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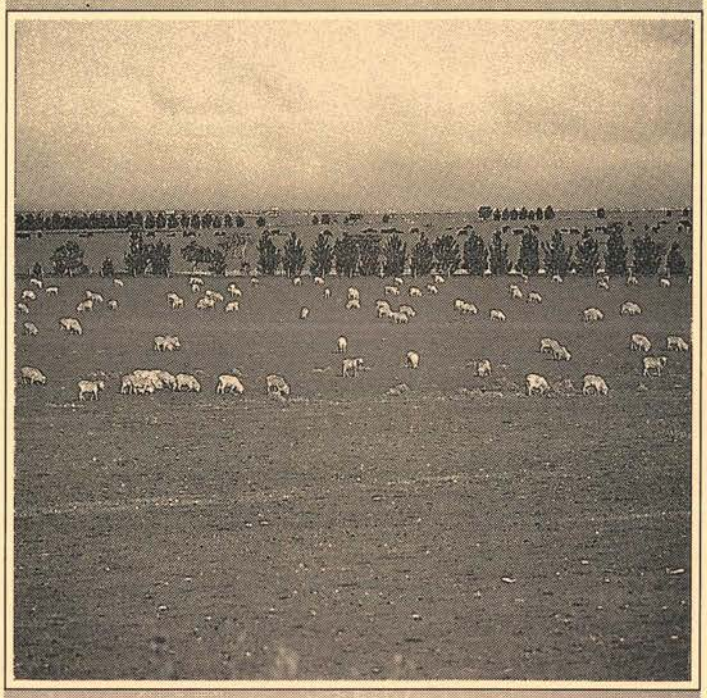
Trees for farms



Compiled by officers of the
Department of Agriculture
and the
Department of Conservation and
Land Management

Editor K.M.W. Howes

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Trees for farms

Preface (2nd Edition)

In this 'Decade of Landcare', tree planting on farms is a major objective. But long before 'Plant trees' became the catchphrase, farmers were aware of the benefits to be gained from tree planting—reduced salinization, reduced erosion and reduced flows of nutrients into waterways.

In recent years there has also been a growing awareness of the direct financial benefits that can be derived from plantations. Timber is becoming more valuable and farmers are now contributing significantly to future timber and woodchip supplies for Australia.

This Bulletin is an updated and revised edition of a book produced in 1986 under the aegis of the Boyup Brook Soil Conservation District Committee. Its aim is to provide prospective tree planters, whether they are doing it for reasons of beautification, conservation or commercial use, with a 'recipe book' of how to establish trees.

There is some repetition between individual chapters but this is intentional. Each chapter is meant to stand alone, without irritating cross-referencing.

Acknowledgements

This Bulletin is heavily dependent on contributions from officers or former officers of the Departments of Agriculture and Conservation and Land Management.

Individual chapters do not carry a by-line but I would like to acknowledge the invaluable input (either directly or by my plagiarism of their writings from elsewhere) by:

Ken Angel[1], David Bicknell[2], Peter Eckersley[1], Roger Edmiston[2], Leon English[1], Malcolm Green[1], Michael Grimm[1], Alec Hart[2], Kerry Hawley[1], John Humphreys[2], Phil Michael[1], Tim Negus[1], Gerry Parlevleit[1], Alan Thamo (Small Tree Farm, Balingup), Alan Walker[2] and Peter Whale[1].

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K.M. W. Howes
Editor

Native seed collection

Introduction

This chapter outlines techniques and equipment required to collect seed from the major genera of local flora. Seed can be collected for immediate use or for storage and future use.

Permits are required if you intend to collect seed for commercial purposes or from areas of Crown land. Collection is prohibited in National Parks and gazetted rare species cannot be collected anywhere. Contact the Department of Conservation and Land Management for full details.

Flowers and seeds

Potentially good seed crops can be identified by recording where patches of the desired species is flowering heavily.

Provided fertilization has taken place, seed will begin to mature in the fruit. Development of a good seed crop following heavy flowering can be upset by:

- sustained cold, windy weather;
- sudden drought;
- lack of birds or insects to complete pollination.

Seed collection

Fresh seed is more viable than old, stored seed. Therefore match the amount you collect to your short-term needs. A few ripe fruit will often suffice.

Before collecting any fruit be sure that you know:

- the time(s) of year when ripe fruit can be picked;
- what ripe fruit looks like.

The fruit of the various species can be divided into two major groups:

- species with persistent woody capsules or fruit;
- species which shed their seed annually.

However, even within a genus there can be considerable variability.

Species with persistent woody capsules or fruit

Some species (for example species from the genera *Banksia, Callistemon, Hakea, Melaleuca* and *Eucalyptus*) retain woody capsules or fruit on the parent plant for a long time and release their seed after some stimulus such as fire or the plant's death.

With the Myrtaceae family (eucalypts, melaleucas, callistemon) the first indication of ripeness is the dark colour and woody texture of the fruit. In addition, on eucalypts and other Myrtaceae with large fruit, the valves - at the top of the fruit - turn brown and begin to separate when the fruit is ripe. Most of the Myrtaceae family carry a series of fruit crops at different stages of ripeness and the ripe fruit are further back on the branch. Check the valves are not already open and seed dispersed.

For the majority of these species, seed can be collected nearly all year. However, it is advisable to collect during the warmer months when fruit can be air dried to extract the seed.

Species which shed seed annually

Species which shed all their seed annually, do so after a relatively quick ripening period and the seed itself is shed over a relatively short period of time. Examples include many of the understorey species such as the native legumes (e.g. acacias and kennedias).

Most of this category, depending on the species, shed their seed between October and December. As the green pod changes towards brown and the texture becomes drier and more brittle, the seed matures. At this stage they must be watched carefully as one hot day in early summer can 'pop' most of the seed on the bushes.

Collection

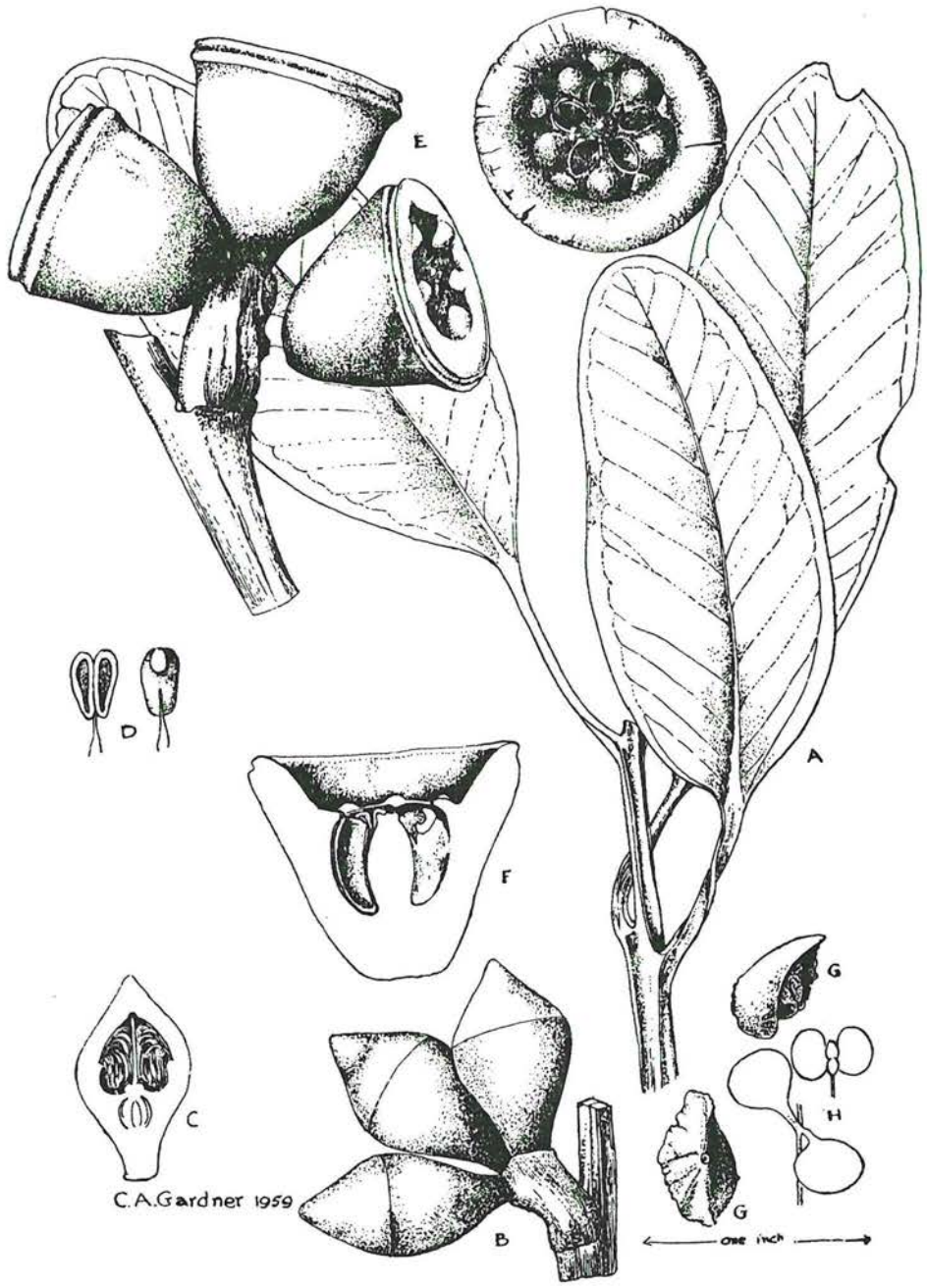
When the fruit is ripe, either individual fruits or heavily laden small branches can be removed, making sure the minimum of damage is done to the parent plants. Collect fruit off the tree because those on the ground are generally empty or will have been attacked by insects or fungi. Place in bags (either paper, cloth or wheatbags), plastic rubbish bins or in the back of a ute for transport to a central area for the extraction of the seed. Do not use plastic bags.

Equipment and collection techniques

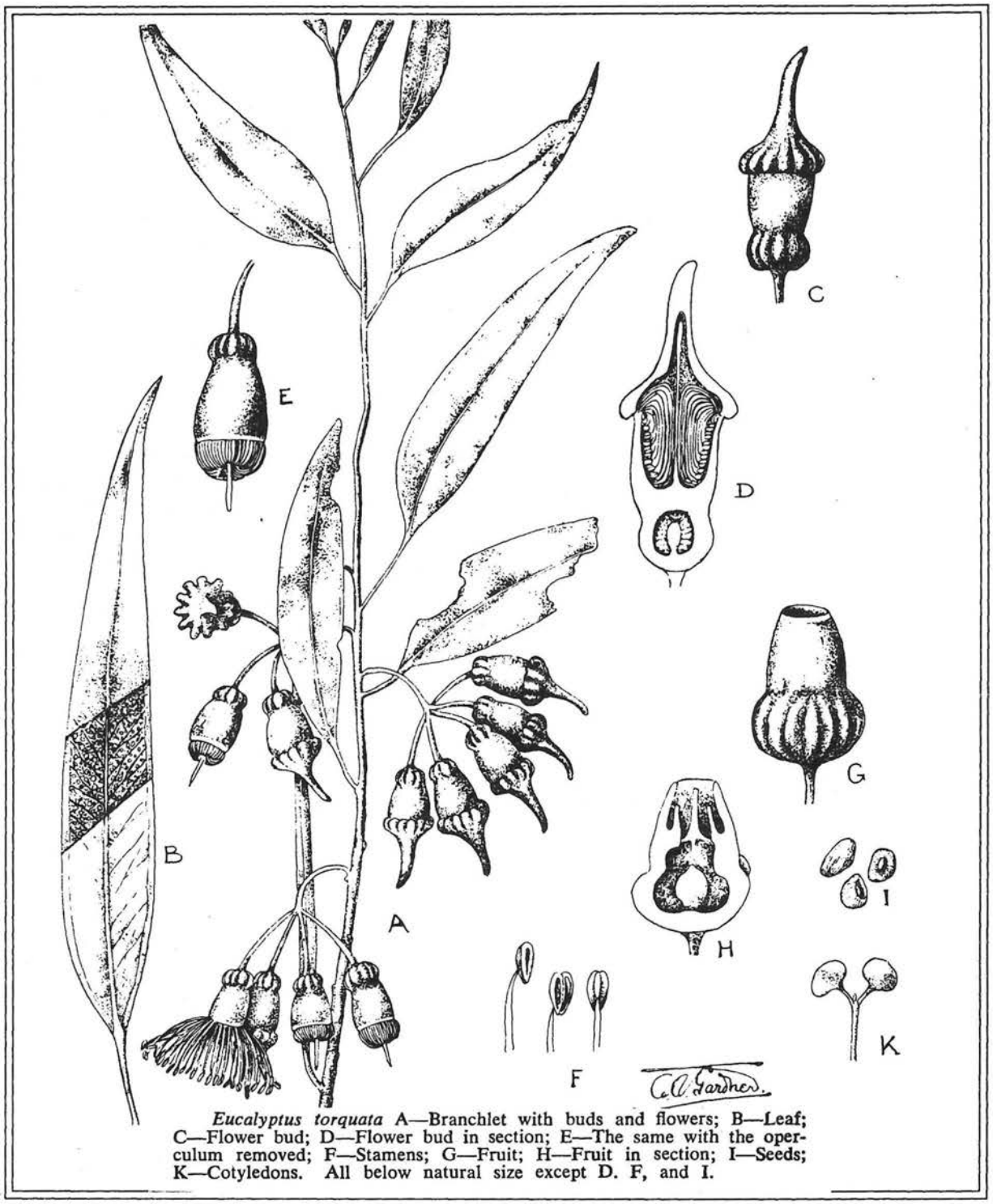
The techniques and equipment used to collect the ripe fruit depends on the amount of seed required and the height of the fruit above the ground. Fruit from the majority of low growing species is relatively easy to collect using secateurs or pruning equipment available in most hardware stores. Gloves may be required.

Tall trees require special equipment and techniques to avoid destroying the parent plants. These include:

- extendable pole pruners or pole saws (to 3 m in length), and/or a sturdy, stable ladder brings the crowns of many smaller trees and shrubs into reach;
- throwing a rope over small branches and snapping them off. For the serious collector a 'commando-saw', a length of flexible saw with ropes on either end, can be used to a height of 10 m. This method requires



Eucalyptus preissiana A—Branchlet with leaves; B—Flower buds; C—Section through flower bud; D—Anthers; E—Fruits; F—Section of fruit; G—Seeds; H—Expanded cotyledons.



Eucalyptus torquata A—Branchlet with buds and flowers; B—Leaf; C—Flower bud; D—Flower bud in section; E—The same with the operculum removed; F—Stamens; G—Fruit; H—Fruit in section; I—Seeds; K—Cotyledons. All below natural size except D. F, and I.

some skill in positioning the saw. Horizontal branches are easier to saw than those with acute angles to the tree;

- collecting from very high trees is hazardous and should only be done by experienced people who have proper safety equipment.

Extraction

The method used to separate seed from the fruit of various native species depends on:

(i) the climatic conditions which prevail where seed is to be extracted;
(ii) the characteristics of the seed or fruit of each species; and
(iii) the size of the collection.

The most economic methods of extraction for most species are:

(a) air drying, particularly in the drier areas of Western Australia and during the warmer months of the year;
(b) oven extraction, in areas of high humidity.

Air drying

Large collections

Place large collections of fruit or branches on a canvas tarpaulin or plastic sheets in a well-ventilated position of partial sunshine (e.g. in a shearing shed) until the seed is shed. In warm weather direct sunshine will overheat the fruit and kill much of the seed. Most species will shed their seed within 7 to 21 days. Wait until most of the fruit has opened or split, then shake the branches to dislodge all remaining seed. Remove empty fruit and branches. Put the seed in paper or cloth bags.

Small collections

Place the fruit in ventilated containers such as paper or cloth bags. An open plastic container can be used provided capsules are spread out evenly over two to three layers, thus allowing for air to circulate between the fruit.

Oven drying

When humidity is high, put lots of capsules into strong paper bags before placing in a kitchen stove at about 60°C. The door of the oven should be partially open, depending on initial heat of the oven. Capsules can be left overnight and removed in the morning.

For extraction of bulk collection in humid localities large drying ovens are required.

Special treatments

Banksia

Place the cones in an oven at 80 to 90°C or scorch the cones in an open fire. Immediately after the heat treatment submerge the cones in water. Allow to dry. If the follicles are open wide, vigorously jar the fruit to remove seeds. If follicles are still closed, repeat the procedure.

Dryandra and Hakea

Place the fruit in an oven at 80 to 90°C. The seed will be released if it is fully mature. Do not exceed these temperatures as high heat will damage the seed. Hakea species hold their typical black, winged seeds strongly within a woody fruit, which will require more than the usual drying time to release seed.

Some legumes

Some species of legumes such as carob beans and a few acacias hold their seeds tightly within their pods. It may be necessary to pass the acacia fruit through a hammer mill or, in the case of carobs, soak them in water before the seed can be separated. Screen the softened carob mass and dry the seed. An alternative is to soak the carob pods for 24 to 28 hours until the pod softens, then use a knife to open the pods and extract the seed.

Cleaning the seed

After extracting seed from the capsules or cones, some cleaning of the sample is desirable to remove fragments of leaf, small twigs, empty capsules or foreign matter such as dust and soil particles. The easiest way to remove these impurities is to sieve the sample through suitable screens.

Seed storage

Essential matters in seed storage are:

- moisture content;
- temperature of storage location;
- storage containers;
- insect infestation.

Moisture content

Generally, moisture contents should be between 4 to 8 per cent and stabilized. Under normal conditions air-drying and oven-drying extraction usually result in suitable seed moisture content. If in doubt, dry the seed further in a warm, shaded and dry area.

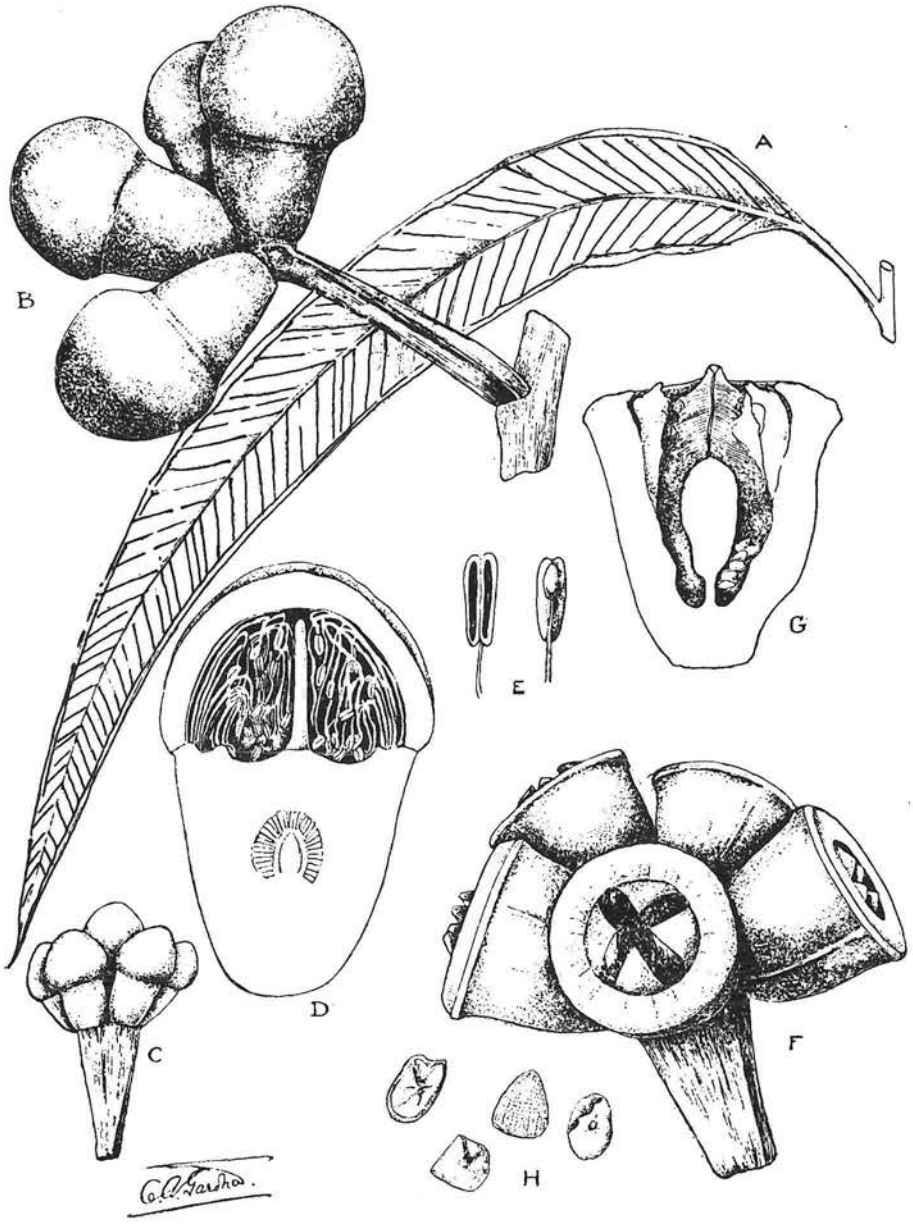
Storage temperature

Once seed has been placed in storage containers, it should be put in a cool and dry area where fluctuations of temperature and moisture are kept to a minimum.

Storage containers

Press-in lid tins or plastic jars with screw top lids ensure a good seal and minimize moisture content changes.

To minimize the amount of air in each container, fill to capacity with seed. The size range of containers available is wide and should be selected in keeping with the size of the collection.



Eucalyptus gomphocephala A—Leaf; B—Buds (x 1.5); C—Buds (x 0.5); D—Section of flower bud (x 2); E—Anthers (much enlarged); F—Fruits (x 1); G—Section of fruit (slightly enlarged); H—Seeds (much magnified).

Labelling seed lots is vital for later identification and should include species' name, date collected, locality details and seed viability results. Place a duplicate label inside with the seed, as the outside label can become defaced or lost.

Insect control

Insect control is important. The Department of Conservation and Land Management use 'Dryacide' to exterminate insect pests in seeds. However, this is only available in a minimum 15 kg bag. An alternative is to dust with an insecticide powder or a combined fungicide/insecticide powder available from most stores. A light application is all that is required. Check the stored seed lots frequently to monitor insect attack and moisture content changes.

Seed viability testing

Viability varies with age, storage conditions and with the maturity of the seed. Test the seed on collection and, if stored for some time, before use. With large seeds such as acacias use 30 seeds for testing. With fine seeds use a small pinch of seed. A small pinch of seed is about 0.2 g.

A simple procedure to test seed involves:

(a) placing a fine grained sponge on a saucer of water;
(b) placing or sprinkling the seed sample on the sponge;
(c) keeping the sponge moist and in a warm place at 20 to 25°C.

Viable seed will germinate in about 14 to 28 days. By simple calculation you can now determine the number of grams or kilograms of seed you will required to grow a certain number of plants.

Growing eucalypts from seed

Raising eucalypts from seed can be a rewarding and inexpensive method of producing a quantity of trees for shade, shelter or conservation. The Department of Conservation and Land Management has some excellent Information Notes on this subject.

Chaff and seed

The seeds of eucalypts vary greatly in size, ranging from 0.5 to 15 mm long and from 0.5 to 7 mm wide. In any single capsule, only a few seeds are fertile. The rest are unfertilized ovules known as chaff. It is difficult to distinguish between the two in most varieties of eucalypts, and allowances must be made for this chaff when sowing.

Soil moisture

The soil used for seed germination should be light textured - it can be a dark, surface sand or a sandy loam. If the local soil is heavy, mix it with equal parts of sand and compost. Strong manures should not be used, but a handful of a 50/50 mixture of blood and bone and potato manure E per barrow load of soil is beneficial.

Cover the seed with an open textured medium which is not inclined to compact. It can be sand, stone dust, vermiculite, peat moss, rotted sawdust, finely sieved compost or a mixture of any of these components.

Both the soil and the covering medium should be sterilized before use.

Sterilization

Soil sterilization destroys weed seeds and any harmful pathogens that may be present.

Commercially, steam or methyl-bromide gas are used to sterilize the soil, but in small programmes these methods are not practicable.

Heating the soil to 82°C on a metal tray over a fire is effective, but the main problem with this form of treatment is obtaining an even temperature throughout the medium when treating a reasonably large quantity of soil. Excessive heat can destroy the organic matter in the soil.

The most suitable method for small scale operations is sterilization with formalin. This product is readily obtainable and can be used for treating soil in containers or on open areas. Use one part of commercial formalin to 24 parts of water and sprinkle the solution on to the soil at 1.2 L/m^2. The soil is then watered to seal the surface and covered with a tarpaulin, plastic sheeting or bags for 48 hours. When dry enough, the soil is worked with implements (previously soaked in the solution) to assist the escape of formaldehyde gas. Plants and seeds can be grown in treated soil when no smell of formalin can be detected - usually in 10 to 14 days.

Other proprietary soil fumigants are available on the market. They are easy to apply and should be used according to instructions.

Take care not to re-contaminate the soil by using dirty tools, containers, or by bringing the medium into contact with untreated soil.

Containers

The type of container used for growing the tree is not important, but good drainage is essential. The choice will depend on availability and convenience, and can be either separate pots for each plant or boxes in which several seed are sown and the plants are pricked out into pots at a later stage.

Direct sowing in individual pots is recommended because the tree does not receive a check in its growth, as it does when transplanted from a seed box. An ideal size is the 10 cm square pot used in most nurseries, but small tins or terracotta pots can also be used. Peat pots are also available, and have the advantage that the pot does not have to be removed at planting out.

Preferably one type of container should be used for a sowing, otherwise they will dry at different rates and can cause problems with watering, and subsequent germination failure.

