Integrating dairy and hill country farming with forestry for profitable and sustainable land use

Case Study 9: Pa-iti

Report prepared by
Perrin Ag Consultants Ltd
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Executive Summary

- This report explores how the integration of space-planted trees into a farm system can support landowner objectives on a sheep and beef farm. Three tree planting scenarios are used to investigate the potential of tree planting to reduce erosion, maintain long-term productivity and diversify income.
- 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. Pa-iti comprises 306 ha of effective pasture and 55.7 ha of existing retired farmland and commercial woodlots. The farm is considered winter wet and historically "summer safe", with annual rainfall of 1,020 mm per annum. The heavy soils and winter rainfall make the easier contoured parts of the farm prone to pugging risk during this time and the steeper parts of the property with good top soil are prone to erosion when saturated.
- In total, 39.5% of the farm comprises land between 20°-35° in slope which is highly erodible as a result of soil type, and a further 28% of steep land is >35° in slope. Some of the land above 35° in slope is already retired from grazing, but the easy country most at risk from shallow landslides (slips) forms the engine room of the farming operation.
- 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. The tree planting scenarios were the targeted space-planting of conventional narrow crowned poplars at two different proportions of the highly erodible land on farm, both eligible for inclusion in the ETS, and a further scenario with fastigiate clones, that are currently ineligible for ETS inclusion.
- In all the analysed space-planting scenarios for Pa-iti, the present value of the investment made in space-planting was greater than not taking steps to protect the farm from slip damage.
- The impact of space-planted poplars being eligible for inclusion in the ETS is the ability to currently calculate their NZU allocation based on the current exotic hardwood look-up tables, which made a significant difference to the discrete investment returns from planting the trees and claiming carbon. In fact, on that basis, space-planting poplars for carbon had a higher internal rate of return than the underlying farming activity over the time horizon considered. However, even if assumed carbon sequestration rates were reduced to the levels we expect more likely from space-planted trees, for a farm like Pa-iti with approximately 40% of the farm area at risk from erosion, it still makes sense to utilise space-planting.
- Despite the apparently small financial benefit at lower rates of sequestration, 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 9%. The latter will become more important if pastoral agriculture has to account for, and potentially pay for some or all of, their methane and nitrous oxide emissions.
- Due to their expected lower impact on pasture production, the use of fastigiate formed poplars would be advantageous if assumed rates of sequestration for space-planted poplars are revised down from those currently applicable in the ETS. However, this would require a change in ETS eligibility linking canopy cover to sequestration rates.
- Assuming the case study farm operated with the average amount of debt for sheep and beef farms in the Western North Island region of $2,372/ha, space-planting would not impact the ability of Pa-iti's owners to repay these levels of debt over a 20 year amortisation period and, in fact, at the extent assumed, all of the space-planting scenarios considered demonstrated higher equity accumulation (post tax) than no space-planting at all after 28 years.

- However, further analysis of space-planting scenarios demonstrated that the long-time frame over which such plantings are expected to accrue benefits to the farming enterprise can be undervalued by conventional economic analysis. This is particularly so when higher rates of return (expressed by the choice of discount rate) are required, externalities (like phosphorus or sediment loss) are not appropriately valued [if at all] or when policy settings don't support or encourage potentially valuable land use decisions (a blanket assumption on canopy closure and sequestration rates for example).
- 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.

CONTENTS

Introduction

The Integrated Farm Forestry Systems project is a multi-agency funded research and extension project, led by Te Uru Rākau and co-funded by DairyNZ, the Waikato, Bay of Plenty and Horizons Regional Councils, The Living Waters Trust, Farmlands Co-operative and the Forest Growers Levy Trust.

The project is being delivered by Perrin Ag and PF Olsen researchers in collaboration with farmer (dairy and sheep and beef cattle) and industry groups. The project aims to address key issues associated with increasing adoption of forestry within farm business and provide land owners, iwi and rural professionals with the information they need to help land owners make well-informed forestry enterprise decisions and increase their confidence in implementing forestry as a land-use option.

One of four key phases of the project is completing a diverse range of farm case studies (including iwi-owned) to illustrate the impact of integration of various forestry options into existing pastoral farming systems. This follows on from a series of farmer interviews that were completed in 2019 to gain an in-depth insight into farm forestry practices, views and knowledge, and enablers and barriers to integrating forestry into pastoral farming businesses (Dooley et al. 2020).

For this project phase, a range of complementary, integrated farming and forestry enterprises have been evaluated with six Waikato / Bay of Plenty cases and four Rangitikei individual cases. Case studies cover a variety of primary land uses (e.g. dairy, sheep and beef cattle, deer). Forestry options across the case studies include *Pinus radiata*, Douglas fir, mānuka and apiculture, PFSI (permanent forest sink initiative) forests for carbon and biodiversity, short rotation exotic species (including high stocking rate special purpose radiata pine for wood fibre supply), poplar space-planting, and totara for timber. Case studies have been selected on their potential to demonstrate enhanced business and environmental performance and to ensure questions and knowledge gaps identified in Phase 1 of the project are explored. Once completed, the case studies will be publicly available on-line and the findings disseminated amongst farmers and rural professionals through a series of workshops and field days.

This case study, Pa-iti, comprises an owner-operated sheep and beef farm in the Rangitikei region that explores:

- The potential of space-planted poplars to offset environmental externalities (primarily sediment loss), improve financial resilience and enhance productivity.
- The integration of different tree species within the landscape as an alternative to monocultural planting.

Method

A list of case studies were identified through the researcher's professional networks and local project steering groups and the final case studies confirmed after evaluating the specific opportunities and challenges for each property against the key questions and knowledge gaps identified in Phase 1, as well as ensuring appropriate regional and sector diversity. Pa-iti is one of the four Rangitikei case studies analysed.

PROCESS

A property inspection was conducted at Pa-iti on 18 March 2020, in which the farmers' interest and preferences for integrating forestry into their existing business was explored, the suitability of potential sites evaluated and information about the existing farm and forestry activities was captured. A standardised data capture method adapted from the DairyNZ Whole Farm Assessment (DairyNZ, 2016) process was used to ensure consistency in this process between case studies. A follow-up visit occurred on 11 August 2020.

Financial and physical data from the current and preceding year was analysed in order to develop a feasible status quo model ("base scenario") of the business, which was modelled in Farmax Red Meat (www.farmax.co.nz.) and OVERSEER FM (OVERSEER, 2019) software to ensure feasibility and estimate the nitrogen (N) and phosphorus (P) losses to water and biological greenhouse gas emissions (bGHGs) from the current land use activities. Best data input standards were followed (Overseer 2019).

As part of this process the farm property was mapped and analysed in ARC GIS software. This was done to identify the geo-physical differences of areas of the property. This is needed to both ascertain the impact on aggregated pasture production of changing land use and to assess erosion risk.

To evaluate the impact of slope and aspect on pasture production and feed quality, assumptions were formed using principles drawn from journal articles, discussions with the case study farmers, and observations made by the project researchers during the farm visits (Appendix 1). The assumptions were subjective but provide an approximation for the analysis. The relative pasture production for these areas was then able to be estimated based on validation from whole farm Farmax modelling and the empirical relationships known to exist between aspect, slope and fertility and inherent pasture production potential based on Radcliffe (1982), Gillingham (1973) and Morton & Roberts (1999). A simulation model was created in Microsoft Excel to model the impact on pasture production over time from erosion and utilising space-planted poplar trees to reduce erosion.

Once a suitable status quo model had been developed, space-planted poplar scenarios for integration to the farm's existing land activities were developed in association with the Gordons, ensuring scenarios aligned with their objectives and were of interest to them. The scenarios were then analysed for projected expense, revenues, pasture production and carbon sequestration. Scenarios were analysed over a 56-year timeframe, essentially two full 28 year cycles of planting, growing, harvesting for *Pinus radiata*. While radiata pine was not considered in any of these scenarios, this timeframe was used for consistency with other case studies. Where applicable, the impact of accessing regional or national grant schemes was included.

The farm system was then re-modelled in Farmax and OVERSEER for each scenario to account for the impact of afforestation on the farm system and the resulting financial and physical outputs recorded. These were then combined with the respective forestry outputs for each scenario and the aggregated changes to financial performance and environmental outcome were evaluated against the base scenario. This was done by utilising investment analysis tools (see page 27), primarily discounted cash flow analysis, to allow the regular (annual) cash flow from farming to be treated consistently with the irregular cash flows from forestry. The scenarios were also analysed for their aggregate impacts on the property's environmental footprint using OVERSEER. Full assumptions are presented in Appendix 3.

Section 1: Farm and business description

INTRODUCTION

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. More or less divided in two by Koeke Road, 242 ha makes up the original Gordon property farmed by John's farther, Ron, since 1947 when the property was acquired by the Gordon family as a post-war settlement block. The balance of the property has been purchased more latterly. After 12 years working in Tauranga as a builder, John came home to the family farm in 2005.

The farming enterprise is operated as a partnership, with a rental paid to a landowning trust.

The family has been heavily involved with the New Zealand Farm Forestry Association since they came to the farm. After observing the direct impacts of significant slip damage not long after coming to Pa-iti, their collective interest in forestry as a complementary land use to farming was further enhanced by the realisation in the early 1950s that the new family homestead was sited in the middle of a previously unrecognised slump zone on the property.

BUSINESS STRATEGY

John and Julie have a strong focus on intergenerational land management and are motivated by making decisions that will have longer benefits to the business and Pa-iti than their tenure as owners and managers of the property. The scale of the business provides challenges for labour efficiency and work-life balance for John.

VISION AND GOALS

- Debt repayment
- Continue to improve animal performance
- Diversify income streams
- Provide opportunity for family succession
- Increase the sustainability of the property and farm business

Figure 1: Pa-iti Station aerial map with property boundary

FARM DESCRIPTION

Pa-iti is a 361.7 ha property, comprising 306 effective ha and 55.7 ha of existing retired farmland and commercial woodlots. The majority of the property comprises brown hill soils on the rolling country, with gley soils – poorly drained and 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, which makes a lot of the farm at risk from earthflow and slips. The farm is considered winter wet and historically "summer safe", with annual rainfall of 1,075 mm per annum.

Only 18.9 ha (6%) of the effective area would be considered flat, with half of this area comprising traditional alluvial river flats and the balance elevated plateaus subject to exposed weather conditions. In total 39.5% of the farm comprises between 20°-35° in slope that is highly erodible due to soil type and a further 28% steep land >35° in slope. Some of the latter has already been retired from grazing, but the easy country most at risk from shallow landslides (slips) forms the engine room of the farming operation.

The heavy soils and winter rainfall make the easier contoured parts of the farm prone to pugging risk during this time and the steeper parts of the property with good top soil are at risk from slips when saturated.

Stock water is provided by a mixture of reticulation and dams.

At between 500 to 700 m above sea level, snowfall is irregular, but can be significant when storm events occur.

PASTURE GROWTH ACROSS FARM'S LAND CLASSES

Total annual pasture production and seasonal distribution for the evaluated land classes is presented in Figure 2.

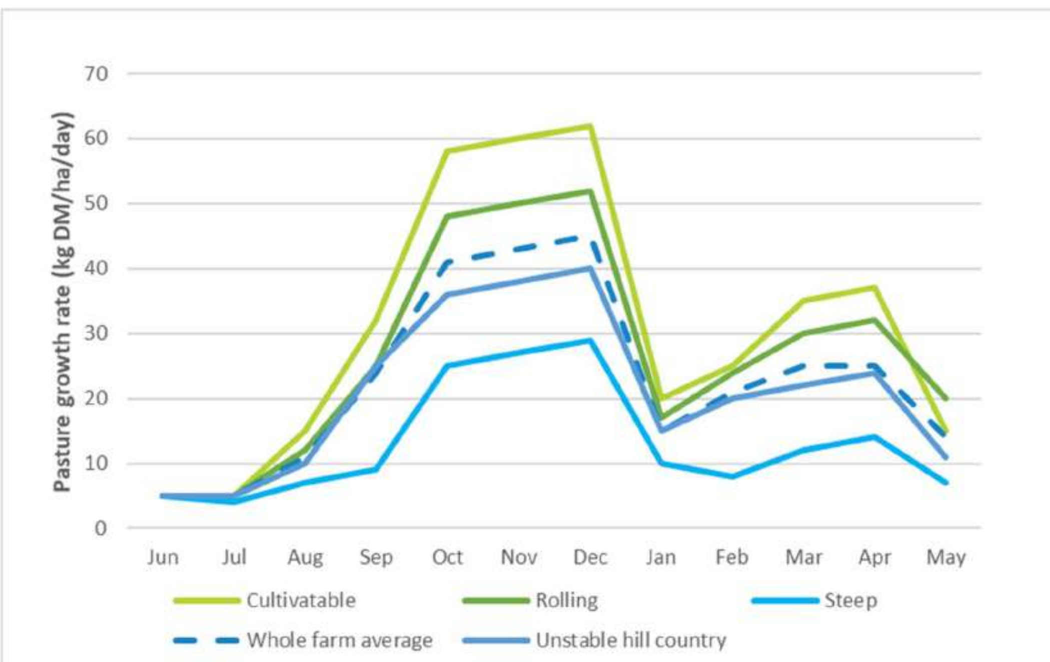

Figure 2: Estimated pasture production curves for the main land classes at Pa-iti

Average annual pasture production was modelled in Farmax Red Meat for the 2018/19 season. Altitude and often saturated soils result in low winter growth rates. A capital fertiliser regime has seen pasture growth rates increase to an average of 8.4 t DM/ha.

CURRENT FARM SYSTEM

The climate and landscape invariably result in a farm system that remains dominated by sheep. The property runs a breeding ewe flock of 1,920 mixed age and two-tooth ewes, typically lambing in excess of 145%. Approximately 620 replacement ewe hoggets are carried, with 60% of these also put to the ram and achieving lambing performance >110%. Most surplus lambs are sold prime each year, with carcass weights of 18-19 kg. Store sales tend to be limited to tail end lambs or where dry conditions require prompt destocking.

The cattle policy is based around a herd of 70 breeding cows and 16 in-calf rising two year old heifers, purchased as replacements each year. All progeny are sold at weaning.

The annualised stocking rate for the property is 13.1 SU/ha, with 677 kg liveweight wintered/ha. Sheep to cattle ratio is 85:15.

Pasture utilisation is estimated at 76%, with just over 6.4 t DM/effective ha eaten each year. A summer crop is planted each year to improve the feed quantity and quality available for lambs post weaning and a small area of winter crop improves the ease of cattle management during this period of the year and ensures good pasture covers are available for the ewes at set-stocking.

The high performance of the sheep flock underpins the profitability of the farm business and high lamb and mutton prices in recent seasons has seen the property achieve operating profits (EBITR[1]) in the order of $530/ha.

CURRENT TREE PLANTING

The property has a long history of tree planting, with the original part of the farm that had been owned by John's father, Ron, having forest compartments and space-planted poplars throughout the landscape.

The current plantings and managed forest areas include:

- A 7 ha arboretum around the homestead dominated by Coast redwoods (*Sequoia sempervirens*) (Figure 3) below the house site and regenerated native bush directly above the homestead. Originally retired by Ron Gordon, this area has moved through its first phase of reversion and the mānuka and kānuka that grew originally has given way to mature kowhai and seedling podocarps.
- Two 8 ha (1993/94) and 2.6 ha (2000/01) compartments of *Pinus radiata*.
- A 9.4 ha mixed compartment of Douglas Fir, *Eucalyptus fastigata* and lusitanica (*Cupressus lusitanica)*, funded through the Afforestation Grants Scheme and planted in 2000.
- 2 ha of lusitanica and redwoods.
- 1 ha (2019) of canker resistant macrocarpa (*Cupressus macrocarpa)*.
- Areas of space planted poplars (1950s to present) to stabilise the land of greatest risk of earthflow (Figure 4).
- Riparian margins planted in natives (including harakeke, hebes, kowhai, carexes, coprosmas, pittisporums and ti kouka).
- Alders planted for road verge stabilisation.

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[1] Earnings before interest, tax and rent – inclusive of an allowance for wages of management at market values.

Areas of reverted native scrub (Figure 5) still exist within the effective area of the farm, remnants from the original bush clearance. These provide shelter to both shorn and lambing ewes. While the fencing of these areas is impractical, they are being left to regenerate, enhanced by pest control.

The family's historic experiences with radiata pine (see Section 2: Forestry options below) have led to their conclusion that further plantings of this specie is not appropriate for their property and location. As a result alternative softwoods and hardwoods are the focus for commercial woodlots on land unsuited for pastoral farming. Where farming is to remain the most appropriate land use, trees that protect the balance of the property from erosion and enhance its ongoing sustainability are of the greatest interest.

ENVIRONMENTAL FOOTPRINT AND LIMITS

While GHG reduction targets have not yet been set for the sector and agriculture is not yet explicitly in the Emissions Trading Scheme (ETS), all farmers can expect to be required to make changes to reduce on-farm GHGs and contribute to the above targets being met.

The make-up of the farm's biological greenhouse gas (bGHG) emissions, which have averaged 4.1 t CO_2e in the last three seasons, are currently 79% methane and 21% nitrous oxide. Methane is related directly to dry matter intake (DMI x 21.6 g/kg DM eaten). The amount of nitrous oxide (N_2O) is driven by nitrogen fertiliser use, total annual nitrogen excreted and soil type (high losses on heavier soils).

Lowering the bGHG footprint at Pa-iti will primarily require lowering total DM intake.

The integration of trees on farm may provide a valuable tool to mitigate environmental externalities. Key opportunities relate to retiring low quality land into a low nitrogen land use, providing shade and shelter to support higher per head performance and reduce livestock wastage, and providing income from log sales and carbon sequestration over time. If the business can achieve more production from less animals in addition to revenue from trees, the total environmental footprint reduces and the efficiency per unit of product increases, providing a more sustainable and resilient business.

More information on expected GHG requirements is provided in Appendix 5.

