Mataroa | Pa-iti (#9)

Integrating Forestry for Profitable and Sustainable Land Use

perrin ag
NEW ZEALAND AGRI-BUSINESS ADVISORS

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Te Uru Rākau
Forestry New Zealand

Executive Summary

- John and Julie Gordon farm Pa-iti, a 361.7 ha hill country property located 11 km west of Taihape.

- Three scenarios were considered to assess how space-planting poplars at varying density covering 30 to 40 ha of area at risk from earthflow and slips can support the Gordon's goals of increasing the long term sustainability of their farm system.
- Where no further planting is modelled stocking level is expected to decline by 9% due to a 30% loss of pasture production on unstable hill country over the next 28 years. This would reduce operating profit by 36% compared with a 7% to 14% decline expected by planting either fastigiate or crowned poplars over 30 to 40 ha.
- Farm equity will likewise be impacted by stocking level and profitability such that where additional planting has been undertaken equity at year 28 would be expected to be 2.7% to 9.4% greater than if no further planting was undertaken.

- Integration of other species such as mānuka, kānuka, redwoods and eucalyptus offers the opportunity to improve environmental resilience, diversify income and enhance the property's biodiversity and aesthetics.

- The importance of long-term thinking around land use decisions and stewardship are highlighted by this case study. Capital costs and changes to cash flow need to be considered along with personal and environmental factors. In most scenarios planting will be undertaken progressively over a number of years to fit in with cash flow requirements.

- Planning for right tree, right place and right purpose is fundamental in achieving landowner objectives.

Table 1. Key physical metrics for the status quo with no more area planted and 3 space planted scenarios modelled for Pai-iti.

Farm parameters	Status quo - "unplanted"	Scenario 1	Scenario 2	Scenario 3
Effective pastoral area (ha)	306	306	306	306
Total area of space-planted poles (ha)		29.7	38.6	29.7
Predomiant cultivar		Crowned	Crowned	Fastigiate
Stocking rate (SU/ha)	11.9	12.6	12.5	12.9
% decline from base system	-9%	-3.8%	-4.5%	-2%
Sheep SU	3,132	3,347	3,320	3,438
Cattle SU	509	509	509	509
kg liveweight wintered/ha	621.8	658	653	664.0
Meat & wool produced per ha/year (kg)	266	285	283	289
Pasture eaten (t DM/ha)	5.78	6.20	6.10	6.27
Loss of pasture production on unstable hill country (HEL)	-30%	-13%	-15%	-9%

Case Study Overview

This case study illustrates the impact of integrating space-planted trees into a pastoral sheep and beef farm business. Three options were analysed specific to the Gordon's farm and farming aspirations. Financial and environmental analysis demonstrate potential returns, impact on improving the farm's environmental resilience, 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 space planting options analysed.

Read more on page 4-5

RIGHT TREE RIGHT PLACE RIGHT PURPOSE

Factors motivating tree plantings and land use change are outlined to understand 'why' trees are being considered. The impact of space-planting of poplar trees on this highly erodible land was evaluated via a number of scenarios, including the option of doing nothing and accepting continual loss of productivity from the erodible parts of the farm. 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 6-8

WHOLE BUSINESS ANALYSIS – BEST FUTURE LAND USE & FARM SYSTEM

The forestry options at an enterprise (sheep and beef 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 9-13

Farm Overview (Status Quo Farm System)

John and Julie Gordon farm Pa-iti, a 361.7 ha hill country property located 11 km west of Taihape, in the Upper Turakina catchment. The property includes 306 ha of effective pasture, 55.7 ha of existing retired farmland of which 23 ha are commercial woodlots. In total 39.5% of the farm comprises land between 20°-35° in slope (which tends to be the most erodible due to soil type) and a further 28% of steep land of more than 35° in slope. Some of the steeper land has progressively been retired from grazing since John's father Ron bought the farm in 1947. The easier country (20°-35°) is most at risk from shallow landslides yet forms the engine room of the farm operation.

The Gordon's are interested in how space-planting a variety of tree species on these at risk areas can support their goals, including increasing the sustainability of their farm system. Integration of forestry offers the opportunity to improve environmental resilience, diversify income and enhance the property's biodiversity and aesthetics while supporting the sheep and beef operation.

