NZ DRYLAND FOREST INITIATIVE

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NZ DRYLAND FORESTS INITIATIVE: A MARKET FOCUSED DURABLE EUCALYPT R&D PROJECT

1. INTRODUCTION

New Zealand is the only Southern Hemisphere country that is reliant principally on pine plantations for its forest resource. However, pine timber has proven to lack the wood properties required for high strength and high value uses, and for many structural applications it requires chemical treatment to ensure durability.

For year ended June 2008, New Zealand imported 28,000 m^3 of sawn hardwood timber and sleepers for a cost of over $31 million, while a further $241 million was spent on importing wooden furniture (MAF, 2008), with a significant component of this likely to made from tropical hardwood.

Internationally, while the trade in tropical hardwoods is unsustainable, demand continues unabated for valuable threatened timbers. Total production of tropical roundwood (logs) in ITTO producer countries totalled over 137 million m^3 in 2006 (UNCDA, 2009). Much of this cut is from unsustainably managed tropical rain forests, some of which is likely to have been logged illegally. However, many consumers, both in New Zealand and in our international markets, are demanding traceability on the products they purchase, including timber.

Political pressure for the NZ government to do something about this was reported last year when New Zealand came under international pressure to stop importing kwila/merbau (*Intsia sp.*) because of concerns about the illegal logging of forests in Indonesian-controlled West Papua and in Papua New Guinea. The then Minister of Agricuture and Forestry, Hon. Jim Anderton, agreed in principle that all kwila imports should carry a label stating whether the supplier can verify the wood is legally sourced. This resulted in a number of large hardware chain stores announcing they would stop selling kwila when existing stocks run out (NZ Herald 18/8/08). Ironically, later in the year, OnTrack admitted they were purchasing greenheart (*Ocotea rodiaei*) sleepers for their rail network upgrade cut from South American rain forests.

Consumer demand for organic food is increasing in some of New Zealand's international markets. However, organic wine and fruit growers are being required to look beyond the continued use of CCA-treated posts, due to the United States' USDA National Organic Programme (NOP) shunning treated posts for new installation or replacement purposes. New Zealand's organic exports to the US are currently reported by BioGro New Zealand to be worth $40 million (pers comm. Seagar Mason, Technical Director, BioGro NZ), so alternative posts are needed.

A select group of eucalypt timbers are renown for their colour, natural durability and strength. Historically, these were cut from native Australian old-growth forests,

to supply both domestic and offshore markets, including New Zealand. Unsustainable harvesting of the most desirable eucalypts lead to many of them being logged to exhaustion. Although large areas of old-growth remain, many of these now have high biodiversity values and have been set aside as conservation reserves. Consequently, few forests remain for logging to supply the traditional markets for highly durable timber and this scarcity has ensured high price rises. (Grealy, 2008)

While there are large areas of eucalypt plantations in several states of Australia, much of this is *E. globulus* for chip export. Although, since 1997, there has been a new focus on establishing plantations of high quality eucalypts for sawn timber to supply domestic Australian markets given that traditional supplies, once logged from old-growth forests, are now greatly depleted (Bacon, 2007).

Equally, New Zealand forest growers have the opportunity to develop fully eco-certified eucalypt plantations to produce high value hardwood for our domestic market, the Australian market, and many other international timber markets currently buying tropical and Australian hardwoods.

Durable eucalypt forests can offer other benefits beyond wood production.

One of the predicted impacts of climate change is an increase in number and severity of droughts. New Zealand's drylands are in the eastern regions, from Gisborne to Otago. Landowners in these drylands (600-800 mm annual rainfall) face the prospect of increasingly droughty conditions and need new, sustainable land use options to complement pastoral farming and to prevent erosion. Eucalypts are renown for their adaptability to droughty and eroding landscapes.

As an aside, plantation eucalypts with high wood densities and fast growth rates will sequester carbon more rapidly than radiata pine, while their high calorific values mean that forest/wood residues have value for co-generation or biofuel.

2. THE NEW ZEALAND DRYLAND FOREST INITIATIVE (NZDFI)

The NZDFI is a collaborative cross-sector research and development project to investigate and promote the establishment of genetically-improved naturally-durable eucalypts in plantations and woodlots on drought prone and erodible pastoral land within New Zealand. The work of the NZDFI is based in Marlborough and Canterbury. These are two of New Zealand's drier regions.

Members of the NZDFI include the Marlborough Research Centre Trust, Marlborough District Council, New Zealand School of Forestry (University of Canterbury), Marlborough Lines, Vineyard Timbers Ltd, Proseed NZ Ltd and three rural landowners.