Figure 3: Redwoods planted on hill foot slope

Figure 4: Space-planted Lombary poplars

Figure 5: Remnant native scrub under semi-managed reversion

BASE SYSTEM

The representative status quo base farm system for Pa-iti to be used as the base scenario for the analysis is presented summarised below. This system reflects the current performance being achieved from the property at its current stage of development.

STATUS QUO PHYSICAL PERFORMANCE

The business' assumed status quo physical performance and parameters is presented in Table 1.

Table 1: Summary of key current status quo farm system details

Farm details		Current farm system	
Nearest town and catchment	Taihape, Upper Turakina	**Annualised stock numbers (SU)**	4,009
Season's rainfall (Overseer)	1,075 mm	**Sheep SU**	3,407
Soil type(s)	Brown soils (93%)	**Cattle SU**	601
	Gley soils (7%)	**Sheep:cattle ratio**	85%:15%
		Annualised stocking rate (SU/ha)	13.1
Terrain (flat/rolling/steep)	Flat (6%)	**kg liveweight wintered/ha**	677
	Rolling (15%)	**kg meat & wool produced per eff ha**	296
	Easy (25%) Steep (54%)	**Area in summer and/or winter crop (ha)**	19
Total farm size (ha)	361.7	**Average pasture production (kg DM/ha)**	8,433
Effective area (ha)	306	**Annual pasture intake (kg DM/ha)**	6,424
		Lambing %	144%
Labour (FTE)	1	**Calving %**	84%
Native and riparian trees (ha)	7.2	**Average lamb carcass weight (kg)**	18.7
Timber woodlots (ha)	23.0	**Average calf weaning weight (kg)**	220.5

STATUS QUO FINANCIAL PERFORMANCE

The business' assumed status quo financial operating performance is presented in Table 2. Medium term prices for meat and fibre products have been assumed, along with "normalised" inputs for fertiliser and repairs and maintenance. Assumptions are presented in Appendix 4.

Table 2: Status quo financial performance of the sheep and beef enterprise

Financial KPIs	Status quo
Gross Farm Income ($/ha)	1,379
per kg meat & wool produced ($/kg net meat & wool)	4.66
Operating Expenses incl. wages of management (WOM) per ha ($/ha)	929
% Gross Farm Income	67%
per kg meat & wool produced ($/kg net meat & wool)	3.14
Operating Profit ($/ha)	450
Operating Profit Margin ($/kg net meat & wool)	1.52
Cash surplus after interest ($/ha)	146
Asset Turnover %	12.4%
Return on Assets%	4.0%

STATUS QUO ENVIRONMENTAL PERFORMANCE

The business' assumed status quo environmental indicators are presented in Table 3.

Table 3: Status quo environmental performance indicators for Pa-iti

Environmental Indicators	2016/17	2017/18	2018/19
Total N leached (kg N/yr)	4,885	4,514	4,804
N leached per hectare (kg N/ha)	13.5	12.5	13.3
N surplus (kg N/ha/yr)	56	62	61
N conversion efficiency	16%	7%	7%
P Loss (kg P/ha/yr)	0.4	0.4	0.4
bGHG/ha (t CO_2 eq./ha)	4.07	4.14	4.17
% methane	79%	79%	79%
% nitrous oxide	21%	21%	21%

*Based on OVERSEER FM v6.3.4

Figure 6: One of the few P. radiata plantations on the property.

Section 2: Forestry options

In this section options are evaluated for integrating trees to improve farm performance and meet the Gordon' goals and values. The current physical, environmental and financial performance and identified constraints discussed earlier provided guidance for designing planting scenarios.

It was important to the Gordons that their farm business needed to be enhanced, not replaced by any afforestation. This has been the underlying basis for all of the afforestation the family has undertaken on the property since the late 1940s. The tree planting objectives identified from discussions with the Gordon's that were considered in the scenario design include:

- Forestry contributing to increasing overall property income
- Helping achieve sustainable land use
- Improve resilience to climate change (and the impact that severe weather events can have on the landscape and soil resource)
- Allowing debt reduction to continue

RIGHT TREE RIGHT PLACE: SUITABLE SPECIES SELECTION FOR THE FARM

With an intergenerational business focus and a strong family interest in the sustainable; and sensible integration of trees within their farming operation, the Gordons have undertaken significant plantings across their property and have, often through trial and error, developed a good knowledge of what works and does not in their environment.

Not only is their property characterised by a number of distinct land types, the lack of landscape uniformity within the farm has led the Gordons to integrate multiple tree species within forestry compartments, as opposed to a more traditional approach of singular species selection and use within a commercial woodlot. Species choice and use, along with insights into their decision-making process, are explored below. The New Zealand Farm Forestry Association website (https://www.nzffa.org.nz/) is a great source of specific tree species information.

FLAT TO ROLLING PRODUCTIVE LAND

Flat land is at a premium on a property like Pa-iti and given it has the highest pasture growth potential, it is too valuable to the farming business to warrant significant afforestation. The exposed plateaus would potentially benefit from shelter plantings along their southern and south-western paddock boundaries, which would improve the utility of these areas for lambing. On the alluvial flats, riparian margins present the most obvious opportunity for revegetation. At Pa-iti, the fencing-off of streams and the restoration of native vegetation (including harakeke, hebes, kowhai, carexes, coprosmas, pittisporums and ti kouka) along their margins has already started. The chosen revegetation 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

These areas of the farm are typified by deeper topsoil, a result of years of accumulated soil movement down slope, are often saturated for the winter period and on south-facing landscapes will experience significant shading. These areas are often not well suited to pastoral farming, particularly where they are south-facing or poorly-drained.

Lusitanica is well suited to these conditions, able to be grown in sunny positions and cooler southern slopes, provided soils are well drained and rainfall is regular. It is reasonably shade tolerant but grows fastest in open sites with full sun. As such it is a viable option for south facing areas and will thrive on similar sites with a northerly aspect, particularly if the site is well drained.

Where drainage is poorer, Redwood) can be well suited to lower slopes. Redwood also develops an extensive root system making it suited for erosion control on lower slopes, such as on or below previous earthflows or slumps – the planting at Pa-iti is a perfect example of this. Redwood is good at withstanding flood events and sedimentation below sites where gully erosion is likely, and it can be planted in flood zones to filter debris flows. Being shade tolerant, redwood can cope with south facing aspects and can also be harvested under a mixed-age continuous canopy system (i.e. where individual trees are harvested on reaching a particular size rather than a particular age). However, on very wet sites a "nurse" crop of moisture removing trees (like willows) will assist with establishment.

Where landscapes are prone to soil movement, such as adjacent to cuttings, roads or tracks, and timber production or pastoral grazing is problematic, red alder (*Alnus rubra*) is an exotic hardwood that quickly establishes and can stabilise these areas. As the species readily coppices, stands can be kept at manageable heights through pruning without loss of root integrity, making them well suited to small compartments that might otherwise be left unplanted or alternatively planted with poorly chosen timber species that create problems as the stand matures.

UNSTABLE HILL COUNTRY (20°-35° SLOPE)

With so much of a property like Pa-iti likely to be considered at risk of erosion if left unprotected, it is not viable to retire all such land for forestry and retain a viable farming enterprise. The use of space-planted poplars to stabilise the areas of the landscape most at risk of slip damage is well recognised by the farming community and regional councils alike. The soil erosion protection afforded by poplars occurs because of their root systems stabilising saturated soils, both individually and where their roots interlock. Densities as little as 40 stems per hectare (McIvor 2012) may be sufficient to achieve stability. Broader crowned species tend to be better suited towards being planted at the bottom of these landscapes where there is more shelter from wind, with narrower-crowned cultivars planted further up the slopes. The fastigiate formed cultivars like Lombardy (*P. nigra var Italica*) are best planted on the most exposed sites, where wind run is likely to be greatest. However, the well reported reduction in pasture production under space-planted canopies, the large areas often requiring planting, the cost of establishment and the need to protect planted areas from cattle grazing until trees are of sufficient size have been disincentives for many farmers to extensively adopt such planting.

The economic impacts of space-planting poplars on Pa-iti are explored in depth in the Forestry Analysis section below.

However, these areas of such farms are also well suited for production forestry. Like so many other farmers, the Gordons planted radiata pine as an alternative to pasture to diversify income, create intergenerational wealth and assist with erosion control. But at the higher altitude and thinner yet wetter soils of Pa-iti on the steeper areas of the farm, their experiences with this tree species have been challenging. Several storm events resulted in significant tree/leader loss from snow weight and toppling from the trees having grown fast but with limited root penetration on the wetter soils. These events have required the Gordons to undertake 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.

With radiata pine poorly suited to properties like Pa-iti, Douglas fir is a viable alternative for production forestry. 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, the soil is suitably deep for Douglas fir and despite the potential for mudstone- based soils to become saturated in winter, the slope assists with drainage and the trees themselves can provide effective erosion control until clear-felled. 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. However, the use of grants not available for radiata pine to establish such plantations improves the economics for Douglas fir and the poor suitability of the property to radiata pine means that conventional returns from that species are unlikely to be as high as a result of more intensive management required and likely poorer tree quality as a result of snow damage.

At Pa-iti, remnant native revegetation is also proving to be a suitable choice of non-pasture vegetation within the farming system. While not stock excluded and subject to a degree of limited stock browse, these areas of primarily kānuka (*Kunzea ericoides*) are slowly reverting and provide both soil stability and valuable stock shelter at key times of the year (such as post-shearing). While fencing these areas off is impractical unless the entire paddock was to be retired, restricting stock to sheep only is proving effective at increasing vegetation density and promoting the growth of succession species.

STEEP HILL COUNTRY (>35°)

These areas of the property have limited plant rooting depth and thin topsoil, poor fertility and low soil moisture capacity. These limitations severely restrict the number of tree species able to survive – for example the Douglas fir that grows so well on more moderate slopes is poorly suited to the thin, already eroded soils on this landscape. Trees on the Pa-iti 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, which, as pioneer species, are ideal for these areas. As a shrub, the risk of the plant becoming too tall and toppling is minimised, and the plant's ability to readily revegetate will suppress noxious weeds. Eventually, as vegetation builds up, other native plants may also begin to grow. Enhancing this regeneration through supplementary planting with podocarps after two to three years will accelerate the reversion process and create potentially valuable timber resource that non-conventional harvest techniques might be able to extract in the future without the need for clear-fell. While this is unlikely to be realised by the current generation of Gordons who own the property, it is an option for those who own the land in the future. More information on the financial returns from establishing podocarps for timber in this way are provided in Case Studies 8 & 10[2].

DRY WINDY RIDGES

The ridge lines of the farm present the most challenging landscape for tree establishment. Despite having deeper and more fertile soils than those associated with the steepest land, these areas have the challenge of wind exposure and the impacts wind can have on soil moisture and tree form. The reality is that such landscapes are often unable to be discretely managed within a farming business, but form parts of management units (i.e. paddocks). The Gordons are attempting to manage this by diversifying tree species within planting "compartments" (see the section "Mixed species in a landscape – A Pa-iti example" below).

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[2] Case Study 8: Lazy G Ranch and Case Study 10: Makokomiko

The so-called ash group eucalypts are potentially better suited to these sites than many other species, having better tolerance of prolonged dry periods than other types (Florence 1996). They naturally occur on the upper slopes of their environment and have been shown to perform well when planted on windy, erodible hill country (Gea & Shelbourne 2006). *Eucalyptus fastigata*, used at Pa-iti on such sites, is one of the most common of the ash group eucalypts planted in New Zealand and has been subject to breeding programs to develop cultivars with improved growth rates and form. These eucalypts are also able to cope with the snowfall that occurs intermittently at this altitude. *Eucalyptus nitens* is also well suited to windy conditions, but less tolerant of the thin, infertile soils found on ridge peaks.

MIXED SPECIES IN A LANDSCAPE – A PA-ITI EXAMPLE

While 57% of the property would be strictly defined as of steep contour (>25°) and a further 25% as easy contour (16°-25°), like so many properties in the lower North Island, there is a distinct lack of uniformity in the landscape. Paddocks may be fenced along a ridgeline and consist of steeper faces easing in contour on the down slope to take in a saturated foot slope at the base of the hill. Exposure to wind, depth of topsoil and soils moisture can all vary significantly across a paddock. Paddock aspect can add a further dimension as regards the seasonal impact of these features. As a result there can exist within a relatively small area, conditions that will best suit different tree species.

John and Julie Gordon have identified and deliberately adopted such an approach with one significant forestry compartment on their property (Figure 5) – a steep, south facing 9.4 ha paddock.

While the planting is predominantly Douglas fir, three other species feature in the compartment – *E. fastigata*, lusitanica and poplar.

Figure 7: *E. fastigata* at Pa-iti

Figure 8: Lusitanica at Pa-iti

Three to four rows of the *E. fastigata* have been planted at 1,110 stems per hectare (SPH) at the top of the ridge, where the prevailing wind is likely to make this part of the paddock most exposed. All of the trees have been form-pruned to maximise timber yield and increase their value for dressed timber as an end use. They were originally intended to have been planted on the upper 20% of the slope, but poor planting technique resulted in insufficient establishment so these areas were then planted with Douglas fir as well.

The Doulas fir have then been planted at 1,120 SPH as the predominant species down the majority of the slope. Relative to radiata pine, their resistance to snow and slower growth profile increases the resilience of the stand to storm events.

Then lusitanica have been planted the foot slope of the hill at 830 SPH, given the cypress' tolerance for shade and a preference for the deeper soils that develop in these areas. These are largely being form-pruned, but the potential for leaving some suitable trees for "green knot timber" is also occurring.

One unplanned addition to this compartment were regenerating poplars originally planted to stabilise the slope when it was in pasture. Although removed from site prior to the Douglas fir being established, a number of trees have come back, invariably helping stabilise the slope. In hindsight, John indicated that leaving existing trees or planting specialist erosion protection trees on clean sites would be an evolution of this concept he'd probably adopt. Given the fact that 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.

One other important feature of John's management of this block is the intermittent grazing of the understory with shorn ewe hoggets, to keep pasture down, reducing fire risk over summer and competition for the trees.

Figure 9: Multiple species planted within a commercial woodlot at Pa-iti (cypresses are growing to the right of this image)

FORESTRY ANALYSIS

The Gordon's are familiar with the use of space-planted poplars to protect valuable farming areas and already involved with annual pole plantings. However, like many forestry activities on farm, they need to be prioritised against the other uses of discretionary cash. However, the potential for erosion control plantings to qualify for NZU allocation under the ETS, increases the potential attractiveness of larger scale space-planted afforestation.

One area of real interest to John and his family is the use of fastigiate forms of poplar in erosion control. Historically maligned due to their susceptibility to rust in the wetter climate of the Rangitikei , Lombardy poplars have the distinct advantage of reduced risk of wind topple on saturated soils, as well as what was expected to be a reduced impact on pasture production due to reduced canopy closure at similar planting densities with non-fastigiate types. This reality is implied by McIvor and Douglas (2012) by the exclusion of Lombardy-type poplars from the regression analysis of the relationship between canopy closure, planting density and diameter at breast height (DBH) for New Zealand poplar cultivars because they reduced the R^2 value. Of course, unless such plantings can achieve a minimum canopy closure of 30%, they are currently <u>ineligible</u> for inclusion within the ETS.

Productive impact of shallow landslides

GIS analysis (Figure 12) indicates Pa-iti has 118.7 ha considered highly erodible land (HEL) – some 40% of the farm area and contributing to 35% of the farm's pasture production. With no steps taken to reduce erosion risk would experience a sustained loss of productivity over time as a result of slip events.

Based on the work of DeRose et al (1995), the annual average impact of slip damage and erosion on pasture production is assumed to be a loss of pasture growth in the order of an average of 40 kg DM per ha per year over the entire highly erodible landform (as opposed to loss of production from the slip area itself). While this seems minimal, over a 50-year period, this would equate to a loss of production of approximately 2 t DM/ha/year on affected landscapes– a 30% loss of productivity over 40% of the property.

Space-planting as an erosion mitigation

The positive impact of space-planted poplars on preventing soil movement is well known. In a review of New Zealand literature Basher et al (2019) found the efficacy of space-planted trees at reducing landslide events varied between 70%-95%. While blanket planting at-risk landscapes will stabilise hill slopes, targeted planting of the areas at the greatest risk of movement should achieve the same outcomes without incurring the greater direct cost of large scale afforestation or the loss of pasture production associated with it. In line with Parminter et al (2001), it has been assumed that only 25% of the at-risk landscape needs to be planted to provide erosion protection to the other 75% of the landscape. A planting density of 40 SPH within the targeted areas is considered sufficient to achieve erosion control (McIvor 2012). Given the higher density (80-100 SPH) assumed in this analysis due to the importance of plantings being eligible for the ETS (see the "Carbon sequestration" section below), a 90% reduction in the impact of erosion has been assumed in this analysis based on McIvor and Douglas (2012)

The soil erosion protection afforded by poplars occurs because of their root systems stabilising saturated soils, both individually and where their root systems interlock. Space-planted poplars are considered to achieve their maximum level of erosion protection anywhere between 5-13 years of age (McIvor & Douglas 2012; Wall et al 2006), depending on site, planting density and choice of cultivar. For the purposes of this analysis we have assumed a straight-line relationship between the level of erosion protection afforded and tree age from pole establishment through to year 13, at which point the slope is considered stable.

