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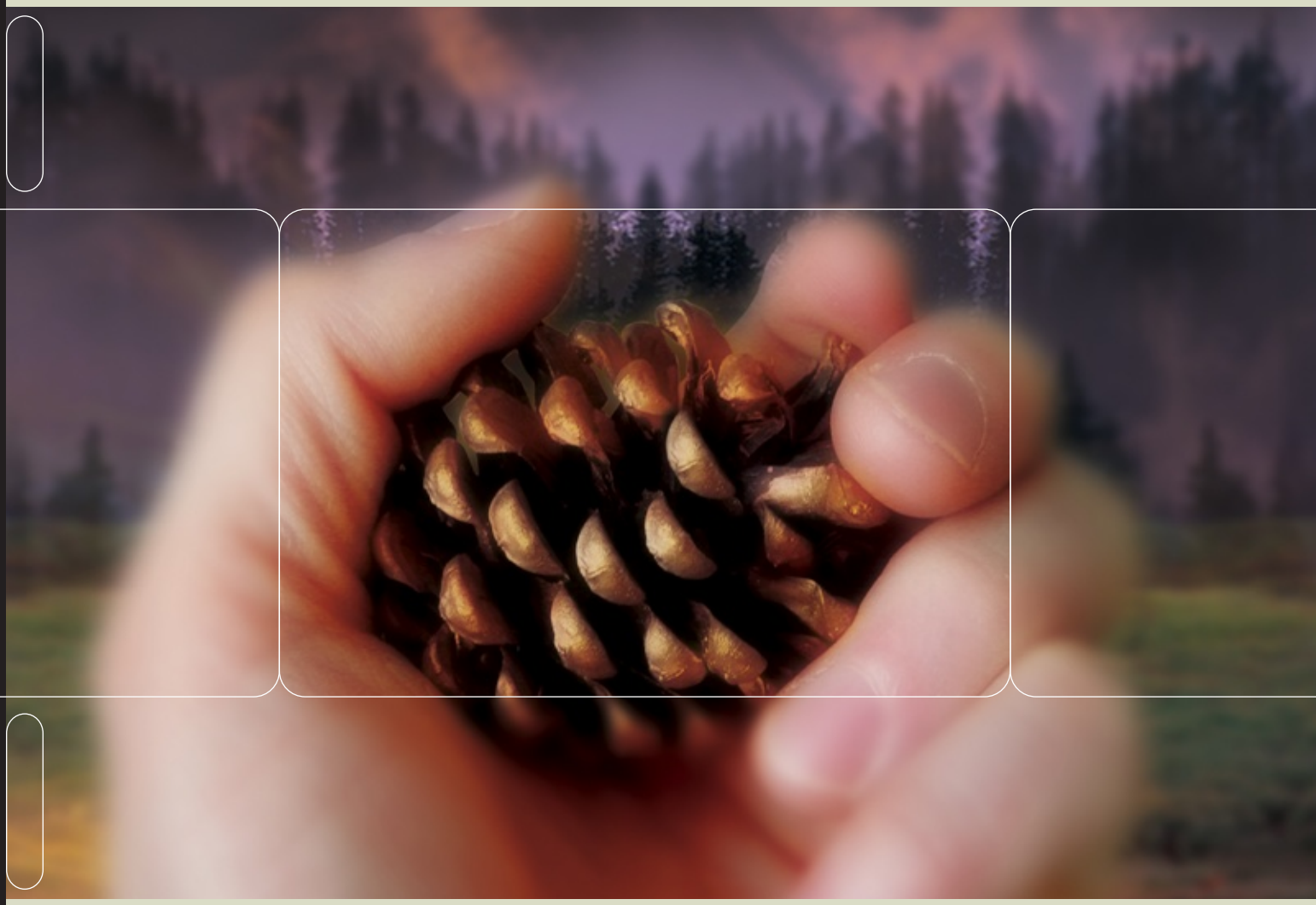
# RADIATA PINE GROWTH