Additional funding comes from AGMARDT (Agricultural and Marketing Research and Development Trust), the Neil Barr Farm Forestry Foundation, and other interest groups including Marlborough Tree Growers Association, NZ Farm Forestry Association's Eucalypt Action Group, and NZ Winegrowers.

3. EARLY NEW ZEALAND INTEREST IN DURABLE EUCALYPTS

Neil Barr's *Growing Eucalypt Trees for Timber milling on New Zealand Farms (*1996) provides a colourful history from the early period following European

settlement to more recent times. For much of our history there has been little focus on naturally durable species, despite the over-cutting of durable native timbers, particularly totara. Much of interest was curtailed by the advent of CCA treatment of pine during the 1950s.

Barr (1996) recommended planting three well-proven durable stringybark species (*E. pilularis, E. muelleriana* and *E. globoidea*) that he and others had grown both for untreated naturally durable posts and poles, and for high quality durable sawn timber. Neil Barr died in January 1996, leaving both 'a legend' and 'a legacy' in having founded the New Zealand Farm Forestry Association (Various, 1996).

In 1970, as part of erosion control trials undertaken by the Ministry of Works and Development Plant Division, John Sheppard planted eucalypt trials in one of New Zealand's driest environments, the Wither Hills, a name now synonymous with the internationally renowned Marlborough sauvignon blanc that is grown in this area. Sheppard established three trials to investigate early survival and growth of ten dryland eucalypts. By 1988, he concluded that *E. bosistoana* and *E. camaldulensis* were the best species overall (Sheppard, 1988). These species are both durable species and of special interest to the NZDFI project.

In 1975 the newly established hardwood research unit of the Forest Research Institute released its Special Purpose Species policy. This unit promoted for further research species that were either from the non-durable ash group (class 4) or *E. saligna* and *E. botryoides* (only moderately durable class 3 species). No very durable or durable (class one or two) species were included.

4. RECENT NEW ZEALAND INVESTMENT AND RESEARCH ON DURABLE EUCALYPTS

4.1. Growing eucalypts

In 1991 the Special Purpose Species group of the NZ Forest Research Institute moved to include naturally durable species in its programme (McKenzie, 1993). The group recognised that international concern over the depletion of tropical rainforests would affect consumer choice and that plantation-grown durable eucalypts could be substituted in these markets. They also recognised that while there had been a long history of introductions and planting by pioneering farm foresters, little attention in research and investment had been paid to evaluating the growth of these species, identifying the best seed sources, site requirements and to test spacing regimes. Eight species were identified for evaluation including four durable eucalypt species (*E. pilularis, E. muelleriana, E. globoidea, E. microcorys*). Existing stands were surveyed to help develop genetic and silvicultural trials. In 1994, *E. muelleriana* was planted into two provenance trials in Northland and the Bay of Plenty. These are the only breeding trials of a durable eucalypt species in New Zealand.

In 2003, Scion planted a set of research trials to test the performance of 12 species from the stringybark group (*E. agglomerata, E. baxterii, E. blaxandii, E. calignosa, E. cameronii, E. eugenoides, E. globoidea, E. laevopinea, E. macroryhncha, E. muelleriana, E. tenella* and *E. youmannii*). A further three

durable species were included, *Corymbia maculata, E. microcorys and E. pilularis*. This research was focused on testing both a wider selection of durable species for survival and early growth. These trials were planted into ten sites in 2003, nine in North Island sites and one in the South Island at Marlborough. In 2008, the best overall performing class 1 or 2 durable species across these sites was assessed as *E. globoidea* (McConnochie *et al.,* 2008).

Linked to this work was the establishment in 2004 of over 40 small trials throughout many regions of New Zealand to test the survival and early growth of 14 eucalypt species, mainly stringybarks and a small number of other durable species. This work was lead by the Eucalypt Action Group of the NZ Farm Forestry Association, with support from Scion. Gordon *et al.,* (2007) provides useful information on the site requirements for their successful establishment.

Also 2003 and 2006 Paul Millen established over 80 small research trials of 25 durable eucalypt species in a joint venture between Vineyard Timbers, the Marlborough District Council and Proseed NZ Ltd. These provided the foundation for the NZDFI project to develop. Species selected included several of the stringybark species planted in the Scion and NZFFA EAG trials, as well as nine class 1 durable species. These were *E. bosistoana, E. cladocalyx, E. longifolia, E. melliodora, E. microcarpa, E. moluccana, E. quadrangulata, E. tereticornis* and *E. wandoo*. In addition, *E. camaldulensis* a class 2 durable species was also included. These species were selected for their potential to produce very durable timber and the trials were planted on a range of sites. While not formerly evaluated, these were monitored for survival and growth rates and in July 2007, at a workshop held at the Marlborough Research Centre, Millen reported on the potential of *Eucalyptus bosistoana, E. camaldulensis, E. globoidea, E. macroryncha* and *E. quadrangulata* as durable species suitably adapted to be grown for durable timber posts in the diversity of soils and climate found across NZ drylands.