Carbon sequestration

As well as preventing shallow landslides, like all forests, space-planted poplars will sequester carbon. So long as they meet the minimum criteria under the ETS, space-planted poplar forests are eligible to accumulate NZUs. To be eligible, stands must be 1 ha or more with an average minimum width of 30 m, have a potential height of >5 m and be capable of achieving 30% canopy cover. For narrow-crowned non-fastigiate type cultivars, this is assumed to occur at between 80-100 SPH, approximately twice the density required to achieve soil stabilisation. For ETS registrations less than 100 ha, NZUs are accumulated based on the Exotic Hardwood look-up tables published by Te Uru Rākau (MPI 2017). Forest360 (2019) suggested that it seems likely that at the minimum planting densities required to achieve 30% canopy closure, the amount of carbon being sequestered by such stands will be significantly less that assessed using the look-up tables. It is unknown how MPI might treat NZUs already claimed under current provisions if sequestration rates for space-planted poplars were officially changed. Research into the quantity of carbon sequestered by poplar trees supports this premise. Fang et al (2007) measured 117 t C/ha in the above ground components of in poplar plantations planted at 500 SPH by year 10 – only 46% of that estimated in the look-up tables used for the ETS and at a planting density 5-6 times that suggested for eligible space planting here in NZ. Kouchi et al (2017) measured carbon stocks in 10-year-old *Populus alba* trees in Iran planted at 625 SPH at 123 t C/ha – similar to Fang et al (2007). While both studies excluded root biomass, the work of Guevara-Escobar et al (2002) suggests that root biomass accounts for little (21%) of the trees' total carbon pool. This is not inconsistent with Dewar and Cannell (1992) indicating the combined root and leaf biomass only accounts for 30% of total carbon in a deciduous tree. Cannell (1998) reported that poplar trees planted at 156 SPH sequestered an average of 26 kg C per tree per annum (over a 25-year growing period). This would equate to 101.4 t C/ha at year 25. The work of Guevara-Escobar et al (2002) that estimated the carbon pool in mature (29-year-old) space-planted poplar-pasture systems (40 SPH) was only 18.9 t C/ha. With 1 t C equivalent to 3.663 t of CO_2, the amount of CO_2 sequestered by poplars in the studies described is presented in Table 4 below.

Table 4: Summary studies assessing the amount of carbon sequestration in poplar trees at varying densities

Study	Density	Age	Carbon (t ha^{-1})	CO_2 (t ha^{-1}) *	Comments
Fang et al (2007)	1111	10	146.0	535	Root biomass excluded
	833	10	138.7	508	
	625	10	130.8	479	
	500	10	117.6	431	
Kouchi et al (2017)	20000	10	401.7	1471	Root biomass excluded
	10000	10	324.5	1189	
	2500	10	95.0	348	
	625	10	123.5	452	
Cannell (1998)	156	25	101.4	371	
Guevera-Escobar et al (2002)	40	29	18.9	69	Likely insufficient density to achieve 30% canopy closure
ETS look-up table Exotic Hardwoods		10		251	
		25		618	

*1 t C = 3.663 t CO_2 sequestered

Based on Cannell, the amount of CO_2 sequestered by a poplar stand at 156 SPH at 25 years is approximately 60% of that assumed by the New Zealand ETS look-up tables.

For the purposes of this analysis, the rate of carbon sequestration assumed is as per the Te Uru Rākau look-up tables (MPI 2017). However, the impact the amount of sequestration that seems more likely to be correct is also considered. For the latter we are using an assumption of 155 t CO_2/ha for an ETS eligible 25-year-old poplar stand planted at 90 SPH. This broadly equates to carbon sequestration at a rate 75% lower than that assumed in the ETS tables.

For fastigiate form clones, the same total quantum of carbon dioxide is assumed to be sequestered (McIver, pers. comm.), but over a longer time period (55 years versus the 35 years assumed for broad/narrow crowned clones.)

Accumulated NZUs are assumed to be claimed every five years on the anniversary of each compartment's establishment.

Impact of space-planted poplars on pasture production

Space-planted poplars do reduce pasture production for the majority of the growing season as a result of their canopies intercepting light and moisture. The legume component of swards under space planted trees may also decline (Wall et al 2006), which may also contribute to lower pasture production. The extent of pasture production decline is directly related to the extent of canopy closure. Wall et al (2006) found that pasture production declined to approximately 50% of that of open grassland as canopy closure approached 80%. The relationship was almost linear, but the loss of pasture accelerated between 20% and 50% of canopy closure. At 30% canopy closure, the relationship developed by Wall et al (2006) indicates a 25% loss of pasture production under space-planted trees with a canopy cover of 30%.

Figure 10: Modelled pasture production over time under differing space-planting regimes at Pa-iti

The speed at which the degree of canopy closure is achieved will depend on cultivar, specific site within a landscape and management regime. McIvor and Douglas (2012) measured a 10% decline in pasture production under 7-year-old pruned space-planted poplar trees (with the pruning impact effectively replicating a fastigiate form until that period of time). Assuming poplars are planted at 80-100 SPH, being the minimum density required to achieve both the maximum amount of soil stabilisation and the 30% canopy cover required for ETS eligible stands, for the purposes of this analysis we have assumed a linear reduction in pasture production to 10% of non-planted areas to year 7. We have then assumed a linear relationship from year 7 to year 13 for a further 15% loss of pasture production - to the point that maximum erosion protection is achieved.

At Pa-iti, applying these assumptions indicates that, while after 58 years pasture production on highly erodible land (HEL) will still be higher than that directly under space-planted poplars, overall pasture production on HEL will be significantly higher with 25% of the area space-planted, thanks to the significant reduction in erosion-related production loss across the landscape.

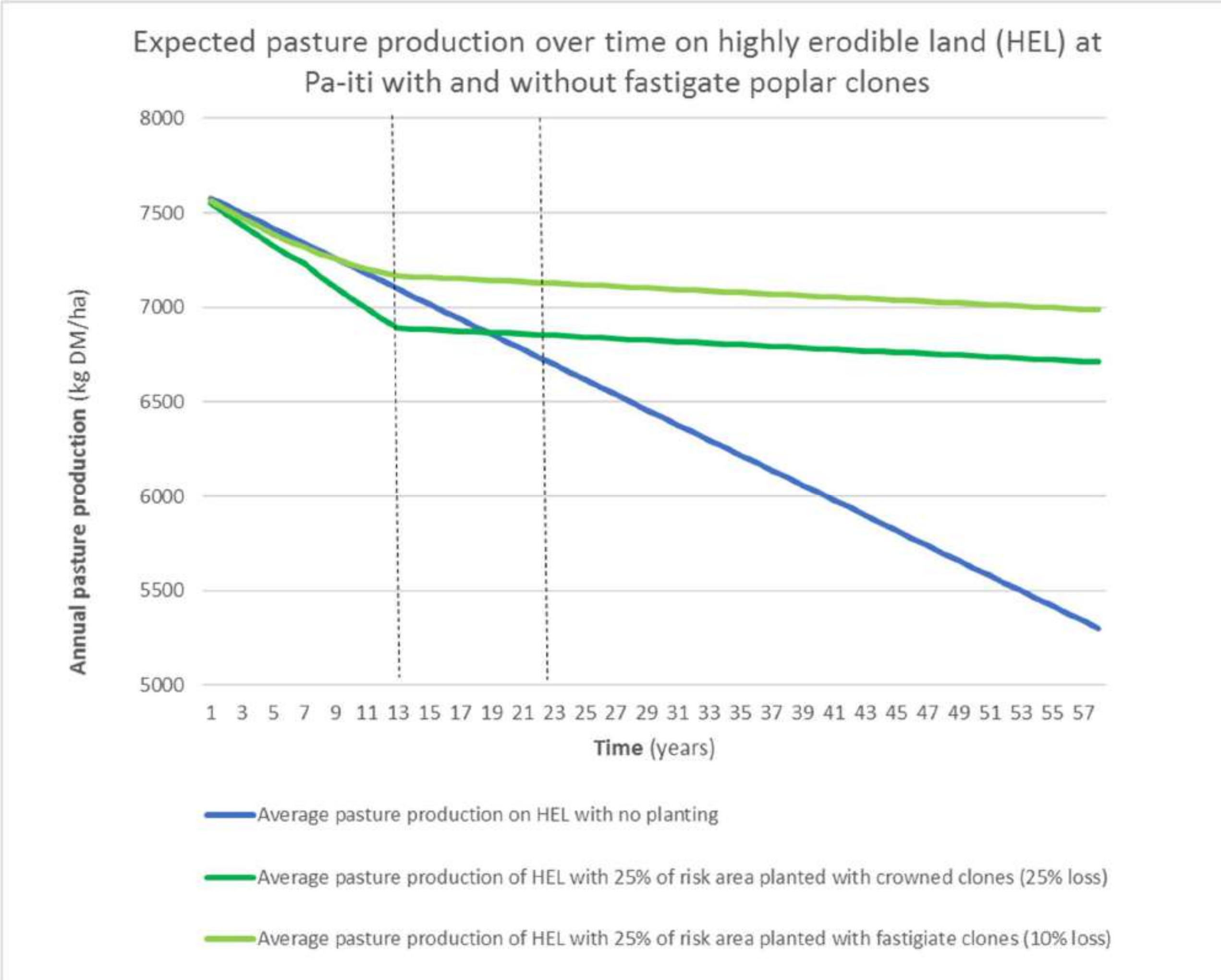

Figure 11: Modelled pasture production over time at Pa-iti based on different poplar clone selection for space planting.

On the assumption that fastigiate forms of clones have a lower impact (c. 10% reduction) on pasture production when planted at the same density as broader-crowned clones (25% reduction), the average pasture production on HEL protected with targeted space-planted fastigiate poplars could be as much as 4% (200 kg DM/ha) higher than where non-fastigiate poplars are used.

Planting costs and management regime

Space-planted poplars are assumed to be established using poles of 3-4 m 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 SPH equates to a cost of $2,072/ha. Form-pruning at three years is also assumed.

The 30 ha of required establishment is assumed to occur over 6 years, largely to manage the practical implications of having to exclude cattle from such areas for 2-3 years, with 5 ha planted each year. At 450 poles per annum, this is three times the rate which is often recommended for soil protection planting.

It is assumed that each compartment comprises a minimum area of 1 ha. The impact of 30% more area being planted than necessary to ensure areas are ETS eligible has been (with no additional gain in erosion protection) has been modelled.

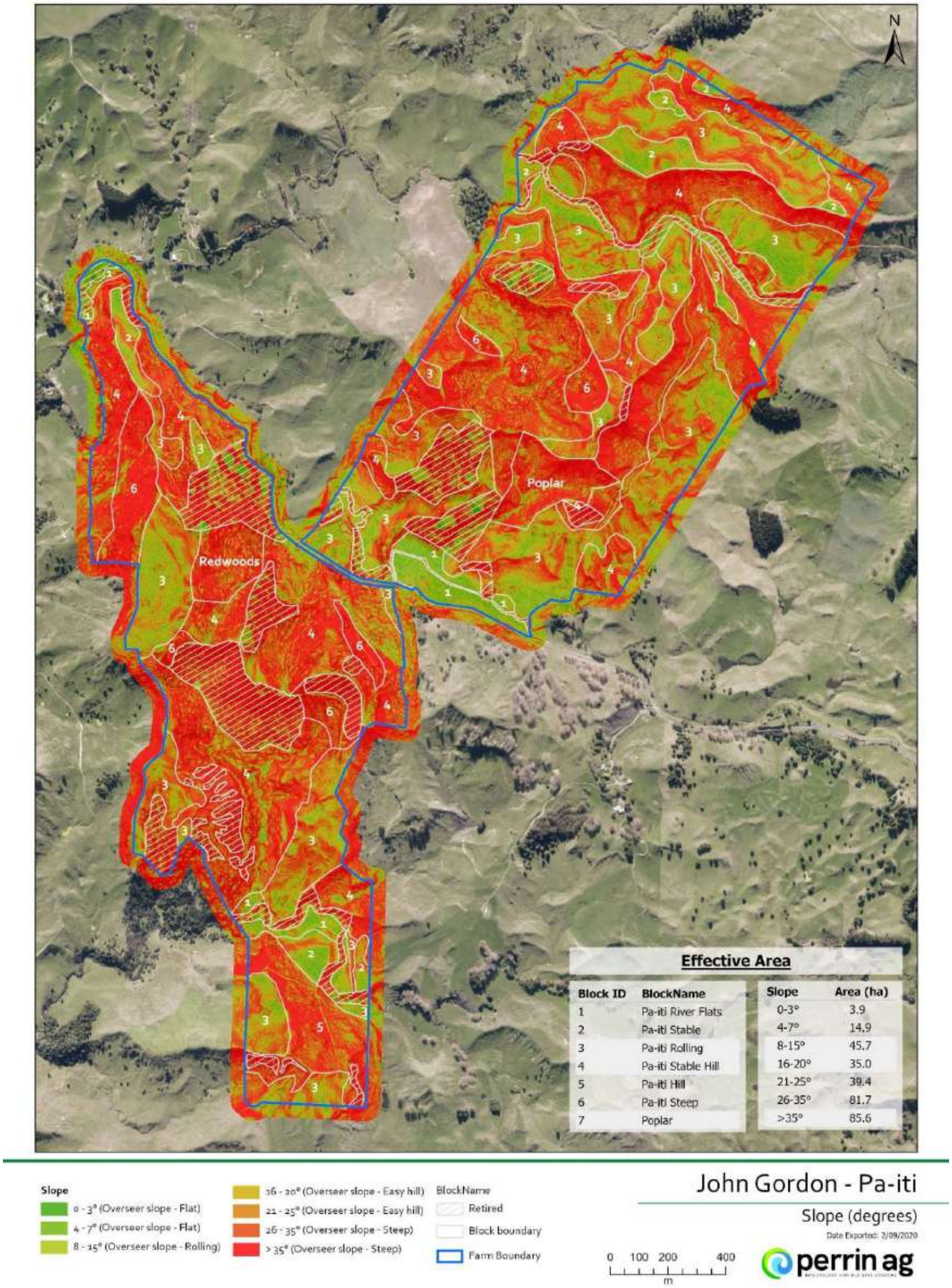

Figure 12: Slope distribution at Pa-iti

SCENARIO 1A – TARGETED SPACE-PLANTED POPLARS

The targeted space-planted poplar regime (Scenario 1a) is based on the planting of poplar poles to high risk areas of the farm's landscape that has a slope category of 20°-35° to prevent shallow landslides (slips) and the accompanying loss of soil and permanently lowered pasture production resulting from their occurrence. Specifically, we have assumed:

- 25% of the HEL (29.6 ha in total) will be planted in poplar poles at a density of 90 SPH. Narrow-crowned poplar cultivars are preferred to reduce wind-throw.
- The poplars are form-pruned at year three to remove double leaders and pruned to reduce the effects of pasture shading. Pruning should be undertaken to leave half the green crown, and to reduce the effects of regrowth, it is undertaken in early summer.
- Areas and features targeted within the high-risk landscape include the 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.
- The 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.
- It is assumed that targeted landscape features are 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.

The associated impact on the farm is:

- The effective area of 306 ha remains unchanged. However pasture production on space-planted compartments is expected to decline to 25% of its current growth until the trees achieve their maximum extent for 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 be13 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.
- Pasture growth rates (and the associated stocking rate) on all other areas of the farm remain unchanged.
- As a result, stocking rate decline over the analysis period is expected to be limited to only 0.5 SU/ha, compared to the expected fall of 1.2 SU/ha if no effort is made to stop shallow landslides.
- Co-benefits from the establishment of space-planted compartments such as reduced environmental stresses on stock (with their accompanying reduction in maintenance feed requirements and faster growth rates) and reduced stock water requirements have not been considered in the analysis.

We recognise that the property has already established suitable space-planted poplar stands on some higher risk landscapes and is already capturing some of the impacts of this decision. For ease of analysis, we have assumed the landscapes of high risk of erosion within the farm are yet to be planted. As such the benefits and/or costs of the planting scenario are likely to be overstated. However, the relative impact of planting versus not planting will still be relevant.

SCENARIO 1B – TARGETED SPACE-PLANTED POPLARS AND LOWER CARBON SEQUESTRATION

Scenario 1b is identical to Scenario 1a except that the NZUs able to be claimed through the ETS will be only 25% of those currently deemed to be available – the result of a possible recalibration of CO_2 assumed to be sequestered in space-planted poplar and willow stands.

- The revised quantum of CO_2 sequestered per space-planted hectare is as per Table 5 below.

Table 5: Revised rates of carbon sequestration for space-planted poplars

Years	CO_2 sequestration in each period (t ha^{-1})	
	Current assumptions	Revised sequestration
0-5	63	16
6-10	188	47
11-15	158	40
16-20	117	29
21-25	92	23
26-30	67	17
31-35	44	11
Total	729	182

SCENARIO 2A – TARGETED SPACE-PLANTED POPLARS REQUIRING GREATER AREA FOR ETS ELIGIBILITY

Scenario 2a is identical to Scenario 1a with the exception that the total area space-planted with poles is 30% greater than Scenario 1 (13% of the effective farm area and 32.5% of the at-risk landscapes) to consider the possibility that the areas of targeted pole establishment may not be sufficiently large or wide to allow the compartments to be eligible for the ETS.

- 32.5% of land in this slope class (38.5 ha in total) will be planted in poplar poles at a density of 90 SPH. Narrow-crowned poplar cultivars are preferred to reduce wind-throw.
- This greater area of planting results in commensurate increases in establishment costs, carbon revenues and loss of pasture production from shading in planted compartments. However, as trees are being planted on areas with no direct impact on the prevention of shallow soil movement, the rate of erosion protection is no different than in Scenario 1a.

The associated impact on the farm is:

- The effective area of 306 ha again remains unchanged. However, 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. As this area is 30% larger than in Scenario 1a & b for no additional or accelerated protection from shallow soil loss, the net loss in pasture production over time is marginally greater.
- As a result, stocking rate decline over the analysis period is expected to be just over 0.6 SU/ha, slightly greater than the expected fall if only the minimum required area to achieve soil stabilisation on the farm needed to be planted.
- Again, co-benefits from the establishment of space-planted compartments such as reduced environmental stresses on stock (with their accompanying reduction in maintenance feed requirements and faster growth rates) and reduced stock water requirements and not considered in the analysis.

SCENARIO 2B – TARGETED SPACE-PLANTED POPLARS REQUIRING GREATER AREA FOR ETS ELIGIBILITY BUT WITH LOWER CARBON SEQUESTRATION

Scenario 2b is identical to Scenario 2a expect that the NZUs able to be claimed through the ETS will be only 25% of those currently deemed to be available – the result of a possible recalibration of CO_2 assumed to be sequestered in space-planted poplar and willow stands.

- Assumed CO_2 sequestration per space-planted hectare will be as per Table 5 above.

