

RATING THE GENETIC QUALITY OF RADIATA PINE



RPBC
Radiata Pine Breeding Co Ltd
BREEDING QUALITY



> WHAT IS GENETIC QUALITY?

Genetic quality can be defined as a measure of the genetic potential of a population to produce the characteristics, or traits, required. Genetics does not work in isolation, with the effect of genetics usually in addition to those of site and stand management.

> USE OF GENETICS IN FORESTRY

Through the use of tree breeding techniques and forest trials, research has identified superior individuals that can be included in a breeding population as parents. At the same time, material with poor genetic performance has been screened out. Seed producers are able to make crosses using these selected parents in either open-pollinated (OP) or control-pollinated (CP) orchards. The seed produced inherits the genetic traits of its parents.

Fortunately for tree breeders, many of the desirable traits, such as density, are highly heritable. There are considerable



Measuring grain angle

advantages in a grower being able to better estimate (prior to establishment) how material might subsequently perform in plantations. A rating system provides a benchmark by which seed or cuttings with different parental mixes (seedlots) can be compared in terms of likely genetic performance.

> HISTORY OF RATING GENETIC QUALITY

Initially, seed producers used terms such as select, seed orchard, elite and second generation to describe their product. By 1985 seed producers were selectively collecting from the better parents in seed orchards to increase genetic quality and produce seedlots for special-purpose end uses. As a result, the determination of comparative genetic quality became much more complex. In 1987 the Forest Research Institute established the Seed



Certification Service (SCS) to provide more information. A growth and form (GF) scale was developed to rate seedlots. The GF rating works on the basis that

the higher the rating the greater the potential gains in growth and form (straightness) from genetic improvement. From 1987 to 2001 radiata pine breeding was jointly funded by a group of major forest companies and Forest Research through the New



Zealand Radiata Pine Collecting density core samples.

Breeding Cooperative (NZRPBC). Since February 2001 the Radiata Pine Breeding Company (RPBC), with major forest companies from New Zealand and Australia as its shareholders, has continued breeding development. Recent tree breeding efforts have focused on developing and testing material for a number of specific tree growing and wood property traits in addition to growth and form. In order to make information on these traits available outside the RPBC, the *GF Plus* trait rating system was implemented in 1998. Since the RPBC owns the radiata pine genetics and information, and to help fund further research and development of radiata pine breeding, the RPBC provides growers with the right to use such genetics and information (in certain circumstances and under certain terms and conditions) through a royalty payment scheme.

> GF PLUS TRAITS

GF Plus ratings for the traits shown are currently provided. Detailed information sheets on each of these traits are, or soon will be, available from your seed producer, nursery grower or the RPBC. The *GF Plus*

> GF PLUS TRAITS

- > GROWTH
Diameter growth.
- > STRAIGHTNESS
Stem straightness (previously 'form').
- > BRANCHING HABIT
Branch incidence (multinodal v uninodal).
- > DOTHISTROMA RESISTANCE
Resistance to Dothistroma needle blight.
- > WOOD DENSITY
Average wood density.
- > SPIRAL GRAIN
Incidence of significant spiral grain.

scheme offers information on important additional wood property traits compared with only the growth and form rating of the GF scheme. It is anticipated that other significant wood property traits will be introduced over time as more information becomes available.



> HOW DOES GF PLUS WORK?

Seed producers apply to the SCS to have their seedlots rated. A *GF Plus* Seed Certificate rating the genetic potential of each trait is issued to the seed producer, along with a unique seedlot number. The seed producer then sells its seed and collects a royalty at time of sale from the purchaser. The seed purchaser, usually a nursery grower, produces planting stock for deployment in the forest. Where the seed purchaser produces cuttings material, a Propagation Licence issued by the RPBC is required. The seed purchaser collects a royalty, equivalent to that paid on seed,

when the cuttings are sold. When purchasing *GF Plus* planting stock the forest owner is entitled to a copy of the *GF Plus* Seed Certificate relating to the trees purchased. This certificate shows the individual trait ratings and other information as shown in the example.

