Waipā / Taumata Farming Partnership Ltd (#2)

Integrating Forestry for Profitable and Sustainable Land Use

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With funding support from
Te Uru Rākau
Forestry New Zealand

Executive Summary

- Taumata Farming Partnership Ltd is a 262.8 ha effective farm property located in Pukeatua, Waipā.
- Two scenarios (S1 & S2) evaluated radiata, eucalypt and native plantings on 21.3 ha of pastoral land.
- The high level of pasture grown indicated neither scenario could outcompete the base system with IRR and equity at year 56 reduced for both scenarios.
- Incorporation of trees, largely on the drystock support unit, creates greater flexibility within the farm's N loss limit to increase production on the remaining farm area.
- Biological GHG emissions reduced under both scenarios providing a pathway to achieve on farm contribution to national targets. This reduction, however, needs to be weighted against the economic performance of land use change.
- One Billion Tree's grants or similar are assumed to be available. These can help alleviate cash flow constraints that occur from capital intensive land use change. However, a strong balance sheet is also required to ensure financial obligations can be met.
- Planning and intergenerational thinking are key to long-term investment opportunities. Capital costs and changes to cash flow need to be considered along with personal and environmental factors.
- Planning for right tree, right place and right purpose is fundamental in achieving landowner objectives.

Table 1. Key physical, financial and environmental metrics for the base system and forestry scenario's modelled for Taumata Farming Partnership Ltd.

	Base system	Scenario 1 & 2
Effective area converted to trees (ha)	-	21.3
Dairy	157.5	▼ 1%
Drystock	105.4	▼ 18%
Dairy production (kg MS)	174,840	▼ 1%
Drystock production (kg product sold)	35,204	▼ 16%
IRR%	39.4%	▼ 1%
Equity at Year 56 (incl. sale of carbon)	-	▼ 6% / ▼ 11%
Total N leaching loss (kg N/yr)	7073	▼ 5%
Biological GHG (t CO2 eq./ha/yr)	7.7	▼ 6%

Case Study Overview

This case study illustrates the impact of integrating various forestry options into a mixed dairy and drystock farm business. Two options were investigated in line with the owner's farm and farming aspirations. Financial and environmental analysis demonstrate the impact on potential returns, change to the farm's environmental footprint, and total farm business performance. 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 past three seasons 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 two land classes (gullies and sidlings and the low producing steep to very steep areas) 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, drystock 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 7-12

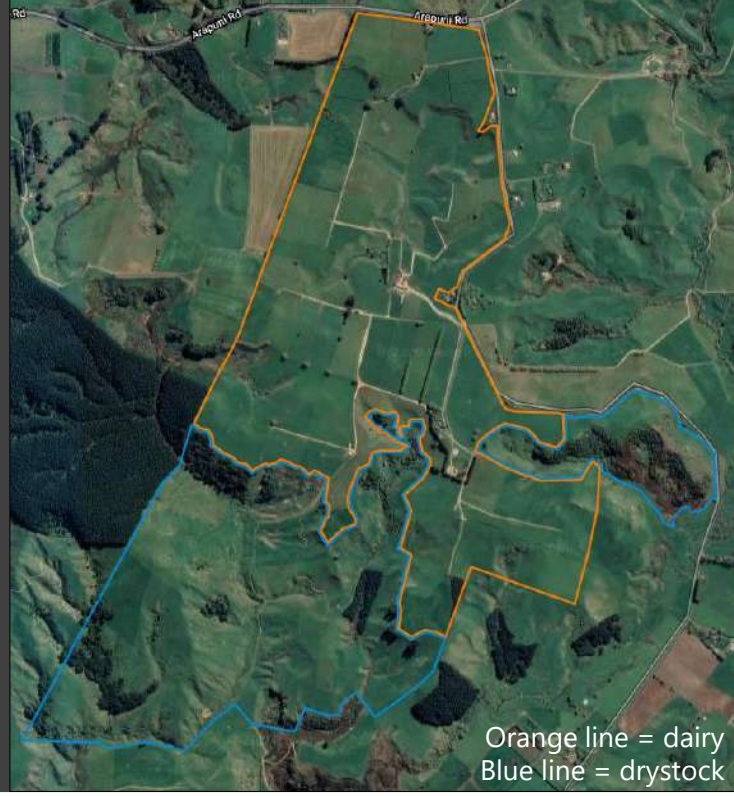
Farm Overview (Status Quo Farm System)