SCENARIO 3A – TARGETED SPACE-PLANTED POPLARS USING FASTIGIATE CULTIVARS THAT ARE ETS INELEGIBLE

Scenario 3a is identical to Scenario 1a with the exception that fastigiate ("Lombardy"-type) poplars e.g. var. "Chiba", are used instead of narrow-crowned cultivars.

- There is limited information on the relative rates of carbon sequestration between the fastigiate and narrow and broad crown poplar varieties. While anecdotal observation suggests that space-planted fastigiate cultivars seem to have no difference in soil erosion value, their inability to reach canopy closure at preferred planting densities makes such compartments ineligible for inclusion in the ETS.

The associated impact on the farm is:

- The effective area of 306 ha again remains unchanged. However, pasture production on space-planted compartments is estimated to decline to only 10% of its current growth at the point the trees achieve their maximum extent erosion protection due to the reduced canopy area
- As a result, stocking rate decline over the analysis period is expected to be 0.2 SU/ha, compared to the expected fall of 0.5-0.6 SU/ha if wider canopy cultivars are used.

SCENARIO 3B – TARGETED SPACE-PLANTED POPLARS USING FASTIGIATE CULTIVARS WITH A CHANGE TO ETS ELIGIBILITY

Scenario 3b is identical to Scenario 3a expect that we are assuming changes to the ETS recognise that despite a lack of canopy cover, fastigiate forms of poplar planted at 80-100 SPH still sequester a similar quantum of CO_2 to non-fastigiate forms, but potentially over a significantly longer time period (McIvor, pers. comm) Accordingly, as with no-fastigiate trees, we have assumed NZUs able to be claimed through the ETS will be only 25% of those currently deemed to be available under the look-up tables – the result of a likely recalibration of CO_2 assumed to be sequestered in space-planted poplar and willow stands – but with assumption that fastigiate form clones will take an additional 20 years to sequester the same amount of carbon (due to the lower leaf area associated with fastigiate form leading to slower growth).

- Assumed CO_2 sequestration per space-planted hectare of fastigiate poplar clones will be as per Table 6 below.

Table 6: Suggested rates of carbon sequestration for fastigiate form space-planted poplars

Years	CO_2 sequestration in each period (t ha^{-1}) for fastigiate crown poplars
0-5	11
6-10	33
11-15	34
16-20	25
21-25	20
26-30	14
31-35	10
36-40	10
41-45	9
46-50	8
51-55	8
Total	181

A NOTE ON INVESTMENT ANALYSIS

The relative financial performance of the both the individual forestry and aggregate land use enterprises in each scenario is measured by both net present value ("NPV") and internal rate of return ("IRR"). The forestry enterprises are also described using an annuity.

The NPV of an investment is the sum of the present value for each year's net cash flow less the initial cost of the investment. Investments with a positive NPV mean that the investment generates a return greater than the assumed discount rate (see below); those with a negative NPV generate a lower return than the assumed discount rate and would be rejected as positive financial investments.

The IRR is the actual rate of return on an investment with proper accounting for the time value of money – essentially the discount rate at which the NPV of an investment would be zero.

An annuity is an annual cash flow that would deliver the same NPV over the lifetime of the investment at the assumed discount rate (in today's dollars) as the investment itself. This is useful in helping quantify the relative annual average profitability of forestry with land uses that generate revenue every year. However, the phasing of cash flows is not directly apparent from this measure so it needs to be considered in conjunction with time series cash flow analysis.

A uniform discount rate of 6% has been used in analysing across both the forestry and farming aspects of the business model, including returns from ecosystems services such as nitrogen and carbon. A consistent discount rate is necessary when presenting a NPV indicator between scenarios but may not be appropriate where landowners have a preference for one revenue source over another. The use of a consistent discount rate here was a necessary practical assumption.

We note that while 6% is a common agricultural discount rate, 8% is a more common forestry discount rate. There are also other conventions which differ between standard practice for agricultural and forestry economic evaluation, such as the treatment of land opportunity costs and the length of time considered. These factors interact with the choice of discount rate. Additionally, it is useful to treat uncertain revenue streams such as the sale of carbon credits with a higher discount rate. While differing discount rates are useful to account for differences in risk profiles and other aspects of the revenue streams included, that additional level of analysis is considered out of scope for this report.

In this analysis, the investment in the land is deliberately excluded and only reflects the investment made by the case study in livestock, tree stock, plant and machinery and any additional rights to discharge nutrients to water. This assumption is made on the basis that the investment in the land is not discretionary between scenarios, but the choice of land use is.

Section 3: Results of forestry scenario analysis

This section describes the discrete performance of the forest investment under each scenario. These results are analysed separately to the impact on the farm business. Table 7 summarises the discrete investment outcomes from space-planting poplar poles as described in the scenarios, with the forestry revenues (if any) considered over a 56 year period – equivalent to two radiata pine rotations and broadly in line with the effective lifespan of the poles before they potentially start to become susceptible to failure.

Reductions of environmental externalities (N and P loss to water, GHG emissions and carbon sequestration) are discussed later in Section 5 (whole farm business analysis).

Table 7: Summary of individual investment performance of the forestry investments under each scenario

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		Fastigate	
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%**

Details of the individual scenarios are discussed below.

SCENARIO 1

While some poplar clones have historically been planted with timber potential in mind (i.e. Kawa), the value proposition for space-planted poplars has generally been with regard to their co-benefits for the farm system they have been integrated with. The potential for space-planted trees to enter into the ETS has clearly altered this.

As is evident from the 1a analysis above, 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%. With a positive NPV at that assumed discount rate, the internal rate of return (IRR) must be higher than that – in this case the IRR is 19%.

However, if the government decides to reduce the extent of 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, a reduction in sequestered carbon to only 25% of that currently assumed in the ETS look-up tables lowers the IRR to 5% and accordingly delivers a negative NPV at the assumed discount rate of 6% ($8,040) for the 29.7 ha of space-planting. 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

With a larger area of trees planted (38.6 ha versus 29.7 ha), Scenario 2a generates a larger NPV at 6% than Scenario 1a, although, the IRR is exactly the same for 1a and 2a. However, due to the higher cost of establishment (larger area) and the impact this has on the investment when the time value of money is considered, the NPV is lower (more negative) in Scenario 2b (where assumed quantum of carbon sequestration is lower).

SCENARIO 3

If fastigiate poplar cultivars planted at 90 SPH are ineligible for the ETS due to lack of minimum canopy closure, then there is no forestry related revenue and the NPV of the investment is simply the cost of establishment expressed in today's value. With no revenue, we are unable to calculate an IRR.

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[3]. 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.

RISK ANALYSIS

The following section analyses the sensitivity of a space-planted poplar forest's IRR pre-tax to carbon price ($/NZU) and the likely rate of sequestration relative to the Exotic Hardwood look-up tables currently used to assess this. Only Scenario 1 was analysed, given the similarity between the scenarios.

The carbon values provided align with a supplementary order paper currently before Parliament that proposes lifting the fixed-price option under the ETS – a clause allowing emitters to pay money instead of surrendering carbon credits – from the current $25 to $35, along with a $20 price floor and a $50 price cap. The relativity of carbon sequestration to the current ETS tables ranges from 0% (where space planted trees may simply not have sufficient density under current requirement to be eligible to be entered in the ETS), to 25% (where we estimate space-planted poplar's true rates of carbon sequestration to be) through to the amount of NZUs <u>currently</u> able to be claimed. The 50% and 75% rates indicate possible intermediate levels of NZU allocation that government *might* consider using to reflect the wider community co-benefits that such plantings might afford, such as permanent sediment reduction.

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[3] The slight difference in assumed total sequestration (182 t CO_2/ha versus 181 t CO_2/ha) accounts for the slight ($4,000) difference in total carbon revenues.

Table 8: Impact of amount of carbon sequestered and carbon price ($/NZU) on internal rate of return (IRR%) pre-tax on Scenario 1

		Relativity of sequestration to current ETS tables				
		0%	25%	50%	75%	100%
Carbon price ($/NZU)	**20**	-	3%	9%	13%	16%
	25	-	5%	11%	16%	19%
	35	-	8%	15%	20%	24%
	50	-	11%	19%	25%	30%

Assuming space-planted poplars are considered eligible for the ETS, then at the current statutory bounds of New Zealand carbon values, it appears as if such plantings will generate a positive IRR *before* considering any potential co-benefits. At a given carbon price expectation, the underlying rate of return is extremely responsive to the amount of NZUs such a forest is deemed eligible to generate. So, while the carbon price is important, the extent of eligibility and deemed sequestration appears to be more so. With the potential for the recalculation of sequestration rates for space-planted poplars, confirming this will be critically important with regard to the extent of any direct financial incentive for farmers to adopt or more likely accelerate the extent of space-planted trees on highly erodible land.

Figure 13: Poplar tree loss within a space-planted compartment

While not considered directly in this analysis, poplar trees have a reputation for being shorter lived than some other tree species. Over time, space-planted trees will invariably die and need to be replaced. Under current ETS provisions, the loss of canopy cover (through tree death) and ultimately ETS eligibility could result in a potential carbon liability that would need to be met. At Pa-iti there are examples of areas of space-planted poplars that were established over 50 years ago and are still sound and growing well. However, the loss of individual trees because of wind rock (Figure 13) or canker still occurs. In most cases the underlying planting density would still be sufficient to protect the slope from erosion, but with the density needed to effect erosion control approximately half that required to ensure ETS eligibility, the loss of a moderate amount (5-10%) of mature trees might result in a compartment moving out of eligibility. As is demonstrated below (Section 4: Impact on the Pa-iti farm system), the considerable co-benefits of space-planting poplars is such that farmers will likely be motivated to “blank” (replace) tree loss to maintain soil protection. We would expect that so long as replacement occurred in a timely fashion, the carbon deemed to accrue by stands such as these wouldn't be jeopardised by sporadic tree loss, in the same way such losses are now treated in "permanent" forests. However, clarity in this area would also be of value. The need to replace trees would obviously dilute investment returns, but the ongoing protection afforded to a valuable pastoral land would likely more than compensate for this.

Section 4: Impact on the Pa-iti farm system

IMPACTS OF SPACE-PLANTING

The effects of the decision to establish space-planted poplars on HEL need to be assessed in a slightly different way to conventional forestry. This is due to the underlying reason for their establishment - protection from soil loss. Unprotected, the soil resource on large areas of properties like Pa-iti will continue to be lost over time, resulting in loss of productivity, additional costs and intermittent disruption. On the basis of the productivity losses established by DeRose et al (1995) described above, operating profit at a property like Pa-iti would be expected to decline by 36% over the next 50-60 years relative to current performance if the 40% of its farm comprising HEL was allowed to continue to slip and head down to the Turakina River. This loss of profitability is essentially due to a 9% reduction in stocking rate with limited capacity to reduce overhead costs, including the required management input. Furthermore, large slip events are expected to increase operating expenses when they occur, assumed here at $5,000+GST of contingent digger work every five years. While discounted cash flow analysis is needed to properly assess the gradual impact of these impacts over time, comparing current farm performance with indicative levels of performance with and without space-planting is a useful exercise.

MEAT AND WOOL PRODUCTION

Under all of the space-planted scenarios pasture production and meat and wool production is expected to trend lower than that at Pa-iti today as a result of the loss of some pasture production directly within the space-planted compartments and the fact that space-planting will eliminate most, but not all erosion. However, the true comparator is what will happened to the farm system today without addressing the erosion risk. As can be seen in Table 9, without intervention the overall farm stocking rate (SU/ha) is estimated to decline by 9% and production (kg meat & wool) by 10.4% as result of the 30% reduction in pasture production from the unstable hill country at Pa-iti. Space-planting of poles is expected to reduce this impact by a minimum of 60% and potentially more if erosion control can be achieved with less shading of the pasture, say with fastigiate forms of poplar (Scenario 3).

Table 9: Summary of physical situation of the scenarios compared to base system at Year 56

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%

PROFITABILITY

All of the scenarios considered result in a loss of profitability over time from that currently achieved at Pa-iti. The respective farm performance parameters are presented in Table 10 below. However, as with pasture production, in the absence of establishing space-planted poplars on the HEL, profitability decline is estimated to be significantly higher. The expected farm enterprise profitability decline is greater (in % terms) than the expected production decline due to the impact of overhead costs (including the reward for management) and sticky operational costs (like R&M) which are assumed to change little, if at all, with the declining stocking levels. Although not overtly considered here, in practice some variable costs might increase in the face of uncontrolled erosion – mustering made more difficult with slips, greater levels of stock misadventure and losses, more minor fence, track and dam maintenance etc.

Table 10: Summary of financial performance indicators for the sheep & beef enterprise at year 56 (FY76).

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%

* Revenue assumptions based on a reference season average prime lamb price of $6.50/kg cwt, prime cattle price of $5.30/kg cwt and wool at $2/kg greasy.

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 ultimately the cash the Gordons want to draw from the business over and above that already assumed to reflect the owner's labour and management input. Based on the latest 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 equate to $725,000 of term debt, requiring $38,425 of surplus cash to meet current interest costs (at 5.3%) and a further $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. At the Gordon's level of operating performance, this level of debt servicing and repayment would likely be achievable. But higher levels of debt would constrain the availability of profit for other purposes and reduce financial resilience.

Section 5: Whole farm business analysis

IMPACT OF INTEGRATED FORESTRY LAND USE

Whole business cash flows, with ETS variations as described in Section 3: Results of forestry scenario analysis above for each of the three space-planted forestry scenarios compared to the base system were completed and analysed using discounted cash flow analysis. The results are summarised in Table 11 below.

Table 11: Summary of financial results from integrated land use.

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	Fastigiate	Fastigiate
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 from base system		$398,696	$169,545	$455,563	$157,668	$131,565	$191,463
% change to equity		8.2%	3.5%	9.4%	3.3%	2.7%	4.0%

Key observations from this analysis include:

- 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 (also see Figure 14).
- The current assumptions in the ETS as to the amount of carbon that can be claimed from eligible space-planted hardwoods makes a significant difference to the discrete investment returns from planting the trees and claiming carbon. In fact, on that basis space-planting poplars for carbon had a higher IRR 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, a result of the same extent of erosion protection, but with reduced loss of pasture production from shading. But their current ineligibility for the ETS means that Scenario 1a currently provides the greatest overall return.

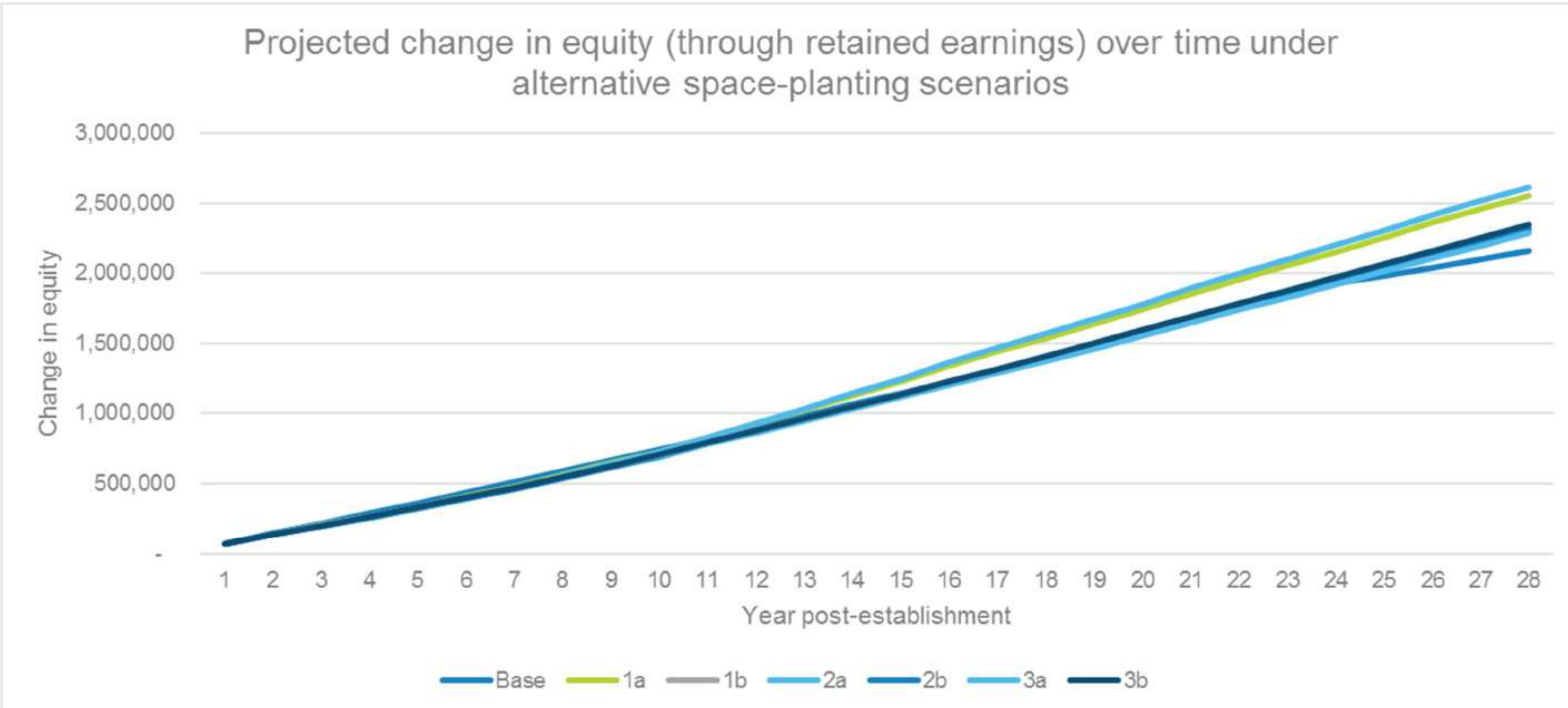

Figure 14: Comparison of total business change in equity positions for all scenarios compared to the base system including the sale of carbon ($25/NZU) if applicable (1b located under line 2b)

RISK ANALYSIS

Risk analysis of the three space-planting regimes in Section 3: Results of forestry scenario analysis above indicated that while the carbon price is important in determining the underlying investment return from stands of space-planted poplars, the extent of eligibility and deemed sequestration appears to be more so.

