



REGIONAL STRATEGY 2020 to 2030

Durable Eucalypts

A Multi-Regional Opportunity for New Zealand's drylands

Focus Areas and Action/Goals for 2019- 2022

Prepared for central government, regional government, and those involved in the forestry and agriculture sectors of New Zealand's east coast regions.



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EXECUTIVE SUMMARY

The NZDFI has developed this regional strategy to provide a rationale and overview of its planned activities over the next three years and beyond.

The strategy identifies six key focus areas where skills, knowledge, resources and investment are needed to continue to build the capability required to establish a new durable hardwood industry.

This strategy highlights what has been achieved through enduring partnerships and a collaborative approach that attracts forest growers, farmers, Māori, regional councils, Government and industry organisations to provide ongoing support and invest in making a future hardwood industry possible.

Developing sustainable regional industries based on high-value durable hardwood forests

Focus Areas

Identifying markets for durable hardwoods	Modelling forest productivity and economic feasibility	Working regionally to encourage new forests	NZDFI's durable eucalypt forestry research plan	Educating growers on durable hardwood forest management	Industry partnerships to build support and capability
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Key Work Areas



Investigate markets for durable timber and engineered wood products	Continue to develop productivity and economic models	Work with regional councils and industry organisations	Further selection and breeding for key traits	Engage with landowners via extension activities	Maintain NZDFI partnership and commitment to collaborate with industry
Work with regional processors to develop products	Develop veneer production economic model	Promote planting of durable eucalypts in target regions	Improve clonal propagation and scale up	Ongoing development of NZDFI website and regular project updates	Continue in SWP programme until 2022
Promote hardwood products in local markets	Produce a site/species matching guide	Extend demonstration trial network	Release first generation improved seed	Develop on-line education and professional development resources	Request additional funding from government and industry
Maintain trial measurement and data base					



Key Partners/supporters



Marlborough Research Centre	University of Canterbury	Regional councils	University of Canterbury	Marlborough Research Centre	University of Canterbury
University of Canterbury	Marlborough Research Centre	Forest Growers Research	Proseed NZ Ltd	University of Canterbury	Proseed NZ Ltd
Industry supporters	Industry supporters	NZFFA branches	Marlborough Research Centre	Landowners	Marlborough Research Centre
		Beef & Lamb	Industry supporters	Consultants	Forest Growers Research

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1 CONTEXT

The New Zealand Dryland Forests Initiative (NZDFI) is encouraging investment in planting new eucalypt forests and in future wood processing facilities to create a new sustainable regional hardwood industry.

Forestry is New Zealand's third largest primary export earner. However, it relies heavily on a single species, radiata pine, leaving the industry vulnerable to fluctuations in demand and the threat of pests and diseases.

Our vision is aligned with the recently published Forestry Roadmap for Aotearoa New Zealand (NZ Forest Owners Association 2019) that promotes diversification of the traditional forestry sector.

Regional communities need new economic growth and development in order to build resilient and diverse regional economies that will deliver employment and positive environmental outcomes in the long-term.

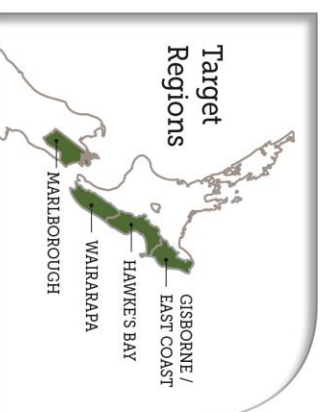
Dryland eucalypt species that produce durable hardwood could diversify and expand New Zealand's forestry and wood processing sectors as well as enhance the sustainability of many other New Zealand sectors. For this to happen, new eucalypt forests need to be planted.

These forests could be grown by farmers, Māori landowners and forest growers in drier east coast regions of the North Island and northern South Island to build on existing forestry and wood processing sectors in these regions.

This strategy is intended to engage representatives of central government, regional government and industry organisations in our target regions, also with farmers and forest growers, Māori landowners and nurseries.

Focus areas are identified in this strategy that build on past work and successes, and these define NZDFI's renewed commitment to lead and facilitate collaborative action that supports development of a significant new regional industry.

Under these focus areas there are actions and goals planned from the next three years i.e. until June 2022.



DURABLE EUCALYPTS: A Multi-Regional Opportunity For New Zealand's Drylands

OUR AIM:

To build sustainable regional industries based on high-value, fast-growing hardwood forests

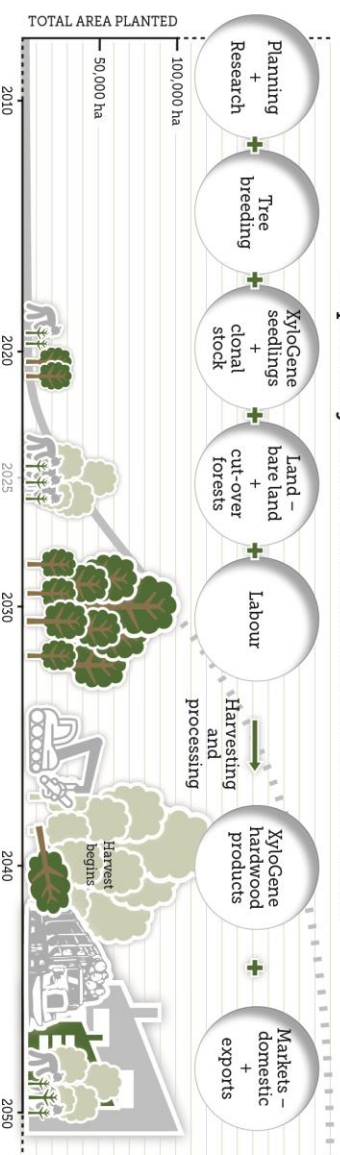
WE WILL SUPPLY:

Genetically improved XG seedlings and clonal plants that thrive in dry conditions

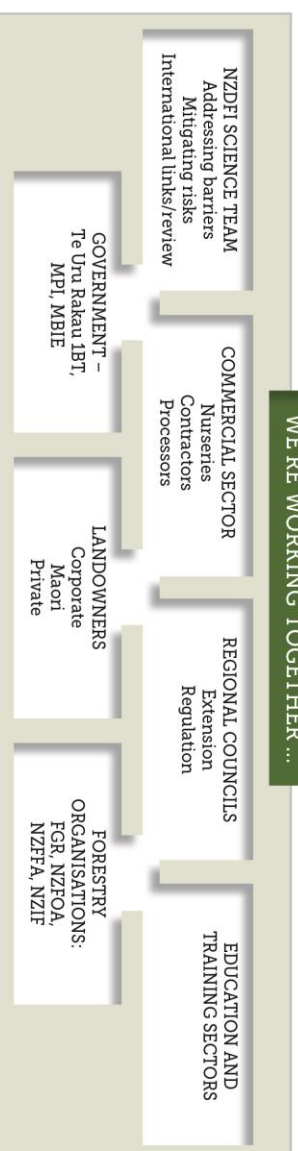
TO PRODUCE:

Certified timber that is naturally durable, strong, and richly coloured for laminated veneer lumber, decking and posts

We plan a XyloGene branded hardwood value chain



WE'RE WORKING TOGETHER ...



THE BENEFITS:

- Diversify land use in dry regions
- Generate regional jobs and skills
- Produce high-value products
- Produce an alternative to CCA-treated pine
- Combat climate change by storing carbon
- Protect soil by coppicing
- Provide pollen and nectar for bees and birds

FOCUS AREAS

1. Identifying markets for durable hardwood
2. Modelling forest productivity and economic feasibility
3. Working regionally to encourage new forests
4. NZDFI's durable eucalypt forestry research plan
5. Educating growers on durable hardwood forest management
6. Industry partnerships to build support and capability



2 DURABLE EUCALYPTS: A NEW OPPORTUNITY FOR NZ DRYLANDS

NZDFI's long-term goal is:

“the establishment of a multi-regional sustainable durable hardwood products value chain that could be worth \$2 billion annually by 2050.”

NZDFI believes this could be possible if up to 100,000 hectares of durable eucalypt forests and woodlots of are established in northern New Zealand east coast regions between 2020 and 2030.

The trees planted would be selected, genetically improved durable eucalypts, well adapted to dry hill country farmland. These species offer farmers an alternative to radiata pine woodlots or planting mānuka or new native forests.

NZDFI have also proven that durable eucalypts can be used to replant cut-over land following radiata pine harvests and thereby reduce forest owners' reliance on a single species.

Forestry and timber processing are already significant rural industries in many regions of New Zealand. Diversifying with hardwoods will generate new employment and economic growth through increased planting, management, harvesting, wood processing and log and timber export activities.

The current Government's 'One Billion Trees' (1BT) programme is aimed at increasing New Zealand's regional economic and environmental sustainability by encouraging the planting of new forests. This includes offering a grant of \$1500 per hectare for planting exotic trees including durable eucalypts.

Since 2008, NZDFI has promoted the potential for durable eucalypts to be an alternative forestry option that will offer the following benefits:

- Diversifies the forestry sector by introducing an alternative to radiata pine
- Offers an alternative forestry opportunity to farmers and Māori landowners
- Produces high value naturally durable hardwood sustainably to supply international and domestic markets
- Enables production of certified high strength engineered wood products that receive a premium in international and domestic markets.
- Provides environmental benefits of carbon sequestration by forests, carbon storage in wooden buildings, honey production and erosion control.
- Reduces the use and disposal of CCA treated pine in NZ's agricultural, horticulture and viticulture industries and urban environments.

NZDFI's success has been dependent on collaboration and investment by the partners, industry supporters and host landowners and by engaging with a wide range of other stakeholders.

Actions/goals have been planned within each of the following six focus areas so as to continue the NZDFI programme under the Special Wood Products partnership until this ends in June 2022.

In addition, further actions/goals have been identified that require additional funding if they are to be achieved in the next three years and beyond.

3 NZDFI'S FOCUS AREAS 2020-2022

[Focus Area 1: Identifying markets for durable hardwood](#)

NZDFI has identified a wide range of potential markets for durable hardwood products. These include both solid wood and engineered wood products.

We have established relationships with regional processors who have undertaken trials to evaluate the manufacture and performance of engineered wood products made from durable eucalypt timber. We have also trialled durable timber products in vineyards. Continuing our focus on identifying markets will encourage the establishment of a forest resource able to supply a diverse range of products.

[Timing/key actions](#) (click here or below to go straight to the section of interest).

[Focus Area 2: Modelling forest productivity and economic feasibility](#)

All forest growers want to plant trees with improved growth and form as well as known wood properties. They also need regimes to manage their forest investment and to assess the potential economic feasibility each of these offer.

Measurements from NZDFI's trials are providing the basis for modelling potential productivity at different sites and a comparative economic feasibility study of growing durable hardwoods forests has been completed.

[Timing/key actions](#)

[Focus Area 3: Working regionally to encourage new forests](#)

Since 2008, the NZDFI partners have consulted and engaged with local government representatives in key regions as well as with farmers and forest growers including Māori, forest industry organisations and other industry groups in our target east coast regions to promote the potential of new durable eucalypt forests. The development of the NZDFI's regional strategy commenced last year with a working group of representatives from the east coast regions.

[Timing/key actions](#)

[Focus Area 4: NZDFI's durable eucalypt forestry research plan](#)

NZDFI has developed a forestry research and development plan for the north eastern regions of New Zealand because these regions have a strategic advantage to grow, process and market durable eucalypts. This plan is underpinned by eleven years of intensive and ongoing research and breeding. The first of NZDFI's elite selections are already under propagation and commercial seed and clonal plant production is planned from 2021.

[Timing/key actions](#)

[Focus Area 5: Educating growers on durable hardwood forest management](#)

Growers need to be confident that durable hardwood forestry is an economically and environmentally sustainable land use, and one which can complement their other enterprises and operations. Therefore, NZDFI's aim's to develop best management practices and to educate all those directly involved in establishing new durable eucalypt forests including forest growers, farmers and Māori landowners as well as forestry consultants and regional council land management advisers.

[Timing/key actions](#)

[Focus Area 6: Industry partnerships to build support and capability](#)

Since NZDFI's establishment in 2009 a cornerstone for success has been the long term commitment to collaborate by the four main partners (Table below). Their partnership and active support have made NZDFI's tree breeding and research programme possible. However, NZDFI urgently needs additional funding to accelerate research and propagation; expand hardwood product and market development; and increase extension work.

[Timing/key actions](#)

4 FOCUS AREA 1: IDENTIFYING MARKETS FOR DURABLE HARDWOOD

4.1 International and domestic market demand for naturally durable hardwood

Global markets are demanding high-stiffness, naturally durable timbers, that avoid the need for preservative chemicals. By establishing forests of elite eucalypt species, New Zealand can become a leading sustainable producer of naturally durable hardwood. This hardwood could be processed in the regions where it is grown, and supplied as high-value products for domestic and export sales.

4.1.1 Potential for high-stiffness engineered wood products

Commercial scale timber buildings are increasing in number and size dramatically as well as demand for modular wooden houses. New Zealand based companies already manufacture laminated veneer lumber (LVL) and plywood from radiata pine with these products currently delivering the highest export unit value for any forest products processed in New Zealand. To the end of June 2017, annual exports of some 61,000 cubic metres of product were worth over \$127 million with an average unit value of over \$2,000 per cubic metre.

However, LVL producers in New Zealand are seeking an additional wood supply as large buildings need super-stiff components that cannot be manufactured from radiata pine. There is a market premium of 30% for super-stiff timber products (16 GPa and above) but these cannot be manufactured from radiata pine – 13.2 GPa pine LVL is the maximum stiffness manufactured commercially in New Zealand.

On optimal sites, eucalypts can achieve growth rates exceeding radiata pine while producing much stiffer wood. Rotary peeling allows for the processing of small young trees with higher recoveries than are possible for sawing solid wood. Therefore, eucalypts could be well-suited to supply wood for structural timber products such as LVL or plywood, achieving three different objectives:

- i. production of higher value structural products (16 GPa and above) that require exceptionally stiff veneers could be obtained from some durable eucalypts in reasonable quantities
- ii. for standard LVL products (8 - 13 GPa), which are currently manufactured from radiata pine, fibre costs could be reduced by utilising trees grown in shorter rotations and achieving higher veneer yields
- iii. manufacture a high stiffness hybrid eucalypt and radiata pine LVL will produce a greater total volume of product for export, thereby adding value to NZ's pine resource.

4.1.2 Solid wood products

NZDFI have already identified there is strong and increasing national and international demand for naturally durable hardwood timbers. There are several key product streams with excellent market potential including where naturally durable timbers can substitute chemically treated softwood products. This includes posts, poles and other sawn wood products as these timbers need no preservative treatment. They are accepted by organic producers, and avoid the environmental problems associated CCA treated timber, including disposal problems and soil contamination. Some durable eucalypt species are renowned for their rich, dark timber. This hardwood could replace highly-coloured tropical hardwoods, which are often logged unsustainably, especially if grown in NZ durable eucalypt forests managed under sustainable principles.

- **Domestic markets**

There is significant NZ domestic market demand for imported durable hardwood required for critical infrastructure products such as cross arms for power poles and rail sleepers that underpin NZ's electricity and rail networks. NZ consumer demand for imported hardwoods includes timber for specialty decking, flooring and joinery.

NZ's Annual Forestry Statistics (Ministry for Primary Industries 2017) reported total annual hardwood timber imports of over 40,000 cubic metres, valued at almost NZ\$50 million. This suggests an average value of imported hardwood of \$1,200 per cubic metre. Species imported include SE Asian Kwila, North American white oak, South American purpleheart, Tasmanian oak and many others.

<https://catalogue.data.govt.nz/dataset?tags=forestry>

An average unit value of \$1,200 per cubic metre for imported sawn hardwood timber is two and half times greater than the average unit value of NZ's radiata pine sawn timber exports. While total pine exports were worth over \$800 million to end of June 2017, the average unit export value is only \$472 per cubic metre.

New Zealand consumes over 3 million cubic metres per annum of sawn timber and other manufactured wood products. This includes large volumes of CCA-treated timber used in NZ's diverse agricultural industries; the transport sector and in urban environments. Durable sawn timber and posts and poles could be used for many of these applications including trellis structures for vineyards, kiwifruit, hops and other horticultural crops; also as decking, boardwalks and landscaping timbers.

- **International markets**

Demand for hardwoods in two of New Zealand's major international timber trading partners is huge. China imports up to 15 million m³ of hardwood logs annual, plus 10 million m³ of hardwood sawn timber, worth over US\$8.4 billion (FAO 2016). Recent figures indicate that Australia is importing more than AUS\$5 billion in wood products annually to meet the demand unable to be supplied locally (Australian Forest and Wood Products Statistics 2011).

