Review of the information and resources available to farmers and industry on incorporating trees on farm

Prepared for Te Uru Rākau One Billion Trees

Final Report

December 2019

Perrin Ag Consultants Ltd

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2 December 2019

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Prepared by:	Rachel Durie BAgSci (Hons), MNZIPIM Consultant	
Reviewed by:	Liz Dooley PhD (Agricultural Systems and Management), MNZIPIM Senior Consultant	
	Leighton Parker BApplSc (Hons), MNZIPIM (Reg.), ASNM Senior Consultant	
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1. Introduction

Te Uru Rākau has developed the One Billion Trees Programme which aims to double the current planting rate with the goal of achieving the planting of one billion by 2028. This programme is not species specific and is based on the premise that the right tree is planted in the right place for the right purpose in order to provide environmental, social and economic benefits.

Perrin Ag Consultants have been commissioned by Te Uru Rākau One Billion Trees and industry co-funders to undertake research on "*integrating dairy and hill country sheep & beef farming with forestry for profitable, sustainable land use*" focusing on the Waikato, Bay of Plenty and Whanganui/Manawatu (Rangitikei) regions. This work is being conducted by Perrin Ag researchers and forestry scientists from PF Olsen, with input from a governance group comprising Perrin Ag and PF Olsen researchers, representatives from funding organisations, farmers and an iwi representative.

This work has three components: (1) the identification of information and resources available to farmers and industry on trees on farms; (2) face-to-face and phone interviews to identify farmer practices, perceptions and knowledge pertaining to farm forestry across a broad range of farmers to identify information needs and barriers to adoption and; (3) ten individual farm business case studies working closely with owners, and four syndicated case studies, across the Bay of Plenty, Waikato and Whanganui/Manawatu regions providing real-life information on a range of farm forestry alternatives that farmers can relate to. Upon completion of the project, findings will be shared with local industry, farmers and iwi through workshops and presentations.

This first stage of this project is a review of the information and resources available for farmers and industry people considering farm forestry. This review aims to help both farmers and advisors meet the goals of the One Billion Trees Programme by providing a compilation of key points and resources. Much of this information is sourced from grey literature and web sites. This information is not meant to be an exhaustive list, but rather a starting point aided by key information resources, for further follow-up. This resource will be made available to farmers and industry via the funders. This resource will also be used to assist in developing a questionnaire for the interview stage of the project, and to identify areas where further information may be required to inform the case studies. In addition to the review, a searchable excel spreadsheet database of information sources by type and topic was also developed and will also be made available to the funder.

2. Forestry Establishment and Management

2.1. Species, Silviculture and Site Selection

2.1.1. Species choice and characteristics

Selection of a tree species within the farming landscape ultimately depends on the planned purpose of the tree. For timber, there a range of exotic and indigenous tree species that can be planted and selecting a species will depend on the site's physical conditions and the market the landowner wishes to supply. In New Zealand, production forestry for timber tends to be dominated by *Pinus radiata* comprising 90% of all planted forests (New Zealand Forest Owners Association, 2019). Douglas-fir, cypress and eucalypts make up the remaining exotic forest plantations (Te Uru Rākau, 2018b).

Radiata pine has become popular in New Zealand due to its high profitability and reliability as a tree crop (Yao *et al*., 2013). It tends to establish well on a wide range of soils but greatest productivity will occur on warmer wetter sites compared to cooler drier areas (Moore *et al*., 2015). A new hybrid species (*P. radiata x P. attenuata*) has however been developed for the cold, dry southern conditions. Current trials of this hybrid species at mid-rotation age are showing good tree performance at altitudes of 300 – 800 metres and are demonstrating the species resistance to both cold and snow (Scion, 2014a). Historically, a typical rotation length has been between 26 and 32 years (Yao *et al*., 2013) with logs used for a range of purposes depending on the quality including appearance grade joinery timber, structural timber, outdoor timber, pulp and paper, and panel products (Moore *et al*., 2015). Many forest management companies are however now predicting shorter rotation lengths, between 20 and 25 years, for new plantings as a result of improved forest management, genetics and modern sawmill log restrictions.

Douglas-fir accounts for approximately 6% of the total planted forest area and has a rotation length of 70-80 years, although this can be shortened to 45 years or less with improved silvicultural regimes (Yao *et al*., 2013). Compared to *P. radiata*, Douglas-fir tends to be more resistant to windthrow and snow damage and is therefore more popular in the South Island. In addition, due to its superior shade tolerance Douglas-fir can be a good option for continuous-cover forestry on high-risk erosion slopes where clear-cut harvesting may result in negative environmental impacts (Maclaren, 1996). There have been significant Douglas-fir plantings in the central North Island however the prevalence of Swiss Needle Cast disease has resulted in many of these stands reforested with radiata (Moore *et al*., 2015).

Eucalyptus species comprise 1.3% of New Zealand forests with rotation lengths dependent on the end use. For instance, eucalypts grown for less than 20 years will be used for pulp wood and as such fast-growing cultivars (*Eucalyptus nitens*) should be selected (Yao *et al*., 2013). There is a desire to grow eucalypts for solid wood however this will require longer rotation lengths and more intensive silvicultural regimes (Moore *et al*., 2015), as well as possibly different eucalyptus species (Specialty Wood Products Research Partnership, 2019).

Cypress, including *Cupressus lusitanica and C. macrocarpa*, account for 0.6% of the total forest area and have rotation lengths of 30-40 years (Yao *et al*., 2013). These species are typically grown for their attractive timber and natural durability. Careful siting of the tree is required to avoid warm, humid areas in which stem canker is likely to occur.

The remainder of the New Zealand plantation forest consists of other softwoods and hardwoods including redwoods, kauri and totara (Yao *et al*., 2013). Coast redwoods (*Sequoia sempervirens*) are typically grown for the North American market where their natural durability and dimensional stability are used for building and landscaping. Kauri and totara are typically grown for their potential timber production and biodiversity value. In productive sites, these indigenous species can be grown in 60-80 year rotations with their wood used mainly for interior uses due to low natural durability (Moore *et al*., 2015).

Best Places to go for Information

Scion Research – Diversifying commercial forestry
Information on New Zealand forest species (https://www.scionresearch.com)

NZFFA Tree Species
Information on a range of common and alternative tree species grown in New Zealand (https://www.nzffa.org.nz)

Moore, J., West, G., & Dowling, L. (2015). An update on forestry economics and market outlook to support land-owner decision making on lower nutrient leaching land use systems
Overview of forest timber species

Tane's Tree Trust
Publications and profiles on the characteristics and management of various native tree species (https://www.tanestrees.org.nz/species-profiles/)

2.1.2. Establishment and silviculture regimes

The choice of growing regime will be dependent on multiple factors including site characteristics, management and market demand and is influenced by landowner preference. For radiata stands, trees can be either pruned or unpruned and thinned or not thinned (Yao *et al*., 2013). Pruning increases the proportion of higher-grade clear knot-free timber able to be recovered at harvest. However, in recent years the number of pruned stands has reduced due to recent reductions in premiums for pruned log grades relative to unpruned grades (Moore *et al*., 2015). If pruning is undertaken, generally this occurs in two or three events (known as 'lifts') to a final height between 5.5 and 6.5 m, which allows a pruned butt log of good length for log traders. The number of trees pruned per hectare depends on the site, objective and costs. Generally, 400-600 stems per hectare are pruned on the first lift, decreasing to 200-400 per hectare on the final lift (NZFFA, 2007).

Thinning refers to the selective removal of trees from the forest before harvest. Initially, more trees are planted than what is required at harvest to control branch size and provide protection against exposure while the trees are young. Thinning out as the trees grow reduces the risk of windthrow and improves the growth rate of the remaining trees (Yao *et al*., 2013).

Douglas-fir stands can have more conservative silvicultural regimes with only very light thinning's to aid in creating high natural stiffness for framing timber and interior posts (Satchell, 2018). Recommendations for planted stocking range from 1,000 to 1,666 stems per hectare (sph) to promote early canopy closure and restrict branch growth. From approximately 15-20 years, trees are then thinned to waste (i.e. left to rot on the ground) to 800 sph at an average height of 14 metres. A final production thinning is then completed at 30 years, provided the terrain is suitable, to a density of 500 sph (Scion, 2016).