4.2. Processing eucalypts

In the mid 1990s, the Davies-Colley family set up a specialist mill in Whangarei to saw durable and high quality eucalypts, utilizing the small resource of maturing farm woodlots in the Northland region. They produce high quality durable timber products, but because there are insufficient plantations of mature eucalypts they cannot satisfy demand in existing domestic markets.

Given the dearth of specialist eucalypt mills in New Zealand, it is hardly surprising that only 0.6% (2,575 m^3) of the 4.3 million m^3 of sawn timber cut in 2008 is NZ grown eucalypt (MAF, 2008). Only a very small percentage of the eucalypt is likely to be naturally durable.

Recent research by Scion included a sawing and drying study of 25 yr-old *E. globoidea, E. muelleriana and E. pilularis. E. fastigata* to determine if these species could produce high-quality timber on shorter rotations. While this study confirmed these species could offer shorter rotations, early pruning was needed to ensure the butt log produced a high proportion of visual and machine stress grades for high value appearance and structural applications (Jones *et al*., 2008).

Sawing techniques have also been developed by Dean Satchell in Northland for milling very young (15-18 years) durable species using the specialised Woodmizer portable band saw.

In-ground durability of eucalypts and other species is assessed by leaving small timber samples for many years in 'graveyard' field tests and observing decay and failure. The results of such work in New Zealand was summarised by Page *et al.* (1997). *E. cladocalyx* and *E. cornuta* were the only class 1 species, while *E. amygdalina, E. botryoides, E. globoidea, E. muelleriana, E. pilularis, E. saligna, E. microcorys* and *E. radiata* were placed in class 2. The classification of *E. botryoides, E. muelleriana,* and *E. saligna* is higher than that assessed in Australia for the same species, while *E. microcorys* was assessed as a class 2 durable whereas it is class 1 in Australia. (Standards Australia, 2003).

5. RECENT AUSTRALIAN RESEARCH TO DEVELOP DRYLAND DURABLE EUCALYPT PLANTATIONS

The Australian Low Rainfall Tree Improvement Group (ALRTIG) was established in 1999 to improve a number of species that are adapted to southern Australia's low rainfall areas (400-750 mm/year) and so provide options for farm diversification. ALRTIG is a cooperative involving State and Federal organisations including CSIRO and Forests NSW. ALRTIG's focus is to develop short rotation tree crops for essential oils (fragrances), fibre, energy, carbon credits and to remediate saline lands as well as for long-rotation timber production. Within this broad programme five dryland durable eucalypts, *E. camaldulensis, E. cladocalyx, E. occidentalis* and *E. sideroxylon/E. tricarpa*, as well as *Corymbia maculata/ C. citriodora* were planted in large scale breeding trials in 2001 (Harwood *et al*., 2005).

Australia has a wine industry almost ten times the size of New Zealands. One study by ALRTIG evaluated the potential of 8 yr-old posts of *E. cladocalyx* and *E. occidentalis* as naturally durable substitutes for CCA-treated pine posts (Bush, 2006). Examination for early heartwood formation and durablity was by way of core samples using accelerated testing in CSIRO's fungal cellar in Melbourne. Results showed that some wild families within *E. cladocalyx* developed early heartwood while other families had little heartwood. Furthermore, durability of the heartwood was variable, with some heartwood samples rating up to class 1 while others were less durable. Thereby, they established that these critical traits are very likely to be heritable and that they can be improved within a tree breeding programme.

Forests NSW, a member of the ALRTIG, started their own durable eucalypt breeding programme in 2004/05. They included *E. argopholia* which is also included in the NZDFI project. Proseed NZ Ltd. is the principal supplier of genetically improved pine seed to FNSW and through this relationship they have collaborated in the collection of *E. bosistoana* seed.

A significant recent a cross-sector conference *Plantation Eucalypts for High Value Timber* (Brown and Beadle, 2008) brought together 130 growers, managers, processors, investors, policy makers and researchers to review their collective work on developing plantation eucalypts to produce high value timber.