Coloured heartwood associated with tropical species such as teak and rosewood are highly sought after in many international markets. Much of this demand is currently supplied from illegal/unsustainable sources. For example, the current rosewood craze is apparently worth more than the trade on ivory, pangolins, rhino horn, lions and tigers put together (e.g. see <http://www.unodc.org/unodc/en/data-and-analysis/wildlife.html> and <http://www.bbc.co.uk/programmes/p05hll9v>).

There are international efforts to combat illegal timber trade. Consumers are demanding sustainable supply and many major markets – e.g. Australia, the USA and some EU countries all restricting supply to timbers that are legally sourced.

And, while there have been some durable eucalypt plantations established in Australia, (for example <http://www.heartwoodplantations.com.au/>), these are insufficient in scale to substitute the huge log supply formally cut, but now heavily restricted, from the indigenous eucalypt forests.

4.2 Timing for key action/goals: Focus Area 1

Year	Key Activity	Source of Funds	Key Activity - funding needed
2020	Investigate international value of high stiffness veneer.	SWP	
2020	Investigate additional durable hardwood products	SWP	
2021			Complete assessment of hardwood used for cross arms with Marlborough Lines and other network companies
2022	Complete assessment of essential oils produced by <i>E. bosistoana</i> .	University of Canterbury	Complete assessment of potential product substitution of treated timber used in New Zealand Complete assessment of nectar and pollen production by <i>E. bosistoana</i> , <i>E. globoidea</i> and other durable species

5 FOCUS AREA 2: MODELLING PRODUCTIVITY AND ECONOMIC FEASIBILITY OF DURABLE EUCALYPTS

NZDFI have developed three different regimes for modelling and to undertake an economic feasibility of durable hardwood management. These regimes are based on our research and trials, and have led to the development of models for comparative economic analysis of each plantation management approach. Two of the regimes have been designed to generate a log supply for products that already attract a premium in international markets such as engineered wood products and highly durable hardwood.

The third regime is planting permanent durable eucalypt forests to sequester carbon and earn NZU's.

1. Peeler pole plantation – high final stocking; 15-20 year rotation; small piece size; flat to easy sites
2. Peeler log/saw log plantation - low final stocking; 30-40 year rotation; large piece size; accessible stable steep land sites
3. Permanent Forests – low initial stocking; low cost management; large stable forest; remote and unstable steep land sites.

The economic feasibility of these regimes has been modelled using data measured in Marlborough trials of *Eucalyptus bosistoana*. (See Section 4.6 for economic models and Appendix 1 for more information on these regimes.)

For each of the two timber production regimes the potential economic feasibility has been evaluated by calculating the range of stumpage values per cubic metre payable to the forest grower at a range of harvest ages that earn a 3%, 5% or 8% internal rate of return (IRR) on the capital invested to plant and manage a plantation. These are calculated by an analysis of the forest growing costs against the total recoverable volume predicted by the models at each given harvest age. The models are run with measurement data from a high productivity site and a low productivity site.

For potential carbon sequestration by permanent forest, an analysis is made of potential growth and carbon sequestration possible over a period of 50 years based on modelling the productivity of permanent forests over this time. We have compared our growth models to the Te Uru Rākau carbon tables for exotic hardwoods.

5.1 Feasibility study sites

Data applied in the models have been measured within permanent sample plots (PSPs) located in two of NZDFI's *E. bosistoana* trial sites, planted in 2009.

These two Marlborough sites have different environmental conditions, one more favourable than the other. After eleven years of growth, significant differences in productivity have been measured and are compared in this feasibility study.

Both the sites were established as open-pollinated progeny tests (breeding populations), representing 66 plus trees from the southern Australian distribution of *E. bosistoana*. The families were planted in a single-tree-plot, incomplete, replicated blocks and established at a spacing of 2.4m x 1.8m, this being 2315 stems per hectare (spha). Each family was represented by 25 to 75 seedlings at each site with 3750 seedlings planted at both trials.

The high productivity site is called Cravens and is located 7 kms north of Blenheim on the Wairau river berm reserve owned by the Marlborough District Council. This site is 10 metres above sea level, reasonably sheltered with well drained alluvial silt and annual rainfall estimated to be 668 mm p.a. An April frost of -6 degrees occurred 7 months after planting that killed over 40% of seedlings. Following that initial set-back the surviving seedlings have had fast growth rates. There have been a number of low flow floods through the

entire site as a result of heavy rainfall producing high river flows. In 2013 this trial was thinned with the current stocking around 600-700 spha.

The low productivity site called Lawsons is located in southern Marlborough about 8 kms south west of Seddon on a moderately steep north east facing hill slope owned by a local grape grower. This is a relatively exposed site at 155 metres above sea level, with loess top soil that is moderately fertile but poor structure. Annual rainfall is estimated to be 590 mm p.a. The site was well established with 98.5% survival recorded 18 months after planting. Trees have grown despite long periods of drought and high survival has continued. Much of this trial was thinned in 2014 with the current stocking at about 1000 spha.

5.2 PSP measurement data, stand evaluation and selection of optimal trees for 'virtual' clonal forest modelling

In 2013, permanent sample plots (PSPs) were established in the Lawsons site and these were re-measured in 2014 and 2015. Permanent sample plots (PSPs) were established in the Cravens site in 2014 and these were re-measured in 2015.

Then in 2019 one PSP was selected at each of the two sites and re-measured. In addition a full stem assessment was made of every tree within the plot. This assessment of growth and stem form was used to select the 'optimal tree' currently within each of these two PSPs.

The optimal trees selected were not the top family selections made within these trial sites: rather they are the optimal tree within the actual PSP plot.

This optimal tree has then be used to populate the productivity models for the three regimes we have developed thereby by mimicking a 'virtual' clonal plantation in which all trees grow at a similar rate with similar tree form and wood properties.

5.3 Modelling potential productivity at each site

As there are no mature plantations of *E. bosistoana* anywhere in New Zealand, it is not yet possible to develop an *E. bosistoana* growth model for predicting potential productivity. Therefore an alternative eucalypt productivity model has been applied in this study. This is the Candy model developed for NZ plantation grown *E. nitens*. Buck Forestry Services Ltd, who undertook the modelling for this study, and have access to this model under a YTGen licence.

It should be noted that these stands were not planted to model the possible regimes that are proposed. Being progeny tests, the growth differences between different trees have been substantial. Also the initial stocking was over twice a commercial stocking for establishment. The early thinning of both sites ensured that there has not been substantial inter-tree competition although that is now developing.

At the Cravens site, the modelling of the virtual forest productivity produced very high values so these were reduced by a factor of 15% in calculating the economic feasibility of each regime.

5.4 Forest growing costs

Forest growers have been consulted on the current likely costs for establishing and managing durable eucalypt plantations. These costs have been applied to calculate the potential economic feasibility of each regime at both sites. There has been no sensitivity analysis made of the costs (except to evaluate the benefit of a 1BT grant).

Annual land rental has not been included in the calculations. This will vary from site to site as the land value will be dependent on the type of land planted and its location. Future harvest costs also significantly affect profitability so these need to be taken into account by the forest grower on a site by site basis.

5.5 The inclusion of a One Billion Trees grant

Under Government's One Billion Trees (1BT) programme, new eucalypt planting of farmland is eligible for a grant of \$1500 per hectare. This grant can significantly contribute to offsetting the cost of establishment. It has been included in the models to demonstrate how much it can improve the economic feasibility of each regime to the forest grower if they are planting new land.

5.6 The carbon opportunity under the ETS

Durable eucalypts are eligible to be entered into the Emissions Trading Scheme (ETS) as long as they are planted on 'Post 1989 forest land', and meet the other standard criteria of the ETS. Growers of any of NZDFI's proposed regimes will benefit in terms of accruing carbon credits from entering the ETS. Due to their much higher density than radiata pine, eucalypts on productive sites have very fast sequestration rates.

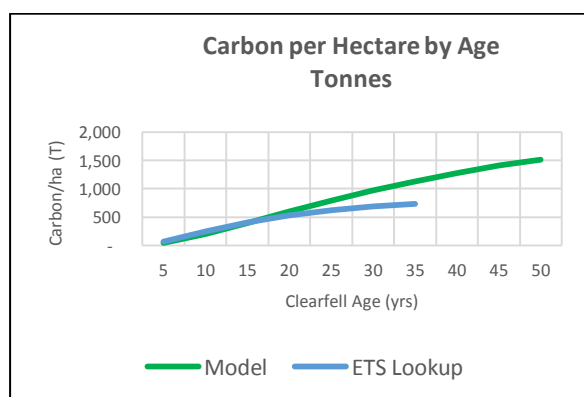
Use of Te Uru Rākau look up tables – areas under 100 hectares

Durable eucalypts are classified as Exotic Hardwoods within the ETS. This means that where any one forest-owning entity has less than 100 hectares registered, generic national Te Uru Rākau 'look-up' tables are used to estimate the amount of carbon sequestered by the trees. The amount of carbon per hectare sequestered by 'exotic hardwoods' over a 30-year rotation is shown below:

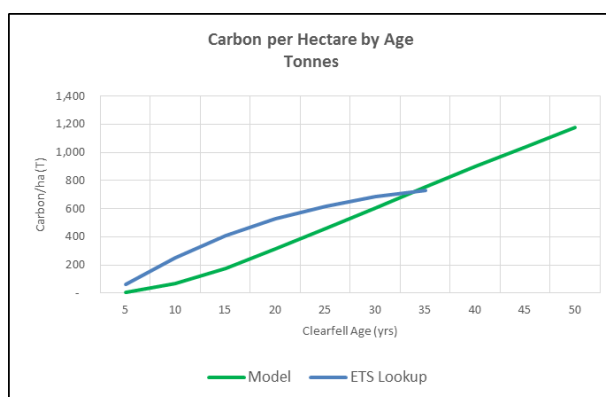
Age of trees	1 - 5	6 – 10	11 -15	16 - 20	21 - 25	26 - 30
NZU/ha for 5-year period	63	188	158	117	92	67
NZU/ha total accrued	63	251	409	526	618	685

If a forest-owning entity has more than 100 hectares registered in the ETS, the trees will be measured once every five years under the Field Measurement Approach (FMA), producing 'Participant Specific Tables' which reflect more accurately the amount of carbon stored in the trees. Whether this is more or less than the look-up tables will depend on the site and growth rate of the trees.

The two graphs below show a comparison between the Te Uru Rākau 'look-up' tables and NZDFI's growth models, and highlight the difference between the two NZDFI case study sites (high and low productivity).



Graph 1: High productivity site comparison of NZDFI model and Te Uru Rākau look-up tables.



Graph 2: Low productivity site comparison of NZDFI model and Te Uru Rākau look-up tables.

NZDFI urges MPI that in order to improve accuracy, tables for different hardwood species need to be developed, rather than one set of tables covering all exotic hardwoods. Growth data of durable eucalypts already held by NZDFI is probably the most accurate data available on eucalypt growth on different site types, and additional data could be collected by re measuring NZDFI's PSP's and completing biomass research. All this is needed for the development of new look-up tables.

Introduction of 'averaging' proposed under ETS review

Until the recent review of the ETS (2018-19), carbon has been allocated according to a 'sawtooth' model, where, the landowner receives carbon while the trees are growing, and then once the trees are harvested, the majority of carbon credits associated with the trees have to be returned to the Crown. As the second rotation crop grows, carbon is allocated again, and paid back again at harvest *ad infinitum*.

Under the 2019 review of the ETS, 'averaging' has been proposed. If adopted, owners of new forests planted from 2019 on Post 1989 land will be able to opt to receive the average amount of carbon stored in the forest over multiple rotations. As long as the land remains in forest, this allocation of carbon will never have to be returned to the Crown. The allocation would be made during the first rotation only, and thereafter the forest's main output would return to being timber. The advantage of averaging is that it avoids the on-going bureaucracy associated with carbon accounting through every rotation.

The exact details of how the average amount of carbon per hectare in any given forest will be calculated are not yet known: however it is estimated that for a forest with a 30-year rotation, the allocation would be around the amount of carbon sequestered by the trees in their first 18 years' growth. For a eucalypt crop and based on the current tables, this would be some 483 NZUs per hectare, worth over \$12,000/ha at the current carbon price of around \$25/NZU (May 2019).

If considering carbon as an additional income to the proposed NZDFI timber production regimes, the amount of carbon that the grower will be able to keep with only limited liabilities will vary depending on the regime.

The peeler pole and sawlog regimes have not been modelled to include carbon and would need to be assessed on a site by site basis because of the variables that can affect returns to the grower from carbon.

However, the economic feasibility of a permanent forest regime has been modelled, which, in theory, will continue to sequester carbon for many decades, albeit at a diminishing rate as the trees mature. This regime is also discussed in Section 6 and Appendix A1.4.

Professional advice should be sought on entering the ETS and estimating the amount of carbon likely to be available to the grower without liabilities.

5.7 Comparative evaluation of regime economic feasibility

The potential economic feasibility of the two timber production regimes and the permanent forest regime has been evaluated by using data from a high and a low productivity site to model potential productivity under each regime for both sites.

The tables and charts below show the results from this modelling in total recoverable volume (TRV) and mean annual volume increment (MAI).

The economic feasibility for all scenarios has been evaluated by producing required stumpage values per cubic metre (based on TRV). These are calculated by an analysis of the forest growing costs against the total recoverable volume predicted by the models across a range of harvest ages. The stumpage value is what needs to be the minimum value of the total standing forest across a range of harvest ages against either 3%, 5% or 8% internal rate of return (IRR) on the capital invested to establish and manage the forest.

5.7.1 Summary: outcomes of economic models

Regime and site type	Optimum rotation length	Required \$/m ³ stumpage to achieve 8% IRR	
		With 1BT grant	Without 1BT grant
A. Peeler pole regime, high productivity site	15-20 years	\$12-\$14	\$23-\$27
B. Saw log/peeler log regime, high productivity site	30-40 years	\$56-\$87	\$87-\$133
C. Permanent forest regime, high productivity site	Indefinite	Carbon price required to achieve 8% IRR over 50 years \$2.30	Carbon price required to achieve 8% IRR over 50 years \$6.80
D. Peeler pole regime, low productivity site	20-25 years	\$31-\$42	\$58-\$81
E. Sawlog/peeler log regime, low productivity site	30-40 years	\$113-\$150	\$177-\$233
F. Permanent Forest regime, low productivity site	Indefinite	Carbon price required to achieve 8% IRR over 50 years \$4.10	Carbon price required to achieve 8% IRR over 50 years \$11.70

More details of each regime A-F, and the outputs of the economic models, follow below.

A. Peeler pole regime: high productivity site

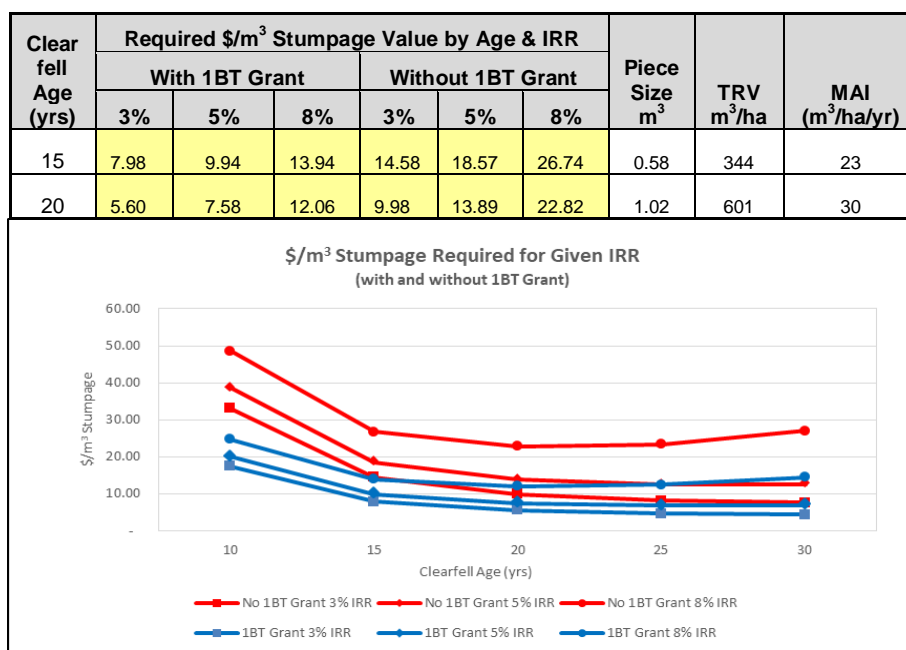
This regime has been designed to produce small logs (poles) grown on a short rotation of 15 to 20 years for peeling to produce high stiffness veneer and peeler cores for naturally durable posts. This regime is a new concept for New Zealand forest growers and is based on NZDFI's tree breeding and research programme.

