Rural Landowners Guide:

Capturing the Value of Carbon Sequestration for Tōtara Forests 2023

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INTRODUCTION

This user guide booklet has been developed by Thriving Southland in collaboration with Agri Intel. It aims to provide farmers and rural landowners with valuable insights to capture the carbon sequestration opportunities available for landowners planting tōtara, a significant forest species in New Zealand.

Tōtara holds great historical and contemporary importance, playing a crucial role in the ecological and cultural landscape of our country. Planting and restoring native forests will store carbon, providing a potential income for landowners, while enhancing natural landscapes, indigenous biodiversity, and cultural values.

This guide will provide the reader with:

- A background on tōtara as a forest species in New Zealand and its importance on-farm.
- An understanding of the Emissions Trading Scheme (ETS), eligible ETS forestland, how carbon sequestration is calculated, and the registration process.
- A guide on how landowners can plant tōtara for ETS eligibility – site requirements, on-farm scenarios, and indicative costs.
- A step-through process of registering tōtara into the ETS.
- An indicative current investment analysis of earning carbon credits for tōtara forestland on-farm.
- A summary of ongoing ETS forest management and compliance.

BACKGROUND ON TŌTARA IN NEW ZEALAND

Tōtara is a large, long-lived evergreen podocarp tree that is indigenous to New Zealand. It possesses distinctive reddish-brown bark and dense, dark-green foliage, often seen growing nationwide to up to 30m tall. There are two fundamental species – the Common Tōtara (Podocarpus totara) and Mountain Tōtara (Podocarpus laetus), often referred to as Hall's Tōtara.

Tōtara holds immense cultural significance for Māori. It is considered a taonga (treasure) and has been traditionally used for various purposes, including building canoes, houses, and carvings. Its timber played a vital role in New Zealand's development. Its durability and resistance to decay made it highly sought-after for construction, fencing, and railway sleepers, and still maintains significant value as a timber product today.

Farmers and rural landowners in New Zealand can generate significant on-farm benefits by including Tōtara plantings as a keystone native species on-farm:

Biodiversity Enhancement: Provide essential habitats for a wide range of native flora and fauna, including birds, insects, and lichens.

Carbon Sequestration: Tōtara is known for its exceptional carbon sequestration abilities. Its large size and longevity enable it to store significant amounts of carbon, making it a valuable contributor to reducing farm carbon footprints through offsetting. Additionally, forest owners may wish to sell their earned carbon credits to the market and capitalise on a supplementary, additional income stream.

Soil Conservation: Tōtara has an extensive root system that helps stabilise soils and prevent erosion, particularly in hilly or vulnerable areas. The tree's ability to retain soil moisture can benefit some pastoral systems and support sustainable land management practices.

Timber Production: Tōtara continues to be valued for its high-quality timber, which is durable, weather-resistant, and suitable for various applications such as furniture, flooring, and decking.

THE EMISSIONS TRADING SCHEME (ETS) – WHERE FORESTS ARE RECOGNISED FOR THEIR CARBON SEQUESTRATION

The Emissions Trading Scheme (ETS) is a policy tool implemented by the New Zealand Government to help reduce greenhouse gas emissions. It is managed by the Ministry for Primary Industries (MPI). Currently, for landowners, this is the only scheme that forests can earn certified carbon credits for the carbon sequestration occuring. These credits, called New Zealand Units (NZUs), represent one metric tonne of carbon dioxide equivalent (tCO2e). Registered ETS participants can sell their NZUs on the carbon market, or farmers can use them to voluntarily offset their farm carbon footprint. In the event that agriculture emission pricing is implemented, the potential utilisation of ETS NZUs as a pivotal offsetting tool highlights the importance of farmers capturing the value of NZUs occurring on their farm as an advantage.

ETS Eligible Forestland

For any forest occurring on land, whether planted or naturally regenerating, to be eligible for registration into the ETS, it must fulfil the following requirements. MPI term this 'Forest Land Definition':

- Be at least 1 hectare in size.
- Have the potential to reach an average canopy width of 30 metres.
- Have the potential to reach a canopy cover of at least 30% at maturity.
- Have tree species that can grow to at least 5 metres in height at maturity.
- Canopy gaps on the perimeter trees must not exceed a width of 15m.
- Have met all the above after the year 1990.
- Have not existed prior to 1990.

Eligible forestland in the ETS is termed "Post-1989 Forestland". Areas of forestland that existed before the year 1990 are labelled "Pre-1990 Forestland". Pre-1990 Forestland cannot currently earn carbon credits in the ETS.

