

## It all comes back to good breeding

By Dr TA (Tony) McRae

Plantation growers and private foresters must plant genetically improved trees on their land if they are to generate maximum profits at harvest time, says Dr Tony McRae, the General Manager of the Southern Tree Breeding Association.

Based in Mount Gambier SA, the Southern Tree Breeding Association (STBA), manages the national genetic improvement programs for the major plantation species of Pine (*Pinus radiata*) and Blue Gum (*Eucalyptus globulus*). The STBA is a tree improvement cooperative with 17 industrial members and five research members. The STBA breeds genetically elite trees specifically adapted to Australian conditions. Members of the STBA value genetic improvement and cooperate to maximise the genetic quality of material planted in their own plantations or customers estates.

In the long term, the difference in cost between purchasing low quality unimproved material and the best elite genetic material is small, given the potential returns from trees grown from improved genotypes. Unfortunately, some foresters focus on costs per plant at establishment, rather than the extra hundreds and thousands of discounted dollars extra per hectare realised at harvest.

It's all about making the right business decision. You might save a couple of bucks this year, but condemn your plantation or tree lot to producing unsaleable worthless timber.

The buyer of forest products is becoming more discerning and product quality is increasingly important to the grower. Growers using the best genetics will have a competitive advantage in the market place. On a plantation basis genes may contribute up to half of the differences observed among trees in a stand for a given character. It would be smart just to have the good ones growing.

Members of the STBA wisely pay up front for the development of elite genetic material. This minimises risk, guarantees genetic gain and quality, and is usually the cheapest option. However, non-members can also access elite material by purchasing seed and/or plants from STBA members and/or seedEnergy Pty Ltd (trading under licence). Purchases made by non-members are subject to a royalty.

### WHAT IS GENETIC IMPROVEMENT?

The performance of an individual tree results from a combination of the environmental conditions in which the tree grows and its genetic make up. Environmental conditions can include temperature, sunlight, rainfall, soil type, disease incidence and silvicultural practices. Different trees contain different combinations of genes. It is these genetic differences that explain why trees from different species, provenances (localities), families and individuals within families perform differently under the same set of environmental conditions.

The process of natural selection and evolution has been responsible for the development of naturally interbreeding populations of trees that are specifically suited to the environmental conditions found in particular provenances of native forest. Tree improvement programs make use of this natural variation among trees, but speed up the evolutionary process to genetically improve the species by intensive breeding and selection.

Breeding is all about sexual preference. Tree improvement is all about breeding, testing and selection of proven performers. In native forests a female (flower) has little control over its choice of male partner (pollen), providing they are sexually compatible. In tree breeding, the geneticist deliberately interferes with the sexual and social behaviour of trees by artificially cross-pollinating a female with specific male pollen. This interference allows us to mate good female parents with good male parents for any given trait or character.



STBA eucalypt breeder David Pilbeam demonstrating voyeuristic tendencies, checking flowers in the STBA breeding arboreta located at Manjimup in WA.

Full sib progeny (sons and daughters) are produced from a specific cross (family with same parents) and will share genes in common. Although sibs are genetically similar, as are brothers and sisters, they are also genetically different as only a sample of half of their genes are inherited from the mother (ovule) and the other half from the father (pollen).

The breeding value of a parent is the average genetic worth of the genes passed from the parent to its progeny. Usually the mean performance of progeny from a given family is best predicted by the average of the parental breeding values. Brothers and sisters are genetically different with a range in breeding values due to Mendelian sampling, the average being midway between the parents. Some will be above average and some below.

More importantly, a few will be genetically superior to both parents. The opportunity for tree breeders is to identify and select these elite siblings from a good family and use them as parents in future crosses. By replacing parents with better progeny in a breeding program, we can systematically improve the genetic quality of the population over generations and time.

The magic ingredients for rapidly capturing genetic gain include plenty of heritable genetic diversity for the trait of interest, quality data, a high selection intensity (select few elite from the many available) and, a rapid turnover of generations (run faster).

### IT GETS MORE COMPLICATED

In theory the process of genetic improvement is simple. However, in practice the science can get complicated. Identifying individual trees that are genetically superior can be difficult because environmental effects can mask performance and underlying genes. That is, we are unable to 'look up a trees genes' because the appearance (growth, form, wood quality and disease resistance) of a tree is determined jointly not only by its genes but also growing conditions. A bit more fertiliser or water and a tree will grow better relative to its neighbour.

We may just pick a show pony if we select visually without allowance for this unfair advantage. Pigs are a good analogy. The runt of a litter may have the best genes but is out competed for resources by its bigger bullying brothers. However, use the runt as a parent and its progeny may grow faster than the progeny of its porky siblings.

Carefully planned and designed experiments (progeny tests) are used to separate the genetic (G) and environmental (E) effects in tree improvement programs. A further complication can arise where different genes are desirable for different growing conditions. It's a matter of horses for courses. For example, the best genotypes in a wet climate are not necessarily the best for drier regions. This change in ranking of genetic performance of trees is usually referred to as GxE interaction.

It is for these reasons that the STBA plants many genetic trials spread geographically across southern Australia for both *P. radiata* and *E. globulus*. Each replicated trial may contain up to 400 different families with about 15-20 full sibs per family per site. Each tree is measured for important tree characteristics during its life such as growth rate, stem straightness, branch size and angle, disease resistances, wood properties and pulp yield. Clearly, the breeding population gets into the hundreds of thousands of trees very quickly with massive amounts of data and information collected. Sometimes some families are not planted in all trials due to a lack of seed.

Analysing the data with robust statistical methods is required if we are to get to the truth, tease out the noise, and quantify the genetic differences among all trees and families. Until recently the tools for this task were deficient. The first task is to store all the information in a centralised database. The STBA has developed a modern database for storage and retrieval of information via the internet for the national *P. radiata* and *E. globulus* programs. This allows field technicians and geneticists to input and access information (pedigree and trial layout) from remote field sites distant from Mount Gambier. It also allows registered forestry companies to access current breeding values via the web.