For eucalypts, the recommended initial stocking density is 1100 sph with a common silvicultural regime of growing logs for wood fibre with no further silvicultural intervention after planting and releasing. Another option is to grow for timber, which will involve thinning and where pruning is recommended. Eucalyptus species including *E. globoidea* and *E. fastigata* are self-pruning, additional pruning to a maximum of ten metres is recommended to achieve high value clearwood. Ideally, this should be done in dry weather to avoid rotting of branch stubs and no more than 40% of the green crown should be removed per lift. Final stocking density for a 25-30 and 50 year rotation is 200 and 100 sph, respectively. Thinning should occur twice, once at age six to 500 sph and then again at age ten to 200 sph (Scion, 2014b).

For redwood and cypress species there is no universal agreement on silviculture regimes. Both species are tolerant to low light conditions so higher stocking rates can be grown to maximize timber production. Alternatively, a lower stocking rate will increase log diameters. Pruning and/or thinning will provide higher value timber, particularly for larger logs (NZFFA, 2007; Moore *et al*., 2015). A publication by Scion (2014c) states that for clear heartwood (i.e. the dense inner part of the tree trunk which produces the highest value timber) pruning is essential. For redwoods specifically, epicormics shoots (i.e. shoots growing from buds underneath the tree bark) are common after pruning and must be removed to maintain timber quality which can add significant cost to pruning operations. While spacing trials are still ongoing, it is recommended at this stage a final density of around 400 sph. Lower stockings can improve diameter growth and therefore produce more clearwood, allowing earlier harvest but will result in lower volume. For saw logs, high stockings can be held until 15-20 years of age before thinning and harvest after 35 to 40 years, from which the wood produced is used for panelling or structural timber.

For Kauri and Totara, silvicultural regimes are not well understood however good weed control is essential to ensure trees are not outcompeted by unwanted vegetation. The use of manuka as a nurse crop could be a good option for managing weeds and will also help improve stem form and control branch size (Moore *et al*., 2015). Current silviculture trials are currently taking place by the Northland Totara Working Group (NTWG) on naturally regenerating Totara stands across a number of Northland sites. To date, trial work has suggested that thinning of stands from 6,000 sph down to 800-2,000 sph will significantly improve growth rates and reduce mortality.

Best Places to go for Information

NZFFA Guide Sheets (2007).
Information on establishment and silviculture of radiata pine, redwood, eucalypts and cypresses grown for timber (https://www.nzffa.org.nz/)

Scion – Diversifying commercial forestry.
Publications on specific commercial forestry species and their silviculture regimes linked to webpage (https://www.scionresearch.com)

Satchell, D. (2015). Trees for steep slopes.
Silviculture regimes for various tree species planted on steep slopes for erosion control (Report linked to https://www.nzffa.org.nz/)

Totara Industry Pilot webpage
Publications on managing Totara stands (https://www.totaraindustry.co.nz/resources-publications)

Tane's Tree Trust
Publications and bulletins on establishment and management of various native tree species (https://www.tanestrees.org.nz/resource-centre/publications/)

Tane's Tree Trust Technical Handbook
Establishment of native trees and management regime for Totara and other natives (https://www.tanestrees.org.nz/)

2.1.3. Site considerations

The NZFFA website and the calculators available through Forest Growers Research is a good starting place when considering where to plant forestry stands on farm. Of particular note are the Forecaster and Woodlot Analysis Tool (https://fgr.nz/programmes/calculators/) as well as the Species Choice software available through the University of Canterbury School of Forestry webpage (https://www.canterbury.ac.nz). More information on these tools is provided in Section 2.2.

Factors that should be considered when selecting a planting location include slope, soil type, fertility, climate, access, distance to port/processor and area available to plant as these can have a large impact on the success and profitability of the woodlot. Depending on the type of tree planted, the location and site characteristics required will vary. This section will mainly focus on the requirements for timber species. For other tree types and end uses, information is provided in Section 2.3. A brief description of some of the considerations landowners should think about when selecting a site is provided below.

<u>Slope</u>
Woodlots with steep topography will have significantly greater silviculture and harvest costs than flat or rolling terrain. For instance, if tracking is necessary or if haulers rather than ground equipment is required for harvesting then this will have large impacts on the final return.

On flat slopes, soil drainage and frost should be considered. Timber species tend not to grow on poorly drained sites and constructing artificial drainage can be expensive. Frost will also create establishment issues and may slow down tree growth in the initial stages (NZFFA, 2005).

Existing vegetation
Existing vegetation will need to be removed from the site before planting. In particular, gorse and broom need to be controlled as these will affect tree growth and silviculture costs (NZFFA, 2005).

Soil Type
Soil type should be understood and considered before planting. Deep, well-drained soils with good soil moisture retention and high fertility are capable of high log yields, however wood quality and stem density are often reduced due to faster tree growth. In comparison, low fertility sites tend to produce less volume but log quality is greater. Soils with shallow rooting depth tend to have reduced productivity and are unable to produce high yields (NZFFA, 2005). Areas with high water tables should be avoided as this can lead to rot and increased risk of tree toppling. In addition, unstable soil types (e.g. papa in the King Country, coastal sand dunes) can cause rooting issues and more hardy species or an initial stabilising plant may need to be considered.

Climate
The climatic conditions of a particular site should be considered when selecting a tree species. In general, radiata can grow in a wide variety of climates but on cold, dry or very exposed sites growth is slow and other species may be more suitable. Douglas-fir, for instance, will outperform radiata in areas where snowfall is likely and is more resistant to windthrow, although still prefers shelter and requires good rainfall. Humidity should also be considered as this can increase the risk of fungal diseases in some species. Alternative timber species such as eucalypts and cypress tend to grow well in sites where water stress is not an issue (NZFFA, 2005).

Access
Transporting logs from the harvest site to a public road requires good roading infrastructure. If large upgrades are required, then consideration around the size of the planned woodlot should be given to dilute this fixed cost to ensure profitability is not severely affected (NZFFA, 2005).

Distance to port/processor
The distance to the nearest port or processing plant is one of the single biggest factors that will impact on the profitability of small woodlots due to the high transport cost associated. In general, woodlots more than 100 km from the market will be impacted by transport costs, and woodlots further than this may struggle to deliver a sufficient return (NZFFA, 2005).

Best Places to go for Information

NZFFA Information leaflet No.1: Choosing land for planting for profit (2005).
Description of site characteristics to consider before planting (https://www.nzffa.org.nz/)

Satchell, D. (2015). Trees for steep slopes.
Species specific siting requirements (Report linked to https://www.nzffa.org.nz/)

2.2. Decision Support Software

2.2.1. Tools available

A range of decision support software (DSS) is available to forestry consultants and farmers alike, most of which are freely available (Table 1). For small woodlot owners the online Forecaster Calculator has been specifically designed to calculate a rough estimate of the volume and log product mix for a particular site and age of tree. The tool is targeted for radiata stands although can simulate Douglas-fir stands if specific measurement data (e.g. 500 Index value, the mean annual volume increment at 40 years; Knowles, 2005) is entered.

A more comprehensive desktop version called 'Forecaster' also exists and is available for a fee and is intended for forestry consultants to predict the volume of log grade likely to be available, support the correct scheduling of pruning and thinning and compare the potential cost impacts of adopting various silvicultural regimes and species (West *et al*., 2012). The ability to predict carbon yields and tree nutrient uptake also sits within the model as well as economic calculators which allow for a predicted net present value (NPV) and an internal rate of return (IRR) to be calculated.

Web-based calculators also exist for less popular tree species including kauri, cypress and *Eucalyptus fastigata* and are aimed at providing scientific growth model projections to foresters. An excel-based redwood calculator is also available for use to provide basic redwood growth models and log volume predictions.

A recent tool that exists for small woodlot owners is the Woodlot Analysis Tool. This calculator takes log grade information such as that produced by the various calculators and predicts the net revenue expected from established woodlots at harvest from a given set of input data including location and access.

Finally, for landowners looking at establishing trees on farm the 'Species choice for afforestation of difficult sites New Zealand' tool exists within the University of Canterbury School of Forestry webpage. This calculator was built for landowners who have a specific area of land where they want to establish trees and will provide a weighting for the suitability and success of different tree species on that site. Climate and location data combined with landowner objectives for the end use of the tree is used to provide this weighting.

