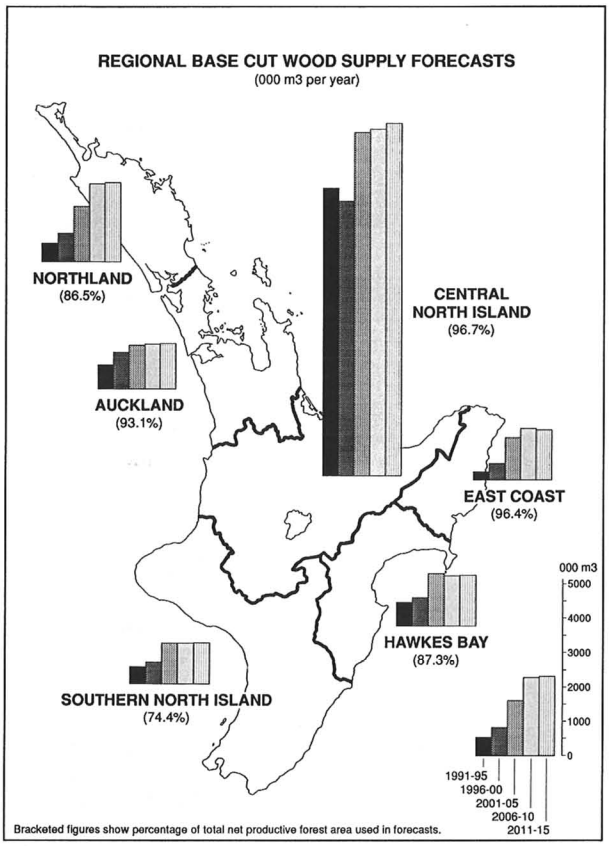

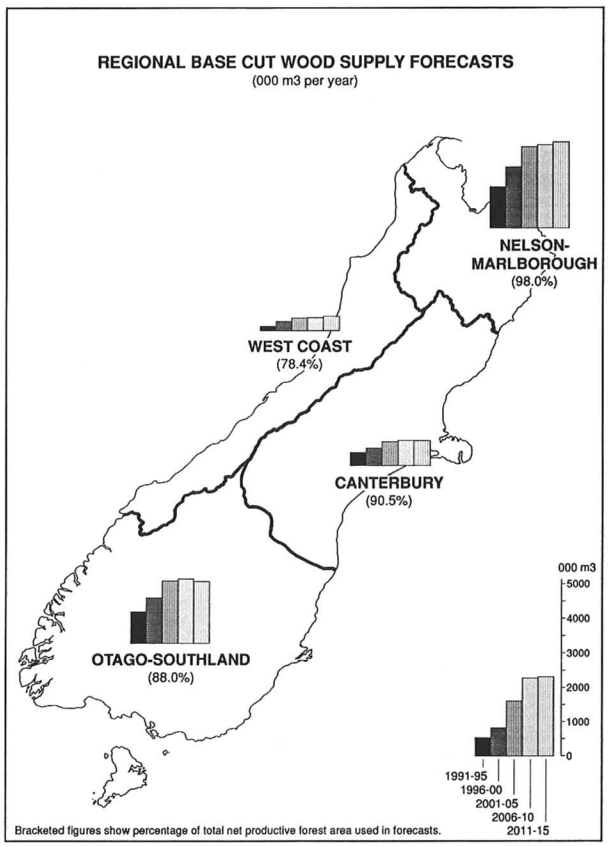

Supply of improved radiata pine seed

T.G. Vincent*

Abstract

There is a large increase in demand for genetically improved seed throughout the forestry sector. In response to this, the industry has collected over 7000 kilogrammes of seed rated **GF16** to **GF17**. However, less than 5% of the total seed collected is rated higher than **GF20**. With reasonable nursery management and providing that all this seed is sown, this should be sufficient to provide planting stock for around 125,000 hectares in 1994. Cuttings of highly-rated material could also provide planting stock for an additional 10,000 hectares. Those experiencing difficulty in meeting their requirements for genetically improved seed or plants should note that increasing stocking per hectare will not adequately compensate for using lower-rated material.