At Pa-iti, the high sheep: cattle ratio (85%:15%) makes the profitability of the farm business extremely sensitive to changes in sheep meat price and conventional sensitivity analysis probably is not required to demonstrate that.

With regard to the integrated business (using Scenario 1b as the example), given the relative amount of carbon revenue relative to those of the underlying farming operation, dominated by lamb production, it is unsurprising volatility in average lamb price has a greater impact on the underlying level of return than the price of NZU (Table 12), assuming the revised [lower] rates of carbon sequestration assumed from space-planted trees achieving the minimum canopy.

Table 12: Impact of lamb price ($/kg carcass weight) and carbon price ($/NZU) on internal rate of return (IRR%) pre-tax on Scenario 1b (25% of HEL space-planted assuming revised sequestration rates)

		Carbon price ($/NZU)				
		$0	**$20**	**$25**	**$35**	**$50**
Lamb price ($/kg cwt)	**$5.00**	6.5%	6.8%	6.8%	7.0%	7.2%
	$5.50	10.0%	10.3%	10.4%	10.5%	10.7%
	$6.00	13.6%	13.8%	13.9%	14.0%	14.1%
	$6.50	17.2%	17.4%	17.4%	17.5%	17.6%
	$7.00	20.8%	20.9%	21.0%	21.0%	21.2%
	$7.50	24.4%	24.5%	24.6%	24.6%	24.7%

However, the impact that the space-planting has on erosion control and the amount of the property consisting of HEL is of more relevance to the overall business. Within the accepted range of erosion protection afforded by space-planted poplars, the NPV associated with doing so changes very little; less than 1% over the 56-year timeframe considered for a given proportion of the property that might benefit from erosion protection.

Table 13: Impact of the extent of erosion protection afforded by space-planting the proportion of the farm that is highly erodible land (HEL) and carbon price ($/NZU) on the pre-tax net present value ($) for Scenario 1b (25% of HEL space-planted assuming revised sequestration rates)

		Erosion protection afforded by space-planting			
		70%	**80%**	**90%**	**95%**
% farm as HEL	**20%**	1,420,609	1,423,832	1,427,054	1,428,665
	39%	1,361,598	1,367,848	1,374,098	1,377,223
	55%	1,310,694	1,319,556	1,328,418	1,332,849
	100%	1,137,912	1,155,746	1,173,580	1,182,496

However, as can be more easily seen in Table 14 below, as the proportion of a farm that is highly erodible increases, the impact of space-planting on the returns from farm system versus taking no action actually <u>decreases</u>. This may seem counter intuitive, given the significant long-term impact that space-planting has on protecting a farm's pasture resource.

The reason for this apparent anomaly relates to the length of time it potentially takes for the loss of pasture growth under space-planted trees to be "overtaken" by the likely reduction in carrying capacity due to erosion – about 13 years (see Figure 10 above). The long period over which the analysis is considered means that the greater annual operating revenues expected from the less eroded farm property in the future are more heavily discounted than the lower revenues experienced in the first 13 years after establishment.

Table 14: Impact of the extent of erosion protection afforded by space-planting the % of the farm that is highly erodible land (HEL)and carbon price ($/NZU) on the difference in pre-tax net present value ($) between Scenario 1b (25% of HEL space-planted assuming revised sequestration rates) and no planting at all

		Erosion protection afforded by space-planting			
		70%	80%	90%	95%
% farm as HEL	20%	74,708	77,930	81,153	82,764
	39%	34,487	40,737	46,987	50,112
	55%	-209	8,653	17,515	21,946
	100%	-117,309	-99,476	-81,642	-72,725

As presented in Table 14 above, assuming space-planted trees only sequestered 182 t CO_2/ha in the first 35 years, once the proportion of a farm that needed to be space-planted exceeded 55%, the overall return from doing so would (in net present value terms) start to become lower than from not planting at all. However, the amount of carbon assessed as being sequestered by space-planting makes a difference to this assessment. If space-planted trees were deemed to or actually sequestered the amounts of carbon as per the Exotic Hardwood look-up tables (728 t CO_2/ha over 35 years), then the high returns from the planting investment would make the value of space-planting greater for farms who farm more HEL. This is assessed by considering Scenario 1a (see Table 15).

Table 15: Impact of the extent of erosion protection afforded by space-planting the % of the farm that is highly erodible land (HEL) on the difference in pre-tax net present value ($) between Scenario 1a (25% of HEL space-planted assuming current ETS sequestration rates) and no planting at all

		Erosion protection afforded by space planting			
		70%	80%	90%	95%
% farm as HEL	20%	143,663	146,886	150,108	151,719
	39%	168,228	174,479	180,729	183,854
	55%	189,419	198,280	207,142	211,573
	100%	227,468	245,301	263,135	272,052

Similarly, if the amount of pasture production that the poplars supressed at the threshold for ETS eligibility was less (say only 10% if fastigiate forms were used and the ETS changed to allow them to be eligible), then the returns from space-planting for farms with more at risk areas increases (see Table

16), with the financial benefit relative to no space-planting being tangible up to about 68% of the total farm area.

Table 16: Impact of the extent of pasture loss under space-planted trees and the % of the farm that is highly erodible land (HEL) on the difference in pre-tax net present value ($) between Scenario 1b (25% of HEL space-planted assuming revised sequestration rates) and no planting at all

		Quantum of pasture loss under space-planted trees			
		10%	**15%**	**20%**	**25%**
% farm as HEL	**20%**	82,880	82,304	81,729	81,153
	39%	50,337	49,220	48,103	46,987
	68%	- 249	- 2,207	- 4,164	- 6,122
	100%	- 72,082	- 75,269	- 78,455	- 81,642

However, this analysis does overlook the fact that in the absence of planting, the fact that given that the productive potential of the farm is, over time, going to be less than if erosion control had taken place, its capital value is also likely to be lower. While all of the case studies have deliberately excluded the value of land from their investment analyses, it probably makes sense to explore that here.

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 dry matter 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. However, if we apply a reduction in capital value of $1,100/ha of HEL to the terminal value of the scenario without space-planting (the assumed difference between protected and unprotected land), then the NPV still doesn't change much, due to the long period over which that loss of value is discounted. If a property was assumed to incur a $300,000 loss of value in 56 years' time, at 6% that is only worth -$11,481 in today's terms – less than a 1% impact the NPV for a property like Pa-iti. Such analysis potentially explains the lack of incentive many farm owners might have for space-planting erodible hill country.

CHANGE IN ENVIRONMENTAL IMPACT

The impact of the three scenarios modelled relative to both the property's current state and what is expected to occur over time in the absence of erosion intervention with space-planting is presented in Table 17 below.

Table 17: Summary of environmental footprint indicators for the scenarios compared to the base system – both as it is today (status quo) and as it will be in 56 years.

Integrated business environmental results	Current state	Status quo - "unplanted"	Scenario 1	Scenario 2	Scenario 3
Total N leached (kg N/yr)	4,683	4504	4619	4606	4641
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/yr)	146	144	145	145	146
bGHG/ha (t CO_2 eq./ha)	4.08	3.607	3.948	3.92	3.992
Green House Gas emissions (kg CO_2 /kg meat & wool)	19.3	18.9	19.3	19.3	19.3

N AND P LOSS TO WATER

As evident in Table 17 above, total N loss to water from the property is expected to marginally decline over time under any of the scenarios, all as a result of the reducing carrying capacity of the farm (and the strong link between N loss and the urine patch). However, given the limits of OVERSEER modelling, such estimates can essentially be considered as being indicative of no substantive change.

Loss of P is also modelled as being essentially unchanging over time. However, OVERSEER is unable to account for the sediment loss that would be otherwise occurring from HEL unprotected by space-planting. Given P loss from faming is strongly correlated to sediment loss, the likelihood is that in the farm's current "unprotected" state, P loss is either greater than the modelling assumes or P loss will be less than the modelling suggest when erosion is arrested. Either way, the likely beneficial effect of space-planting on P loss is not reflected by OVERSEER.

BIOLOGICAL GHG PROFILE

With the property's bGHG emissions strongly linked to dry matter intake and livestock numbers, with the reduced carrying capacity expected to occur over time, bGHG emissions are all expected to decline under the continuation of the status quo or the space-planting scenarios. Where space-planting reduces the impact of soil erosion and pasture production, bGHGs reduce to a lesser extent than those expected in the absence of erosion protection.

What this analysis does not reflect is the carbon being sequestered in the space-planted trees. While the Zero Carbon Act does not currently allow CO_2 sequestered in trees to directly offset methane and nitrous oxide emissions, the financial return from surrendering NZUs to financially hedge any per kg bGHG levies provides a degree of equivalence between them, assuming the NZU market informs the way the cost of bGHGs might be priced.

On that basis, the net carbon footprint for Pa-iti could be assessed by taking the annual bGHG emissions (in CO_2e) and deducting from them the carbon accumulated in space-planted trees. This has been completed for the three scenarios that assume the level of carbon sequestration our investigations think reasonable to assume for broader-crowned (1b & 2b) and fastigiate (3b) poplars and is presented in Table 18 below for the first 28-year period post planting.

Table 18: Net quanta of greenhouse gases generated from Pa-iti (t CO_2/CO_2e) for the first 28 years following establishment of space-planted poplars

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%

As can be seen in Table 18 above, after 28 years, planting 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. Increasing the area (Scenario 2b) to 38.6 ha sees the net quanta of greenhouse gases reduce by 13% compared to the status quo, while using fastigiate form cultivars delivers a 6% reduction, the impact of the lower rate of sequestration assumed by the more erect poplars and the smaller reductions in stocking rate.

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 isn't 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 bGHG emissions.

Key summary points for case study farm

- The [continued] establishment of 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 on space-planting at Pa-iti would be 15% higher at these levels than simply allowing erosion to occur unhindered (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.
- However, 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.
- Due to their expected lower impact on pasture production, the use of fastigiate formed poplars would be advantageous if assumed rates of sequestration for space-planted poplars are revised down from those currently applicable. But this would require a change in ETS eligibility linking canopy cover to sequestration rates.
- Assuming the case study farm operated with the average amount of debt for sheep and beef farms in the Western North Island region, space-planting wouldn't impact the ability of Pa-iti's owners to repay these levels of debt over a 20 year amortisation period and in fact at the extent assumed, all of the space-planting scenarios considered, even Scenario 3a for which no eligible carbon sequestration was assumed, demonstrated higher equity accumulation (post tax) than no space-planting at all.
- However, further analysis of space-planting scenarios demonstrated that the long-time frame over which such plantings are expected to accrue benefits to the farming enterprise can be undervalued by conventional economic analysis, particularly when higher rates of return (expressed by the choice of discount rate) are required, externalities (like P or sediment loss) are not appropriately valued [if at all] or when policy settings don't support or encourage potentially valuable land use decisions (a blanket assumption on canopy closure and sequestration rates for example)
- 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.

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Appendices

APPENDIX 1: IMPACT OF ASPECT, SLOPE AND FERTILITY ON PASTURE PRODUCTION

To ascertain the impact of modelled scenarios on the farm business, pasture growth curves for the various land classes needed to be developed. Evaluating the productivity of each land class required evaluating differences in soil fertility, pasture species, slope, aspect, and management. These evaluations can then be validated against historical farm performance and observed pasture cover levels at certain times of the year.

To evaluate the impact of slope, aspect and fertility on pasture production and feed quality, assumptions were formed using principals drawn from journal articles, discussions with the case study farmers, and observations made by the project researchers during the farm visit. The assumptions are subjective but provide a sound approximation for the analysis completed. A brief summary of the key principals captured from the journal articles are provided below.

- The main factors influencing pasture growth in steep hill country are soil moisture, temperature, soil fertility and grazing management (Radcliffe, 1982).
- Trials conducted throughout the North Island have shown variation in pasture growth and distribution being affected by slope and aspect (Radcliffe, 1982). There are no set figures for their relative difference with climate, soil type, and seasonal factors influencing variation across regions. Single trial sites have shown no impact in a single season to as high as 30% difference in dry matter production impacted by slope and aspect.
- North facing slopes are warmer promoting growth rates when soil moisture is not limited whereas south facing slopes contain higher soil moisture through the summer months.
- North facing slopes may contain more low quality native and summer grasses (e.g. Paspalum), and a higher proportion of dead material inversely with the amount of legumes and other grasses (Gillingham, 1973).
- The distribution of pasture species is related to topography, especially as this is affected by animal trading, depletion or enrichment of nutrients through animals, or soil moisture conditions.
- The major factor causing variability in DM production and species composition is the fertility of the soil. On steeper slopes this is further complicated by changes in slope and aspect of the soil surface. On moderately steep hill country, variable pasture utilization and nutrient transfer cause by grazing animals create marked differences within a paddock and land that is steep enough to develop stock tracks cause further variability to pastures and soil (Gillingham, 1973).
- AgResearch's senior scientist Warren King states "as the slope increases, pasture production decreases from 100-400 kg DM/ha/yr per degree of slope" (Farmer Weekly, 2016). The magnitude of change is largely affected by soil fertility, pasture species and management factors.

- The relationship between soil fertility (as measured by Olsen P) and pasture dry matter production has been well established for the three main soil types in NZ (pumice, allophanic and sedimentary) and productivity curves as presented in Morton and Roberts (1999) provide good guidance as to the impact on relative pasture productivity for soils as Olsen P values change.

APPENDIX 2: SUMMARY OF HISTORICAL ENVIRONMENTAL PERFORMANCE

Table 19: Summary of Pa-iti environmental performance indicators for the period 2017/18 to 2019/20.

Environmental Indicators	2016/17	2017/18	2018/19
Total N leached (kg N/yr)	4,885	4,514	4,804
N leached per hectare (kg N/ha)	13.5	12.5	13.3
N surplus (kg N/ha/yr)	56	62	61
N conversion efficiency	16%	7%	7%
P Loss (kg P/ha/yr)	0.4	0.4	0.4
bGHG/ha (t CO_2 eq./ha)	4.07	4.14	4.17
% methane	79%	79%	79%
% nitrous oxide	21%	21%	21%

APPENDIX 3: KEY MODELLING ASSUMPTIONS

For the Pa-iti case study, the following key assumption have been used in the analysis:

FARMING ENTERPRISES

- Medium term meat and wool prices were used to calculate stock revenues. These were a lamb price of $6.50/kg cwt, a manufacturing beef price of $5.00/kg, a prime beef price of $5.30/kg and a wool price of $2.00/kg greasy.
- Input expense data and product pricing were sourced from the case study farm's annual accounts, adjusted to reflect normalised [non-capital] fertiliser and repairs and maintenance expenditure each year and the use of medium term sheep and beef prices, in order to reflect the unique farm system of the case study.
- Adjustments for wages of management were included to account for the owner's time contributions, negating the requirement to include drawings and thus providing comparative data to other sheep and beef businesses.
- Average opening liabilities ($2,372/effective ha) were sourced from the 2017/18 Beef + Lamb NZ Economic service sheep & beef farm survey (Beef+Lamb NZ, 2019), allowing the farm's actual debt position to remain undisclosed. For the case study, with an effective area of 306 ha, total debt is $725,000 and opening equity is $2.67 million (based on assumed land and livestock values).
- Debt servicing applied at a status quo interest rate of 5.3%,
- The financial performance of status quo farming system has been described both in terms of operating profit (earnings before interest, tax and rent - EBITR) and cash operating surplus.
- Reported bGHGs comprise methane (CH_4) and nitrous oxide (N_2O) and are expressed as t CO_2 equivalent/ha over the entire property area.
- Key Farmax modelling assumptions are detailed in Appendix 4.

FORESTRY ENTERPRISES

- The impact of space-planted poplars on pasture production and erosion protection were drawn from NZ literature as discussed in the body of the report.
- Rates of carbon sequestration from ETS eligible space-planting are referenced against the MPI lookup tables (MPI, 2017) and empirical research.
- A carbon price of $25 per NZU was assumed for the space-planted woodlots.
- Only "safe" carbon is considered tradeable. A space-planted trees have been considered permanent in this analysis, all of the carbon sequestered up to 35 years (the extent of the lookup tables) is considered "safe".
- The applicable forest operations included planting and form pruning.

WHOLE BUSINESS

- We have assumed a requirement to repay loan principal equivalent to the average amount of debt as per the B+LNZ Economic Survey for Class 4 farms in the Western North Island amortized over 20 years at an interest rate of 5.3%.
- A provision for annual capital reinvestment in the farming enterprise, equivalent to the assumed level of plant and equipment depreciated on a 25-year straight line basis, has been made in the discounted cash flow analysis.
- To provide a "like with like" analysis the sheep and beef operating assets (excluding land) were purchased and sold at the start and end of the cash flow analysis.
- Annual cash surpluses/deficits were applied to the farm's total closing liabilities after debt repayment ($100,000/year) along with the annual CAPEX provision ($60,000/year), which flowed through to the projections of closing equity.

- Changes in the value of livestock on hand flowed through to the equity calculation at the end of the 56 years (effectively offsetting the cash flow implication of these transactions).

APPENDIX 4: FARMAX MODELLING ASSUMPTIONS

NORMAL

- Farmax Red Meat is utilised for the physical modelling. If specific assumptions have not been listed below then the standard farm inputs were used.
- The long-term modelling function was used to create a status quo system.
- Pasture quality was varied across the blocks based on contour and fertility using Farmax defaults e.g. Medium quality pasture assumptions below.

