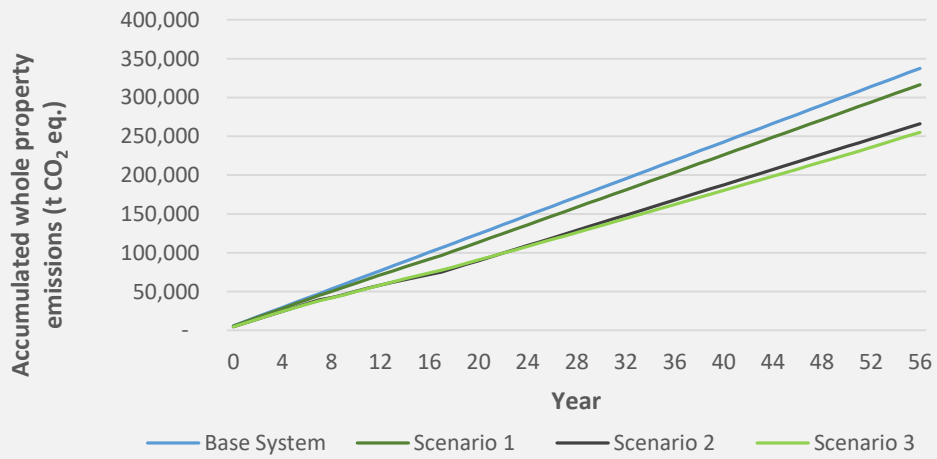



**Figure 1.** Comparison of accumulated bGHG emissions over time.

# Whole Farm Business Analysis

**Scenario 1** with the 17.7 ha of pines and 12.5 ha of permanent retirement was the most profitable integration option, with an aggregate net present value ("NPV") from the farming and forestry enterprises over 56 years essentially the same as that of present farming operation. This option also had an **internal rate of return (IRR) of 15.6% - 0.4% greater than that of the base farming enterprise**. Total **equity is also expected to be $625,000 higher by the end of the first rotation than the dairy farming operation** (refer to Figure 2). This is because forestry provided similar returns to dairy on the poorer quality land and reduced N losses to the extent additional rights to pollute or a more costly system change to lower annual N losses would not be necessary.

Scenarios 2 and 3 had an additional 31.6 ha of forest area on highly productive pasture as well as marginal paddocks. Over the 56 year period analysed the projected profits from **timber and carbon revenues were found to be insufficient to offset the lost dairy farm profits from either scenario**, even after accounting for the financial benefit of lower N loss to water arising due to less dairy area. Furthermore, at current carbon prices, more tradeable carbon from the redwood plantings did not compensate for the lack of timber income (such as that earnt from the radiata woodlot). However, higher carbon prices and inclusion of redwood timber revenues from continuous cover harvesting would increase the relative profitability of this forestry option.

The **17 % reduction in annual methane and nitrous oxide emissions from the land use change in Scenarios 2 and 3** may also have significant value if legislation requires farmers to monetarise their biological greenhouse gas emissions.