For larger forestry owners, the Forest Investment Finder DSS is available on a fee for service basis. This tool identifies the quantity of carbon able to be captured by a block of trees within New Zealand as well as any additional economic or environmental benefits that can be gained. These may include timber and carbon revenue as well as benefits from reduced soil erosion, biodiversity enhancement, recreation opportunities, reduced nitrogen leaching and improved water usage (Scion, n.d.). A study by Yao *et al*. (2016) however indicated that the model was more accurate at providing cost and revenue estimates for large-scale forests over 20,000 ha compared to small woodlots (<100 ha) where more precise predictions could be gained from using the Forecaster tool.

OverseerFM Version 6.3.2 now also includes a carbon stock tool which allows farmers to estimate how much carbon is sequestered within their tree blocks using the Ministry for Primary Industries carbon look-up table available from https://www.teuruRākau.govt.nz. Farmers and advisors can use the tool to test the impact on their greenhouse gas profile from incorporating trees on farm.

Table 1 *Decision support software available to farmers and consultants.*

Tool	Description
Forecaster (online)	• Designed to model radiata • Can model Douglas-Fir if 500 index is known • Estimates log product mix and volume based off location (site index) and silviculture regime • Freely available • Link: https://fgr.nz/programmes/calculators/
Forecaster (desktop)	• More comprehensive version of online Forecaster tool • Includes log product volume, economic calculator, carbon yield forecast, silviculture regime evaluation and scheduling • Targeted for forestry consultants • Available for a fee
Kauri, cypress, and *Fastigata* calculator	• Provides scientific growth model information based off starting conditions and growth model information • Includes economic summary • Freely available • Link: https://fgr.nz/programmes/calculators/
Redwood Growth Calculator	• Excel tool used to estimate log volume • Freely available • Link: https://fgr.nz/programmes/calculators/
Woodlot Analysis Tool	• Estimated net revenue at harvest based on site location, roading requirements and log grade information • Freely available • Link: https://fgr.nz/programmes/calculators/
Species Choice for Afforestation of Difficult Sites NZ	• Gives a success rating to the suitability of various tree species based on a given location, climate and landowner objective. • Freely available • Link: http://www.treesandstars.com/euan/sppchc/
Forest Investment Framework	• Provides economic and environmental analysis of woodlots including carbon assessment • Less accurate for small-scale forests • Paid for on a fee for service basis • Link: https://www.scionresearch.com/
OverseerFM	• Farm system environmental tool used to assess nutrient inputs and outputs • Includes model for estimating carbon sequestered in trees • Annual fee • Link: https://www.overseer.org.nz/overseerfm

Best Places to go for Information

Forest Growers Research
Forecaster and small woodlot calculators (https://fgr.nz/)

UC School of Forestry
Species choice software for difficult sites (http://www.treesandstars.com/euan/sppchc/)

NZFFA Inventory and Decision Support Software
Links to calculators and articles on measuring woodlot yields (https://www.nzffa.org.nz)

OverseerFM Carbon Stock Tool
Video explaining OverseerFM's carbon stock tool and outputs produced (https://www.youtube.com/watch?v=SDoyAMzt5-Q)

2.3. Integrating Trees on Farm

2.3.1. Co-benefits for farming systems

The establishment of trees on farm can provide a number of co-benefits for the farming system including shade, shelter, fodder for stock, soil conservation, biodiversity and food for bees. A number of resources are available to help with selecting the right species, location, establishment and silvicultural regimes. The Trees on Farms section of DairyNZ's website (https://www.dairynz.co.nz) is a good place to start looking at different options for incorporating trees within farms and provides links to the appropriate resources.

For stock fodder, poplar and willow trees are generally regarded as the best species for use and will also provide considerable soil conservation benefits for erodible hill slopes and stream banks. Poplars in particular are also ideal for providing shade and wind shelter. The New Zealand Poplar and Willow Research Trust have numerous online resources available for farms to aid in selecting tree cultivars. In particular, the 'Willows for the Farm' and 'Poplars for the Farm' booklets (available from http://www.poplarandwillow.org.nz) are excellent resources for early farmer decision making in selecting and establishing willow and poplar species. Regional councils and local nurseries will also be able to provide further advice and knowledge for particular sites and purposes.

For shade, space-planted poplars as well as poplars grown in shelterbelts can be an excellent option. Other species that can be used for shade include eucalypts, oak and lemonwood. Selecting which species to plant will depend on site-specific conditions and resources to help with this include the DairyNZ 'Trees for Shade' document (DairyNZ, n.d.).

Planting trees for bees also has positive impacts for the farm system through improving pollination for pasture (particularly white clover), horticulture and arable crops (Trees for Bees, 2016; DairyNZ, n.d.). Tree species grown for bee feed can be incorporated into riparian planting, erosion control, shade and shelter plantings and timber plantations. The Trees for Bees (https://treesforbeesnz.org) website has numerous resources available including regional plant guides which support farmer decision making in tree species selection and provide links to appropriate regional advisors. Up to date research, conference proceedings and 'how to' guides are also available through the site.

Best Places to go for Information

The NZ Poplar and Willow Research Trust – Farmer Guides
Resources to aid in choosing poplar and willow species depending on objective (http://www.poplarandwillow.org.nz/farmer-guides)

Plant & Food Research – Trees for the farm: a decision support tool for farmers
Provides key establishment requirements and cost-benefit analysis for planting poplars or willows (https://beeflambnz.com)

DairyNZ – Trees on Farms
Tree planting guides for a range of objectives including erosion control, shade, shelter, fodder, bees, biodiversity and timber (https://www.dairynz.co.nz)

Trees for Bees website
Range of resource booklets and science publications for farmers and advisors interested in tree planting for bees (https://treesforbeesnz.org/)

Waikato Regional Council – Trees on Farms
A guide for Waikato farmers created from local farmer experiences of growing and integrating trees on farm (publication linked to https://www.waikatoregion.govt.nz).

2.3.2. Added-value trees and joint venture opportunities

Besides timber production, a number of tree species can provide alternative products that have the potential to add value to the farm system. Manuka, for instance, is a popular native that can be grown for honey or oil production. Hives within Manuka stands can return $500 per annum each in good seasons and premiums above this are received for honey with high Unique Manuka Factor (UMF). Achieving high UMF honey requires a minimum 20 ha of land planted in manuka to ensure the honey remains monofloral and bees do not go elsewhere for food. Manuka is well suited to steep, inaccessible land although site access for beekeepers still needs to be considered (Moore *et al*., 2015). Joint ventures with revenue sharing arrangements can be a good option for landowners whereby they provide the land and beekeepers manage the hives. The cost of establishing a Manuka crop can range from approximately $2,000-3,000/ha with returns estimated at $500-1,360/ha (Tahuri Whenua, 2018). Besides producing honey and oil, manuka can also act as an excellent nurse crop for erosion protection when interplanted with forestry species. (Satchell, 2018). The Manuka Farming NZ website (https://www.manukafarming.co.nz/) provides a number of useful resources for farmers including funding available, expected returns and designing and growing Manuka stands. Genetically improved Manuka seedlings can also be purchased through their site.

Other added value tree crops include horticultural trees which can successfully be grown within farm systems for nut or fruit production. These trees are however not included in the One Billion Trees programme (Te Uru Rākau, 2019a).

Within forestry plantations, understorey crops can be utilised to improve landowner returns. Ginseng is one such crop that can significantly improve forestry returns if successfully grown. When grown under forestry, the crop is referred to as wild-simulated ginseng and receives huge global demand as natural, wild ginseng has become almost non-existent. The crop requires a high level of shade and therefore suits as an understorey crop for forestry species, particularly radiata. Climate and soil requirements are met in the central North Island region of New Zealand, including winter chilling, moist free-draining sandy loam soils and sufficient rooting depth. The crop is harvested between 7-10 years after planting and must be sown after the final forestry thinning to minimise soil disturbance (Tahuri Whenua, 2018). Economic analyses suggest that successful ginseng crops can more than double profitability compared to forestry alone (Moore *et al*., 2015).

