

Douglas-fir - the current New Zealand scene

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Even though it represents only 6% of the planted estate in New Zealand, Douglas-fir remains the second most important plantation species. The area in Douglas-fir has almost doubled in the last 15 years, from 65,000ha to 109,000ha, as shown by the age class distribution in Fig. 1. After reaching a peak of almost 9,000 ha of new planting in the late 1990s, the annual area of new planting for the species has dropped to about 3,800 ha in 2004. The majority of this new planting has been on inland sites in the southern half of the South Island – in 2004 over 70% of the planting stock was produced in Otago/Southland. Sawn timber production (which includes exports to Australia) has averaged about 150,000m³/year for the past 14 years (Fig. 2).

Advantages and disadvantages

Douglas-fir timber has both advantages and disadvantages over radiata pine. In its favour are its good stability on drying, less variable wood properties, and greater stiffness. This, combined with its better juvenile (corewood) properties, means that framing timber can be cut from small logs, including thinnings. It also has inherent natural durability above ground and lower moisture content, allowing its use in most building construction with no treatment, and with minimal seasoning after milling. From a silvicultural point of view, it is a low-input species requiring no pruning provided the branches are kept below 40 mm in diameter. Its ready acceptance on the international market is very important for its commercial viability. For more than a century it has accounted for a large proportion of world-wide trade in softwood timber, with a well-established market reputation throughout the Pacific rim.

For the grower, its major disadvantages compared to radiata pine are its higher establishment costs and slower initial growth. Additionally, it is not as suitable as radiata pine for finishing or appearance-grade timber, for ground-retention treatment, or for use in making fibreboard and paper.

Siting, growth and yield

New Zealand has some of the best sites in the world for growing Douglas-fir. These are found in both North and South Islands on cooler inland sites with more than 1000 mm annual rainfall, and on sheltered slopes with moderately fertile, free draining soils. Its good resistance to snow damage compared to radiata pine is resulting in many radiata pine cutovers being converted to Douglas-fir above 550m altitude in Otago-Southland, and above 700m in the Central North Island. Conversely, Douglas-fir cutovers below these altitudes are often replanted in radiata pine.

Growth of Douglas-fir is categorised by site index (SI = mean top height @ 40 years) and 500 Index (500-I = mean annual volume increment of a stand that has been thinned

Fig. 1: Douglas-fir resource (as at April 2003). [Source: MAF 2004]

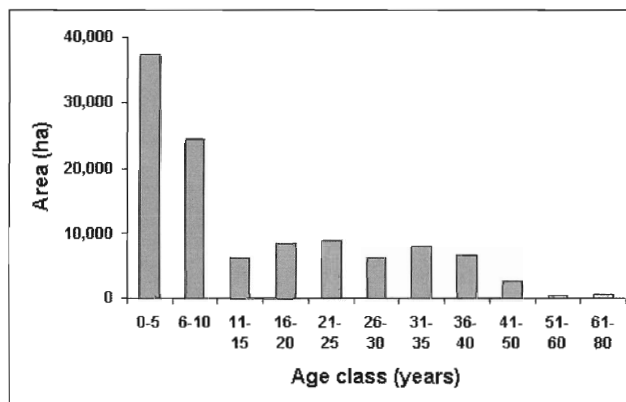
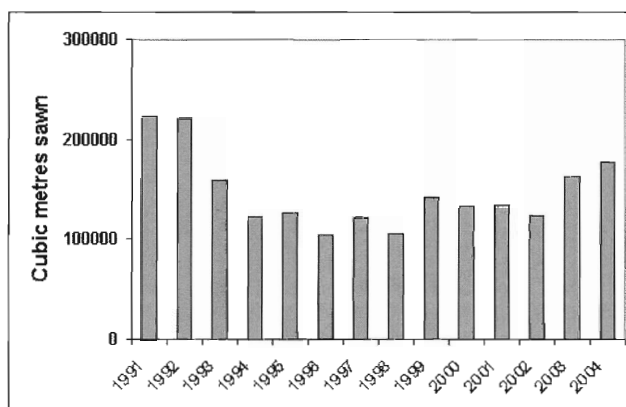


Fig 2: Production of Douglas-fir sawn timber (m³/year) for the period 1991-2004. [Source MAF]



to waste to 500 stems/ha by 15m mean top height, and grown to age 40 years). Analysis of the Forest Research permanent sample plot database shows a mean SI of 31.3m, and a 500-I of 18.4m³/ha/year (Table 1). Recent analysis of a large sample plot dataset from the coastal Pacific Northwest showed a similar mean site index to New Zealand, but a 500-I average of only 12.4m³/ha/year, indicating New Zealand has an apparent basal area growth and overall yield advantage of around 50%.