When considering planting or naturally regenerating tōtara and native forests, all the above factors must be met for it to be eligible to enter the ETS to earn carbon credits.

Carbon Sequestration Measures

The carbon dioxide absorbed by trees is stored in the tree biomass and cellulose; in the stems, branches, foliage, and root mass, therefore, increases in biomass of these equates to net increases of stored carbon dioxide.

The rate of which carbon sequestration occurs for forests in the ETS is calculated through two methods: using the MPI Carbon Look-Up tables[1] or by the Field Measurement Approach (FMA)[2]. If forests are equal to or under 100 hectares in size, the MPI Carbon Look-Up Tables must be used, and for anything over 100ha, FMA must be used.

The Look-Up Tables provide estimated values for forest carbon stocks based on forest age for both regional and nationally averaged growth factors, depending on species. They do not reflect

[1] Ministry for Primary Industries (MPI), "Carbon Look-Up Tables for Forestry in the Emissions Trading Scheme" (2017)

[2] https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/emissions-returns-and-carbon-units-nzus-for-forestry/the-field-measurement-approach-fma/

New Zealand's diverse growing conditions at the individual forest level, nor do they capture the diverse range of native forest species.

The Field Measurement Approach involves conducting on-site field measurements to assess key parameters such as tree species, diameter at breast height (DBH), tree height, and forest densities. Carbon dioxide sequestration by trees occurs during photosynthesis.

Both options report measures as tonnes of carbon dioxide stored per hectare per year ($tCO_2/ha/yr$).

ETS Registration Process

If you've finished planting your forest to 'Forest Land Definition', or you have identified naturally regenerating eligible forestland, you can apply to register your forest within the ETS. A successful ETS registration requires excellent evidence, therefore, it's very important to have good record-keeping during the whole planting process. Given the intricacies of the ETS, it is strongly recommended to engage the services of a competent forestry or agriculture consultant to assist with the registration process.

Agri Intel uses the following methodology to achieve successful registration of ETS forestland for their clients following forest establishment.