The product from New Zealand's current seed orchards has proved to be widely adaptable but very little seed rated higher than **GF14** is being exported. Recipients of these seed exports are organisations assisting with the further improvement of radiata pine in New Zealand. The use of imported seed is not recommended until it has been adequately tested in New Zealand.

Additional areas of seed orchard are currently being established and yields of control-pollinated seed should increase in the future.

Introduction

Expressions of concern and feelings of insecurity over seed supplies of genetically improved radiata pine are evident in many parts of the forestry sector. These concerns have been brought about by the large increase in demand for improved seed, mainly from newer companies and investors in plantation forestry with no traditional source of seed supply. Also, because management of a large proportion of New Zealand's seed production is now on a more commercial basis, the practice of maintaining national seed reserves has been discontinued. Other factors that have contributed to the upsurge in demand for seed of high genetic quality include the increased awareness of the advances made by New Zealand's tree breeding programme (FRI 1987), and the general use of the Seed Certification Service's improvement ratings throughout the forestry sector (Vincent 1987). (Around 90% of the seed certified is of the growth and form breed, so the improvement ratings are often referred to as **GF** numbers.) People who have seen the results achieved through tree improvement are unwilling to go back to using low-rated seedlots. Others arrive at a nursery aware that there is something good called **GF25** and, because that they do not realise that supplies are currently very limited, they are disappointed when there are no plants available.

Because of the progressive, advancing nature of the tree breeding programme, there will always tend to be a shortage of the latest, most highly improved seedlots (Carson et al 1992). Currently less than 5% of the genetically improved radiata pine seed produced in New Zealand is rated above **GF20.** This is produced in control-pollinated (or meadow) seed

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orchards (Arnold 1990). Most of the remainder is rated **GF16** or **GF17** and is collected in open-pollinated orchards located mainly in the central North Island.

How much improved seed is available?

In the short term, the availability of any improved seedlot is limited to the production capacity of existing seed orchards. As with many other crops there can be a large natural variation in the quantity of seed produced each year. It is fortunate that the open-pollinated orchard seed crop available for nursery sowing in the 1993 season was heavy, compared to that of the previous year. The 1994 crop also looks good, although the number of full seeds per cone is as yet unknown.

In 1989, when the total New Zealand seed requirement for radiata pine seed was at a low of about 2400 kilograms, there was a surplus of **GF16** and **GF17** seed. In the last two years national demand and production of seed rated **GF16** or **GF17** seed has markedly increased and New Zealand seed producers are currently collecting and extracting over 7000 kilograms. This should all be available for sowing this spring, unless some forest or nursery managers over-order or hold stocks to form their own reserve. Assuming 18,000 plants per kilogram of seed and an average of 1000 trees planted per hectare, with good management practice, 7000 kilograms should be sufficient to plant 126,000 hectares.

Also, it is estimated that well over 10 million cuttings have been set throughout New Zealand this year as a means of increasing the amount of highly-rated material available for forest planting. This is the approximate equivalent of an extra 500 kg of seed, and could make up about 7% of the total radiata pine planting stock available in 1994. However, these cuttings have been set mainly by the larger organisations in the North Island and all of this material is likely to be pre-ordered or otherwise committed.

The national total of about 7000 kilograms of seed rated **GF16** and **GF17** combined with the estimated 10 million cuttings should provide enough planting stock for over 135,000 hectares in 1994. This total excludes seed available for sowing that is rated **GF18** and higher (perhaps a further 600 kg), a proportion of which will be used for establishing more cutting stool-beds.

Use of lower-rated seedlots

The above quantity of plants may still be insufficient to meet demands for tree stocks in 1994. However, tree growers should be wary of using plants produced from lower-rated seed at a higher initial stocking per hectare as a substitute for higher-rated seed. In many cases when low-rated material is used, it is impossible to obtain the required number of acceptable trees per hectare after thinning even with very high initial stocking rates. In trial plantings that contain blocks of trees each with different levels of genetic improvement, thinning can sometimes improve stem form, but the lower-rated seedlots have slower growth, and a greater tendency to suffer subsequent leader and stem malformation. Thus, within two years after first thinning, the original stem form differences between seedlots have usually become obvious again, and the vigour of trees remaining after thinning in higher-rated seedlots is greater. Also, the returns from production thinning of improved seedlots are normally better, because of the increased log size and higher log quality (more are suitable for sawlogs rather than pulpwood).