Product performance and marketing of Douglas-fir timber

For reasons given above, Douglas-fir timber has certain marketing advantages over radiata pine, and this has allowed it to prosper for some end uses – notably construction. However, as many readers will be aware, the potential for utilising the species' natural stiffness and durability advantages for the local market have been recently undermined as a consequence of the 'leaky building' problems and the regulations recommended as a solution.

Changes to the Building Code

The NZ Building Industry Authority (BIA), now the Department of Building and Housing, had the task in 2003 of changing the Building Code to rectify the problems

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Table 1: Douglas-fir productivity indices (SI and 500-I) by region.

Region	No of plots	Mean Site Index (m)	No of plots	Mean 500 Index (m3/ha/year)
South Waikato	52	32.8	50	22.4
Rotorua-Taupo/East Coast	467	32.8	441	18.3
Hawkes Bay	241	28.2	143	14.6
Central North Island (Karioi)	46	28.0	18	24.9
Lower North Island	58	29.2	19	14.1
Nelson/Marlborough	272	32.7	251	18.9
Westland	42	29.8	34	16.6
Canterbury	228	31.5	209	19.5
Otago	157	30.6	144	19.7
Southland	55	30.9	54	21.8
Total NZ	1618	31.3	1363	18.4

exhibited by the increasing number of leaky homes. The process involved industry submissions to both Standards NZ on timber preservation and to the Building Code itself. The BIA was under pressure from government to make progress due to looming litigation from a growing number of owners of poorly performing homes. Changes to timber preservation were finalised first, being easier to adjust, but not necessarily providing the solution. In this haste to make progress, self interest from treatment providers and dominant radiata suppliers relegated Douglas-fir timber into categories undifferentiated from radiata pine.

The real solution to the leaky home problem came with the later release of updates to the building code (E2AS1) that dealt with changes to the building envelope. This follows much of the British Columbia, Canada solution of the 4 D's – Deflection, Drainage, Drying and Durability, in order of importance from greatest to least. The BIA were not prepared to consider the 50+ years of in-service history of Douglas-fir timber as having any particular relevance, effectively relegating untreated Douglas-fir to use in roof trusses, interior wall framing, and external wall framing only behind brick veneer.

Treatment options

Treatment options for Douglas-fir were previously confined to oil treatments for posts and poles, but were undeveloped for sawn timber. The impact of the changes on the industry over the last 18 months has resulted in a

loss of market share to treated radiata pine for some small sawmillers by as much as 50%.

Recently we have seen the development of a remarkably effective boron treatment process for Douglas-fir which relies on an 'activation chamber' to achieve high humidity and moderate temperatures. This ensures penetration of boron into the sawn timber to achieve H1.2, the level now prescribed in NZ for framing not in contact with the ground nor exposed to wet environments. Although this is not seen by the Douglas-fir industry as a logical solution to the leaky home problem, it may provide a means of recapturing market share for Douglas-fir producers.

Stiffness testing

Stiffness testing shows Douglas-fir to be significantly superior to radiata pine. Now that stiffness testing is becoming a requirement for all structural timber, the Douglas-fir industry can expect to regain much of the support Douglas-fir timber previously had as a specialist structural product, simply by virtue of its inherent internal properties.