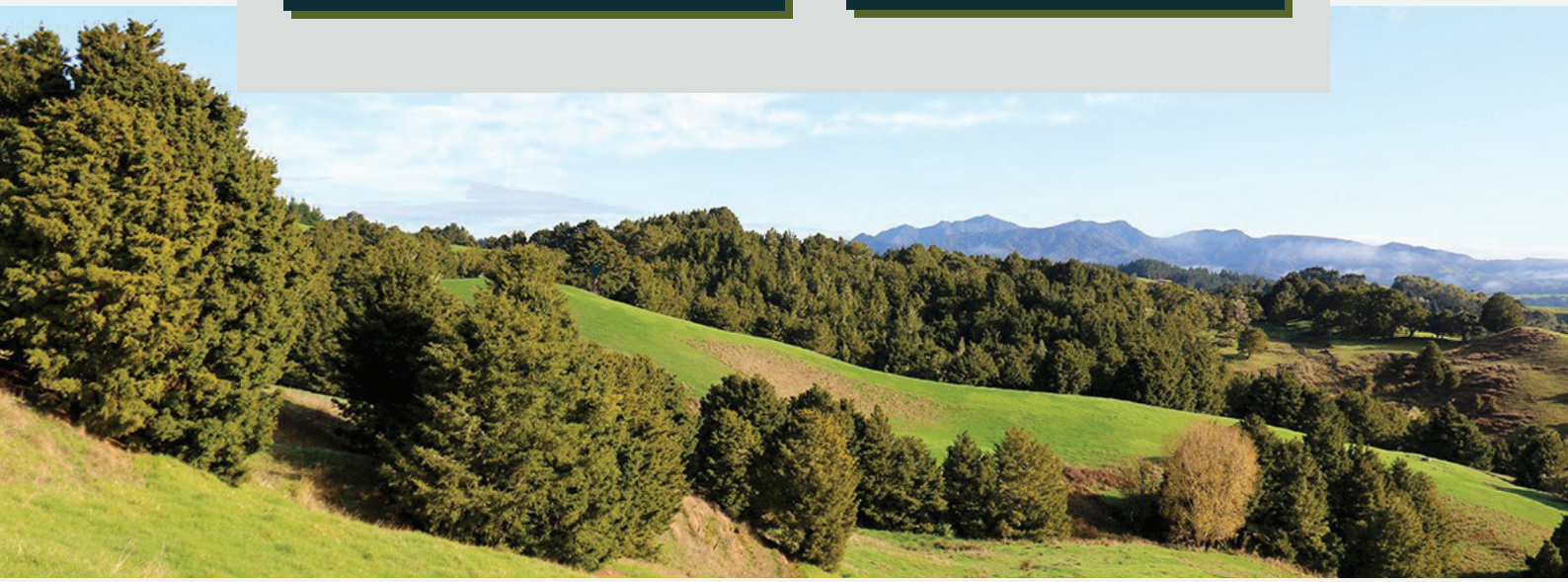
Planted Forests

ETS Registration Process -

- Field assessment – capture drone orthomosaic mapping, obliques, and video of site.
- Write a consultant report providing ETS evidence and outcome.
- Compile evidence package for MPI and submit it.
- MPI process the application (estimated six months)
- Successful registration – start earning NZUs.
- Help clients sell NZUs to market for cash or store them for offsetting.

Evidence Required:

- Planting records, contractor invoices, seedling purchases.
- Drone orthomosaic map of forest areas, photos, and video.
- Consultant report showing forest ages, mapping, historic land use, and future management practices.
- GIS data of mapped areas, grouped into carbon accounting areas (CAAs).



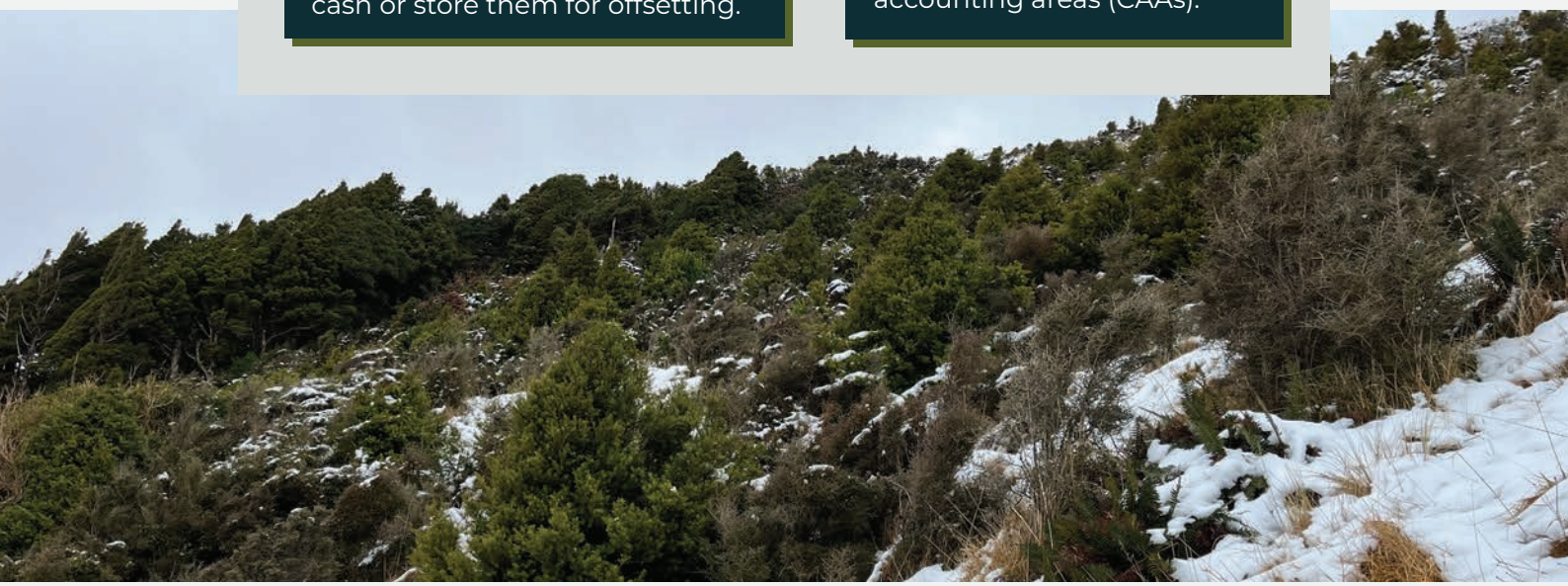
Naturally Regenerating Forests

Registration Process

- Preliminary assessment identifying Post-1989 forestland areas.
- Field assessment – use field plots to measure forest ages and capture drone imagery.
- Write a consultant report providing ETS evidence and outcome.
- Compile evidence package for MPI and submit it.
- MPI process the application (estimated six months)
- Successful registration – start earning NZUs.
- Help clients sell NZUs to market for cash or store them for offsetting.

Evidence Required:

- Drone orthomosaic map of forest areas, photos, and video.
- Consultant report showing forest ages, mapping, historic land use, and future management practices.
- GIS data of mapped areas, grouped into carbon accounting areas (CAAs).