6. THE NZ DRYLAND FORESTS INITIATIVE (NZDFI) STRATEGY

The NZDFI's strategy is to become a world leader in the breeding and management of elite plantation eucalypts that produce high quality naturally-durable wood. The NZDFI is committed to working with farm foresters, forest growers, industry groups and local government to promote the option of growing durable eucalypts, especially in NZ drylands to provide income diversification and to mitigate climate change.

Early research emphasis by NZDFI members has been focused on Marlborough, including finding mature on-farm plantings and former trials as well as establishing new trials of those highly durable species that might or might not flourish in different climatic regions of Marlborough, as the region offers a diversity of climatic and geological sub-regions.

One of these sub-regions is South Marlborough, located between Blenheim and Kekerengu. This area is strongly influenced by its location, with mountains to the north, south and west that effectively create a rain shadow making it one of the driest in the country (Figure 1).

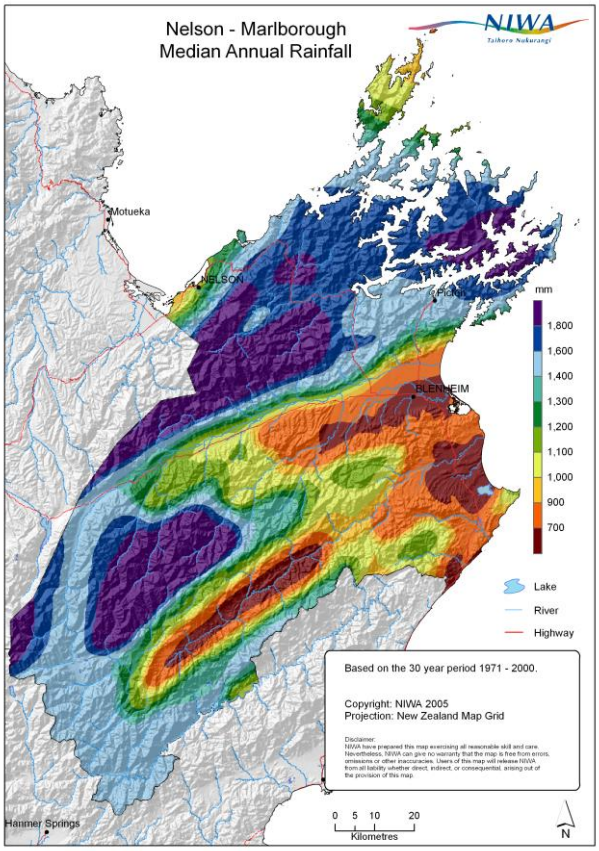


Figure 1. Marlborough Annual Rainfall. Source NIWA, National Climate Centre, Wellington.

South Marlborough has high sunshine hours and mild winters with only occasional light frosts on the coastal hills and heavier more frequent frosts inland. Snowfall is rare. However, South Marlborough is exposed to northwest and westerly winds throughout spring and early summer. These winds combine with a rainfall deficit throughout the dry summer months to result in a long history of drought, with the period from 1997 to 2007 being the driest decade on record. Average rainfall for the last ten-year period in much of South Marlborough has been less than 600mm per annum, which is 15 percent lower than the long-term average. The first two trials will be planted on two South Marlborough private farm properties in spring 2009.

A third trial site is being sought in North Canterbury for the NZDFI project. This is planned to complement the two trial sites in South Marlborough. North Canterbury is not quite as dry but is colder with occasional snowfall in winter. This site will provide opportunities for students at the School of Forestry to be involved in the NZDFI research programme.

These three trials will provide the foundation for a long term tree breeding and improvement programme for up to six class 1 and 2 durable species. Alongside these will be sivicultural trials to develop management and silviculture strategies to maximise production of straight uniform posts with well developed early heartwood.

In summary, the first stage of this research will be to complete individual tree selection within the breeding trials for the key traits required to produce an intermediate short term crop of durable posts and poles, to be followed later by research to develop larger pole wood and sawlog regimes using a "coppice-and-standard" system and to develop suitable harvesting and processing.

7. WHY GROW DURABLE EUCALYPT POSTS FOR VINEYARDS?

Vineyards are dominated by copper-chrome-arsenate (CCA) treated radiata pine posts that also have low strength and therefore suffer premature breakage. In the medium term, up to 900,000 replacement posts could be required annually at a cost of $40 per post installed, i.e. $36 million pa, which is approx 3% of the value of all NZ wine exports. Broken posts have the potential to generate up to 24,000 m^3/yr of hazardous waste for which there are no acceptable disposal facilities other than secure landfills. Landfill costs in Marlborough are $21/$m^3$.