FARMAX YOUR ADVANTAGE RM 8.0.1.24

Medium Quality
1BT Paiti, Jul 18 - Jun 19

Month	Controlled %			Uncontrolled %		
	Green	Stem	Dead	Green	Stem	Dead
Jan	60	10	30	40	35	25
Feb	60	5	35	40	20	40
Mar	65		35	45	10	45
Apr	70		30	55		45
May	75		25	60		40
Jun	80		20	70		30
Jul	85		15	80		20
Aug	85		15	85		15
Sep	85		15	85		15
Oct	85		15	85		15
Nov	75	5	20	75	5	20
Dec	60	20	20	55	20	25

- Pasture growth rates were calculated by using default regional assumptions, inputting the physical data for the 2018/19 year and adjusting pasture growth rates until pasture covers at key times of the year replicated those observed on farm.
- The sheep and beef farming areas were split into seven management blocks which were replicated in OVERSEER FM: river flats, stable rolling, rolling, unstable hill, hill, “Poplars” and steep.
- Nitrogen fertiliser applications align with actual inputs from the 2018/19 season and align with the OVERSEER FM file.
- Utilisation rates for supplement were 82% percent for feed crops.

FINANCIAL

- Farm operating expenses were adjusted as per the schedule below, with **bold text** denoting the application of the costs to the modelled scenarios.

FARMAX
RM 8.0.1.24

1BT 2018-19

1BT Paiti : 1BT, Jul 18 - Jun 19

($/year)		Model (tick to use)		Timing	$ Total	$ / ha (306)	$ / SU (4,010)
Wages	Wages			Monthly	**16,000**	52.29	3.99
	Management Wage			Monthly	**60,293**	197.04	15.04
	Total Wages				**76,293**	**249.32**	**19.03**
Stock	Animal Health	11,155	☐	Monthly	18,446	60.28	**4.60**
	Shearing	**19,337**	☑	As Incurred	0	0.00	0.00
	Velveting	**0**	☑	As Incurred	0	0.00	0.00
	Total Stock				**18,446**	**60.28**	**4.60**
Feed, Crops & Grazing	Conservation	**2,100**	☑	As Incurred	0	0.00	0.00
	Cash Crops	**0**	☑	As Incurred	0	0.00	0.00
	Forage Crops	**23,096**	☑	As Incurred	0	0.00	0.00
	Purchased Feeds	**0**	☑	As Incurred	0	0.00	0.00
	Regrassing	**12,000**	☑	As Incurred	4,200	13.73	1.05
	Grazing	**0**	☑	As Incurred	0	0.00	0.00
	Total Feed/Crops/Grazing				**4,200**	**13.73**	**1.05**
Fertiliser	Fertiliser (Excl. N & Lime)			Oct, Apr	37,332	**122.00**	9.31
	Nitrogen	**6,373**	☑	As Incurred	0	0.00	0.00
	Lime			Oct, Apr	0	**0.00**	0.00
	Total Fertiliser				**37,332**	**122.00**	**9.31**
Other Farm Working	Irrigation Charges			Custom	0	**0.00**	0.00
	Weed & Pest Control			Monthly	3,672	**12.00**	0.92
	Vehicle Expenses			Monthly	8,020	**26.21**	2.00
	Fuel			Monthly	8,020	**26.21**	2.00
	Repairs & Maintenance			Monthly	20,080	**65.62**	5.01
	Freight & Cartage			Monthly	5,333	17.43	**1.33**
	Electricity			Monthly	2,005	6.55	**0.50**
	Other Expenses			Monthly	**5,905**	19.30	1.47
	Total Other Farm Working				**53,035**	**173.32**	**13.23**
Standing	Administration Expenses			Monthly	**10,083**	32.95	2.51
	Insurance			Monthly	**9,180**	30.00	2.29
	ACC Levies			Jul, Jan	**1,913**	6.25	0.48
	Rates			Jul, Oct, Ja...	**9,180**	30.00	2.29
	Total Standing Charges				**30,356**	**99.20**	**7.57**
Total Farm Working Expense					**219,662**	**717.85**	**54.78**
Depreciation				Monthly	**6,000**	19.61	1.50
Total Farm Expenses					**225,662**	**737.46**	**56.28**
Other	Rent/Lease			Monthly	**0**	0.00	0.00
	Interest			Monthly	**92,979**	303.85	23.19
	Principal			Monthly	**0**	0.00	0.00
	Drawings			Monthly	**0**	0.00	0.00
	Taxation			Jul, Oct, Ja...	**0**	0.00	0.00
	Total Other Expenses				**92,979**	**303.85**	**23.19**
	Total Expenses				**318,641**	**1,041.31**	**79.46**

APPENDIX 5: BACKGROUND TO ENVIRONMENTAL LIMITS

GREENHOUSE GASES (GHG)

New Zealand has signed up to international conventions and protocols to reduce GHGs including:

- Reduce emissions to 5% below 1990 levels by 2020
- Reduce emissions to 30% below 2005 levels by 2030 (Paris Agreement).
- Reduce emissions to 50% below 1990 levels by 2050. This was notified in the New Zealand Gazette in March 2011.
- The Zero Carbon Bill introduced in 2019 requires carbon dioxide (CO_2) and nitrous oxide (N_2O) to reduce to net zero by 2050 and methane (CH_4) to reduce to 10% below 2017 by 2030 and 24-47% below 2017 by 2050.

Reducing agriculture emission will be essential for achieving these targets as the sector contributes 48% of New Zealand's total emissions and 85% of the sector's emissions are generated on farm. Other than for biogenic methane and nitrous oxide (through the Zero Carbon Act) and indirectly for fuel and electricity, GHG reduction targets have not yet been set for the sector and agriculture is not yet explicitly in the ETS. However, farmers can expect to be required to make changes to reduce on-farm GHGs and contribute to the above targets being met. The ETS is being updated, including with respect to the settings for forestry, to support the attainment of these reduction targets. Including forestry in farm business enterprises, particularly on land less suited to intensive agriculture, can provide a practical multi-purpose solution to the above challenges.

APPENDIX 6: BUDGETED (STATUS QUO) FINANCIAL PERFORMANCE

FARMAX YOUR ADVANTAGE RM 8.0.1.24

Forecast Profit and Loss for 1BT Paiti

Jul 18 - Jun 19

			$ Total	$/Farm ha	$/SU
Revenue	Sheep	Sales - Purchases	353,108	1,154	88.1
		Wool	32,712	107	8.2
		Total	**385,820**	**1,261**	**96.2**
	Beef	Sales - Purchases	36,220	118	9.0
		Total	**36,220**	**118**	**9.0**
	Total Revenue		**422,040**	**1,379**	**105.2**
Expenses	Wages	Wages	16,000	52	4.0
		Management Wage	60,293	197	15.0
	Stock	Animal Health	18,447	60	4.6
		Shearing	19,337	63	4.8
	Feed/Crop/Grazing	Conservation	2,100	7	0.5
		Forage Crops	23,096	75	5.8
		Regrassing	12,000	39	3.0
	Fertiliser	Fertiliser (Excl. N & Lime)	37,332	122	9.3
		Nitrogen	6,373	21	1.6
	Other Farm Working	Weed & Pest Control	3,672	12	0.9
		Vehicle Expenses	8,020	26	2.0
		Fuel	8,020	26	2.0
		Repairs & Maintenance	20,080	66	5.0
		Freight & Cartage	5,333	17	1.3
		Electricity	2,005	7	0.5
		Other Expenses	5,905	19	1.5
	Standing Charges	Administration Expenses	10,083	33	2.5
		Insurance	9,180	30	2.3
		ACC Levies	1,913	6	0.5
		Rates	9,180	30	2.3
	Total Farm Working Expense		**278,370**	**910**	**69.4**
	Depreciation		6,000	20	1.5
	Total Farm Expenses		**284,370**	**929**	**70.9**
Economic Farm Surplus (EFS)			**137,671**	**450**	**34.3**
Other Expenses		Interest	92,979	304	23.2
Farm Profit before Tax			**44,692**	**146**	**11.1**

EFS is a measure of farm business profitability independent of ownership or funding, used to compare performance between farms.

EFS should include an adjustment for unpaid family labour and management. This can be added to the expense database as management wage.

APPENDIX 7: FULL SCENARIO FARM ENTERPRISE FINANCIAL ANALYSIS

FARMAX YOUR ADVANTAGE RM 8.0.1.24

Compare Forecast Profit and Loss

Jul 18 - Jun 19

			1BT Paiti	1BT Paiti	1BT Paiti	1BT Paiti
			No planting	**25% HEL planted**	**30% HEL planted**	**25%HEL planted with fastigates**
Revenue	Sheep	Sales - Purchases	315,826	340,126	337,061	344,375
		Wool	29,280	31,494	31,225	31,904
		Capital Value Change	0	-570	-760	-380
		Total	**345,107**	**371,049**	**367,526**	**375,900**
	Beef	Sales - Purchases	36,220	36,220	36,220	36,220
		Total	**36,220**	**36,220**	**36,220**	**36,220**
	Total Revenue		**381,327**	**407,270**	**403,746**	**412,120**
Expenses	Wages	Wages	16,000	16,000	16,000	16,000
		Management Wage	60,293	60,293	60,293	60,293
	Stock	Animal Health	16,795	17,869	17,742	18,061
		Shearing	17,296	18,620	18,464	18,858
	Feed/Crop/Grazing	Conservation	2,100	2,100	2,100	2,100
		Forage Crops	23,096	23,096	23,096	23,096
		Regrassing	12,000	12,000	12,000	12,000
	Fertiliser	Fertiliser (Excl. N & Lime)	37,332	37,332	37,332	37,332
		Nitrogen	6,373	6,373	6,373	6,373
	Other Farm Working	Weed & Pest Control	3,672	3,672	3,672	3,672
		Vehicle Expenses	8,020	8,020	8,020	8,020
		Fuel	8,020	8,020	8,020	8,020
		Repairs & Maintenance	20,080	20,080	20,080	20,080
		Freight & Cartage	4,856	5,166	5,130	5,222
		Electricity	1,826	1,942	1,928	1,963
		Other Expenses	5,905	5,905	5,905	5,905
	Standing Charges	Administration Expenses	10,083	10,083	10,083	10,083
		Insurance	9,180	9,180	9,180	9,180
		ACC Levies	1,913	1,913	1,913	1,913
		Rates	9,180	9,180	9,180	9,180
	Total Farm Working Expense		**274,019**	**276,844**	**276,511**	**277,351**
	Depreciation		5,908	5,908	5,908	5,908
	Total Farm Expenses		**279,927**	**282,752**	**282,419**	**283,259**
Economic Farm Surplus (EFS)			**101,400**	**124,517**	**121,327**	**128,861**
Other Expenses		Interest	92,979	92,979	92,979	92,979
Farm Profit before Tax			**8,421**	**31,538**	**28,348**	**35,882**
Farm Profit per ha before Tax			**23**	**87**	**78**	**99**

EFS is a measure of farm business profitability independent of ownership or funding, used to compare performance between farms.

EFS should include an adjustment for unpaid family labour and management. This can be added to the expense database as management wage.

APPENDIX 9: INTEGRATED SCENARIO FULL CASH FLOWS

UNPLANTED

		Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Year ending 30 June																															
Farming																															
Annual profit ($)				143,696	143,069	142,430	141,792	141,153	140,515	139,877	139,238	138,600	137,962	137,323	136,685	136,046	135,408	134,770	134,131	133,493	132,854	132,216	131,578	130,939	130,301	129,663	129,024	128,386	127,747	127,109	126,471
Erosion repair ($)								-5,000					-5,000					-5,000					-5,000					-5,000			
Investment in livestock ($)			-602,507	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099
Investment in plant and machinery ($)			-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars																															
Planting costs ($)					-	-	-	-	-	-																					
Pruning ($)							-	-	-	-	-	-																			
Carbon revenue ($)	$25	/NZU		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Annual cash flow ($ pre-tax and interest)			-752,507	138,795	138,167	137,529	136,890	131,252	135,614	134,975	134,337	133,699	128,060	132,422	131,783	131,145	130,507	124,868	129,230	128,591	127,953	127,315	121,676	126,038	125,399	124,761	124,123	118,484	122,846	122,208	121,569
Interest ($)				-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134	-19,213	-17,291	-15,370	-13,449	-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	-38,764	-38,764	-38,764	-38,764
Tax ($ at 28%)				-29,476	-29,838	-30,197	-30,557	-30,916	-31,275	-31,634	-31,993	-32,353	-32,712	-33,071	-33,430	-33,789	-34,149	-34,508	-34,867	-35,226	-35,585	-35,945	-36,304	-36,663	-36,484	-36,306	-36,127	-25,094	-24,915	-24,737	-24,558
Principal repayments ($)				-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250								
Free cashflow ($)				34,644	35,575	36,499	37,423	33,346	39,270	40,194	41,117	42,041	37,965	43,888	44,812	45,736	46,659	42,583	48,507	49,430	50,354	51,278	47,201	89,375	88,915	88,456	87,996	54,626	59,167	58,707	58,247
Residual liabilities ($)				-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500	-326,250	-290,000	-253,750	-217,500	-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0	0	0
Opening equity ($)				2,677,507	2,748,401	2,820,226	2,892,975	2,966,648	3,036,244	3,111,764	3,188,207	3,265,575	3,343,866	3,418,080	3,498,219	3,579,280	3,661,266	3,744,175	3,823,008	3,907,765	3,993,445	4,080,049	4,167,577	4,251,028	4,340,403	4,429,318	4,517,773	4,605,769	4,660,396	4,719,562	4,778,269
Closing equity ($)			0	2,748,401	2,820,226	2,892,975	2,966,648	3,036,244	3,111,764	3,188,207	3,265,575	3,343,866	3,418,080	3,498,219	3,579,280	3,661,266	3,744,175	3,823,008	3,907,765	3,993,445	4,080,049	4,167,577	4,251,028	4,340,403	4,429,318	4,517,773	4,605,769	4,660,396	4,719,562	4,778,269	4,836,516
NPV				**1,331,446**																											
IRR				**17.9%**																											

	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Annual profit ($)	125,832	125,194	124,555	123,917	123,279	122,640	122,002	121,363	120,725	120,087	119,448	118,810	118,172	117,533	116,895	116,256	115,618	114,980	114,341	113,703	113,064	112,426	111,788	111,149	110,511	109,873	109,234	108,596
Erosion repair ($)		-5,000					-5,000					-5,000					-5,000					-5,000					-5,000	
Investment in livestock ($)	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	1,099	537,755
Investment in plant and machinery ($)	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	6,000
Carbon revenue ($)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Annual cash flow ($ pre-tax and interest)	120,931	115,292	119,654	119,016	118,377	117,739	112,100	116,462	115,824	115,185	114,547	108,909	113,270	112,632	111,993	111,355	105,717	110,078	109,440	108,801	108,163	102,525	106,886	106,248	105,610	104,971	99,333	652,350
Interest ($)	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764	-38,764
Tax ($ at 28%)	-24,379	-24,200	-24,022	-23,843	-23,664	-23,485	-23,307	-23,128	-22,949	-22,770	-22,592	-22,413	-22,234	-22,055	-21,877	-21,698	-21,519	-21,340	-21,162	-20,983	-20,804	-20,625	-20,447	-20,268	-20,089	-19,910	-19,732	-19,553
Free cashflow ($)	57,788	52,328	56,868	56,409	55,949	55,489	50,030	54,570	54,111	53,651	53,191	47,732	52,272	51,812	51,353	50,893	45,433	49,974	49,514	49,055	48,595	43,135	47,676	47,216	46,756	46,297	40,837	594,034
Residual liabilities ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Opening equity ($)	4,836,516	4,894,304	4,946,632	5,003,500	5,059,909	5,115,858	5,171,348	5,221,378	5,275,948	5,330,058	5,383,709	5,436,900	5,484,632	5,536,904	5,588,716	5,640,069	5,690,962	5,736,396	5,786,369	5,835,884	5,884,938	5,933,533	5,976,668	6,024,344	6,071,560	6,118,316	6,164,613	6,205,450
Closing equity ($)	4,894,304	4,946,632	5,003,500	5,059,909	5,115,858	5,171,348	5,221,378	5,275,948	5,330,058	5,383,709	5,436,900	5,484,632	5,536,904	5,588,716	5,640,069	5,690,962	5,736,396	5,786,369	5,835,884	5,884,938	5,933,533	5,976,668	6,024,344	6,071,560	6,118,316	6,164,613	6,205,450	6,799,483

SCENARIO 1A – 25% OF HEL SPACE-PLANTED AND CARBON CLAIMED AS PER CURRENT ETS LOOK-UP TABLES

	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Year ending 30 June		**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Farming															
Annual profit ($)			143,696	142,818	142,225	141,590	140,921	140,224	139,506	138,775	138,038	137,295	136,548	135,795	135,036
Investment in livestock ($)		-602,507	1,766	1,193	1,277	1,346	1,402	1,443	1,471	1,482	1,493	1,504	1,514	1,526	1,537
Investment in plant and machinery ($)		-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars															
Planting costs ($)				-10,247	-10,247	-10,247	-10,247	-10,247	-10,247						
Pruning ($)						-1,122	-1,122	-1,122	-1,122	-1,122	-1,122				
Carbon revenue ($)	$25 /NZU		0	0	0	0	0	7,790	7,790	7,790	7,790	7,790	31,035	23,245	23,245
Annual cash flow ($ pre-tax and interest)		-752,507	139,462	127,764	127,255	125,568	124,954	132,088	131,399	140,925	140,198	140,589	163,097	154,566	153,819
Interest ($)			-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134	-19,213	-17,291	-15,370
Tax ($ at 28%)			-29,476	-26,899	-27,271	-27,317	-27,667	-30,191	-30,528	-33,731	-34,062	-34,706	-41,544	-39,690	-40,015
Principal repayments ($)			-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250
Free cashflow ($)			35,311	28,111	29,151	29,340	30,297	36,828	37,723	45,968	46,831	48,499	66,091	61,335	62,184
Residual liabilities ($)			-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500	-326,250	-290,000	-253,750
Opening equity ($)			2,677,507	2,749,068	2,813,430	2,878,831	2,944,421	3,010,967	3,084,045	3,158,018	3,240,236	3,323,317	3,408,066	3,510,407	3,607,992
Closing equity ($)			2,749,068	2,813,430	2,878,831	2,944,421	3,010,967	3,084,045	3,158,018	3,240,236	3,323,317	3,408,066	3,510,407	3,607,992	3,706,425
NPV			**1,507,840**												
IRR			**18.1%**												