The regime exploits two key features eucalypts offer: (i) rapid early productivity especially on optimal sites and (ii) the production of high quality hardwood by young trees particularly when enhanced by genetic improvement. NZDFI is researching commercial production of clonal plants that will have similar growth and form as well as similar wood properties. These will require minimal silviculture. This regime will be best suited to sites where ground based mechanical harvesting is feasible like at the Cravens site used in this evaluation.

This regime shows there is a significant financial benefit from a 1BT grant as shown by the lower minimal required stumpage signalling that a grant effectively reduces a forest growers costs by between 40-50% over the rotation. Key trends include the levelling off from a harvest age of 20 to 30 years of the required stumpage values with little change in this period. However, volume can almost double over that period due to MAI exceeding 30 cubic metres from year 20 on. Piece size also almost doubles over this time and larger logs can reduce harvest costs on more challenging sites.

The option of a harvest at age 15 also looks economically feasible even at an 8% IRR and with no 1BT. With piece size of 0.6 m³ at this age it maybe that smaller scale harvesting equipment can be used to reduce costs.

There are also the carbon opportunities for this regime if land to be planted is eligible for the ETS.



B. Saw log/peeler log regime: high productivity site

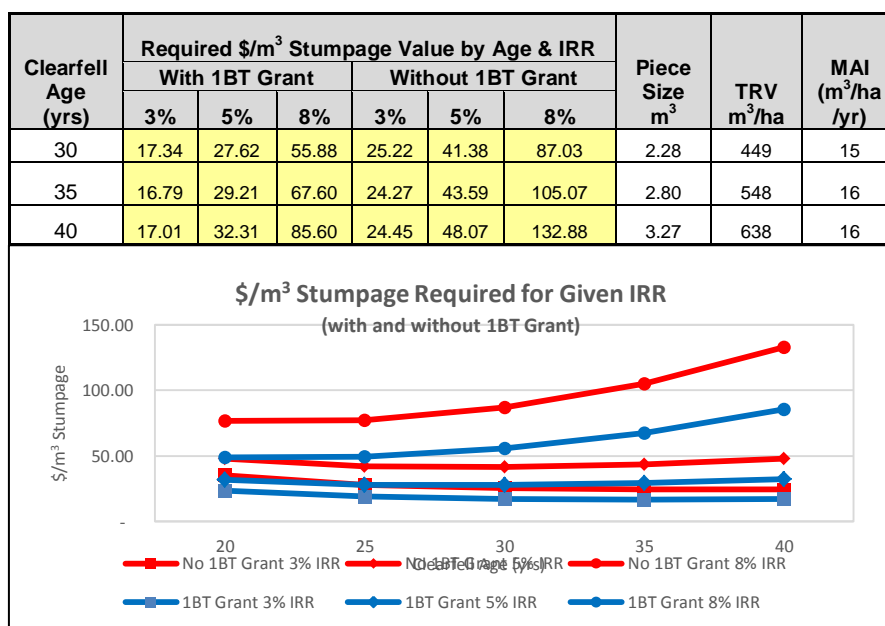
This regime has been designed to produce large logs on a rotation of 30 to 40 years that can be sawn for high grade timber or peeled to produce high stiffness veneer and peeler cores for naturally durable posts. The regime is based on eucalypt regimes already developed for other species by New Zealand forest growers.

The regime includes pruning combined with early thinning to a low stocking so as to grow large trees able to produce large logs. However, a consequence of early heavy thinning is the reduction of stand productivity with TRV being 60% lower than for the same harvest age shown in the peeler pole regime above. This lower volume results in much higher minimal stumpage values being required for the regime to be feasible with harvest at about age 30 likely to be the best option to ensure trees are large enough to lower harvest costs and produce large sawlogs. However, if a 3-5 % return is applied then feasibility will increase by delaying harvest until 35 years due to the higher volume and larger piece size further lowering harvest costs.

On suitable sites, there is the feasibility of combining both regimes through production thinning for peeler poles between age 10 to 20 years and a clear fell harvest age 30 to 40 years. This is difficult to model due to lack of data but is likely to significantly improve profitability due to the sale of the peeler poles providing an early return on the investment to establish and manage the plantation.

The modelling also shows there is a significant financial benefit from a 1BT grant as shown by the lower minimal required stumpage. The 1BT grant effectively reduces a forest grower's costs by between 30-40% over the rotation.

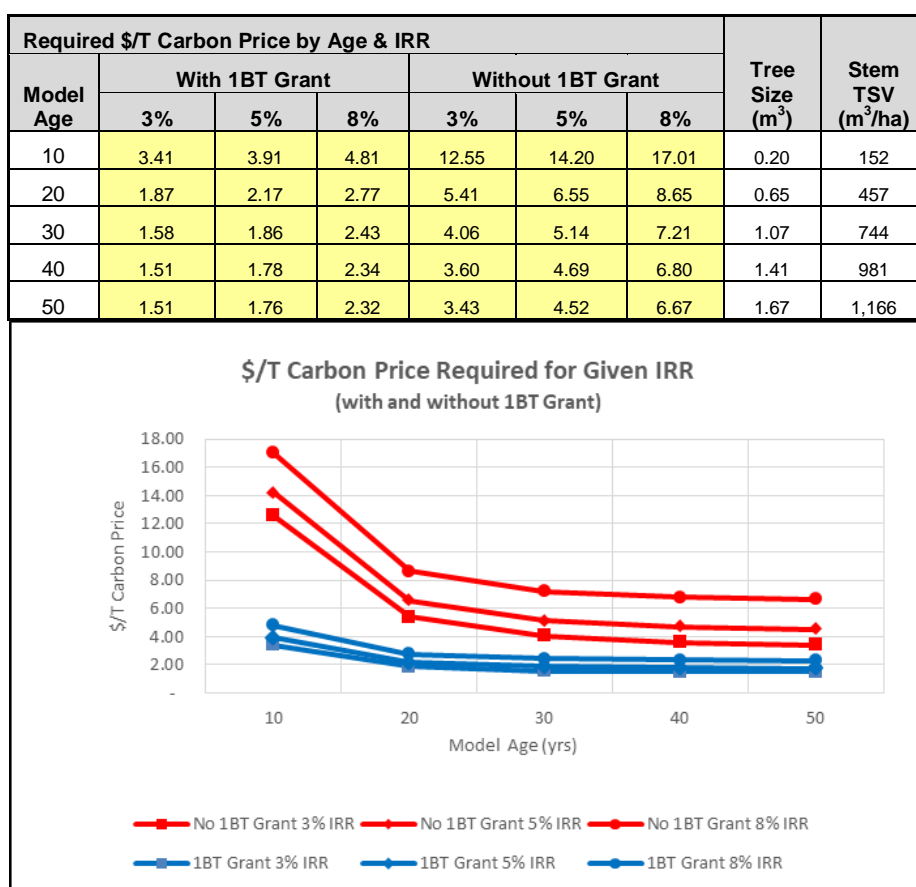
There are also the carbon market opportunities for this regime if land to be planted is eligible for the ETS.



C. Permanent forest regime: high productivity site

Permanent forests, with no harvesting ever envisaged, could suit very steep and remote sites, where eucalypts will deliver benefits of carbon sequestration, pollen and nectar production, and a resilient forest of species adapted to climate change. They also have higher wood density than pine so can sequester more carbon per cubic metre. On high productivity sites their carbon sequestration rates are likely to be greater than any other species. To model this regime maximum early carbon sequestration rates are possible by planting 800 spha and leaving the trees to grow. Also total stem volume has been calculated by allowing for an additional 30% in volume over TRV.

With current carbon prices at around \$25 per tonne, the table and charts below demonstrate that it is economically feasible to plant permanent forests on land eligible for the ETS because the minimum required carbon prices generated in the evaluation are much lower than this, even at 8%, without a 1BT grant and after only ten years.



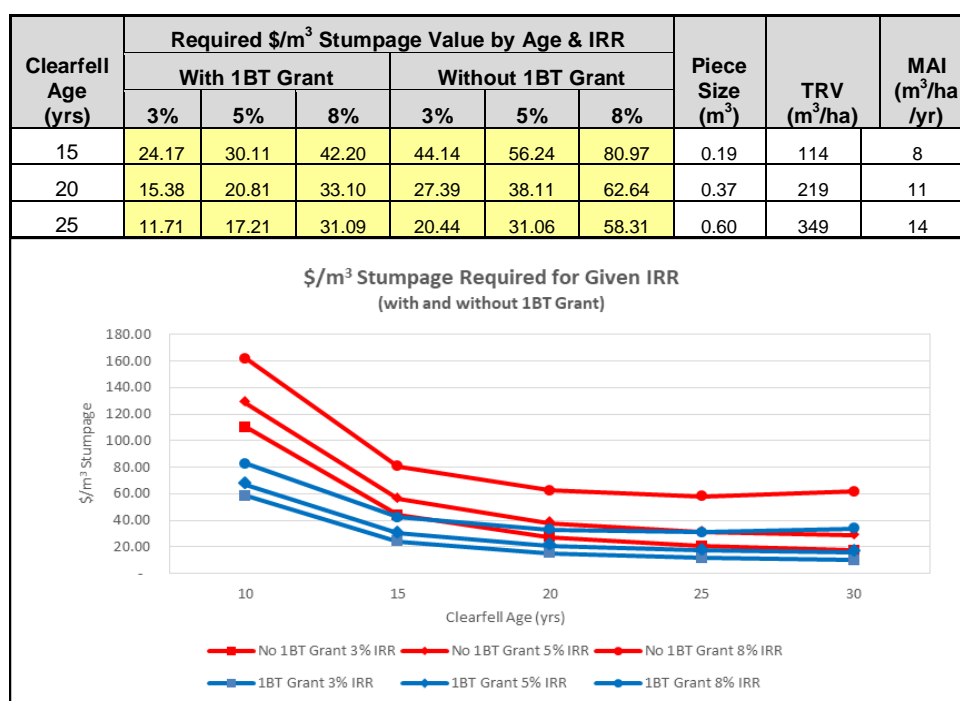
D. Peeler pole regime: low productivity site

This site demonstrates the significantly lower productivity that can be expected from a forest under this regime with the overall harvest volumes predicted to be only 50% of the Cravens site. This results in the minimum required stumpage increasing by about 200% i.e. 3 times more than the required values for the high productivity Cravens site.

However, the trends are similar with significant financial benefit from a 1BT grant effectively reducing a forest grower's costs by between 40-50% over the rotation. This improves the economic feasibility of the regime particularly if applying an 8% IRR.

The option of a harvest at age 15 may not be feasible due to the small piece size. The required stumpage values level off from a harvest age of 20 to 30 years so that a later harvest will yield higher volumes and higher total value.

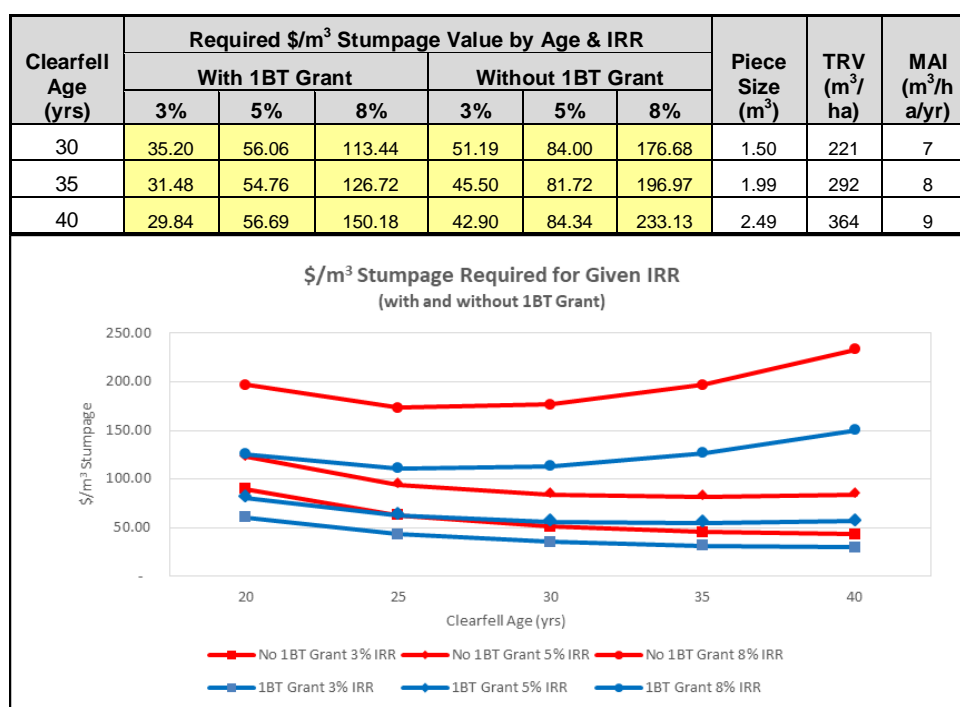
There are also the carbon market opportunities for this regime if land to be planted is eligible for the ETS.



E. Saw log/peeler log regime: low productivity site

This regime has been applied with a lower final crop stocking of 150 spha. This is lower than the 200 spha applied at Cravens high productivity site. This scenario also demonstrates that, in remote low productivity locations with difficult harvesting, this regime is unlikely to be economic feasible. Even including a 1BT grant an 8% IRR will be difficult to achieve unless there are very high log prices.

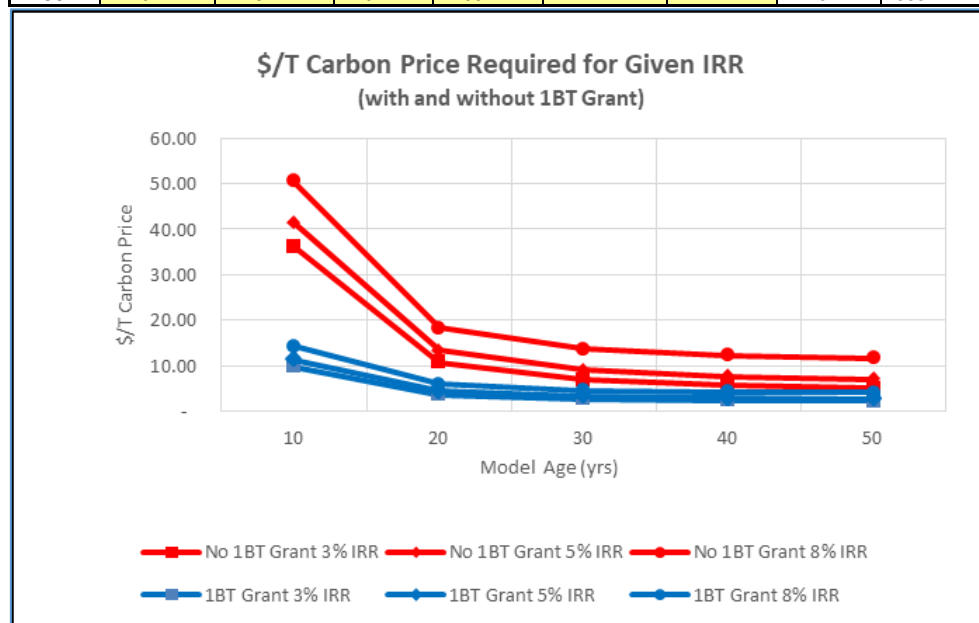
There are also the carbon market opportunities for this regime if land to be planted is eligible for the ETS.



F. Permanent forest regime: low productivity site

This site demonstrates that, as a consequence of lower carbon sequestration rates due to lower productivity, the required carbon price by age 10 is higher than \$25 if no 1BT grant is included. However, by year 15 the increase in growth results in the required carbon price falls to less than \$25 and this continues at a diminishing rate until year 50.