Taumata Farming Partnership Ltd is a 308.7 ha family business, owned by Doug and Kathy Wallace, based in Pukeatua, Waipā 24 km South East of Te Awamutu. The 262.8 ha effective property includes 157.5 ha of dairy and 105.4 ha of drystock. There are 10.3 ha of native and riparian plantings and 7 ha of *Pinus radiata*. The dairy unit consists of flat to rolling land while the drystock block is a mix of easy hill and steep land.

Significant development work has been completed by the Wallace's including extensive riparian planting, retirement of sidelings, creation of wetland catchments, upgrades to farm races and increased riparian buffer strips. The owners are now interested in exploring how further integration of trees can support their continuing environmental work, increase farm performance and operational efficiency.

Other farm business goals are to:

- Optimise land use on marginal/steeper areas while meeting environmental obligations.
- Reduce total farm contaminant loss.
- Develop the farm asset to provide opportunities for future generations.



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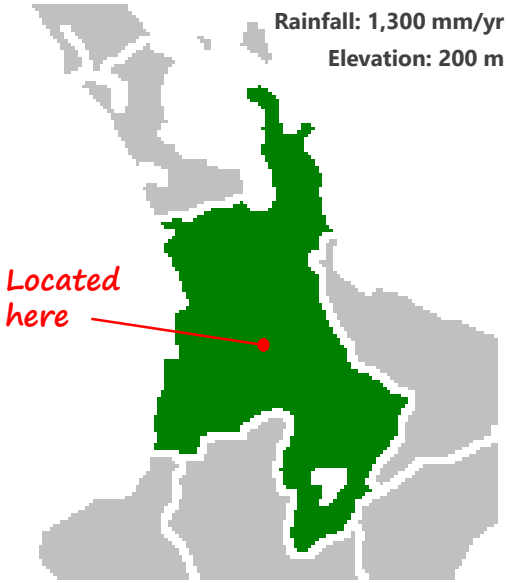

Farm Details

Whole farm (ha)	**308.7**
Effective pasture (ha)	**262.8**
Soil type	**Mairoa ash, Oronoko & Airfield brown soils**
Total milk production (kg MS)	**173,000**
Total meat and wool (kg)	**35,204**
Avg. pasture production (t DM/ha)	**13.2 (7.3-16.1)**

Livestock Details

Breed type	**Crossbred**
Dairy herd size	**470**
Production per cow (kg MS)	**372**
Stocking rate (cows/ha)	**3.0**
Drystock stocking rate (SU/ha)	**13.2**
Sheep:cattle ratio	**26:74**
Lambing %	**138**

Performance Indicators

Production per hectare (kg MS/ha)	**1,112**
Operating profit ($/ha)	**1,365**
Return on asset (ROA%)	**4.5**
N leaching overall (kg N/ha/yr)	**23**
Dairy N efficiency (kg MS/kg N loss)	**36**
Drystock N efficiency (kg meat & wool/kg N loss)	**15**
Biological GHG emissions (t CO_2 eq./ha)	**7.7**

Factors Motivating Tree Planting and Land Use Change

Physical Constraints

- Steep areas of north facing, browntop dominated slopes have peaky production with minimal growth in summer/winter and flushes in spring which are difficult to control. Management of gorse and hawthorne on these and recently retired areas is an issue due to low grazing pressure and is costly and time consuming to control.
- Tributaries of the Puniu River and Mangapiko Stream which ultimately feed the Waipā RIver all begin on farm and need careful management. The Owairaka Stream begins from a spring within the steep hill slope of the drystock unit and flows along the base of the hill before exiting the farm. Slope is over 25° for most of the waterway making fencing off the stream challenging and impractical.
- The Wallace's would like to retire these steeper contoured areas from grazing and continue to plant with natives or other species. The question arises: **"What would be the impact on the farm system if these less productive areas were retired and planted in trees?**