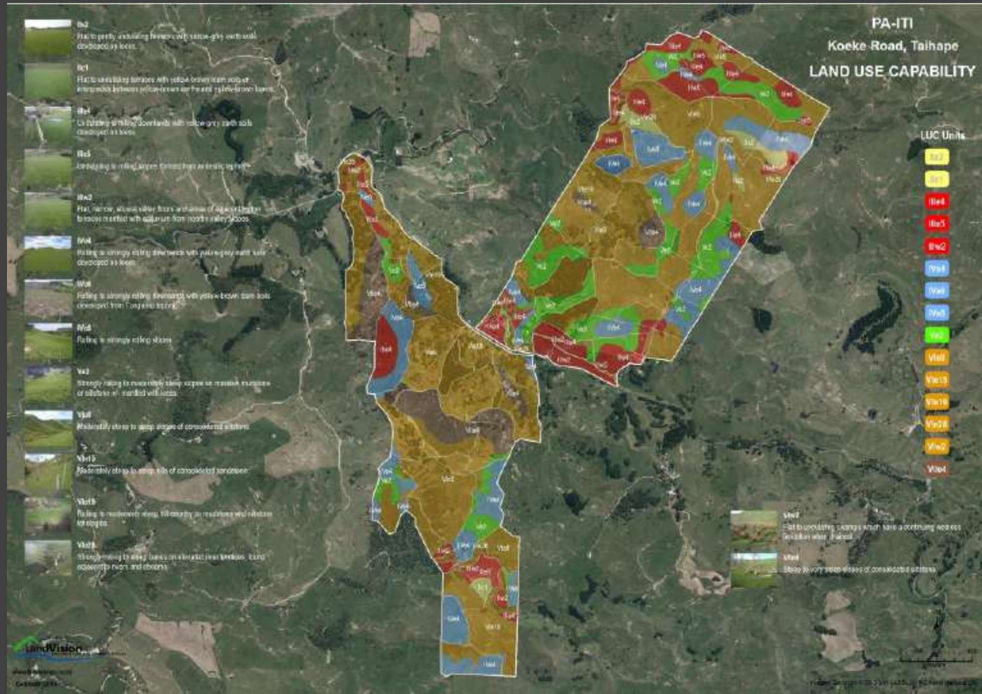
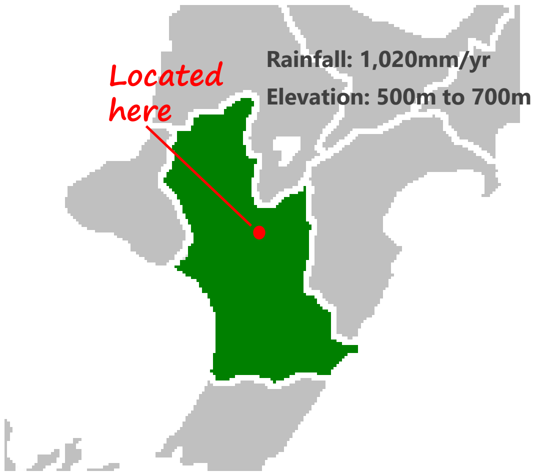


Figure 1: Pa-iti Land Use Capability

Location



Farm Details

Home farm (ha)	**361.7**
Effective pasture (ha)	**306**
Soil type	**93% brown hill soils 7% gley flats**
Water course	**Turakina River**
Est. pasture grown (per effective ha/yr	**8.4 tDM**
Est. pasture eaten (per effective ha/yr)	**6.4 tDM**

Livestock Details

Flock size (ewes)	**1,920**
Lambing %	**145%**
Ave lamb ccwt (kg)	**18.7**
Herd size (cows)	**86**
Calf weaning wt (kg)	**220.5**
Sheep/cattle ratio	**85%:15%**

Performance Indicators

Stocking rate (su/ha)	**13.1**
Operating profit ($/ha)	**450**
Return on asset (ROA%)	**4%**
N leaching (kg N/ha/yr)	**13.3**
P loss (kg P/ha/yr)	**0.4**
Biological GHG emissions (t CO_2 eq./ha)	**4.1**

Factors Motivating Tree Planting and Land Use Change

Physical Constraints

- The majority of the property comprises brown hill soils and poorly drained gley soils with a high clay content – on the flats and the “toes” (foot slopes) of hills. Concretionary mudstone is the primary parent material of the soils, increasing the **risks from earthflow and slips**.
- The winter wet and “summer safe” climate provides an annual rainfall of 1,075 mm. The heavy soils and winter rainfall make the **easier contoured parts** of the farm **prone** to **pugging** while the **steeper parts** of the property with good top soil are at **risk from slips** when **saturated**.
- The **high altitude** between 500 m and 700 m above sea level mean **snow** fall is possible and the impact can be significant when it occurs. **Pasture growth is limited** by both the **saturated soils** and **cooler** temperatures at this **altitude** as outlined in **Figure 2**.
- As some of the land **above 35° in slope has already been retired** from grazing, a lot of the **focus** is now on the **40% of the farm** that is between **20°-35° in slope**.