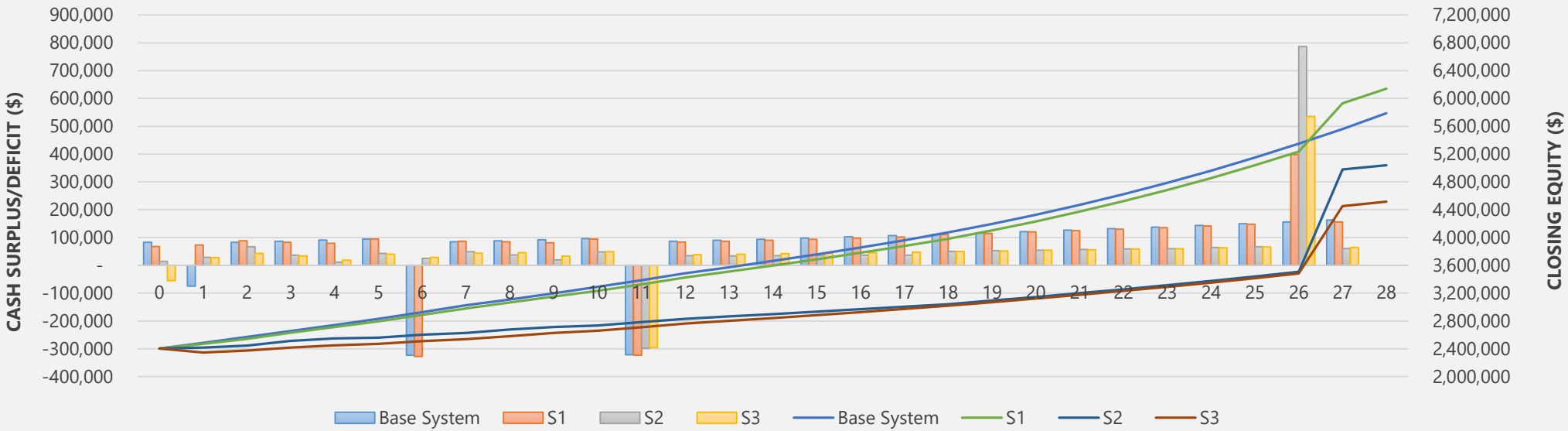



**Figure 2.** Comparison of total business cash surplus/deficits before principal repayments (LH axis, bars) and closing equity position (RH axis, line) for the three forestry scenarios compared to the base system including the sale of carbon. Note average closing liabilities ($24.51/kg MS) were sourced from the 2017/18 DairyNZ Economic Survey, allowing the farm's actual debt and equity position to remain undisclosed.

# Summary

- **Scenario 1 provides the closest alignment to the owner's objectives,** has the highest IRR and equity growth with minimal impact to cash flow provided One Billion Trees Fund (1BT) and BOPRC grants are used. Productivity differences between pasture and trees on various land classes highlight an opportunity to retire poor quality land and achieve productivity increases through an alternative land use. The scenario demonstrates a business that is more diversified, financially robust and environmentally resilient.

- The case study **highlights the multiple dimensions of evaluating how to best integrate trees** into a pastoral farm business. Land owners need to bring together a wide range of advice to consider the options and support high quality tree planting outcomes.

- **Tree planting grants** such as those assumed to be available from the One Billion Trees Fund would **alleviate cash flow constraints** providing farmers with the option to convert marginal land, lower environmental losses and diversify income streams with limited impact on farm profitability

- It is important to understand current performance to plan how the business is best positioned to meet environmental challenges. **Including the cost of environmental externalities (N and P loss to water, bGHG emissions) and the benefit tree plantings provide is crucial for evaluating the integration of trees on farm.** At current prices (N and carbon), there is a clear benefit from retiring poorer quality land into trees. However, if cost to offset dairy N losses and GHG emissions increase significantly, further land retirement and tree planting may support land use optimisation and the attainment of businesses objectives.

- Tree planting is once in a generation decision and poor choices can dramatically impact results. The long term nature of tree planting, means planning is crucial. Key considerations include cash flow and cost of capital over time, and how these align with the owner's objectives at various stages of the investment life cycle.

- The planning and analysis provided in this case study demonstrates the integration of the **Right Tree** in the **Right Place** to achieve the **Right Purpose**: optimising land use while meeting environmental obligations, improving animal welfare through the provision of shade and shelter. Retiring marginal land would also diversify income, improve farm aesthetics and the long-term value of the business.

# Project Details

Name: Integrating Forestry for Profitable and Sustainable Land Use

Completed by: perrin ag NEW ZEALAND AGRI-BUSINESS ADVISORS

Subcontractor: PF OLSEN NEW ZEALAND

Funded by: Te Uru Rākau Forestry New Zealand

Co-funders:

DairyNZ

LIVING WATER

Fonterra Dairy for life

Department of Conservation Te Papa Atawhai

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

FOREST GROWERS RESEARCH

horizons REGIONAL COUNCIL

Farmlands co-operative