GF Plus™

RPBC™
Radiata Pine Breeding Co Ltd
BREEDING QUALITY

- **Volume growth is a major determinant of the profitability of commercial radiata pine forests.**
- **Genetic selection can significantly increase growth rates, with increasing *GF Plus* rating for growth showing progressive improvement in volume over GF14.**
- **Improvements in growth rates through tree breeding are being made in conjunction with efforts to improve wood quality, with particular emphasis on corewood quality.**
- **Choice of silvicultural regime should take into account the more rapid growth of improved seedlots in order to ensure that wood quality is maintained or further improved.**
- **Trial data shows that genetic improvement in growth can be achieved consistently across forest regions, site qualities, silvicultural regimes and throughout the life of a stand.**
- ***GF Plus* provides a separate genetic rating for growth, unlike the old GF rating that combined growth with form together into a single rating.**

## > TREE BREEDING AND GAIN IN GROWTH

Genetic gain in growth represents the ability of a stand of trees to produce increased volume at rotation age by means of tree breeding. Stand volume is a function of basal area (i.e. the cross-sectional area of the stem calculated from diameter at breast height) and height, with basal area the stronger determinant of total volume. Growth is one of the traits currently identified in the ***GF Plus*** scheme (see Information Bulletin No.1 'Rating the Genetic Quality of Radiata Pine').

## > WHY IS GROWTH AN IMPORTANT TRAIT?

Volume growth makes a significant contribution to the profitability of commercial forests. If all other stand characteristics are held constant, increasing growth rate will increase return. An ability to increase growth rate can be viewed either as a greater volume produced in a given amount of time, or a reduction in the amount of time required to achieve a desired stand volume.

## > WHAT FACTORS AFFECT GROWTH?

Climate, site quality and silvicultural regime have a huge influence on tree growth. Tree breeding, through genetic selection, can also significantly increase growth rates. However, the effects of genetic selection on growth rate are generally much smaller than the effects of climate, site and silviculture. Therefore it is important to optimise forest management practices and manage them in conjunction with genetic improvement. The grower's choice of silvicultural regime should take into account the more rapid growth of improved seedlots in order to ensure that wood quality is maintained or further improved.

Substantial increases in growth have been associated with using genetically superior planting stock in genetic trials in all forest regions and across a wide range of site qualities and silvicultural regimes.

## > HOW DOES GROWTH INTERACT WITH OTHER TRAITS?

Diameter growth of trees in a stand, on which the ***GF Plus*** growth rating is based, is highly correlated with their height growth, so selecting for one or the other will improve both. Breeding for improved growth can have an impact on other traits. Selection for increased growth if unconstrained can be accompanied by a slight improvement in stem straightness and *Dothistroma* resistance, a slight increase in multinodality and a slight decrease in wood density.

Diameter is a key determinant of tree volume

Where they are undesirable, these associated changes can be avoided by selecting parents that do not show an altered performance for these other traits. However, there is a trade-off in that a slightly decreased growth rate must be accepted in order to prevent an accompanying change in these other traits. Increased growth can result in an increase in the proportion of low quality corewood in the centre of the tree stem. Tree breeding is being used to increase

the quality of corewood produced from genetically improved planting stock.

The old GF rating was based on the expected performance for growth and form (straightness), with diameter growth weighted 2/3 and straightness weighted 1/3. In addition to providing an updated rating for growth, ***GF Plus*** provides a rating that is not confounded with any other trait, thus providing the transparency required when considering genetic options in view of trade-offs with changes in other traits.

## > HOW ARE TRAIT RATINGS DERIVED?

***GF Plus*** growth trait ratings are derived from Radiata Pine Breeding Company (RPBC) single-tree-plot progeny trials. Current ratings use data from 26 trial sites planted across New Zealand. Diameter at breast height was measured at approximately age 8 years from planting and an overall performance rating calculated (see Information Bulletin No. 1 'Rating the Genetic Quality of Radiata Pine' for more details on rating calculation). Diameter, not height, is measured largely because of the high expense of measuring height. However, genetic worth for height and diameter growth are highly correlated, with large increases in diameter growth accompanied by small increases in height growth.

Ratings represent relative predicted performance and, as such, suggest which parents are most likely to have progeny with the highest growth rates. ***GF Plus*** growth ratings have corresponded well with actual growth increases measured in large-plot genetic gains trials.

