

Is genetic quality important?

Making the right decisions when you are planting is important for all forest growers. The most important ones are to choose the right species-site combination and to use the best establishment techniques (Matching species to sites, Technical Information Sheets No. 5, Site Preparation No. 14, Planting, No. 16, Fertilisers, No. 17, Weed Control, No. 15). There are four sorts of genetic decisions that a tree grower has to make – these have direct parallels with other agricultural enterprises (see Table 1).

Always choose the best material that is available. This is because usually the price you have to pay for improved material of the major commercial species is not as great as the benefit that you get from having it. However conditions in the seed/seedling market may mean that the market price is unreasonably high at times. In the table below (Table 2), I have shown for a number of forestry options how much extra you could pay at establishment for improved stock for every 1% increase in growth and still break even.

Table 1: Parallels with other agricultural enterprises

Which species?	Pines or eucalypts	Sheep or cattle?
What provenance (breed)?	King Island or Geeveston, for blue gums?	Merinos or Leicesters, for sheep?
Choose improved stock?	Seed orchard rather than native forest seed?	Stud rams rather than any ram from your flock?
Choose a reputable source for your best genetic material?	Get certified genetic stock if possible?	Obtain stud ram of certified quality (see pedigree papers) ?

Table 2: Extra amount (in \$ per 1000 plants) you can afford to spend at establishment for every 1% increase in growth

Species	Product	Site productivity	Management regime	Clear fell age (yrs)	Extra amount
Radiata Pine	Veneer/appearance	High	Multi prune & thin	30	\$34
Radiata Pine	Veneer/appearance	Low	Multi prune & thin	35	\$32
Radiata Pine	Structural & pulp	High	No prune, multi thin	35	\$21
Radiata Pine	Veneer/appearance	High	Low stocking, multi prune & waste thin	25	\$103
Radiata Pine	Veneer/appearance	Low	Low stocking, multi prune & waste thin	35	\$65
Eucalypt	Pulpwood	High	Short rotation	15	\$14

The table assumes 1998 costs and a 7% interest rate and a 10% higher tax on income than expenditure. It also assumes that increased growth will allow earlier harvesting and reduced stocking. This will reduce wood quality a little, but this is offset by breeding. Other traits are ignored.

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For example, consider situation (1) for *Pinus radiata* in the Table 2 above, where you have a choice between 2 sorts of planting stock, one of which grows 10% faster than the other. You are growing it for veneer and appearance grade products on a highly productive site (good soils and high rainfall) with a multi-prune (pruned in several lifts) and thinning regime for 30 years. You can afford to pay an extra \$340 (\$34 x 10%) for every thousand seedlings for the better quality planting stock. The prices for radiata pine seedlings are about \$150-500 per thousand, so to justify paying the extra \$350 per thousand for the most expensive stock you will have to be sure you are getting more than the additional

10% in growth, or some other benefits, to make investment worthwhile.

Although the best clonal material of radiata pine may be certified, seed certification (for eucalypts and pines) is not currently available, so claims by seedling suppliers are not easily substantiated. However, major seed suppliers (e.g. Southern Tree Breeding Association and its members) are beginning to provide this information to nurseries, so ask for it.

In general, the higher the value of the crop at harvest, the more you can afford to pay for improved stock.

How is improvement achieved?

Tree breeding is a very sophisticated science. Its value to farm forestry lies in the improvement in the quality of planting stock. Improvement in genetic quality is achieved by two steps:-

1. Breeding (see 'The breeding cycle' below).
2. Multiplication - the bulking of stock from selected trees.

After each cycle of breeding the selected traits will improve. How much improvement occurs depends on what traits were selected, how these traits are related to one another, and how intense

the selection was. In most breeding programs, a 10% improvement in growth can be expected for each generation of breeding. Traditionally trees have been selected for high growth and good form (small branches and straight stems). More recently there has been greater emphasis on wood quality traits such as wood density. This has arisen from a greater understanding of the economics of tree growing.

Multiplication

A multiplication system (e.g. cuttings or seed) may itself enhance or diminish the gains achieved through breeding.

Breeding Improves the genetic quality of the planting stock

To start the breeding cycle you must have some **base trees (A)**. Initially these must come from **native forests**, but they may also come from existing **plantations**. Unimproved seed is collected.

The **seedlings** from different **base trees** are planted together in **trials (C)** to compare them.