Environmental Constraints

- **Annual N loss** at **13.3 kg N/ha** is **low** in **line with** the **high sheep to cattle ratio at 85:15** and **lower stocking level** reflective of pasture grown on this land class.
- P loss at **0.4 kg P/ha** reflects the low proportion of the farm cropped. This would be reduced further by additional space planting and **taking steeper, stock tracked areas out** of **grazing**.
- 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). Lowering the **GHG** footprint from **4.1 t CO2e** at Pa-iti will primarily require lowering total DM intake.
- 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 reducing P loss and sequestering carbon over time.

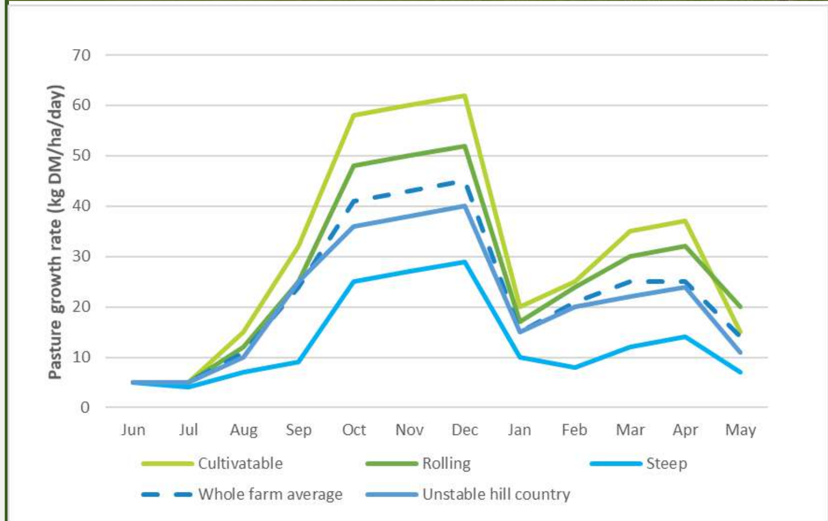
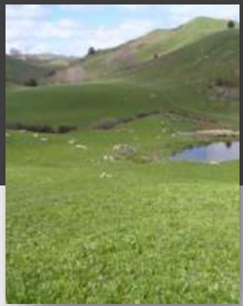


Figure 2: Estimated pasture growth for main land classes at Pa-iti

Right Tree Right Place Right Purpose

Understanding a planting site and its effect on tree performance and any 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 Pa-iti are explained. The Gordons have undertaken significant plantings across their property and have, often through trial and error, developed a good knowledge of what works and what does not in their environment. The variation in landscape suits multiple tree species being planted within forestry compartments rather than a singular species.



Flat to Rolling Productive Land

- The flat to rolling areas which cover 6% and 15% of the farm respectively have the highest pasture growth potential making them too valuable to the farm business to warrant significant afforestation.

- For exposed plateaus **shelter plantings** along their southern and south-western paddock boundaries would improve these areas for lambing.

- On the alluvial flats, planting of riparian margins with **natives** such as **harakeke** improves biodiversity, protects the alluvial flats from sediment depositing flood events and the fencing from flood debris. It also provides shelter to lambing ewes.

Foot slopes of hills

- Foot slopes, have deeper topsoil from soil movement accumulated down slope. Many are saturated for the winter period and on shaded south-facing landscapes are often not well suited to pastoral farming. Where drainage is poorer, **Redwood (*Sequoia sempervirens*)** can be well suited. Redwood develops an extensive root system useful for erosion control on lower slopes. Being shade tolerant they can cope with south facing slopes and can be harvested under a mixed-age continuous canopy. However, on very wet sites a "nurse" crop of moisture removing trees will assist with establishment.

- **Lusitanica (*Cupressus lusitanica*)** and other cypresses are better suited areas where drainage is less problematic and on low slope soils that are unstable .

Unstable Hill Country

- As 40% of Pa-iti is highly erodible land, if left unprotected, it is not viable to retire all such land for forestry and retain a viable farming enterprise. Space planting with poplars (*Populus sp*.) has been used with the more upright **Lombardy (*P. nigra var Italica*)** used in more exposed areas. **Kānuka (Kunzea ericoides)** provides soil stability and stock shelter on slowly reverting land.

- **Red alder (Alnus rubra)** suit landscapes prone to soil movement, such as adjacent to cuttings, roads or tracks, where timber production or pastoral grazing is problematic. They can quickly establish to stabilise these small areas. Stands can be kept at manageable heights through pruning without loss of root integrity.