Environmental Constraints

- The farm operates in the Waikato catchment under Regional Plan Change 1. In 2016, approval was obtained for resource consent for land use change. One of the key conditions of the consent is the farm must comply with a leaching loss rate estimated by OverseerFM from quantifiable inputs detailed in the property's Farm Environmental Plan (FEP).
- 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. Key opportunities relate to retiring low quality land to reduce N and P loss, planting up waterways to mitigate sediment and phosphorus runoff and providing income from log sales and carbon sequestration 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 Taumata are explored. The property is characterised by three distinct land types: the highly productive flat to rolling land in dairying and the easy hill country in drystock, the retired but unutilised gullies and sidlings, and the low producing steeper land in drystock and reverting scrub.

Gullies and sidelings

- The property includes 20 ha of gullies and steeper sidlings which have poor productivity due to shading, shallow topsoil, low soil fertility and moisture holding capacity. The gullies contain steep upper slopes, lower slopes, flats and gully bottoms that the right tree species need to be matched with. While the land is stable, soil movement typically relates to livestock tracking.
- Difficulty with access and the small scale of these broken up gullies and sidlings makes timber harvesting prohibitive. As such, these areas are better suited to native planting for environmental protection, biodiversity benefits and carbon return.

Steeper low producing land

- Around 33% of the effective farm area comprises steep and very steep country estimated to grow 7.3-8.0 t DM/ha. Included in this area is 33.5 ha of unimproved hill country at an average slope of 29.7°. The impact of planting timber woodlots on some of this country was explored with *Pinus radiata* and *Eucalyptus fastigata* species considered.
- Where topography precluded harvesting, native trees were used to provide biodiversity, soil protection and potentially carbon income, rather than timber. Mānuka (*Leptospermum scoparium*) was used as a nurse species to aid establishment of other mixed native plants given the farm's gorse problem.

Integrated Forestry Analysis

The Wallace's are interested in considering two timber options - ***Pinus radiata*** which has an established market and ***Eucalyptus fastigata*** as an alternative species with enhanced aesthetic appeal. Radiata aligns with the Wallace's goals of improving business performance. Eucalypts tend to grow best on low altitude, fertile and relatively sheltered sites with good drainage and regular rainfall, although this can vary between species. Additional **native plantings** are also considered for areas prohibitive for timber harvesting.

Two scenarios were tested to evaluate the integration of forestry. Afforestation was classified as either timber woodlot 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 assumed to be available for planting, plus any carbon revenue that would accrue over time if eligible for the ETS.

For this case study Te Uru Rākau direct grants were assumed to be secured to support planting. Costs for natives were based on the landowner completing planting themselves over three years. The cost of seedlings assumed a small number of species to keep planting costs at the lower end of the range for natives. Follow up weed and pest control for two years after planting did not include grant support.

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

Planning Considerations

Three dimensional map of the steep hill planting site (dark green shaded area) on the drystock block. Red line indicates the new road upgrade required. Blue line indicates the Owairaka Stream. Light green shaded area indicates riparian buffer. Imagery sourced from QGIS.

Planning of woodlots needs to involve consideration of site characteristics on tree growth and how future harvesting will be carried out. On Taumata, the majority of woodlot plantings are on steep hill slopes where log yield is likely to be less than that grown on flat to rolling country due to poorer soil fertility and moisture holding capacity. Log quality, however, can be greater due to slower growth rates.

Future harvesting of the hill site on Taumata (shown above) is likely to require uphill extraction to a skid site given the narrow area between the base of the slope and the Owairaka Stream. This will require additional harvest costs and 600 m of new roading to provide access to the skid site at the top of the hill. Where these challenges exist, landowners should evaluate whether the scale of planned woodlots is large enough to dilute fixed costs (especially regarding roading). Consideration of environmental responsibilities (e.g. setbacks from waterways) should also be given to planting sites and owners should consult the National Environmental Standards for Plantation Forestry (NES-PF, 2018).