In the early 2000s, concern mounted in Marlborough regarding the potential for arsenic leachate from CCA treated pine posts to contaminate the groundwater within the Rarangi area in the lower Wairau Valley. Local newspaper reports resulted in very negative feedback from international wine markets about NZ's wine production and the negative effect this story had on it's clean and green marketing image.

Consequently, the NZDFI project is focused on growing durable eucalypts to produce a profitable early cash flow within 8 to 10 years from a low-risk product, of untreated (CCA-free) posts and poles for New Zealand's vineyards and other agricultural industries. Further, if woodlots of strong and durable eucalypts are grown close to vineyards, the cost and energy required from tree-to-post will be minimal and there will be no hazardous waste.

This is a low risk investment because the many wood properties that are critical for sawlog production can be deferred – poor drying, checking, collapse, growth

stresses. The latter difficulties can be addressed later once the species have already established roundwood markets.

The successful planting and use of naturally durable eucalypts for posts will contribute to the "sustainability" image of NZ's vineyards and other horticultural industries and help retain the credibility and recognition of New Zealand's clean green brand in our international markets.

8. SEED COLLECTION OF DURABLE EUCALYPT SPECIES FOR NZDFI

The NZDFI has selected the most promising species from the Marlborough trials for the breeding trials in Marlborough and Canterbury. All species are highly prized naturally durable eucalypts. In some cases they have been logged to exhaustion from Australian commercial natural forests, with remnant old growth stands now found only found in national parks, public reserves or on private land. For most of these species, seed collection is being undertaken from wild populations. For one species, there is genetically improved seed and plant material available from Australia and other countries that will be purchased and introduced to the NZDFI programme.

As trees are very variable in their wild state, and because natural selection operates on extremes - out of season frosts rather than mean annual temperatures, for example – where possible, seed collections need to be made across a wide range of wild families in different areas. Therefore seed collection sites extend across Queensland, NSW and Victoria, in order to sample across a wide climatic range, soil types etc (Jovanovic and Booth, 2002). In addition, for some species, there are mature stands of trees established at several farm sites in New Zealand from where seed may be collected, if landowner access is agreed.

The six species selected for trial establishment are *E. bosistoana, E. argopholia, E. camadulensis, E. quadrangulata, E. macrorhyncha* and *E. globoidea*.

8.1. Eucalyptus bosistoana (Coast Grey Box)

Natural Range – Coastal Victoria/NSW

E. bosistoana is found in coastal areas of eastern Victoria and up into NSW, just south of Sydney in areas with mean annual rainfall of 700-1200 mm per year. It is

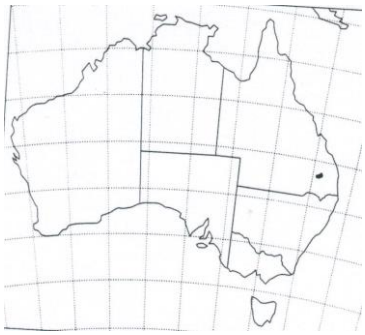
the largest of the box group being a tall straight stemmed tree with small rounded crown. The species grows well on fertile soils, preferably over limestone. It can survive both periodic waterlogged soils and periods of drought. It can withstand up to 40 frosts per year.

It is a very good class 1 durable species producing timber with pale brown/pink sapwood with darker heartwood – with fine, even-texture and interlocked grain. It has very high density (1100 kg/m^3) and is therefore heavy and moderately difficult to work. It was historically used for poles, sleepers and fences in Australia. The species was almost cut to exhaustion in the 1920s because of its high durability and stability.

The species does not yet feature in any Australian tree breeding programme, so there are no opportunities to source improved material. Therefore, Proseed NZ Ltd., with the help of Forests NSW, has collected seed from 55 wild families in Australia and purchased a further 20 families from CSIRO's Canberra Seed Store. This seed has been generously donated to the programme by Proseed. There are also a few mature stands of *E. bosistoana* planted in New Zealand that have been reported by Scion (Nicholas, 2007) and Proseed intends to make seed collections this year from sites where landowners will grant access.