If using trays, a depth of 8 to 10 cm is ample.

Drainage holes should be made in tins and wooden trays. If the latter have spaces between the bottom boards, holes are not necessary. Broken clay pots, blue metal, gravel or cinders can all be used to assist drainage. If bottom watering is practised, the crocking material should have fines among the bulk to prevent the soil coming out.

The sterilized soil is placed in the container and firmed to within 14 mm of the rim.

Sowing time

The ideal temperature for germination of eucalypt seed is 20 to 25°C.

The main disadvantages with autumn sowing are the possibility of heavy rains which may wash the seed-covering away and the danger from frosts. Growth rates during the cold winter months will also be slow. However, in some localities autumn sowing can be an advantage.

Spring is the generally-accepted sowing time. After germination, the warm weather hastens growth and the plant will be an ideal size for setting out the following winter.

Sowing the seed

The two most important factors in successful seed germination are sowing depth and moisture. Sowing too deep will impair germination. Watering too lightly or too heavily can kill the seedling.

When sowing into individual pots, a small pinch of seed (allowing for chaff) is placed in the centre of the pot and firmed lightly with the finger so that the top of the seed is level with the soil surface. The seed is then covered. The recognized rule for depth of covering is twice the diameter of the seed at its narrowest section. This means that the covering thickness could range from 1 to 14 mm. Where light mediums such as vermiculite or peat moss are used, a thicker covering can be applied. When the seedlings are 2 to 5 cm high, they are thinned out leaving the strongest plant in each container.

Moisture requirements

Germinating seeds need high moisture levels - if the surface dries out the seed may die. Watering with a heavy spray can remove the surface covering, exposing the seed to drying. Bottom watering or covering the tray or containers with hessian helps to prevent this.

Bottom watering

The pots are placed in a flat container which is filled with water to half the depth of the seed container. Capillary action will carry the water to the surface, after which the pots should be removed or the water drained from the container.

Hessian

Hessian is soaked in water, allowed to drain, then placed carefully over the seed containers. If the containers have been correctly filled, the damp hessian should lie on the surface. Weights or wire pegs should be used to prevent the hessian blowing off. Light watering is then applied to the surface of the hessian. Daily inspections must be made so that the hessian can be removed as soon as the seed germinates. Frequent, light waterings are then applied.

A frame with a plastic covering can also be used to retain moisture in the surface, but it should be lifted every day or two to allow aeration.

The seed containers should be kept in partial shade until the plants are about 5 cm tall.

Broadscale direct seeding of trees

Introduction

Farmers recognize that two of the biggest threats to their livelihood are soil erosion and salinity. The placement of large numbers of trees in the rural landscape can alleviate these threats and at the same time enhance the aesthetic value of the country, provide natural habitat and connect corridors for birds and other wildlife. The problem has been the cost and time involved in planting and tending seedling trees.

Direct seeding may prove to be a practical way to establish very large numbers of trees on farms. Tree seed can be sown through a combine or a specialized direct seeder. Direct seeding machines are available to place a continuous single row, or blobs of seed along a line. Some machines can plant seedlings or seed, and produce a furrow or scraped area for weed control. Discuss these options with your tree adviser. Most of this article focuses on the use of a combine.

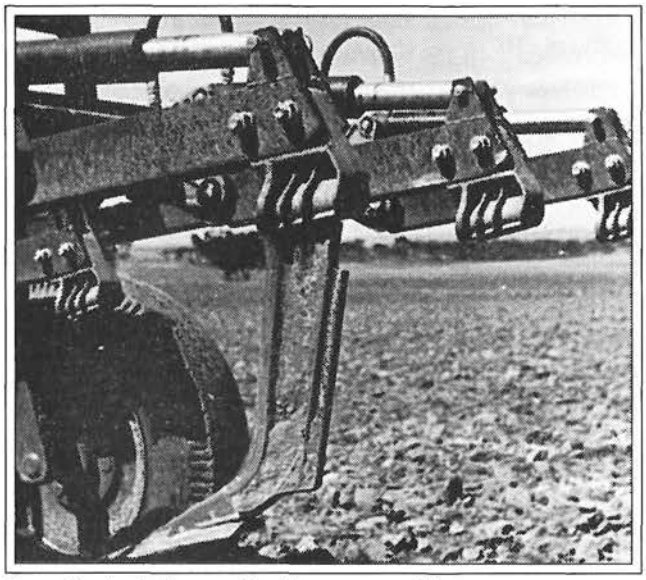
Direct-sown seed needs ideal conditions to germinate - that is, a series of soaking rains after sowing. Given this, and providing they are free of competition for moisture and nutrients, direct sown seedlings grow very rapidly in the first few months.

The elimination of weeds from the seed bed is essential as they will compete against the slower growing native species. Despite this, direct seeding is relatively cheap, simple and quick. There is no need to purchase any new machinery - a standard combine does the job. It takes (for example) only a few hours of work in ground preparation to establish a kilometre of trees. Also, direct seeding ensures the early development of a strong root system which removes the need for summer watering of young trees.

Ground preparation on old land

Land that has been cropped or pastured for years develops a compacted layer which young tree roots have difficulty penetrating. Deep ripping (40 to 100 cm deep) allows roots and moisture to penetrate deeper into the soil profile.

Ripping is best done in autumn or early winter in lines up to 1 m apart.



Deep ripping before seeding improves establishment, particularly on old land.

Weed control

Established farm land usually has a 'bank' of weed seeds in it. The elimination of competition from weeds is the most important factor in establishing trees by direct seeding. The aim is to have the ground absolutely weed free before sowing and control all weeds at least into the first summer after sowing.

This is best achieved on medium and heavy soils by multiple cultivation using a scarifier. It will need to be repeated at least three times so that successive germinations from the weed seed bank are killed. On sandy surfaced soils this continued cultivation will leave the prepared land susceptible to erosion. The risk can be lessened by sowing rows of a suitable cover crop to protect the seeded area.

Scalping off the top 5 to 7 cm of soil with a blade or road grader just before direct seeding removes the weed seed bank altogether and provides very effective weed control into the first summer. A very light cultivation to loosen the top soils is all that is required before seeding. Do not scalp shallow duplex soils where clay will be exposed once the overlying sand is removed, as very poor results have been achieved on exposed heavy soil types.

Chemical weed control

Cultivation or scalping can be supplemented with applications of contact herbicides such as glyphosate or paraquat/diquat before sowing. All residual herbicides appear to have a detrimental effect on the germination of tree seed.

Late germinating grasses can be, and must be, controlled with the selective grass herbicides (Fusilade® or Sertin®) sprayed, at recommended rates, over the top of germinating tree seedlings. Keep a close watch on grass weeds, particularly during the first eight weeks after sowing, and spray as soon as the problem is noticed.

Ground preparation on new land

Because there is no compacted soil, and no weed seed bank on newly cleared land, ripping and repeated cultivation are usually unnecessary. However, if the soils are shallow and over clay, ripping is beneficial. Otherwise, just lightly cultivate immediately before sowing and leave the soil as rough as possible. New land can be sown any time after the season has broken; the earlier the better.

Difficult sites

It is advisable to begin with the sites which are easier to establish; that is, well drained, sand or loam soils which are not salt affected.

Late germinating broad-leaved weeds

Sites with late germinating, aggressive broad-leaved weeds are a major problem, and should be avoided because we currently have no practical way of controlling them after the tree seed has germinated. Scalping can be used on such sites before sowing to remove the seed store; cultivation and chemical weed control have not proven successful. However, on most sites, broad-leaved weeds germinate early and can be controlled before sowing.

Heavy textured soils

'Surface-sealing' of clay soils makes direct seeding difficult and further research is required. Many of these soil types (salmon gum, red morrel areas) naturally had few trees per hectare and therefore using nursery raised stock can augment the natural cover.

Deep sands

Light sandy soils need protection to avoid sandblast and erosion by wind. A protecting crop of cereal must be planted either side of the direct sown tree strip on these soils. However, do not sow grasses with the trees because they will compete for moisture and eventually dominate the slower growing native species. Non-wetting sands present additional problems with direct seeding and unless these sands can be scalped off before sowing, direct seeding is not recommended for these sites.

Waterlogged/saline sites

Germinating seedlings will not survive if they are waterlogged, even for short periods of time and most species are very sensitive to saline conditions, particularly when young seedlings. Such areas are not recommended for direct seeding.

Steep slopes

Erodible slopes can be difficult to revegetate because seed is washed away with worked up topsoil. To avoid this the water can be harvested by building small crescent shaped banks across the flow of surface water; that is, on the contour. They should be short - say 10 m long - to avoid excessive overflows that may cause erosion. They can be constructed by using a backblade or roadgrader to bare strips 1 m or more wide. Move the top-soil downhill to form a curved bank that will hold water. In heavier soils the bare area should be ripped with a chisel plough to improve water penetration.

Water harvesting is used to increase the amount of available water to germinating plants as well as to provide a collection point of seed that would normally be washed away. It is especially valuable in the drier zones of the wheatbelt, and on erodible slopes.

Sowing

Old land should be seeded when good weed control has been achieved, usually in June or July. Trials have shown spring sowing (August or September) gives very poor germination and should only be contemplated on sites where winter waterlogging is a problem. Most eucalypt seed will germinate two to six weeks after sowing, however, during winter the small seedlings will remain dormant until soil temperatures increase. So seedlings often remain unobserved until as late as October or November.

Seed should be sown at 350 g/ha for new land and between 500 to 1000 g/ha for old country. This is mixed with super in a combine and applied at rate of 100 to 150 kg/ha going over the area twice to ensure complete coverage. Other 'bulking-up' agents used have been grade 2 vermiculite, graded sand, bran

A direct drilled windbreak.

flakes and chicken pellets. A 5 m wide combine over a distance of 2 km will cover 1 ha. The area to be sown must be scarified before sowing. When sowing, the combine tines are set just above ground level so the seed drops onto the rough ground surface. The hoses should preferably be disconnected from the boots.

For small seeded species such as most eucalypts, melaleucas and casuarinas the seed may be either left uncovered on the soil surface or very lightly covered by dragging wheat bags, a chain, brush or even a piece of carpet behind the combine. If the seed is buried even 1 cm below the surface, germination is severely affected.

However, large seeded species such as marri (*E. calophylla*), coastal blackbutt (*E. todtiana*) and all legume species (acacias, pea-flowered natives, tagasaste) germinate best when buried to a depth of about 1 cm. This can be achieved by pulling harrows behind the combine. If a mix of both small and large seeded species are to be sown on the one site, we suggest either they are sown separately (the large seeded species sown first) or if sown together, the best compromise would be surface sowing and lightly covering the seed using wheat bags or a chain pulled behind the combine.

Sometimes vibration will separate the seed and super, so it is advisable to have someone agitating the mix during sowing.

Germination can be significantly improved on sandy textured soils by compacting the site with the tractor tyres or a roller, immediately after sowing. Heavy textured soils should not be compacted.

Observation plots

Because of the small seedling size of many of our native species we suggest 'observation plots' be established i.e. two to three 50 cm square plots per site be permanently pegged, seeded by hand and carefully observed for seedlings. Once there is germination in the observation plots and you can recognize each species, seedlings can more readily be spotted over the whole site. Regular and close inspections of the observation plots will enable early identification of pest problems such as redlegged earth mite, lucerne flea, rutherglen bugs or grasshoppers. Seeded areas should be sprayed when the pests are seen in large numbers.

Protect the seedlings

Stock, wind and rabbits can all harm the young trees. The area must be fenced, or stock excluded from the paddock, for at least three years. Rabbits should be baited in co-operation with the Agriculture Protection Board.

Aftercare

If the plants are not vigorous at the start of the following season, a granulated NP (e.g. MAP) or NPK fertilizer application at 150 kg/ha will stimulate growth, especially on light soils.

Species selection

Use a mixture of at least four or five species to create a mixed windbreak of trees of various forms. This mixture will usually allow for any minor variation in soil types and topography. Select species native to the area, soil type and topographic position that are growing well in your district. If you wish to extend the range choose species from similar soil types and the same or lower rainfall (see Table 1).

Table 1. Eucalyptus species suitable for sowing at 350 g/ha on new land, and 500 g/ha on old established pasture or grazing land. (Rainfall - 400 to 600 mm)

Sand	Loam	Clayey-loam
E. camaldulensis	*E. camaldulensis*	*E. accedens*
E. cladocalyx v *nana*	*E. cladocalyx* v *nana*	*E. crebra*
E. gomphocephala	*E. gomphocephala*	*E. gardneri*
E. platypus v *heterophylla*	*E. platypus* v *heterophylla*	*E. spathulata*
*E. conferruminata** (x 1.5)	*E. gardneri*	*E. kondininensis*
E. lehmanii		
E. gardneri	*E. conferruminata*	*E. melliodora*
	E. lehmanii	
*E. todtiana** (x 6)	*E. crebra*	*E. occidentalis*
E. redunca v *melanophloia*	*E. sideroxylon*	*E. drummondii** (x 4)
	E. redunca v *melanophloia*	*E. sideroxylon*
	E. leucoxylon v *macrocarpa*	*E. platypus*
	E. megacornuta	*E. leucoxylon* v *macrocarpa*

* These species have known low germination rates, so seed quantities will need to be adjusted accordingly by the factors indicated.

Collecting seed

Collecting seed from your own farm or nearby has many distinct advantages. By collecting tree seed from a provenance close to the proposed direct seeding site you know what to expect when the seeds are sown. You will also be able to take advantage of easily harvested tree seed crops to reduce the cost of purchasing seed, and you have the guarantee of fresh seed. (See chapter on 'Native seed collection').

Germination testing

The viability of seed can vary enormously through factors such as age, storage temperature, maturity at collection or even the weather when the tree was flowering. A number of species are known to have inherent poor germination. This is no problem, provided that you are aware of poor germination and you make allowance in the amount of seed used. Seed purchased from reputable suppliers will have been tested before sale, seed you have collected yourself will have to be tested. Place a sponge pad (like Wettex) on a saucer and moisten it with water, spread a pinch of seed on the pad. Keep the pad moist and in a warm (20 to 25°C) position. Most viable seed will germinate within a fortnight under these conditions. A pinch is about 0.2 g and the benchmark is 100 germinants per gram. If you get less than 20 germinants in your pinch you should adjust the amount of seed used in the mix.

More information

This article was compiled from limited experience on research plots. The CALM Rural Advisory Service is keen to hear of any problems, successes or anomalies so that we can form a clearer picture of how direct-seeding works. Similarly, if you require more information to get started, contact an advisory officer at any of the locations below:

State Operations Headquarters

Como: (09) 367 0333

Bunbury: (097) 25 4300

Esperance (090) 71 2088

Narrogin (098) 81 1113

Tree planter's guide

Many farmers are now planting trees to control salinity and erosion, alleviate waterlogging, for shade and shelter or simply for aesthetic reasons.

Beware that you don't bite off more than you can chew. If you try and plant too many at your first attempt, and have inadequate preparation and poor aftercare, many of the trees will die. You may then be reluctant to spend time and money on further plantings.

Planning the planting programme

First draw up a firm plan - your local Department of Agriculture adviser can help with this.

Mark the following areas on your plan or on an aerial photograph:

- areas prone to erosion;
- non-wetting soils;
- seasonally flooded areas;
- seepage areas;
- saline areas;
- existing native vegetation;
- areas of tree decline;
- non-productive areas.

Within these boundaries mark areas requiring urgent treatment and then set priorities, bearing in mind realistic limitations of both time and money on what can be planted and tended each year.

Before planting any trees, carry out major works, such as relocation of fences, drainage lines and contour banks, which may conflict with the planting programmes. You will also need to take account of the direction of prevailing winds and other environmental factors.

Species selection

The species selected will depend on what you are trying to achieve. For example, if trees are being planted in salt prone areas, plant salt tolerant species. Shelterbelts require trees with foliage extending down close to ground level. (For windbreaks you can achieve the same result by planting small trees and shrubs between taller trees.)

Details of species are given elsewhere in this book. Advice is also available from CALM and the Department of Agriculture.

Before deciding on exotic species for the area check the potential of the local species. These species have developed under the climatic conditions of the area and are therefore well adapted. Frequently, local species are not considered suitable because of their slow growth rates. While this is true for some species, most species grown under cultivated conditions, with fertilizer and exclusion of weed competition, respond with much faster growth rates.

If the local species are not satisfactory then choose species which grow in similar soil types to your own and under similar or lower rainfall. Trees which grow in lower rainfall should be more drought tolerant than existing native species.

Ordering trees

Most nurseries seed their trees in November-December for sale the following winter. If orders, particularly large ones, are placed around seeding time the order can be filled. Delays in ordering will reduce your chances of getting the species you have decided to plant.

Size of stock

The seven to eight month seedling is ideal for establishment under natural rainfall or lower watering regimes. Most farm tree nurseries supply this type of seedling.

Under natural conditions trees establish themselves by first developing a deep root system to tap soil moisture. Pot grown plants cannot do this and suffer water stress when planted out. It is unwise to buy 'advanced stock' since the large foliage area on such plants puts them under severe moisture stress and the chance of successful establishment without frequent watering is minimal.

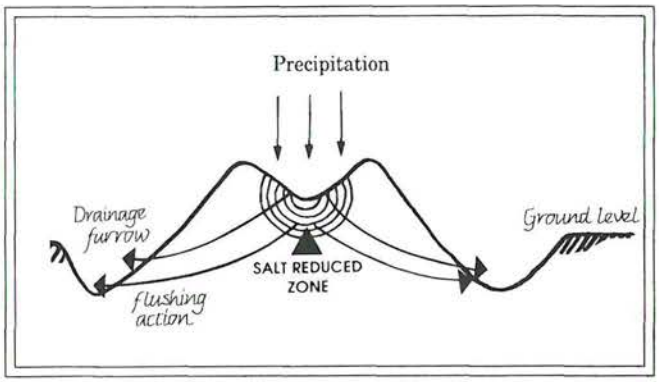
Another problem with advanced eucalypt stock is that the tap root will curl if left in the container for too long. After planting, the tree grows and the roots thicken. A restriction develops which can result in a severe setback or even strangulation of the tree. It can also make the tree prone to windthrow.

Preparing the site

Mechanical weed control

The elimination of weed competition with the young trees is critical to their survival in the first year following planting.

Removing the top 5 to 7 cm of soil with a grader removes the weed seed bank. (Note - do not use this technique on shallow duplex soils where clay will be exposed after removing the shallow top soil.)



Cross-section of a mound showing principle of salt reduction.

Ripping

Ripping is essential for heavy soils and is strongly recommended for all planting sites.

The depth of ripping is dependent on machinery, but should be to a minimum of 45 cm and preferably to 1 m. If possible rip during the summer months.

At least one but preferably three lines are ripped for each row of trees, and the trees are planted in the centre ripline. In sandy soils a single ripline will suffice. Multiple riplines should be spaced the depth of penetration apart.

Ripping should be on the contour, but if ripping has to be carried out down a slope, lift the ripper at various stages, depending on slope. Alternatively, rip and cross rip at the point of planting to prevent moisture running to the end of the row or erosion will occur. Ripping will more than compensate for the added cost by providing faster and healthier growth and reducing the need for summer watering.

Mounding

Young trees in saturated soil will die. Therefore do not plant early in low-lying areas where flooding can be a problem by the end of winter.

On such sites mounding will be necessary. After ripping, mounds can be made by using two opposing discs or a blade. On saline sites it is better to spread the discs to form a mound with a dished centre. The dished centre will concentrate the winter rains and increase the leaching of any salts.

Mounds thrown up on salt-affected land ready for planting.

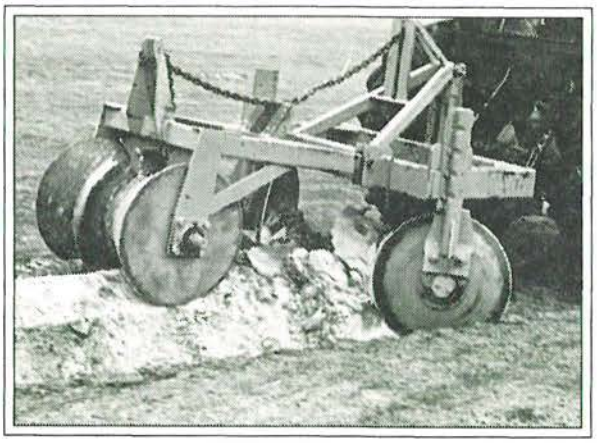
Water harvesting

In areas of low rainfall water harvesting techniques will accumulate rainfall and enhance the chances of establishment. One method is to grade the surface soil along the contour, at an angle, pushing the soil into an embankment. Water will pond behind this bank, and if the trees are planted in the riplines on the slope at the margin of the ponded water the chance of successful establishment is increased.

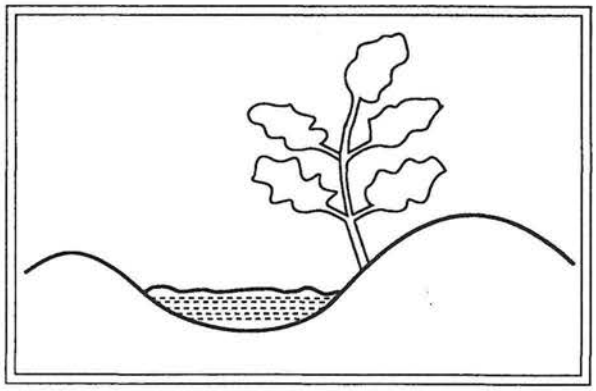
Pitting, another water harvesting technique, is an abbreviated form of furrow-lining. Individual niches approximately 2 m long and 1 m wide are made for each tree. The niche will accumulate water and the tree is planted at the bottom of the niche. Again, riplines should precede pitting.

Furrow-lining

Non-wetting soils can be a problem for tree establishment. The non-wetting soil must be removed by furrow-lining. A rip-line is made, as close as



A mounding plough in action.



Water-Harvesting

possible to 1 m deep. A furrow is then made with opposing discs or a blade. The furrow may need to be as much as 30 cm deep and 1 m wide at the top.

The furrows should preferably be at right angles to the damaging winds. If this is not possible the furrows should be broken at intervals and a barrier of lupins or other crop planted to alleviate erosion problems.

Inter furrow planting of crops will also help to protect against erosion.

Chemical weed control

The herbicide rates recommended below are applicable to most areas, however, care should be taken on sandy soils in low rainfall areas where problems with burning can arise. Herbicides should be applied four weeks before planting.

Dry soils (mid-slope to ridge top)

Pre-planting spray of amitrole (0.5 to 1.0 kg/ha active ingredient) mixed with atrazine (2.5 kg/ha active ingredient). Output should be between 150 and 250 L/ha, applied in a swath 1.5 m wide. The lower rate of amitrole should be used when weeds are below 5 cm in height and the higher rate when weeds are above 15 cm in height.

Moist sites (lower slopes and river flats)

Apply the same treatment except lift the rate of atrazine to 3.5 kg/ha active ingredient. Note: the swath width should be extended to 2 m where tall weeds occur, e.g. wild radish.

Control of perennial weeds (all sites)

Pre-plant spray of a mixture of Roundup® (use label recommendation for specific weed species) and atrazine (3.5 kg/ha active ingredient). Add ammonium sulphate to the atrazine at 2 per cent weight/volume adding the Roundup® subsequently to this mixture. Output should be below 100 L/ha and swath width as prescribed earlier.

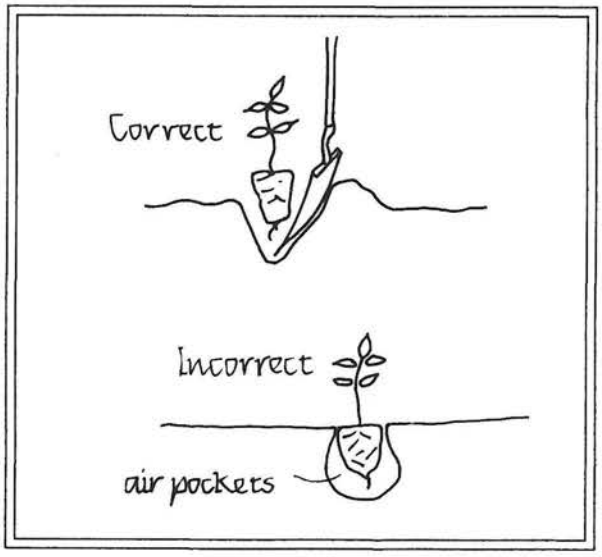
Handling seedlings

Open-rooted trees are those lifted from nursery beds without soil around the roots. Handling of these plants is critical since the roots can readily dry and the seedlings die. The handling procedure is the same for all species.

Open-rooted plants are machine lifted in the nurseries and immediately packed in wet bags before the roots can dry. They are then watered before being picked up or consigned.

Plants should be transported either in covered vehicles or else the bags and plants wrapped in plastic to protect against the wind.

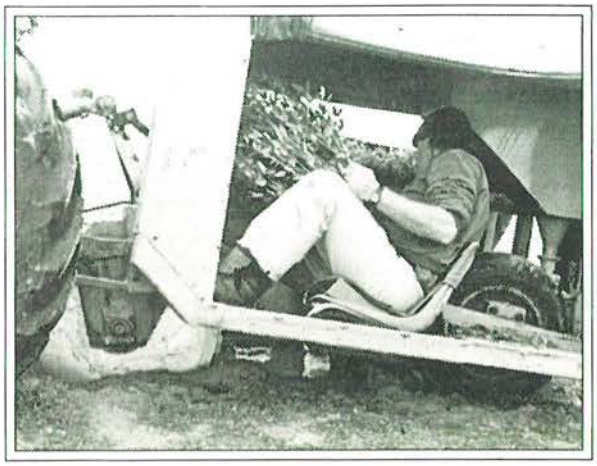
On arrival bundles of seedlings should be placed in a shady position out of the wind and well watered. Excess water from this should seep out through the bagging. Trees in pots should be straightened in the tray, placed in a sheltered position and thoroughly watered.