> HOW ARE GF PLUS RATINGS DERIVED?

The SCS uses a combination of RPBC data and tree breeding genetic parameters to estimate a *GF Plus* rating for a seedlot. Trait ratings are calculated using two major components:

> Estimates of genetic worth of parent trees

> Proportional contribution of each parent to the seedlot

Estimates of genetic worth are derived from RPBC progeny (performance) trials. Individual trees within these trials are rated for trait performance using skilled field crews to ensure consistency of assessment across trials and regions. Often the group of parents that make up a commercial seedlot have not all been tested in the same trial. In these instances, both across-trial adjustments of the genetic worth estimates and a method of reducing impact on the data of variable age, site and unequal representation are required. The rating for each parent is based on its deviation from the average of the total amount of genetic variation in the group of trees tested for a given trait. A feature of the estimation process is that when there is less information for a particular trait, the parent is placed closer to the middle of the rating range for that trait. *GF* and *GF Plus* ratings are derived differently, and there is no direct correlation between a *GF* rating for a particular seedlot and its *GF Plus* growth and straightness ratings. The *GF* rating is an amalgam of growth and form, while the traits are kept separate under *GF Plus*.

> HOW DO THE RATING SCALES WORK?

The trait rating scale is open-ended. Currently the highest rated *GF Plus* material has a maximum trait value of 30. As tree breeding progresses and more advanced seedlots become available, it is expected that higher trait ratings will be achieved. Forest growers are able to use these *GF Plus* trait ratings to help them rank seedlots and so determine the most suitable genetic material for their particular situation. For traits other than branching habit, the higher the rating the better the estimated performance for that trait - for example, a seedlot with a density rating of 23 will have a higher density than a seedlot with a density rating of 18. For branching habit, the higher the rating the more multinodal the seedlot is likely to be. Tree growers seeking increases in clear cuttings timber grades should select seedlots that have a lower branching habit rating. Trial results show that the average internode length in the second log may be increased up to 1.5 metres without incurring stem form problems. The *GF Plus* trait ratings for branching habit generally correlate well with internode index values used in silvicultural modelling software.

GF Plus™ SEED CERTIFICATE

SEED PRODUCER:	DATE:
ORCHARD:	YEAR OF COLLECTION:
	SEEDLOT NUMBER:
NUMBER OF PARENTS:	NUMBER OF CROSSES:
POLLINATION METHOD: CP	

Relying on the information provided by the seed producer this seedlot is rated as:

Pinus radiata

and individual trait ratings are:

GROWTH	STRAIGHTNESS	BRANCHING	DOTHISTROMA	WOOD DENSITY	SPIRAL GRAIN
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Proportion of seedlot rated:

Special Comments:

Manager: _____ Date: _____

An indication of the estimated ratings for an average unimproved seedlot is:

GROWTH	STRAIGHTNESS	BRANCHING	DOTHISTROMA	WOOD DENSITY	SPIRAL GRAIN
11	17	17	15	19	18

Ratings allocated are estimates of the seedlot average. They are developed from data that has differing levels of confidence, thus the more parents involved in a seedlot, the higher the confidence level of the rating. An asterisk (*) after a GF rating infers a less than average confidence level, and a hyphen (-) means that there was insufficient data available to estimate a rating.

When different seedlots are compared strictly under the same conditions the following will usually apply, the higher the rating, the:

Better the expected average growth (diameter).	Better the expected average stem straightness.
More multinodal branching habit of the seedlot.	Greater the resistance to Douthistroma.
Higher average wood density (juvenile wood).	Lower the average incidence of spiral grain.