PLANTING TŌTARA FOR ETS REGISTRATION

Site Requirements

Tōtara is one of the easiest native tree species to grow and establish in New Zealand due to its resilience to biotic factors that typically influence tree growth and succession. They thrive in the following varied environments[3]:

Altitude:	From sea level to moderate altitudes (0-500m above sea level), however, Mountain Totara can often be found exceeding this.
Rainfall:	Moderately low to high rainfall environments (750 - >1,250mm/yr).
Soil depth:	A range of soil depths, from deep soils to shallow soil matrixes.
Varied Soil drainage:	A range of soil drainage types, whether free draining or poorly drained.
Varied Temperature:	All temperatures, whether warm or cold.
Wind:	Very wind tolerant even in high wind zones.
Light:	Reasonably shade tolerant, often does well when interplanted with manuka or gorse as a nurse crop. They can be frost susceptible when very young on very cold sites.
Competition:	Moderately resistant to browsing by cattle, hares, and rabbits, but less resilient when browsed by sheep, deer, and possums. It can be susceptible to defoliation by insects such as stick insects, scale insects, and cicadas. The species is also subject to a fungal leaf spot disease.

Talking with your forestry consultant about your site's biotic factors should be the first step to understanding how you should plant and manage your forest.

Typical On-Farm Scenarios

Tōtara forests on-farm can typically be found in the following scenarios:

Natural regeneration –
Regenerating naturally from its own seed source as a monoculture or as a mixed native forestland.

Mixed native plantings –
E.g. riparian plantings and native forest restoration.

Plantation –
Grown in a production scenario at a high stocking rate for carbon and/or timber.

Another forest model that may interest farmers using tōtara is agroforestry –
Low density plantings of just tōtara that will eventually incorporate holistic animal grazing on pasture.

[3] https://www.nzffa.org.nz/farm-forestry-model/species-selection-tool/species/indigenous-species/totara

PLANTING, ESTABLISHMENT, AND MAINTENANCE

High Density
(e.g. plantation/riparian/ mixed native)

Site preparation
Prepare grass sites by spot spraying using glyphosate at one metre circles for each planting site. Clear scrub if required and boom spray.

Planting
Plant trees with a slow-release fertiliser tablet underneath (DAP or urea). Most tōtara plantation stands suggest a stocking rate of 2,000 stems per hectare at 2 x 2.5m spacings. If the trees are going to be form-pruned, stocking can be lower.

Low Density
(e.g agroforestry)

Site preparation
Prepare grass sites by spot spraying using glyphosate at one metre circles for each planting site.

Planting
Plant trees with a slow-release fertiliser tablet underneath (DAP or urea). Planting spacings can be as low as 40 stems per hectare at 20-meter spacings. This will ensure ETS eligibility (30% canopy cover achieved) and allow for continual pasture production.

Natural Regeneration

If existing in an ETS-eligible format meeting 'forest land definition" this can be registered as is. Enhancing the forest and encouraging additionality by increasing biodiversity would be recommended, such as fencing off the forest, implementing pest control, and encouraging birds to spread seed, however, it is not essential for registered ETS forestland if the forest met "forest land definition" using existing land management practices. The look-up tables do not require any FMA plotting.

Post-Planting Releasing
Maintain young trees by clearing or spraying weeds around them for at least three years or until they are well established and growing. Climbing plants and dense woody weeds can overtop young native trees and may require manually cutting back to provide a light well for the young tree to grow up through. Fence, either permanently (mixed native/riparian), or until trees are not susceptible to stock pressure (e.g. plantation).

Silviculture
Although these are permanent forests, trees could be form pruned at regular intervals to encourage a single dominant leader for a future timber product (production). Prune the trees every two years to prevent lower branches from getting too big. Pruning can begin once the trees are well-established and above the height of any competing weed vegetation.

On-Going Management
Monitor forests annually and check for tree deaths. Continue to prevent weeds from competing by spraying them. Keep stock out (depending on scenario) and manage pests regularly (e.g deer and possums). FMA plots will be required every ETS reporting year, usually, these run every 5 years.

On-Going Management
Monitor forest annually and re-plant dead seedlings to ensure canopy cover is sufficient. Continue to prevent weeds from competing by spraying them. Keep stock out until a time allows reintroduction. Manage introduced ungulates regularly (e.g deer and possums. The look-up tables do not require any FMA plotting.

COSTS

Table 1 below provides indicative, rounded, estimated costs for planting, establishing, and maintaining tōtara forests in the three scenarios identified on-farm. Fencing has been excluded. Some variability is likely depending on each planting sites specific establishment and maintenance requirements (e.g. fencing, pest control etc). This does not include any initial consultant fees that may be required for planting and/or ETS assessments.