Integrated Forestry Analysis

Areas on farm suited to space planting poplars and grazing are also well suited to production forestry with the **Right Tree. Douglas fir (*Pseudotsuga menziesii*)** is a viable alternative to ***Pinus radiata*** which was **poorly suited** to Pa-iti. The higher altitude and thin but wet soils result in the pine trees having grown fast but with limited root penetration leading to toppling. Several storm events resulted in significant tree/leader loss from snow weight requiring more remedial silviculture (involving time and cost) than was expected. Fortunately, the compartments planted with radiata pine are located close to the road and on landscapes such that harvest will be simple and less costly. **Douglas Fir** requires cool conditions and is resistant to snow damage, growing best at altitudes of 350 – 950 metres in higher rainfall sites. On unstable hill slopes, soil is suitably deep for Douglas fir and the slope assists with drainage and the trees themselves can provide effective erosion control until clear-fell. While rotations are longer than radiata pine (and investment returns nominally lower), for farm owners with an intergenerational perspective like the Gordons, this is less important.

The Douglas fir that grows so well on more moderate slopes is poorly suited to the thin, already eroded soils on the **steep hill country(>35°).** These areas of the property have limited rooting depth and thin topsoil, poor fertility and low soil moisture capacity. Trees on steep hill country should therefore be limited to trees for biodiversity, shelter and potentially carbon income, rather than trees for timber. Species that may suit planting on this country include **mānuka (*Leptospermum scoparium*)** or **kānuka**.

The **ridge lines** of the farm present the most challenging landscape for tree establishment. Despite having generally deeper and more fertile soils, these areas are exposed to wind drying soil moisture and impacting tree form. ***Eucalyptus fastigata***, used at Pai-iti on such sites is also able to cope with the intermittent snow falls due to its more erect form. This eucalyptus is commonly planted in New Zealand and has been subject to breeding programs to develop cultivars with improved growth rates and form. ***Eucalyptus nitens*** is also well suited to windy conditions.

Mixed species planting has been trialled by the Gordon's. An example with four species in one compartment has used predominantly **Douglas fir** on the majority of the **slope**, with ***Eucalyptus fastigata*** used on the exposed **ridgelines and 20% of the way down the slope*,* *Cypress lusticanica*** on the **foot slope** of the hill as they are more **tolerant to shade** and **prefer deeper soils** and **regenerating poplars** originally planted to **stabilise** the **slope**. As Douglas fir invariably has to be clear felled (as it is not suited to continuous canopy harvest), having space-planted poplars left standing during the primary species harvest (or erosion protection species with a different harvest timing and method) will **ensure the slope retaining its integrity during harvest** and before a new forest is established**. Intermittent grazing** of the understory with shorn ewe hoggets, keeps pasture down, reducing fire risk over summer and competition for the trees.

Three scenarios were tested to evaluate the use of erect-fastigiate forms of **space planted poplar** for erosion control, the **impact on pasture** production under the planted zone and of the surrounding landscape and the level of **carbon sequestration** and **eligibility** for inclusion within the **ETS**.

Space-planted poplars are assumed to be established using poles of 3-4m in height and covered with a plastic sleeve to prevent damage to the bark and trunk by stock browsing during the initial period of establishment. At a cost of just over $23+GST per pole planted, establishment at 90 stems per hectare equates to a cost of $2,072/ha. Form pruning at three years is also assumed.

Scenario Design

Scenario 1 – Targeted Space-planted Poplars

Scenario 1 targets planting 25% of the highly erodible land (29.6 ha) in poplar poles at a density of 90 stems per hectare. Narrow-crowned poplar cultivars used to reduce wind throw. Areas include land above old slip scars, areas of deposited material from previous slips where mudstone is the underlying parent material and areas of earthflow considered able to be stabilised with plantings. Pole establishment will occur over a period of 6 years to minimise the impact of cattle exclusion from planted areas for 2-3 years post-planting and allow the plantings to be funded out of operating cash flow. Targeted landscape features are assumed to be sufficiently large enough that space-planted compartments are ≥1 ha in area and have a minimum average width of 30 m. As such, these compartments are eligible for inclusion within the ETS.

While the effective ha remains at 306 ha pasture production on space-planted compartments is expected to decline to 25% of its current growth until the trees achieve their maximum extent erosion protection. However, the annual average decline of pasture production on these high-risk landscapes will gradually reduce until after 20 years (when the last 5 ha compartment planted will be 13 years old), the entire high-risk area will be considered protected from erosion with 90% of the continual loss of productivity from shallow soil movement eliminated. Stocking rate decline is limited to 0.5 SU/ha compared to the expected fall of 1.2 SU/ha if no effort is made to stop shallow landslides.