Control-pollination at Amberley seed orchard. Part of the expected increase in control-pollinated seed production. Photo: NZFRI, Rotorua.

Seed exports

In the late 1980s when national seed demand was at its lowest for many years, exports of seed rated between **GF14** and **GF17** accounted for about 35% of the total seed collected. In a very short time, New Zealand seed producers established a significant market (mainly in Australia) based on recognition of the high genetic quality of New Zealand orchard seed. However, even though the demand is still there, export levels of seed rated **GF16** and **GF17** have declined rapidly as the increased New Zealand requirement has meant that there is insufficient surplus.

An exception to this is the continued supply of improved seed to Australian members of the New Zealand Radiata Pine Breeding Cooperative (NZRPBC). These Australian members are contributing to the future development of radiata pine breeding in New Zealand, both through the supply of their own tree breeding material for future testing in New Zealand, and by direct funding of the cooperative work programme. Seed export to these NZRPBC members currently accounts for less than 5% of seedlots rated **GF16**. Lower-rated orchard seed, not considered to be acceptable on the New Zealand market, is also being exported to a number of countries.

Seed imports

It is understood that because of the assumed seed shortage, some New Zealand nursery managers are considering sowing orchard seed imported from Australia this season. One of the major advantages of improved seed of New Zealand origin is that it has been tested on a wide range of sites over many years. Most of this material was selected on central North Island sites where a wide variation in stem

form is expressed. It has proved to be widely adaptable. As an example, four commercial seedlots with a range of **GF** ratings were planted in 1978-79 on 22 different sites from Aupouri to western Southland. Results from measurements taken at each of these sites have shown the ranking of the seedlots to be the same, regardless of location. In contrast, seedlots from an open-pollinated seed orchard that contained trees selected in Canterbury performed well only when planted in Canterbury, and had inferior tree form, crown-health, and growth rate when planted on other New Zealand sites.

Seed from a number of Australian orchards is currently being tested in New Zealand, but at present the trees are too young to provide comparative results. Trees in a few earlier plantings of imported orchard seed indicate variable growth rate and generally inferior tree form when compared to equivalent New Zealand-origin material. Before seed from Australian orchards is deployed in New Zealand plantations, it should be adequately tested to obtain a measure of its performance on a number of sites. It would be of benefit to tree growers in both New Zealand and Australia to have common standards for seed certification of genetic quality, but at present a system that adequately compares seedlots across these two countries is yet to be developed.

How are the genetic resources managed?

New Zealand's genetic resources of radiata pine are being managed by NZFRI for the NZRPBC. This cooperative work programme is jointly funded by the Government (through the Foundation for Research, Science, and Technology) and the many forest companies who are active members. The NZRPBC programme involves numerous genotypes with differing levels of genetic improvement. It includes unimproved material originating from natural stands in California, through to the highly selected and well-tested parents used for commercial seed production (Shelbourne et al 1986). The management of this range of genotypes by the NZRPBC ensures that the genetic diversity of the species is retained as well as used to develop suitable material for plantation purposes. Forest companies and nursery managers use the improved material developed by the cooperative for commercial seed production.

In open-pollinated orchards there is always a trade-off between seed quantity and genetic quality. Orchard managers can selectively collect from only the best orchard parents to increase the genetic quality of a seedlot. However, this reduces the quantity of that seedlot compared to a collection from all the trees in the orchard. If seed is also collected for the remaining lower-ranked parents to form another seedlot then the total quantity of seed collected remains the same, but there can be a large difference between the two seedlots in genetic quality.