In addition to the added value trees and joint venture opportunities mentioned above, Crown Forestry are also helping farmers through the One Billion Trees programme through their own joint venture offering. This programme exists for landowners with a minimum area of 200 ha available for commercial radiata pine planting. Crown Forestry will either lease the land from the landowner or enter into a joint venture for one 30-year rotation. The Crown will pay for all establishment and management costs over the full rotation and pay a rental to the landowner. This rental can be negotiated and structured as an annual rental or a share of the net profit, or a mix of both. All carbon credits are retained by the landowner (Te Uru Rākau, 2018a).

Best Places to go for Information

Manuka Farming NZ
Useful website with resources available on expected Manuka returns, funding and preparing and managing sites (https://www.manukafarming.co.nz)

Moore, J., West, G., & Dowling, L. (2015). An update on forestry economics and market outlook to support land-owner decision making on lower nutrient leaching land use systems
Overview of manuka and ginseng crops.

Tahuri Whenua – Rotorua Land Use Directory 2018
Description and estimated investment and returns from added value trees and understorey crops (report linked to https://landusenz.org.nz/).

Te Uru Rākau - The One Billion Trees Programme: Our future, our billion trees 2018
Publication describing Crown Forestry Joint Venture opportunity (report linked to https://www.mpi.govt.nz)

2.4. Financial Considerations

2.4.1. *Investment*

Investment costs, including establishment and tending, for a range of timber species were modelled across three central North Island sites in a study by Moore *et al*. (2015). Coast redwood and *C. lusitanica* had the highest growing costs at approximately $8,000/ha due to higher purchase cost and intensive silviculture regimes for high quality appearance grade timber. In comparison, unpruned radiata and *E. fastigata* had the lowest growing costs at approximately $3,800/ha. Pruning the radiata increased growing costs by $1,600/ha (Table 2).

Table 2 Modelled investment costs (including establishment and tending; $/ha) from three central North Island woodlots. Adapted from data from Moore *et al*. (2015).

Species	Growing Cost ($/ha)
Radiata (clearwood)	$5,360
Radiata (structural)	$3,730
Coast Redwood	$7,920
Cupressus lusitanica	$8,000
Eucalyptus fastigata	$3,840

For space-planted trees grown for erosion control, Plant and Food Research has published the Trees for the Farm booklet which includes a cost-benefit evaluation. Establishment and maintenance (whether pruned or pollarded for fodder) costs were reported at $1,480/ha and $1,500/ha, respectively, for a total cost of $2,980/ha. An additional $3,000/ha could be expected if trees were to be harvested at 20 years.

For riparian planting, the DairyNZ riparian planner tool is available online. This allows specific areas on farm to be mapped and calculated and estimates the total cost to plant including site preparation, planting and maintenance.

Best Places to go for Information

Moore, J., West, G., & Dowling, L. (2015). An update on forestry economics and market outlook to support land-owner decision making on lower nutrient leaching land use systems
Investment costs, net stumpage and NPV analyses of a range of tree species grown in central North Island.

Plant and Food Research. (2016). Trees for the farm.
Cost-benefit analysis for growing space planted poles on farm (https://beeflambnz.com).

DairyNZ Riparian planner.
Online tool available to estimate riparian planting costs (https://www.dairynz.co.nz)

2.4.2. Returns

Often, the current profitability of forestry or the perceived future profitability of forestry is the key determinant in whether farmers plant woodlots on their land (Moore *et al*., 2015). The major factors determining the profitability of small woodlots however is location which directly impacts harvesting and transport costs (Park, 2011; Moore *et al*., 2015). Areas located close to public roads with good access and roading infrastructure will have significantly less transportation costs and woodlots on easier terrain will have reduced harvesting costs.

Along with harvesting and transportation, log prices also have a significant effect on final return but are much harder to predict. Historic log prices for radiata pine are widely available online including through the Te Uru Rākau and interest.co.nz webpages. For current market trends and log price indicators, AgriHQ provides monthly updates at an annual subscription cost. Laurie Forestry also provides freely available monthly market updates online. Similarly, future carbon prices can be found online through the Carbon News site which includes current and historic carbon prices.

Returns from a number of tree species grown in the central North Island were modelled in the report by Moore *et al*. (2015) (Table 3). Their finding showed that *P. radiata* forestry was the most profitable with pruned forest management providing higher returns at harvest, but also incurring higher costs of forest management. As shown in Table 3, minor species were able to provide higher returns at harvest but took much longer to get there, resulting in lower overall profitability. If a $15/t carbon price was included in the total returns then *E. fastigata* gave a positive return but still at a rate below radiata with carbon.

Table 3 Net stumpage ($/ha) from three modelled central North Island woodlots. Adapted from Moore *et al*. (2015).

Species	Net stumpage ($/ha)
Radiata (clearwood)	$23,290 – $40,920
Radiata (structural)	$15,110 – $36,430
Coast Redwood	-$2,310 – $30,970
Cupressus lusitanica	$53,480 – $68,730
Eucalyptus fastigata	-$6770 – -$19,690

Best Places to go for Information

AgriHQ
Monthly forestry market report and log price indicator available for annual subscription (https://agrihq.co.nz/forestry)

Laurie Forestry
Freely available monthly market updates (http://www.laurieforestry.co.nz/Monthly-Newsletter)

Te Uru Rākau – Historic indicative NZ radiata pine logs
Historic export and domestic radiata log prices dating back to 1992 (https://www.teururakau.govt.nz)

Forest Growers Research Calculators
Woodlot calculators to estimate expected returns at harvest (https://fgr.nz/programmes/calculators/)

Carbon News
Current and historic carbon price (http://www.carbonnews.co.nz)

Moore, J., West, G., & Dowling, L. (2015). An update on forestry economics and market outlook to support land-owner decision making on lower nutrient leaching land use systems
Investment costs, net stumpage and NPV analyses of a range of tree species grown in central North Island.

2.4.3. Tax management for forests

There are numerous taxation rules that apply to forestry. A brief overview of tax rules considered of importance is given here with the full Income Tax Act 2007 available online. The NZFFA also has a number of articles relating to farm forestry. In particular, NZFFA Information Leaflet No.15 on Taxation of Forestry is particularly useful and provides an overview of the relevant rules with links to specific subsections within the Income Tax Act 2007.

The Inland Revenue Department (IRD) defines investors as either farmers or foresters. A forester is someone that grows timber while a farmer grows trees. Trees, as defined by the IRD, are non-harvestable while timber is live, harvestable wood. This is important to note as each party has different liabilities within for taxable activities. For instance, management including fertiliser, and weed and pest control, is fully deductible if a farmer is managing trees for erosion control, shelter or water quality and deductible up to $7,500 per year if managing for timber. For a forester however, all management is fully deductible. The same rules apply for planting whereby if the planting is for erosion, shelter or water quality then the planting is fully deductible for farmers but only deductible up to $7,500 if growing for timber. For foresters, planting costs are fully deductible (Moore, 2018).

At harvest, all income is part of the normal taxable activity and liable for income tax but timber harvested and used in the forest or on farm (e.g. for gates, posts, farm buildings) does not generate taxable income. If timber is sold for less than the market value then the Commissioner of the IRD is entitled to assign a market value for tax purposes (Moore, 2018).

Farmers and foresters can spread income forward, up to five years, from the sale of timber using an income equalisation account held at IRD which is charged interest at 3%. Tax is only paid on the amount of income withdrawn from the account in any one year. Foresters are also able to spread income backwards for three years. This means foresters can in total spread income for up to eight years (Moore, 2018).

Timber sold standing is liable for income tax. All trees, whether grown for erosion control, shelter or water quality, are assumed to be grown for timber at sale as a result of the Tax Administration Act 1994 outranking the Income Tax Act 2007. As a result, these trees are also liable for income tax unless a certificate from Regional Council can be presented confirming that harvesting is not possible or that a 'suitably qualified person' can provide a certificate stating that harvesting costs would outweigh returns (Moore, 2018). The purchaser of standing timber can claim the value of forestry at purchase as the cost of timber and claim this as an expense when the trees are sold or harvested.

In terms of carbon, NZU's that are being earnt from timber or trees in post-1989 forests under the ETS are not taxable on issue or surrender but create taxable income on sale. NZU's issued for pre-1990 forests are treated as capital and not taxable on issue, surrender or sale. If NZU's are being bought and sold for trading then these must be valued each year with tax paid/repaid on the annual change in value (Moore, 2018).