Douglas-fir Association

In the last year, the forest industry has formed the Douglas-fir Association, which has the task of promoting the timber to a greater number of end-users, and lobbying regulators to enable the timber to be used where it has traditionally performed untreated. Among its successes has been the development of an 'Alternative Solution' for

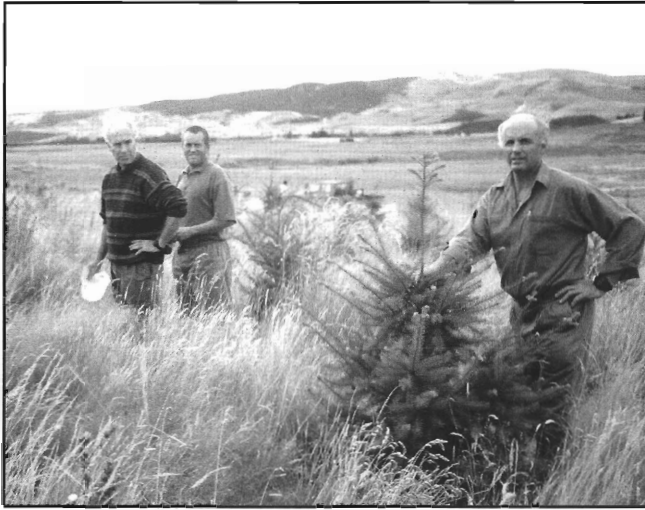


Photo 1: The authors (l to r: Leith Knowles, Phil De La Mare, Nick Ledgard) in a Douglas-fir Cooperative seed source trial at Gowan Hill.

extending uses of untreated Douglas-fir timber, and this is currently being considered by the Department of Building and Housing for inclusion under the 'Acceptable Solution'. The association now has a very strong following and is currently establishing collaborative linkages with the Douglas-fir Research Cooperative, which shares a considerable overlap in membership.

Research

Since 1993, research efforts have been led by the NZ Douglas-fir Research Cooperative – a body combining the research knowledge and experience of Forest Research, with the practical needs of the Douglas-fir forest growers, processors, marketers and end users. Today the Cooperative has 15 full members representing nearly all the major players in the industry, plus 17 associate members (smaller consultancy businesses, nurseries, and growers with under 500ha of resource). The Cooperative helps direct a research budget of around \$450,000, including funds available from the Foundation for Research Science and Technology (FRST).

The Co-operative work programme ranges from seed to product, and involves seven major research areas – tree improvement and propagation, mensuration and silvicultural response, growth modelling and decision support, siting, forest health, environmental issues, and product performance.

In addition to NZ-based and directed research, the Co-operative has also formed links with researchers in the Pacific Northwest (PNW) of America and with the UK and Germany. Visitors from the PNW have frequently given presentations to the annual meetings of the Co-operative.

Tree improvement and propagation

Much of the early research effort on Douglas-fir went into comparing provenances, and improving the form and productivity of the NZ plantation resource. A wide-ranging collection of provenances was established in 1957-59 (Miller & Knowles 1994). Later, seed was collected from selected

coastal fog-belt trees in California and Oregon and was planted out in replicated provenance/progeny trials in 1996. First and second generation seed sources of coastal Californian origin have consistently out-performed Oregon and Washington seed sources, and their resultant NZ land-races. The fastest growth in these trials is being achieved on mild sites by control-pollinated crosses between coastal Californian and Oregon provenances. Best results in the future will probably be gained from matching particular parents to specific sites.

In combination with the growth and yield research, considerable work is currently going into comparing methods for non-destructive testing of 'plus trees' with desirable timber properties. New Zealand grown Douglas-fir shows very good timber stiffness (as measured by Modulus of Elasticity, or MoE), with within-population variation indicating good potential for selective breeding (Knowles *et al.* 2003, 2004). Reliable production of improved seed from progeny-tested parents has proved an elusive target, and remains a problem. To this end, more research is being carried out on techniques for mass vegetative propagation as a means of bulking-up scarce material.