Avoid bell-shaped holes when planting.

Seedlings should be planted as soon as possible. If open-rooted seedlings have to be held for longer than two or three days the bags can be dug into the

ground to protect the roots from drying in the wind and watered regularly. It is preferable, however, to heel the seedlings in a sandy protected site near a watering point.



A mechanical planter.

Heeling in

Open a trench at an angle of about 45° in a weed-free area. Place the seedling trees three or four thick along the trench and refill the trench. Water heavily with a hose to force soil around the roots and eliminate air pockets. Continue to water regularly. Plants can be held like this for lengthy periods.

Planting

Timing

Planting time will differ between areas, but it should be finished by the middle of July unless the area is very wet. In areas of reliable winter rains begin planting once initial rains have penetrated the soil profile and follow up rains can be reasonably assured. This gives the plant time to establish itself before the end of the winter rains.

In drought areas, where rainfall is unpredictable, plant in the cooler months. The soil will need a good watering before planting and subsequent waterings until reasonable rainfall is received or the trees have established.

In drought areas where watering has to be maintained for some time it is particularly important that planting programmes are manageable.

Planting techniques

Potted stock:

- Dig a hole in the prepared moist ground sufficient to accommodate the teased root system.
- Tap the plant out of the pot.
- Gently tease out the roots from the side and base. If the tap root springs back into a coil, remove it with secateurs.
- Put the plant in the centre of the hole at a depth of 1 to 2 cm deeper than it was in the container. Be careful not to turn the roots upwards or allow them to coil.
- Fill the hole gently and firm with your feet.
- Build a 'saucer' around the plant using soil away from the tree.

Hand planting jiffy pots:

- Completely saturate the plant before planting.
- Remove the peat at the base of the pot and tease out the roots from the bottom 1 cm of soil.
- Then plant as for potted stock taking care to keep the peat rim below the surface soil level, otherwise it will act as a wick and dry the pot and soil.

Machine planting potted and jiffy pot stock:

Planting manually.

Mechanical planters are generally used for large scale plantings. A variety of machines are available for sale or hire.

When planting ensure that:

- Weed control and soil preparation has been properly completed.
- Non-wetting soils have been removed.
- The trees are planted in moist soil.

- The trees are planted with their roots vertically downwards.
- The firming wheels are working efficiently.

Hand planting open-rooted stock:

- Provided the soil is wet the trees should be planted early in the season (June).
- Plant 6 to 8 cm deeper than nursery level.
- Planting after the end of July is not advisable.
- Furrow-lining (see earlier section) must be done if non-wetting soils are a problem.
- Never allow the roots to dry out during planting. (Do not carry a handful of plants with roots exposed.)
- If the tap roots are excessively long and bend up in the hole the excess should be cut off.

Machine planting open-rooted stock:

The same points apply as for machine planting jiffy pots by machine. You must ensure the roots are vertical after planting.

Tamarisk cuttings

Tamarisk trees are ideally suited for windbreaks, particularly in the sandy soils around Geraldton. These trees can be started cheaply by the direct planting of cuttings.

First, create a weed-free strip 2 m wide by blading off the top 5 cm or by the use of Roundup® or other non-residual spray. Cuttings are then prepared from the current season's vigorous growth. The thickness of the cutting is not crucial, but a range of 10 to 20 mm at the thickest end is ideal. Cut 45 cm lengths, using sharp secateurs, or saws for the thickest cuttings. They can be treated with a root-inducing hormone but this is not essential.

The tractor then proceeds along the prepared line pulling a ripper penetrating to approximately 37 cm. The planter walks behind the tractor pushing three cuttings (5 cm apart) the full depth of the ripline every 5 m along the ripline. At the end of the line the tractor runs back along the line, with the back wheel 17 cm from the cuttings, firming the ground. The same procedure is used on the opposite side of the planted line.

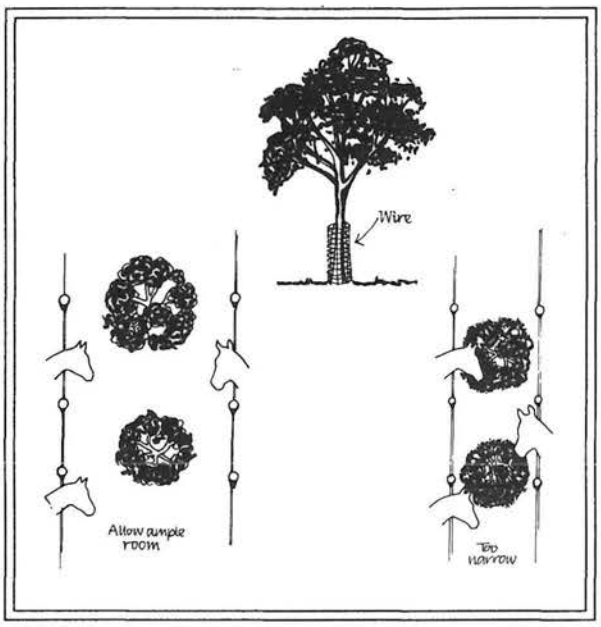
The cuttings should be planted in June, and not later than the middle of July.

Weeds should be kept away from the cuttings during the first summer, and if the summer is dry monthly watering will be necessary until the winter rains begin.

Maintenance after planting

Fences or guards are essential to protect the young trees from stock. Rabbits must also be controlled.

One useful technique is to plant along an existing fenceline then build another fence so that the trees are in a fenced laneway.



Protect trees from livestock.

The ease of erection and low material costs make electric fencing a sensible alternative. Where electric fencing is already being used, the additional fences can easily be added. If it is being used for the first time, careful planning is needed. (See Western Australian Department of Agriculture Bulletin 4131 - 'Electric fencing')

If grasshoppers are a problem follow the control measures outlined in the Department of Agriculture's Farmnote No. 47/86 'Wingless grasshoppers and their control' (Agdex 622).

Weed control

Providing initial weed control is effective into the first summer after planting and trees are growing, no follow-up weed control is necessary.

If weed control is not adequate into the first summer, however, additional spraying will be necessary. There are three options:

1. Pines (not eucalypts) can be resprayed over the trees with amitrole and atrazine (not Roundup®) at the rates prescribed earlier in the section on chemical weed control. Some spray damage may result once the trees begin to actively grow (spring) so spray as soon as the problem shows itself in late winter.
2. Two herbicides, Fusilade® and Sertin® can be sprayed directly over newly planted trees and are useful for eradicating most grasses, but will not control broad-leaved weeds. If these herbicides are used where broad-leaved weeds are also present the latter will proliferate and fill the openings left by grasses, causing further problems.
3. Systemic sprays such as Roundup® present no problems providing the trees are covered. The plants can be protected by using short lengths of 100 mm diameter plastic piping with the top covered with a small plastic bag. Place these over a number of trees, spray, and then move the covers to another set of trees. Alternatively, use a protective guard (such as an empty icecream container) over the spray nozzle to contain the spray.

(See also chapter 'Weed control near trees' page 35)

Fertilizing

The addition of a fertilizer two weeks after planting promotes faster growth and increases the drought resistance of a tree. All fertilizers, in particular nitrogen-based fertilizers, can be damaging to plants and must be applied according to instructions, either on the container or as outlined below. At the time of planting slow-release fertilizers, such as Agriform tablets and Osmocote, can be used to advantage because the chances of damage to the plant are minimal. Commercial fertilizers can be compressed and made into slow-release tablets at a low cost. The tablets can be made any size, and the recommended application of one handful is equivalent to 60 g.

Potato manure E is suitable and is not damaging to the plant if applied at the rate of one handful per tree, scattered around the base or else placed in a hole, on the downward slope, 15 cm from the trunk of the tree and at a similar depth in the soil.

Agras No. 1 or No. 2 at a similar rate and speared into the soil as just mentioned, is used by the Department of CALM for eucalypt tree establishment.

Pine trees require only superphosphate which is applied at a similar rate and manner to other fertilizers. Where the soils are known to be deficient in copper and zinc, a super copper zinc mixture is used.

Repeat fertilizer applications the following year will further increase the health and growth of the trees.

Watering

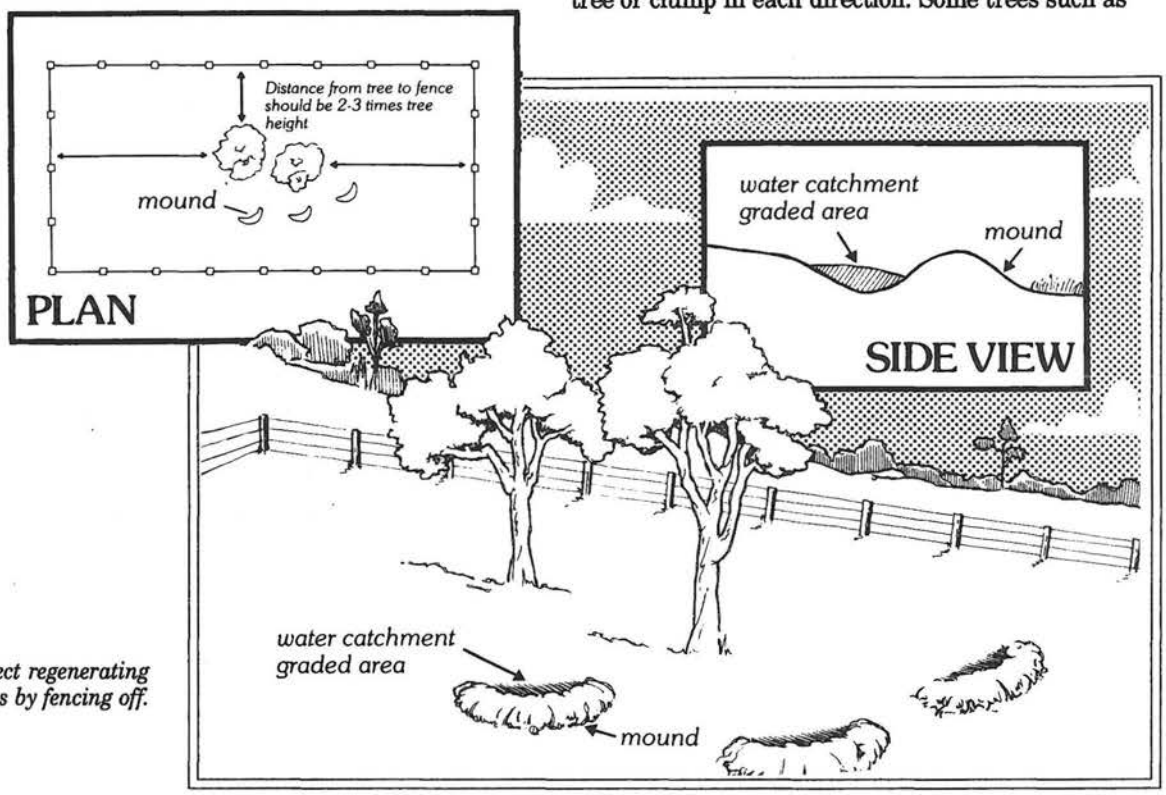
It is difficult to specify the watering needs of a plant since factors such as rainfall (timing and quantity), soil type, temperature, drying winds, plant size and water quality will control the need or frequency of watering. During years of normal rainfall, in moisture retentive soils, and where the rainfall is about 500 mm, trees can be established under natural rainfall conditions providing soil preparation and weed control have been effectively carried out.

In poor sandy soils of the same rainfall, and in all soil types of lower rainfall, watering during the first summer may be necessary. This is impossible with large scale planting, and in these situations farmers must be prepared to accept a high proportion of losses rather than the work involved in extensive watering programmes. In dry areas, supplementary watering during the first summer will ensure a higher success rate and faster initial growth.

As a general guide, water should be applied in heavy, widely spaced applications rather than light, frequent ones, which tend to create a surface root system. Where the salinity level of the water is relatively high, the accumulation of salts in the upper soil profile can be avoided by infrequent, but deeply penetrating waterings.

Natural regeneration of bush areas

Since European settlement, large areas of native bush have been cleared for townsites, farms, roads and communications. Native trees that remain in and near these disturbed areas are not regenerating, and their population is being further affected by old age, drought, strong winds, road-widening and other factors.



Protect regenerating areas by fencing off.

This large scale loss of trees is removing protection to the valuable topsoil, reducing wildlife habitats, and ruining the beauty of the area. To arrest this problem it is essential to protect and manage the areas of woodland which have been retained on farms, along road verges, and as reserves in townsites, so that they will regenerate and thus continue to survive.

Natural regeneration is a cheap way of replacing large areas of degraded bush, and requires minimal effort if the techniques suggested here are followed.

Fencing

Regeneration of some eucalypt species in assured rainfall areas, can be achieved simply by fencing an area around the tree or clump of trees to exclude domestic stock and by ensuring there are no rabbits in the vicinity.

Regeneration may occur from seed on the ground, but it is advisable to have a ripe crop of fruit on the tree at time of fencing. The fence should extend two to three tree heights from the base of the tree or clump in each direction. Some trees such as *Eucalyptus calophylla* (marri), *E. rudis* (flooded gum) and *E. loxophleba* (York gum) can regenerate readily with this limited preparation.

However, most species do not necessarily regenerate after simply fencing off an area; additional preparation is often required.

Weed control

On established farmland, slow-growing native species cannot compete against the introduced pasture grasses. The removal of weed competition is most important for the regeneration of native vegetation. However, it can be very difficult to achieve without detrimentally affecting the native seedlings as well. To achieve successful regeneration weed control must be assured well into the first summer

after germination of native species. This can be done with cultivation, herbicides, grading or combinations of the first two.

Cultivation

Cultivation for weed control must be done when weeds are actively growing. At this time seed has already dropped from the ripe fruit on the trees and cultivation will bury the majority of seed too deep for germination. Unburied seed will grow vigorously, but results are unpredictable.

The best technique is to cultivate for weed control one winter, and allow the ground to lie fallow during the following summer months. Weed germination will be reduced the following winter. If fallowing is timed to coincide with a ripened fruit crop, and good weed control achieved, regeneration of native vegetation should follow.

Herbicides

Weed control can also be improved by spray topping pasture weeds the spring before the summer/ autumn seedfall with contact herbicides such as paraquat/diquat (Spray.Seed®) or glyphosate (Roundup®) to reduce the seed bank.

Contact sprays early in autumn (particularly paraquat/diquat) will often allow tree seed to germinate. Selective herbicides may be needed later in the season.

The use of residual herbicides amongst existing native vegetation is not recommended.

For other herbicide techniques, contact the Department of CALM.

Chemical weed control has its limitations in areas of high rainfall and old pasture areas where the weeds are aggressive and the weed seed bank is strong. The following techniques will ensure more reliable results for a wider range of species and conditions.

Graded surface

The most successful way to remove weed competition is to grade 5 to 7 cm strips of topsoil to one side along the contour after the weeds have shed their seed (December-January). Seed from the surrounding trees and shrubs will drop onto the bare ground during late summer and autumn and will germinate without weed competition after the winter rains. For best results rip the graded strips at 1 m widths to give germinating seedlings a better chance to develop strong taproots. If this cannot be done without damage to parent trees the graded surface should be tine cultivated. This technique can not be used if removal of the top 5 to 7 cm of soil exposes a clay sub-soil. Establishment of seedlings on clay is known to be poor.

Water harvesting

Water harvesting is used to increase the amount of available water to germinating plants as well as to provide a collection point for seed that would normally be washed away. It can be a valuable addition to all methods of regeneration described in this chapter.

Water is harvested by building small crescent-shaped banks across the flow of surface water; that is, on the contour. They should be short - say 10 m - to avoid excessive overflows that may cause erosion. They can be constructed by using a backblade or roadgrader to bare strips 1 m or more wide. Move the top-soil down hill to form a curved bank that will hold water. In heavier soils the bare area should be ripped with a chisel plough to improve water penetration.

Water harvesting is especially valuable in the drier zones of the wheatbelt, and on erodible slopes.

Burning

The yearly burning of natural areas of bush is detrimental to the stands. Burning of a weed-infested stand of natural bush area will only promote a better weed crop, which will compete with, and kill, any germinating native seedlings, unless the fire is hot enough to partially sterilize the soil and kill any weed seed present.

To achieve a relatively high intensity fire, old stag trees and dead timber are removed to create openings in the stand. This material is heaped over an area in sufficient quantity to ensure a fire hot enough to kill weed seed in the top 5 to 7 cm of soil. The area of the fire-heap will depend on the size of the openings and available fuel. Fire-heaps can be in windrows or in clearings with a diameter of 5 m or more. The height of the fire-heap is the important factor, and should be no lower than 1 m of reasonably compressed fuel. The stacks of fuel need to be far enough away from the trees to prevent damage, and

should be fired in late summer or early autumn. The seed capsules of banksias, hakeas, and eucalypts are all triggered by fire.

If trees close to the fire-heap have a good crop of ripe fruit the heat of the fire will dry out the capsule valves, causing the fruits to open and release seed a day or so later. The cool ashes left by the fire form a fertile seedbed for the regenerating bush.

After burning, it is wise to augment the supply of eucalypt seed by removing branches carrying ripe fruit from nearby trees and laying the branches on the cooled ash-bed. The branches should be widely distributed over the ash-bed, making sure the edges, where the most successful germination will occur, are well covered. The fruit will open and deposit the seed before the winter rains. In windy situations use a heavy branch to anchor the smaller seed branches.

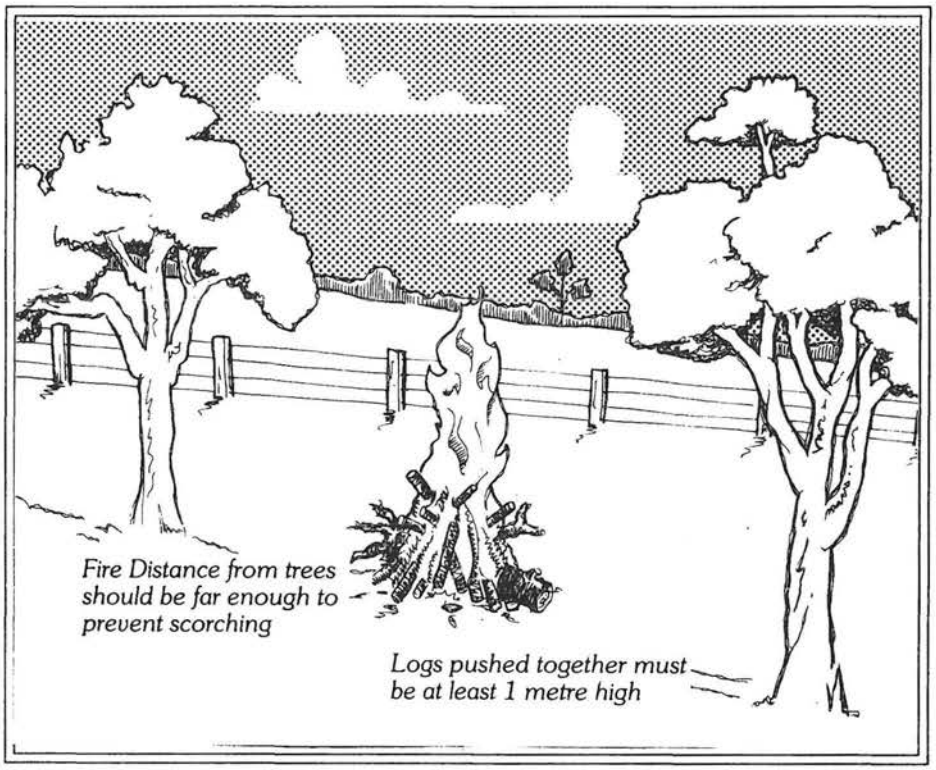
Eucalypt fruit is ready for harvesting when the capsules turn reddish-brown or grey and the valves turn brown. Most eucalypts carry a series of crops in various stages of development. Branches with older more mature fruit with the valves unopened should be chosen.

If seed is not available locally it can be purchased from seed merchants, and broadcast by hand over the ash-beds. The seed can be mixed with weed-free sand to assist broadcasting. In exposed situations, place branches at random around the broadcast seed to prevent the seed blowing away.

Rainfall is the most important factor for successful regeneration from seed. In rural areas which have periodic droughts it is advisable to regenerate natural bush stands in sections over a period of years to ensure success.

Summary

- The area must be fenced to keep stock out.
- Rabbits, if present, must be controlled.
- The trees should be checked for ripe fruit. If ripe fruit is not present in the stand then it will need to come from an outside source - other trees, branches, or picked fruit; or from a reliable seed merchant.
- Weed competition must be eliminated.
- Water harvesting and high intensity burning will increase the chance of successful regeneration.



High intensity fires will kill weeds, form a seed bed and trigger seed release.

(Diagrams courtesy of Department of Conservation and Land Management)

Remnant vegetation protection scheme

Background

Remnant vegetation on private land is an important natural resource contributing to flora and fauna conservation, soil conservation, aesthetics and amenity. Recognizing the broad benefits to the community of such remnants, the State Government has implemented a scheme to assist private land users to voluntarily protect and manage areas of native vegetation on farms. The scheme provides technical advice to farmers and a subsidy for the protective fencing of such areas.

Elements of the scheme

Farmers can nominate areas of native vegetation that they wish to protect to their local Land Conservation District Committee. Where a Land Conservation District does not exist, farmers will need to nominate areas initially to the local Department of Agriculture Office.

The Department of Conservation and Land Management have developed criteria which Land Conservation Districts can use to put in priority the nominations within their areas.

The Government contributes 50 per cent of the cost of fencing; it is allocated on the basis of priority. The subsidy provided depends on the type of fence erected. The maximum subsidy is $1,150 per km.

Funds will be allocated through the Land Conservation District Committee or Department of Agriculture office to the nominated land owner who will enter into an agreement to manage the area as native vegetation for 30 years. The area will be protected by a special notice under the Soil and Land Conservation Act and details will be registered as a memorial on title.

Conditions

1. Areas of remnant vegetation considered under this scheme should be in good condition or be able to be regenerated to good condition.
2. Land entered into this scheme will not be able to be grazed by livestock or managed in any other way that would degrade the conservation values of the vegetation.
3. The land owner will remain responsible for the management of the area. Officers of the Department of Agriculture and CALM will be available to provide advice on management where required.
4. Land Conservation District Committees will be requested to report on the condition of the vegetation from time to time.

Windbreaks

Introduction

Tree windbreaks can reduce the speed and damaging effects of wind. They are capable of providing substantial benefits when correctly designed and located.

Benefits recorded from users of windbreaks in Western Australia include:

- protection from sand blasting and soil erosion;
- 'silt traps' to catch windblown sand;
- a reduction in chilling deaths of newborn lambs;
- increases in crop and pasture production.

Evidence from eastern Australia indicates that windbreaks can also provide:

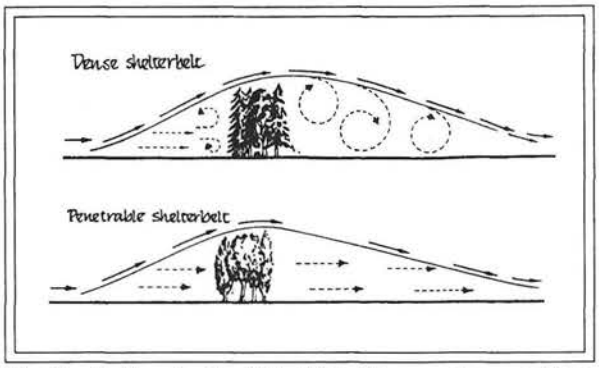
- increases in animal production (particularly sheep);
- a reduction in chilling deaths of newly-shorn sheep.

In areas prone to soil erosion, windbreaks should be used in conjunction with conservation farming practices, such as, stubble mulching, direct drilling, avoidance of over-grazing, and maintenance of a rough soil surface when cultivating.

Windbreaks are a long-term project. Some years will elapse before the trees reach a height where they will provide substantial shelter. However, once at this height, they will last many years.

Specialist advice on tree species selection and whole-farm planning should be sought before starting extensive planting programmes.

Testing species for use in windbreaks.



Ideally windbreaks should be 35 to 45 per cent permeable to the wind.

The protection given by windbreaks

The effect of a windbreak depends on its height. The distance over which it affords protection is expressed in multiples of its height; usually 20 times the height of the windbreak.

Designing windbreaks

Design principles

For maximum distance of protection the windbreak must be permeable to wind. Trees with very dense foliage form poor windbreaks. Trees that provide a barrier that is 35 per cent to 45 per cent permeable to the wind, are the most effective.

Foliage must extend to ground level or strong winds will funnel under the windbreak and increase the wind speed.

The windbreak need only be narrow, forming a rather abrupt obstruction to the wind. The zone of protection may be greatly reduced if the belt of trees is too broad, when it tends to act like a solid barrier creating eddying winds of high velocity.

Alignment

Ideally the tree belt should be at right angles to the direction of the most damaging wind. For example, to give protection from a northerly or southerly wind requires a break to be aligned east to west. However, the alignment of the break may vary up to 45 degrees either side of a right angle to the wind with no loss in effectiveness, provided the break is long enough.