Distance to port or processor is another key consideration when planning woodlots as this will have a large impact on profitability, particularly for small stands. For Taumata, several local processors for radiata and eucalypt logs are located within 30-55 km of the farm, and the Port of Tauranga is 100 km away.

Scenario Design

Scenario 1 – Pinus Radiata

Scenario 1 includes planting 27.9 ha of marginal steep land in radiata woodlots and native plantings. This comprises 5.9 ha of sidelings and gullies on the dairy unit and 22 ha of steep hill slopes and gullies on the drystock unit. A combination of **woodlots (20.5 ha), native (6.3 ha) and riparian planting (1.1 ha)** is used to support '**right tree, right place and right purpose'.** The woodlot areas are all located on the steeper but more easily accessible farm areas. A 5 m wide riparian setback planted in natives is included to mitigate the risk of contaminant and debris loss at harvest where the Owairaka stream flows at the base of the woodlot. *Pinus radiata* stands are planted at 800-850 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 smaller gully networks and areas where scale and farm access are prohibitive for harvesting timber.

Changes to the dairy enterprise include a reduced pastoral area to 155.2 ha. Cow numbers reduced by 6 to a peak of 464. Per cow productivity was assumed to remain at 372 kg MS/cow with total production reduced by 2,232 kg MS.

On the drystock unit pastoral area reduced by 19 ha to 86.4 ha. Pasture growth was estimated to increase by 3.5% on a per ha basis due to the reduced proportion of marginal land. Dairy heifer numbers remained unchanged while breeding ewes were removed from the system. Additional trade lambs were bought in from December to utilise surplus feed. Total product sold (kg meat and wool) reduced by 5,702 kg.

Over the whole property, total **pastoral area reduced by 8%** to 241.6 ha.

Table 2. Physical summary of the scenarios on the **drystock unit**.

Drystock Farm Parameters	Base System	Scenario 1 & 2
Effective pastoral area (ha)	105.4	86.4
Timber Woodlots - Pinus Radiata and/or Eucalyptus	7.0	21.6
Native (ha)	10.3	16.6
Riparian (ha)	0.0	1.1
Stocking rate (SU/ha)	13.2	13.2
Sheep SU	361	108
Cattle SU	1,028	1,028
Liveweight wintered (kg/ha)	479	385
Meat and wool produced (kg/ha)	334	341
Pasture eaten (t DM/ha)	7.14	7.04

Scenario 2 – Mixed Woodlot

Scenario 2 considers planting the same 27.9 ha used in Scenario 1 into a mix of ***P. radiata* (15.1 ha)** as well as ***E. fastigata* (5.4 ha)** recognising the land owners preference for species with greater aesthetic appeal. *E. fastigata* was grown under a pulp regime at 1,100 stems/ha with two form pruning's at 5 and 7 years and no thinning. *E. fastigata* was chosen for pulp over alternatives such as *E. nitens* for superior *Paropsis charybdis* (eucalyptus tortoise beetle) resistance, despite potentially slightly lower growth rates and poorer form. Close proximity to Kinleith for pulp processing was a factor in the decision to use *Eucalyptus*.

When selecting areas for planting, farmers should consider the advantages and disadvantages of taking out a whole paddock or shifting fence lines and just planting up the steeper, lower-productive areas. Factors such as cost of fencing, stock movement, lost pasture production and future weed control as well as the total size of the area planted in relation to grant and ETS eligibility should all be considered in the decision-making process.

Results of Forestry Scenario Analysis

Table 3 summarises the investment outcomes from two full forest rotations (plan, grow, harvest, replant, grow, harvest), excluding and including carbon revenues.

Scenario 1 – Pinus Radiata

The net pre-tax undiscounted return from timber plantings only and excluding carbon was **$47,376/woodlot ha.** On an annual basis this would be equivalent to $3,145 ($153/woodlot ha) in present value from the 20.5 ha planted. Applying a discount rate of 6% to the investment provided a positive present value of $50,412 or $2,460/woodlot ha and an internal rate of return **(IRR) of 8%** over the 56 year period.