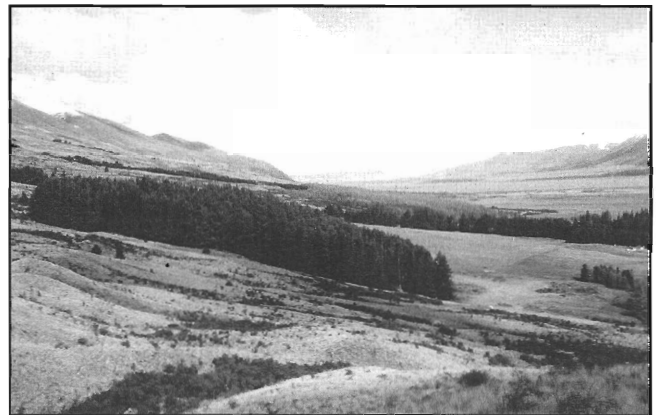


Photo 2: New Zealand has some of the best sites in the world for growing Douglas-fir. This Glen Lyon stand had a total standing volume of over 1750 m³/ha at age 52.

Mensuration, silvicultural response, and decision support

In addition to analysing growth and yield from the broad-based sample-plot database, the Cooperative has installed a series of replicated silvicultural trials on a wide range of sites. The continuing analysis of this combined data has led to the development of an NZ-wide stand-level growth model termed DF-NAT. In a joint venture with the NZ Farm Forestry Association, and with financial assistance from the MAF Sustainable Farming Fund, this model has been installed in a comprehensive EXCEL-based decision support system termed the Green Solutions Douglas-fir Calculator. Individual-tree growth models have also been developed for inventory projection.

Smaller growers in particular would welcome development of standardised NZ-wide log grades, and publication of prices for these by MAF.

Site factors and nutrition

One of the most common comments by overseas visitors inspecting our Douglas-fir stands is the high incidence of stem malformation compared to their situation. Many attribute this to inferior genetics. However, investigations are showing that it is most likely our windy and fast-growth environment that is causing the problem. A current trial is relating a measure of site exposure (in the form of TOPEX) to growth rate and stem form, so that GIS-based TOPEX maps can be used to predict growth performance, and hence appropriate siting for Douglas-fir. Nutrition research has standardised foliage sampling protocols, with seasonal sampling recommendations that are quite different from their northern hemisphere counterparts, but trials have shown no significant response to a range of nutrient additions, including boron.

Health

In North America, there are a wide range of pests and diseases that attack Douglas-fir. Fortunately the majority of these are not present in New Zealand. The only major health problem in this country is Swiss needle cast (SNC - *Phaeocryptopus gaeumannii*), which has caused substantial growth losses in some of the more coastal and northern plantations, but is of only minor concern in the cooler, less humid inland regions. Collaboration with PNW researchers is planned to further explore the influence of environmental factors on SNC in NZ, and DNA will be used to examine the nature of the NZ SNC population in comparison to Oregon.

Environmental issues

Probably the greatest current environmental concern focuses on the risk of unwanted natural regeneration, or wilding spread. The species can regenerate vigorously and is often planted in lightly grazed and vegetated grassland/scrub sites, where there is a high risk of spread. Research is determining that careful siting, plantation design and management of surrounding land (via strategic use of grazing and/or fertilisers) can minimise the risk of spread to zero or a controllable level.

Douglas-fir is an ideal species for continuous cover forestry and carbon storage. Its shade tolerance compared to the pines means that an understory (or continuous cover) of young Douglas-fir can be maintained while mature trees are harvested, which also contributes to the fact that on many sites the species can retain more basal area and hence store more carbon than radiata pine.

Product performance

Protocols are being developed for applying acoustics in assessing stiffness (MoE) of standing trees, logs, and timber. It is intended to develop an understanding on how timber stiffness varies with geography, genetics and silviculture, and to show the linkages between measurements taken of standing trees, logs, and timber. Initially three-point bending of sawn timber is being used as the stiffness benchmark, but in future new benchmarks based on acoustic measurements may be possible.



Photo 3: Douglas-fir, compared to radiata pine, has better stiffness and stability, together with less variable wood properties from pith-to-bark. This means that framing timber can be cut from small logs including thinnings.

Conclusion

As long as it is carefully sited, and the most appropriate seed sources are used, Douglas-fir has many advantages as a commercial plantation species in New Zealand. However, the most pressing current issue relative to its future is the lack of official recognition for its timber characteristics, which for interior structural use are significantly better than radiata pine. Once these differences are recognised within the New Zealand Building Code, the full potential of the species will be realised, and the New Zealand Douglas-fir industry will inevitably prosper.

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