The **trials** are **grown** for three to ten years and then

commercially important traits are **measured** and the best trees **selected (D)**

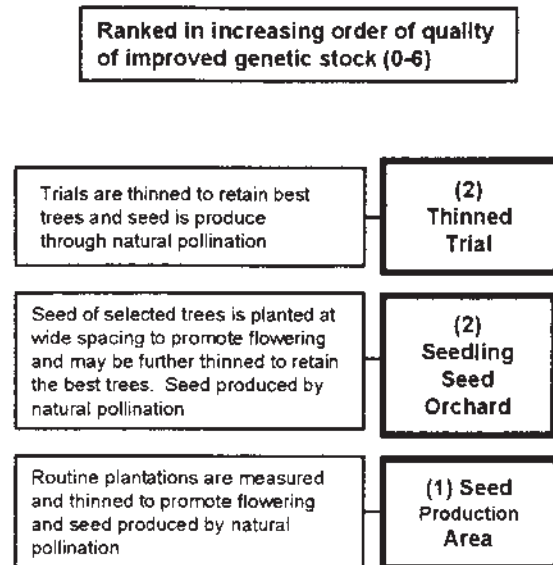
When the **selected trees** flower, they are **mated** to produce improved **seed (E)**, and the cycle can start again.

- Breeding stock is improved with each cycle of breeding. In each cycle the increase in genetic quality (usually about 10%)

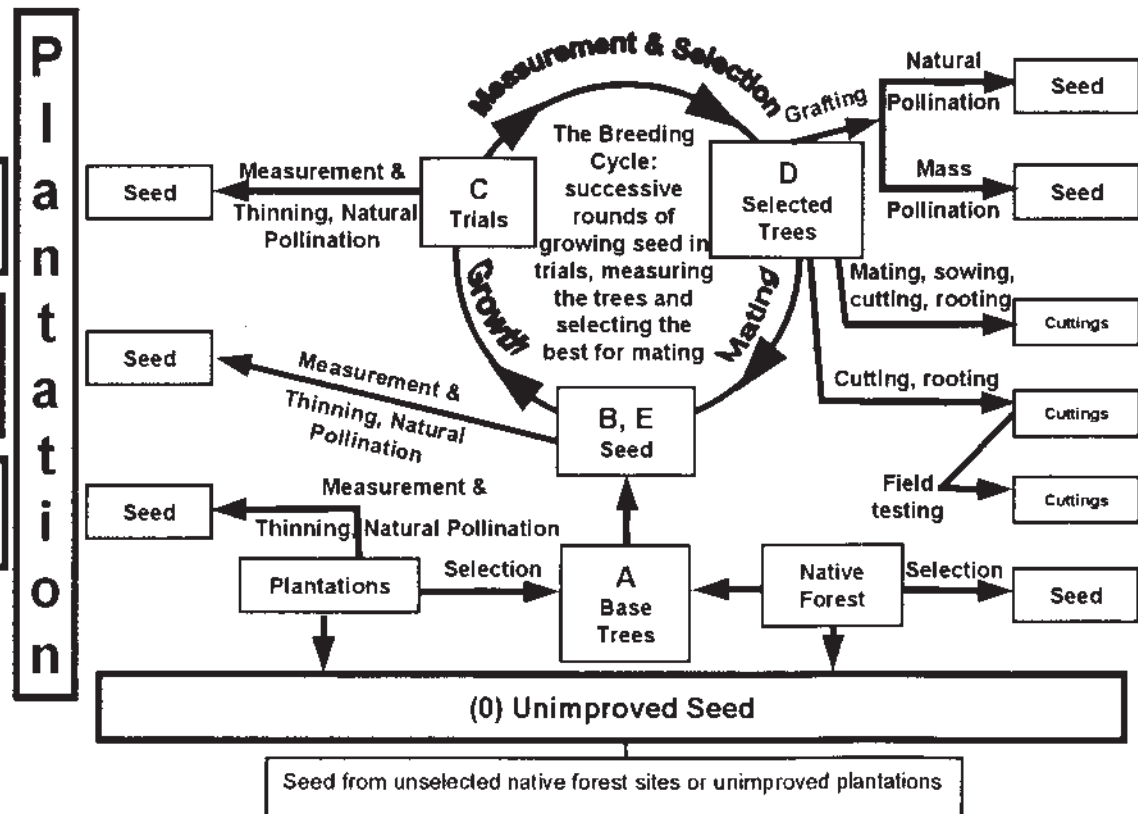
depends on the traits measured and the intensity of selection.