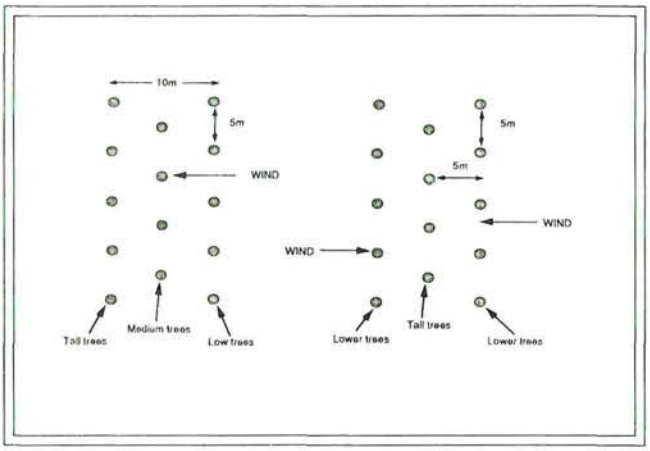
The shading of adjacent crop or pasture by the belt of trees also needs to be considered. Shading is minimized by aligning breaks north-south.

Length

A minimum length of 20 times the height of the trees is recommended. This should be increased to at least 30 times the height for breaks that are not at right angles to the damaging wind. This minimizes the effect of eddying around the ends of the windbreak.

Planting pattern

The simplest form of windbreak is a single row of trees of a type that retain their foliage to ground level. Tamarisk and some species of pine fulfil this requirement. However, because of the risk of losing some trees and a gap forming in the break, a minimum of two or three rows of trees is recommended.



An effective windbreak.

Most of our taller eucalypts shed their lower branches leaving a bare trunk. If you use this type of tree in your windbreak, it is essential to plant a second row of shorter trees. The species selected for the second row must retain its foliage to ground level. Again, to avoid gaps caused by the loss of trees, two rows of each of the two types of trees should be established.

Gaps and the ends of windbreaks

Windspeeds are higher than normal through gaps, and round the ends of the windbreak. Gaps should be avoided. If access is needed through a windbreak, form the track diagonally through the break. An alternative solution is to locate access through the windbreak on an area of soil that is not liable to erode. Similarly, the end of the windbreak should be located where there is minimal risk of soil erosion.

Ends of windbreaks

The ends can join onto other tree lines or natural vegetation. If they finish in an open area, the trees should be thinned out towards the end, or shorter and shorter trees used to taper the windbreak down.

Distance between windbreaks

In planting a series of parallel breaks to protect a large area of land from the wind, the distance between each break will depend on the height of the trees and the windspeeds you need to combat.

For maximum benefit, windbreaks should be no further apart than 10 to 12 times their height, but such close spacings are likely to be uneconomic except for the protection of high-value horticultural crops.

A more realistic spacing for the broadscale farmer is 20 to 30 times their height. Even those spacings may be extended if a mild level of soil erosion is acceptable, and if the windbreak system is accompanied by conservation farming practices.

Some indication of the downwind distance of protection can be gauged from remnants of native vegetation remaining in or on the borders of paddocks subject to wind erosion. If the height of the vegetation

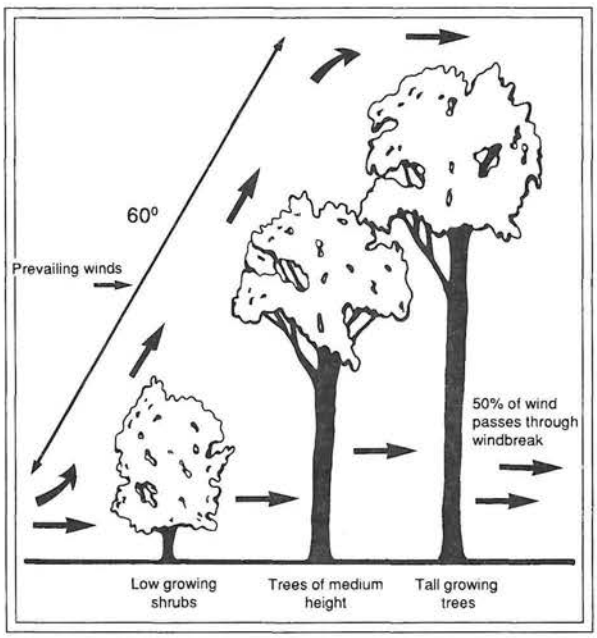
Windbreaks can provide fencing materials and commercial timber

is measured, and also the depth of the protected (non-eroded) area downwind of it, the spacing needed between windbreaks can be calculated.

The location of windbreaks in hilly country

Extra care is needed in siting windbreaks in hilly country. Some broad principles that need to be followed are:

- they follow the contour on hill slopes;
- they cross the contour in valleys;
- they need to be spaced more closely on the windward side of the hill and on the upper leeward side of the hill.



Foliage must extend to ground level. This can be achieved with a combination of trees and shrubs.

Establishing windbreaks

Belts of trees for breaks can be established by planting seedlings, or by direct drilling.

Recommended spacings for planted seedlings are 4 m between trees and between rows in areas with average annual rainfall exceeding 500 mm. For areas of less than 500 mm average rainfall, the spacing should be extended to 5 m.

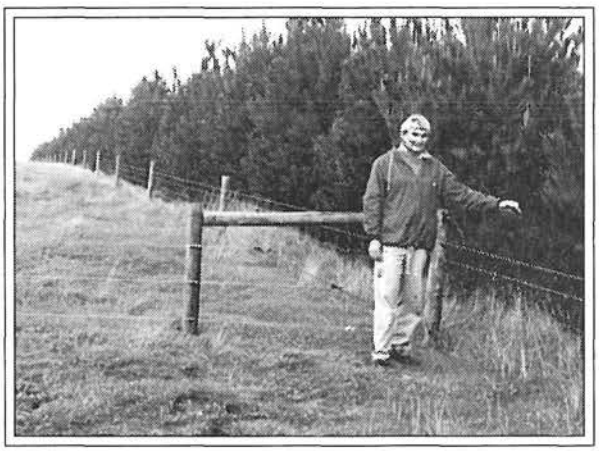
Direct drilled belts should be thinned to roughly these spacings.

Fencing

If you carry stock, windbreaks should be permanently fenced. Stock will otherwise browse the lower branches and destroy the important shelter near ground level.

Maintaining windbreaks

Tree windbreaks require little maintenance once they are established.



Windbreaks must be fenced to protect them from livestock.

Weeds

Weeds in fenced-off windbreaks may pose a fire hazard, particularly when the trees are young. Provided the trees have reached a height of 1.5 to 2 m, weeds can be controlled by 'crash' grazing with sheep. Care must be taken to remove the sheep as soon as they start to browse the trees.

Some recommended species for windbreaks

Note:

- Figures in brackets are the likely heights of the mature trees in metres.
- Species recommended for a particular rainfall zone can also be used in an area with a higher rainfall, but not the reverse.

Trees that retain their foliage to ground level

Light soils - 400 to 500 mm rainfall

Eucalyptus cladocalyx var *nana*	-	dwarf sugar gum (8)
E. platypus var *heterophylla*	-	coastal moort (7)
Pinus canariensis	-	canary pine (12)
P. halepensis	-	Aleppo pine (12)
Tamarix aphylla	-	tamarisk (10)

500 to 600 mm rainfall

Casuarina obesa	-	swamp oak (10)
Eucalyptus conferruminata	-	Bald Island Marlock (10)
E. todtiana	-	coastal blackbutt (6)
Melaleuca lanceolata	-	Rottnest ti-tree (6)
Pinus pinaster	-	maritime pine (12)
Tamarix aphylla	-	tamarisk (10+)

More than 600 mm rainfall

Agonis flexuosa	-	peppermint (10)
Eucalyptus cinerea	-	mealy stringybark (12)
Melaleuca nesophila	-	western tea myrtle (5)
Pinus pinaster	-	maritime pine (17)
P. radiata	-	Monterey pine (20+) only on yellow sand

Heavy soils 400 to 500 mm rainfall

Casuarina obesa	-	swamp oak (10)
Eucalyptus gardneri	-	blue mallet (10)
E. platypus	-	moort (6+)
E. spathulata	-	swamp mallet (6+)

More than 500 mm rainfall

Agonis flexuosa	-	peppermint (10) above

600 mm rainfall only

Casuarina obesa	-	swamp oak (10)
Pinus radiata	-	Monterey pine (20+)
Lephostemon confertus	-	Queensland box (10) above 600 mm rainfall only

Trees that shed their lower branches

Light soils 400 to 500 mm rainfall

Eucalyptus camaldulensis	-	river red gum (15) but only in drainage lines where extra moisture is available

E. cladocalyx - sugar gum (18)

More than 600 mm rainfall

Eucalyptus botryoides - southern mahogany (20)
E. gomphocephala - tuart (25)
E. maculata - spotted gum (25) on yellow sands only

Heavy soils 400 to 500 mm rainfall

Eucalyptus kondininensis - Kondinin blackbutt (12)

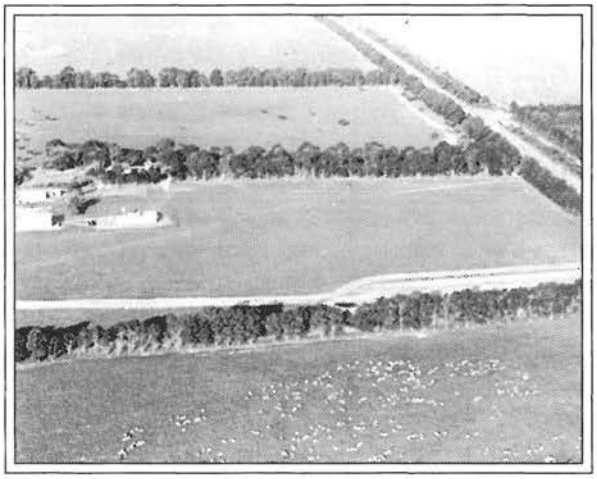
500 to 600 mm rainfall

Eucalyptus crebra - narrow-leaved red ironbark (16)

E. melliodora - yellow box (20)

More than 600 mm rainfall

Eucalyptus diversicolor - karri (40)
E. globulus - Tasmanian blue gum (30)
E. maculata - spotted gum (25)
E. muellerana - yellow stringybark (30)
E. nicholii - Nichol's gum (20)



Windbreaks on the Esperance plain.

The robbing of crops and pasture

The effect of tree roots robbing water and nutrients far into adjacent crop or pasture can be reduced by root pruning (ripping) along the edges of the windbreak. If this practice is to be followed, ripping should start when the trees are no more than five years old, and be repeated every few years.

New-land development

Farmers developing new land could leave strips of native vegetation to act as windbreaks. This is a cheaper alternative than planting or drilling trees. However, if the strips are to be effective, they must be tall enough to provide shelter, and they will need fencing to exclude stock.

Should you plant windbreaks?

Broadscale farmers may consider the cost of total farm protection by windbreaks to be too high, or uneconomic due to the productive land taken up by the trees.

If this is your situation, you might consider using them to protect special areas on the farm:

- areas especially prone to erosion;
- lambing paddocks;
- to protect holding yards;
- to protect dams and roads from filling with windblown sand.

Farmers in areas of more than 750 mm average rainfall have the option of combining timber production with shelter from the trees in windbreaks. Special techniques are required to manage breaks for this purpose. These can be explained to you by Advisory Officers of the Department of Conservation and Land Management.

Weed control near trees

Effective weed control is essential if trees are to be successfully established on farms. Weeds compete with young trees for light, nutrients and moisture. Young trees growing in a weed free environment will not only have a better chance of survival, but will also have a better growth rate.

There are a wide range of herbicides which control a variety of weeds. Herbicides can be divided into three major groups.

Knockdown herbicides

These herbicides are absorbed by the plant leaf - they control weeds which are present at the time of spraying. Common knockdown herbicides include Roundup®, Gramoxone® and Tryquat®. These herbicides become inactive after contact with the soil and are not residual. Wetting agents should be added to facilitate even coverage. Care should always be taken if spraying near existing trees - avoid spray drift damage.

Residual herbicides

These herbicides are applied to the soil and are absorbed by plant roots. They slowly kill existing weeds and also prevent further germinations. Atrazine and simazine are common residual herbicides.

Combinations of residual and knockdown herbicides

These herbicides quickly kill existing weeds and also prevent further germinations (e.g. amitrole and atrazine).

The most effective chemicals for weed control prior to tree planting are a combination of a knockdown and a residual herbicide. When used at the recommended rate, they give reasonable weed control for 12 months, you should spray at least two weeks prior to planting.

Although a knockdown + residual chemical mix is the preferred option, some people may choose to use a knockdown herbicide. To get the best results (in the case of annual weeds), spray the site about two weeks after the opening rains and then again about a week before planting the trees in June or July. This is even more important in high rainfall areas. If only spraying once, spray one to two weeks before planting.

Selective and post plant sprays

Some selective grass herbicides are available which can be sprayed over established trees. Products tested include Fusilade® and Sertin®. Simazine has also been used over eucalypts to provide additional residual control of emerging seedlings.

Hints

1. For single rows of trees, spray a strip about 1.5 m wide.
2. When using Vorox® or simazine/Roundup® mixtures through a boom spray, apply a minimum of 200 L/ha of water.
3. When using a Roundup®/simazine mixture, half fill the tank with water, add the simazine, mix thoroughly, add the Roundup®, then the balance of water. Use the mixture promptly.
4. Simazine is sold under the trade names of Farmco Flowable Simazin-500® and Flowable Gesatop 500 FW®.
5. *Micro Herbi*. Use the nozzle as prescribed in the table overleaf and walk at 1 m/second (a slow walk). It will spray a strip about 1.2 to 1.5 m wide.
6. *Knapsacks*. These recommendations are based on applying water at the rate of 15 L (usually one tank full) on a strip 100 m long and 1.5 m wide (150 m^2). Before applying the herbicide, do a dummy run on a similar area somewhere else, with just water, to calibrate your speed of operation. As a general rule, thoroughly wet all plant foliage.
7. In all cases, use the higher recommended rate for large weeds and the lower recommended rate for small weeds. Best results for weed control are usually achieved when weeds are young and actively growing. Observe the manufacturer's recommendations along with all necessary safety precautions.

Masks and protective clothing are essential, particularly when using knapsacks and other operator carried sprayers.

Chemical control

	Application rate		
	Boom spray L/ha	Knapsack mL/L water	Micro herbi mL herbicide/ mL water
Annual weeds (capeweed, ryegrass, bromegrass)			
Knockdown			
Tryquat*	4.5	7.5	
Gramoxone*	3.0	5.0	
Roundup*	1-3	1-3	1:3 (blue nozzle)
Knockdown + residual			
Flowable Vorox AA			
Low rainfall (<600 mm)	3-4	3-4	
High rainfall (>600 mm)	5-6	5-6	
Simazine (50%)	10-16 (higher rate in wet conditions)		
Perennial grass (kikuyu, couch)			
Fusilade*	4.0	5.5	
Roundup**	6-9	6-9	2:1 (yellow nozzle)
Perennial broadleaf			
Roundup**	6-9	6-9	2:1 (yellow nozzle)
Selective post planting			
Eucalypts			
Fusilade			
Sertin			
Simazine			
Pines			
Fusilade			
Sertin			
Amitrole/atrizine			

* Add simazine to obtain residual activity.
** Roundup® is systemic in action and can kill trees if spray drifts on to green material.

CAUTION: Always read the label before using chemicals. Refer to chemical companies for more detailed information and recommendations.

Fencing trees from stock

Protecting trees from livestock for the first two or three years is as important as any of the other aspects of a good tree planting programme. One or two animals can destroy many hours of work and many dollars worth of trees in less than a day.

The ease of erection and low material costs make electric fencing a sensible alternative. Where electric fencing is already being used, the additional fences can be easily added. If it is being used for the first time, careful planning is involved. Without good earthing and careful planning, electric fencing should not be considered.

Bulletin 4131, 'Electric fencing' (Agdex 723/75), published by the Western Australian Department of Agriculture, provides a comprehensive guide to the construction of this form of stock control.

Many farmers are also planting clumps of trees into their paddocks to improve the look of their farm. A lot of time and material can be used in protecting these trees. Barbed wire (not electrified) and sloping posts can save time and money as a permanent fence. Posts are driven into the ground about 30 degrees from the vertical (leaning into the trees) and spaced no more than 5 m apart. The barbed wire is pulled by hand (not strained) and tied to the post. The number of wires used depends on stock, but five wires will control sheep. The bottom wire must be close to the ground. Three wires have been used to control cows and calves.

Any fencing of trees should be considered as permanent. By putting in gates, grazing under trees can be carefully controlled.

Further reading

'Electric fencing', Bulletin 4131, Department of Agriculture, Western Australia.

Insect pests of eucalypts and other native plants

This chapter describes typical symptoms seen on trees after attack by a range of insect pests. It also provides a description of the adult insect and/or its larval stages. An excellent Bulletin, 'Insect and allied pests of extensive farming' (Bulletin 4195) is available from the Department of Agriculture. Colour photographs of all the pests described here and the damage they cause are included in that Bulletin.

Recommendations on control measures frequently change so no details are given here. For this information you should contact your nearest Department of Agriculture office or the Department of Conservation and Land Management.

Autumn gum moth

Damage

Young caterpillars of the autumn gum moth feed as a group and skeletonize the leaf so that only the veins remain. Older caterpillars feed on the whole of the leaves, and branches are completely defoliated, with only a few curled brown leaves remaining, in which the caterpillars shelter during the day.

The juvenile leaves of bluegum trees are preferred and the Tasmanian bluegum is the most commonly attacked species in Western Australia, although river red gum is also sometimes attacked.

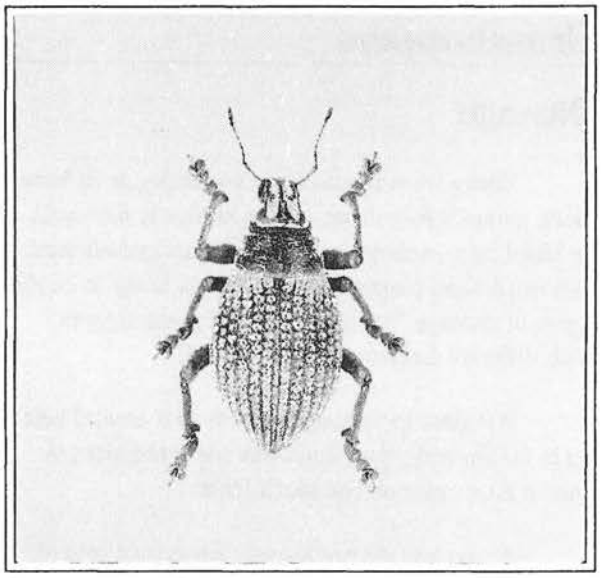
Description

Young caterpillars are light yellow-brown with dark brown and green markings. Older caterpillars are dark greenish brown, up to 30 mm long, with two red patches containing two yellow swellings on each segment, those on one segment being particularly prominent. They are not obviously hairy.

Catasarcus weevils

Damage

On farms, most damage has been noticed on Australian native plants grown around farm buildings and along farm fences as windbreaks. Generally



Catasarcus weevil

such plants are eucalypts. In the Esperance area the planted species most commonly attacked are tuarts, while around Albany, bluegums are often attacked.

The weevils chew leaves around the edges, giving a scalloped appearance. Heavy infestations can strip trees completely, especially if they are small. The seriousness of the damage is largely a matter of opinion; some farmers claim trees are severely retarded or even killed, while others find that trees can compensate for the defoliation. Young trees are most likely to be adversely affected. Some observations suggest that trees suffering from some other setback are most affected - for example, trees suffering from water stress or nutritional imbalance.

Description

These weevils are restricted to Western Australia and some parts of South Australia. At least 41 different species have been identified.The species most commonly found in the Esperance region has a black and ochre stippled abdomen; the thorax is black, while the head has two ochre coloured lines running down its 'snout'. Overall the insect is a large robust creature, about 15 mm long. When disturbed they can 'play dead', tucking their legs tightly beneath them and dropping from the leaf or branch upon which they have been feeding or resting.

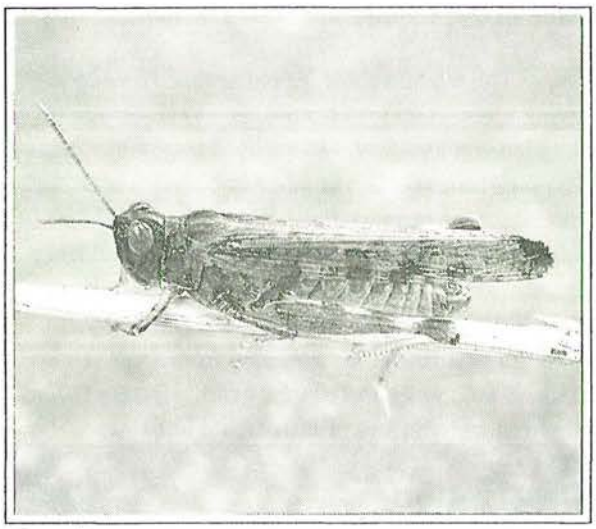
Grasshoppers

Damage

Young trees planted into paddocks, or in belts along paddock fencelines, can be seriously damaged or killed by grasshoppers. The wingless grasshopper and Australian plague locust are most likely to be the cause of damage, but other types of grasshoppers with different habits may be involved.

Wingless grasshoppers occur in a coastal belt up to 50 km wide, from Lancelin north of Perth, to east of Esperance on the south coast.

Australian plague locusts can extend into all agricultural areas, originating in inland pastoral areas, if seasonal conditions (spring and summer rain) suit them.



Plague locust

The small plague grasshopper occurs in the drier inland agricultural regions, and can build up to large numbers in some seasons.

At least 12 other types of grasshoppers occur throughout all these regions, and may be responsible for damage at times.

Gumleaf skeletonizer

Damage

The young caterpillars of gumleaf skeletonizers are gregarious and feed together on the lower leaves first. They eat most of the leaf tissue except the veins reducing the leaves to a skeleton. The older caterpillars feed separately and may leave only the midrib. Trees may be completely defoliated by heavy infestations, but death does not usually result.

Many species of eucalypt are attacked, of which jarrah, wandoo and river red gum are probably the worst affected.

Description

The caterpillars are green and yellow with long pale hairs which are irritant to human skin. A characteristic brown horn-like tuft on the head is formed from moulted head capsules stacked on top of each other. Fully grown caterpillars are about 25 mm long.

Gumtree scale

Damage

Gumtree scales infest young stems and leaves, sucking the sap and producing a sugary secretion which may cover the leaves and cause them to glisten. A sooty mould fungus often infects this secretion and causes the leaves to turn black. Ants commonly attend the scales to feed on their sugary exudate, which they promote by stroking the scales. Continued attack results in debilitation of the tree and small trees may die. A number of eucalypts are attacked by this scale, but in Western Australia wandoo is probably the most commonly infested, particularly in the wheatbelt.

Description

The female scale grows 3 to 4 mm long and is fixed to small stems, branches and near the midrib of leaves. The felted globular sac which encloses each adult varies from white or yellow to dark brown and when squashed contains a reddish fluid. The male scales are smaller, being 1 to 2 mm long, white and more elongated than the females and are often clustered above the females on the stems or leaves.

Leafblister sawfly

Damage

The larvae of leafblister sawflies mine the leaves of eucalypts and feed within the upper surface of the leaves, producing rounded blotch mines, which may cover the whole leaf surface, giving it a scorched appearance. Heaviest damage usually occurs to foliage within 6 m of the ground and young trees are

worst affected. Older flooded gums may suffer serious damage at heights exceeding 10 m. More than 15 eucalypt species, both introduced and native to Western Australia, are attacked. Of these, rose gum, swamp mahogany, river gum and flooded gum are the most heavily attacked.

Description

The adult sawflies are small orange and black active wasps, about 5 mm long. The larvae are yellow-cream with dark spots, about 5 mm long when fully grown, slender and somewhat flattened. They feed actively in the leaf.

Lerp insects

Damage

The developing nymphal stages of lerps suck the sap of the leaves while sheltering under their 'lerp' scales. In heavy infestations this eventually results in discoloration of the leaf which turns reddish brown and eventually dies and falls off. Severe defoliation may result from heavy infestations, and debilitation and death may follow repeated attacks.

Flooded gum is the main host tree in riverine and farm sites and wandoo may also be infested in drought affected wheatbelt areas. River gums planted as a saltland rehabilitation species may also be heavily infested. Remnant areas of flat topped yate in swamps in southern areas can be severely affected.

Description

The adult psyllid is about 4 mm long with transparent wings and a yellowish brown body. It is usually found in numbers on lerp infested leaves in summer. The lerp scale when fully formed in spring, is about 8 mm long, horn shaped and tapering from about 0.5 to 4 mm in width and is yellow to pale brown. Under each lerp scale there is an orange nymph which is active when the leaf is moved.

Jarrah leafminer

Damage

Jarrah leafminer larvae feed between the leaf surfaces during winter, producing blotch mines which often cover the whole leaf surface giving an appearance resembling fire scorch. Severe infestation may be found commonly along forest edges, in clearings and on partly cleared farmland. Jarrah is the main host tree, with flooded gum also heavily attacked in riverine environments and partly cleared farmland. About ten other eucalypts native to Western Australia may suffer slight damage.

Description

The adult moth is grey-brown and about 6 mm long. Maximum activity may be observed on sunny autumn days when moths run up and down twigs and leaves after emerging from the soil.

The mining larvae are cream coloured and reach 4 mm long when fully grown.

Leaf beetles

Damage

Many eucalypt species are attacked by larvae and beetles. The larvae can strip most of the leaves from young trees and seriously retard their growth. Adult beetles feed mainly on leaf edges and do not generally cause such serious damage.

Description

The larvae are generally a yellowy cream with some black patches; they grow to about 5 mm long. The adult beetles are generally brightly coloured, usually pink, orange or red-brown. They are similar in shape to ladybird beetles but are larger, being up to 10 mm long.

Spitfires

Damage

Larvae of spitfires feed on the foliage of young trees and regrowth stems, and can strip the branches of foliage particularly at the tops. This is usually replaced during the spring-summer flush of leaf growth. Serious retardation of high growth may result from repeated attack but death is unlikely. Wandoo is the most commonly attacked species in Western Australia.