Required \$/T Carbon Price by Age & IRR							Tree Size (m³)	Stem TSV (m³/ha)
Model Age	With 1BT Grant			Without 1BT Grant				
	3%	5%	8%	3%	5%	8%		
10	9.83	11.41	14.30	36.15	41.43	50.59	0.07	54
20	3.70	4.43	5.89	10.73	13.34	18.36	0.31	240
30	2.69	3.30	4.60	6.90	9.11	13.64	0.60	466
40	2.35	2.93	4.21	5.58	7.71	12.23	0.89	692
50	2.20	2.78	4.07	4.99	7.12	11.71	1.16	903



5.8 Economic feasibility of veneer production to be evaluated

Working in collaboration with Nelson Pine Industries, NZDFI was able to successfully peel and test veneer from *E. globoidea* in 2017 and then more recently logs from young trees of both *E. bosistoana* and *E. quadrangulata* were successfully peeled, with the veneer produced currently under evaluation.

NZDFI plan to evaluate the potential value of logs to processors by modelling potential yields from veneer production by stiffness grade using radial stiffness profiles and evaluating potential log supply costs against potential veneer values.

In order to do this NZDFI is seeking information on the potential market premium for veneer that exceeds 16 GPa and the potential scale of the market demand for this.

The opportunity for peeling small young eucalypt logs has been further reinforced by recent research results by the Queensland Department of Agriculture and Forestry at their Salisbury Research Facility. They focused on the production of LVL-type products from small logs of several high density/strength eucalypts and *found that the rotary peeling, enabled by spindleless lathe technology, yielded higher and more consistent product recoveries than previously tested alternatives*. In fact, the project leader Dr Rob McGavin reported that *the recovered proportion of dry, graded and trimmed veneers were produced at around **twice** the volume of dried, dressed and graded sawn boards*.

Additionally, the veneer-grade quality, combined with the measured mechanical properties, indicated the recovered veneers would suit the manufacture of structural engineered wood products.

However, use in New Zealand of eucalypt veneer of any species for new LVL products will need either approval following adequate testing under NZ building standards or the use of a specific code mark.

5.9 Timing for key action/goals: Focus Area 2

Year	Key Activity	Source of Funds	Key Activity - funding needed
2020	Complete first version of <i>E. bosistoana</i> and <i>E. globoidea</i> productivity and economic models based on peeler pole and peeler log/saw log regimes. Evaluate economic feasibility of durable eucalypt veneer production.	SWP	Re measure PSP's and extend modelling of <i>E. bosistoana</i> and <i>E. globoidea</i> to other sites and regions.
2021	Establish site characteristics for optimal production of all NZDFI species; develop an easily usable guide for growers.	SWP	Use heartwood assessment tool to assess variation between site and species so as to maximise production on optimal sites.
2022	Complete <i>E. globoidea</i> wood quality assessment; taper equation and heartwood model.	SWP	Establishment of 100 new PSPs in trials planted 2018. Re-measurement of PSPs.

6 FOCUS AREA 3: WORKING REGIONALLY TO ENCOURAGE NEW FORESTS

6.1 Priority regional development

NZDFI has developed this strategy for the north eastern regions of New Zealand because of their strategic advantage to grow, process and market durable eucalypts. This advantage is due to a combination of suitable environments and available land as well as existing, well-established processors and ports.

The regions included are:

- Gisborne/East Coast
- Hawke's Bay
- Wairarapa
- Marlborough

The Te Uru Rākau One Billion Trees programme also presents a significant opportunity for these regions to plant new durable eucalypt forests on suitable sites so that future log supply can be coalesced to support regional scale value chains.

NZDFI have also identified other NZ regions with suitable environments for growing durable eucalypts. These are:

- Other North Island regions including Northland, Bay of Plenty, Taranaki and Manawatu
- Northern South Island regions, namely Nelson/Tasman and North Canterbury.

NZDFI's first regional value chain are most likely in northern Hawkes Bay/Gisborne regions and in Wairarapa. These will be based on short rotation forests that in 2035 will commence to supply small peeler logs to produce super-stiff veneer for LVL manufacture by Juken New Zealand Ltd. This integrated forestry and processing company is based in both Gisborne and Masterton. Juken NZ Ltd hosts several NZDFI trials and has played an active role in the NZDFI since 2011. The company has planted several hundred hectares of durable eucalypts (with unimproved plants) over the past seven years so as to be first to market with NZ grown, high strength LVL and durable hardwood products.

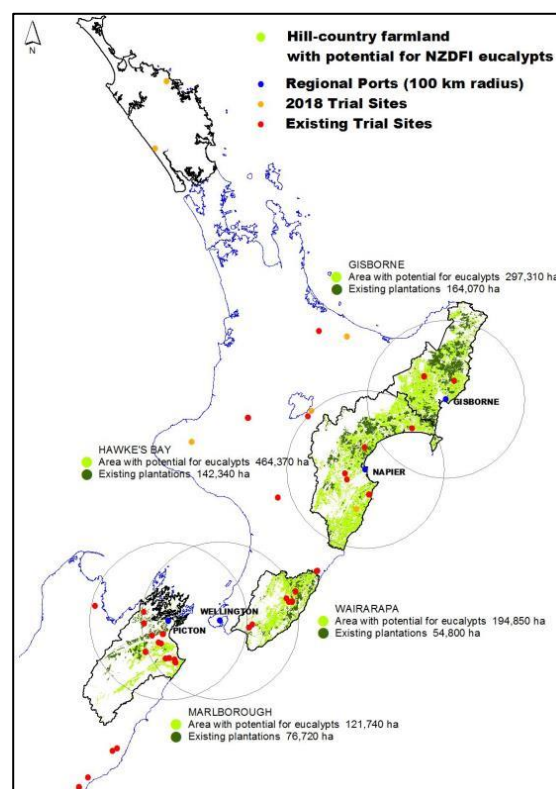
Numerous other east coast forest growers and farm foresters are collaborating in NZDFI research.

6.1.1 Target regions for planting durable eucalypt forests

There are over 1 million hectares of low quality hill country (Land Use Capability classes 6-8) that is used for dryland farming within the Marlborough, Gisborne, Hawke's Bay, and Wairarapa regions (Figure 2). For farmers and forest growers wanting to diversify their use of this land, there are numerous sites that are highly suited to durable eucalypt forestry.

NZDFI's '100,000 hectares by 2030' target is about 10% of this area if only farmland is planted. NZDFI are promoting the establishment of durable eucalypt plantations in regional clusters with annual planting targets from 2020 to 2030 that will establish sufficient resource for a sustainable supply to one or more value chains.

The four main target regions identified all have moderate winter temperatures and are prone to hot dry summers with relatively low total annual rainfall. Long range climate predictions indicate that summer droughts in these areas will become more frequent and



intense. Traditionally the land being targeted is used for sheep and beef production, with production always likely to be limited by summer droughts. There are over 400,000 hectares of radiata pine plantations already in these four regions.

6.2 Regional opportunities identified

The following table summarises the market opportunities identified in NZDFI's target region; each region's existing wood processing and infrastructure and the area of farmland suited to growing durable hardwood forests.

Region	Key regional market opportunities identified	Existing processing assets/infrastructure	Existing plantation forestry (ha)	Land potentially available for planting (ha) *
Gisborne	Re establish LVL production based on using high stiffness durable eucalypt to produce high-strength product. Posts/poles for horticulture, vineyards and organic agriculture. Māori land - opportunity for integrated forests for carbon, honey and timber, followed by new investment in processing.	Well established forest industry including y LVL processor Vibrant horticulture sector Port at Gisborne	164,070	297,310
Hawke's Bay	Largest regional potential for planting new forests including to supply to high strength LVL producer in Gisborne. Māori land - opportunity for integrated forests for carbon, honey and timber, followed by new investment in processing Possible expansion of existing processing industry to include hardwoods. Posts/poles for horticulture, vineyards and organic agriculture	Well established forest industry including several timber processing plants Large-scale horticultural production Port at Napier and rail link to Wairoa	142,340	464,370
Wairarapa	Enhance existing LVL production by using high stiffness durable eucalypt to produce high-strength product. Expansion of existing processing industry to include hardwoods Posts/poles for vineyards, horticulture, and organic agriculture	Well established forest industry including several timber processing plants Small but vibrant wine industry Rail link to CentrePort, Wellington	58,800	194,850
Marlborough	Vineyard posts/poles to supply the region's \$1billion wine industry. Focus on sustainable/organic producers Enhance existing LVL production by using high stiffness durable eucalypt to produce high-strength product (Nelson manufacturer)	30,000ha vineyards requiring one million posts per annum Well-established forest industry including key LVL processor in Nelson. Ports at Picton and Nelson	76,720	121,740

*Land potentially available for planting has Land Use Capability 6 to 8 and is unimproved hill country farmland

6.3 Opportunity for Māori landowners in NZDFI target regions

NZDFI support the Vision Mātauranga goal to unlock the potential of the Māori economy. Patterns of Māori forest ownership are changing. As land managed by other entities under Crown Forest Licences has reverted back to iwi, Māori forest ownership/management is approaching 40% of the total forested area. Māori are seeking options for early cash-flow, and to maximise returns from their land; these benefits could be delivered by our durable eucalypt species.

6.3.1 Iwi organisations represented in NZDFI target regions

Region	Iwi
Gisborne/East Coast (Tairāwhiti)	Ngāti Porou, Te Whānau a Apanui, Ngāi Tahu, Te Aitanga a Hauiti Ngāti Ruapani, Te Aitanga a Māhaki, Rongowhakaata Ngāi Tāmanuhiri, Ngāi Tuhoe
Hawkes Bay/Wairarapa	Ngāti Kahungunu ki Wairoa, ki Heretaunga, ki Wairarapa, Rangitāne
Marlborough/Nelson	Rangitāne, Ngāti Koata, Ngāti Kuia, Ngāti Rarua, Te Ati Awa, Ngāti Tama

NZDFI recognize that Iwi are cautious investors. They cannot put either their land or their recent Treaty of Waitangi settlements at risk. Therefore, NZDFI will seek the support of regional councils and Te Uru Rākau to broaden Māori engagement.

Māori already participate in NZDFI's research and development programme, with Ngāi Tahu and Ngāti Tuwharetoa both actively involved.

Ngāi Tahu is directly involved as a founding partner of the NZDFI through their subsidiary company Proseed New Zealand Ltd. Proseed is Australasia's largest supplier of tree seed. In 2014, Proseed opened a new propagation facility to undertake propagation research followed by planting their first grafted seed orchards of durable eucalypts in 2016.

Lake Taupō Forest Trust (Ngāti Tuwharetoa) has planted trials of durable eucalypts in order to diversify the species they grow. While not located in our target regions, their land will be in forest in perpetuity due to the nitrate pollution problems in the Lake Taupō catchment.

In addition, Te Tumu Paeroa is a member of the Specialty Wood Products programme.

6.4 The role of regional/district councils

NZDFI has been collaborating closely with regional and district councils in our target regions, who together make a major stakeholder group through the financial and technical support that they provide. These councils have a strong interest in diversifying land-based regional economic development and employment. Several have already invested in durable eucalypt trials on their own land, or supported trials on others' land within their regions. Regional council staff have also played an important role in NZDFI's extension activities to date.

6.5 Gisborne/East Coast

6.5.1 Why Gisborne?

Potential value chains

The Gisborne/northern Hawkes Bay region presents the potential for the first regional value chain to be established, based on short rotation forests which could supply small peeler logs to produce high strength LVL. This opportunity was first recognized by Juken NZ Ltd, an integrated forestry and processing company based in both Gisborne (sawn timber) and Masterton (sawn timber, plywood and LVL). Juken NZ Ltd hosts several NZDFI trials and has planted several hundred hectares of durable eucalypt. Gisborne's vineyards and other horticulture ensures there will be an additional market opportunity to sell naturally durable posts from the peeler cores.

Existing forestry/wood processing infrastructure

Gisborne has the highest forest productivity for radiata pine of any region in New Zealand. Large areas of hill country in this region were planted in 1970s-1990s with many of these forests having been harvested and replanted. As a result Gisborne has an established forest industry with over 164,000 hectares of plantations from which an estimated 1.8 million cubic metres were harvested in 2017. A small number of timber processors operate in the region. There is also a busy port dealing largely with log exports.

As with the rest of NZ, Gisborne forest growers rely heavily on radiata pine, leaving the industry vulnerable to long term changes in market demand and the impact of pests and diseases.

Existing land uses and land/climate suitability of durable eucalypts

Much of the Gisborne region has average annual rainfall of at least 1000mm; however, summers tend to be hot and dry. These conditions are highly suited to NZDFI's selected eucalypts.

Growers will have the opportunity to plant eucalypts for small peeler logs and posts/poles (15-20 year rotation) or sawlogs (30 year-rotation), depending on their objectives, their site and its location in relation to future markets.

The region is also renowned for its occasional very heavy rainfall, which, when combined with steep land and erosion-prone soils, creates a high erosion risk environment for both pastoral farming and large-scale plantation forestry. Heavy rainfall has led to some catastrophic forest debris slides from recently harvested radiata pine plantations in recent years.

Thus we believe that, depending on land type, planting eucalypts as permanent forests, or developing continuous cover systems, may be an ideal alternative on some of the most erodible land in the region.

Support from NZDFI stakeholders in Gisborne/East Coast

- Juken NZ Ltd
- Gisborne/East Coast District Council
- Gisborne Farm Forestry Association
- Two private landowners with NZDFI trials

6.6 Hawke's Bay

6.6.1 Why Hawke's Bay?

Potential value chains

Northern Hawke's Bay growers may well have the potential to supply small peeler logs into anticipated value chain based around the production of LVL at Juken NZ Ltd.

In addition, the region is NZ's second largest wine producer, and is a leading horticultural region, with existing demand from organic growers for durable timber posts, poles, trellis and other products.

Existing forestry/wood processing infrastructure

Hawke's Bay has an established forest industry with 135,000 hectares of plantations from which an estimated 1.8 million cubic metres were harvested in 2017. Much of this existing forest is located in northern Hawke's Bay where the rainfall exceeds 1000mm and was planted in 1970s-1990s. Along with Gisborne this area has some of the highest forest productivity in New Zealand.

Hawke's Bay is well serviced with both timber processors and a vibrant export port.

Existing land uses and land/climate suitability of durable eucalypts

The Hawke's Bay climate is generally summer dry, with frequent droughts making sheep and beef farming challenging on the drier land types.

NZDFI have identified that the expansion of a sustained planting programme in Hawke's Bay could establish a resource that can provide sufficient log supply as the basis for a new hardwood industry based on several regimes. This could extend to major planting in the Wairoa River catchment as the rail link from Napier to Wairoa is due to be re-opened later this year.

Also the large Māori landownership in this part of the region creates an opportunity for local Iwi to develop an integrated plan to plant durable eucalypt forests for carbon, honey and timber and then invest in processing.

Support from NZDFI stakeholders

- Hawke's Bay Regional Council – became involved in 2011 by providing annual financial support and then hosted a NZDFI trial in 2014. Maungaharuru Tangitu forest interns pruned this trial.
- Five landowners/farmers with trials
- Hawke's Bay Farm Forestry Association – supports extension activities.
- Hawkes Bay Regional Investment Company is currently developing a regional afforestation strategy that includes durable eucalypts as one of the options.

6.7 Wairarapa

6.7.1 Why Wairarapa?

Potential value chains

Juken NZ Ltd has a large processing plant in Masterton, already producing radiata pine LVL. There is considered to be excellent potential for the development of new high-stiffness engineered wood products which incorporate durable eucalypts.

In addition, the Wairarapa has a small but strong wine industry, with several boutique producers whose strength is their organic or sustainable status and who have shown strong interest in durable timber posts and poles. There are also numerous high-profile organic farms and lifestyle properties in the region.

Existing forestry/wood processing infrastructure

Wairarapa has an established forest industry with almost 55,000 hectares of plantations from which an estimated 1.8 million cubic metres were harvested in 2017. It is well serviced with regionally based timber processors and a road and rail link to Wellington's Centreport as well as good transport links north to the Hawkes Bay.

Existing land uses and land/climate suitability of durable eucs

Eastern Wairarapa has large areas of pastoral farms on summer-dry land, often on highly erodible land types. Many hill-country farmers in the Wairarapa are becoming aware of the potential to add trees to their farming mix. As in other similar regions, new tree plantings currently may have the potential to enable Wairarapa sheep and beef farmers to stay on their land and keep farming. Durable eucalypts are a multi-purpose species, and may well be preferable as a land-use to radiata pine for many farmers.

Support from NZDFI stakeholders

- Juken NZ Ltd – extensive trials in forests at Ngaumu, processing plant in Masterton
- Greater Wellington Regional Council – involved in demonstration trials and NZDFI extension activities to date
- Six landowners/farmers with trials – breeding and demonstration trials.