Scenario 1 has been modelled with both a) full eligibility of NZUs and b) only 25% of NZUs being available as claimable if the CO_2 sequestered is recalibrated. Over the 35 years t CO_2 /ha would be 729 t/ha versus 182 t/ha.

Figure 3: Newly space planted poles left and established Lombardy poplars right.

Scenario 2 – *Targeted Space-planted Poplars Requiring 30% more area for ETS eligibility.*

Scenario 2 targets planting thirty percent greater area than in S1. By planting 32.5% of the highly erodible land (38.5 ha) this overcomes the issue that the various compartments previously planted may not have been large or wide enough to qualify for the ETS. This greater area of planting results in increases in establishment costs, carbon revenues and loss of pasture production from shading. Stocking rate decline is expected to be just over 0.6 SU/ha.

Scenario 2 has also been modelled with both a) full eligibility of NZUs and b) only 25% of NZUs being available as claimable if the CO2 sequestered is recalibrated.

Scenario 3 – Same area planted as in S1 that is 29.6 ha but with narrower, very erect, fastigiate species such as "Lombardy"-type *var "Chiba"* which are not wide enough to reach canopy closer and therefore not eligible for ETS. Option a) assumes no eligibility of NZUs while option b) assumes it takes 55 years instead of 35yrs to achieve 181 t CO_2 /ha

Results of Forestry Scenario Analysis

The investment outcomes are summarised in Table 2 over a 56 year period equivalent to two full forest rotations and in line with the effective lifespan of the poles before they start to fail. Carbon sequestration has been included at the two levels for each scenario and assume dead trees are replaced.

Scenario 1 The value proposition for space-planted poplars has generally been with regard to their environmental benefits for the farm system they have been integrated with although some species such as the wider crowned "Kawa" have historically been planted for timber. The potential for space-planted trees to enter into the ETS has clearly altered this. As is evident for Scenario 1a, if space-planted poplars that achieved 30% canopy cover were eligible for NZUs as per the current Exotic Hardwood look-up tables, then at a carbon price of $25/NZU, such plantings would generate in the order of $540,000 of carbon revenue from years 5-35 post-planting, which over the 56 year period considered generates positive net present value (NPV) of $133,000 at a discount rate of 6% and the internal rate of return (IRR) is 19%.

However, if the government reduces the extent that CO_2 space-planted poplars are deemed to sequester, assuming most stands will only be planted in order to achieve the minimum canopy cover of 30%, then the direct investment returns will reduce. For scenario 1b the IRR is lowered to 5% delivering a negative NPV of minus $8,040 at the assumed discount rate of 6%. While still potentially a positive return on investment at current interest rates, the return may not be sufficient to justify establishment for potential carbon returns alone.

Scenario 2 The greater area planted, 38.6 ha versus 29.7 ha, generates a larger NPV of $164,004 from more carbon income while the IRR is the same at 19.2%. As greater costs are incurred at planting then reducing the carbon sequestration to 25% for scenario 2b lowers the NPV to minus $9,861.

Scenario 3 If fastigiate (narrow, erect) poplar cultivars planted at 90 SPH are ineligible for the ETS due to lack of minimum canopy closure, there is no forestry related revenue and the NPV of the investment is the establishment cost expressed in today's value. With no revenue, we are unable to calculate an internal rate of return. If, however, sufficient evidence was put forward to establish that despite inadequate canopy cover fastigiate poplars planted at 90 SPH sequestered the same total quantum of CO_2 as research indicates crowned cultivars might but at a slower rate, then the sum of the undiscounted cash flows for Scenario 3b would be effectively identical to those of 1b . However, the NPV and IRR are both lower than Scenario 1b due to the extended period of time over which the carbon revenues are expected to be received.

Table 1: Summary of individual investment performance for the forestry investments, under each scenarios.