Table 1: Estimated plant, establishment, and maintenance costs[4] for tōtara on-farm, 2023.

Estimated Totara Investment Costs $/ha						
	Year No.	**1**	**2**	**3**	**4**	**5**
High Density (e.g. plantation)	***$/ha***					
Pre-plant spray (spot)	*$500*	*$500*				
Seedlings (2,000sph)	*$8,000*	*$8,000*				
Planting labour (2,000sph)	*$1,200*	*$1,200*				
Release spray (spot)	*$500*	-	*$500*	*$500*	*$500*	
Pest control	*$150*	*$150*	*$150*	*$150*	*$150*	*$150*
FMA plots & ETS compliance	*$50*	*$50*	*$50*	*$50*	*$50*	*$5,000*
Total		**$10,000**	**$700**	**$700**	**$700**	**$5,150**
Low Density (e.g. agroforestry)						
Pre-plant spray (spot)	*$100*	*$100*				
Seedlings (40sph)	*$160*	*$160*				
Planting labour (40sph)	*$200*	*$200*				
Pest control	*$150*	*$150*	*$150*	*$150*	*$150*	*$150*
Release spray (spot)	*$100*	-	*$100*	*$100*	*$100*	
ETS compliance	*$50*	*$50*	*$50*	*$50*	*$50*	*$50*
Total		**$700**	**$300**	**$300**	**$300**	**$200**
Natural Regeneration						
ETS compliance	*$50*	*$50*	*$50*	*$50*	*$50*	*$50*
Total		**$50**	**$50**	**$50**	**$50**	**$50**

[4] Contractor planting/establishment rates sourced (Forest Management) 2023 & www.nzffa.org.nz/farm-forestry-model/species-selection-tool/species/indigenous-species/totara/

EARNING CARBON CREDITS AND REVENUE

Carbon Sequestration Rates

Tōtara forests under 100ha will default to using the 'native' category on the Look-Up Tables. This category has been modelled using early-stage successional native regeneration of measured manuka and kanuka stands, and therefore, does not provide an accurate measurement for tōtara, as they grow much slower but over a significantly longer period.

The most recent and robust data available on the sequestration rates of native forests in New Zealand has been completed by Tanes Tree Trust. Tōtara is a species that has been well studied within this database and there is good carbon yield data to show more realistic rates of what a well-managed tōtara stand will achieve compared to using the Look-Up tables.

Currently, the ETS only allows registered permanent forests to earn carbon credits until Year 50. Therefore, only this period can be used for investment analysis as of current. However, tōtara has been measured to sequester incremental carbon gains out to at least Year 100[5].

[5] https://www.tanestrees.org.nz/site/assets/files/1069/carbon_sequestration_by_native_forest_-_web.pdf

Figure 1 below provides an analysis of the carbon sequestration rates for landowners planting tōtara at less than 100ha, using the carbon Look-Up Tables (LUT), and planting over 100ha, using FMA data. The FMA values have been estimated using the Tanes Tree Trust Carbon Calculator[6] which represents an 'average' (growth) tōtara stand planted in a plantation format (2,000 stems/ha).

For tōtara, the Look-Up Tables overstate the amount of carbon sequestration in the short term (first 30 years), and significantly underestimate it in the long term (50-100 years). The Look-Up tables state that a total of 323 tonnes per hectare of carbon is sequestered over a 50-year period, however, an average measured (FMA) plantation stand of tōtara had measures of 837 tonnes of carbon over the same period.