6.8 Marlborough

6.8.1 Why Marlborough?

Potential value chains

NZDFI's inception was due to the significant potential market in Marlborough for vineyard posts. The wine industry's standard posts made of CCA-treated radiata pine cause a number of problems. Local grape growers break many thousands of posts annually during harvesting. These broken posts are a hazardous waste and require disposal to a secure landfill, which is expensive. While the disposal using a high temperature kiln is possible, a proposal for setting one up in Marlborough was withdrawn following public opposition. This waste stream and associated costs and community concerns could be eliminated by using naturally-durable timber posts.

Natural durability and strength are the two essential wood properties that make durable eucalypts an obvious choice. As these timbers need no preservative treatment they can be recycled; burned for firewood or chipped for mulch. Their use will eliminate the long term problems of soil contamination and disposal associated with the use of CCA-treated timber.

Existing forestry/wood processing/port infrastructure

Besides the wine industry, Marlborough has an established forestry sector covering over 76,000 hectares, much of which was planted in the 1970-1990s and is now being harvested. The forestry industry is supported by a highly skilled labour force and an excellent local road network.

There is a diversity of local wood processing supply chains including high density and high stiffness pine logs being purchased by Nelson Pine Industries for their laminated veneer lumber (LVL) plant. A key potential market identified and being actively explored by the NZDFI is for the use of durable eucalypt timber as a component of LVL.

There are two export ports, one at Picton and the other Nelson.

Much of the existing pine forests are in higher rainfall areas of Marlborough, where there is excellent potential for durable eucalypts in some parts if owners were keen to replant cut-over sites.

Suitability of farmland for durable eucalypts

While there are some large areas of pine plantations and woodlots in south Marlborough much of the coastal hill country is still farmed. The annual rainfall is less than 1000mm rainfall for much of this area with some areas having an annual rainfall of less than 700mm. Over 30,000 ha of vineyards are located in this dry climate, supporting the region's \$1billion wine industry.

NZDFI has selected durable eucalypt species that have proven their adaptability and productivity in the drier east coast areas of southern Marlborough. This was a focus given the large areas of hill country farmland where new forests could be planted. NZDFI has planted numerous trials in Marlborough since 2004, and can now recommend certain preferred species and growing regimes with confidence (see Section 6.3).

Support from NZDFI stakeholders

The following Marlborough stakeholders have already shown strong support towards the NZDFI's vision of creating a durable hardwood industry in the region:

- Marlborough Research Centre Trust (founding partner of the NZDFI)
- Marlborough District Council – provides land for trials and other support
- Eight farmers/landowners (who host trials)
- Marlborough industries (e.g. Marlborough Lines)
- Nelson Pine International (major producer of engineered wood products)

6.9 Other NZ regions with potential

As a result of increasing interest in the opportunity to grow durable timber, NZDFI have had support from landowners in other regions who have planted trials to test the adaptability of durable eucalypts on other sites. This has included trials being established in Northland, Bay of Plenty, Waikato, Taranaki, Horizons-Manawatu, Tasman and Canterbury regions. Many of these trials have been successful and demonstrate there is wider potential to grow durable eucalypts in other NZ regions.

6.10 Timing for key action/goals: Focus Area 3

Year	Key Activity	Source of Funds	Key Activity - funding needed
2020	<p>Follow up release of NZDFI regional strategy to regional councils, Te Uru Rākau and to industry organisations.</p> <p>Continue to provide input to Hawkes Bay Regional Council Afforestation Plan and any other regional council led plans</p> <p>Confirm support of regional councils and Te Uru Rākau to broaden Māori engagement.</p>	SWP & regional councils	Hold 2x NZDFI workshop/field days in collaboration with regional councils; local iwi and industry organizations and Te Uru Rakau in target regions. (SWP, regional councils and TUK).
2021			Hold 2x NZDFI workshop/field days in collaboration with regional councils; local iwi and industry organizations and Te Uru Rakau in target regions. (SWP, regional councils and TUK).
2022			Establish five new demonstration trials in different regions with support of Te Uru Rakau including deployment of clonal plants

7 FOCUS AREA 4: NZDFI'S DURABLE EUCALYPT FORESTRY RESEARCH PLAN

A multi-faceted research and development plan focused on growing and processing durable eucalypts is being led by NZ's School of Forestry at the University of Canterbury. This requires an ongoing programme that currently involves a wide range of scientists. At the heart of NZDFI's product-focused research plan is the commercial deployment of elite nursery stocks that are straight, fast growing and produce abundant durable heartwood able to meet the requirements of hardwood growers.

Using the NZDFI trial site network, researchers are also developing regimes and working on site/species selection; and integrated pest management.

7.1 Potential forestry regimes and wood processing/value chain options

NZDFI propose four forestry regimes for growing durable eucalypts. These are based on known and anticipated markets but also other recognised objectives and constraints relevant to landowners in eastern regions of New Zealand.

Two of the regimes proposed are to produce durable hardwood logs, each of which suits different site types. These regimes offer prospective hardwood growers, who will have different objectives and varying land types, two main options for how to grow trees for clear fell harvest.

These two regimes – a short rotation producing peeler poles and a longer rotation to produce larger logs - have been assessed as to the economic feasibility that each offers to produce hardwood logs to supply value chains producing engineered wood products and durable sawn timber. (See Section 4 for economic modelling.)

7.1.1 The two main timber production regimes

NZDFI have developed a short rotation and a more traditional long rotation regime for hardwood timber production

- i. Peeler pole plantations - on flat-to-easy sites with good road access and short transport distances, a short rotation plantation with clear felling to produce logs for peeling from around age 15 to 20 offers the potential for a relatively rapid return on investment. These logs will be suitable for rotary peeling to produce veneer for use in engineered wood products with the peeler cores sold as preservative-free posts and poles for vineyards, horticulture, agriculture, and organic enterprises.
- ii. Peeler log/sawlog plantations - on less accessible sites, plantations can be grown to produce large sawlogs with harvest at age 30 to 40 years. These logs will be suitable for sawing high value durable hardwood products including cross-arms, decking, sleepers, outdoor furniture etc and also be suitable for peeling veneer for engineered wood products.

(Appendix 1.1. and 1.2 has more information on the proposed regimes):

7.1.2 Long-term/permanent regimes

In addition to the two main timber regimes envisaged, there is potential for durable eucalypts to be planted as long-term forests (see Appendix 1.3 and 1.4 for more details):

- i. Permanent forests - with no harvesting ever envisaged. Permanent forests will suit very steep and remote sites (Erosion Susceptibility Classification 'Very high'/NES-PF 'red-zone' land), where eucalypts will deliver benefits of carbon sequestration, pollen and nectar production, and a resilient forest of species adapted to climate change.
- ii. Continuous cover forestry – harvesting would be limited to individual trees or small-coupe systems using small scale harvesting equipment and on-site portable sawmilling. Eucalypts are well suited to this form of management as they can readily coppice and regenerate from seed within a mixed age stand following harvest

7.1.3 Summary: possible growing regimes for durable eucalypts

Regime	Estimated rotation length	Primary outputs/benefits	Key features
Peeler pole plantation	15 to 20 years	Posts and poles (vineyards/horticulture) LVL (logs rotary peeled) Potential for bio energy and eucalypt oil	Short rotation and high stocking. Potential for clonal forestry with regular injection of new genetics
Sawlog/peeler log plantation	30 to 40 years	Peeler logs for LVL Sawlogs for domestic processing or on-farm use.	Long rotation and low stocking to produce large logs.
Permanent forests	Species are adapted to climate change and trees can live for hundreds of years.	Carbon sequestration; soil stabilisation; nectar and honey for beekeeping; biodiversity; as a nurse for long-term indigenous regeneration on some sites.	Potential for steep and erodible sites. High productivity and wood density produces fast carbon sequestration rates. No harvesting.
Continuous cover forests	Small-scale felling from age 20 onwards	Multiple log types depending on growth rates/age at harvest; on site portable sawmilling; nectar and honey for beekeeping, soil stabilisation, carbon sequestration	Optimise multiple product with annual sales – timber, carbon, honey etc. Offers intergenerational management.

These regimes still require further evaluation with long term measurement and eventual harvest of NZDFI's trials in order to improve assessment of their economic value.

7.2 Selecting the right regime

NZDFI's selected species are adapted to cover the wide range of hill country with differing soils and climate within the hugely diverse geography of New Zealand's northern east regions.

Within these regions, forest growers' choice of durable eucalypt regime and species will be influenced by:

- Owners' objectives and resources**
 Landowners interested in growing durable eucalypts are likely, first and foremost, to want a competitive financial return from the crop, whether this be from timber, carbon, or a combination of outputs. However, landowners will have different site environmental conditions and the scale of forest area they can plant and manage will vary. Choice of a durable species and regime needs to match these factors.
- Property soils, climate and land class (LUC)**
 Site conditions, scale, soils and climate combined with aspect and drainage will also influence the choice of species and regime for any given site.
- Topography including internal access for regime management and harvest**
 The topography of a possible forestry site may limit the regime that can be chosen, particularly on steep hill country where harvesting options are generally limited to cable systems. Under the National Environmental Standards for Plantation Forestry, some 1 million hectares of hill country in NZ's east coast has been 'red zoned', potentially restricting forestry harvesting. These areas may in future be best used for permanent forests, with potential benefits of carbon sequestration, soil conservation, and biodiversity.
- Property location including transport options and sustainable log markets.**
 The location of a property could also influence a forest grower's regime options as distance to markets is critical to economic success.

NZDFI recommends that growers interested in planting durable eucalypts take into account these factors in selecting one of the four different forestry regimes that have been described above.

A description of each regime is provided (see Appendix 1) to inform forest growers on these options and offer them guidelines to match species and regime to their site and capability. Information on matching species to different sites is found below (Section 6.3). Ultimately the choice of species and regime needs to be decided by the landowner.

7.3 Site and species matching information

While many eucalypts planted in New Zealand will grow best on low altitude, fertile, relatively sheltered sites with good drainage and regular rainfall, NZDFI trials have confirmed there are a small number of species that can tolerate very hot, dry, infertile and moderately exposed conditions.

- Key site conditions which need to be taken into account when considering establishing durable eucalypt forests and managing these under a particular regime are:
 - **Frost:** eucalypt species vary in their frost tolerance with no species recommended for areas that exceed minus 6 degrees. Avoid planting flat sites in cooler regions while a north facing slope can ensure good air drainage and warmer winter temperatures. In cooler areas plant in late October or early November to avoid spring frosts on newly planted trees.
 - **Wind:** eucalypts species vary greatly in their tolerance to wind, although in general all common timber-producing species have better form on relatively sheltered sites.
 - **Annual rainfall:** NZDFI eucalypts can tolerate dry conditions, but this does vary between species. Species selection for very dry sites (<800 mm/rainfall per year) needs to be made with care.
 - **Soil depth, fertility and drainage:** some NZDFI species can tolerate quite challenging sites, where soils are dry, shallow and infertile. Others need deep, fertile, freely drained soils to thrive. A small number are tolerant of periodic flooding.

NZDFI's research includes assessing the performance of a number of durable eucalypts species in a wide range of environments by planting over 30 trials. Data from these trials are being used to develop species and site matching information to guide growers on species choice for their particular site-type.

NZDFI's tree breeding programme includes three primary species with an on-going genetic improvement programme:

- *E. bosistoana* (Coast grey box)
- *E. globoidea* (White stringybark)
- *E. quadrangulata* (White-topped box)

Secondary species also in the NZDFI programme but with limited genetic improvement work:

- *E. argophloia* (Western white gum)
- *E. cladocalyx* (Sugar gum)
- *E. macrorhyncha* (Red stringybark)
- *E. tricarpa* (Red iron bark)

Further details of these species are provided in Appendix 1. The following table provides a summary of the initial selection criteria for growers.

7.3.1 Summary: Grower information on selected NZDFI species

Species	Australian name	Frost tolerance	Rainfall Min and Max	Wind tolerance	Soil type/drainage	Insect threats
<i>E bosistoana</i>	Coastal grey box	-6	600 - 2500	Moderate	Requires fertile well drained soils but can tolerate periodic flooding	Susceptible to Paropsis and EVB browse.
<i>E globoidea</i>	White stringybark	-5	800 - 2500	High	Suited to a wide range of soils except skeletal and stony soils	Low incidence of insect browse
<i>E quadrangulata</i>	White topped box	-6	1000 - 2500	Low	Suited to a wide range of soils except skeletal and stony soils	Susceptible to seasonal Paropsis and EVB browse
<i>E argophloia</i>	Western white gum	-6	500 - 1000	Moderate	Requires fertile well drained soils	Low incidence of insect browse
<i>E cladocalyx</i>	Sugar gum	-3	500 - 1500	High	Suited to a wide range of soils including skeletal soils	Low incidence of insect browse
<i>E macrorhyncha</i>	Red stringybark	-8	500 - 1500	High	Suited to a wide range of soils except skeletal and stony soils	Low incidence of insect browse
<i>E tricarpa</i>	Red ironbark	-6	500 - 1000	Moderate	Requires fertile well drained soils	Susceptible to Paropsis and EVB browse.

7.3.2 Summary: Wood properties of selected NZDFI species (based on Australian native old growth)

Species	Density 12% MC (kg/m ³)	Stiffness (GPa)	Colour	Texture and grain
<i>E. bosistoana</i>	1100	21	Pinkish pale brown	Fine even texture with interlocked grain
<i>E. globoidea</i>	880	17	Pinkish pale brown	Moderately fine texture with straight grain
<i>E. quadrangulata</i>	1030	18	Pale yellow brown	Moderately fine texture with straight grain
<i>E. argophloia</i> (* age 13)	1055*	14*	Orange-brown to deep red-brown	Fine to medium texture with straight grain that can be interlocking
<i>E. cladocalyx</i>	1090	17	Pale yellow brown	Fine uniform texture with interlocked grain
<i>E. macrorhyncha</i>	635-955	No data	Reddish pink brown	Moderately fine to fine texture with interlock grain.
<i>E. tricarpa</i>	1130	17	Dark red and lustrous	Medium even texture with interlocked grain.
<i>Pinus radiata</i>	480	9	Light brown to chestnut brown	Medium texture with prominent growth rings.

NOTE: Properties of young plantation grown timber will vary from the old growth with lower density and strength having been demonstrated through NZDFI research. Through selection for breeding and clonal forestry NZDFI aim to improve the wood properties and reduce variability.

7.3.3 Natural durability ratings of NZDFI species according to Australian Standard AS5604

Species	Lyctid susceptibility of sapwood	Termite resistance of heartwood	In-ground life expectancy (years)	Above-ground life expectancy (years)	Life expectancy in southern waters (years)
<i>E. bosistoana</i>	Susceptible	Resistant	>25	>40	21 to 40
<i>E. globoidea</i>	Not susceptible	No data	15 to 25	No data	21 to 40
<i>E. quadrangulata</i>	Not susceptible	Resistant	15 to 25	15 to 40	No data
<i>E. argophloia</i> *	Susceptible	No data	>25a	>40	No data
<i>E. cladocalyx</i>	Susceptible	Resistant	>25	>40	41 to 60
<i>E. macrorhyncha</i>	Susceptible	Resistant	15 to 25	15 to 40	41 to 60
<i>E. tricarpa</i>	Susceptible	Resistant	>25	>40	41 to 60

* Source Dept of Agriculture, Fisheries and Forestry. Queensland

Note on durability: All NZDFI species are highly naturally durable. Class 1 durability = >25 years in-ground; >40 years above ground; Class 2 – 15-25 years in-ground; 15-40 years above ground

Natural durability is defined as “the inherent resistance of a specific timber to decay and to insect attack”. The most durable timbers last for many decades when used both in-ground and above ground. An Australian Standard is commonly used to classify timbers according to their expected durability. Natural Durability classes provide the basis for rating the timber’s performance and longevity in contact with the ground, or above the ground, when exposed to average environmental conditions.

In practice, timber longevity depends on a number of factors as well as the inherent durability of the timber, including local conditions, the age of the tree the timber came from, and the piece size.

7.4 Production of genetically-improved planting stock for NZ’s east coast regions

Proseed NZ Ltd commenced the establishment of durable eucalypt seed orchards in Canterbury by planting 3 hectares of grafted elite selections of *E. bosistoana* in 2016. These selections were made from the top 18 families first identified in NZDFI’s 2009 breeding populations. Many individuals are now flowering and will produce the first crop of improved orchard seed in 2020.

Therefore, NZDFI’s goal is to commence the sale of improved XyloGene (XG) seed in 2020 and that production will rise (if there is demand) to produce 5 million seedlings/clonal plants by 2025. This will be boosted by the planting grafted selections of 10 more elite families including those identified in NZDFI’s 2010 breeding populations.