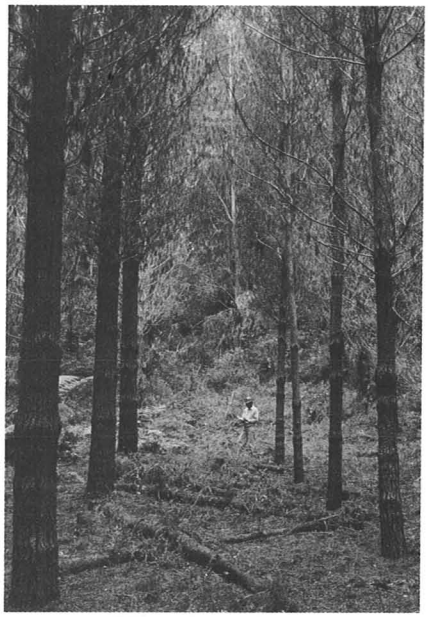
Future seed supply?

Open-pollinated orchards have a limited life of around 20 years from planting before they become too tall for economic cone collection. Topping (pollarding) can be used as a method of extending their effective life, but this reduces cone production in the short term. Also, after this length of time their genetic quality has usually been superseded by more advanced material from the breeding programme. Most of the existing open-pollinated orchards in New Zealand were planted between 1970 and 1980, so production from them can be expected to be greatly reduced by the year 2000.

New or replacement open-pollinated orchards are no longer being planted in New Zealand. Although they have achieved high levels of genetic improvement when compared to unimproved seed, their major limitation is the inability to effectively control pollen contribution to the developing seed. In an open-pollinated orchard the pollen cloud has at best the average genetic quality of the trees in the orchard, and at the worst can contain a high proportion of pollen originating from undesirable trees located outside the orchard, thus reducing the genetic quality of the orchard seed. On many sites, open-pollinated orchards produce almost no pollen for about the first five years after planting. In these cases all seed produced up until age seven in a new orchard has been fathered by non-orchard trees.

Other important reasons why control-pollinated orchards are preferred to open-pollinated orchards are: a reduced lead-time to seed production (three-five years, versus five-ten years), flexibility of the breed-type produced (pollens with different desired characteristics, e.g. disease resistance, can be applied in the same orchard), and the advantages of doing all the operations (including cone collection) from the ground.

The area established in control-pollinated orchards is being extended, and the development of improved orchard management techniques has meant that cone production per hectare is increasing. However, like any system that involves new technology, delivery is slower than initially expected. The three companies that own control-pollinated orchards, plus the School of Forestry, Ilam, and NZFRI, have recently formed a seed orchard research group (SORG). Results of this



Radiata pine progeny test. Trials like this provide estimates of the genetic worth of parent trees involved in commercial seedlots. Photo: NZFRI, Rotorua.

cooperation have already proved effective, particularly in the area of improved pollen handling.

It is estimated that between 700 kg and 1000 kg of control-pollinated seed (rated **GF20** and higher) could be available nationally in 1994 or 1995. This is only 10 years after the first attempts to commercially produce control-pollinated seed in New Zealand.

Because its members are aware of the strategic nature of New Zealand's radiata pine seed production and the age of existing open-pollinated orchards, plus the increasing need for greater supplies of highly-rated seed, the NZRPBC has initiated a grafting programme to provide plants for the establishment of more control-pollinated orchard area in 1994. This grafting programme is in addition to that currently being undertaken by existing orchard owners. If the NZRPBC bid for ownership of Proseed (New Zealand's major seed producer) is successful, grafts from the NZRPBC programme are likely to be planted as part of the Proseed orchards. If the NZRPBC bid fails, these grafts will be either used to produce seed on contract to the cooperative or planted in a new NZRPBC orchard. The cooperative considers that it is critical to provide its members with wide access to high-quality seed, protect New Zealand's strategic seed production resources for the foreseeable future, and increase national seed production.

Conclusions

When the limitations of the size of the open-pollinated orchard resource and real-

istic lead-times to production in new orchards are considered, New Zealand seed producers have done remarkably well in increasing the total quantity available for sowing in 1993 without greatly decreasing the overall genetic quality.

At present no organisation is planning seed supply for the national interest, yet there is a need for stability and security of improved seed supplies, particularly for the smaller grower. When compared to most of the large forest companies, this increasingly important group is less able to provide for its own needs. There is a danger that they will finish up planting trees raised from cheaper seed sown by nurseries for speculative sales, simply because it is available.