Forestry scenario	1a	1b	2a	2b	3a	3b
Area of unstable hill country space planted at 90 SPH (ha)	29.7		38.6		29.7	
Variety	Narrow crowned		Narrow crowned		Fastigiate	
ETS assumption for CO_2 sequestration	As per ETS tables	25% of tables	As per ETS tables	25% of tables	Ineligible	25% of tables at a slower rate
Cost of establishment	**-$68,211**	**-$68,211**	**-$88,674**	**-$88,674**	**-$68,211**	**-$68,211**
Pre-tax carbon revenue (undiscounted)	**$540,847**	**$135,207**	**$703,075**	**$175,769**	**$0**	**$131,275**
Present value for whole term (6% discount rate)	**$133,726**	**-$8,040**	**$164,004**	**-$9,861**	**-$52,166**	**-$16,411**
Internal rate of return	**19.2%**	**4.7%**	**19.2%**	**4.7%**	**-**	**3%**

Risk analysis

The IRR for scenario 1 lifts by 5.5% for every $5 lift in $/NZU so that at $35/NZU the IRR goes up from 19% to 24%. The sensitivity to the % of sequestration that is claimable is even greater. Were the allowable sequestration rate deemed to be 50% of the current look-up tables for ETS then at $25/NZU the IRR goes up from 5% to 11%. At 75% allowable the IRR increases to 16% at $25/NZU or 20% at a $35 NZU price. Confirming how much is likely deemed allowable will be critical in planting decisions.

Impact on the Pa-iti Farm Enterprise

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

As space-planted poplars are established primarily to protect soil loss due to erosion the potential decrease in pasture production and hence farm production, if no planting occurred, forms an important part of the decision making.

MEAT AND WOOL PRODUCTION

Pasture production on the easy hill country at Pa-iti would be expected to decline by 30% over the next 50-60 years, relative to current performance if the 40% of its farm comprising highly erodible land was allowed to continue to slip and head down to the Turakina River. Stocking rate would reduce by 9% and there would be a 10.4% reduction in kg meat and wool produced.

Space-planting of poles is expected to reduce the impact by 60% and potentially more if erosion control an be achieved with less shading of pasture as with fastigiate varieties of poplar in scenario 3.

Table 2: Summary of physical performance indicators for the farm enterprise.

Farm parameters	Status quo - "unplanted"	Scenario 1	Scenario 2	Scenario 3
Effective pastoral area (ha)	306	306	306	306
Total area of space-planted poles (ha)		29.7	38.6	29.7
Predomiant cultivar		Crowned	Crowned	Fastigiate
Stocking rate (SU/ha)	11.9	12.6	12.5	12.9
% decline from base system	-9%	-3.8%	-4.5%	-2%
Sheep SU	3,132	3,347	3,320	3,438
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kg liveweight wintered/ha	621.8	658	653	664.0
Meat & wool produced per ha/year (kg)	266	285	283	289
Pasture eaten (t DM/ha)	5.78	6.20	6.10	6.27
Loss of pasture production on unstable hill country (HEL)	-30%	-13%	-15%	-9%

PROFITABILITY

All scenarios considered result in a loss in profitability over time compared to the current position. The decline is greatest where no further planting occurs. The % loss in profitability is greater than the % loss in stocking level and production due to the inability to reduce overhead costs (including reward for management) and sticky operational costs such as R&M assumed to change little with declining stocking levels. If no planting was done expenses could actually increase through cost to clean up slips, more animal losses and repairs to fences.

Table 3: Summary of financial performance indicators for the enterprises.

Farm parameters	Status quo - "unplanted"	Scenario 1	Scenario 2	Scenario 3
Gross Farm Income ($/ha)	$1,246	$1,331	$1,319	$1,348
Farm operating expenses ($/ha)	$915	$905	$923	$906
% GFI	73%	68%	70%	67%
Operating profit ($/ha)	$331	$407	$396	$422
Change from base system (FY20)	-$36,357	-$13,250	-$16,439	-$8,589
$/effective hectare	-$119	-$43	-$54	-$28
% decline	-36%	-11%	-14%	-7%

With less free operating cash flow available it is important to understand whether the business still generates enough cash to meet debt servicing and repayment, tax, development requirements and additional reward for management. Based on Beef+Lamb Economic Survey, Class 4 farms in the Western North Island are estimated to have average debt servicing and rent costs of $151.26/ha in FY19. Average term debt is estimated $2,372/ha. For a farm like Pa-iti, this would require $38,425 for interest costs (at 5.3%) plus $36,205 of after-tax surplus for repayment over a 20 year term –a requirement for pre-tax operating surplus of say $289/ha reducing to $164/ha over time. Likely achievable at present.

Environmental Performance

Water Contaminant Losses (Nitrogen and Phosphorus)

Total **N loss** to water is expected to marginally decline over time under any of the scenarios, as a result of the reducing carrying capacity. At Pa-iti the N loss reduction from **12.9 kg N/ha** to **12.5 kg N/ha** for the current state if no planting occurs is the only substantive change.

Modelled **P loss at 0.4 kg P/ha** remains unchanged across the scenarios. However, as **P loss** is strongly correlated to soil loss space planting poplars which would protect soils from overland soil flow would also help reduce P loss.