In addition, NZDFI will start delivering seed of other species to growers by 2021 through having rogued some breeding trials (removed the poorest quality trees) and collecting seed from the top individuals of elite families.

Over the next three years, Proseed plan to develop another 3 hectares of grafted seed orchards of other NZDFI durable species using the best families identified from NZDFI’s breeding trials.

Proseed have also had promising success in developing clonal plants from cuttings of elite *E. bosistoana* trees. Clonal forestry is largely used throughout the eucalypts plantations worldwide as many of the best pulp wood species can be mass propagated using cuttings. In spring 2018, over 3000 elite clonal plants of *E. bosistoana* were planted in new trials in Marlborough and several other regions. Proseed plans to scale up the production of mother plants of the best 20-30 individuals and investigate deploying these to commercial nurseries for mass production of elite XyloGene (XG) clonal stocks from 2021.

7.5 Branding of NZDFI germplasm

NZDFI's partners have developed a strategy for branding the quality of germplasm captured within improved nursery stocks so that farm foresters and forest growers can select these plants to ensure high productivity and wood quality in their forests. To this end, the XyloGene trademark has been registered with the International Property Office of New Zealand.



NZDFI will develop a nursery licensing system for production of certified XyloGene planting stock similar to that used by the Radiata Pine Breeding Company (RPBC) for the branding and sale of genetically improved pine nursery stocks. This will include that all branded nursery stock will include a 5 cent royalty per plant to be charged on all sales and payable to NZDFI. A discount on the royalty will be made to industry supporters that have contributed to NZDFI's research programme including Speciality Wood Products members. The discount will take into account the level of financial contribution made to NZDFI's research.

7.5.1 Traceability and certification of XyloGene stock

NZDFI believe that there is potential for the XyloGene brand or trademark to be used for branding not just durable eucalypt nursery stocks, but also other products throughout the value chain. NZDFI's focus is on delivering a multi-regional opportunity to sustainably grown, naturally durable hardwood that will compete in international markets on quality rather than price.

Therefore, NZDFI believe that the XyloGene brand will add value if also used to market and certify durable hardwood products produced in the future. This requires certification and traceability along the value chain for growing, processing and sales of durable hardwood in a similar way to that used by Zespri in the production and sales of kiwifruit. With brands and trademarks already a key part of New Zealand's international export success, we propose investigating this in advance of the onset of major planting.

Tracing products from the nursery to the final consumer is possible: all the nursery records of production and deployment of the XyloGene nursery stocks can be recorded on a database along with accurate maps and records of where all the new forests are planted. This will enable future traceability and certification of the durable hardwood grown in these forests. Logs could be tracked from the forest to the timber processor who can then use the XyloGene brand as a certifying trademark to identify and add value to all products including posts, poles, sawn timber and engineered wood products such as laminated veneer lumber (LVL).

7.6 Potential for a growers' and processors' co-operative

In future, NZDFI plans to investigate the possible formation of a co-operative or other legal entity of XyloGene forest growers and processors that produce XyloGene hardwood products for domestic and export markets. The role of this co-operative would be to build brand recognition and markets, invest in continuing research, product development, market development, and forest grower extension and support. This could benefit large and small growers by adding value and increasing market access via the XyloGene brand.

7.7 Timing for key action/goals: Focus Area 4

Year	Key Activity	Source of Funds	Key Activity - funding needed
2020	<p>Select top 30 clones of <i>E. bosistoana</i> and establish nursery requirements from commercial clonal production.</p> <p>Expand <i>E. bosistoana</i> elite families in seed orchard from 18 to 28.</p> <p>XyloGene nursery licencing and royalty collection established.</p> <p>Trial assessment, thinning and wood sampling then convert a selection of 2009-2012 NZDFI breeding populations to seed stands.</p> <p>Maintain NZDFI research database on Katmandoo system.</p>	<p>Proseed and MRC</p> <p>Proseed</p> <p>NZDFI partners</p> <p>SWP and trial host landowners</p> <p>SWP</p>	<p>Accelerate trial assessment, thinning and wood sampling then convert additional 2009-2012 NZDFI breeding populations to seed stands.</p> <p>Collect seed from thinned trial sites</p>
2021	<p>Collection from grafted seed orchard and commercial release of 1st XyloGene improved seed.</p> <p>Trial assessment, thinning and wood sampling then convert a selection of 2009-2012 NZDFI breeding populations to seed stands.</p> <p>Maintain NZDFI research database on Katmandoo system.</p>	<p>Proseed</p> <p>SWP and trial host landowners</p> <p>SWP</p>	<p>Accelerate trial assessment, thinning and wood sampling then convert additional of 2009-2012 NZDFI breeding populations to seed stands.</p> <p>Collect seed from thinned trial sites</p>
2022	<p>Commence improving tree health by selection of <i>E. bosistoana</i> pest tolerant germplasm.</p> <p>Complete population-genomics and taxonomy of <i>E. argophloia</i> and <i>E. bosistoana</i>.</p> <p>Trial assessment, thinning and wood sampling then convert a selection of 2009-2012 NZDFI breeding populations to seed stands.</p> <p>Maintain NZDFI research database on Katmandoo system.</p>	<p>SWP</p> <p>SWP</p> <p>SWP and trial host landowners</p> <p>SWP</p>	<p>Establish accurate breeding values for NZDFI germplasm.</p> <p>Collection and successful grafting of scion of elite genotypes and deploying in 3 hectares of new seed orchard.</p> <p>Establishment of 2nd generation breeding populations of <i>E. bosistoana</i> and <i>E. globoidea</i>.</p> <p>Hold professional science workshop.</p>

8 FOCUS AREA 5: EDUCATING GROWERS ON DURABLE HARDWOOD FOREST MANAGEMENT

8.1 Multiple benefits of durable eucalypts

We know that our landowners, supporters and many others have proven skills, knowledge and expertise in plantation forestry and are waiting for improved nursery stocks to become available to increase planting rates. Central government and east coast regional councils want to encourage investment in planting more trees and NZDFI want durable eucalypts to be a part of this investment.

For new landowners to have confidence to plant hardwoods they need information about the range of benefits offered by planting durable eucalypts and how to best grow their trees for harvest. This applies both to large-scale forest growers, and also farmers and woodlot owners who could plant durable eucalypts to complement other land uses in dryland regions such as livestock grazing, conventional forestry, and mānuka/honey ventures.

8.1.1 Multiple potential benefits and hardwood production

- Possible benefits while growing
 - carbon sequestration
 - soil erosion control
 - nectar and pollen production to sustain hives over winter
 - shelter and shade for livestock
 - waste-water remediation/nutrient stripping
 - landscape/amenity benefits.
- Hardwood production
 - peeler pole production from short rotation plantations if veneer/LVL processor within economic range of forest.
 - peeler log/saw log production for sale to processors or for sale to export.
 - on-farm production of posts, poles and timber for farm infrastructure from Year 15 onwards.
 - excellent firewood.

8.1.2 Permanent forests

Durable eucalypts can live for hundreds of years so could also be established as permanent forests on steep unproductive land for erosion control and to sequester carbon. On sites with annual rainfall of over 1500mm, eucalypts could be spaced widely to allow under-planting of native species, or for natural regeneration, with the eucalypts providing shade and a protective canopy for native plants to develop.

8.1.3 Financial support offered through Government grants and the ETS

For landowners to be motivated to plant durable eucalypts, some will need predictions of the likely costs and returns from the trees so that they can undertake a comparative financial analysis with other land use options. Therefore continuing the development of specific growth models for predicting yields from durable eucalypts is necessary.

Landowners that plant new durable eucalypt forests on open farmland could be eligible for the One Billion Trees fund and/or the East Coast Erosion Control Fund. Regional council financial assistance through erosion control and other programmes is also likely in the Hawke's Bay and Greater Wellington regions.

Owners of eucalypts planted on 'Post'89 land' and which meet other Emissions Trading Scheme (ETS) 'forest land' criteria will be eligible to claim carbon credits on their plantings. In general, eucalypts have faster early growth rates and higher timber densities than radiata pine, which makes them an attractive option if generating returns from carbon is an objective. The introduction of 'averaging' for ETS-registered forests planted from 2019 onwards could be an additional incentive to growers, as it will increase the amount of carbon allocated which should never have to be paid back as long as the land remains in forest.

8.2 Growers already planting durable eucalypts

Innovative growers are already planting durable eucalypts and gaining valuable skills and experience in establishing and managing NZDFI species. The 2019 Speciality Wood Products forestry nursery survey shows that seedling sales/forecast sale 2009-2020 now total over 3.2 million trees (see Appendix 4 for more details). Around 153,000 of these have been planted in NZDF's breeding and demonstration trials.

This demonstrates there is interest in durable hardwood forestry, especially as to date no genetically improved planting stock has been available. These blocks of new forest are located throughout NZDFI's target regions and will start to generate a small log supply from 2030 onwards. However, substantially more planting is required and NZDFI is confident that demand will increase significantly once improved nursery stock is available to growers.

8.3 Skilled labour required

Potential growers of durable eucalypts may understandably be concerned that there will be insufficient skilled labour available to plant, manage and harvest the trees.

As with all of NZ's primary sector industries, there is a shortage of labour to service New Zealand's forest industry, and NZDFI's partners are concerned that the lack of suitably skilled labour will be the primary constraint limiting the Government's new tree planting targets. Government and both the Forest Industry Contractors Association (FICA) and the Forest Owners Association are working hard to address labour shortages, and the situation may improve over the coming years.

Planting and managing eucalypts requires a different approach to pine, so not only are more people going to be needed, both existing and new entrants to the workforce will need to be trained. Given the importance of a suitably trained workforce, we are also seeking feedback on current and possible future initiatives to build human capability as part of this strategic planning process.

8.4 Overcoming biological risks

There are significant biological risks that could threaten the substantial capital investment involved in planting 100,000 hectares of durable eucalypt plantations. These include climate and soil being unsuitable for the species chosen for any particular afforestation site; poor handling of nursery stock during establishment and incorrect timing of planting; some young eucalypt seedlings can develop poor form despite genetic improvement; and insect pests and diseases, and fire.

These risks can be mitigated through:

- careful site planning by farm foresters and forest growers so as to correctly match species to site. This could be significantly assisted through by upskilling regional council land managers, Te Uru Rākau advisors and local forestry and farm management consultants.
- completing establishment operations to a high standard which does require different methods to those used for planting radiata pine and a high standard of animal pest control.
- form pruning (to create a single, straight stem) may be necessary to ensure optimal selection of crop trees

- integrated pest management strategies to combat the potential impacts of insect pests and possibly Myrtle rust on some NZDFI species. NZDFI research for pest tolerance is already underway

8.5 Potential for negative environmental impacts from eucalypt plantations

Two environmental risks have been identified in the recent sector consultation. These include fire risk and safety (which is intended to be mitigated by locating plantation away from peri urban areas and rural buildings) and the potential impact of large scale eucalypt plantations on water availability/quality.

NZDFI accepts that both these risks warrant further consideration and investigation. However, this is best undertaken at a catchment scale by the regional councils in the target regions. And, additional resources to research the potential effects of durable eucalypt forestry will need to be secured.

A further public and landowner concern is whether durable eucalypts pose a threat by producing wildings (i.e. the trees will spread beyond plantation boundaries) and become an environmental issue. Despite many eucalypt species having been introduced into New Zealand and planted across a wide range of environments, they are not known to have developed wildings. This could be due to the specificity of sites that eucalypts require as well as the care required for establishment. Also eucalypt seed does not naturally disperse over long distances, NZDFI consider the risk of eucalypt wildings is low.

8.6 Extension and trials

NZDFI has already worked with many landowners, forest companies, local authorities and others to test species and possible growing regimes, and to demonstrate the potential of durable eucalypts through planting a large network of trial sites. NZDFI has held workshops, field days and delivered conference presentations. Also scientific reports, journal articles and the NZDFI web site have been produced. NZDFI now sees its primary role as educating industry professionals such as forestry consultants, Te Uru Rākau staff, and regional council land management advisers. This work is planned continue provided that sufficient additional funding can be found.

8.7 Timing for key action/goals: Focus Area 5

Year	Key Activity	Source of Funds	Key Activity - funding needed
2020	Update website, maintain database and circulate Project Update six monthly. Deliver 1 conference presentation and submit 1 article annually to industry journals and magazines	SWP	Hold 2 NZDFI workshop/field days in collaboration with regional councils; local iwi and industry organizations and Te Uru Rākau in target regions.
2021	Update website, maintain database and circulate Project Update six monthly. Deliver 1 conference presentation and submit 1 article annually to industry journals and magazines	SWP	Hold 2 NZDFI workshop/field days in collaboration with regional councils; local iwi and industry organizations and Te Uru Rākau in target regions.
2022	Update website, maintain database and circulate Project Update six monthly. Deliver 1 conference presentation and submit 1 article annually to industry journals and magazines	SWP	Professional development course on durable eucalypts available on-line for forest owners and managers.

9 FOCUS AREA 6: INDUSTRY PARTNERSHIPS TO BUILD SUPPORT AND CAPABILITY

9.1 NZDFI partnership developed 11 years ago

NZDFI's inception in 2008 came about as a result of initial investment by Vineyard Timbers Ltd, a local start-up company established by Paul Millen (now NZDFI's Project Manager), who recognised the huge potential market in Marlborough for vineyard posts. The wine industry's standard posts are predominantly CCA-treated radiata pine. They have high rates of breakage as a result of mechanical harvesting and their toxicity means they are very difficult and costly for grape growers to dispose of safely.

This brought the identification of species which could produce timber 'fit for purpose' as vineyard posts into focus. Natural durability and strength are the two essential wood properties that made durable eucalypts an obvious choice.

From 2003 and 2006, over 80 small research trials of 25 durable eucalypt species were established in an early research joint venture between Vineyard Timbers, the Marlborough District Council, Proseed NZ Ltd and several private local landowners with scientific advice provided by University of Canterbury's NZ School of Forestry.

Marlborough Research Centre (MRC), as an independent regional trust focused on connecting research and business to improve Marlborough's rural economy, facilitated meetings and workshops and also contributed seed funding for Vineyard Timbers to get started on this early research. Then in 2008 the MRC provided the leadership, expertise and ongoing professional administration needed to underpin the establishment of NZDFI.

Proseed NZ Ltd's and the University of Canterbury's long term investment in NZDFI was based on a shared view that eucalypts have significant potential to diversify New Zealand's forestry estate.

NZDFI's continuing success is because of the enduring partnership and collaboration by the four main partners (Table below), who have all financially invested and provided active support and resources to make this research programme happen. The partnership benefits from having defined a collective long-term strategy, with innovative contributions by all key players, and consistent management since its inception.

NZDFI partners and areas of activity

Partner	Area of activity
Marlborough Research Centre Trust	Trial management, trial assessments and outreach programme
Proseed NZ Ltd	Seed collection, propagation, seed orchard management
New Zealand School of Forestry (University of Canterbury)	Manage a comprehensive research programme including: site-species matching; growth and yield modelling; tree health; breeding (growth, health, wood quality); wood processing.
Vineyard Timbers Ltd	Vineyard Timbers Ltd is the company of NZDFI project manager, Paul Millen

9.2 Building support and capability with stakeholders

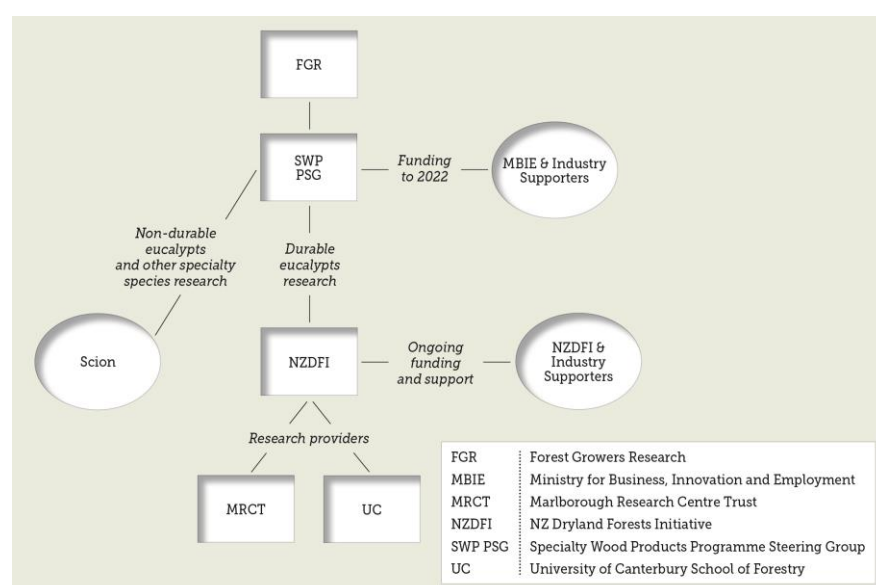
Tree breeding is a complex, time consuming and expensive research challenge. NZDFI partners knew this but were prepared to invest in a minimum 20-year research programme. In order to deliver this they brought together a well organised team of skilled people tasked with completing three main stages: (i) trial establishment, (ii) assessment and selection, followed by (iii) production of elite planting stock. NZDFI now has thousands of pedigreed individuals under research in an internationally leading tree breeding programme based on a unique trial network from the Bay of Plenty to North Canterbury.