Description

The larvae vary from dark blue or black to yellow and brown depending on the species and are about 25 mm long. The body is sparsely covered with white bristly hairs and the tail, which is raised when

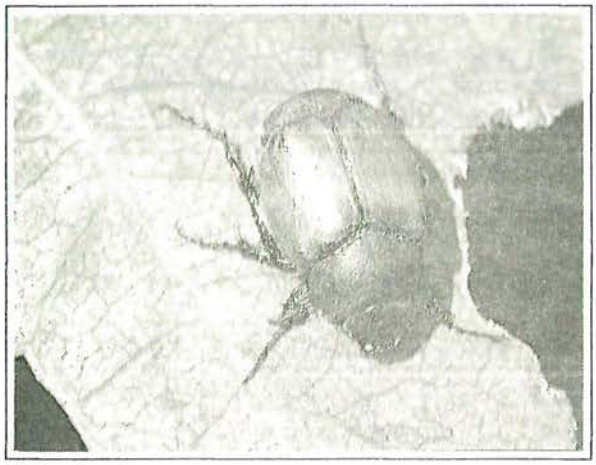
disturbed, is yellow and can exude an odourous fluid. During the day the larvae congregate in clusters of 20 or 30 for protection and disperse at night to feed.

The adult wasps are mainly black or brown, with yellowish markings and about 20 mm long.

Spring beetles

Damage

Many eucalypt species are attacked by the beetles in wheatbelt and southern areas, and serious defoliation may result. Larger trees may be pruned into rounded shapes, and smaller trees may be stripped completely of leaves. Death of young trees may occur, especially if they are droughted, or waterlogged, and cannot grow new foliage. Seedling trees in rows along paddock boundaries can be highly vulnerable, as beetles from adjacent paddocks congregate on them.



Spring beetle

Some species of spring beetles feed on flowers of many native plants, and can cause damage to blossoms wanted for the flower trade.

Description

The beetles are small scarab or cockchafer beetles, about 5 mm long. They may be bronze and brown, or orange and dark blue.

Tree lucerne (tagasaste) moth

Damage

Caterpillars of the tree lucerne moth can completely defoliate tagasaste (tree lucerne), perennial lupins, and some native leguminous shrubs such as *Hovea* spp. Leaves, twigs and smaller branches are webbed together, with caterpillars congregating in the webbing, and with dark specks of frass (caterpillar droppings) caught up in the webbing. Established shrubs are unlikely to be killed, but plants less than a year old may be at risk. This insect is not commonly reported, probably because, until recently, most tagasaste has existed as ornamental plants in farm yards. Increased farm plantings for fodder or soil conservation will provide more extensive opportunities for tree lucerne moth. Lost drymatter production may be significant, and will depend on how tagasaste is used on farms.

Description

The caterpillars have a fringe of sparse hairs, and grow to 35 mm long. The head is pale brown through to a shiny red-brown, and behind it is a black collar with three white stripes. The body is light green with a yellow and white line just above the legs on each side. Above this there is a dark band made up of black blotches on each segment. Each black blotch has long hairs arising from it, and also has one or two white spots. Three pairs of dark legs at the front are followed by four pairs of green 'sucker legs'. They are slender compared with other larvae such as budworm, which they superficially resemble.

The moth has a distinct 'beak'. At rest with wings folded it is about 20 mm long, and 35 mm across with its wings spread. The fore wings are dark grey-brown with a lighter grey patch towards the rear edge. Often there are light brown lines where the wing scales have been rubbed off. The hind wings are orange-yellow with a broad dark brown margin. The underbody is nearly white, with a white face and coiled feeding tube. Moths have been caught in light traps from early spring to late autumn.

Fitting trees into the farm plan

Trees are only one aspect of farm management, and must be integrated with a whole-farm plan to avoid long term problems. Most trees will survive for more than 30 years, and the plan they fit into also needs to be for at least that period.

Aerial photos serve as good base maps.

In many instances, windbreaks/shelterbelts can give a net financial gain from increased crop and pasture yields, and reductions in lamb and ewe deaths.

As a rough guide, most farms in southern Western Australia would benefit from having 10 to 15 per cent under managed trees.

A good base map should be used, such as an air photo, showing the main topographical features, for example ridge crests, waterways and creeks, rock outcrops and breakaways. This map should also show information on the main land classes or soil types and areas with a known or predictable soil erosion, waterlogging or salinity hazard.

Sites for planting

Often 'square paddock' farm layouts are far from the best possible and since 1955, the Soil Conservation Service of the Department of Agriculture has developed the conservation farm planning concept. This is an integrated approach to planning the farm layout.

Trees need to be located:

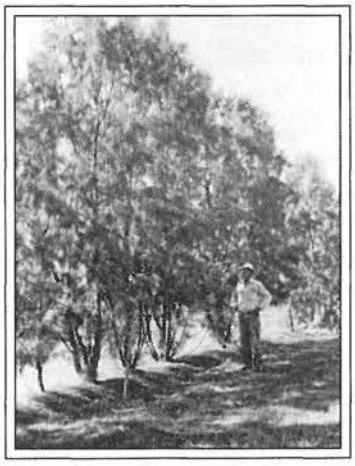
- to give effective stock shelter and provide protection from wind and water erosion;

A two year old tamarisk windbreak.

- where they conflict least with farm operations, and give a net gain in productivity;
- where they will grow fast into healthy long-lived trees and beautify the landscape.

Tree belts need to be fenced to avoid stock damage. Consequently, new plantings located near existing fences or proposed new fence lines will reduce fencing costs. Many fences in a conservation farm plan are located:

- between land classes, such as saltland, deep sand, heavy clay;
- alongside creeks and waterways;
- along ridge crests;
- along rocky outcrops and breakaways;
- along contour banks and along large levee, diversion and interceptor banks.



A six year old tamarisk windbreak.

In all these positions there is scope for useful tree plantings. The land classes fenced off may separate saltland from good arable land. Belts of salt-tolerant trees just inside the salt paddock can help dewater the marginal land, mulch and shade the soil and act as a windbreak for the bare saltland. A fence between good arable land and deep erodible sandplain is often justified. It may be a good location for a two or three line windbreak to help control wind erosion.

Eucalyptus globulus and E. saligna in an agroforestry configuration.

Ridge crests are often ideal sites for shelterbelts for wind erosion control. Wind speeds are highest across exposed ridges. Laneways for stock and vehicle movement are often sited along ridges and being double-fenced, are ideal tree planting areas, provided they are not used for sheep movement during the establishment years.

Rocky outcrops and breakaways are often left uncleared and unfenced; they may show decline and no seedling regeneration. Double fencing of rocky outcrops is probably the cheapest way of getting more trees back on a farm. Fence off, maybe after a burn, and allow regeneration to occur naturally.

Contour banks with fences along them fit in with convenient contour working. To avoid too many strainer posts, small islands of land are often left between the bank and the fence. These pieces of 'dead' land are ideal for groups of trees; usually a single line could be planted along and below the bank. On exposed windward slopes, these midslope contour windbreaks can be valuable in preventing wind erosion.

Bigger banks built with a bulldozer may also provide 'islands' suitable for tree planting. Suitable tree species may be planted on top of the banks or just down-slope of them.

Most of the tree planting sites mentioned above are areas which are either non-arable or should not be cropped. **It is possible to plant many trees on properties implementing a conservation farm plan, without any significant loss of cropping land**. Tree fencing costs are only half those where a special double fence is needed to protect a windbreak not tied in with the paddock fence layout.

Crops and trees

Competition between trees and crops is minimized by locating trees on non-arable land with the arable land along one side of the belt. Root-pruning by ripping along the arable side of the belt can further reduce this problem. It may damage some trees, and should be practised as infrequently as possible.

To be compatible with large agricultural machinery, trees need to be aligned in belts and blocks and not as scattered individual trees or small clumps, as in the 'parkland' pattern of clearing. In any case, individual trees do not seem to thrive. There may be a case on mixed wheat and sheep farms for a few smaller well-treed, parkland paddocks for use by lambing ewes and off-shears sheep. These are often situated close to the house and sheds, where they provide additional shelter for the buildings and create an 'oasis' effect.

Other places where trees can be planted include awkward corners and spots of 'dead' ground, inaccessible to machines and sometimes sheep. Examples include islands of land isolated between deep gullies, acute corners where contour banks join waterways, and sharp paddock corners.

Plantings in and around the farm yards provide shade and shelter for stock and workers, and improve the homestead environment.

Windbreak plantings around dams may be justified to reduce wind speed over the water surface, lowering evaporation losses. They should not be planted too close to the dam and should be below the dam wall to reduce leaf litter and sheep manure pollution of the water.

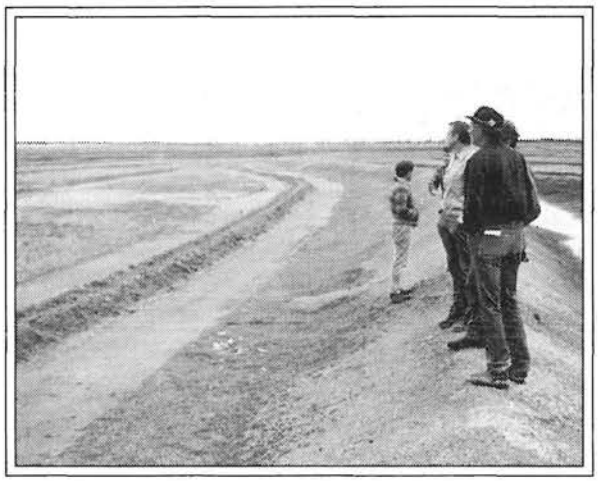
On farms which grow cereals there may be conflict in locating tree belts where they give most benefit in erosion and salinity control, but are situated on fertile, well-drained soil, where they still compete with crops.

Trees for saltland

Advantages of trees

There are many reasons for wanting to plant trees on saltland, for example:

- to beautify an otherwise ugly piece of land;
- to convert a salty area into a future stock shelterbelt. Many farms were overcleared during development. In planning replanting programmes it makes good sense to use non-arable areas if trees will grow on them;
- tree belts help reduce wind erosion. Wind erosion, combined with sheep trampling on saltland, helps enlarge the areas of bare saltland;
- trees planted around the fringes of saltland may lower the watertable enough to avoid further spread of salinity.



Grade banks and graded mounds on saltland.

When the main reason for growing trees has been decided, the best varieties can be selected.

Planting trees is one part of dealing with saline areas; drainage in the salt affected area, earthworks above the site, and higher water use crops and pastures around the site will all help reduce the problem. Planting trees in isolation from the other treatments may give only a very small effect. Also consider the use of salt tolerant grasses and shrubs for fodder value between tree lines. This gives added erosion control and reduced surface salt accumulation.

Site preparation

Before the opening rains, rip 50 cm deep along the proposed tree lines; preferably two lines 50 cm apart. Then, on all salt affected or waterlogged sites, make a mound 25 to 30 cm high with a plough, road grader or a three point linkage blade on a tractor, or a specially built mounder. The mound will protect the seedling from flooding and aid root growth.

Ripping and mounding the soil will encourage the opening rains to leach salt before planting.

Grass competition on saltland is usually confined to low-growing barley grass, which does not shade out the young trees. There is little competition for soil moisture on saline sites, which are often very wet. Consequently it is unnecessary and even undesirable to spray herbicides to control weeds in most saline sites. Spraying the soil surface can increase the rate of salt accumulation in the topsoil.

Mounds may need weed control, especially on mildly affected areas. Pre-plant residual herbicides, or post planting selective grass herbicides can be used.

Species and varieties

A wide range of trees and plants will tolerate slight soil salinity but few plants and very few trees will tolerate saline and waterlogged soils. Soil or water analysis may show if waterlogging or salt is the main concern.

Severely saline sites

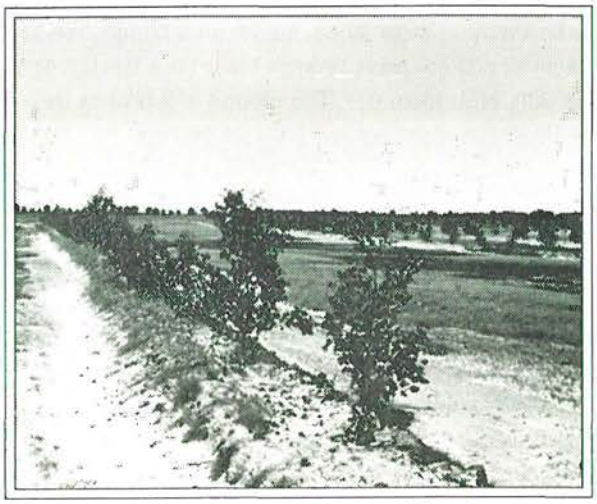
These sites are usually bare and are flooded in winter. Virtually no trees will grow on these sites. The best plant is samphire (*Halosarcia* spp.), which occurs naturally in salt lakes and creeks in Western Australia.

The large shrub, *Melaleuca thyoides*, has outstanding salt and waterlogging tolerance and is useful for shelter and appearance. Other species include *Melaleuca cymbifolia,* and *M. uncinata.*

Moderately saline sites

These sites usually have a patchy covering of barley grass (*Hordeum marinum*). The most salt-tolerant species should be planted here. They include:

- athel tree (*Tamarix aphylla*) the evergreen tamarisk which can be propagated easily from cuttings;
- spring flowering tamarisk (*T. gallica*) the deciduous species which can be propagated from cuttings;
- salt or swamp sheoak (*Casuarina obesa*) which is a good windbreak. It frequently spreads from self-



Eucalyptus occidentalis on mounds on saltland.

sown seed;

- flat-topped yate (*Eucalyptus occidentalis*);
- salt river gum (*E. sargentii*), grows slowly south of Perth and is usually shallow-rooted;
- *E. halophila*;
- coastal moort (*E. platypus* var. *heterophylla*); an excellent, low and attractive windbreak with fair salt tolerance;
- flooded gum (*E. rudis*); good flooding tolerance;
- *Melaleuca uncinata*; a useful bushy, low to medium sized tree;
- *Melaleuca cuticularis;* salt paper bark. Very good flooding tolerance.

Mildly saline sites

- York gum (*E. loxophleba*); a widespread shade tree of better wheatbelt soil types;
- river red gum (*E. camaldulensis*); good flooding tolerance. Some very salt tolerant types available;
- sugar gum (*E. cladocalyx*); not waterlogging tolerant.

Non saline fringes

Trees with high water use, suitable for the rainfall zone should be planted in a belt around the saltland. Examples for high rainfall areas include Tasmanian blue gum (*E. globulus*), Sydney blue gum (*E. saligna*) and spotted gum (*E. maculata*).

Planting

Plant the seedlings into a hole or furrow in the top of the mound and press the earth around the seedling to remove air pockets. Gently water in with fresh water if necessary.

Layout and design

Trees to lower the water table can be planted to intercept water before it reaches the discharge area or planted directly on or adjacent to the problem area, or planted to stop recharge directly on recharge zones. Planting on watertable recharge areas allows more species to be selected from, and often coincides well with other farm planning requirements (see chapter 'Fitting trees into the farm plan'). These sites are generally along gravelly or rocky ridges and deep sand areas.

Planting on or near saline discharge areas (seeps, gully sides, salt flats) gives a direct and possibly rapid effect on the local watertable. Tree survival and growth may be lower on these sites.

Tree numbers to give the desired result have been estimated by rough rules of thumb. This needs some assumptions about the amount of water a tree uses each year and the flow rate of water in the soil. Contact a Department of Agriculture soil conservation adviser for details.

For recharge areas, trees need to be evenly distributed for best results. Interception planting (lateral water movement) needs to be wider on sandy surfaced soils and narrower on heavy loams. That is, more lines of trees on sandy soils.

Planting on flat salt areas to lower the watertable: trees can be in single or double lines spaced across the site. The distance between lines is determined by the soil conductivity (to water) and the speed of a desired change.

Fencing

Fence the area to protect seedlings from grazing animals. Rabbit netting or baits may be necessary to prevent rabbit damage and individual tree guards will ward off parrots.

Watch for damage by insect pests and control with the appropriate insecticide.

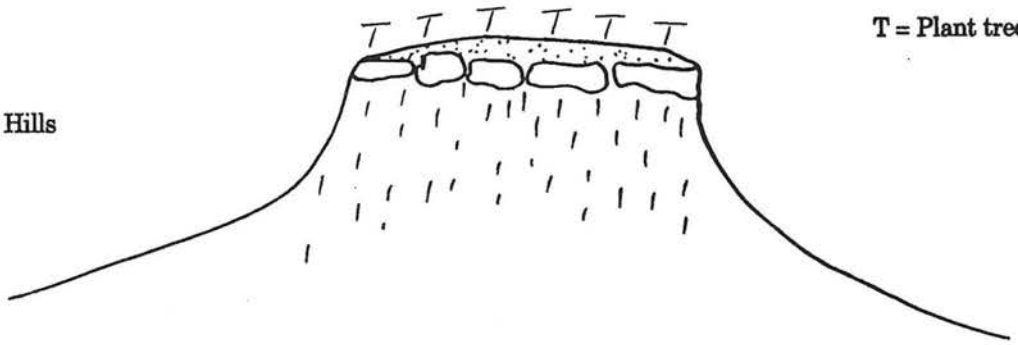
Watering

Apart from fresh water at planting, water only if the trees wilt. Normally, there is adequate water in salty areas and plants die because of flooding rather than a lack of water.

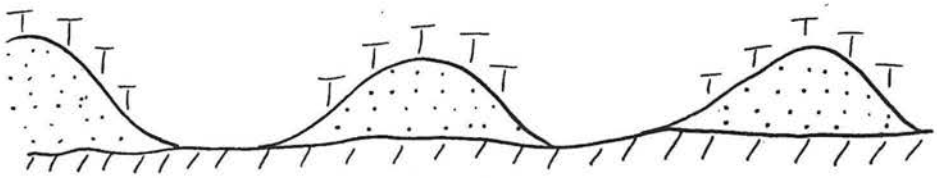
Reducing recharge

T = Plant trees

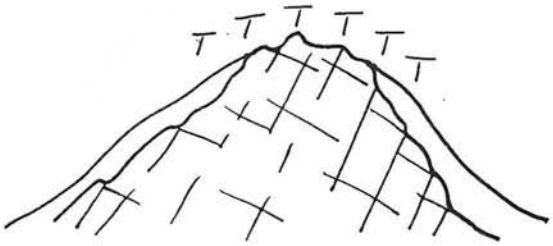
1. Mallet Hills



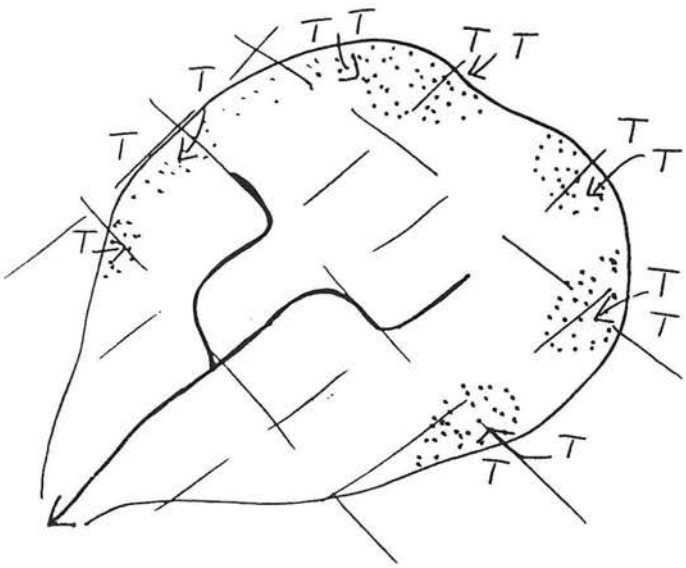
2. Sand dunes



3. Fractured rock



4. Deep sand and shear zones

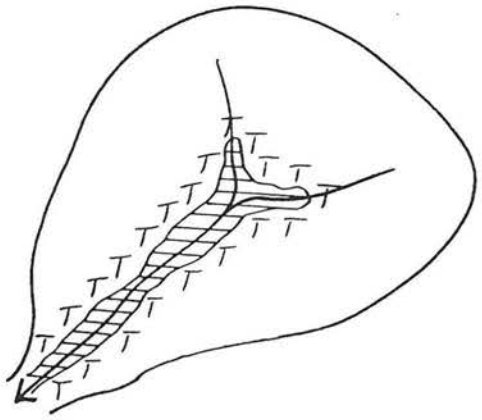


Sites for tree planting to reduce recharge.

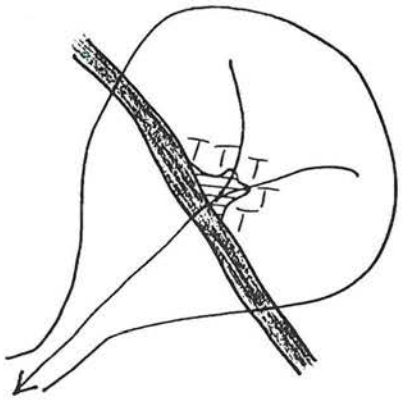
Intercepting groundwater

T = trees

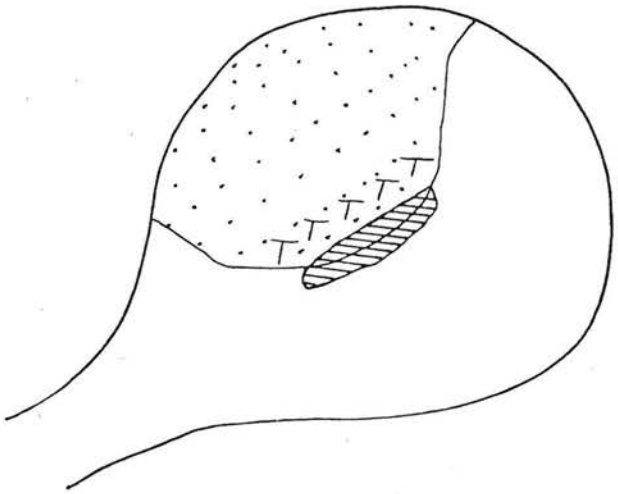
1. Valley salinity



2. Dykes



3. Sand seep



Sites for tree planting to intercept groundwater.

Trees in wet areas

Very few trees will grow in areas that are continuously waterlogged. Therefore the first consideration in reclaiming a wet area is to reduce the amount of water coming into and staying in that area. Earthworks (grade, diversion/interceptor banks and dams) can be used to limit water entry into the area and various drainage systems will reduce the accumulation of water.

Contour (grade) ridging may be necessary to give seedlings a chance to develop in a moist, but not wet, environment - once established, trees can cope better with 'wet feet'. The ridges (on top of rip lines) will also allow leaching of salt that often accumulates in the surface layer of wet areas - the ridging/ripping may need to be done a season before planting in badly affected areas.

When the preparatory work is complete, the area will need to be fenced off - to protect seedlings and to prevent 'pugging'. Electric fencing is the cheapest form and is effective. (See Western Australian Department of Agriculture Bulletin 4131).

For those farmers interested in monitoring the effects of their reclamation/tree planting efforts, several auger holes dug to 2 to 3 m, with slotted 40 to 50 mm P.V.C. pipe inserted, will allow easy measurement of the water-table level and also allow water sampling for salinity tests. Make sure the pipes have lids to prevent rain creating false readings. In areas which are badly salt-affected, it is a good idea to do this first, so that appropriate work can be done and suitable tree species can be chosen. For information on preparation and planting see other appropriate chapters in this book.

The trees selected are a matter of personal choice within the limits set by the site characteristics. The main aim of the exercise is to lower the watertable (to about 2 m depth) and where a large amount of water is present, planting of closely spaced, high water use trees, will achieve this. A closely planted 1 ha plot of well established eucalypts (e.g. *E. globulus*) is estimated to use 20,000 cubic metres of water in a year. To achieve the best effect, spacing should be in the range of 4 m by 4 m (625 plants/ha) to 4 m by 2 m (1,250 plants/ha). Species such as *Acacia melanoxylon* (Tasmanian or southern blackwood) may be planted between rows of one year-old eucalypts - they appear to thrive on the competition and grow quickly and very straight.

Species chosen for their timber may be thinned as they mature to allow for a better end product. Replacement planting is a good idea before mature trees are removed. Poplars and willows may be pruned or coppiced for fodder, and some (particularly hybrid varieties) have been successfully grown alongside salt-affected areas.

The following table provides a list of trees suitable for wet areas - divisions are according to salt tolerance or particular characteristics. These categories are not intended to be definitive - species/tree performance varies considerably and depends on the trees origin (provenance) and what is recognized as 'salt' conditions.

Salt tolerant	Moderately salt tolerant	Slightly salt tolerant
(bare areas - with patchy covering of barley grass [*Hordeum marinum*])	(thick covering of barley grass)	(areas of barley grass amongst other grasses)
Eucalpytus: *occidentalis* *sargentii* *spathulata* *platypus* (var. *heterophylla)*	*Eucalyptus:* *camaldulensis* *campaspe* *cornuta* *conferruminata* *macrandra* *robusta* *rudis*	*Eucalyptus:* *calophylla* *globulus* *gomphocephala* *leucoxylon* *maculata* *muellerana* *ovata* *patens* *saligna*
Melaleuca: *cuticularis* *thyoidies* *rhaphiophylla* *uncinata*	*Acacia melanoxylon* (and others)	
Casuarina obesa	*Populus alba*	
Tamarix: *aphylla (articulata)* *pentandra* *gallica*		
Populus euphrates		

Non-saline areas	Noted for high water usage	Fast growth rate
Eucalyptus: *mannifera* *microcorys* *regnans* *tereticornis* *torquata* *viminalis* *woolsiana*	*Eucalyptus:* *botryoides* *globulus* *leucoxylon* *maculata* *mannifera* *muellerana* 'Mysore' (hybrid: *camaldulensis* / *tereticornis)* *regnans* *saligna* *sideroxylon* *tereticornis* *woolsiana* *wandoo*	*Eucalyptus:* *botryoides* *globulus* *conferruminata* *muellerana* *resinifera* *saligna* *viminalis*
Populus: semi-evergreen hybrids		*Acacia melanoxylon*
Salix babylonica, *vitellina* (var. *pendula)*	*Populus* species	*Populus species*
	Salix	

Sources of assistance

Department of Conservation and Land Management

This organization has two specialist officers available to assist in all aspects of tree planting and management. They can also supply seed and seedlings at moderate cost and they have a good array of leaflets.