Biological Greenhouse Gas (bGHG) Emissions

With biological greenhouse gas (bGHG) emissions strongly linked to dry matter intake and livestock numbers, the reduced carrying capacity expected to occur over time at Pa-iti leads to a **decline in bGHG emissions of 11%** under the continuation of the status quo while only a **2% to 4%** decline occurs for the **space-planting scenarios**.

Assuming these emissions were similarly priced to carbon NZUs, at a **\$25/t CO_2e** the reduction in **bGHG** at a **whole property level** of **170t CO_2 eq./yr** between the current state now and 56 years time if no planting occurred would save the business **\$4,250** per annum. Under Scenario 1 the **3% drop** in **bGHG** emissions only amounts to **47t CO_2 eq./yr.**

What this analysis doesn't reflect is the carbon being sequestered in the space-planted trees. Currently the Zero Carbon Act does not allow CO2 sequestered in trees to directly offset methane and nitrous oxide emissions. If a trade off were allowed, the net carbon footprint for Pa-iti could be assessed by taking the annual bGHG emissions (in CO_2e) and deducting from them the C accumulated in space-planted trees. **After 28 years**, **planting at 29.7 ha** in **broader-crowned space-planted** poplars (Scenarios 1b) is sufficient to **result in a 9% reduction** in the net quanta of **greenhouse gases (in CO_2 and CO_2e)** expected to be produced by the farming enterprise during this time **compared to no planting**. The reduction increases to **13% for 38.6 ha** planted and reduces to **6% for** the more **erect or fastigiate poplars** with **lower rate of sequestration.**

Table 4: Summary of environmental footprint indicators over 56 years

Integrated business environmental results	Current state	Status quo - "unplanted"	Scenario 1	Scenario 2	Scenario 3
N leached per hectare (kg N/ha)	12.9	12.5	12.8	12.7	12.8
N surplus (kg N/ha/yr)	58	52	56	55	56
N conversion efficiency	11%	12%	11%	12%	11%
kg net meat & wool/kg N leached	16.3	15.4	16.0	15.9	16.2
P Loss (kg/hayr)	0.40	0.40	0.40	0.40	0.40
bGHG/ha (t CO_2 eq./ha)	4.08	3.61	3.95	3.92	3.99
Green House Gas emissions (kg CO_2 /kg meat & wool)	19.3	18.9	19.3	19.3	19.3

Table 5: Comparison of accumulated bGHG emissions over time.

Farm parameter	Status quo - "unplanted"	Scenario 1b	Scenario 2b	Scenario 3b
Area space planted (ha)	-	29.7	38.6	29.7
bGHG emmitted (t CO_2e)	48,652	48,954	48,919	49,011
CO2 sequestered (t CO_2)		- 4,902	- 6,377	- 3,068
Total GHG profile (t CO_2e)	48,652	44,051	42,543	45,943
Change from status quo		-9%	-13%	-6%

While the farming enterprise will continue to generate methane and nitrous oxide in perpetuity, the space-planted poplars will stop sequestering at some stage, meaning space-planting as analysed is not a permanent solution to lowering the farm's net emissions, outside of the small permanent reduction in stocking rate resulting from the loss of pasture production under the space-planted trees. However, it does provides a way for farm businesses to lower their overall emissions footprint (CO_2, CH_4, N_2O) for a reasonable period of time, as well as provide a fiscal hedge to any potential financial liability resulting from pastoral agriculture needing to account [and "pay" for some] of their biological greenhouse gas emissions

Whole Farm Business Analysis

In all the analysed space-planting scenarios for Pa-iti, the present value, to the whole business, of the investment made in space-planting was higher than not taking steps to protect the farm from slip damage. As such, equity (from operating cash flows) after 28 years was also estimated to be higher under any of the assessed scenarios than the alternative of taking no action. **Equity lifted by 8.2% with 29.7ha** of **space-planted poplars** and **by 9.4% with 38.6ha planted** as outlined in Table 6 where carbon sequestration was assumed to be included at **100% of ETS** tables. The **lift** in **equity** was **only 3.5% and 3.3%** if it was assumed carbon could only be included at **25%** of the **ETS** tables. Where more **erect slower sequestering species** were used as in scenario 3 the lift in equity was only **2.7%** for no carbon accumulation allowed to be claimed and **4% if 25%** could be claimed over the slower time frame.

The impact of space-planted poplars eligible for inclusion in the ETS being able to calculate their NZU allocation based on the current exotic hardwood look-up tables made a significant difference to the discrete investment returns from planting the trees and claiming carbon. Space planting poplars for carbon had a **higher internal rate of return** than the underlying farming activity over the time horizon considered.