Best Places to go for Information

NZ Government - Income Tax Act 2007
Income tax rules related to forestry (http://www.legislation.govt.nz)

NZFFA Taxation of Forestry Information Leaflet No.15 (2018)
Overview of tax requirements relevant to farm forestry (https://nzffa.org.nz)

2.4.4. Valuation of forestry

The valuation of standing timber is a complex issue that involves a number of factors including the land, trees, carbon, and other assets. To add to this complexity, buyers and sellers have two different objectives when valuing forestry due to differences in tax liability. The interests of the vendor in general is to negotiate a standing timber value that is as low as possible to reduce income tax payable, whereas the purchaser will want a high value that can be claimed as an expense on harvest or sale (Downs, 2005). For high level due diligence on sale and purchase agreements, independent consultants should be used to value farm woodlots using the Forestry Valuation Standards set out by the New Zealand Institute of Forestry (NZIF).

For valuations that don't require such an in-depth analysis, foresters can value small blocks on a rough per hectare basis (Downs, 2005). For young trees, this would be calculated from the total costs incurred to date (i.e. planting, establishment and pruning) which may be about $1500 per hectare for four-year-old radiata. Once trees have reached ten years of age, valuations are conducted by estimating the value at harvest and discounting back to a present timber value (Downs, 2005).

ForestX, an online platform, also provides a basic forestry valuation calculator for *P. radiata* that estimates the value of a forest harvest after deducting harvesting and transport costs based on the tending regime, region and terrain. The site also provides an online marketplace for buying and selling land, standing timber and carbon (ForestX, n.d.).

Best Places to go for Information

NZ Tree Grower February 2005 – Buying or selling land with standing timber How standing timber is valued and its tax liabilities (https://www.nzffa.org.nz)

ForestX
Online forestry valuation calculator and platform for buying and selling land, forestry and carbon (http://www.forestx.co.nz/)

Colliers International – Guide to Forestry Valuation 2014
Brief overview on the purpose and methods used for forestry valuation
(Report linked to https://www.colliers.co.nz)

2.4.5. Forestry rights

A forestry rights may be created by the landowner to give a person the right to establish, maintain and harvest or just maintain and harvest a crop of trees on that land. The forestry right may also extend to give a person the right to access the trees and construct and use tracks, culverts, bridges, and buildings and other works that are necessary for the purpose of establishing, maintaining and harvesting such trees. It may also provide for charges, payments, royalties or division of the tree crop or proceeds (MPI, 2018).

Forest rights can be used to retain the right to harvest trees after the farm has been sold or can be used to generate extra income by selling the forestry rights over a farm. In addition, it can be used to regulate joint venture agreements or could be used as security for a loan if the forestry right is granted to the landowner. In the instance of the latter and if the landowner defaulted on the loan, then the security holder can only exercise their power on the forestry right and are unable to sell or take ownership of the land (Norris Ward McKinnon, 2013).

Best Places to go for Information

MPI. (2018). Forestry Rights Registration Act 1983.
Rules applying to the use and granting of forestry rights (http://www.legislation.govt.nz)

Norris Ward Mckinnon. (2013) Forestry rights.
Reasons for granting forestry rights (http://www.nwm.co.nz)

2.5. Climate Change and ETS Implications

2.5.1. Physical design to qualify for carbon payments

To enter into the Emissions Trading Scheme (ETS) and earn carbon credits landowners must ensure that the forest land will meet the guidelines set out by government. These include a minimum forest area of one hectare that will have a tree canopy cover of at least 30% in each hectare with an average canopy cover width of at least 30 metres at maturity. For forest species, trees must also reach a minimum height of five metres at maturity (Te Uru Rākau, 2019a).

Under the ETS, forest can be classed as either pre-1990 or post-1989 forest depending on when the land was put into forestry. Pre-1990 forests are unable to earn New Zealand Units (NZUs) for carbon stock increases but will automatically join the ETS if the land is deforested and will require the forest owner to pay back NZUs if more than two hectares of forest is deforested without an exemption. A one-off allocation of NZUs is however given to pre-1990 forest owners to compensate for the obligations they face regarding deforestation. Post-1989 forests can volunteer to enter into the ETS and are able to claim carbon credits provided they meet the minimum forest requirements (Te Uru Rākau, 2015).

Land such as grassland, narrow shelterbelts, gorse or broom and scattered forest species unlikely to reach 30% crown cover are unable to enter into the ETS (Te Uru Rākau, 2015). Horticulture species which may meet the requirements are also excluded (Beef and Lamb NZ, n.d.). Agroforestry plantings that may qualify as forest land include grazed pastoral land that has forest species planted in sufficient numbers that it will exceed a crown cover of 30% on each hectare. Space and close-planted poplars may therefore qualify as forest land in the ETS (MAF, 2010). Manuka and riparian planting can also be eligible for entering the ETS (Beef and Lamb NZ, n.d.).

Best Places to go for Information

Te Uru Rākau – Growing & Harvesting: forestry in the emissions trading scheme
Information regarding the ETS and description of minimum requirements for forest land and species (https://www.teururakau.govt.nz/)

2.5.2. Averaging accounting method

All post-1989 forests that register for the ETS from 1 January 2021 will automatically join the new averaging accounting method for carbon credits, whereas for forests that register in 2019 or 2020 the decision will be optional and foresters may still choose to use the old carbon stock change accounting method. Under the new averaging system, rather than accruing credits as the forest grows and paying them back at deforestation, carbon credits only accrue up until a determined average level of carbon storage and no units need to be repaid at harvest (**Figure 1**). This average level is the age at which the forest reaches the average level of carbon it is expected to store over the long-term, which includes future rotations. The default age is considered as the typical age band at which a particular type of forest is commercially harvested. For instance, a forest that is typically harvested at 30 years will store more carbon than a forest harvested at 20 years and as such will have a higher average age. Participants who leave their forests to grow for longer than the typical age of harvest will receive more NZUs as more carbon will have been stored. Likewise, participants that harvest sooner than the typical age will need to surrender units as less carbon will have been stored compared to the average age (MPI, 2019).

Carbon credits will no longer need to be surrendered at harvest provided the forest is replanted. Similarly, foresters will not need to repay NZUs after adverse events but affected areas must be re-established within four years. In addition, foresters using the averaging accounting method won't need to pay repay NZU's if they convert forested land to an alternative use provided that another forest with equivalent carbon storage is planted elsewhere (MPI, 2019).

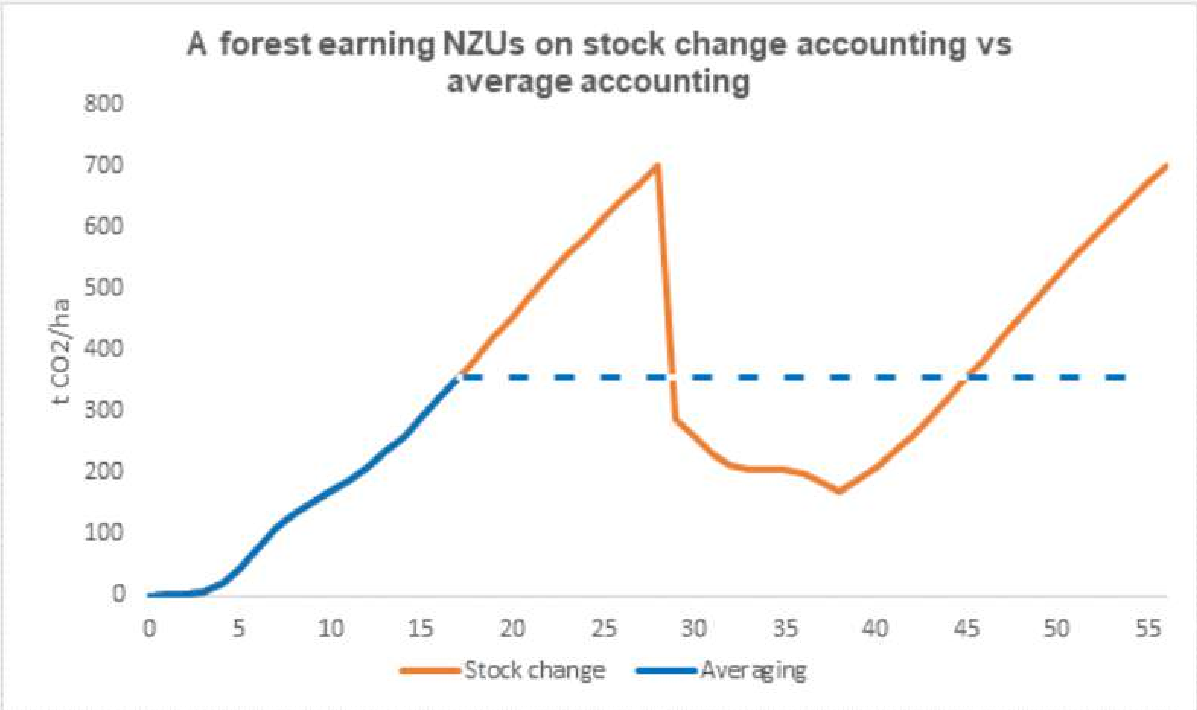

Figure 1 *Comparison of stock change accounting and averaging accounting method in the ETS. Retrieved from MPI (2019).*