IMPORTANT

The GF Plus™ trade mark, copyright in this GF Plus™ Seed Certificate and all other intellectual property used in the testing and certification of the seedlot described above ("Seed") and in the creation of, or pertaining to, this GF Plus™ Seed Certificate ("Intellectual Property") belong exclusively to the Radiata Pine Breeding Company ("RPBC"). Without limiting the terms of any terms of supply or licence between you and RPBC, you may not use the GF Plus™ trade mark, copy this GF Plus™ Seed Certificate or otherwise use the Intellectual Property to promote, advertise, distribute or sell any plants propagated by or for you from plants grown or derived from any of the Seed ("Plants") unless you have signed a licence to do so from RPBC. For purposes of clarification, propagated means the propagation of any plant by vegetative means (including, without limitation, tissue culture) for the purpose of producing multiple plants from a single plant.

If you wish to sell Plants, please contact the GF Plus™ Scheme Administrator on 0800 00 GFPLUS

See reverse for further information.

GF Plus™ Seed Certificate

> CAN RATINGS BE USED ACROSS ALL SITES?

Trial sites used to measure genetic performance are located throughout Australasia. Trait ratings, when used as a means of comparison between



Controlled pollination

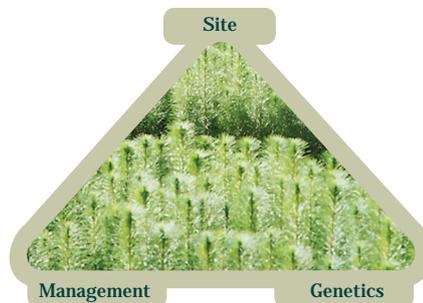
available seedlots, are expected to apply throughout New Zealand. However, forest growers should be aware that the expression of different traits in radiata pine can vary greatly across New Zealand forest sites - for example, independently of GF Plus ratings, average tree wood density can vary as much as 80-100kg/m³ between forest sites on

Northland sands, and in Southland. These site-related effects will provide the environmental background against which the relative GF Plus ratings of different seedlots will perform, and should be taken into account when seed and plant purchasing decisions are made.

> HOW RELIABLE ARE TRAIT RATINGS?

Ratings are for the seedlot described by the seed producer at time of application, using the parental proportions provided. They are an average for the seedlot as a whole and will not necessarily apply to part of the seedlot, each individual tree within the seedlot or if parental proportions are changed (for example, through differential propagation from cutting stool beds or irregular germination). Ratings are based on forest trials and trait performance does not necessarily become apparent in the nursery

bed or in the first few years of forest growth. As a rule of thumb, trait ratings will generally begin to become apparent by age 5-6 in the forest. Genetics alone should not be considered as the key to successful forest growing with site and stand management having a significant impact on actual results achieved.



The use of the GF Plus scheme, through its ranking of genetic quality does, however, assist the forest grower in making informed decisions as to the most suitable planting stock for any particular situation.

> DO GF PLUS RATINGS CHANGE OVER TIME?

The basic data from which GF Plus ratings are derived are taken from forest trials spread throughout Australasia. This is an ongoing programme, with information continually being added to the database. Estimates of parental values that produce seedlot GF Plus ratings are being continually improved. This is likely to result in some rating changes over time. These changes will provide forest growers with the opportunity to make even better selections for the traits or trait combinations considered to be important in their forest estates.

> WILL NEW TRAITS BE INTRODUCED?

The RPBC research and development programme is looking at the genetic influence of other key wood quality traits such as stiffness, internal checking and resin pockets. Once ratings are available for new traits it is anticipated that they will be introduced into the GF Plus scheme.

> NEED FURTHER INFORMATION?

This brochure contains an introductory summary only of the genetic rating of radiata pine. If you would like further information please contact your seed producer, nursery grower or the GF Plus Scheme Administrator (ph 0800 00 GFPLUS).

PLEASE NOTE

None of the NZ Forest Research Institute Ltd, RPBC or the seller of any plants or seed to which a GF Plus Seed Certificate may relate, will be liable to any person in contract, tort (including negligence) or otherwise for any loss or damage, including, without limitation, loss of profits or any other indirect or consequential loss arising directly or indirectly from the GF Plus trade mark, the GF Plus Seed Certificate or their use.