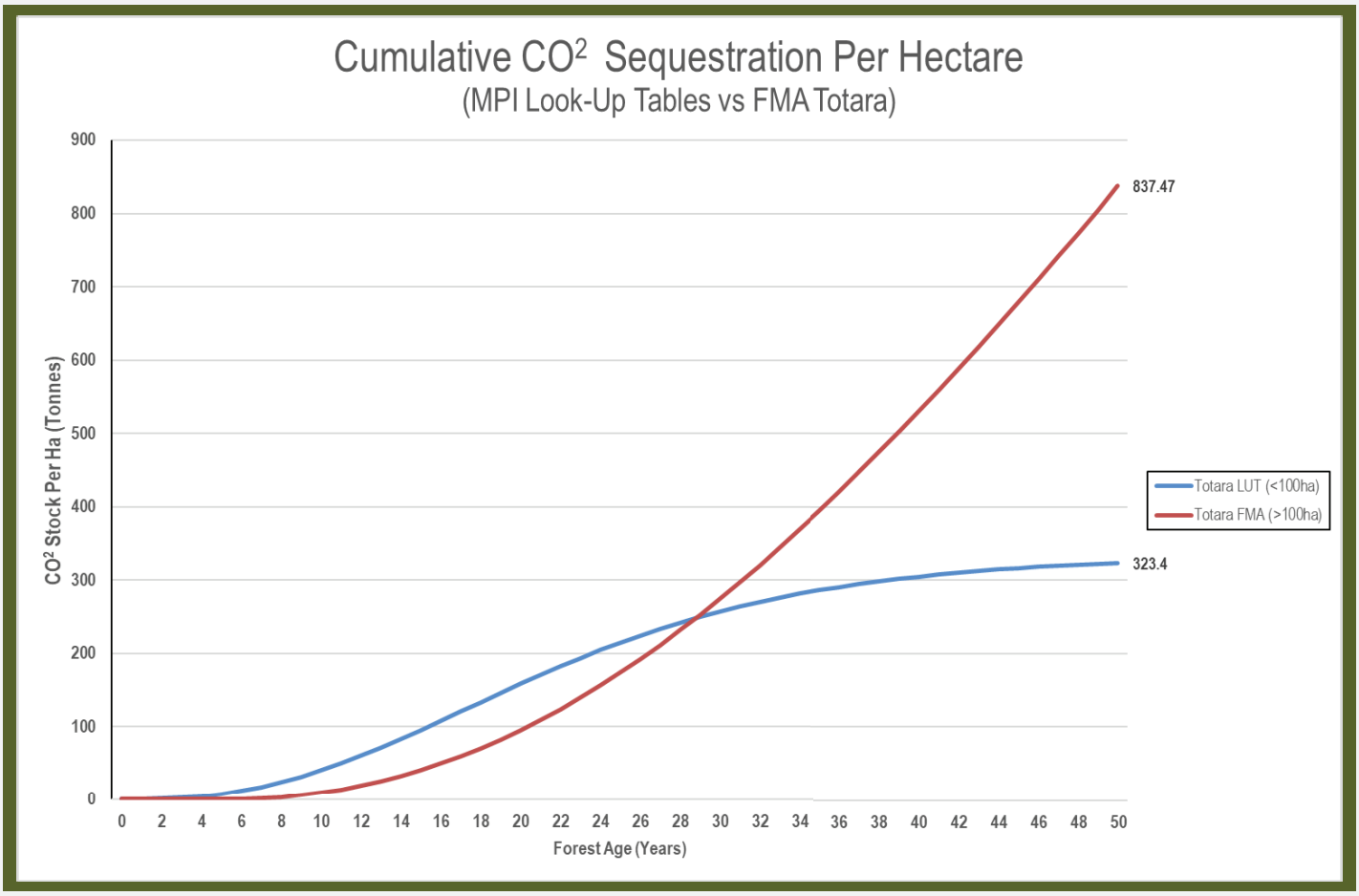


Figure 1: Cumulative carbon sequestration yields (tCO2/ha/yr) of tōtara using the MPI carbon Look Up Tables (forests <100ha) and estimated using FMA (forests >100ha).

[6] https://toolkit.tanestrees.org.nz/carbon-calculator/

Figure 2 below shows the same rates of sequestration as per above but as annual incremental tonnes of carbon sequestered per year. The legend also displays the average annual rate over the 50-year period. Over 50 years, the Look-Up tables state that forests will sequester on average 6.5t CO2/ha/yr. An average measured FMA plantation stand of tōtara shows estimates 16.4t CO2/ha/yr over the same period.

For plantation forestry, FMA is likely to generate significantly more carbon credits for the tonnes sequestered than the Look-Up tables due to the high density of planting and the ability to capture species-specific measurements. However, for lower-density plantings, such as agroforestry, and naturally regenerating blocks that are not well-managed, the Look-Up tables will likely provide greater carbon yields than FMA.