- The best quality plantations are produced from the best breeding programs.

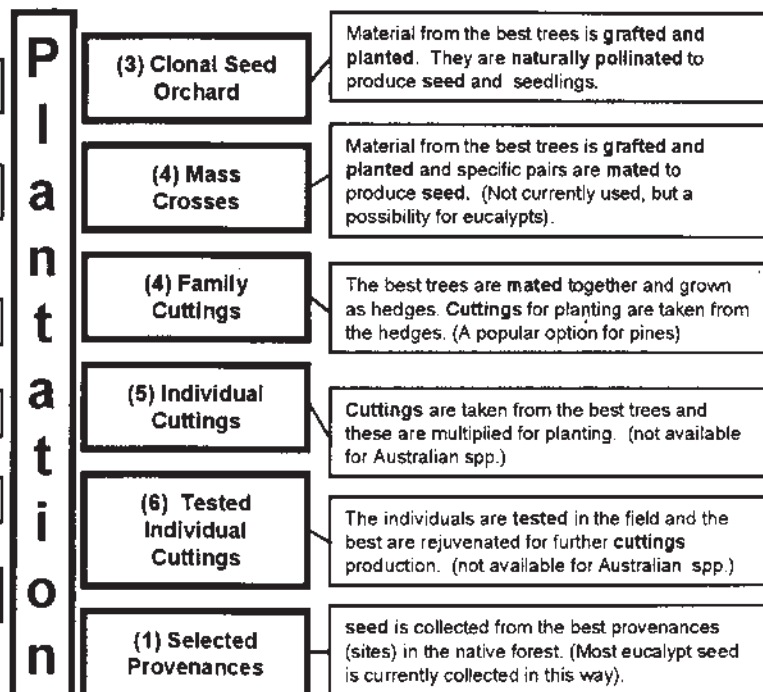
Multiplication Systems



The Breeding Cycle



Multiplication Systems



By seed

Seedlings grown from a selected tree will have some of the traits of that tree (the mother) but also traits of the paternal tree (the pollen parent). This may reduce or increase the value of the seedlings relative to the mother.

Other factors which might affect seed quality include:

- Seed from an isolated tree will be inbred because there are fewer potential father trees and there is a greater likelihood of self fertilisation. Seed should only be collected from trees in dense stands
- Trees used for seed production should be spaced widely to promote flowering. This can be achieved by thinning closely planted trees or by planting at wide spacing.
- Seed orchards are a good seed production system if a wide range of unrelated parental types are grown in close proximity to each other, leading to a low likelihood of inbreeding.
- In a seed orchard poor flowering and lack of overlap in flowering time may reduce the range of potential pollen parents and lead to inbreeding.
- The location of seed orchards is also important. Those close to routine plantations could suffer pollen contamination from poor quality trees.

By cuttings

Many tree species can be propagated vegetatively. However, selected elite trees of pines and eucalypts are too mature at selection to be propagated directly. This problem is overcome by using cuttings from selected families (the progeny of pairs of trees) rather than the trees themselves. This gives genetic variability within the cutting stock so genetic diversity is maintained.

Hybrids

When you cross two closely related tree species e.g. *Eucalyptus globulus* (blue gum) and

E. nitens (shining gum) to produce a hybrid, in some situations you can combine the characteristics of both species in such a way that the hybrid outperforms the parent species. This has not generally been found to be the case for the temperate commercial species. However hybrids of tropical pines and eucalypts have been used extensively. Specific hybrids also have been developed for extreme conditions, such as high salinity, but for commercial plantations such planting sites are best avoided.

What traits have been selected for?

In *Pinus radiata*

There are two main breeding programs from which seed might be available those of the Southern Tree Breeding Association (STBA) in Australia and the New Zealand Forest Research Institute (NZFRI).

STBA are selecting for growth and form, high wood density, *Phytophthora* die-back resistance, and *Dothistroma* needle blight resistance.

NZFRI are selecting for growth and form with a combined trait ranking system called the GF scale. In addition there are selection programs for long branch internodes, *Dothistroma* resistance, spiral grain and wood density.

In *Eucalyptus*

The main breeding program for *Eucalyptus globulus* is that of the Southern Tree Breeding Association (STBA). However a number of companies have breeding and seed orchard programs for *E. globulus* and *E. nitens*.

In the temperate eucalypts, *E. nitens* and *E. globulus*, most selection in Australia has been for a combination of fast growth and high wood density.

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Further Information



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