Best Places to go for Information

Te Uru Rākau
ETS requirements (https://www.teururakau.govt.nz)

Beef and Lamb NZ
Farm, trees and carbon resources (https://beeflambnz.com)

Ministry for Primary Industries – Emissions Trading Scheme reviews
Averaging accounting method for carbon payments and updates on ETS reviews (https://www.mpi.govt.nz)

2.5.3. *Carbon returns and services available for carbon trading*

Carbon returns can significantly improve the NPV of farm woodlot plantings. Moore *et al*. (2015) showed that the annuity from three modelled central North Island radiata plantings at an 8% discount rate ranged between $-59/ha/yr and $145/ha/yr without carbon payments. With the addition of carbon at a constant price of $6/t CO_2, the NPV increased to between $114/ha/yr and $326/ha/yr, depending on the site. For forestry regimes with high upfront costs, early income from carbon credits will have a large positive effect on NPV.

Carbon returns are driven by the amount of carbon able to be stored within trees. This amount is highly site specific with factors including species, growing conditions and rotation length having an impact on the volume of carbon able to be stored. For instance, an analysis in the Bay of Plenty showed the effect of different growing sites on mean carbon storage in small woodlots (L. Dowling, pers comm, 2018). Sites with lower productivity had lower carbon storage capacity as their ability to sequester carbon was reduced, whereas higher productivity sites had greater carbon storage (Table 4).

Rotation length will also have a direct effect on carbon storage, with shorter rotations reducing the amount of carbon able to be stored (Table 5). Internal rate of return calculations were included in the analysis and showed that forests that were entered into the ETS and received a carbon payment of $25/t had a significantly higher IRR compared to those that did not receive carbon credits. For radiata on a 30-year rotation this was equivalent to an IRR of 11.8% with carbon as compared to 4.8% without carbon.

Table 4 *Effect of site-specific growing conditions on carbon storage for pruned P. radiata. Retrieved from L. Dowling, pers comm, 2018.*

Rotation age (years)	MAI at harvest (m3/ha/yr)	Total tree stem volume at harvest (m3/ha)	Mean carbon stored second rotation (t/ha)
30	24.0	721	404
30	29.8	893	546
30	34.2	1025	658

**MAI: mean annual increment*

Table 5 *Effect of rotation age on carbon storage and IRR for pruned P. radiata. Retrieved from L. Dowling, pers comm, 2018.*

Rotation age (years)	Total tree stem volume at harvest (m3/ha)	Mean carbon stored second rotation (t/ha)	IRR with carbon (%)	IRR without carbon (%)
25	711	446	11.8	4.9
30	893	546	11.8	4.8
35	1050	642	11.6	4.6

Due to the site specific nature of carbon storage, farmers and landowners should get specialist advice from a registered forestry consultant with expertise in the ETS regulations before entering into carbon sale agreements. In addition, farmers should consider whether to assess the carbon stored within their forest. For areas less than 100 hectares, a default per hectare carbon stock volume is used from the MPI look-up tables based on the region grown, species and age of the stand (MPI, 2015). For areas of post-1989 forests larger than 100 ha, the Field Measurement Approach must be used when calculating the carbon stock. This involves collecting forest specific information from a set of sample plot locations assigned by MPI. This information is then sent back to MPI to create participant-specific look-up tables that are used to file emissions returns for the carbon stock within their forest (Te Uru Rākau, 2018).

There are a couple of online platforms available for carbon trading in New Zealand. These include OMF Carbon (https://www.commtrade.co.nz/) and Carbon Match (https://www.carbonmatch.co.nz/). Both of these platforms match anonymous parties who want to buy and sell carbon credits on a price basis. Once a match is made, a contract is sent to both parties at which point the traders are able to see who they are making a transaction with and settle the trade. Carbon Match restricts trades to a minimum parcel of 10,000 units while OMF Carbon sets a standard minimum of 5,000 units. This is because the majority of buyers require a large number of units. For smaller trades, it is possible to use aggregators such as forestry consultants who may have a registered carbon trading account and can aggregate small units.

Best Places to go for Information

Moore, J., West, G., & Dowling, L. (2015). An update on forestry economics and market outlook to support land-owner decision making on lower nutrient leaching land use systems
Impacts of carbon on forestry returns

Ministry for Primary Industries – Emissions Returns
Information on carbon look-up tables and filing emissions returns (https://www.mpi.govt.nz)

Te Uru Rākau – A Guide to the Field Measurement Approach
Publication providing information about the FMA for calculating carbon stock (https://www.mpi.govt.nz)

Carbon Match
Platform for carbon trading as well as information on how trading is completed (https://www.carbonmatch.co.nz)

OMF Carbon
Platform for carbon trading as well as information on how trading is completed (https://www.commtrade.co.nz/)

2.6. Grants and Support

2.6.1. *Funding available*

A number of grants are available to landowners wishing to plant trees on farm. The main grant available to farmers under the One Billion Trees programme is the direct grant which helps with either the cost of planting trees or reversion to native forest. Landowners receiving this grant will get a base rate per hectare, depending on the type of planting, as well as a potential additional top-up (Table 6). Landowners who receive this funding and plant radiata pine however will not be able to register in the ETS for six years after planting and cannot claim any NZUs once registered for those previous six years (MPI, 2019).

Table 6 *Direct landowner grants available under the One Billion Trees programme. Adapted from Te Uru Rākau (2019b).*

Category	Size*	Base rate/ha	Top-up/ha			
			Erosion-prone land	**High land preparation costs**	**Fencing**	**Ecological restoration****
Native Planting	1ha – 300ha	$4000	Up to $500		$500	$2000
Native Reversion	5ha – 300ha	$1000	Up to $500		$500	NA
Mānuka/Kānuka Planting	5ha – 300ha	$1800	Up to $500		NA	NA
Exotic Planting	5ha – 300ha	$1500	Up to $500		NA	NA

**The minimum application size is 5ha which can be made up of any combination of categories (an exception is Native Planting where the minimum application size is 1ha)*
***Top-up cannot be used in conjunction with other top-ups.*

Partnership funding is the other grant available under the One Billion Trees programme but is aimed at groups and projects that can improve the long-term success of tree planting in New Zealand. These have included large-scale erosion protection, native nursery upscaling and research projects (Te Uru Rākau, 2019).

A range of other funding options are available for Maori and non-Maori landowners. The growing and harvesting subsection of the Te Uru Rākau website provides a list of forestry funding options for both groups of people. Key funding programmes worth mentioning include the Hill Country Erosion programme which provides funding for highly erodible land, and the Nga Whenua Rahui programme which is aimed at protecting Maori land through funding indigenous plantings (Te Uru Rākau, 2019c).

Best Places to go for Information

Te Uru Rākau – Funding & Programmes
One Billion Trees programme funding regimes and Hill Country Erosion programme details (https://www.mpi.govt.nz)

Te Uru Rākau – Growing & Harvesting
Forestry funding options for Maori and non-Maori landowners (https://www.mpi.govt.nz)

Te Uru Rākau - The One Billion Trees Programme: Our future, our billion trees
Publication containing various funding programmes available including those offered by other organisations (report linked to https://www.mpi.govt.nz).