Including the "safe tradeable carbon" from the woodlots sold between year 8 (the point at which carbon can be claimed from radiata stands grown assuming availability of One Billion Trees grants) and year 17 (the "average age" of a *P. radiata* forest grown under a 28 year rotation) along with the carbon captured from eligible native plantings up to year 48 (point at which sufficient carbon worth selling has been sequestered), then the present value of free cash flow over the 56 year period increases to $92,654 ($3,328/planted ha). The **IRR** generated from this investment also **increases to 9.7%** and provides an equivalent annuity of $5,780 ($208/planted ha).

Scenario 2 – Mixed Woodlot

Inclusion of 25% of the woodlot area in ***Eucalyptus*** provides **lower revenue per hectare**. While expenses were estimated to be $18,500 less for this scenario the income was also $283,600 less so that net pre-tax proceeds for timber alone was **$32,190/woodlot ha**, equivalent to $668 per annum ($33/woodlot ha) in present value.

The **lower log returns reflect the lower value pulp regime**. Applying a discount rate of 6% to the whole term provided a positive present value of $10,700 ($522/woodlot ha) and **IRR of 6.5%.** Inclusion of the net cost of native establishment reduced the proceeds to $31,155/ planted ha and provided an IRR of 5.7%, the lowest for either scenario.

If the **"safe tradeable carbon" is sold**, the net pre-tax return (logs + carbon) increases to $73,640 ($2,645/ha) and **provided an IRR of 9.6%** similar to Scenario 1. These figures use a $25/NZU carbon price. The IRR lifts by 0.11% for each $1 lift in the NZU under Scenario 1 and by 0.17% for Scenario 2.

Table 3. Summary of individual investment performance for each scenario.

Planted Area	**Scenario 1 27.8 ha**		**Scenario 2 27.8 ha**	
Area in P. radiata woodlot	20.5	ha	15.1	ha
Area in eucalyptus woodlot	-	ha	5.4	ha
Area in native and riparian	7.4	ha	7.4	ha
Area in ETS qualifying native and riparian	*6.5*	*ha*	*6.5*	*ha*
Returns over two rotations (56 years)	**Total**	**/woodlot ha**	**Total**	**/woodlot ha**
NET PRE-TAX LOGS	970,739	47,376	659,568	32,190
Present Value for whole term (WACC = 6%)	50,412	2,460	10,700	522
Internal Rate of Return (IRR)	8.0%		6.5%	
	Total	**/planted ha**	**Total**	**/planted ha**
NET PRE-TAX LOGS AND NATIVE PLANTING (undiscounted)	903,855	32,466	638,672	22,941
Present Value for whole term (WACC = 6%)	25,324	910	- 7,622	- 274
Internal Rate of Return (IRR)	6.9%		5.7%	
	Total	**/planted ha**	**Total**	**/planted ha**
NET PRE-TAX LOGS, NATIVE PLANTING & CARBON (undiscounted)	1,073,361	38,555	828,493	29,759
Present Value of free cashflow (WACC = 6%)	92,654	3,328	73,640	2,645
Internal Rate of Return (IRR)	9.7%		9.6%	

Impact on the Farm Enterprise

MILK PRODUCTION

Total milk production for Scenario 1 and 2 decreased by only 2,232 kg MS reflective of the small area (2.3 ha) taken out of the dairy platform. This area was taken out as it was a poorer performing paddock surrounding a retired gully and was required to make up a minimum one hectare planting area. The decrease in dairy area and hence total pasture eaten equated to a reduction of six cows with production per cow remaining unchanged.

DRYSTOCK PRODUCTION

The removal of 19.3 ha of steep country equated to an annual reduction of 144 t DM which required the removal of the breeding ewe enterprise and reducing sheep stock units. Replacement heifer numbers remained unchanged, while trade lambs purchased increased from 100 to 240.

PROFITABILITY

Table 4. Summary of financial performance indicators for Taumata.