## > WHEN ARE GROWTH GAINS LIKELY TO APPEAR?

In side-by-side comparisons of different seedlots, genetic differences become visible at about age 6-8 years, and increase as the stand grows. Increases in growth rate associated with genetic improvement are consistent across age ranges measured in trials.

Measuring diameter at breast height

## > WHAT GENETIC GAINS CAN BE EXPECTED?

Genetic selection for growth results in increased rates of growth for both height and diameter. However, in New Zealand *Pinus radiata* the % increase in basal area growth is about four times the increase in height growth. Data from large-plot genetic gain trials suggest that improvements in growth through genetic selection are achieved consistently across forest regions, site qualities, silviculture regimes, and throughout the life of a stand. Table 1 shows actual genetic gains in growth measured in a series of trials established in 1978.

| Trial Site | Region | Standing volume | | | % Gain in growth | | |
|---|---|---|---|---|---|---|---|
| | | | | | Over GF7 | | Over GF14 |
| | | GF7[c] | GF14[d] | GFPlus26[e] | GF14 | GFPlus26 | GFPlus26 |
| Aupouri[a] | Northland | 300 | 358 | 449 | 19 | 50 | 25 |
| Kaingaroa[b] | CNI | 686 | 722 | 790 | 5 | 15 | 9 |
| Mohaka[a] | Hawkes Bay | 607 | 777 | 910 | 28 | 50 | 17 |
| Golden Downs[a] | Nelson | 368 | 430 | 533 | 17 | 45 | 24 |
| Waimate[a] | Canterbury | 511 | 649 | 706 | 27 | 38 | 9 |
| Longwood[a] | Southland | 582 | 547 | 654 | -6 | 12 | 20 |
| | Mean | 509 | 581 | 674 | 15 | 35 | 17 |

**Table 1:** Summary of results from 1978 Genetic Gains Trial Series, measured at age 22 years

*a* - Sawlog regime
*b* - Pulpwood regime: plant 711sph, no thin
*c* - Climbing select, i.e. seed selected from the best trees in harvested stands
*d* - First generation open-pollinated seed orchard (Gwavas seed orchard)
*e* - A mix of control crosses with 82% of trees having an exceptional performer for diameter as the female parent

Everything else being equal, additional wood volumes produced from genetically improved stock are greater on faster growing sites. For example, within a forest region and for a specific silvicultural regime, it is expected that the absolute amount of extra volume produced from a genetically improved seedlot would increase, on average, with increasing site index (Fig.1a).

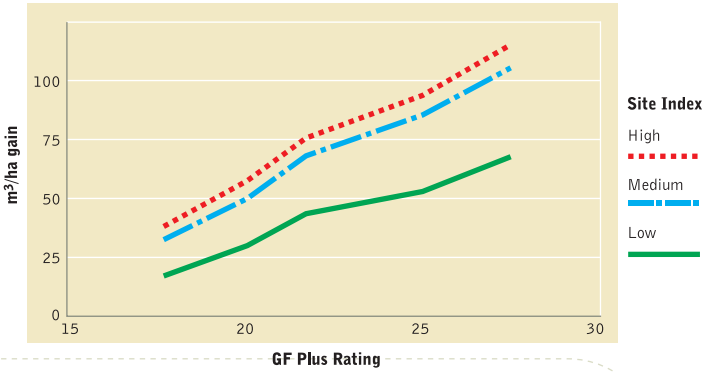



**Fig. 1a:** Extra volume above climbing select predicted at age 30 for central North Island. PPM88 growth model: Plant 800sph, thin to 500sph at MTH8m, thin to 350sph at MTH14m

In contrast, percent gain from genetic improvement will, on average, be lower on better growing sites, even though the

amount of extra volume produced will be higher. This is because the denominator against which the extra volume is compared is higher, and the overall stand volume increases proportionately faster than the extra volume derived from genetic improvement (Fig. 1b)