Providing that there is reasonable nursery management, the increased volume of seed available for sowing this year means that there should be no need to utilise planting stock rated less than **GF16** in 1994, unless the 1994 national planting total exceeds around 130,000 to 140,000 hectares. Rather than use stock of unknown quality, or material that is officially rated less than **GF14**, it would be better to order in advance from a nursery manager or seed supplier and delay planting by a year.

Acknowledgement

Seed collection information from Baigent Forest Industries, Carter Holt Harvey Forests Ltd, Proseed NZ, and Tasman Forestry Ltd is gratefully acknowledged.

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News from the School of Forestry

OVERSEAS CONTACTS

Indonesian Students

The Indonesian Ministry of Forestry has drawn up a ten-year programme to upgrade the skills of its staff, and is hoping to place a thousand students world wide during that time. In this connection a delegation from Indonesia recently visited the School of Forestry on the initiative of the Joint Committee for Forestry Cooperation (JCFC), established in 1991.

The School has for some time been accepting graduate Indonesian students: 11 are currently studying for Masters or Doctoral degrees. In addition, School staff have undertaken promotional work in Indonesia.

Not only does the School have something substantial to offer the Indonesian programme, but there are spin-offs for New Zealand too. This country needs to become a player in global forestry, and helping educate Indonesian foresters provides an opportunity to establish valuable contacts.

IUFRO

Geoff Sweet attended a IUFRO Working Group meeting on "Biology and Cultural Reproductive Processes in Forest Trees" at the University of Victoria, B.C., Canada in August. New Zealand is a leader in seed orchard technology, and the School has an active research programme, with four postgraduate students currently working in this area. Professor Sweet contributed one keynote address and co-authored five other presentations with his graduate students.

Commonwealth Forestry Conference

In September, Graham Whyte attended the 14th Commonwealth Conference in Kuala Lumpur. He reports that the 400 or so delegates from 41 countries strongly supported the outcomes of the 1992 UNCED meeting in Rio de Janeiro and the international initiatives of the UN Commission on Sustainable Development. In other words the pendulum had swung back hard from the previous meeting in Rotorua, and emphasised the beneficial effects of forests in providing a multiplicity of benefits to communities.

Dr Whyte also took advantage of the opportunity to visit a number of forestry operations in Sarawak, and to discuss forestry study at Canterbury with a number of potential postgraduate students. His visit there was much enhanced by insights and study tours provided by former students.

British Wood Preservers' Association

Dr Kevin Archer presented a paper on "Bacterial pre-treatment of Douglas fir roundwood to improve preservative treatability" at the AGM of the Association in Cambridge, England. The paper was based on his Ph.D. studies at the School of Forestry with John Walker and John Allen.

Study Leave

Dr David Norton returned in July, having spent six months in Australia, mainly based at the CSIRO Wildlife and Ecology Division laboratories in Alice Springs and Perth. He was involved in collaborative research on forest fragmentation and mistletoe ecology.

Dr Ted Bilek also returned in July from a 12-month sabbatical. He spent most of the time in Madison, Wisconsin working at the USDA Forest Service Forest Products Laboratory and at the University of Wisconsin, Madison. While on leave, he conducted research into the economics of breaking down and burning wood pallets in addition to teaching an operations research class.

TEACHING

Following recent and impending changes to undergraduate papers, an internal review of the curriculum is being undertaken to see if it is desirable or possible to present the subjects in a more logical sequence. An early result has been recognition of the need for a Silvics paper in the degree course.

RESEARCH

Dr Norton recently received a $2500 research contract from DoC to undertake research on "Assessing the effectiveness of possum control on forest ecosystem health".

EXTENSION

Forest Engineering Institute

The School of Forestry, in conjuction with the Logging Industry Research Organisation, will be holding another Forest Engineering Institute from November 22 to February 4. The FEI is a mid-career training course designed for logging managers and planners, and it is expected that 20 individuals from New Zealand, Malaysia and Australia will attend this intensive eight-week residential course, which will include a week in Nelson studying logging and roading operations. The course Director will be well-known forestry consultant Bill Liley, with Don Robinson form LIRO and Ron O'Reilly from the School acting as Assistant Directors.