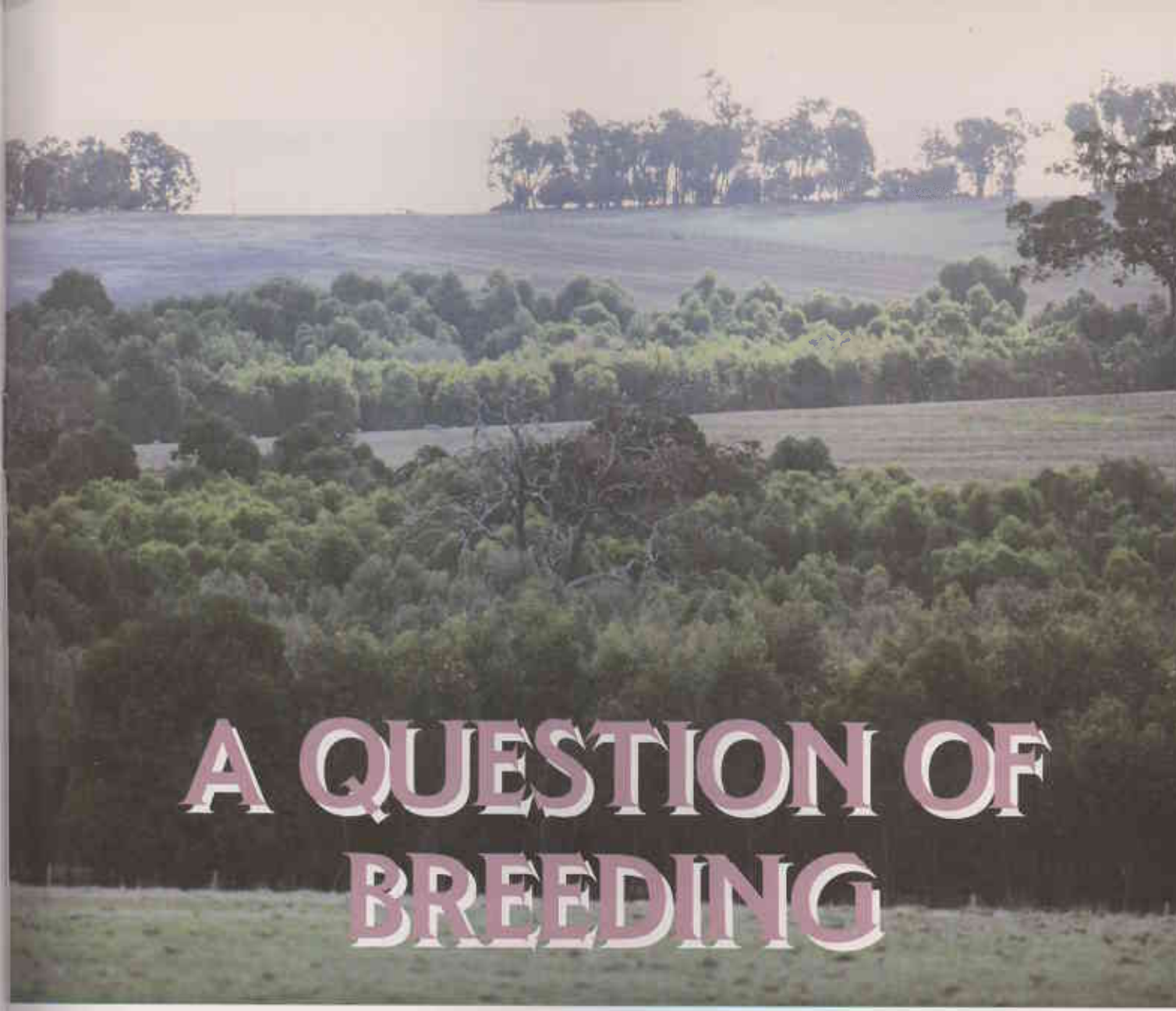

# A QUESTION OF BREEDING

by John Bartle,
Trevor Butcher and
Richard Mazanec

**In planning a tree-planting program the grower will naturally ask, 'What species should I plant?' But this is really only the first question. For the discerning planter, just as for the knowledgeable farmer, planting stock quickly becomes a question of breeding. Which seed source for that particular species will give the best results?**

MOST agricultural plants and animals have been subject to careful selection and breeding over many generations, and well-bred seed or stock is readily available. Tree breeding has also been a long-established practice in pine forestry. But the process of genetic improvement has only just begun in eucalypts.

For most of the eucalypts the only available source of seed is native forests. In any wild population of a species, a diversity of attributes can be found; this means that there is scope to select seed which has the most desirable of these attributes.