There are offices in many major country centres where advice can be obtained.

Department of Agriculture

They can be of assistance in general queries on trees, their use on the farm, agroforestry and insect control.

There are offices at Bridgetown, Manjimup, Narrogin, Katanning, Bunbury, Albany, Jerramungup, Lake Grace, Busselton, Harvey, Northam, Merredin, Moora, Geraldton, Three Springs and Esperance.

Greening Australia

This group encourages tree planting. Grants and information are available for revegetation and tree planting schemes. For example, a group of farmers at Jerramungup received a grant to revegetate their farms after a bushfire.

The group administers the John Tonkin Tree Awards to encourage community involvement in trees.

The 'One Billion Trees' programme is also administered by Greening Australia. Annual grants will be available over the next ten years to individual farmers or to Land Conservation District Committees.

Greening Australia also supply trees under their 'Ribbons of Green' programme to revegetate major roads in the city and the country.

They produce a newsletter 'Leaflet' which contains much useful information.

Greening Australia have taken over the operation of the Hamel Nursery.

Greening Australia (WA) Inc., 1118 Hay Street, West Perth 6005, telephone (09) 481 2144; fax (09) 481 0024

Australian Forest Development Institute

The Institute can provide details on contractors for commercial forests, as well as arrange insurance for pine plantations.

Their address is Australian Forest Development Institute, Western Chapter, 103 Colin Street, West Perth 6005, telephone (09) 322 2088.

Bunnings Tree Farms Pty Ltd

They can be a useful source of information, seedlings and contracts. (See chapter on 'Sharefarming schemes').

Contact: Mr J Sanders, Bunnings Tree Farms Pty Ltd, Manjimup 6258.

Local nurseries

Nurseries and tree planting contractors are located throughout the farming area. These people can supply information on tree selection and planting techniques.

Tax and farm trees

Trees for conservation

Soil conservation

Expenses for establishing shelterbelts and/or windbreaks specifically for the purpose of preventing or combating soil erosion on farms, are deductible in the year of expenditure.

The cost of clearing virgin land or indigenous vegetation no longer attracts any taxation concession.

Shelter, windbreaks and fodder

Expenditure on tree plantations for the purpose of shade, visual improvement, water quality, flora and fauna reserves, education and scientific research, is of a capital nature and is not deductible.

The replacement of any such trees destroyed (e.g. by fire or disease) before the exhaustion of their useful life, would be considered a maintenance expense and is therefore deductible.

However, crop trees (such as apples or tagasaste) which are replaced due to exhaustion of their natural life, are considered to be capital and therefore not deductible.

Maintenance costs such as fertilizing, vermin and weed control, are fully deductible business expenses (Section 51).

Fencing

Construction of a new fence is normally regarded as a structural improvement and as such qualifies for depreciation at 4.5 per cent diminishing value for ordinary fences and 7.5 per cent for electric fencing.

The cost of erecting or extending erosion control fences to exclude livestock or vermin from areas affected by erosion or salinity, is deductible in the year of expenditure (Section 75D).

Trees for income

The definition of forest operations within the context of primary production, if done by the owner who is a primary producer, covers:

- planting trees in plantations or forests intended for felling;
- tending trees in plantation or forests intended for felling;
- felling of trees in a plantation or forest;
- transport of the felled trees for processing. If carting or felling is done by a contractor, this does not apply.

As these expenses are incurred in the generation of income, they are fully deductible, as are the normal maintenance costs. This applies to primary production only.

Standing trees not trading stock

The value of a standing tree crop is not brought to account for the purpose of calculating taxable profit, as is done for livestock. Trees only become trading stock when severed from the land.

Sale of timber

Income from the sale of forest produce is assessable whatever the method of sale if the product has been grown for the purposes of making profits.

This indicates that early documentation of intentions from the outset of a farm programme, such as in a comprehensive farm plan, may prove useful evidence of intent in later years.

However, regardless of the person's intention at the time of acquiring land, once **regular** sales of timber are made, the proceeds are assessable income.

Where a person plants timber for another purpose, for example extensive windbreaks, and makes a **once only** sale, these proceeds may be free of tax.

What if an existing timber stand is purchased?

If purchased with the intention of making profits, proceeds may be included in assessable income. If the new owner did not purchase land with the intention of selling existing stands of timber for profit, the proceeds may not be in the nature of assessable income.

Sales of timber from forests or native stands managed primarily for grazing, may not be regarded as assessable income.

Where a farm forestry operation is planned and carried out for commercial purposes, the tax situation is clearer than for many of the farm uses of trees discussed here.

Criteria which may be used to determine whether or not proceeds from timber sales are assessable income include:

- market price;
- purchaser - farmer, friend or sawmill;
- extent of operation;
- quantity per sale;
- extent of professionalism of enterprise.

This information on tax and farm trees reflects the taxation laws as they currently stand (April 1991). Should you require further detailed information, specific enquiries can be directed to the Deputy Commissioner of Taxation, by you, or through your accountant/tax agent.

Pines - wood for the future

The profitability of growing pine is increasing. Softwood, produced by pines, has a number of advantages over native hardwoods: it is fast growing, light, has a high strength to weight ratio; it is easy to work and nail; and cheaper than hardwood to transport. Although subject to insect attack and rot, the timber may be treated with preservatives and used for any building or outdoor work. It is also used in furniture, cabinet making and veneers.

Only the south-west is suitable for fast growing commercial plantations. Farmers contemplating significant areas of pines should consult with Department of Conservation and Land Management officers regarding site suitability.

Growing pines

Which pine?

Experimental plantings of various pine species throughout the south-west have demonstrated that there are two species suitable for management as plantations in Western Australia.

These are *Pinus radiata* from California and *Pinus pinaster* from the coastal areas of Portugal and France. Each species has characteristics which make it suitable for different areas in the state.

Pinus radiata is the faster growing of the two, and at present provides most of the softwood milled in Western Australia. It does, however, require a deep, fertile loam for best growth and has mainly been planted in the major river valleys of the south-west, such as the Blackwood Valley between Bridgetown and Nannup.

Pinus pinaster can be grown in less fertile soils, and successful plantations have been established on the coastal sand plains near Perth. This species also needs less water than *P. radiata*, but is slower growing. One characteristic of the species that bodes well for the future is that it may be grown on very poor soils, with the use of phosphate fertilizers.

How?

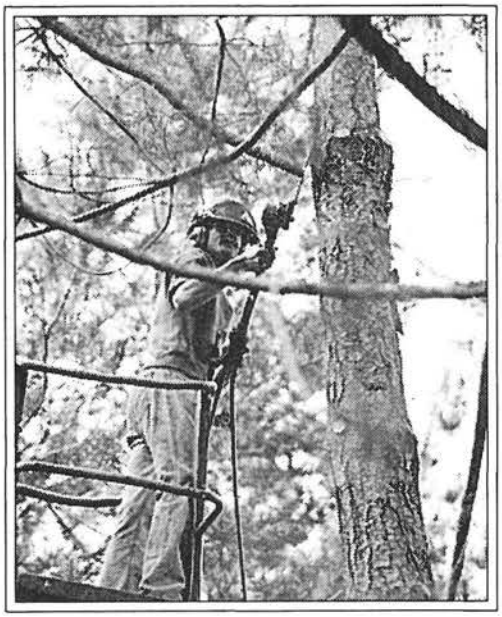
Pine in Western Australia is grown commercially on a 30 year cycle or 'rotation'. At different stages in the rotation, the plantation must be tended in order to encourage maximum growth and ensure high quality timber. At the same time, the plantation will yield certain products. The yield or volume of wood produced by the plantation depends primarily on rainfall, fertility, and management regime.

Where?

There are three factors that must be considered before planting pines:

- Rainfall: both *P. radiata* and *P. pinaster* require a minimum rainfall of 700 mm to maintain an accept-

Agroforestry demonstration site. The pasture between the tree rows was grazed and cut for hay.



Pruning lower branches - an essential part of high quality timber production.

able growth rate for commercial timber production. Both species may be grown in areas of lower rainfall, but will produce less timber.

- Soils: *Pinus radiata* grows best on the more fertile soils such as red loam and red loamy-gravels, but may be grown on yellow sand and some lateritic sands with the addition of fertilizers.

Pinus pinaster grows well on both yellow and grey sand, but requires fertilizing.

- Markets: transportation costs will obviously affect the profitability of your venture and in most cases, distances of more than 70 km from your expected market, will be uneconomic.

The type of timber you produce will also affect your market. Most mills have minimum specifications for the logs they will accept.

Managing your plantation

Year -1 to 0

Site preparation

Site preparation is essential to eliminate all competing vegetation. The planting site should be cleared and burnt, and then ploughed, unless the site is already pasture. Where ploughing is not feasible, scrub control may be assisted by means of herbicides.

External firebreaks are essential and these must be kept clear by annual maintenance. Most shire authorities who have been involved with pines have specific requirements for plantation firebreaks.

Planting

Pine seedlings are raised in the nurseries from seed sown direct into the soil. When removed for planting, the seedlings are open-rooted and their roots must be protected and kept moist. Planting is carried out during the months of June and July when the soil is thoroughly wet. In wet areas mound planting may be necessary, while in the drier coastal sand plain north of Perth, 'furrow lining' is practised, to maximize moisture retention. If required, fertilizer should be applied and clover sown at the time of planting. On some soil types establishing clover at this time will greatly improve soil fertility and ensure continued good growth of the pines.

Pines are planted relatively close to each other to prevent excessive branch development, and to provide for later selection of well formed trees. The spacings currently recommended vary from 3 m x 2.5 m (1,330 trees/ha) to 3 m x 3.25 m (1,000 trees/ha). It is essential to eliminate all competing weed growth in the first year.

Tending your plantation

A pine plantation requires considerable attention throughout its life to maintain it in a healthy condition, and to promote the production of high quality timber. In some instances, on the less fertile sites, refertilization may be necessary.

The various management activities needed to achieve and maintain a healthy, vigorous, productive pine plantation are as follows.

Years 1 to 3

Scrub control

Regrowth of native scrub, eucalypt coppice, or grass compete with pines for moisture and nutrients. Left unchecked, they can severely impair pine growth rates. Control of this regrowth is usually necessary in the early years. This can be carried out by the use of herbicides, slashing, or cultivation.

Years 3 to 10

Pruning

Unlike most eucalypts, pine trees retain their lower limbs, and this results in the formation of knots which lower the quality of the timber. To produce timber free of knots, the lower limbs must be removed by pruning. Initially, all standing trees should be

Pine products, specifications and markets (1984)

Products	Specifications		Markets
	Diameter	Length	
Small pine round logs (small end under bark [u.b.])	7 to 20 cm	1.8 to 4.8 m	Bunbury, Bridgetown and Mundijong
Logs for particleboard (small end u.b.) large end not to exceed 30 to 35 cm u.b.	7.5 to 15 cm	2.7 to 5.4 m	Metropolitan and Dardanup
Case logs, etc. (small end u.b.)	13 to 20 cm	2.1 to 2.7 m	Metropolitan, Balingup, Nannup Bridgetown and Dardanup
Mill logs (for high quality sawn timber)	Not less than 20 cm (small end u.b.)	2.1 to 4.8 m	Metro., Grimwade Dardanup and Pemberton
Peeler logs (for high quality veneers)	Not less than 35 cm(small end u.b.)	Variable up to 2.6 m (as nominated by buyer)	Metropolitan

Anyone wishing to sell pine logs should discuss the required specifications with the buyer.

pruned to 2 m above ground level. This provides easy access generally, but particularly for fire control. Subsequent prunings are generally restricted to trees selected as crop trees.

Pruning is usually done with secateurs, hand saws or mechanical equipment. The height to which the stems are pruned and the number of trees selected for pruning is the decision of the owner or manager. However, severe pruning can inhibit the vigour of the trees. At least one-third of the tree's total height should be left as green branches.

Years 9 to 20

Thinning

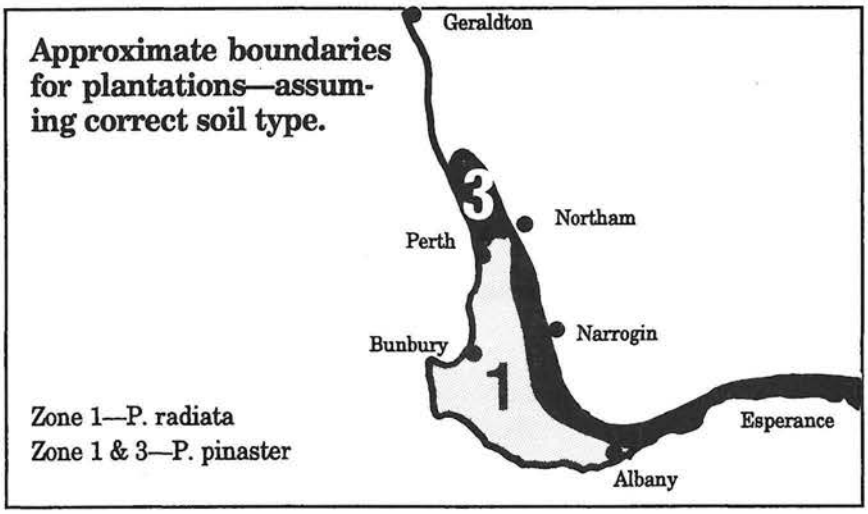
The intensity and frequency of thinnings, and the length of rotation adopted, depend on market opportunities and the type of product required. In Western Australia the opportunities for selling small logs are limited and the commonly accepted aim is to grow high quality sawlogs in the shortest possible time. This is achieved by non-commercial early thinning, thus reducing the number of trees to the final crop early in the rotation. Given access to markets, the early thinnings and tops of later thinnings will produce fence posts and wood for manufacture into particle-board.

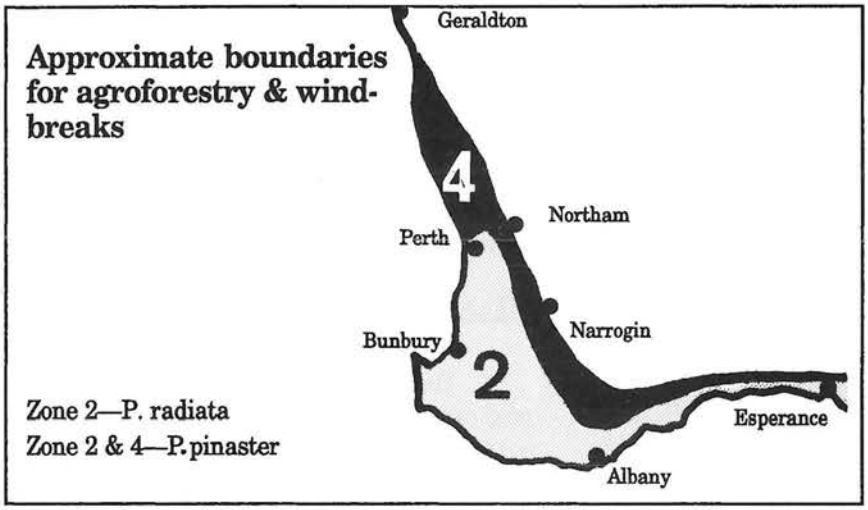
Thinning is a most critical operation especially on drought prone sites. If thinning is delayed, drought deaths can occur about Year 12, if dry summers are prevalent. When drought deaths do occur, the plantation manager loses the choice of which trees to retain for his final crop. His crop trees are also placed under stress, and will grow slowly.

Fire

Uncontrolled fires kill pine trees. It is essential that adequate measure be taken for the early detection and suppression of fires in, or close to the pine plantation.

Firebreaks and roads must be maintained yearly to the standards and specifications of the local Shire. Insurance is available through the Australian Forest Development Institute which represents private forest growing interests in Australia. Further information can be obtained from the West Australian Chapter, P.O. Box 254, West Perth 6005.





Species	Purpose	Zone	Minimum Rainfall Requirements	Soils
P. radiata	Planatations	1	750mm/year for areas of high summer evaporation. 600mm/year for low summer evaporation.	Suitable soil types for both species are moisture retentive (not waterlogged) yellow sand, gravel sands and soil should be penetrable to a depth of at leat 60cm inceasing to more than 1m in lower rainfall zones. Pinus radiata more fertile soils.
	Agroforestry & Windbreak (inc. timber)	1,2	650mm/year for areas of high summer evaporation. 500mm/year for areas of low summer evaporation.	
P. pinaster	Plantations	1,2,3,	600/year for areas of high summer evaporation. 500mm/year for areas of low summer evaporation.	
	Agroforestry & Windbreak (inc. timber)	1,2,3,4,	500mm/year for areas of high summer evaporation. 450mm/year for areas of low summer evaportation.	

Exotics for special purposes

Fodder and timber

Carob

The carob is a tough evergreen tree from the Middle East. It produces dense shade and heavy crops of sugary pods - an average of 1 t/ha from trees planted on 15 m centres. It needs 350 mm of annual rainfall or alternatively it needs to be planted near contour banks or areas which receive run-off. Deep taproots will sometimes find underground water. Both male and female trees are required for pod production, this has been achieved in Western Australia in four years with well managed trees. Young trees are susceptible to frost and are fickle to establish. Good results have been obtained at frost prone Balingup by protecting the trees with clear plastic tubes from topless/bottomless Urea bags held up by three stakes.

Sandalwood

This valuable native tree has all but disappeared from the populated south-west because of commercial exploitation. At present day prices of $600/tonne and no synthetic substitute, it would appear a good investment. Plantings have been successful in bushland and have grown to minimum commercial size in 20 years. The trees are root parasites and need hosts, preferably wattles. Preferred soils are sands/loams over clays. There seems no reason why these trees could not be grown along with wattles as the bushy component of shelter-belts. The trees are highly palatable to livestock but because of their high wood value are best not used as fodder trees.

Acacias (wattles)

Acacias share many of the attributes of tagasaste (tree lucerne). On the other hand many wattles are longer lived, more drought resistant, and have high levels of tannin in the bark which render them less susceptible to ringbarking. Bushy forms are ideal for the low component of shelter-belts. It is essential, particularly in eucalypt dominant belts, to prevent wind from funnelling underneath the main canopy. Under natural conditions eucalypts obtain their nitrogen from that fixed by wattles. Not planting wattles alongside gums is akin to not planting clovers into a pasture.

Honey locust

These trees cast only very light shade allowing pastures to grow to the butt of the tree. Like the carob, a pod bearer, but with a high protein content. These trees are also either male or female, with only the females producing pods. They need summer rainfall or summer ground moisture to do well.

Kurrajong

These beautiful Australian natives have been dubbed the living silo and have been extensively planted in the drier parts of New South Wales for emergency drought fodder. Though slow growing in their early stages, they speed up after some years. They develop an enormous tuberous root system somewhat like a giant carrot. This food reserve enables the trees to recover quickly from being lopped for fodder. Adaptable to most sites, these trees need 400 mm of annual rainfall to do well or alternatively they need to be planted where they receive additional run-off. The slower growing desert kurrajong will grow even in the driest parts of the wheatbelt.

Blackwood and black walnut

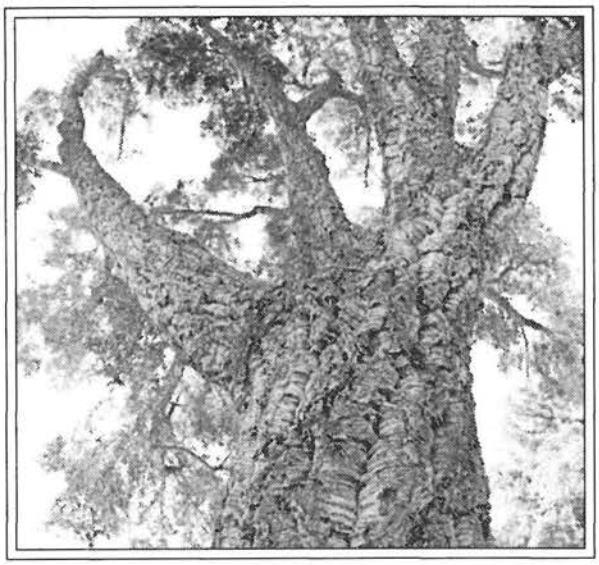
These two trees have excellent potential to produce most valuable furniture timber on wet sites in the higher rainfall areas. Black walnut is legendary for its fine figured timber grain and blackwood is perhaps the next best thing and is widely planted in New Zealand as a timber crop on farms. Both trees need careful management to produce good timber form with expected rotation lengths of 35 years on agroforestry type management systems. Black walnut needs fertile sites whilst blackwood is nitrogen fixing and can grow on somewhat poorer soils.

Oaks

There are many good reasons for growing oaks as farm trees. They are strong growing, adaptable, almost fireproof, produce excellent shade for stock, and drop acorns for fodder, just when they are needed in the autumn.

Acorns are high energy food, rich in fat and carbohydrate. Warming food which drops as the weather turns cold, when the livestock have used up their reserves of body fat from the spring. Sheep, cattle, goats, horses and of course pigs, will all eagerly consume the acorn. By using different varieties an acorn drop extending from early March to early June can be achieved.

Contrary to legend, oaks are not slow growers, particularly in Australian conditions. One English oak at Balingup at 37 years was 28 metres tall and



A cork oak.

3.3 metres girth at breast height. They are, however, slow for the first few years, then once they have their roots established, take off quickly.

The English oak is best suited to the wetter areas, 500 millimetres or more of rainfall, though it may grow where there is adequate soil moisture in drier areas. This tree is one of the main oaks of timber commerce and, in general, carries a heavier crop of acorns than the cork oak. It prefers heavy soils and in its natural habitat, grows in stiff clays. However, it will grow in moist sands. It is deciduous.

The cork oak is at home in a mediterranean climate and is quite happy in poor dry soils, down to around 375 millimetres (15 inches) rainfall, although, of course, in those conditions it grows more slowly. In its native country, Portugal, its bark is first peeled for cork at about age 20 years and then subsequently every six to eight years. The first stripping of virgin cork yields material suitable for insulation. The quality improves with each stripping, the bark growing back finer each time. The poorer the soil, the better the cork. This tree prefers light soils, but will grow quite well on loams. It is an evergreen.

We have found cork oaks most easy to establish at Balingup with 100 per cent success being the norm. English oaks have proved harder to establish. Whilst not dying outright, they become subject to insect attack - a clear sign of stress. Normally the seedlings would start life in a shady humid environment and the summer sun and dry easterly winds of an Australian paddock are quite different. However, once established the trees are strong growers.

The trees can be expected to commence bearing acorns at five to ten years and, depending on conditions, will continue to do so for a very long time. In Europe, oaks live for 400 years or more and, whilst there has not been the opportunity to observe for this long in Australian conditions, ones planted in the 1840s are still going strong.

As they grow into large trees, wide spacings would be the most suitable. It could perhaps be beneficial to interplant with a fast growing legume for the early years, for example, tree lucerne or wattles. These could provided both nitrogen and a more equable microclimate for the oaks, as well as being capable of being lopped for livestock fodder and ultimately producing firewood.

The pin oak, red oak and scarlet oak, all produce spectacular autumn colours. The pin oak will grow in wet soils. All three are suitable for only the wetter, cooler, south-west corner. When possible, we grow ilex oak and Turkey oak, both suitable for hotter drier areas. Chestnuts, close oak relatives, are faster growing and earlier bearing, produce durable poles on a seven year coppice rotation and produce nuts for human and livestock fodder.

Willows and poplars for salt and waterlogging control

Because willows and poplars tolerate waterlogged conditions and transpire large amounts of water they offer opportunities to control waterlogged and saline soils - at the same time they provide summer and autumn greenfeed for livestock. The trees can be used to lower the watertable so that groundwater no longer rises to the surface leaving behind salt as it evaporates. Without the salt, and with improved drainage, grasses can establish on these sites.

The suckering, salt tolerant poplars of of particular use in this situation. They can be planted on the margins of barley grass areas and on 'islands' in scalded areas. As the water table is lowered the suckering root systems of the trees should spread into the scale recolonizing it. Livestock can be turned on to browse these suckers, a nutritious mineral rich feed, several times during the summer and autumn.

Correct management of grazing pressure will keep the suckers short (up to say knee high) so that the stock can make direct use of this feed without any more effort from the farmer than opening and closing the gate.

The large crowns of the parent trees will provide the nutrients for rapid leaf growth on the suckers so that they will be ready for another grazing. If more large trees are required then a drum, with top and bottom removed, can be placed around a sucker. When the sucker is large enough the drum can be shifted to another sucker further into the area which is being reclaimed.

Whilst saltbushes, samphires and associated perennial shrubs offer excellent browse from saline areas they are, by their succulent habit, inherently low water users. However, there seems to be no reason why these can not be grown in combination with an overstorey of suckering poplars.

In badly waterlogged conditions, willows may be more suitable than poplars but they suffer the disadvantage of not suckering - this limits the amount of fodder that the animals can browse directly. In these conditions the low growing, bushy, multi-stemmed osier or basket willow might be of advantage.

Tagasaste - tree lucerne

Tagasaste, or tree lucerne (*Chamaecytisus palmensis*) is a native of the Canary Islands. It is a hardy leguminous shrub or tree growing to a height and crown diameter of about five metres, often with long drooping leafy branches. White, pea-like flowers are borne in clusters at the ends of short branches.