The partners have developed close links with landowners that host a total of over 80 hectares of NZDFI research trials. These landowners represent a total of 32 different entities including large corporate owners, smaller forest growers and farm foresters, iwi and private trust forest owners, regional and district councils.

Building this capability was also possible because NZDFI successfully secured additional funding and in kind support from industry organisations and regional councils and leveraged substantial funds from government sources.

From 2008 to 2016, \$3 million was invested in the NZDFI research and development programme, with about \$0.6 million from central government via two MPI Sustainable Farming Fund projects and \$100,000 from AGMARDT. NZDFI's founding partners invested \$1.8 million over this time. Another \$0.5 million was from other supporters including Marlborough Lines, the NZFFA, multiple regional councils and forest growers from the East Coast regions (Bay of Plenty, Gisborne, Hawke's Bay, Horizons, Greater Wellington, Marlborough and Canterbury).

Then in July 2015, NZ Forest Growers Research Ltd, with funding from NZ Forest Growers Levy Trust (that was established in 2013) and the support of forest industry companies and organisations, secured a 7 year partnership with the Ministry of Business Innovation and Employment for the Speciality Wood Products (SWP) research programme. The SWP programme continues until 2022 under which both the University of Canterbury and the Marlborough Research Centre Trust (MRCT) are contracted to continue with NZDFI's durable eucalypt tree improvement programme, while Scion are contracted by NZ Forest Growers Research Ltd to continue research on non-durable eucalypts already planted in New Zealand for sawlog and pulp wood production (see Figure 4).

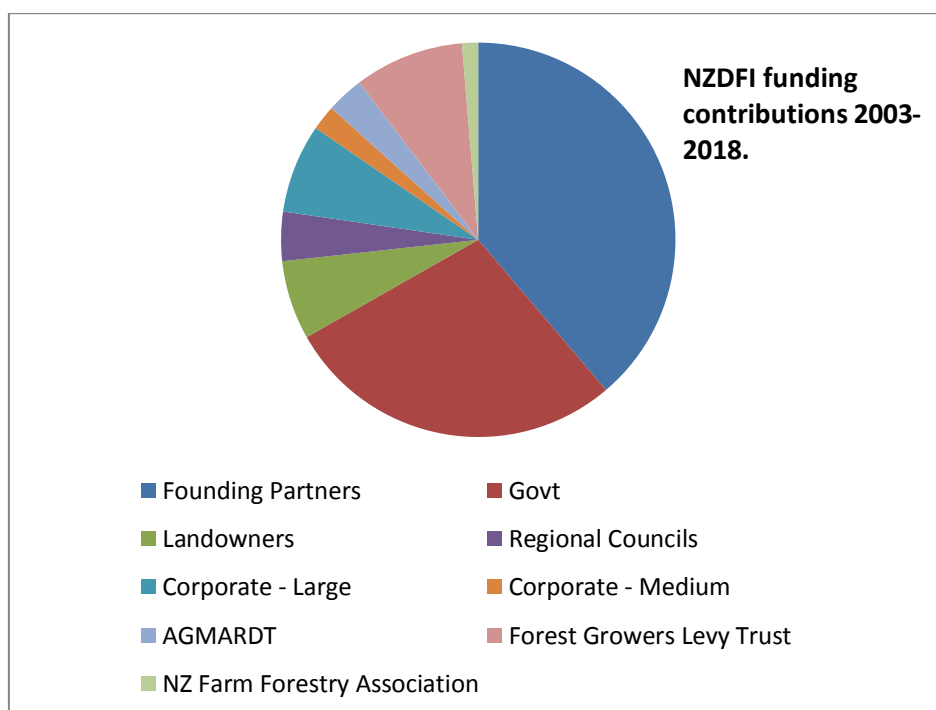


Current NZDFI organisational structure.

NZDFI also receives extra financial support from the partners as well as from Hawkes Bay and Greater Wellington Regional Council's, the Marlborough Research Centre Trust and Marlborough Lines to support core management and extension costs, and to fund additional research projects.

By 30th June 2019 the total value of investment in NZDFI's programme is estimated at \$7.4 million. NZDFI's founding partners having contributed 39% of this and there has been substantial central Government support (28%). 13% has come from AGMARDT, NZ Farm Forestry Association and more recently Forest Growers Levy Trust. In addition, 20% has been contributions by a wide range of other supporters including corporate forest owners, regional councils, landowners and a number of forest growers from NZ's east coast regions (Bay of Plenty, Gisborne, Hawkes Bay, Horizons, Greater Wellington, Marlborough and Canterbury)

Group	Amount	
Founding Partners	2,900,943	39%
Government	2,094,646	28%
Landowners	484,321	6%
Regional Councils	301,644	4%
Corporate - Large	546,083	7%
Corporate - Medium	153,032	2%
AGMARDT	228,773	3%
Forest Growers Levy Trust	671,501	9%
NZ Farm Forestry Association	99,137	1%
Total	7,480,080	100%



NZDFI acknowledges the essential contribution of the 32 landowners who host our trials and that of our industry partners who assist with funding the NZDFI research programme. Without their input and support it would not be possible to sustain the NZDFI research programme.

In addition to their substantial financial investment, Proseed also fund and manage all the seed collection for the NZDFI breeding programme; have undertaken the propagation and establishment of 3 hectares of grafted seed orchard and invested in building a new propagation facility at their Amberley site, North Canterbury to undertake clonal research and development.

9.3 Additional funding required for NZDFI's ongoing programme

NZDFI has established a research programme and developed the capability to scale up production of genetically improved nursery stock to commence planting durable eucalypt forests from 2021. There are nurseries ready to start production of XyloGene nursery stock, using best practice techniques, to produce robust and healthy planting stock. However, they need improved seed to start mass production of commercial nursery stock but NZDFI still have a lot of work to complete before full commercial deployment of all species is possible.

NZDFI also need more resources to expand the extension programme in collaboration with regional council land management teams, Te Uru Rākau, and professional forestry consultants, so that growers will know how to successfully establish durable eucalypts on the right site and manage them to produce high-value hardwoods.

And additional funding is needed to undertake market research and development, including processing trials, so that growers and processors can better appreciate the significant market opportunity there is for durable hardwoods.

Therefore, NZDFI partners are investigating other funding to boost investment in our programme. This includes an application to government that will need additional funding from the NZDFI partners and industry supporters, regional councils and Forest Growers Levy Trust.

9.4 Timing for key action/goals: Focus Area 6

Year	Key Activity	Source of Funds	Key Activity - funding needed
2020	Make application for additional funding to government and industry	NZDFI	

10 APPENDICES

APPENDIX 1: Forestry regimes for growing durable eucalypts: four options

The NZDFI has identified four potential forestry regimes for growing durable eucalypts, which are described in more detail below.

- Peeler pole plantation (15 to 20 year rotation)
- Saw log/peeler log plantation (30 to 40 year rotation)
- Permanent forests
- Continuous cover forests

A1.1 Peeler pole plantation

- **Status**

This regime is aimed at the production of small logs (poles) grown on a short rotation of 15 to 20 years for peeling to produce high stiffness veneer and peeler cores for naturally durable posts. This regime is a new concept for New Zealand forest growers and is based on NZDFI's tree breeding and research programme.

(Eucalypts are already grown on short rotations in New Zealand and overseas, but these are non-durable species grown predominantly for pulp markets, with the logs being chipped after harvest).

- **Rationale/markets envisaged**

On the optimal sites, durable eucalypts have the capacity for very rapid early growth, combined with good genetics can result in production of durable heartwood at a young age. Our proposed short-rotation regime aims to maximise production of straight peeler length (2.7 m) logs with small branches. These logs will produce two products:

- i. engineered wood products - logs can be processed by rotary peeling to produce high-stiffness veneer that is dried and glued into LVL or plywood.
- ii. preservative-free posts and poles from the 80mm diameter cores produced.

- **Grower considerations**

Grower objectives/benefits

This short rotation regime will be optimised through clonal forestry with the grower planting trees with similar rapid growth and form as well as similar wood properties on sites with high productivity. Forest growers will have minimal silviculture to complete and ground based mechanical harvesting for maximum scale and efficiency.

Plantations will be eligible for the ETS if they meet the usual 'Post '89' forest criteria. The trees will coppice (grow back from the cut stump) after harvest, meaning rapid re-establishment of the canopy, reducing the risk of soil erosion. Alternatively growers may want to kill the coppicing stumps to replace with improved genetics. Other secondary benefits will include pollen and nectar production and planting to improve ground water through nutrient stripping of effluent affected sub surface flow.

Suitable site types

Suitable sites for a peeler pole regime are best if flat to easy slopes that are able to be harvested with smaller feller bunchers that can fell, delimb, debark and cut to length. Sites need good road access and to be located within an economic transport distances to a peeling plant and from there on to markets (or back to the grower).

- **Research and development underway to support this regime**

The main focus of NZDFI's innovative research programme has been to exploit the genetic potential for young eucalypts (less than 15 years old) to produce Class 1 timber making them suitable for in ground durable poles and posts. Therefore, *E. bosistoana* was selected as a Class 1 timber-producing species with proven adaptability to grow well in some of NZ's easier east coast environments. Timber posts sawn from 60-year old NZ grown *E. bosistoana* are providing excellent service in Marlborough vineyards. However, unimproved eucalypts at age 15 may not be produce very durable timber. Hence NZDFI's significant focus on identifying and selecting elite trees that can produce durable wood at a young age

The timber from *E. bosistoana* is very strong with stiffness of 21 GPa reported in Australian sources. Therefore NZDFI are also focused on the potential for peeling young trees to produce high-strength veneer for LVL of 16 GPa or higher for which there is a premium international market. In collaboration with Nelson Pine Industries, a small peeling trial was undertaken in 2018 that demonstrated 15-year old trees can be rotary peeled and dried to produce acceptable veneer. Work is underway to test that it can be glued to produce high stiffness LVL.

NZDFI also has identified the potential for the introduction of spindleless lathes to New Zealand - already demonstrated by Australian researchers to produce log to veneer recovery of 70-80%, peeling trees of similar high density eucalypts. These lathes are also widely used in China to peel veneer for plywood manufacture.

Research feeds into Proseed's propagation programme

By core sampling in extensive breeding populations and wood sampling of two-year-old trees grown in nursery conditions, NZDFI have identified and selected many elite trees that can produce highly stiff and durable heartwood at a young age. Using traditional propagation to capture these trees in the NZDFI tree breeding programme, Proseed NZ Ltd has established a grafted seed orchard with the first improved seed to be available in 2020.

In addition, Proseed have developed techniques to produce clonal plants and in 2018 NZDFI planted over 3000 plants to test their performance on different sites. Clonal plant production offer NZDFI the potential to scale up the production of large numbers of elite nursery stock for landowners to plant that will have good growth and form along with producing highly durable timber.

NZDFI research has also proven that there is also a significant site effect on the production and durability of heartwood. Therefore, careful matching of improved plants to optimal sites will ensure the production of highly durable timber.

NZDFI are also focusing on selecting and cloning trees that are self-pruning. In future, forest growers could plant these trees at final spacing and eliminate the cost of thinning. In addition NZDFI are researching the potential biomass values of the tree's top logs and branches and of foliage for production of pharmaceutical oils.

Harvest operation considerations and future research

The optimal spacing and stocking for this regime needs to take into account the future harvest operation. Rows of trees will need to be spaced so as to provide good access for felling including allowing the potential for production thinning. The initial stocking recommended is 1100 seedlings per hectare.

It could be possible that pruned peeler logs will have a higher value by producing decorative grade veneer. Therefore pruning of a standard log length is 2.7m, a single pruning lift to 3m of 600-800 spha can be undertaken about age 4-5 followed by thinning to waste. A second pruning lift to 6m can then be undertaken to produce a second pruned log.

NZDFI have undertaken a regional case study based on two sites in Marlborough that includes economic modelling to assess the potential for this short rotation regime to produce hardwood for a supply chain.

A1.2 Saw log/peeler log plantation

- **Status**

NZ research and development into eucalypt forestry regimes for the production of saw logs has been undertaken (e.g. by the NZ Forest Research Institute, and then Scion) over several decades, and is relevant and applicable to growing durable species. In addition, there is a wealth of knowledge and experience held by farm foresters who have successfully grown and harvested durable eucalypts on a small scale, and also have sawn them using portable or local sawmills.

Rationale/markets envisaged

NZDFI have identified strong domestic demand and export potential for sawlog products of durable hardwoods, including cross-arms, sleepers, decking and beams, outdoor furniture and landscaping. In addition there are markets for fencing materials and other timbers used in horticulture and viticulture.

Despite this there is no region in New Zealand where sufficient eucalypt forests have been planted to establish a medium scale sawmill producing high quality durable hardwood.

From a log market perspective, in the last ten years, a small value chain has developed for the export of NZ grown eucalypt sawlogs to China. This trade includes export of an unspecified range of eucalypt species typically grown in unmanaged NZ stands that are typically *E. regnans*, *E. fastigata* and *E. nitens*. The exported logs are sawn in China to produce hardwood for constructing heavy duty industrial crates and pallets.

A number of small-scale saw millers already successfully saw eucalypt on portable mills.

- **Grower considerations**

Grower objectives/benefits

A 30 to 40 year sawlog/peeler log regime is obviously a longer-term prospect for growers than the short-rotation option. However, for some growers this type of regime could be of relatively similar duration to a conventional radiata pine regime but with the possible benefit that logs may attract a higher-value at harvest than radiata, durable hardwood for use by the grower, carbon benefits on Post'89 ETS-registered sites, and nectar, pollen and other biodiversity gains.

NZ sawing studies of eucalypts have demonstrated that even with only minimal silviculture other than thinning, eucalypt stands will produce good quality merchantable logs that can yield high grade timber.

Suitable site types

Longer rotation regimes will suit forestry sites on medium to steep hill country where aerial harvesting is necessary and a larger log size reduces harvest cost. For these sites, an initial stocking of 1000 to 1200 spha is recommended. Pruned sawlogs are likely to have a higher value than unpruned logs so a single pruning lift to 3m of 300-400 spha can be undertaken at about age 4-5 years and then a second pruning lift to 6m at around age 6-7 years followed by thinning to waste to produce a pruned log. Sites will need good road access and to be located within an economical transport distances to a peeling plant and sawmill.

- **Research and development to support this regime**

NZDFI's research has demonstrated that on optimal sites, sawlog stands could be clear-felled from age 30 or older to produce high grade pruned butt logs for either sawing or rotary peeling. On very productive sites earlier clear felling at around 25 years could be an option. NZDFI have reviewed the values of imported sawn durable hardwood imports and highlighted the potential margin these values offer for establishing a medium scale regional sawmill to substitute with locally grown timber.

Sawmilling options include a relatively low capital cost highly efficient band sawmill that can work as a portable unit or be set up at a permanent site through to a medium scale *in situ* sawmill and/or rotary peeler and LVL manufacturer to which logs are transported following harvest.

An annual log supply of 2,500 cubic metres would be sufficient for a small band saw mill while 7,500 – 10,000 cubic metres annually would be needed to supply a medium scale mill.

Therefore, even quite a small forest area in any one region could produce a sustainable supply of logs for either a sawmill or rotary peeling mill to be established.

NZDFI have undertaken a regional case study based on two sites in Marlborough that includes economic modelling to assess the potential of this long rotation regime to produce hardwood for a supply chain.

A1.3 Permanent forests

- **Status**

Planted permanent forests will possibly become a feature of very steep (NES-PF) red-zoned) land where harvesting restrictions are imposed.

- **Markets envisaged**

There would be no timber harvested from permanent forests on very steep land.