Department of Conservation – Nga Whenua Rahui Fund
Description and criteria for Nga Whenua Rahui fund (https://www.doc.govt.nz)

Regional Council website/local land management advisor
Local funding options for tree planting

2.7. Environmental and Social Considerations

2.7.1. Environmental considerations

Tree plantings provide a number of market (e.g. timber, carbon) and non-market (e.g. soil conservation, water quality, biodiversity) benefits. Non-market benefits tend to provide significant environmental protection but are hard to value. For farm plantings, erosion control and improved water quality are two of the most common environmental reasons behind establishing trees. With the recent Action for Healthy Waterways proposal as part of the Essential Freshwater package (Ministry for the Environment, 2019), tree plantings for improved water quality is likely to become more important on farms particularly as part of riparian setbacks. For large rivers and streams (more than a metre wide) as well as lakes and wetlands, the Ministry for the Environment (MfE) are proposing a five metre setback from the waterway. Use of riparian plants in these areas will significantly improve the performance of the setback in reducing contaminant loss to water. DairyNZ has a number of resources available to help landowners plan and estimate the cost of planting these areas. Local council land management advisors can also help with planning and funding options.

Areas on farm where soil conservation planting is best suited includes marginal hill country or steep slopes, gullies and critical source areas where water tends to channel, areas of loose or poorly consolidated soil, and stream banks (DairyNZ, n.d.). A range of afforestation options can be used for these areas depending on the severity and likelihood of erosion. These include retiring land to productive or non-productive forestry, space-planting poles on productive slopes, and riparian planting. Trees reduce erosion primarily through their root structure which binds soil together. The effectiveness of erosion control depends on the tree species, their rooting structure, growth rate, age and spacing. The most commonly used trees for soil conservation are poplars and willows due to their extensive rooting structure relative to other species which allows them to be space-planted at 10-15 metres apart on grazed slopes (Plant and Food Research, 2017a; 2017b).

Water quality, as compared to grazed pastoral land, is positively affected by farm woodlots and riparian planting through improved infiltration capacity of soils which subsequently reduces surface runoff. In addition, water quality is improved by stream shading and by reducing nutrient inputs to waterways (Yao *et al*., 2013). There are however concerns that environmental issues caused at harvesting outweigh these positive impacts. These include exposing bare ground to erosion, increased runoff due to reduced vegetation, roading infrastructure and soil compaction (NZFOA, 2009). Research on pine stands, however, has shown that while nutrient outputs are greater at harvest compared to grazed pasture land, these impacts are short-lived and over the whole forest lifecycle forestry provides greater environmental outcomes to water quality (Quinn, 2005). Nevertheless, the impact on the environment at harvest can be reduced by following best environmental practices as set out in the New Zealand environmental code of practice for forestry (New Zealand Forestry Owners Association; NZFOA, 2009) and the standards set out in the National Environmental Standards for Plantation Forestry 2017.

Native tree plantings on farm can also provide significant biodiversity value to farming systems. The QEII National Trust has a range of useful publications around native forest restoration and protecting wetlands and biodiversity. In addition, they offer the ability for farmers to covenant significant natural areas, particularly those containing threatened native species, within private land for the benefit of present and future generations. The covenant is an agreement between the landowner and the QEII Trust to protect the area of land forever. The landowner continues to own and manage the protected land, and the covenant and associated protection remains on the land even after the property is sold or surrounding land use changes. Usually protection involves stock exclusion, pest and weed control and may have restrictions on grazing, removing native vegetation and diverting water. Funding for management of covenants is available and more information can be found on their website or through the Trust's regional representatives (QEII National Trust, n.d.).

Best Places to go for Information

The NZ Poplar & Willow Research Trust
Large inventory of resources for poplars and willows including research and farmer guides for erosion control planting (http://www.poplarandwillow.org.nz/)

DairyNZ – Planting Waterways
Resources and planting guides for riparian planting on farm (https://www.dairynz.co.nz)

Maclaren, J.P. (1996). Environmental effects of planted forests in New Zealand. New Zealand Forest Research Institute: FRI Bulletin No. 198.
Impact of forest stands on water quality and yield, soil erosion and biodiversity as well as the environmental implications of forest practices.

NZFOA. (2009). New Zealand environmental code of practice for plantation forestry
Best environmental practices for forestry operations (http://www.nzfoa.org.nz)

QEII National Trust
Information on protecting native biodiversity and covenants for significant natural areas (https://qeiinationaltrust.org.nz/)

2.7.2. Social considerations

Forests and planted trees provide a number of social and cultural services that contribute to the well-being of society. For trees on farm, these benefits include aesthetic experiences, appreciation of biodiversity and conservation (Yao *et al*., 2013).

Despite these benefits, there are concerns from the rural sector that the goal to plant more trees on farm may reduce local employment opportunities and income through the loss of farmland to forestry which would have flow-on effect for agriculture-dependent communities. Early work by Maclaren (1996) looked into these concerns in the sheep and beef cattle sector and summarised that in some regions a moderate switch to forestry may have little to no detrimental effect on livestock numbers, particularly in hill and high country where considerable marginal land exists. In other areas, increases in afforestation may reduce livestock numbers and employment for a period until harvest, at which point employment would be expected to expand greatly. Similarly, a more recent study in 2019 looked at the impact on converting all sheep and beef farms in the Wairoa District to forestry in response to the Zero Carbon Bill (BakerAg, 2019). The resulting impacts of such a land use change was found to be a loss of 700 jobs and $23.5 million less spent in the local economy as compared to blanket forestry. However, this did not include the harvest year when employment and spending was expected to rise.

Best Places to go for Information

Maclaren, J.P. (1996). Environmental effects of planted forests in New Zealand. New Zealand Forest Research Institute: FRI Bulletin No. 198.
Impact of afforestation on farming communities

BakerAg. (2019). Case study: socio-economic impacts of large-scale afforestation on rural communities in the Wairoa District. *Client Report for Beef + Lamb NZ.*
Impact of afforestation on employment and income in Wairoa.

2.8. Climate Risk Management

2.8.1. *Managing climate risk*

Forests face a number of climatic risks, including fire, drought, wind and snowfall, which can severely damage and affect profitability of stands. NIWA predicts that these risks will increase in future with climate change resulting in more frequent high intensity rain, a 10% increase in wind speed and the likelihood of severe droughts doubling or quadrupling. As a result, erosion and sedimentation risk is expected to increase along with the risk of windthrow and fire damage (Scion, 2012a). Landowners with large plantings should consider obtaining a forecast on the climate outlook to assist with species selection and site location.

A number of precautionary steps can be taken to minimise climatic risk. In brief, some of the steps small forest owners should consider include avoiding the establishment of woodlots adjacent to forests or scrublands as this will reduce the risk of forest fires spreading to farm woodlots. In addition, for larger farm woodlots farmers should consider planting in several locations on farm to minimise the risk of fire spreading through all trees (NZFFA, 2005).

The risk of drought, windthrow and snow damage can be somewhat reduced by tree species selection. Macrocarpa for instance is susceptible to canker and Douglas-fir to needle cast in drought conditions which reduces productivity and value. These species should therefore be avoided in hotter climates whereas radiata is less likely to suffer. Similarly, Douglas-fir is more resistant to snow than radiata and should therefore be preferentially selected in cool and altitudinal climates that receive annual snowfall (NZFFA, 2005).

Windthrow damage can occur in all tree species. The risk of these events causing damage can be reduced through site and species selection, and good silviculture practices. Avoiding planting in exposed sites, including gullies which funnel wind and have wet soils, as well as any soil types that encourage shallow rooting is a good first step in reducing windthrow risk. Selecting species more tolerant to wind (e.g. Douglas-fir compared to radiata) where exposure is likely will also lessen the risk. Ensuring trees are thinned early in their rotation before trees reach a mean top height above 18 metres will also reduce the risk of windthrow damage in planted stands (Scion, 2012b).