Farm parameters	Base system	Scenario 1 & 2
Gross farm income ($/ha)	$3,879	$4,074
Farm working expenses ($/ha)	$2,111	$2,220
Total cash operating surplus	$464,909	$447,971
Change from base system		-$16,938
$/ha	$1,768	$1,854

Scenario 1 and 2 generate a 3.6% reduction in total cash operating surplus (-$16,938) from the farming enterprise (excluding forestry returns) but provide 4.8% higher cash returns on a per hectare basis. This is achieved through the removal of the less productive land and allows a higher per hectare margin to be generated. Overhead costs remain relatively unchanged despite a smaller farming platform, while variable costs relating to the land and livestock proportionately decrease.

With a smaller farming operation and less free operating cash available it is important to consider the impact to the business on the capacity to pay debt, tax and capital expenditure requirements, as well as the ability to draw from the business. This highlights the impact of a loss of scale and ability to dilute fixed expenses.

Environmental Performance

Water Contaminant Losses (Nitrogen and Phosphorus)

Scenario 1 and 2 both demonstrated a 3% and 6% drop in N loss from the dairy and drystock units, respectively, and a **reduction over the whole farm of 5%.** Reductions in N loss from the dairy system were small as cow numbers, milk production and fertiliser inputs remained relatively steady. The drystock unit had greater reductions in N loss due to the larger conversion of productive pastoral area to forestry and the associated removal of the breeding ewe enterprise, pasture eaten and N fertiliser use. The **reduction in N loss (325 kg N) achieved** from the scenarios provides a **greater buffer** between the N required to operate the farm system and the N loss limit allowed under the farm's resource consent. This provides **increased flexibility** in the farm operation allowing for greater production to be achieved from the remaining pastoral land.

OverseerFM modelled a **9% decrease in P loss** for Scenario 1 and 2. These reductions relate to 57 kg/ha less P fertiliser use on the steep hill blocks. Further reductions (not modelled in OverseerFM) would also be expected from **reduced overland flow** from areas planted in native due to **less stock tracking**, **reduced exposure of bare land, improved land stability** and provision of **contaminant buffers**.

Biological Greenhouse Gas (bGHG) Emissions

Biological greenhouse gas emissions at a whole property level **reduced by 0.5 t CO_2 eq./ha/yr (-6.5%)** in Scenario 1 and 2 compared to the base system. This resulted primarily from **lower methane emissions** due to **fewer stock** and **reduced feed intake**. A small reduction in nitrous oxide was attributed to the loss of grazed land and **reduction in nitrogen fertiliser** use. Improvements in greenhouse gas emissions efficiency were modelled across the farm with total dairy emissions per kg MS reducing by 2% and total drystock emissions per kg of product sold reducing by 6.5%.

Overall, biological emissions reduced by 159 t CO_2 eq./yr to 2,190 t CO_2 eq./yr. Pricing these emissions similar to carbon NZUs ($25/t), **would save the business $3,975 per annum** if the carbon was, in future, able to be used as an **offset against farm emissions.**

Total carbon claimed for Scenario 2 (8,198 t) was greater than for Scenario 1 (7,444 t) due to the inclusion of eucalypts which sequester carbon at a faster rate than radiata initially and provide tradeable carbon in the first six years (compared to radiata grown with One Billion Trees grants). Both scenarios include 2,088 t of native carbon claims.

Table 5. Summary of N and P losses.

Nitrogen and phosphorus	Base system	Scenario 1 & 2
Total farm N Loss (kg N)	7,073	6,748
N loss/ha (kg N/ha)	23	22
N surplus (kg N/ha)	141	129
N conversion efficiency	22%	25%
kg MS/kg N loss from dairy unit	36.2	37.6
kg product sold/kg N loss from drystock unit	15.1	13.5
Total farm P Loss (kg P)	301	274
P loss/ha (kg P/ha)	1.0	0.9

Table 6. Summary of greenhouse gas emissions.

Greenhouse gases	Base System	Scenario 1 & 2
Total biological GHG (t CO2 eq./ha/yr)	7.7	7.2
Methane (t CO2 eq./ha/yr)	6.1	5.7
Nitrous oxide (t CO2 eq./ha/yr)	1.6	1.5
GHG efficiency on dairy unit (kg CO2 eq./kg MS)	11.9	11.7
GHG efficiency on drystock unit (kg CO2 eq./kg product sold)	16.8	15.7

Whole Farm Business Analysis

The **improvement in per hectare productivity** from converting the most marginal land to forestry and native means the IRR for the farm enterprise increases for both scenarios modelled relative to the base system. However, the integration of forestry and native planting on farm, modelled in both scenarios, **reduces total farm business profitability** compared to the base system whether carbon is included or not.