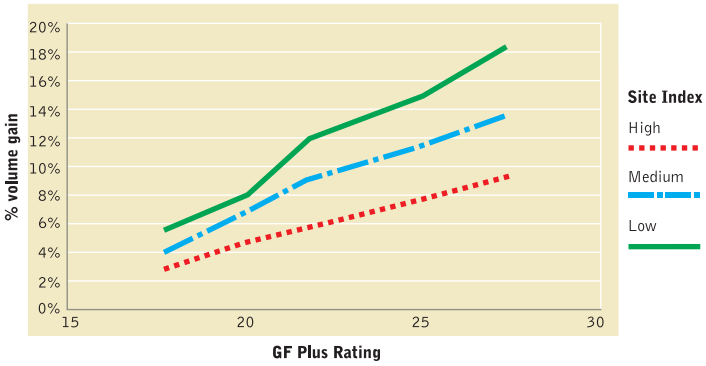



**Fig. 1b:** % Gain over climbing select predicted at age 30 for central North Island PPM88 growth model: Plant 800sph, thin to 500sph at MTH8m, thin to 350sph at MTH14m

## > USE OF GROWTH MODELS IN FORESTRY

Data collected over time from permanent sample plots (PSPs) have been used to develop computer growth models that provide estimates of future volume yields. Much of the work in developing these models in New Zealand has been carried out by the Stand Growth Modelling Co-operative (SGMC), a joint Forest Research and industry co-operative. Forest managers use these models extensively to assist with forest estate management. Uses include prediction of future wood flows and regulation of yield, planning processing facilities, determining optimum time of pruning, thinning, and felling specific stands and to analyse the economics of silviculture.

Seven New Zealand regional growth models developed by the SGMC have been modified, using growth rate multipliers, to reflect increased growth rates associated with genetically improved planting stock. Growth model users are able to input the genetic worth of planting stock in order to predict their increased growth. The genetic gain multipliers were developed from trial data representing 18 large-plot genetic gain trials consisting of 494 PSPs and 35 seedlots, and are well correlated with ***GF Plus*** growth trait ratings. Conservative assumptions were made when implementing the multipliers into the growth models in an attempt to avoid over-prediction of genetic gain.

Height and diameter distributions do not appear to differ among genetically improved seedlots, meaning that models, which generate size distributions for grade out-turn and other analyses, can be used in stands with improved genetics.



## > GROWTH MODEL YIELD PREDICTIONS

Table 2 presents gains in growth associated with genetic improvement as predicted by growth models with the genetic gain multipliers. Models representing seven regions were used to predict growth on a medium site index site under a typical intensive management pruned regime, i.e. planted at 800 stems per hectare and progressively thinned (twice) to a final crop stocking of 300 stems per hectare. Since predictions were derived from conservative modifications of growth models derived from trial results representing a wide range of seedlots and growing conditions, the growth model predictions represent conservative estimates of average gain that can be expected when growing improved seedlots.

| Trial Site | Climbing Select ($m^3$/ha) | Volume Gain v Climbing Select ($m^3$/ha) | | | |
|---|---|---|---|---|---|
| | | GF19 | GFPlus22 | GFPlus25 | GFPlus27 |
| North Island Sands | 615 | +32 | +40 | +50 | +61 |
| Auckland Clays | 699 | +48 | +59 | +73 | +88 |
| Central North Island | 763 | +55 | +68 | +86 | +103 |
| Hawkes Bay | 852 | +51 | +61 | +74 | +86 |
| Nelson | 654 | +77 | +99 | +126 | +153 |
| Canterbury | 448 | +57 | +62 | +75 | +87 |
| Southland | 781 | +65 | +81 | +103 | +124 |

**Table 2:** Predicted standing volume gain over climbing select at age 30 for growth sites with medium site index. Mgmt regime: Plant 800sph, thin to 500 at 8m and to 300 at 14m

## > HOW DOES GROWTH AFFECT VALUE?

Results from trial data summarised in Table 1 and the growth model predictions described in Table 2 together show that genetic improvement can result in a significant gain in volume growth. This gain in volume will be associated with a corresponding gain in value. It is important for the forest grower to consider that, when purchasing genetically improved planting stock, growth is just one of the traits described under the ***GF Plus*** scheme. Increased financial returns from improved growth rates will be in combination with other traits such as stem straightness, branching habit, density, grain spirality and disease resistance.

**For more information**
**Freephone 0800 00 GFPLUS (0800 00 437587)**

RPBC™ Radiata Pine Breeding Co Ltd BREEDING QUALITY

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