Best Places to go for Information

Scion – Managing forestry risk & climate change
Information and links to managing wind and fire risk in forests (https://www.scionresearch.com)

Climate Cloud – Forestry
Publications on managing climate risk including wind, heavy rain, pests, diseases and weeds (http://www.climatecloud.co.nz)

2.8.2. *Forest insurance*

Again, the NZFFA is the best place to go to gain initial understanding of what insurance cover farm foresters may need and the risk level individual forest stands present. In general, forestry insurance cover will vary from farmer to farmer based on individual business activities and risk appetite. However, public liability insurance is heavily recommended by the NZFFA and protects forest owners against third party claims for personal injury or property damage (McIntosh, 2015). Fire damage on neighbouring properties is a common claim made against forest owners and can often involve significant costs. Understanding the forest risk for a particular situation such as fire is key to deciding how much, if anything, to insure your forest for. Factors that will increase fire risk and should be considered include remoteness, low rainfall and drought-prone areas, easy access by public and power lines going through the stand. Forest owners should understand if the value of their trees is covered under their insurance plan and whether carbon revenue is also protected.

Best Places to go for Information

NZFFA Forest Management - Wind, Fire and Snow Risk
Articles and journals on managing climatic risk and insurance requirements (https://www.nzffa.org.nz).

3. Surveys on Farm Forestry

3.1. Forestry Trends and Farmer Attitudes

The Survey of Rural Decision Makers (Landcare Research, 2017) provides information on forestry practices by region with the latest survey in 2017 including data on ETS registered forests, forest species grown, forest age and intentions to replant. These surveys are available biannually starting in 2013 and enable trends in forestry practices to be identified.

Other surveys have also been conducting looking only at small-scale forest owners. For instance, a recent 2015 survey of small-scale forestry owners investigated what the information needs were for this group and what information channels worked best. Of the 364 small-scale owners surveyed, 36% were farmers, 26% were foresters and 19% were lifestyle block owners. The remaining 19% included family businesses, partnerships, joint ventures and trusts. Most (39%) woodlots were between 11-40 ha (West & Satchell, 2017).

Another study in 2011 conducted by Rodenberg and Manley (2011) surveyed 728 farm owners who also had small woodlots (20 – 200 ha). Similar to survey findings by West and Satchell (2017), median woodlot size was 37 ha while median farm size was 400 ha. Of these landowners, 52% owned sheep and beef, 12% owned beef and a further 12% owned dairy land. The majority of landowners grew radiata pine (90%) while 3% grew Douglas-fir, 3% grew cypresses and 2% grew eucalypts. At the time of the survey, 90% of landowners were currently pruning but only 61% planned to prune in the future. Overall the study found that the majority of small woodlot owners enjoyed having forestry on their land and would continue to replant and manage forestry into the future.

3.2. Reasons for Investment

In New Zealand, the main reason for integrating forestry into farmland was to provide additional income from timber according to a survey by Rodenberg and Manley (2011). This was followed by environmental reasons, owning forestry for future generations, land/capital investment, scenic beauty, carbon income and finally recreation (Table 7).

***Table 7** Ownership objective of small-scale forest owners who also own farmland. Adapted from Rodenberg and Manley (2011).*

Ownership Objective	Score (out of 5)
Income from timber	3.94
Environmental reasons	3.84
To keep for future generations	3.12
Land investment/real estate/capital investment	3.01
Scenic beauty	2.80
Income from carbon	2.56
Recreation	2.27

The 2015 survey conducted by West and Satchell (2017) also looked at the ownership objectives of small-scale forest owners, although only 36% of these respondents identified as farmers. Similar reasons for forestry investment were found with investment diversification ranked the highest with 55% of respondents scoring it as the main reason for investing. This was followed by best land use, superannuation, environmental protection, aesthetics, farm succession, recreation, other and understorey crops/wildlife (Table 8).

Table 8 *Ownership objective of small-scale forest owners. Adapted from West and Satchell, 2017.*

Ownership Objective	Per cent
Investment diversification	54.6
Best land use	43.5
Superannuation	37.3
Environmental protection	25.9
Aesthetics	17.8
Farm succession	17.0
Recreation	16.4
Other	6.4
Understorey crops/wildlife	5.6

3.3. Constraints to Adoption

Considerable uncertainty exists amongst small woodlot owners in regards to the advantages of pruning, cost of harvesting trees and government initiatives, particularly the ETS. With regards to the latter, small scale forestry owners responded in a 2011 survey that "income from carbon was too political at the moment" and that there was "not enough information to decide on entering the ETS." For many, the concept of carbon as an income source was confusing as it is not a product that can be touched or visualised (Rodenberg and Manley, 2011) and was an adoption barrier for entering the ETS.

West and Satchell (2017) surveyed what lack of information needs were hindering small-scale forestry owners in managing their woodlots. For the 166 respondents who answered, information around harvesting, markets and marketing were the main areas of need. Maximising forest growth and tending to the trees were in the middle, while species, site selection, environmental compliance and land use planning were least selected (Table 9).

Table 9 *Information needs of small scale forestry owners. Adapted from West and Satchell, 2017.*

Information needs	Per cent
Harvesting options and issues	62.0
Links to reputable wood buyers and harvesting contractors	57.8
Market information and price trends	54.2
Methods of marketing woodlots	51.2
Getting harvest ready	50.0
Links to harvesting and marketing advisors	45.2
Maximising forest growth and income	44.0
Trading of carbon	42.8
General forest management	39.2
Establishment and re-establishment of plantations	37.3
Roading requirements and costs	37.3
Tending - pruning and thinning	36.1
Species and site selection	30.1
Environmental compliance	30.1
Strategic land use planning	17.5

In terms of information channels, West and Satchell (2017) found that small-scale landowners preferred workshops, seminars, web pages and field days as opposed to rural newspapers and brochures to supply information needs. Web learning and journal articles were also considered useful. Decision support software was indicated as being useful by 79% of respondents with tools to help assess woodlot value, when to harvest and harvesting costs scoring in the top five of tools wanted (Table 10). Profitability of various land use options was scored in the mid-range, while historic log price trends, scheduling tending operations and soil analysis considered least wanted.

Table 10 *Value of software tools by small scale forestry owners. Adapted from West and Satchell 2017.*

Software tool needs	Per cent
Assess your woodlot for area and volume	70.2
When to sell my woodlot	67.2
Assess your woodlot's current value	65.6
Log price forecasts	64.1
Estimate roading and harvesting costs	60.3
Profitability of land use options – decision support	38.2
Historic log price trends	36.6
Record system suitable for forest certification	33.6
Schedule your tending operations	29.0
Soil nutrient analysis for growth projections	23.7
Other	8.4

Best Places to go for Information

Rodenberg, J., & Manley, B. (2011). Small forests in New Zealand: a survey of landowner objectives and management. ***NZ Journal of Forestry 56(2): 15-19***.
Ownership objectives of farm forest owners and adoption constraints.

West, G., & Satchell, D. (2017). Survey of the needs of small-scale forest owners for information and decision support. ***New Zealand Tree Grower May 2017.***
Ownership objectives of farm owning and non-farm owning forest owners and information needs.

4. Summary

A large amount of information relating to the incorporation of trees on farm exists online. The NZFFA is an excellent resource for farmers wishing to incorporate forestry on farm, with articles and leaflets spanning a range of topics including tree species and uses, forest management and case studies. This site is a good starting point for almost all aspects of farm forestry, whether for timber, the environment, shelter or stock fodder. The Scion digital library also has a wide range of publications that are publicly available, however, navigating the site can be challenging. Information pertaining to a range of topics is available through the Scion database, particularly for less popular alternative tree species and for older literature.

In general, publications and literature relating to species information and site selection tends to be widely available, whereas information on harvesting and marketing is less available. It is likely that the difficulty in predicting future markets limits the information that is available online, and therefore local forestry consultants and decision support software are perhaps the best information sources for farmers trying to understand the value of their woodlots and how best to harvest and market them. Our findings are similar to results from the survey by West and Satchell (2017) which identified that the main constraints for small-scale forestry owners was access to information on harvesting, markets and marketing. These owners also wanted more information on maximising forest growth and tending to trees, which similarly was more challenging to find online compared to species information. Despite information on woodlot economics and returns being sparse, it is clear that the profitability of woodlots is hugely site-specific which again reinforces the need to use forestry experts to gain an accurate understanding of the value of individual lots.

In addition to these information gaps, understanding the adoption barriers to incorporating trees on farm could be more widely researched. Furthermore, the few studies currently available focus on understanding information and adoption barriers to farmers and landowners who have already incorporated production forestry into their farming system. However, research into the reasons for non-adoption by landowners who do not currently have forestry on farm is likely to provide useful and insightful information on information requirements and what might be required to overcome barriers to tree planting on farm.

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