8.2. Eucalyptus argophloia (Western White Gum)

Natural Range – Southern Queensland



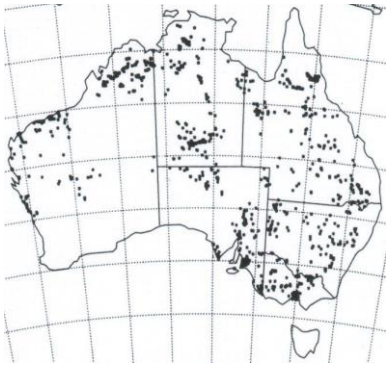
E. argophloia is only found naturally in one small area of southern Queensland, northeast of Chinchilla. Mean annual rainfall is 700 mm per year with up to 10-15 frosts occuring each year. It is a medium-sized to tall tree, generally of excellent form, attaining 40 m in height and 1 m dbh. Very little natural forest remains due to conversion to cropping and pasture in the 19th century. Despite its restricted distribution, the species can grow on a wide range of sites including those with heavy soils. Early growth is slow, but picks up later in the rotation. The species is regarded by Queensland foresters as a good, long-term performer. The wood is a deep-red colour, hard and durable, and is reputed to have high basic density.

It is classed as a nationally threatened species and is protected under the Queensland Conservation Act, so seed collections are increasingly difficult to undertake (Michael Henson pers comm.). Forests NSW established a seed stand of

this species in 2004. The species has not been tested in the early NZDFI trials, but it is closely related to *E. bosistoana* and offers the opportunity to develop hybrids with *E. bosistoana* that have a broader site/climatic range while exhibiting greater vigour, and enhanced wood properties such as intense colour and durability. Therefore a seed collection of 20 families of *E. argopholia* has been purchased from Queensland DPI by Proseed NZ ltd and donated to the NZDFI project.

8.3. Eucalyptus camaldulensis (Red River Gum)

Natural Range – Throughout Australia

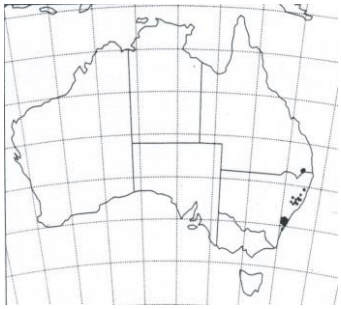


E. camaldulensis grows in many inland arid areas of Australia much of it along the river margins and waterways. Here rainfall ranges from 300 - 600mm per year with up to 20 frosts per year. It can develop into medium to tall tree with a large bole, up to 2 m dbh and sometimes larger. It has an open crown and often poor stem form. *E. camaldulensis* is also grown extensively around the world in arid and semi-arid areas. Tree breeding programmes in WA, NSW and Chile include this species. It has been extensively tested in Israel, South Africa and Mediterranean parts of Europe. Thus this species offers the best opportunity for sourcing improved material. This is a class 2 durable species whose mature wood typically has basic density values of 900-1000 kg/m^3. The wood is red with a fine texture and interlocked wavy grain. It is hard, durable and resistant to termites.

Proseed has investigated the breeding work reported on this species and established there is differentiation between a northern (summer rainfall) and southern form (winter rainfall) of this species. NZDFI will focus on obtaining collections from the southern provenances, in particular Lake Albacutya in Victoria. This has proved to be the best provenance in tests in the winter rainfall zones in Australia, California and the Mediterranean. In Australia, seedlings from the southern provenances are recorded as surviving winter frosts of -7º to -10º C and the species has superior drought tolerance.

8.4. Eucalyptus quadrangulata (White-Topped Box)

Natural Range – New South Wales and Southern Queensland



E. quadrangulata is a tall tree with good form in forest situations that is found on the better soils of the coast and adjacent ranges in New South Wales and southern Queensland. It occurs in the tablelands of central and northern NSW, where mean annual rainfall is 900-1700 mm per year. It grows best on moderately heavy soils and can withstand up to 50 frosts per year. It produces a Class 1-2 durable timber with light yellow brown heartwood and fine texture. It is very hard and heavy, also very stable and highly decay resistant. A NZ standard for hardwood use also identifies timber from this species as suitable for use in crossarms. (Standards Association of New Zealand, 1969).

While the distribution is somewhat restricted, there is considerable variation between provenances. Forests NSW have evaluated *E. quadrangulata* for its suitability as a plantation species. It showed good growth and survival after three years and also ranked well for health and form. The species does not yet feature in any Australian tree breeding programme, so there are no opportunities to source any improved material. Therefore, Proseed NZ Ltd with the help of Forests NSW plan to collect seed from wild populations in New South Wales.