Tagasaste grows most vigorously on well drained, fertile soils in high rainfall areas, but will tolerate a wide range of climatic conditions, soil types and fertility. On the fringe of bushland, the growth is normally retarded because of poor fertility and competition for water and light from the native vegetation.

Uses

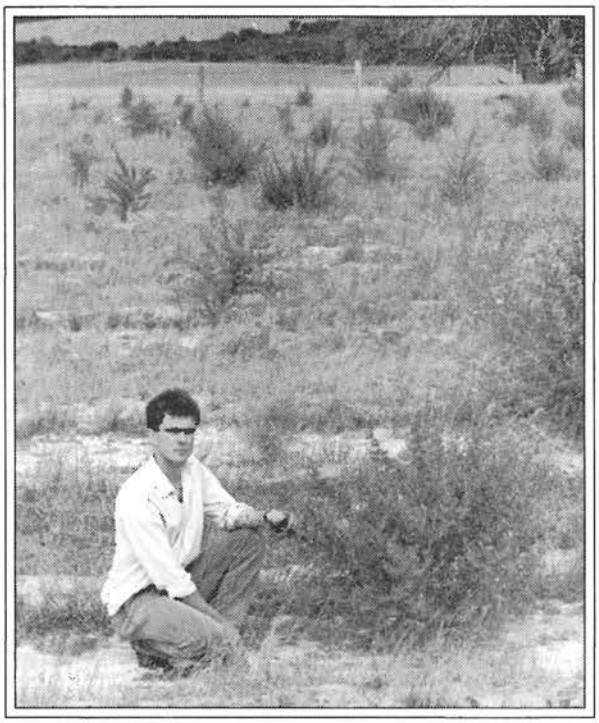
The increasing popularity of planting trees on farms has renewed interest in tagasaste.

Some of the uses and benefits being promoted for the species are:

- as a productive source of fodder and seed for livestock and poultry;
- an aesthetically attractive tree for roadside, driveways and homestead privacy;
- shelter for buildings and livestock;
- colonizer of stony and waste areas;
- windbreak for sensitive horticultural trees and crops and a possible source of nitrogen;
- control of soil erosion by wind and water;
- reduction in salinity through water consumption and lowering of the water table;
- a restorer of fertility to impoverished soils through nitrogen fixation and nutrient recycling;
- a source of pollen and nectar for bees during winter when other flowers are scarce;
- a haven for birds which are beneficial in controlling plant pests; and
- as a source of firewood.

Fodder value

Attention has been focussed on tagasaste because of its potential as a fodder tree, particularly on deep sands where pasture production is poor and often unprofitable.



An open stand, planted as seedlings six months previously.

Yield

Research by Dr L.C. Snook in Western Australia in the 1940s and 1950s and recently in New Zealand indicated yields of edible dry matter of 11 tonnes per hectare per year can be obtained from dryland tagasaste.

Quality

Nutritive value depends on the type of material sampled, maturity and the proportion of leaf to stem, as is indicated by samples analysed from trees from Bridgetown and Bokerup (70 km east of Manjimup).

With crude protein levels as high as 310 g/kg and digestibilities in excess of 65 per cent tagasaste is comparable with lucerne for protein and energy values.

Minerals

Trees which have received dressings of superphosphate have adequate calcium and phosphorus for animal production.

A few analyses have indicated that tagasaste can have low levels of sodium and copper, particularly during summer, limited experimental work has been unable to substantiate that, in a paddock situation, supplementation will improve animal production.

While cutting trials and quality analyses indicate that tagasaste may have high potential as a fodder tree this needs to be confirmed by conversion into economic livestock production.

The results of grazing experiments are discussed later in the section 'Livestock production'.

Establishment

Seed supplies

Tagasaste produces heavy crops of seeds which ripen in December. The seed pods can be stripped from the branches in December or early January prior to shattering. Pods spread out on black plastic sheets in the hot sun will shatter readily, releasing the seed. Seed still attached to the pods can be freed by vigorous shaking in a plastic bag.

Five metre row spacing allows easy access for stock and machinery.

On a large scale, seed can be separated from sun dried material which has been crushed by a tractor and then passed through a harvester.

There can be strain differences within and between stands of trees, therefore seed should be collected from vigorous trees only.

Seed is available from seed merchants; prices range from $30 to $50 per kilogram.

Germination

Seed collected from trees will, without treatment to break seed dormancy, have a germination of only three to four per cent. The most convenient and effective farm method for improving germination is to cover seed in a container with boiling water and allow to cool. A germination of 65 to 70 per cent can be achieved with this method.

Another technique, which has given similar results in laboratory tests, is to apply the boiling water treatment and soak for a half hour then dry the seeds in an oven at 80°C for one and a half hours. The advantage is that the seed can be sown when convenient. It is also unlikely to be physically damaged when mixed with superphosphate, as can occur with seed softened by longer soaking with the boiling water treatment.

Scarified seed can be obtained commercially with germination percentages of up to 99 per cent.

Inoculation

The need for inoculation of the seed with specific rhizobia (nitrogen fixing bacteria) for various soil types in different climatic situations is unclear. In many instances trees have been established without treatment because of the presence of suitable rhizobia in the soil. However, there may be situations where nodulation will not be effective and the trees will fail to establish.

An inoculum is available commercially from seed merchants or Root Nodule Pty Ltd, Woy Woy, NSW. One packet will treat 50 kg of seed. Inoculated seed mixed with superphosphate must be lime pelleted.

Seedlings

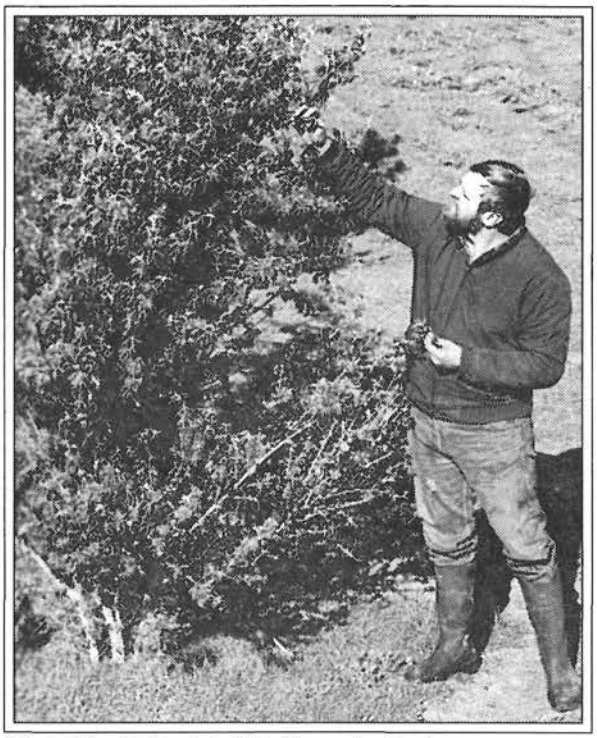
Various nurseries advertise the sale of seedlings. Orders should be placed well ahead of the anticipated planting date to ensure availability of suitable plants.

Seedlings can be purchased either bare rooted or in cell packs. Prices vary from as low as 10 cents to more than 50 cents each.

Seedlings should be inspected to ensure they are not root bound as trees which subsequently develop will be prone to uprooting by winds.

Planting should be into soft, moist ground, preferably ripped, care being taken to compact the earth around the seedling.

A pre plant knockdown and residual herbicide treatment should be applied and fertilizer banded with, or applied alongside, the seedlings.



Most of the feed is out of stock's reach - the trees need to be mechanically pruned.

Planting as soon as the break of the season is assured will provide maximum opportunity for survival.

Direct seeding

For large areas this is the most practicable and economical method. Successful establishment can be achieved by sowing through one or a number of runs of a seed drill.

After the boiling water treatment seed should be mixed with a dry base and sown immediately.

Inoculated and lime pelleted seed can be mixed conveniently with superphosphate.

More precise sowing can be obtained by using tractor-mounted, row seeders. Machines equipped with a fertilizer box are an advantage as they allow banding of the fertilizer alongside or beneath the seed.

Seeders are available which incorporate features such as, a scraper for weed control, variable sowing spacings and depth, press wheel for soil compaction after sowing, fertilizer applicator, subsoil ripper, coulter for trash control and detergent application for non wetting sand. Prices are in excess of $10,000.

For small areas an efficient, manually operated machine is the Earthway, Model 1001-B seeder. With a fertilizer box, the price is around $280.

Depth of sowing should be around 10 mm and no deeper than 25 mm. The deeper sowing should only be used where there are doubts about soil moisture retention around germination, particularly in medium to low rainfall areas.

Germination is likely to be affected when seeds are sown at greater depth.

Ground preparation

Ripping

In limited trial work, ripping has not been found beneficial for direct seeding. Where it may be beneficial is in sandy soils which have developed a hardpan through frequent cropping. In these situations ripping to at least a half metre is advised. Rip lines should be compacted prior to sowing for satisfactory depth control and to eliminate air pockets. On heavier soils, multiple row ripping prior to seeding, followed by heavy rain, can cause bogging problems during the seeding operation.

Cultivation

This will be determined by the previous use and condition of the land, for example, new or old land, cropped or pastured, level or rough. A scarifying followed by harrowing is normally adequate to achieve a level friable seed bed.

Cultivation of sandy soils should be minimal to avoid wind erosion and sand blasting of seedlings.

Sowing strips of cereals, such as cereal rye, adjacent to tagasaste rows may be required to reduce sandblasting. Sow with a nitrogen/phosphorus compound fertilizer to stimulate rapid early growth to obtain seedling protection.

Sowing in a minimum tillage operation, especially after cropping, is possible provided that care is taken in controlling sowing depth.

For reliable germination and establishment it is essential to compact the sowing line after sowing. At New Norcia, a 300 per cent increase in trees was recorded at 12 months when a tractor was driven down the seed bed after sowing.

Weed control

Weeds must be controlled to minimize competition for moisture and nutrients. This is unlikely to be achieved without the combined use of cultivation and herbicides, except on new land.

Suitable contact herbicides for application prior to sowing and two to four weeks after the break of season are Spray.Seed® and Roundup®, at normal recommended rates.

More research is required to identify safe pre and post emergence residual herbicides, in relation to soil types, particularly sands. Contact your local Department of Agriculture for the latest advice on herbicides suitable for tagasaste.

Water repellent soils

Frequently sandy soils fail to wet evenly at the break of season, resulting in patchy germination and establishment. These water repellent properties can be overcome by spraying specially formulated wetting agents in narrow bands over the sowing lines.

Two products are Aquasoil® and Wetta Soil®. A suggested rate of application is 20 L/ha (in the sprayed band), sprayed immediately after sowing.

Sowing/planting time

This should be as early as is practicable within the constraints of adequate soil moisture for germination and establishment and satisfactory weed control.

In low rainfall areas, early sowing is particularly important, to provide the greatest opportunity for seedling survival over summer.

Use of pre and post emergence herbicide treatments permits sowing at or near the break of the season.

On forest soils in high rainfall areas (above 550 mm) experience has shown that sowings as late as August can be successful, provided weed control is adequate.

Fertilizers

As tagasaste is a legume, nitrogen applications should be unnecessary for rapid growth, provided nodulation is effective.

Other fertilizer requirements will depend on soil type and past fertilizer history.

Only limited research has been conducted to determine requirements and, until these become clearer, fertilizer recommendations for pastures should be applied to tagasaste. These should include copper, zinc and molybdenum where normally recommended for new land sowings and on old land where the history of application is uncertain.

Banding of superphosphate is likely to be beneficial, particularly on new land and will help to control competition. Lime pelleted seed should be sown where banding is adopted.

Care should be taken not to overdo rates when banding fertilizer in a normal drilling operation. For example, the equivalent of 200 kg/ha drilled by combine is only 3.5 kilograms per kilometre of row.

Potash should not be banded with seed because of likely toxic effects.

On deep sand at New Norcia experiments showed that deep placement of fertilizer (100 to 250 mm) in the year of sowing, at 25 kilograms per kilometre of row, increased the yield of edible dry matter of 15 month old Tagasaste by 30 per cent.

Shallower placement at 50 to 100 mm decreased seedling survival through toxicity.

A suggested preparation and sowing procedure is:

- cultivate and harrow where necessary;
- rip and deep fertilize;
- compact rip line;
- spray knockdown and residual herbicides;
- scalp soil from sowing line;
- precision seed or sow by combine;
- press wheel to compact sowing line;
- spray wetting agent to sowing line; or
- spray residual pre emergent herbicide.

Soil types and sites

Tagasaste grows well on a wide range of well drained and non saline soils. It grows remarkably well on ironstone hills and breakaways and on deep sands which fail to support productive crops or pastures. The tree does not tolerate waterlogging. Perched water tables in wet seasons have caused the death of mature stands. Best yields are obtained from summer moist but well drained, deep sands, such as occur on the south coast at Esperance.

Planting patterns and tree density

The most practicable and economic method of utilizing tagasaste is by grazing animals with minimal machine thinning and harvesting.

Planting patterns should be designed with these points in mind and to try to maximize yield of herbage through rotational grazing.

Experience has shown that a suitable pattern incorporates single rows five to six metres apart, allowing easy access by stock to both sides and convenient space for the passage of machinery for row trimming and top-dressing.

There seems little purpose in multiple close planted rows as the inner sides of these rows become inaccessible for grazing and present difficulties for top grazing and cutting.

There may be a case for close spaced (up to a metre) dense double rows where the hedge is used as a replacement for conventional sub division fencing. The interwoven thatch of branches of the rows, encouraged by topping, could possibly create an impenetrable barrier to grazing stock as a cheaper alternative to fencing.

Cropping

Experience has shown that patterns designed to allow both inter row cropping and grazing are not practicable. Wider inter row spacings are required for cropping machinery thereby reducing tagasaste yield. The extended deferred grazing during the cropping phase subsequently results in the need for heavy side and top pruning of thick branches to maintain row form.

Also, on deep sands where tagasaste grows well the economics generally does not favour cropping.

Row alignment

Where possible, alignment should be north-south, to maximize use of sunlight by trees and pasture, and at right angles to the prevailing winds to provide shelter and protection from wind erosion. Consideration should also be given to the effect of alignment on water erosion.

Water points

Gaps should be left within the rows about every 100 metres to allow stock easy access to water and other rows and to minimize mismothering of lambs.

To minimize costs for water points, locate troughs in raceways providing common access to adjoining paddocks of tagasaste grazed on a rotational basis.

Tree density

There is no information for Western Australia which relates tree density within rows and inter-row spacing to total yield under different environmental conditions. However, experience has indicated that it is unnecessary to exceed two to four trees per metre of row.

At each seed drop at least three seeds should be sown to account for germination failures and mortalities following germination. The seed requirement at the highest seeding rate would be about 350 grams per kilometre of row, or 700 grams per hectare, with a between row spacing of five metres.

Tree density at four per metre and a between row spacing of five metres would be 8,000 per hectare.

Management

Insect pests

During the establishment year control of insect pests is essential.

Regular monitoring of emerging seedlings for redlegged earth mite and cutworm is essential. Spraying should be carried out, using recommended insecticides, immediately damage is noted. Repeat spraying may be necessary.

During the first spring and summer spraying for budworm and Rutherglen bug and spraying and baiting for locusts and grasshoppers may be necessary, especially if ringbarking occurs.

Once established, tagasaste is relatively free of insect pests. Occasionally the tagasaste moth (*Uresiphita ornithopteralis*) will damage trees in the autumn. Spraying is not usually necessary but grubs can be controlled with carbaryl.

Stem borers may also attack trees, but damage is normally insignificant.

Vermin

Rabbit should be controlled in the summer preceding sowing as only a few rabbits can be very damaging to developing seedlings.

Tree training

The objective is to stimulate branching close to the ground so that tree production remains within grazing height of stock. This can be achieved by early grazing or cutting, or a combination of both.

Dense, low branching also helps protect trees from bark stripping by stock.

Grazing should be at high stocking rates for short periods to minimize physical damage. Trees should be a minimum of 25 to 30 cm tall before grazing.

Subsequent management should aim to maintain the pruned height at about 50 cm. This will be achieved without mechanical topping at some times, as stock never completely eat regrowth back to the old growth.

In young plantations conventional 'sickle bar' type hay mowers have been used successfully for topping.

Specialized cutting machinery, incorporating five contra rotating circular saw blades, is now available from Kimseeds for around $15,000. This is a robust machine capable of handling overgrown plantations. Operated by power take off the machine has an adjustable cutting angle.

The company also offers a contract pruning service at $120 per hour, plus a location fee. In an average well-managed plantation the travelling speed would be about 8 kilometres per hour.

A commercial 'sickle bar' type machine is being developed, but not yet available.

Grazing

Graze stands rotationally to allow recovery after grazing and minimize damage from bark stripping by stock.

Paddock sizes will depend on stock numbers, area and production of tagasaste and how it is to be used in relation to other feed sources on the farm.

Commercial producers have subdivided into paddocks ranging from 8 to 20 hectares for successful grazing management.

Tagasaste is likely to have greatest feed value during summer/autumn when all other paddock feed is dry and low in quality. Depending on productivity, however, trees may have to be grazed two or even three times per year to be kept under control. Multiple grazings will reduce total production. An experiment at New Norcia showed sheep grazing days were reduced by 40 per cent when tagasaste was grazed twice annually compared with once in the autumn.

Bark stripping

This has occurred in some instances, even where inter row feed or green tagasaste has been plentiful.

Freshly cut trees are most susceptible and wounds should be allowed to 'harden up' for several days before grazing. The wilted, cut material will be eaten readily by stock.

Protection of trees rows by fencing is impracticable and uneconomic. Successful management involves rotational grazing coupled with periodic mechanical pruning. Stock must be removed when leaf material has been eaten and before significant bark stripping occurs.

Subdivision fencing

Costs can be at least halved by the use of mains electric fencing. In a trial at Bokerup, with posts 50 metres apart and two droppers per span, a minimum of four wires (top and alternate live) were required to contain Merino ewes. An extra wire is needed for lamb proofing.

Livestock production

There is no doubt that in Western Australia on deep sands, which grow unproductive pastures, tagasaste can provide economical production.

This has been established by the Martindale Research Project of the University of Western Australia at New Norcia.

A 1988 trial showed that 900 adult trees per hectare produced 7,500 kg of edible green matter yielding 3,400 weaner sheep grazing days. The trees were allowed to grow ungrazed for 12 months and utilized in April/May.

For a normal 90 day grain feeding period 38 sheep could be fed on each hectare of tagasaste. This was calculated to be equivalent to a saving in 1988 of $137 per hectare as replacement grain feeding.

Over the two years 1986/87 and 1987/88 weaners grazed throughout the summer produced on average an extra 550 grams per head of clean fleece. Fibre diameter increased by 0.7 microns in 1986/87, but there was no difference in 1987/88 when compared with wool from flockmates grazing dry pasture.

The value of extra wool was $4.80 per head or $58 per hectare. Savings in grain feeding and pasture or stubble feed over the 210 days amounted to $72 giving a total value of $130 per hectare.

At Esperance farmers who have established extensive areas also report marked improvements in productivity on previously unproductive deep sands. An annual carrying capacity of 12 dry sheep per hectare has been achieved and higher levels are believed possible.

On heavier soils, which support productive subterranean clover based pasture, the potential for tagasaste has not been established by research.

At Bokerup (70 km east of Manjimup) in 550 to 600 mm rainfall zone, a large scale trial failed to show any benefit from tagasaste on predominantly gravel and gravelly loam soils. Double rows were sown one metre apart with an inter row spacing of 20 metres.

Breeding ewes were fed the tagasaste in the autumn-winter period but there were no benefits in bodyweight, fleece weight, lamb weaning percentage or weaning weight.

In an observation trial in the Wellington Dam catchment, no obvious increases in dry sheep bodyweights or wool production were recorded when compared with similar sheep on dry pasture. Tagasaste was fed for 49 days in the autumn.

Other uses

The potential for tagasaste to act as a pump to lower water tables for salinity control is currently being investigated.

Evapotranspiration was measured in December 1984 to June 1985 in the Wellington catchment where it was shown that tagasaste could possibly use twice as much water as lupins over a season.

Table 1. Nutritive value of tagasaste

Material	Sampling date	Crude protein (g/kg D.M.)	Digestibility %
Old bark	June	81 to 91	48 to 55
New bark	August	90	62
Tips from growth (not vigorous)	June	194	62
Tips from fresh growth with flower buds	Early August	198	65
Old growth with flowers	Early August	102	50
Growth from tips of young tree just prior to flowering. Stems up to 8 mm diameter	June	124	54
Fresh growth stems up to 5 mm thick Bokerup	Early August to late October	156 to 256 Average 176	67 to 77 Average 71.3

At Bokerup, drawdown of the water table has been inconclusive. Closer spacing of the trees rows may have given greater water usage.

A more comprehensive trial is now in operation at New Norcia.

Farmer experience at Dandaragan and Esperance has been that close spaced tagasaste rows have dried out adjoining wet and potentially saline sites below plantations.

Toxicity

Claims have been made that tagasaste has caused intoxication in horses, when eaten in the pod stage. Alkaloids could be the problem.

Nevertheless, it has been fed to sheep for extended periods without ill effect. No documented reports of toxicity in sheep, cattle, goats, deer or poultry have been cited.

Trees as fire protection

Planting trees near dwellings can increase the risk of fire. However, the risk can be reduced by careful selection of species.

Some trees are less flammable than others. Trees that have a reduced fire risk are those low in volatile oils, high in salts or high in moisture. Trees which have their lower limbs high above the ground (spotted gum) are hard to ignite. Trees with fibrous or stringy bark, for example, messmate and manna gum, ignite easily and fire can spread quickly. Wind can carry the burning bark to new fire sites.

Trees high in oil such as eucalypts, callistemons and paperbarks, can also increase fire risk.

The following list groups trees in order of decreasing fire resistance:

- salt accumulating plants, e.g. saltbush, tamarix, boobialla;
- deciduous trees, e.g. oaks, maples, elms, poplars, willows;
- evergreen hardwoods, e.g. peppercorn, pittosporum, mirror bush;
- introduced conifers, e.g. pines, firs, cypress, cedar;
- native shrubs, e.g. wattles, paperbarks, callistemons, grevilleas, hakeas, tea trees and banksias;
- eucalypts.

No matter how fire tolerant trees are, their tolerance is negated by poor maintenance.

Removing dry leaves, branches, litter and mulch, is critical to generating a safer area. The ground below the trees should be bare.

Trees and shrubs with low potential fire hazard

Introduced species

Acer campestre	common maple
Acer negundo	box elder maple
Acer platinoides	Norway maple
Acer pseudoplatanus	sycamore
Alnus jorulensis	evergreen alder
Calodendron capense	cape chestnut
Castanea dentata	American chestnut
Castanea sativa	sweet chestnut
Ceratonia siliqua	carob
Coprosma repens	mirror plant
Corynocarpus laevigatus	New Zealand laurel
Elaeagnus angustifolia	Russian olive
Fagus sylvatica	common beech
Elex aquilifolium	holly
Lagunaria patersonii	pyramid tree
Ligustrum spp.	privet species
Liriodendron tulipifera	tulip tree
Olea europaea	olive
Photinia glabra	red-leaf photima
Photinia serrulata	Chinese hawthorn
Pittosporum eugenioides	tarata
Prunus laurocerasus	cherry laurel
Prunus lusitanica	Portugal laurel
Quercus canariensis	Algerian oak
Quercus cerris	Turkey oak
Quercus ilex	holm oak
Quercus robur	English oak
Schinus molle	peppercorn tree
Tamarix aphylla	athel tree/tamarisk
Ulmus procera	English elm

Native species

Acacia baileyana	Cootamundra wattle
Acacia cyanophylla	western wattle
Acacia cyclops	W.A.coastal wattle
Acacia glandulicarpa	hairy pod wattle
Acacia howittii	sticky wattle
Acacia iteaphylla	Gawler range wattle
Acacia melanoxylon	blackwood
Acacia pravissima	Oven's acacia
Acacia prominens	golden rain wattle
Acacia terminalis	cedar wattle
Acacia vestita	hairy wattle
Casurina cunninghamiana	river sheoak
Eucalyptus maculata	spotted gum
Hakea salicifolia	willow hakea
Hakea sauveolens	sweet hakea
Melaleuca lanceolata	moonah
Myoporum insulare	common boobialla

Properly designed windbreaks can help in slowing and diverting the fire.

These aspects involve careful consideration of tree species, tree height, length and width of break, as well as alignment. An incorrect combination can cause a greater risk. The topic is too complex for details to be incorporated in this bulletin. If you have a specific requirement, the Bushfires Board and the Department of Conservation and Land Management can provide further details.

There is a very useful publication on 'Bush fire safety' available from the Bushfire Board of Western Australia, the Department of Agriculture or Shire offices.

Further reading

- Frances, Pat. Trees can save your farm from fire. Farm Magazine, November 1984, p. 74.
- Brennan, M. Bushfire risk in residential bushland regions. Australian Horticulture, December 1985.
- Brown, P. Living in a flammable landscape. Australian Horticulture, December 1985.
- Anon. (1987) Bushfire safety in urban fringe areas. Bushfire Board and Insurance Council of Australia.

Sharefarming schemes

Bunnings Treefarms private forestry

Bunnings Treefarms (formerly WACAP) has been actively encouraging landowners to plant eucalypts on their land since 1982 when a number of Tree Growing Incentive Schemes were initiated. These schemes have involved a total of about 160 landowners and 1,800 hectares up to the end of the 1990 planting season. The schemes generally involved the provision of free advice, seedlings and sometimes fertilizer in return for a right of first refusal to the paperwood harvested from the plantation.