	Year	14	15	16	17	18	19	20	21	22	23	24	25	26
Year ending 30 June		**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**
Farming														
Annual profit ($)		134,272	133,644	133,144	132,765	132,501	132,346	132,291	132,236	132,182	132,127	132,073	132,018	131,963
Investment in livestock ($)		1,264	1,006	761	530	313	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)		-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars														
Planting costs ($)														
Pruning ($)														
Carbon revenue ($)	$25 /NZU	23,245	23,245	42,781	19,536	19,536	19,536	19,536	34,003	14,467	14,467	14,467	14,467	25,842
Annual cash flow ($ pre-tax and interest)		152,782	151,894	170,686	146,832	146,351	145,992	145,937	160,349	140,758	140,704	140,649	140,594	151,915
Interest ($)		-13,449	-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	0	0
Tax ($ at 28%)		-40,339	-40,701	-46,569	-40,493	-40,957	-41,451	-41,974	-46,547	-41,062	-41,046	-41,031	-41,016	-44,185
Principal repayments ($)		-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250						
Free cashflow ($)		62,744	63,416	78,261	62,404	63,381	64,448	65,792	113,802	99,697	99,657	99,618	99,579	107,730
Residual liabilities ($)		-217,500	-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0
Opening equity ($)		3,706,425	3,805,419	3,905,085	4,019,595	4,118,249	4,217,880	4,318,578	4,420,620	4,534,422	4,634,119	4,733,776	4,833,394	4,932,973
Closing equity ($)		3,805,419	3,905,085	4,019,595	4,118,249	4,217,880	4,318,578	4,420,620	4,534,422	4,634,119	4,733,776	4,833,394	4,932,973	5,040,702

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
2047	**2048**	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**
131,909	131,854	131,799	131,745	131,690	131,636	131,581	131,526	131,472	131,417	131,362	131,308	131,253	131,199	131,144
110	110	110	110	110	110	110	110	110	110	110	110	110	110	110
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
11,375	11,375	11,375	11,375	19,660	8,284	8,284	8,284	8,284	13,725	5,440	5,440	5,440	5,440	5,440
137,394	137,339	137,285	137,230	145,460	134,030	133,975	133,920	133,866	139,252	130,913	130,858	130,803	130,749	130,694
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-40,120	-40,104	-40,089	-40,074	-42,378	-39,178	-39,162	-39,147	-39,132	-40,640	-38,305	-38,290	-38,274	-38,259	-38,244
97,274	97,235	97,196	97,156	103,082	94,852	94,813	94,773	94,734	98,612	92,608	92,569	92,529	92,490	92,451
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5,040,702	5,137,977	5,235,212	5,332,408	5,429,564	5,532,646	5,627,498	5,722,311	5,817,084	5,911,818	6,010,430	6,103,038	6,195,607	6,288,136	6,380,626
5,137,977	5,235,212	5,332,408	5,429,564	5,532,646	5,627,498	5,722,311	5,817,084	5,911,818	6,010,430	6,103,038	6,195,607	6,288,136	6,380,626	6,473,077

42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
2062	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
131,089	131,035	130,980	130,925	130,871	130,816	130,762	130,707	130,652	130,598	130,543	130,488	130,434	130,379	130,325
110	110	110	110	110	110	110	110	110	110	110	110	110	110	570,296
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	150,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
125,199	125,145	125,090	125,035	124,981	124,926	124,871	124,817	124,762	124,708	124,653	124,598	124,544	124,489	850,620
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-36,705	-36,690	-36,674	-36,659	-36,644	-36,629	-36,613	-36,598	-36,583	-36,567	-36,552	-36,537	-36,521	-36,506	-36,491
88,494	88,455	88,416	88,376	88,337	88,298	88,258	88,219	88,180	88,140	88,101	88,062	88,022	87,983	814,129
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,473,077	6,561,571	6,650,026	6,738,441	6,826,817	6,915,154	7,003,452	7,091,710	7,179,929	7,268,108	7,356,248	7,444,349	7,532,411	7,620,433	7,708,416
6,561,571	6,650,026	6,738,441	6,826,817	6,915,154	7,003,452	7,091,710	7,179,929	7,268,108	7,356,248	7,444,349	7,532,411	7,620,433	7,708,416	8,522,545

SCENARIO 1B – 25% OF HEL SPACE-PLANTED AND CARBON CLAIMED AT 25% OF THE CURRENT ETS LOOK-UP TABLES

		Year	0	1	2	3	4	5	6	7	8	9	10
Year ending 30 June			**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Farming													
Annual profit ($)				143,696	142,818	142,225	141,590	140,921	140,224	139,506	138,775	138,038	137,295
Investment in livestock ($)			-602,507	1,766	1,193	1,277	1,346	1,402	1,443	1,471	1,482	1,493	1,504
Investment in plant and machinery ($)			-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars													
Planting costs ($)					-10,247	-10,247	-10,247	-10,247	-10,247	-10,247			
Pruning ($)							-1,122	-1,122	-1,122	-1,122	-1,122	-1,122	
Carbon revenue ($)	$25	/NZU		0	0	0	0	0	1,947	1,947	1,947	1,947	1,947
Annual cash flow ($ pre-tax and interest)			-752,507	139,462	127,764	127,255	125,568	124,954	126,246	125,556	135,082	134,356	134,746
Interest ($)				-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134
Tax ($ at 28%)				-29,476	-26,899	-27,271	-27,317	-27,667	-28,555	-28,892	-32,095	-32,426	-33,071
Principal repayments ($)				-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250
Free cashflow ($)				35,311	28,111	29,151	29,340	30,297	32,622	33,516	41,761	42,625	44,292
Residual liabilities ($)				-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500
Opening equity ($)				2,677,507	2,749,068	2,813,430	2,878,831	2,944,421	3,010,967	3,079,839	3,149,605	3,227,617	3,306,491
Closing equity ($)				2,749,068	2,813,430	2,878,831	2,944,421	3,010,967	3,079,839	3,149,605	3,227,617	3,306,491	3,387,034
NPV				**1,374,098**									
IRR				**17.4%**									

Year	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Year ending 30 June	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Annual profit ($)	136,548	135,795	135,036	134,272	133,644	133,144	132,765	132,501	132,346	132,291	132,236	132,182	132,127	132,073	132,018	131,963	131,909	131,854
Investment in livestock ($)	1,514	1,526	1,537	1,264	1,006	761	530	313	110	110	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Carbon revenue ($)	7,759	5,811	5,811	5,811	5,811	10,695	4,884	4,884	4,884	4,884	8,501	3,617	3,617	3,617	3,617	6,460	2,844	2,844
Annual cash flow ($ pre-tax and interest)	139,821	137,132	136,385	135,348	134,460	138,600	132,180	131,699	131,340	131,285	134,847	129,908	129,854	129,799	129,744	132,534	128,862	128,808
Interest ($)	-19,213	-17,291	-15,370	-13,449	-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	0	0	0	0
Tax ($ at 28%)	-35,026	-34,808	-35,134	-35,458	-35,820	-37,585	-36,390	-36,854	-37,348	-37,871	-39,406	-38,024	-38,008	-37,993	-37,978	-38,759	-37,731	-37,715
Principal repayments ($)	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250								
Free cashflow ($)	49,332	48,782	49,631	50,191	50,863	55,159	51,855	52,831	53,899	55,243	95,441	91,885	91,845	91,806	91,767	93,775	91,132	91,092
Residual liabilities ($)	-326,250	-290,000	-253,750	-217,500	-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0	0	0
Opening equity ($)	3,387,034	3,472,616	3,557,648	3,643,529	3,729,970	3,817,084	3,908,492	3,996,597	4,085,678	4,175,826	4,267,319	4,362,760	4,454,644	4,546,490	4,638,296	4,730,062	4,823,837	4,914,969
Closing equity ($)	3,472,616	3,557,648	3,643,529	3,729,970	3,817,084	3,908,492	3,996,597	4,085,678	4,175,826	4,267,319	4,362,760	4,454,644	4,546,490	4,638,296	4,730,062	4,823,837	4,914,969	5,006,061

Year	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Year ending 30 June	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**
Annual profit ($)	131,799	131,745	131,690	131,636	131,581	131,526	131,472	131,417	131,362	131,308	131,253	131,199	131,144	131,089
Investment in livestock ($)	110	110	110	110	110	110	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Carbon revenue ($)	2,844	2,844	4,915	2,071	2,071	2,071	2,071	3,431	1,360	1,360	1,360	1,360	1,360	0
Annual cash flow ($ pre-tax and interest)	128,753	128,699	130,715	127,816	127,762	127,707	127,653	128,958	126,832	126,778	126,723	126,669	126,614	125,199
Interest ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tax ($ at 28%)	-37,700	-37,685	-38,249	-37,438	-37,423	-37,407	-37,392	-37,758	-37,162	-37,147	-37,132	-37,116	-37,101	-36,705
Principal repayments ($)														
Free cashflow ($)	91,053	91,014	92,466	90,379	90,339	90,300	90,261	91,201	89,670	89,631	89,591	89,552	89,513	88,494
Residual liabilities ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Opening equity ($)	5,006,061	5,097,114	5,188,128	5,280,594	5,370,972	5,461,312	5,551,612	5,641,872	5,733,073	5,822,743	5,912,374	6,001,965	6,091,517	6,181,030
Closing equity ($)	5,097,114	5,188,128	5,280,594	5,370,972	5,461,312	5,551,612	5,641,872	5,733,073	5,822,743	5,912,374	6,001,965	6,091,517	6,181,030	6,269,524

Year	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Year ending 30 June	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
Annual profit ($)	131,035	130,980	130,925	130,871	130,816	130,762	130,707	130,652	130,598	130,543	130,488	130,434	130,379	130,325
Investment in livestock ($)	110	110	110	110	110	110	110	110	110	110	110	110	110	570,296
Investment in plant and machinery ($)	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	150,000
Carbon revenue ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual cash flow ($ pre-tax and interest)	125,145	125,090	125,035	124,981	124,926	124,871	124,817	124,762	124,708	124,653	124,598	124,544	124,489	850,620
Interest ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tax ($ at 28%)	-36,690	-36,674	-36,659	-36,644	-36,629	-36,613	-36,598	-36,583	-36,567	-36,552	-36,537	-36,521	-36,506	-36,491
Principal repayments ($)														
Free cashflow ($)	88,455	88,416	88,376	88,337	88,298	88,258	88,219	88,180	88,140	88,101	88,062	88,022	87,983	814,129
Residual liabilities ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Opening equity ($)	6,269,524	6,357,979	6,446,395	6,534,771	6,623,108	6,711,405	6,799,663	6,887,882	6,976,062	7,064,202	7,152,303	7,240,364	7,328,387	7,416,370
Closing equity ($)	6,357,979	6,446,395	6,534,771	6,623,108	6,711,405	6,799,663	6,887,882	6,976,062	7,064,202	7,152,303	7,240,364	7,328,387	7,416,370	8,230,499

SCENARIO 2A – 30% OF HEL SPACE-PLANTED AND CARBON CLAIMED AS PER CURRENT ETS LOOK-UP TABLES

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Year ending 30 June	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Farming															
Annual profit ($)		143,696	142,707	142,096	141,425	140,702	139,933	139,126	138,288	137,432	136,557	135,664	134,753	133,822	132,874
Investment in livestock ($)	-602,507	1,989	1,229	1,349	1,455	1,546	1,623	1,686	1,723	1,759	1,796	1,833	1,871	1,908	1,572
Investment in plant and machinery ($)	-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars															
Planting costs ($)			-13,321	-13,321	-13,321	-13,321	-13,321	-13,321							
Pruning ($)					-1,458	-1,458	-1,458	-1,458	-1,458	-1,458					
Carbon revenue ($) $25 /NZU		0	0	0	0	0	10,127	10,127	10,127	10,127	10,127	40,346	30,219	30,219	30,219
Annual cash flow ($ pre-tax and interest)	-752,507	139,685	124,615	124,124	122,101	121,469	130,904	130,160	142,679	141,859	142,480	171,843	160,842	159,950	158,665
Interest ($)		-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134	-19,213	-17,291	-15,370	-13,449
Tax ($ at 28%)		-29,476	-26,007	-26,374	-26,316	-26,651	-29,809	-30,121	-34,154	-34,453	-35,154	-43,903	-41,350	-41,628	-41,900
Principal repayments ($)		-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250
Free cashflow ($)															
	0	35,534	25,854	26,918	26,874	27,828	36,026	36,891	47,298	48,102	49,942	72,477	65,950	66,702	67,066
Residual liabilities ($)	0	-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500	-326,250	-290,000	-253,750	-217,500
Opening equity ($)		2,677,507	2,749,291	2,811,395	2,874,563	2,937,687	3,001,765	3,074,040	3,147,181	3,230,730	3,315,082	3,401,274	3,510,001	3,612,201	3,715,153
Closing equity ($)		2,749,291	2,811,395	2,874,563	2,937,687	3,001,765	3,074,040	3,147,181	3,230,730	3,315,082	3,401,274	3,510,001	3,612,201	3,715,153	3,818,469
NPV		**1,543,411**													
IRR		**18.0%**													

Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Year ending 30 June	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Farming														
Annual profit ($)	132,092	131,470	131,000	130,675	130,489	130,434	130,380	130,325	130,271	130,216	130,161	130,107	130,052	129,997
Investment in livestock ($)	1,251	945	653	374	110	110	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars														
Planting costs ($)														
Pruning ($)														
Carbon revenue ($) $25 /NZU	30,219	55,616	25,397	25,397	25,397	25,397	44,203	18,807	18,807	18,807	18,807	33,595	14,788	14,788
Annual cash flow ($ pre-tax and interest)	157,562	182,030	151,049	150,447	149,996	149,941	168,693	143,242	143,187	143,132	143,078	157,811	138,950	138,895
Interest ($)	-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	0	0	0	0
Tax ($ at 28%)	-42,219	-49,694	-41,639	-42,086	-42,572	-43,095	-48,883	-41,757	-41,742	-41,726	-41,711	-45,836	-40,555	-40,540
Principal repayments ($)	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250								
Free cashflow ($)														
	67,565	86,480	65,475	66,347	67,331	68,675	119,810	101,485	101,445	101,406	101,367	111,975	98,395	98,355
Residual liabilities ($)	-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0	0	0
Opening equity ($)	3,818,469	3,922,284	4,045,014	4,146,739	4,249,336	4,352,917	4,457,842	4,577,652	4,679,137	4,780,582	4,881,988	4,983,355	5,095,330	5,193,724
Closing equity ($)	3,922,284	4,045,014	4,146,739	4,249,336	4,352,917	4,457,842	4,577,652	4,679,137	4,780,582	4,881,988	4,983,355	5,095,330	5,193,724	5,292,080

29	30	31	32	33	34	35	36	37	38	39	40	41	42
2049	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**
129,943	129,888	129,834	129,779	129,724	129,670	129,615	129,560	129,506	129,451	129,397	129,342	129,287	129,233
110	110	110	110	110	110	110	110	110	110	110	110	110	110
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
14,788	14,788	25,558	10,770	10,770	10,770	10,770	17,842	7,073	7,073	7,073	7,073	7,073	0
138,841	138,786	149,501	134,658	134,604	134,549	134,495	141,512	130,688	130,634	130,579	130,524	130,470	123,343
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-40,525	-40,509	-43,510	-39,354	-39,338	-39,323	-39,308	-41,273	-38,242	-38,227	-38,211	-38,196	-38,181	-36,185
98,316	98,277	105,992	95,305	95,265	95,226	95,187	100,240	92,446	92,407	92,368	92,328	92,289	87,157
0	0	0	0	0	0	0	0	0	0	0	0	0	0
5,292,080	5,390,396	5,488,673	5,594,664	5,689,969	5,785,235	5,880,461	5,975,648	6,075,887	6,168,334	6,260,741	6,353,108	6,445,437	6,537,726
5,390,396	5,488,673	5,594,664	5,689,969	5,785,235	5,880,461	5,975,648	6,075,887	6,168,334	6,260,741	6,353,108	6,445,437	6,537,726	6,624,883

43	44	45	46	47	48	49	50	51	52	53	54	55	56
2063	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
129,178	129,124	129,069	129,014	128,960	128,905	128,850	128,796	128,741	128,687	128,632	128,577	128,523	-153,172
110	110	110	110	110	110	110	110	110	110	110	110	566,561	566,561
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	150,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
123,288	123,233	123,179	123,124	123,070	123,015	122,960	122,906	122,851	122,796	122,742	122,687	689,084	563,389
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-36,170	-36,155	-36,139	-36,124	-36,109	-36,093	-36,078	-36,063	-36,048	-36,032	-36,017	-36,002	-35,986	0
87,118	87,079	87,039	87,000	86,961	86,921	86,882	86,843	86,803	86,764	86,725	86,686	653,098	563,389
0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,624,883	6,712,001	6,799,080	6,886,119	6,973,120	7,060,080	7,147,002	7,233,884	7,320,727	7,407,530	7,494,294	7,581,019	7,667,705	8,320,803
6,712,001	6,799,080	6,886,119	6,973,120	7,060,080	7,147,002	7,233,884	7,320,727	7,407,530	7,494,294	7,581,019	7,667,705	8,320,803	8,884,192