8.5. Eucalyptus globoidea (White Stringybark)

Natural Range – Central NSW and Coastal Victoria/NSW

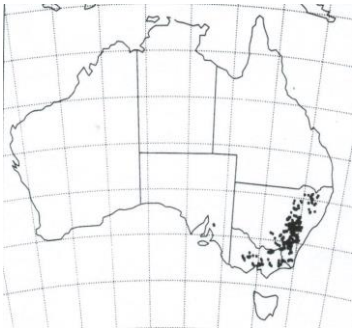
E. globoidea occupies much of the same coastal range as *E. bosistoana* along eastern Victoria and southern NSW. It is a medium sized stringybark, being tall and

straight stemmed, with an open rounded crown. The mean annual rainfall is 650-1400 mm per year. It will grow on a wide range of soils including sand, gravelly loams and clays. It can survive periods of drought and up to 40 frosts per year

E. globoidea produces a class 2 durable hardwood with densities around 900 kg/m^3 in mature trees. There are small mature plantings of *E. globoidea* throughout the North Island, Marlborough and a well known stand at Banks Peninsula. Northern South Island and NZ plantation material is reported to have sawn well with densities ranging from 527 to 623 kg/m^3 with MOEs of around 14 GPA. There is a small breeding programme in NSW, so some selected provenances maybe purchased, although Proseed plan wild collections from within NSW and Victoria. There are also a reasonable number of mature stands of *E. globoidea* planted in New Zealand and the NZDFI plans to seek landowner support for the collection of seed from NZ stands for inclusion in the trials for this species.

8.6. Eucalyptus macrorhyncha (Red Stringybark)

Natural Range – Foothills of Victoria, the Southern Highlands and Northern Tablelands of NSW.



E. macrorhyncha mainly occurs along the western slopes of the Great Dividing Range throughout NSW and Victoria at altitudes between 150-1000m. It is a medium sized stringybark that is stout and straight stemmed with an open rounded crown. The mean annual rainfall is 500-1000 mm per year. It tends to occupy ridges and dry slopes and grows best on well drained moderately fertile soils including clay loams. It may withstand up to 70 frosts per year and occasional snow. Although it is generally a short tree, it is known for its good form, particularly in the lower 1/3-2/3rds of the bole. It saws well producing straight grained even textured reddish brown heartwood that is heavy and finishes well. The Australian rating for durability is class 2-3, i.e. moderately durable. The wood is a pink brown-red colour with densities of 575-775 kg/m^3 recorded from Australian plantations. This species also does not yet feature in any Australian tree breeding programme, so there are no opportunities for NZDFI to source improved material. Therefore, seed for trials of this species will be collected from wild populations in NSW and Victoria.

9. NZDFI BREEDING TRIAL DESIGN AND ESTABLISMENT

A distinctive feature of the NZDFI breeding programme is the very early and intensive selection for roundwood. Therefore, the trials are planned to be large enough to capture a broad range of genetic diversity from which to select for the four key traits that the breeding programme will initially focus on. These are fast growth, good form, early heartwood formation and ability to coppice.

The NZDFI trial sites have also been selected to cover a range of abiotic (cold, drought, soils etc) and biotic (pests, diseases) stress factors likely to be found in Marlborough and Canterbury drylands. This de-risks the project against the unknown relative contributions of genetic and environmental effects on disease, growth and early heartwood formation and ensures that a broad-based elite selection is possible.

In addition, the breeding trials are planned to provide the potential to follow overseas initiatives in developing inter-specific hybrids. Thus the breeding strategy is based on establishing these species in pairs, because inter-species breeding is possible within sub-species.

Therefore, the sequence of trials will be *E. bosistoana* and *E argopholia; E. camadulensis* and *E. quadrangulata*; and *E. macrorhyncha* and *E. globoidea.* NZDFI is committed to this strategy so as to improve growth, form and productivity by capturing hybrid vigour and broaden the diversity of sites durable species can be grown. It may also reduce the potential impact of diseases and pests while offering the prospect to greatly improve the aesthetics and properties of the timber.

On this basis over the next three years the NZDFI have funding to plant the first stage of breeding trials with *E. bosistoana* and *E. argophloia.*

These two species are very closely related their combination in trials will broaden and diversify the pool of genetic material that is used to select for an elite breeding population.

The other four species, *E. camadulensis* and *E. quadrangulata,* and *E. macrorhyncha* and *E. globoidea*, will be introduced as pairs into the programme once further industry and government funding has been secured.

Seedlings for planting the first stage of the trials are being grown by Morgans Road Nursery in Marlborough under contract to the Marlborough Research Centre. In spring 2009, 18,000 will be planted into three replicate breeding trials of 6,000 trees at the three trial sites. The trials will be established on private properties with Forestry Rights Agreements agreed between the Marlborough Research Centre Trust (on behalf of the NZ Dryland Forest Initiative) and the landowners.