However, the carbon sequestration rates of permanent eucalypt forests are high - they have higher wood density than pine so can sequester more carbon per cubic metre, and will grow much faster than almost all native species planted on the same site. Eucalypts can live for several centuries. If planted on ETS-registered Post '89 sites there is potential for a long-term carbon income from eucalypts or mixed eucalypt/native forests. For smaller forests (under 100 ha) the sequestration rates are claimed under the current ETS look up tables for hardwoods. For larger forests the forest grower uses regular forest measurement to record sequestration rates.

- **Grower considerations**

Remote areas with low rainfall and areas where there is no existing native forest remnants could be planted in permanent eucalypt forest with one or more durable species. Maximum early carbon sequestration rates can be achieved by planting 800 spha and leaving these to grow. NZDFI have observed old unthinned stands of eucalypts in New Zealand that had been close planted and then left to grow. Overtime these stands develop into a mix of dominant, sub dominant and suppressed trees with some natural mortality.

In areas with high summer rainfall areas (and at least 1200mm per annum) and where there is local native forest remnants that are a seed source, eucalypts could be planted at wide spacing/low stocking (100 - 200 spha) to allow native planting or regeneration, with these native species eventually becoming part of the permanent forest. Whatever the eventual composition of the forest, there will be significant biodiversity/amenity values. There will be little input required by the grower once the trees are established.

There is significant pressure on New Zealand's apiary industry including the need for bee forage to support hives. Durable eucalypts flower prolifically producing high-quality nectar and pollen able to support bees, and hence can contribute to hive health and honey production. Some durable eucalypts flower outside the Mānuka flowering season, and so plantations could be established to complement Mānuka honey enterprises. Many types of *Eucalyptus* honey are sought after in Australia so extensive plantations in New Zealand's east coast will present the opportunity for an additional honey crop.

- **Research and development to support this regime**

NZDFI have undertaken a regional case study based on two sites in Marlborough that includes economic modelling to assess the potential of permanent forest of durable eucalypts to sequester carbon and to compare this to the rates provided in the hardwood ETS tables.

A1.4 Continuous cover forests

- **Status**

Continuous cover forestry (CCF) requires the planting and ongoing management of a forest to allow for selective ground based harvesting within the forest environment. This requires good access so that efficient harvesting is possible of only small coupes (less than 1 ha) or selected trees can be thinned from throughout a stand. Where CCF is common in other parts of the world including in natural eucalypt forests in SE Australia, it is based on forests with a mixed age class and can often include multiple species. However it is rarely practised on a commercial scale in New Zealand except within native beech forests under sustainable harvesting on the West Coast and in Southland.

- **Markets envisaged**

Depending on how the forest was managed, trees with timber potential of all ages could be harvested, so the grower would in theory have the opportunity to provide timber for multiple markets, from peeler poles to larger sawlogs and biofuel.

- **Grower considerations**

CCF regimes could well be suited to small-scale durable eucalypt plantations; woodlots and shelterbelts supported by band saw portable sawmilling. Optimal sites will be flat or easy slopes with good internal access and economic transport options to domestic or export markets for hard wood posts and timber.

CCF systems require on-going management, but in return produce a sustainable supply of timber and non-timber benefits – for example, soil conservation and enhanced water quality, nectar and pollen for bees and other wildlife; shelter and shade for stock, retain amenity values and provide opportunities for recreation.

CCF forests on Post '89 land could also be entered into the Emissions Trading Scheme (ETS) to earn carbon credits while they are growing. In theory, these forests may never incur any carbon liabilities following harvest, because they always retain their 'forest land' status provided that 30% of forest cover is retained and selective harvesting is unlikely to remove more than 50 %. This is unlike forests which are clear-felled.

One option is to plant an even aged stand at 1000 – 1200 spha so a single pruning lift to 3m of 300-400 spha can be undertaken at about age 4-5 years. A second pruning lift to 6m can follow at around age 6-7 years and then thinning to waste. Harvest can commence of individual trees once they reach a certain target diameter for say a peeler log or small saw log and then the stand is progressively production thinned of the larger trees as these develop. Once the stand stocking has been reduced to 100 - 200 spha then small clearfell coupes can be harvested and then allowed to regenerate and/or cleared and replanted.

Another approach could be to leave trees once pruned and thinned to 300-400 spha to grow and not harvest as they can continue to sequester carbon until more than 50 years of age. However, once past about 40 years the growth rates will reduce and sub-dominant trees will be suppressed and start dying. At this stage the forest is reaching maximum total site productivity and the rate of carbon sequestered matches that released by the death of trees.

The forest grower can then subdivide the stand (or an entire forest) can be into small coupes of under 0.5 ha which are harvested over a period of years and allowed to regenerate. This would be most easily done if a forest is planted over a number of years.

The practicalities of this approach will, in most situations, result in harvesting costs being greater per cubic metre. However, on-site portable sawmilling and off farm solid wood sales can add significant value if the forest grower is prepared to become a part time hardwood producer and can develop a sustainable market for a range of timber products.

This opportunity could be developed by use of small scale low capital logging equipment for selective harvesting including the use of 4WD agricultural tractors for log skidding and loading.

- **Research and development to support this regime**

Long term continuous cover management of durable eucalypt forests and portable sawmilling could be a viable basis for regional scale development of a local hardwood industry. NZDFI wants to collaborate with forest growers to develop continuous cover management including research of suitable ground based harvesting options.

APPENDIX 2: Eucalypt establishment and silviculture

A2.1 Establishment and early growth

NZDFI has learned from many years' experience about establishing durable eucalypts on different site types.

Guidelines for growers are available on the NZDFI website nzdfi.org.nz/, and a recipe for establishment success has been developed:

Select site to match species by...

Understanding species and spacing requirements

Clear planting sites by spraying in winter

Control animal pests

Ensure tree stocks are high quality

Spring planting (and fertilising)

Summer releasing.

On new forest sites on farmland, pre-plant spot spraying is recommended 4-6 weeks prior to planting in spring. On cut-over sites (following a radiata pine harvest) preparation requirements include desiccant spraying to kill radiata and weed regeneration, and a withholding period following application of some chemicals.

Fertilising at planting can be beneficial on cut-over and low fertility sites.

Planting stock is likely to be containerised, with current price around \$1.00 - \$2.00 per plant. Price will inevitably vary with supply and demand. Initial stocking rates will depend on choice of growing regime (see Appendix 1).

Research is underway into large-scale clonal propagation of elite plants of NZDFI species. Commercial-scale clonal propagation has driven large-scale planting of other eucalypt species in several countries, and NZDFI is planning to fast-track research and development of genetically improved planting stock and make it available and easy to source by growers from 2020.

Growers can expect 90% survival provided that they have effective weed control, high quality seedlings and good planting technique. Losses can occur if the climate and soil are unsuitable for the species chosen for a particular planting site; or there is poor cultivation or poor handling of nursery stock during establishment, and if timing of planting is wrong.

Despite genetic improvement, some young eucalypt seedlings can develop poor form and will be damaged by insect pests.

A2.2 Silviculture and management

Good weed control is recommended for a minimum of 12 months to ensure high survival and rapid early growth. There are a range of selective chemicals that can be successfully applied.

On farms with domestic stock, sites will need to be fenced for establishment. Animal pest control is needed - particularly of rabbits and hares when trees are young. If goats or deer are present then these need to be controlled and maintained at minimal numbers as they can significantly damage young eucalypt trees.

Where this happens, form pruning (to create a single, straight stem) will be needed to ensure an optimal selection of crop trees.

Once trees are well established and on average are 2 metres tall, then sheep can be grazed within the stand.

However, avoid over grazing and do not allow cattle or horses to graze in eucalypt plantations.

A2.3 Establishing durable eucalypts – financial implications

The costs of establishing a durable eucalypt plantation will vary depending on site type and the forestry regime chosen. If grazing livestock are present, the site must be fenced; thereafter, the cost of establishment will depend mainly on the number of trees planted per hectare, which could range from a relatively low number in a permanent forest with native understorey regime (e.g. 100-200 stems per hectare) up to 1000-1200 stems per hectare for peeler pole and sawlog/peeler log plantations.

The additional main establishment cost is for weed control. Other costs in the first 8-10 years following establishment are (i) form pruning, and (ii) thinning.

All these operations could be undertaken by the grower in smaller-scale plantations, but contractors will be needed for large-scale plantings.

Cost item	Estimated cost exc. GST
Fencing – plantations must be livestock-proof	\$12-\$15/linear meter
Pre-planting spraying – either spot-spraying or helicopter spraying on cut-over sites	Approx. \$150/ha
Seedlings	\$1.00-\$2.00/tree
Planting	\$0.50 - \$0.75/tree
Post-planting release-spraying as necessary	\$250-\$300/ha
Form pruning (if required 600-700 spha sawlog and peeler pole regimes)	\$0.80 - \$1/tree or around \$600-\$700/ha
First 7 second 3m clearwood pruning (200 spha for sawlog regime)	\$0.80 - \$1/tree or around \$600-\$700/ha
Thinning to waste (sawlog and peeler pole regimes)	\$800/ha

A2.4 Grant assistance for planting durable eucalypts

At present (May 2019), growers have the option of applying for various types of financial assistance at planting. The two main sources relevant to durable eucalypts are:

- i. the [Te Uru Rākau One Billion Trees Fund](#), and
- ii. various regional councils' erosion control funding packages.

The best option will depend on individual site factors and the region; however, the funds available are generous and will assist considerably in off-setting establishment costs.

See Section 4.5 for more information.

A2.5 Durable eucalypts, carbon and the Emissions Trading Scheme

Durable eucalypts are eligible to be entered into the [Emissions Trading Scheme](#) (ETS) as long as they are planted on 'Post 1989' forest land, and meet the other standard criteria of the ETS.

Growers of any of NZDFI's proposed regimes will benefit in terms of accruing carbon credits from entering the ETS.

See Section 4.6 for full details.

APPENDIX 3: NZDFI founding partners

Marlborough Research Centre Trust provides NZDFI's governance and administration with Gerald Hope, rse(MRCT's Chief Executive), acting as NZDFI's financial manager. MRCT, a charitable organisation, is a facilitator and seed funder with a track record of over 30 years' involvement in connecting research and business to improve Marlborough's and New Zealand's economy.

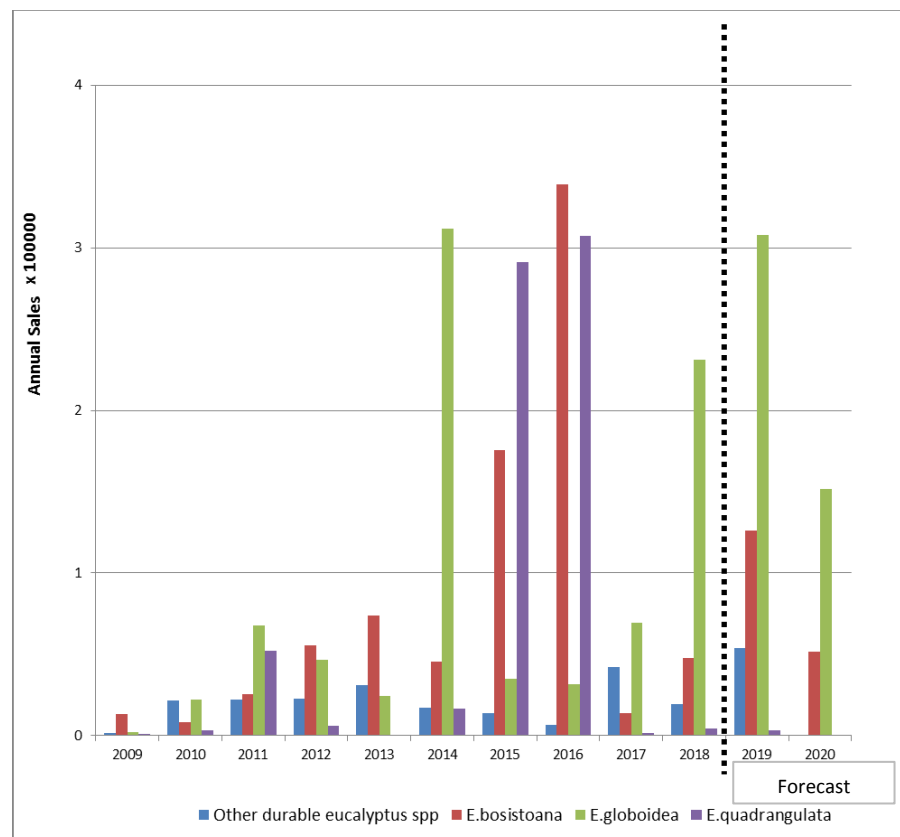
Proseed NZ Ltd CEO, Shaf van Ballekom, chairs NZDFI's management team. Proseed (a Ngāi Tahu subsidiary) is based in Amberley, north Canterbury. With 200 hectares of seed orchards, it is the largest producer of genetically improved forest seed in Australasia.

University of Canterbury Head of the School of Forestry, Professor Bruce Manley, leads UC's experienced science team backed by a cohort of PhD and MSc researchers with the skills necessary to advance NZDFI's vision.

Vineyard Timbers Ltd is a start-up company established by Paul Millen, a Marlborough forestry consultant with expertise in dryland forestry and durable eucalypts, 12 years ago. Paul is now NZDFI's Project Manager. He leads NZDFI work programme and is supported both by NZDFI's landowners who host durable eucalypt trials, and by NZDFI's expanding farmer/industry/regional council network.

APPENDIX 4: NZDFI nursery seedling production survey

Results of the 2019 Speciality Wood Products forestry nursery survey are shown below. The total number of durable eucalypt seedlings sales/forecast sales now totals over 3.2 million trees, of which 153,000 have been planted in NZDFI's breeding and demonstration trials.



Disclaimer: The information shown is based on nursery information supplied. This information is reported as supplied and Buck Forestry Services shall not be liable for any issues relating to accuracy or reliability of data supplied.

APPENDIX 5: Individuals and organisations to be consulted

Central Government

Ministry for Primary Industries

Ministry of Building Innovation and Employment

Regional Councils

Hawkes Bay Regional Council

Greater Wellington Regional Council

Horizons Regional Council

Gisborne District Council

Marlborough Regional Forests (Marlborough District Council)

Tasman District Council

SWP Forest Grower members

Forest Growers Levy Trust

Blakely Pacific

City Forests

Ernslaw One Ltd

Juken NZ Ltd

Lake Taupō and Rotorua Forest Trusts

Marlborough Lines

NZ Farm Forestry Association, National Office
and local branches (Gisborne, Hawkes Bay,
Wairarapa, Marlborough and Nelson).

Proseed NZ Ltd

Southwood Exports Ltd

Te Tumu Paeroa

Timberlands

Other NZDFI supporters

Farm foresters and forest managers who have planted NZDFI trials in east coast regions.

Other sector organisations to be invited to provide feedback include:

Apiculture New Zealand

Eastland Wood Council

Federated Farmers

Hawkes Bay Forestry Group

Landcorp Farming Ltd

Marlborough Forest Industry Association

Ngati Porou Forests Ltd

NZ Institute of Forestry

Organic Winegrowers NZ

Organics Aotearoa NZ

Sustainable Winegrowers New Zealand

APPENDIX 6: Contacts for more information

The NZDFI has a comprehensive website: www.nzdfi.org.nz

For any further information, please contact Paul Millen, NZDFI Project Manager

p.millen@xtra.co.nz; 03 574 1001; 021 662 147

APPENDIX 7: Regional strategy: development process

Activity	Completion date
Draft a consultation paper and circulate to seek feedback from the individuals, organisations and companies listed in Appendix 4 .	Completed
Establish a working group to guide plan development. The role of members will be to engage with representatives of the people and organisations that will be supporting implementation of the strategic plan.	Completed
Prepare a proposal for an initial regional feasibility study. This will include developing an economic model to evaluate a high-stiffness durable eucalypt LVL regional value chain. Circulate proposal to working group for further feedback.	
Complete feasibility study for LVL regional value chain including a preliminary economic model; assessment of capital and infrastructure requirements; and environmental management requirements. Report outcome of feasibility study to working group.	31 st May 2019
Extend work to an economic evaluation of potential value chains in other regions. Prepare recommendations on optimal size and area for forest establishment. Develop annual planting targets to establish a sustainable harvest of durable eucalypt logs able to supply each value chain. Circulate to working group for feedback.	30 th June 2019
Review feedback and complete strategic plan with recommendations for collaborative action to commence regional scale planting programmes. Circulate plan to working group. Plan an extension programme and timetable to promote and implement strategic plan.	30 th September 2019
Implementation of regional strategic plan and extension programme.	Commence October 2019