Some species have such a large variation across their range that they can be divided into subspecies. For example, there are four recognised subspecies of Tasmanian bluegum (*Eucalyptus globulus*). Each can be distinguished by the number of flowers in each cluster and the size and shape of the fruit. Trial plantings in the lower South-West of WA have shown that these subspecies also differ from each other in vigour and in production of wood.

Even within a species or subspecies, where the differences in appearance are small, there may still be important differences in adaptation and performance. For example, river red gum (*E. camaldulensis*) from the Lake Albacutya district of western Victoria is recognised around the world as the best seed source for planting in winter rainfall climates. Such a distinctive, geographically defined variant is called a *provenance*. Information on provenance variation, which is demonstrated through carefully designed trials, is a very useful guide to better tree-seed selection.

Large-scale tree-planting along streams in the Wellington Catchment is used to arrest salinity and produce timber. Genetic improvement will enhance the tree's performance.
Photo - Robert Garvey▲

There is also some variation between individuals within a provenance. Some trees are dominant and display other desirable characteristics, which will be inherited to some degree by their progeny. Seed collection should therefore focus on the superior trees within the stand.

## BREEDING BETTER SEED

The genetic improvement which can be gained just by careful selection of wild seed is valuable, but limited. There is potential for much greater advances by active tree breeding, which involves the production of seed after crossing selected, planted trees. In its simplest form, the selected parent trees can be in an already established plantation, as long as this has been grown from the seed of a large number of parent trees of the best provenance. Such an area (called a 'seed production area') will produce seed that will grow more vigorously than from wild seed of the same parent trees produced in the wild.

This is because of the 'neighbourhood inbreeding' effect which occurs in natural stands. Since pollination and dispersal of seed in eucalypts occurs over only a limited distance, each 'neighbourhood' consists of partly related individuals. Therefore, natural 'outcrossing' can commonly be between partly related individuals, resulting in seed that is slightly less vigorous. The random mixing of seed from the many parent trees used to establish the seed production area breaks the neighbourhood inbreeding effect.

This is why a seed production area should be grown from the seed of widely spaced parent trees. An investigation of the size of the neighbourhood inbreeding effect carried out on mountain ash (*E. regnans*) in Victoria showed a 12 per cent reduction in volume of wood grown to four years of age.

A stand of superior bluegum parent trees near Busselton, used as grafting stock and for seed production.▲

Mature trees are stimulated to produce shoots used for tissue culture and grafting.◄

Young seedlings have been established in a breeding trial near Mumballup. Photos - Trevor Butcher▼

## SEED ORCHARDS

A more advanced stage of managed seed production is to establish seed orchards of selected superior stock. There are two main types of seed orchards. Firstly, the superior trees can be multiplied by cloning. This bypasses sexual reproduction (seed) and preserves the full genetic superiority of the parents. Cloning techniques include grafting, cuttings or various laboratory culturing methods known as micropropagation (including tissue culture). Superior trees multiplied in this way can be used to grow clonal seed orchards. Secondly, seed can be collected from superior trees to produce conventional seedlings for planting in a seedling orchard. Since the seed from the parent trees has been 'open-pollinated', the transfer of the genetic superiority of the parents to the seed orchard is not so efficient. However, it is a lot cheaper and easier to do.

The most improved seed is produced when superior trees placed in seed orchards are generated from a well-designed breeding program. Breeding activity is centred on a population which is established from 'families' of seed

collected from good-quality trees across the full native range of the species or provenance. Repeated cycles of selection, crossing and testing, carried out with meticulous recording of individual and family pedigrees, will produce continuous genetic improvement. This is the stage to which pine tree breeding has advanced in many parts of Australia.

With the expected development of large-scale automated micropropagation techniques, it may become economical to bypass the seed orchard. Superior trees could then be directly multiplied by micropropagation to produce the field planting stock, saving years of time by not going through the seed production step. To facilitate this practice, the creation of an elite nucleus in the breeding population will conveniently package the outstanding genetic material. The first species of eucalypt to which micropropagation has been applied in WA is river red gum. Clones selected for salinity tolerance are now available.

Another important benefit of commercial micropropagation is its application to hybrids (crosses between species). Hybrids can give combinations of traits that might not occur naturally. For example, a hybrid of bluegum and river red gum might combine the rapid growth and good pulpwood qualities of the former with the waterlogging and salinity tolerance of the latter. Being infertile, such hybrids can only be propagated vegetatively. Rapid improvement in the yield of eucalypt pulpwood has been achieved by this method overseas, especially in Brazil.