There are two stages planned for screening of genetic traits. Early screening at age 3-5 will be for growth, form and early onset of heartwood aimed at selecting trees to produce seed that will grow into uniform trees suited for use as durable posts. This will provide growers greater certainty of crop value at 8 years. Our second screening (8-10 years hence) will be for traits critical to timber – colour, collapse, growth stresses, ease of drying, shrinkage and stability. Conceptually, the breeding programme could stop at stage one (durable poles) and still be successful.

9. THE NZDFI BRAND

The NZDFI members see this project as a transformational opportunity for forest growers and farm foresters. They know that for landowners to plant new forests requires a long term vision and commitment. Therefore, they want the project to be recognised as being about breeding trees with a positive project identity and logo supported with a by line that has been designed by Lloyd Graphics of Blenheim.

Figure 1. The NZDFI logo with the byline: 'Breeding tomorrow's trees today.'

The logo uses a stylised eucalypt leaf that curves downward forming a letter 'd' within the initials of the brand. This is a simple reference to the trees that flows and conveys a sense of action and movement. The green colour is selected as being that of the leaves of *E. bosistoana*. The heavy font, with the ends slightly rounded, hints at these being posts, the production of which is one of the major objectives of the project.

Beyond the NZDFI logo and byline, members want to add long term value to the breeding trials that will contribute to sustaining an ongoing research programme on durable hardwoods. Therefore, on behalf of the NZDFI, the Marlborough Research Centre Trust (MRCT), with financial support from the Neil Barr Farm Forestry Association, are developing a trademark that will be used in the future to brand and market genetically-improved durable eucalypt germplasm.

Branding will assist the NZDFI in promoting the establishment of durable hardwood forests and provide MRCT the basis to licence the commercial marketing, distribution and sale of the germplasm by members of the initiative and others in the forestry sector. The trademark can then be used for the sale of seed or cuttings for the species that are improved under the NZDFI project. The brand will provide future forest growers with quality assurance that seedlings they buy are propagated from the NZDFI breeding programme. MRCT will require payment of a royalty on the sale of eucalypt seedlings by commercial nurseries that propagate and sell NZDFI improved durable eucalypt seedlings. The royalties collected will provide for a direct contribution to ongoing research and improvement by the NZDFI project.

10. SUMMARY

The New Zealand Dryland Forests Initiative is a bold initiative.

Members want this project to provide the foundation for New Zealand to become a world leader in growing eco certified naturally durable hardwood forests.

This initiative is timely - new research and investment is needed to diversify the forestry sector. Investing in growing durable forests in NZ drylands is an alternative land use that will improve the sustainability of NZ's wine industry by growing naturally durable posts. These new forests will sequester carbon and assist in mitigating climate change.

In the long term, this initiative's vision is to have New Zealand durable eucalypt forests established that can supply high quality hardwood to replace the domestic trade in tropical hardwoods, and that this timber become a valuable export, traded internationally for high prices due to its desirable wood properties and market scarcity.

11. ACKNOWLEDGEMENTS

A grant from the Neil Barr Trust allowed the author to attend this workshop. This is gratefully acknowledged.

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13. APPENDIX

Natural Durability Classes (Standards Australia, 2003. Revised 2005. AS 5604 – *Timber-Natural durability ratings*.)

16.1. Definitions

- Natural durability is defined as the inherent resistance of a specific timber to decay and to insect attack.
- Natural Durability Classes provide the basis for rating the timber's performance and longevity in contact with the ground when exposed to average environmental conditions.

The classification system is based on the average life expectancy (in years) for any timber species, as shown in the Table 1.

Table 1. Natural durability – probable life expectancy.

Class	Probable in-ground life expectancy (years)	Probable above-ground life expectancy (years)
1	> 25	> 40
2	15 - 25	15 - 40
3	5 - 15	7 - 15
4	0 - 7	0 - 7

Using these classifications to rate the timber of different tree species cannot be done with great precision because of the variability of wood properties within species and the wide variety of ground conditions in which it may be used.

Therefore the classifications are a guide with the actual life dependent on the local ground conditions and other factors that include the following.

- These classifications only apply to heartwood with all sapwood having poor resistance to decay and insect attack.
- The inner core of heartwood around the pith, generally has lower durability than the rest of the heartwood.
- Durability is also influenced by the size or diameter of the post i.e. the larger the piece size the longer is will last.
- The age of the tree used to cut the timber also generally influences natural durability with mature trees producing more durable timber than semi mature trees.

15. AFFILIATIONS

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