SCENARIO 2B – 30% OF HEL SPACE-PLANTED AND CARBON CLAIMED AT 25% OF THE CURRENT ETS LOOK-UP TABLES

		Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Year ending 30 June			**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Farming																	
Annual profit ($)				143,696	142,707	142,096	141,425	140,702	139,933	139,126	138,288	137,432	136,557	135,664	134,753	133,822	132,874
Investment in livestock ($)			-602,507	1,989	1,229	1,349	1,455	1,546	1,623	1,686	1,723	1,759	1,796	1,833	1,871	1,908	1,572
Investment in plant and machinery ($)			-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars																	
Planting costs ($)					-13,321	-13,321	-13,321	-13,321	-13,321	-13,321							
Pruning ($)							-1,458	-1,458	-1,458	-1,458	-1,458	-1,458					
Carbon revenue ($)	$25	/NZU		0	0	0	0	0	2,532	2,532	2,532	2,532	2,532	10,086	7,555	7,555	7,555
Annual cash flow ($ pre-tax and interest)			-752,507	139,685	124,615	124,124	122,101	121,469	123,309	122,565	135,084	134,264	134,885	141,584	138,178	137,286	136,001
Interest ($)				-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134	-19,213	-17,291	-15,370	-13,449
Tax ($ at 28%)				-29,476	-26,007	-26,374	-26,316	-26,651	-27,683	-27,995	-32,028	-32,326	-33,027	-35,431	-35,004	-35,282	-35,554
Principal repayments ($)				-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250
Free cashflow ($)																	
			0	35,534	25,854	26,918	26,874	27,828	30,557	31,422	41,830	42,633	44,474	50,690	49,632	50,384	50,748
Residual liabilities ($)			0	-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500	-326,250	-290,000	-253,750	-217,500
Opening equity ($)				2,677,507	2,749,291	2,811,395	2,874,563	2,937,687	3,001,765	3,068,572	3,136,245	3,214,325	3,293,208	3,373,932	3,460,872	3,546,754	3,633,388
Closing equity ($)				2,749,291	2,811,395	2,874,563	2,937,687	3,001,765	3,068,572	3,136,245	3,214,325	3,293,208	3,373,932	3,460,872	3,546,754	3,633,388	3,720,386
NPV				**1,369,547**													
IRR				**17.2%**													

		Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Year ending 30 June			**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Farming																
Annual profit ($)			132,092	131,470	131,000	130,675	130,489	130,434	130,380	130,325	130,271	130,216	130,161	130,107	130,052	129,997
Investment in livestock ($)			1,251	945	653	374	110	110	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)			-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars																
Planting costs ($)																
Pruning ($)																
Carbon revenue ($)	$25	/NZU	7,555	13,904	6,349	6,349	6,349	6,349	11,051	4,702	4,702	4,702	4,702	8,399	3,697	3,697
Annual cash flow ($ pre-tax and interest)			134,898	140,319	132,002	131,399	130,948	130,894	135,541	129,137	129,082	129,027	128,973	132,615	127,859	127,804
Interest ($)			-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	0	0	0	0
Tax ($ at 28%)			-35,873	-38,015	-36,306	-36,753	-37,239	-37,761	-39,601	-37,808	-37,792	-37,777	-37,762	-38,782	-37,450	-37,434
Principal repayments ($)			-36,250	-36,250	-36,250	-36,250	-36,250	-36,250								
Free cashflow ($)																
			51,247	56,447	51,761	52,632	53,617	54,961	95,940	91,329	91,290	91,251	91,211	93,834	90,409	90,370
Residual liabilities ($)			-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0	0	0
Opening equity ($)			3,720,386	3,807,883	3,900,580	3,988,591	4,077,473	4,167,340	4,258,551	4,354,491	4,445,820	4,537,110	4,628,360	4,719,572	4,813,405	4,903,815
Closing equity ($)			3,807,883	3,900,580	3,988,591	4,077,473	4,167,340	4,258,551	4,354,491	4,445,820	4,537,110	4,628,360	4,719,572	4,813,405	4,903,815	4,994,184

29	30	31	32	33	34	35	36	37	38	39	40	41	42
2049	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**
129,943	129,888	129,834	129,779	129,724	129,670	129,615	129,560	129,506	129,451	129,397	129,342	129,287	129,233
110	110	110	110	110	110	110	110	110	110	110	110	110	110
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
3,697	3,697	6,389	2,692	2,692	2,692	2,692	4,461	1,768	1,768	1,768	1,768	1,768	0
127,750	127,695	130,333	126,581	126,527	126,472	126,417	128,131	125,384	125,329	125,275	125,220	125,165	123,343
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-37,419	-37,404	-38,142	-37,092	-37,077	-37,061	-37,046	-37,526	-36,757	-36,741	-36,726	-36,711	-36,696	-36,185
90,331	90,291	92,190	89,489	89,450	89,411	89,371	90,605	88,627	88,588	88,548	88,509	88,470	87,157
0	0	0	0	0	0	0	0	0	0	0	0	0	0
4,994,184	5,084,515	5,174,806	5,266,997	5,356,486	5,445,936	5,535,346	5,624,718	5,715,323	5,803,950	5,892,538	5,981,086	6,069,595	6,158,065
5,084,515	5,174,806	5,266,997	5,356,486	5,445,936	5,535,346	5,624,718	5,715,323	5,803,950	5,892,538	5,981,086	6,069,595	6,158,065	6,245,223

43	44	45	46	47	48	49	50	51	52	53	54	55	56
2063	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
129,178	129,124	129,069	129,014	128,960	128,905	128,850	128,796	128,741	128,687	128,632	128,577	128,523	-153,172
110	110	110	110	110	110	110	110	110	110	110	110	566,561	566,561
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	150,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
123,288	123,233	123,179	123,124	123,070	123,015	122,960	122,906	122,851	122,796	122,742	122,687	689,084	563,389
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-36,170	-36,155	-36,139	-36,124	-36,109	-36,093	-36,078	-36,063	-36,048	-36,032	-36,017	-36,002	-35,986	0
87,118	87,079	87,039	87,000	86,961	86,921	86,882	86,843	86,803	86,764	86,725	86,686	653,098	563,389
0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,245,223	6,332,341	6,419,419	6,506,459	6,593,459	6,680,420	6,767,341	6,854,224	6,941,066	7,027,870	7,114,634	7,201,359	7,288,044	7,941,142
6,332,341	6,419,419	6,506,459	6,593,459	6,680,420	6,767,341	6,854,224	6,941,066	7,027,870	7,114,634	7,201,359	7,288,044	7,941,142	8,504,532

SCENARIO 3A – 25% OF HEL SPACE-PLANTED WITH FASTIGIATE CLONES AND NO CARBON CLAIMED DUE TO INELIGIBILITY UNDER CURRENT ETS

		Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Year ending 30 June			**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Farming																	
Annual profit ($)				143,696	142,988	142,423	141,844	141,257	140,671	140,090	139,523	138,994	138,504	138,053	137,639	137,264	136,926
Investment in livestock ($)			-602,507	1,423	1,138	1,165	1,179	1,180	1,167	1,141	1,063	985	908	831	755	679	552
Investment in plant and machinery ($)			-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars																	
Planting costs ($)					-10,247	-10,247	-10,247	-10,247	-10,247	-10,247							
Pruning ($)							-1,122	-1,122	-1,122	-1,122	-1,122	-1,122					
Carbon revenue ($)	$25	/NZU		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual cash flow ($ pre-tax and interest)			-752,507	139,119	127,879	127,341	125,654	125,069	124,469	123,863	133,464	132,858	133,412	132,884	132,394	131,943	131,478
Interest ($)				-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134	-19,213	-17,291	-15,370	-13,449
Tax ($ at 28%)				-29,476	-26,947	-27,326	-27,388	-27,762	-28,135	-28,511	-31,759	-32,149	-32,864	-33,275	-33,697	-34,130	-34,574
Principal repayments ($)				-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250
Free cashflow ($)			0	34,968	28,179	29,183	29,355	30,317	31,265	32,205	40,479	41,404	43,165	44,146	45,155	46,193	47,205
Residual liabilities ($)			0	-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500	-326,250	-290,000	-253,750	-217,500
Opening equity ($)				2,677,507	2,748,725	2,813,154	2,878,587	2,944,192	3,010,759	3,078,274	3,146,729	3,223,458	3,301,112	3,380,527	3,460,923	3,542,328	3,624,771
Closing equity ($)				2,748,725	2,813,154	2,878,587	2,944,192	3,010,759	3,078,274	3,146,729	3,223,458	3,301,112	3,380,527	3,460,923	3,542,328	3,624,771	3,708,226
NPV				**1,357,262**													
IRR				**17.3%**													

Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Year ending 30 June	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Farming														
Annual profit ($)	136,652	136,435	136,268	136,144	136,059	136,004	135,950	135,895	135,840	135,786	135,731	135,676	135,622	135,567
Investment in livestock ($)	437	336	248	172	110	110	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars														
Planting costs ($)														
Pruning ($)														
Carbon revenue ($)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual cash flow ($ pre-tax and interest)	131,089	130,771	130,515	130,317	130,169	130,114	130,059	130,005	129,950	129,896	129,841	129,786	129,732	129,677
Interest ($)	-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	0	0	0	0
Tax ($ at 28%)	-35,035	-35,512	-36,003	-36,507	-37,021	-37,543	-38,066	-38,051	-38,035	-38,020	-38,005	-37,989	-37,974	-37,959
Principal repayments ($)	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250								
Free cashflow ($)	48,277	49,403	50,577	51,797	53,056	54,400	91,994	91,954	91,915	91,876	91,836	91,797	91,758	91,718
Residual liabilities ($)	-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0	0	0
Opening equity ($)	3,708,226	3,792,753	3,878,406	3,965,233	4,053,279	4,142,585	4,233,234	4,325,228	4,417,182	4,509,097	4,600,973	4,692,809	4,784,606	4,876,363
Closing equity ($)	3,792,753	3,878,406	3,965,233	4,053,279	4,142,585	4,233,234	4,325,228	4,417,182	4,509,097	4,600,973	4,692,809	4,784,606	4,876,363	4,968,081

29	30	31	32	33	34	35	36	37	38	39	40	41	42
2049	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**
135,513	135,458	135,403	135,349	135,294	135,239	135,185	135,130	135,076	135,021	134,966	134,912	134,857	134,802
110	110	110	110	110	110	110	110	110	110	110	110	110	110
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
129,622	129,568	129,513	129,459	129,404	129,349	129,295	129,240	129,185	129,131	129,076	129,022	128,967	128,912
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-37,944	-37,928	-37,913	-37,898	-37,882	-37,867	-37,852	-37,836	-37,821	-37,806	-37,791	-37,775	-37,760	-37,745
91,679	91,640	91,600	91,561	91,522	91,482	91,443	91,404	91,364	91,325	91,286	91,246	91,207	91,168
0	0	0	0	0	0	0	0	0	0	0	0	0	0
4,968,081	5,059,760	5,151,400	5,243,000	5,334,561	5,426,083	5,517,565	5,609,008	5,700,411	5,791,776	5,883,101	5,974,386	6,065,632	6,156,839
5,059,760	5,151,400	5,243,000	5,334,561	5,426,083	5,517,565	5,609,008	5,700,411	5,791,776	5,883,101	5,974,386	6,065,632	6,156,839	6,248,007

43	44	45	46	47	48	49	50	51	52	53	54	55	56
2063	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
134,748	134,693	134,639	134,584	134,529	134,475	134,420	134,365	134,311	134,256	134,202	134,147	134,092	134,038
110	110	110	110	110	110	110	110	110	110	110	110	110	577,764
-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	150,000
0	0	0	0	0	0	0	0	0	0	0	0	0	0
128,858	128,803	128,748	128,694	128,639	128,585	128,530	128,475	128,421	128,366	128,311	128,257	128,202	861,801
0	0	0	0	0	0	0	0	0	0	0	0	0	0
-37,729	-37,714	-37,699	-37,684	-37,668	-37,653	-37,638	-37,622	-37,607	-37,592	-37,576	-37,561	-37,546	-37,531
91,128	91,089	91,050	91,010	90,971	90,932	90,892	90,853	90,814	90,774	90,735	90,696	90,656	824,271
0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,248,007	6,339,135	6,430,224	6,521,274	6,612,284	6,703,255	6,794,187	6,885,079	6,975,932	7,066,746	7,157,520	7,248,255	7,338,951	7,429,607
6,339,135	6,430,224	6,521,274	6,612,284	6,703,255	6,794,187	6,885,079	6,975,932	7,066,746	7,157,520	7,248,255	7,338,951	7,429,607	8,253,878

SCENARIO 3B – 25% OF HEL SPACE-PLANTED WITH FASTIGIATE CLONES AND CARBON CLAIMED AT 25% OF THE CURRENT ETS LOOK-UP TABLES

		Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Year ending 30 June			**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**
Farming																															
Annual profit ($)				143,696	142,988	142,423	141,844	141,257	140,671	140,090	139,523	138,994	138,504	138,053	137,639	137,264	136,926	136,652	136,435	136,268	136,144	136,059	136,004	135,950	135,895	135,840	135,786	135,731	135,676	135,622	135,567
Investment in livestock ($)			-602,507	1,423	1,138	1,165	1,179	1,180	1,167	1,141	1,063	985	908	831	755	679	552	437	336	248	172	110	110	110	110	110	110	110	110	110	110
Investment in plant and machinery ($)			-150,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000
Space- planted poplars																															
Planting costs ($)					-10,247	-10,247	-10,247	-10,247	-10,247	-10,247																					
Pruning ($)							-1,122	-1,122	-1,122	-1,122	-1,122	-1,122																			
Carbon revenue ($)	$25	/NZU		0	0	0	0	0	1,363	1,363	1,363	1,363	1,363	5,431	4,068	4,068	4,068	4,068	8,219	4,151	4,151	4,151	4,151	7,226	3,074	3,074	3,074	3,074	5,491	2,417	2,417
Annual cash flow ($ pre-tax and interest)			-752,507	139,119	127,879	127,341	125,654	125,069	125,832	125,226	134,827	134,221	134,775	138,315	136,462	136,011	135,546	135,157	138,990	134,667	134,468	134,320	134,265	137,285	133,079	133,024	132,970	132,915	135,278	132,149	132,094
Interest ($)				-38,425	-36,504	-34,583	-32,661	-30,740	-28,819	-26,898	-24,976	-23,055	-21,134	-19,213	-17,291	-15,370	-13,449	-11,528	-9,606	-7,685	-5,764	-3,843	-1,921	0	0	0	0	0	0	0	0
Tax ($ at 28%)				-29,476	-26,947	-27,326	-27,388	-27,762	-28,517	-28,892	-32,141	-32,531	-33,245	-34,796	-34,836	-35,269	-35,713	-36,174	-37,813	-37,166	-37,669	-38,183	-38,706	-40,089	-38,911	-38,896	-38,881	-38,865	-39,527	-38,651	-38,636
Principal repayments ($)				-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250	-36,250								
Free cashflow ($)			0	34,968	28,179	29,183	29,355	30,317	32,247	33,186	41,460	42,385	44,146	48,057	48,084	49,121	50,134	51,206	55,320	53,566	54,786	56,045	57,389	97,196	94,168	94,128	94,089	94,050	95,751	93,498	93,459
Residual liabilities ($)			0	-688,750	-652,500	-616,250	-580,000	-543,750	-507,500	-471,250	-435,000	-398,750	-362,500	-326,250	-290,000	-253,750	-217,500	-181,250	-145,000	-108,750	-72,500	-36,250	0	0	0	0	0	0	0	0	0
Opening equity ($)				2,677,507	2,748,725	2,813,154	2,878,587	2,944,192	3,010,759	3,079,256	3,148,692	3,226,402	3,305,038	3,385,434	3,469,741	3,554,075	3,639,447	3,725,831	3,813,287	3,904,857	3,994,673	4,085,709	4,178,004	4,271,642	4,368,838	4,463,006	4,557,134	4,651,223	4,745,272	4,841,023	4,934,521
Closing equity ($)				2,748,725	2,813,154	2,878,587	2,944,192	3,010,759	3,079,256	3,148,692	3,226,402	3,305,038	3,385,434	3,469,741	3,554,075	3,639,447	3,725,831	3,813,287	3,904,857	3,994,673	4,085,709	4,178,004	4,271,642	4,368,838	4,463,006	4,557,134	4,651,223	4,745,272	4,841,023	4,934,521	5,027,980
NPV				**1,393,017**																											
IRR				**17.4%**																											

	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
	2049	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**
	135,513	135,458	135,403	135,349	135,294	135,239	135,185	135,130	135,076	135,021	134,966	134,912	134,857	134,802	134,748	134,693	134,639	134,584	134,529	134,475	134,420	134,365	134,311	134,256	134,202	134,147	134,092	134,038
	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	577,764
	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	150,000
	2,417	2,417	4,178	1,760	1,760	1,760	1,760	2,985	1,224	1,224	1,224	1,224	2,448	1,224	1,224	1,224	1,224	2,337	1,113	1,113	1,113	1,113	2,102	989	989	989	989	1,978
	132,040	131,985	133,691	131,219	131,164	131,110	131,055	132,225	130,410	130,355	130,300	130,246	131,415	130,136	130,082	130,027	129,973	131,031	129,752	129,697	129,643	129,588	130,523	129,355	129,301	129,246	129,191	863,780
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-38,620	-38,605	-39,083	-38,391	-38,375	-38,360	-38,345	-38,672	-38,164	-38,149	-38,133	-38,118	-38,445	-38,087	-38,072	-38,057	-38,042	-38,338	-37,980	-37,965	-37,949	-37,934	-38,196	-37,869	-37,853	-37,838	-37,823	-38,085
	93,419	93,380	94,608	92,828	92,789	92,750	92,710	93,552	92,246	92,206	92,167	92,128	92,970	92,049	92,010	91,970	91,931	92,693	91,772	91,733	91,694	91,654	92,327	91,487	91,447	91,408	91,369	825,695
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5,027,980	5,121,399	5,214,779	5,309,387	5,402,216	5,495,005	5,587,754	5,680,465	5,774,017	5,866,263	5,958,469	6,050,636	6,142,764	6,235,733	6,327,782	6,419,792	6,511,762	6,603,693	6,696,386	6,788,158	6,879,891	6,971,585	7,063,239	7,155,566	7,247,053	7,338,500	7,429,908	7,521,276
	5,121,399	5,214,779	5,309,387	5,402,216	5,495,005	5,587,754	5,680,465	5,774,017	5,866,263	5,958,469	6,050,636	6,142,764	6,235,733	6,327,782	6,419,792	6,511,762	6,603,693	6,696,386	6,788,158	6,879,891	6,971,585	7,063,239	7,155,566	7,247,053	7,338,500	7,429,908	7,521,276	8,346,972