Scenario 1 with carbon excluded provides a projected equity at Year 28 comparable to the base system at $3.7 million. In contrast, the lower income from eucalypt woodlots in Scenario 2 results in a 7% decrease in equity after the first rotation. Sale of carbon improves the equity position considerably for both forestry analyses with **Scenario 1 generating a 5% increase in equity** and **Scenario 2 providing comparable equity with the base system**. This, however, is a **short term gain only** as safe carbon from woodlots can only be sold in the first rotation.

By Year 56, the cost of replanting and tending to the woodlot stands for a second rotation assuming no further planting grants or carbon revenue results in equity reducing by 6% and 11% for Scenario 1 and 2, respectively, compared to the base system. The significance of the change in equity levels at the end of different investment periods will depend on the business owner's approach to the investment. For the Wallace's, it may be that while the decline in equity over a long-term period is not desirable from a financial aspect the benefits from an environmental and compliance perspective may still outweigh this.

Scenario 1 and 2 deliver a 12% and 13% reduction in accumulated biological emissions, respectively, over the 56 year period relative to the base system. If legislation required farmers to account for their GHG emissions then this may provide significant value to the business.

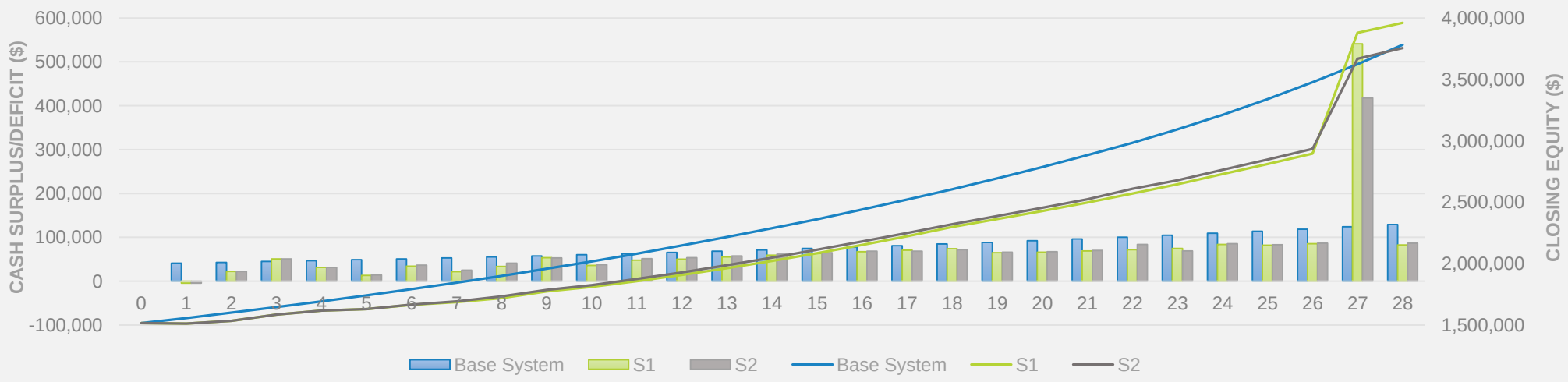

Figure 1: Comparison of total business cash surplus/deficit before principal repayments (LH axis, bar) and closing equity position (RH axis, line) for the two forestry scenarios compared to the base system including the sale of carbon. Note average closing liabilities ($24.92/kg MS) were sourced from the 2018/19 DairyNZ Economic Survey, allowing the farm's actually debt and equity position to remain undisclosed.

Summary

- The base farm system provides the greatest wealth creation and return on investment over the 56 year period of all scenarios modelled and reflects the high productivity land classes on the property.