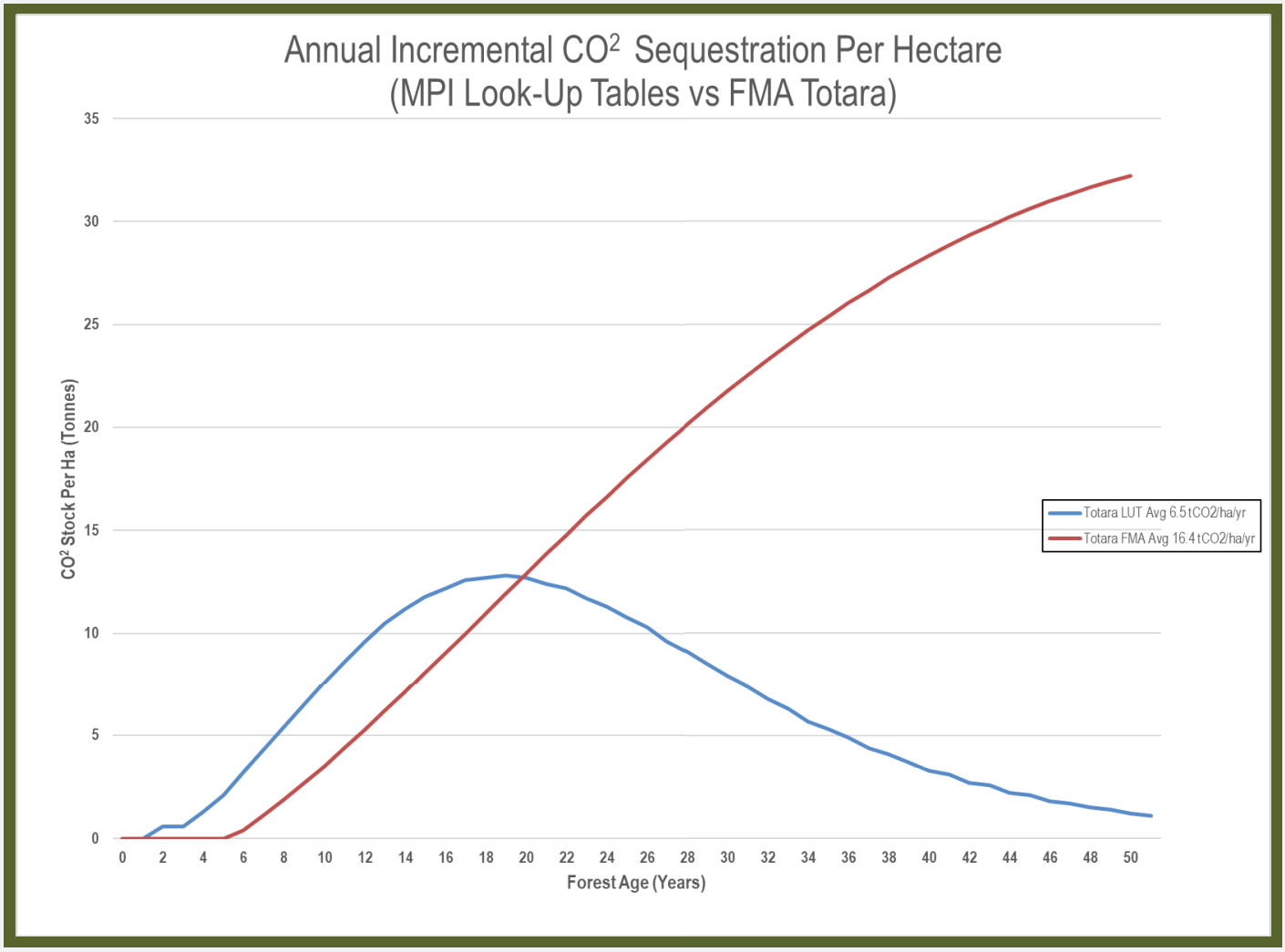


Figure 2: Annual incremental carbon sequestration yields (tCO2/ha/yr) for tōtara using the MPI carbon-look up tables (forests <100ha) and estimated using FMA (forests >100ha).

CASH FLOW ANALYSIS

The value of one tonne of carbon sequestered is equal to one carbon credit (NZU). The monetary value of this is linked to the carbon price, which is currently $50/NZU/tonne[7]. As the carbon price regularly fluctuates, carbon investments should be modelled using a price sensitivity analysis showing the range of potential carbon prices over the investment period (e.g., $30/NZU for pessimistic, $50/NZU for current, and $160/NZU for optimistic). For simplicity, the following investment scenarios are reported at the current carbon price only. The timber element to totara has been excluded from this assessment, however, in a well-managed tōtara plantation forest, timber will be worth a significant amount, with an estimated harvest age of 50-80 years.

The following economic measures are used on a per-hectare basis over the investment period (50-years):

- **Capital Cost ($/ha) @ Yr 1:** The initial cash injection required in year one.
- **Total NZU's earned/ha:** The total sum of carbon units the forest will earn as a permanent forest over 50 years.
- **Average annual cash flow ($/ha):** the average of the net annual revenue earned over the investment period.
- **Cumulative cash flow ($/ha)** the continual sum of the net annual cash flow received each year over the investment period.
- **Cash Payback Period (Yrs):** The time taken for the investment to become cash positive.