## EUCALYPT BREEDING IN WA

Work to increase the range of species and improve the quality of eucalypt seed in WA began in the early 1980s. A major program of seed collection to form breeding populations of eastern states species suitable for rehabilitation of bauxite-mined areas was commissioned by ALCOA in 1982. This has given the State high-quality breeding stock of many species, which are also valuable for rehabilitation of degraded farmland, wood production on farmland, and amenity planting. CALM has augmented this work with collections of local species, mainly the major forest zone species: jarrah, karri, marri and wandoo.

Good breeding populations have now been established for 16 species. Intensive breeding work will be confined to a few major species, such as Tasmanian bluegum, due to its importance to the infant farmland-based pulpwood industry. There will be somewhat less intensive testing and selection of other species and the breeding populations will function mainly as seed production areas. Improved seed should start to become available in three to five years' time.

There is a pressing need to extend genetic improvement to other native tree species, especially for planting in the Wheatbelt. This work would aim to secure what is left of the genetic diversity of these species, establish it in seed production areas, and provide outcrossed seed for planting. Such outcrossed seed would greatly enhance the prospects of these species coping with the extreme change that has been imposed on their environment.

The size of this task is very large. One way in which it might be done is with the support of farmers and other enthusiasts. For example, a Keysbrook farmer, Neil Kentish, and his nursery man, Bob Harrington, have made a collection of *E. lane-poolei*. This is a rare species which occurs as small scattered populations on farmland along the foot of the Darling Scarp from Mundijong to North Dandalup. CALM is keen to encourage this type of commitment and can provide technical advice on how it can best be done.

Genetic improvement offers long-term gains in the performance of productive trees and in the protection of local species. It will be the foundation of the diversity and success of trees in our rural landscape in the next century.

SPECIES OF EUCALYPTS UNDERGOING GENETIC IMPROVEMENT IN WESTERN AUSTRALIA

| SPECIES | COMMON NAME | 1 | 2 | 3 |
|---|---|---|---|---|
| *E. globulus* | Tasmanian bluegum | 1980 | high | 1995 |
| *E. resinifera* | Red mahogany | 1986 | low | 1993 |
| *E. maculata* | Spotted gum | 1985 | med | 1993 |
| *E. saligna* | Sydney bluegum | 1987 | med | 1995 |
| *E. pilularis* | Blackbutt | 1987 | low | 1995 |
| *E. muellerana* | Yellow stringybark | 1988 | med | 1998 |
| *E. botryoides* | False mahogany | 1989 | high | 1998 |
| *E. viminalis* | Manna gum | 1991 | high | 2000 |
| *E. camaldulensis* | River red gum | 1984 | med | 1998 |
| *E. sideroxylon* | Red ironbark | 1986 | med | 1998 |
| *E. microcarpa* | Grey box | 1986 | med | 1998 |
| *E. wandoo* | Wandoo | 1983 | med | 1995 |
| *E. accedens* | Powderbark wandoo | 1984 | med | 1995 |
| *E. marginata* | Jarrah | 1988 | high | 2000 |
| *E. diversicolor* | Karri | 1980 | med | 1995 |
| *E. calophylla* | Marri | 1992 | med | 2000 |

1 Date of establishment of breeding population
2 Current priority for breeding work
3 Expected date for beginning the production of improved seed

Grafting is used to produce large numbers of superior trees from a single individual.
Photo - Trevor Butcher▲

John Bartle is working on revegetation of disturbed land, while Trevor Butcher and Richard Mazanec run the genetic improvement program on eucalypts. For further information contact CALM's Como Research Centre, (09) 367 0299.

*Rock-wallabies threw down the gauntlet to scientists trying to trap them for research. Who ended up winning the catch-me-if-you-can contest?*
*See page 35.*

*Shells, tiny crabs and sundry other creatures are sure to please the curious naturalist who invades the intertidal zone at low tide. Explore the place where the shore meets the sea on page 23.*

*Waterbirds flock to the Vasse-Wonnerup wetlands in their tens of thousands, some travelling over 10 000 kilometres from summer breedings grounds in northern China and Siberia. Turn to page 17.*

# LANDSCOPE

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*Scientists will use modern technology to restore two rare and endangered mammals to an area in the Gibson Desert from which they have become extinct.*
*See page 10.*

*It's the burning question! Is prescribed burning in spring or autumn better for the jarrah forest? Or is there another alternative?*
*See page 28.*

## FEATURES



## REGULARS



## COVER

The designs of desert artist Benny Tjapaltjarri show events associated with the Pakuru or golden bandicoot dreaming in the Gibson Desert. The three central roundels depict rockholes and the others represent hills. The background dots show the vegetation of the area.

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