The use of fastigiate poplars appeared to have the most co-benefits to the underlying farm system, as there was the same extent of erosion protection, but with reduced loss of pasture production from shading. If we assumed that the average land value at Pa-iti at its current level of productivity (7,600 kg DM/ha/year) was $7,500/ha, then land protected by space planting with annual DM production of (6,600 kg DM/ha) might be worth say $6,600/ha and eroded land with annual production of 5,300 kg DM/ha say $5,500/ha – a nominal loss in capital value of say 16% in the absence of space-planting.

Table 6: Summary of financial results from integrated land use over the first 28 years.

Integrated business financial results	Status quo - "unplanted"	Scenario 1		Scenario 2		Scenario 3	
		1a	1b	2a	2b	3a	3b
Effective pastoral area (ha)	306	306	306	306	306	306	306
Total area of space-planted poles (ha)	-	29.7	29.7	38.6	38.6	29.7	29.7
Predomiant cultivar	N/A	Crowned	Crowned	Crowned	Crowned	Fastigate	Fastigate
ETS status	N/A	As per ETS tables	25% of ETS tables	As per ETS tables	25% of ETS tables	Ineligible	25% of tables at a slower rate
Aggregate NPV of investment (over 56 years)	$1,331,446	$1,507,840	$1,374,098	$1,543,411	$1,369,547	$1,357,262	$1,393,017
Aggregate internal rate of return	17.9%	18.1%	17.4%	18.0%	17.2%	17.3%	17.4%
Sheep & beef enterprise	17.9%	18.0%	18.0%	17.9%	17.9%	18.1%	18.1%
Forestry enterprise	-	19.2%	4.7%	19.2%	4.7%	-	3%
Projected equity at Year 28*	$4,836,516	$5,235,212	$5,006,061	$5,292,080	$4,994,184	$4,968,081	$5,027,980
% change to equity		8.2%	3.5%	9.4%	3.3%	2.7%	4.0%

Summary

- Establishing 30-40 ha of targeted space planted trees at Pa-iti on the 38% of the farm at greatest risk of slips will be of benefit to the property in the medium term, with or without significant carbon returns. However, the quantity of carbon deemed to be sequestered by eligible trees makes a significant difference to the financial impacts of doing so.
- Currently, ETS eligible space planted poplars would be assumed to accrue some 728 t CO_2/ha over a 35-year sequestration period post-planting. This is approximately four times the amount of carbon empirical research suggests poplars planted at 80 SPH would actually sequester. However, the NPV of the farm at Pa-iti would be 15% higher at these levels of space-planting than simply allowing erosion to occur unhindered as shown in Scenario 1a. On the basis that such plantings only accrued 182 t CO_2/ha, the NPV for the whole farm business would only be marginally higher than not planting at all.
- Despite the apparently small financial benefit, space-planting at the scale suggested is likely to significantly reduce loss of phosphate to water and improve the net GHG position of the farm in the first 28 years after planting by in the order of 9%. The latter will become more important if pastoral agriculture has to account for and potentially pay for their methane and nitrous oxide emissions.
- As the more erect or fastigiate formed poplars have lower impact on pasture production due to reduced shading these would be advantageous if assumed rates of sequestration for space-planted poplars are revised down from those currently applicable and the rule around “canopy cover” for these species was revised.
- The space planting scenarios considered demonstrated higher equity accumulation from 2.7% to 9.4% gain than no space planting at all and establishment costs could be paid without debt servicing being negatively impacted.
- The importance of **long-term** thinking around **land use decisions** and **stewardship** are highlighted by this case study – not just in the analysis of integrating forestry amongst a pastoral farm business in a way that potentially underpins the long-term viability of pastoral land use, but with the example of the Gordons of Pa-iti who, despite a lack of overt short-term financial incentive to do so, have embraced the integration of forestry in their pastoral landscape to protect and preserve their asset for future generations.

Definitions

SU/ha	Stock units per ha based on 550kg 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 product sold	Net increase in kilograms of meat(eg beef/lamb/mutton) and wool grown on farm

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 exceed plant requirements
Green House Gas Emissions (GHG)	Green house gases on a whole farm basis expressed as CO_2 equivalents
Biological Green House Gas Emissions (bGHG)	A measure of methane (CH4) and nitrous oxide (N2O)emitted from a farm as CO_2 equivalents. CO_2 from electricity, fuel, and fertilizer 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 use 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 analyze 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 a investment equal to zero

Project Details

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