Table 2: summary economic measures for planting one hectare of totara, 2023

Economic Measure	Plantation		Agroforestry	Natural Regeneration
	LUT	FMA	LUT	LUT
Capital Cost ($/ha) @ Yr 1	10,000	10,000	700	50
Total NZU's earned/ha	323	837	323	323
Average annual cash flow	-100	400	300	500
Cumulative cash flow ($/ha)	-6,000	20,000	15,000	16,000
Cash Payback Period (Yrs)	Never	35	9	1

Unless the carbon price is significantly higher than $50/NZU, high-density stands may never break even when using the Look-Up tables. This is due to high capital and maintenance costs coupled with a low sequestration rate. It is only when forests are over 100ha and in a plantation or well managed mixed stand scenario that the investment is likely to become profitable. This is largely typical for establishing native forests in New Zealand due to exceptionally high costs versus returns. Further research has recently started emerging to reduce this cost, such as the latest work completed by Our Land and Water[8].

Lower-density planting scenarios, such as that of agroforestry or space planted tōtara, provide more of a return due to significantly lower planting and maintenance costs. Holistic grazing may be appropriate once these trees are more mature when they are not susceptible to the pressures of stock movement and browse, however, grazing will not be suitable when trying to establish biodiverse forestlands. This is not a well-established model yet, however, it does have promise with tōtara. Species richness in biodiversity will be higher when grazing is excluded, but that's

[7] www.commtrade.com

[8] The Tīmata Method for Low-Cost Native Forest - Our Land & Water - Toitū te Whenua, Toiora te Wai

not to say this doesn't offer an integrated farming and biodiversity tool for trees on farm, which, from a biodiversity perspective, is still better than planting exotic agroforestry forestlands.

Similarly, naturally regenerating native with tōtara provides a good return on investment due to the lack of capital investment required as the forest has already established itself. Existing land management which enabled the forest to meet 'Forest Land Definition' will be acceptable so long the forest maintains that ETS forestland status. However, using practices that enhance the forest and encourage the additionality of biodiversity is always recommended (such as fencing off the forest, implementing forest management such as pest control, and encouraging birds to spread seed).

ON-GOING ETS FOREST MANAGEMENT AND COMPLIANCE

For permanent ETS forests registered in the ETS, the most important thing is maintaining 'Forest Land Definition' to remain compliant. As discussed, the management of each forest scenario will vary, but in all scenarios, they must remain standing as forests for at least 50 years. If deforestation occurs, a carbon liability to the forest owner will occur where all carbon credits earned through sequestration will be required to be surrendered. The same would be said if 'Forest Land Definition' were not maintained.

On-going management procedures for registered ETS forestlands:

- Ensure 'forest land definition' is always met– checking your forest annually to see that perimeter trees have not died. If they have, re-plant them.
- Drone orthomosaic mapping of your forest every emissions reporting period (typically every 5-years) is a great way to track your forests growth, biodiversity, and ensure ETS compliance for the above.
- Ensure emissions returns are filed every ETS reporting period. Voluntary returns can be completed annually for forest owners to extract their NZUs and sell them to the market.
- For FMA forests, FMA plots will need to be deployed with measures taken to calculate carbon stock changes every reporting period.
- For most, a good consultant will be required to manage the above.

The ETS offers a unique and lucrative opportunity for farmers and forest owners, but it can be a complex and complicated system with large occurring participant liabilities if procedures are not followed correctly. We suggest that landowners work with a good forestry or agri-based consultant for all operations of registering native forests into the ETS to ensure compliance. Additionally, by using a good consultant, landowners may have the option of choosing whether they remain using the Look-Up tables or use FMA. There are ways this can be achieved with the correct advice.

RESOURCES

Our Consultant Support

Agri Intel
sam@agriintel.co.nz
027 305 8549
www.agriintel.co.nz

New Zealand Farm Forestry Association: https://www.nzffa.org.nz/

https://www.nzffa.org.nz/farm-forestry-model/resource-centre/tree-grower-articles/november-2009/totara-a-growing-resource/

Totara Industry: https://www.totaraindustry.co.nz/overview

Tane's Tree Trust: https://www.tanestrees.org.nz/

Pure Advantage: https://pureadvantage.org/

Trees that Count: https://treesthatcount.co.nz/resources

Our Land Our Water:
https://ourlandandwater.nz/news/the-timata-method-for-low-cost-native-forest/

The Emissions Trading Scheme:
https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/ets-online-system/

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