- The **inclusion of carbon sales improves the equity position after the first rotation** for both scenarios, and for Scenario 1 generates a 5% growth in equity. However, by Year 56 (two rotations) total equity is reduced for both scenarios (6% - 11%) compared to the base system. Decisions around the incorporation of trees on farm in these scenario's is therefore likely to depend on the environmental and compliance benefits of plantings as opposed to financial gains. Given that Taumata operates under a nitrogen loss limit, the reduction in N modelled under both scenarios provides greater flexibility over the remaining farm system with potential to add value to the farm business. In addition, the reduction in biological GHG emissions highlights the potential **for forestry as a tool to support farm level contribution to national reduction targets**. This reduction also becomes more valuable if pastoral agriculture has to account for biological emissions.

- **Tree planting grants** assumed to be available from One Billion Trees or similar grants would help to **alleviate cash flow constraints** providing farmers with the option to convert marginal land, achieve lower environmental losses and diversify income streams with reduced impact on cash flow. These grants are important when considering that **establishment costs** may put the farm in a position where debt servicing is no longer possible.

- **ETS eligible native plantings** provide an alternative afforestation option to timber trees, require **less upfront capital investment**, particularly if planted using funding from grants, and provide carbon revenue for at least the first 50 years of growth (albeit at a slower rate than exotic timber species). Natives therefore present another option for difficult to manage marginal land that is prohibitive for timber harvesting or where business' are capital constrained.

Definitions

Actual LWT (Liveweight)	Actual average liveweight of the herd in December.
Stocking rate (SU/ha)	Stock units per hectare based on 550 kg DM eaten per year.
Pasture eaten (t DM/ha)	Measures how much pasture grown that is being eaten and is measured in kilograms or tonnes of dry matter per hectare, standardised at 11 MJ ME/kg DM.
kg DM	Kilograms of dry matter.
kg MS	Kilograms of milk solids (fat + protein).
kg meat and wool	Net increase in kilograms of meat (eg beef/lamb/mutton) and wool grown on farm.
Crossbred	Refers to the progeny of crossing Friesian-Holsteins with Jerseys to produce an animal midway in size between the two parents and with the advantages of both.
Nitrogen loss	An estimate of the N that enters the soil beneath the root zone (>60 cm), expressed as kg N/ha/year.
N surplus	The quantity of N supplied that exceeds plant requirements.
Greenhouse gas emissions (GHG)	Greenhouse gases on a whole farm basis expressed as CO_2 equivalents.
Biological greenhouse gas emissions (bGHG)	A measure of methane (CH_4) and nitrous oxide (N_2O) emitted from a farm as CO_2 equivalents. CO_2 from electricity, fuel, and fertiliser manufacturing is excluded because a levy is applied by the supplier and included in the cost of goods.
FWE (farm working expenses)	Direct farm working costs including owner operator remuneration before depreciation and financial costs.
Operating profit	A measure of farm profitability used for benchmarking comparison between farms. Dairy operating profit is dairy gross farm revenue less dairy operating expenses.
Capital expenditure (CapEx)	Funds used by a business to acquire, upgrade, and maintain physical assets such as property, building, plant and equipment.
Present value (PV)	Is the current value of a future sum of money or stream of cash flows given a specified rate of return. Future values are discounted at the discount rate, and the higher the discount rate, the lower the present value of the future cash flows.
Net present value (NPV)	The different between the present value of cash inflows and the present value of cash outflows over a period of time. NPV is used in capital budgeting and investment planning to analyse the profitability of a projected investment or project.
Discount rate	Interest rate used to determine the present value of future cash flows in a discounted cash flow analysis. The weighted average cost of capital (WACC) is commonly used for a businesses discount rate when completing an investment analysis.
Weighted average cost of capital (WACC)	Is a calculation of a businesses cost of capital in which each category of capital is proportionately weighted. All sources of capital are included.
Internal rate of return (IRR)	Used in capital budgeting to estimate the profitability of potential investments. The IRR is a discount rate that makes the net present value (NPV) of all cash flows from an investment equal to zero

Project Details

Name: Integrating Forestry for Profitable and Sustainable Land Use

Completed by: perrin ag NEW ZEALAND AGRI-BUSINESS ADVISORS

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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