The plantings established under these schemes consist primarily of Tasmanian blue gum (*E. globulus*). However smaller areas of other commercial eucalypts such as the eastern States flooded gum (*E. grandis*), Sydney blue gum (*E. saligna*), karri (*E. diversicolor*) and yellow stringybark (*E. muellerana*) have also been planted. Bunnings Treefarms believes that the Incentive Schemes have achieved their objective of stimulating general community interest in tree growing and is currently reviewing their structure.

Bunnings Treefarms plans to establish 3,500 hectares/year of Tasmanian blue gum plantations in the south-west of Western Australia over the next 10 years. Much of the land for these plantations is expected to be leased from landowners via a licence agreement. Under this agreement the landowners receive an annual licence fee (annuity) in return for granting Bunnings Treefarms a right to grow and remove timber from their land. The agreement covers two rotations and will last for 20 years on average.

To be accepted for a licence agreement land must total more than 20 hectares, be located within 120 kilometres of Bunbury or 100 kilometres of Manjimup, receive more than 700 millimetres of rainfall per year, have an acceptable soil type and have been cleared and pastured for at least five years. Apart from receiving the annual licence fee the landowner receives a share of both crops of timber as well as retaining the grazing rights under the plantation following establishment. Bunnings Treefarms is totally responsible for plantation establishment, access roads, insurance, maintenance and harvesting while the landowner is responsible for fencing and the payment of rates.

Bunnings Treefarms also sells a wide variety of seedlings at very reasonable prices to the general public. A total of 24 species of trees including 22 eucalypts are available in small peat (jiffy) pots. The trees can be ordered in September or October and are ready for picking up in the following June. Delivery anywhere in the State can be arranged if required through our contract nurseries. Bunnings Treefarms' forestry experts can advise on the correct choice of the tree species as well as providing advice on the correct establishment procedures.

Department of Conservation and Land Management

Softwood and hardwood sharefarming schemes are administered by the Department of Conservation and Land Management. Interested growers should contact the Department for up-to-date details of contracts which are available.

Suppliers

This is a list of some of the major suppliers of seeds, trees, contract services and revegetation equipment. As it has not been possible to identify every supplier, we apologise to those whose names are omitted.

As a rough guide to the products supplied, the letters after each name refer to:

E - eucalypts
P - pines
T - tagasaste seedlings
A - saltbush seedlings
D - deciduous trees
O - other tree species
S - seeds
M - machinery
C - contract services
F - conservation farm planning
V - vegetation consulting
W - pruning service

Agro Forestry (Aust.) - C
17 Greenshields Street
Albany 6330
Phone: (098) 41 6424

Australian Revegetation Corporation
(Kimseed) - S, M, C
51 King Edward Road
Osborne Park 6017
Phone: (09) 446 4377

Bunnings Tree Farms - E
Eastbourne Road
Manjimup 6258
Phone: (097) 71 1222

Chatfield's Tree Nursery - E, T, A, O, S, M, C
P.O. Box 3
Tammin 6409
Phone: (096) 37 1075

Crosby Bros. - W
1 Nelson Street
Bridgetown 6255
Phone: (097) 61 1147

Cunderdin Tree Nursery - E, A, O, S, C
127 Cubbine Street
Cunderdin 6407
Phone: (096) 35 1174

W.C. Diamond & Co - A, S, M, C
c/- Post Office
Maya 6614
Phone: (096) 64 2011

Earth Repair (David Vann) - E, T, O, S, C
RMB 1182
Denmark 6333
Phone: (098) 40 8043

Echidna Nursery - E, O
Graham Street
Albany 6330
Phone: (098) 41 6899

Fodder Shrub Industries (John Cook) - S, M, C, V
P.O. Box 25
Dandaragan 6507
Phone: (096) 52 8062

Geegelup Native Plants - E, O
P.O. Box 236
Bridgetown 6255
Phone: (097) 61 1163

Gidgegannup Nursery (Country Landscape) - E, P, T, O, M, C
Toodyay Road
Gidgegannup 6555
Phone: (095) 74 6163

Greening Australia Hamel Nursery - E, P, D, O
P.O. Box 147
Waroona 6215
Phone: (097) 33 1241, after hours 537 1360

Green Scene (Bev Hundley) - E, T, S, O, V
RMB 7055
Esperance 6450
Phone: (090) 76 8519

Harper Seed Co - S
Box 315
Cannington 6107
Phone: (098) 54 1065

K. & N. Contracting - C
P.O. Box 9
Tambellup 6320
Phone: (098) 25 1023

D.C. & J.M. Ingram - E, P, T
P.O. Box 264
Bridgetown 6255
Phone: (097) 64 3555

Dean Melvin - T, A, O, S, C
P.O. Box 155
Dowerin 6461
Phone: (096) 34 1024

Mitchell's Nursery - E, P, T, A, O, S, C
P.O. Box 47
Wickepin 6370
Phone: (098) 88 1066

Nindethana Seed Service - S
RMB 939
Woogenilup 6324
Phone: (098) 54 1066 or 54 1065

Nufab (Peter Nunn) - M
P.O. Box 171
Dongara 6525
Phone: (099) 27 1297

Prince Growers Tree Farm - E, O
P.O. Box 562
Northam 6401
Phone: (096) 22 2971

Rural Trees of W.A. - E, A, O
Warrigal Way
Chidlow 6556
Phone: (095) 72 4358

Rural Planning (Viv Read) - F
P.O. Box 809
South Perth 6151
Phone: (09) 367 6646

Small Tree Farm (Andrew Thamo) - E, P, D, O, S, C
P.O. Box 27
Balingup 6253
Phone: (097) 64 1113

Bob Stafford - C
Quindalup
Phone: (097) 55 1114

The Tree Planters (Cameron Caldwell) - C
10 Lobelia Drive
Greenmount 6056
Phone: (09) 299 6223

Total Saltland Treatments (Ashley Lewis) - E, S, C, F
RMB 126
East Wickepin 6370
Phone: (098) 88 6040

Walkaway Tree Planters - E, O, C
c/- Post Office
Walkaway 6528
Phone: (099) 26 1183

Wandoo Farmland Service (Dewe Vincent) - C
22 Goldsworthy Road
Esperance 6450
Phone: (090) 71 4149

Wendana Saltbush Nursery - A, M
P.O. Box 56
Gnowangerup 6335
Phone: (098) 22 1540

Department of CALM Nursery, Narrogin - E, O
P.O. Box 100
Narrogin 6312
Phone: (098) 81 1113

Department of CALM Nursery, Gnangara - P
980 Wanneroo Road
Wanneroo 6065
Phone: (09) 405 1222

Department of CALM Nursery, Manjimup - E (large orders only)
Brain Street
Manjimup 6258

Trees - integrate for sustainable profit

Trees can be a profitable enterprise in their own right, as well as providing shelter, land conservation, water quality and aesthetic benefits.

Tasmanian bluegums *(E. globulus)* show prospects of adding to farm profits in the areas west of Albany Highway and with annual rainfall at least 600 mm. By planting trees on farms as various forms of timberbelt these profits may be realized without greatly affecting livestock carrying capacity.

This chapter outlines the expected costs and returns from planting and managing bluegums for pulpwood. Some farmers, when armed with this information, are likely to find ways of blending a pulpwood enterprise with their other activities to enhance overall farm success. A number of farmers already have substantial plantings of bluegums an are looking to other potential end uses for the timber to achieve even higher returns.

Table 1. Typical bluegum establishment costs

Operation	Cost $/ha
Site and soil assessment	20
Mounding or ripping	50
Weed control	80
Planting and fertilizing	120
Plants	190
Fertilizer	30
Pest control	10
Total	500

Tree establishment

Good establishment of trees requires ground preparation, weed control, fertilizing and pest control. Each must be done in the right way at the right time to be effective, as there are no second chances. The right technique for each depends on the site. More detail can be found in the booklet 'Grow trees for profit' produced by the Department of Conservation and Land Management (CALM).

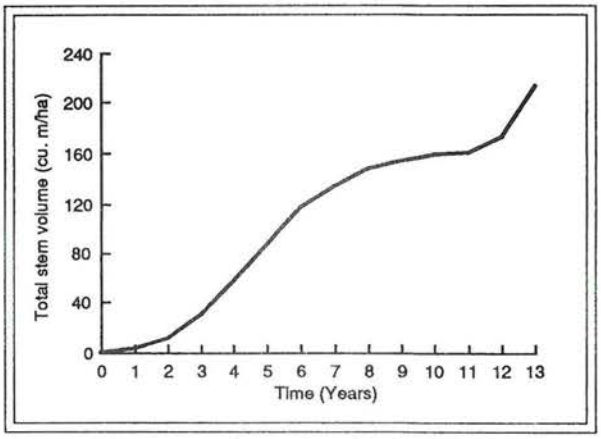


Figure 1. Total stem volume of E. globulus *on Stene's Farm, Wellington Catchment. (Data source: G. Inions pers. comm.)*

Typical costs are shown in Table 1, but these vary with the nature of the site.

The penalty for poor establishment can include partial replanting (by hand), higher weed control costs, increased fire hazard, slower growth and/or later harvest.

Maintenance

Other than firebreak maintenance, the main outlays are periodic applications of fertilizer, and a ground burn and yield assessment prior to each harvest.

After the first harvest, and again after the second cut, the trees are allowed to regrow from the stumps (coppice).

This coppice needs to be pruned (thinned) to limit the number of stems, after the first and second cuts. The final outlay is a clean-up operation to restore the land for replanting to whichever species is then appropriate.

Table 2 summarizes the maintenance costs for a typical block, as estimated by CALM researchers from their National Afforestation Programme investigations.

Given the high cost of the coppice thinning operation it may well be more profitable to actually replant, especially since superior trees should be available within 10 years.

Table 2. Typical bluegum maintenance costs

Operation	Year(s)	Cost/ha
Firebreaks	1-30	$20/year
Fertilize	3, 5, 7, 12, 14, 16, 22, 24, 26	$80/application
Prune/thin	11, 21	$200/operation
Burn under trees	8, 18, 28	$15/burn
Inventory	10, 20, 30	$20/operation
Clean-up	31	$100

Returns

Bluegum growth rates in the 600 to 800 mm rainfall zone are estimated to range between 150 and 220 cubic metres of wood per hectare per 10 years. A similar yield is expected from each rotation. This is based on measurements by CALM researchers of trees grown in this region during the 1980s, a period of below average rainfall.

Figure 1 shows the mean total stem volume of bluegums on Stene's Farm, in the Wellington Dam catchment (G. Inions, pers. comm., 1990). Wood production was slow at first, accelerating as the trees grew. Low growth rates in years 8 to 11 coincided with low rainfall. Rapid growth in year 13 coincided with higher rainfall (1988-89).

The most profitable age to harvest the wood might vary between 7 and 13 years depending on the growth pattern on a particular site. The cost of deferring the sale of progressively larger stocks on hand must be weighed against the benefit of each extra year's growth.

Although no market currently exists in the State for bluegum pulpwood, the price (stumpage) is predicted by CALM to be within the range $20 to $30 per cubic metre for standing bluegums. The stumpage is the price net of harvest and transport costs. This is much higher than the $10.29 per cubic metre currently paid for marri chipwood, but is believed to accurately reflect the value of 200 mm diameter bluegum stems.

At a yield of 200 cubic metres and a price of $25 per cubic metre, pulpwood revenue would be $5,000 per hectare in each of years 10, 20 and 30.

Livestock can not be grazed between the rows of trees during the first two or three years of each crop of pulpwood logs.

Profitability

The likely profitability of bluegums can be expressed as an equivalent net annual return per hectare. To do so, we discount future costs and returns to give a present lump sum value, then convert that to an annuity value. The choice of discount rate is significant, because the higher it is the less valuable are future sums of money.

If the cost of money is projected to be 18 per cent, and inflation 8 per cent, the real discount rate is 10 per cent.

Table 3. Net returns from grazing enterprises

Main product gross price	Pessimistic weaner beef 210 ¢/kg	Optimistic Merino wool 650 ¢/kg
Gross income	20.00	26.50
Per head costs	3.50	6.00
Fertilizer	3.00	3.00
Operator salary	3.00	3.00
Cost of livestock capital (10%)	3.50	1.50
Net return	7.00	13.00

Any benefits from grazing around the bluegums, shelter they provide, or a lowered water table, are additional to the direct financial returns from trees.

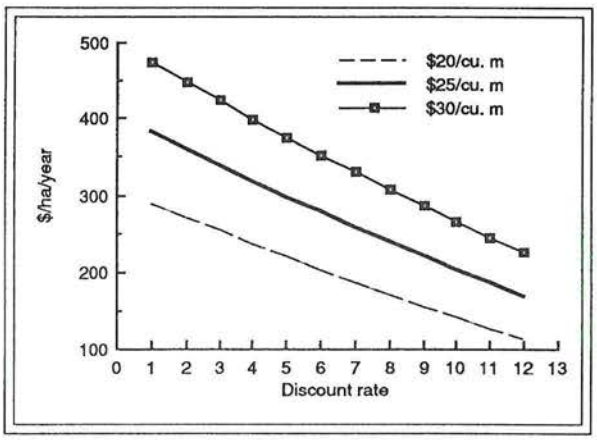


Figure 2. Net annual returns per annum for bluegums at various discount rates.

Figure 2 shows the annuitized returns at a range of discount rates, for bluegums priced at $20, $25 and $30 per cubic metre. The annuity exceeds $100 per hectare across the range of pulpwood prices and discount rates.

The per hectare annuity can be compared with expected agricultural returns.

Sheep and beef enterprises can be expected to return in the order of $7 to $13 per dry sheep equivalent (DSE) net of stock expenses, fertilizer, labour and livestock capital (see Table 3). At stocking rates typical for the 600 to 800 mm rainfall zone it would be unusual for net returns to exceed $100 per hectare.

Integrating trees and stock

To some extent trees and grazing enterprises complement one another; trees reduce wind speed and lower groundwater levels, livestock recycle nutrients and reduce the fire hazard.

There is also potential to reduce tree growing and transport costs by making use of farm machinery at times when it is not required, e.g. establishment, firebreaks, pruning, harvesting and backloading. Transport costs could also be reduced by drying the logs on farm from 50 per cent down to say 12 per cent moisture content, thus reducing their weight.

While it is useful to compare the two land uses as competitors, it is important to recognize their complementarity. A combination of livestock and trees promises the highest overall returns.

List of trees suitable for farm use

Key to uses

1 = Ornamental, 2 = Tannin production, 3 = Oils or perfumes, 4 = Honey or pollen, 5 = Timber or firewood, 6 = Salt tolerant
7 = Windbreak, 8 = Shade

Botanical name	Common name	Mature height (m)	Rainfall (mm)	Use	Comment
Acacia acuminata	Raspberry jam	5-8	<500	1,5,6,7,8	Adapted to N&E wheatbelt
Acacia baileyana	Cootamundra wattle	6-8	>500	1,4,5	Drought resistant
Acacia cyclops	W.A. coastal wattle	3	>500	6,7	Frost tolerant
Acacia dealbata	Silver wattle	10-15	>500	1,7,8	Suckers can be problem
Acacia decurrens	Black wattle	<15	>500	1,2,7	Fast grower
Acacia elata	Cedar wattle	20	>600	1,7	Prefers yellow sand subsoil
Acacia glandulicarp	Hairy pod wattle	2		1	Drought and frost resistant
Acacia howittii	Sticky wattle	6		7	Drought and frost tender
Acacia iteaphylla	Gawler range wattle	2-3	<500	1,7	Useful in two tier shelter belts
Acacia melanoxylon	Tasmanian blackwood	12-14	>500	1,5,7,8	Longer lived wattle
Acacia microbotrya	Manna gum	4-6	>400	1,2,4	Adapted to ridges short lived
Acacia podalyriaefolia	Queensland silver wattle	4-5	<500	1,7	Short lived
Acacia pravissima	Oven's acacia	6		1	Drought tender
Acacia prominens	Golden rain wattle	6		1	Needs shade, drought and frost resistant
Acacia pycnantha	Golden wattle	4-6	<500	1,2,4	Adapted to ridges
Acacia saligna	Golden wreath wattle	<10	>350	1,7	Waterlogged areas
Acacia terminalis	Sunshine wattle	2-3		1	Drought resistant
Acacia vestita	Hairy wattle	4			
Acer campestra	Common maple	20		1,8	Deciduous
Acer negundo	Box elder maple	20		1,8	Alkaline soils, drought tender, deciduous
Acer platinoides	Norway maple	30		1,8	
Acer pseudoplatanus	Sycamore	15-20	>500	1,8	Deciduous, frost tender
Acmena smithii	Lilly pilly	18		1	Drought and frost resistant
Agonis flexuosa	W.A. peppermint	6-9	>400	1,8	Not frost tolerant
Alnus jorulensis	Evergreen alder	8		1	Frost and drought tender
Angophora costata	Smooth-barked apple-myrtle	<25	>600	1,5	Poor areas
Araucaria excelsa	Norfolk Island pine	30	>600		Coastal areas
Brachychiton acerifolium	Illawarra flame tree	20-25	>500	1,8	Frost tender, drought resistant
Brachychiton populneum	Kurrajong	8-16	>500	1,4,8	Grows on range of soils, prefers loams
Brachychiton gregorii	Desert kurrajong	4-8	<400	1,8	Grows under severe conditions, very slow grower
Callistemon phoeniceus	Lesser bottlebrush	3	>500	1,7	Heavy soils, moist, salt tolerant, drought and frost tender
Callitris endlicheri	Black cypress pine	10-20	<500	1,5,7	Slow grower
Callitris huegelii	White cypress pine	10	<500	1,7	Drought, frost resistant
Callitris preissii	Rottnest Island pine	6-9	>500	1,7	Excellent low shelter, slow early growth
Calodendron capense	Cape chestnut	12		1	
Castanea dentata	American chestnut	30		1	Deciduous, drought tender
Castanea sativa	Sweet chestnut	25		11	Deciduous, drought tender
Casuarina cunninghamiana	River sheoak	12+	>600	1,7,8	Will grow in drier areas on wet sights

Table contd. . .

Botanical name	Common name	Mature height (m)	Rainfall (mm)	Use	Comment
Casuaraina decaisneana	Desert oak	15	<400	1	Very drought tolerant
Casuarina huegeliana	Rock oak	6-9	<400	1,8	Grows on difficult sites
Casuarina obesa	WA swamp or salt sheoak	12	<500	5,6	Heavy flats
Ceratonia siliqua	Carob bean	6-9	>400	1	Fodder tree (pods)
Chamaecytisus proliferus	Tagasaste (tree lucerne)	3-5	>450	1,7	Fast growth fodder
Cinnamomum camphora	Camphor laurel	10-30	>750	1,8	Adapted to moist soils and conditions
Coprosma repens	Mirror plant	3		1	Good coastal species
Corynocarpus laevigatus	New Zealand laurel	6			Drought and frost tender
Cupressus arizonica	Arizona cypress	20	>300	1,7	Drought and frost resistant
Elaeagnus angustifolia	Russian olive	5			Full sun, drought and frost resistant
Eucalpytus accedens	Powderbark wandoo	25	>500	1,4,5	For gravelly soils
Eucalyptus angulosa	Ridge-fruited mallee	6	<500	7	Good for sand and soil conservation
Eucalyptus annulata	Open-fruited mallee		>500	4	Useful small tree
Eucalyptus astringens	Brown mallet	15	400+	1,8	Shade value decreases with age
Eucalyptus bicostata	Eurabbie	20+	>500	1,7	Heavy soil, drought and frost resistant
Eucalyptus botryoides	Southern mahogany	10-20	>600	1,4,5,7	Better sands and well drained soils
Eucalyptus brockwayi	Dundas mahogany	15-24	<400	1,4,5,7	Prefers light soils
Eucalyptus burdettiana	Burdett gum	2-4		1,4	Prefers light soil, frost tender
Eucalyptus burracoppinensis	Burracoppin mallee	3-6	<500	1,4,5	Very adaptable
Eucalyptus caesia	Gungurru or silver princess (large flowered form)	6-8	<500	1	Very adaptable
Eucalyptus calcicola	Bushy moort	2	>500	7	Coastal
Eucalyptus calophylla	Marri, red gum	35+	>500	1,4,5,7	Better sands
Eucalyptus calophylla (v. rosea)	Pink flowered marri	35+	>500	1,4,5,7	Better sands
Eucalyptus camaldulensis	River red gum	10-50	>400	1,4,5,6,7	Widespread and adaptable
Eucalyptus campaspe	Silver (topped) gimlet	8-12	>400	1,4,5,6	Adaptable
Eucalyptus cinerea	Mealy stringybark	10+	>600	1,7	
Eucalyptus citriodora	Lemon-scented gum	25+	>500	1,3,4,5	Light soils
Eucalyptus cladocalyx	Sugar gum	25+	>400	1,2,5,7	Light soils, toxic to stock
Eucalyptus cladocalyx (v. nana)	Dwarf sugar gum	10	>300	1,2,5,7	Light soils, toxic to stock
Eucalyptus conferruminata	Bushy yate	10	>400	1,2,7	Very adaptable, drought tolerant
Eucalyptus cornuta	Yate	20	>500	7	Adaptable
Eucalyptus crebra	Narrow-leafed ironbark	20-30	>500	1,5,7	Heavy soils
Eucalyptus crucis	Southern Cross silver mallee	5	>200	1	Hardy
Eucalyptus decipiens	Limestone marlock (Redheart)	13	>500	1	Very adaptable
Eucalyptus desmondensis	Desmond mallee	5	<500	1	Light and heavy soils
Eucalyptus dielsii	Cap-fruited mallee	4-6		1	Well drained soil
Eucalyptus diptera	Two-winged (bastard) gimlet	6	<500	7	Some salt tolerance
Eucalyptus diversicolor	Karri	80	>600	1,4,5,7	Prefers loam soil types
Eucalyptus dongarraensis	Dongarra mallee	8	<500	1,7	Prefers sandy soils
Eucalyptus doratoxylon	Spearwood mallee	2-5	>500	7,8	Prefers protected sites
Eucalyptus drummondii	Drummond's gum	8	<500	1,4,5	Useful shrub on light soils

Table contd. . .

Botanical name	Common name	Mature height (m)	Rainfall (mm)	Use	Comment
Eucalyptus dundasii	Dundas blackbutt	20	<500	1,4,5,7	Prefers lighter soils
Eucalyptus ebbanoensis	Sandplain mallee	5	<500	1,7	Small tree
Eucalyptus eremophila	Tall sand (Goldfields) mallee	4-6	>250	1	Sandy soils
Eucalyptus erythrocorys	Illyarrie	5-8	<500	1	Showy ornamental
Eucalyptus erthyronema	White (red flowered) mallee	3-6	<500	1,2	Heavier soils
Eucalyptus ewartiana	Ewart's mallee	6	<500	1,4,5	Bushy mallee for sandy areas
Eucalyptus falcata	Silver or white mallet	10	<500	1,2,5	Very adaptable, mallee and tree forms
Eucalyptus ficifolia	Red flowered gum	5	>500	1	Restricted to southern areas
Eucalyptus flocktoniae	Merrit	10-13	>400	1,2,4,5,6,7	Adaptable
Eucalyptus foecunda	Narrow-leaved red mallee	2-5	<500	1,4	Very adaptable
Eucalyptus forrestiana	Fuchsia mallee	3-6	<400	1,6	Suitable for Salmon Gums and southwards
Eucalyptus gardneri	Blue mallet	10-12	>400	1,2,4,5	Very adaptable
Eucalyptus globulus	Tasmanian blue gum	20+	>600	1,5,7	Well drained soils. Fast growth
Eucalyptus gomphocephala	Tuart	15-35	>600	1,4,5,7	Very adaptable, best on limeston soils
Eucalyptus gracilis	Yorrel	8-12	>300	1,4,5,6,7	Very adaptable
Eucalyptus kochii	Watheroo mallee	8-10	<500	1,3,4,5	Adaptable, prefers sandy soils
Eucalyptus kondininensis	Kondinin blackbutt	12-20	>300	1,5,6,7	Adaptable and salt tolerant
Eucalyptus kruseana	Book leaf mallee	2-5	>200	1	
Eucalyptus landsowneana	Crimson mallee box	6	<500	1,5	Adaptable
Eucalyptus lehmannii	Lehmann's mallee	2-10	>400	7,8	Ideal for windbreaks
Eucalyptus leptophylla	Slender leaf white mallee	5	>300	1,7	
Eucalyptus leptopoda	Tammin mallee		<500	1,4,5	Prefers sandy area
Eucalyptus leucoxylon	Yellow gum	10-20	>500	1,2,3,4,5,7	Grows over 1 m/year on favourable sites
Eucalyptus leucoxylon *(v. rosea)*	Pink flowered yellow gum	10-20	>500	1,2,3,4,5,7	
Eucalyptus longicornis	Red morrel	10-22	>500	1,4,5	Very adaptable
Eucalyptus loxophleba	York gum	5-12	>300	1,4,5,6	Very adaptable
Eucalyptus macrandra	Long-flowered marlock	3	<500	1,4,6,7	Very adaptable and hardy
Eucalyptus macrocarpa	Mottlecah	2-5	<500	1	Pruning develops a dense shrub
Eucalyptus maculata	Spotted gum	20+	>600	1,4,5,7	Prefers better sands
Eucalyptus mannifera	Brittle gum	15	>100	1,8	Well drained soils
Eucalyptus marginata	Jarrah	15+	>600	1,4,5,7,8	Heavier soils
Eucalyptus megacarpa	Bullich	1.5-3		1	
				(8, tree form)	Tree form develops in wetter areas
Eucalyptus melliodora	Yellow box	20-30	>400	1,4,5,7	Best honey box
Eucalyptus microcorys	Tallow wood	20+	>600	1,4,5	Loams
Eucalyptus microtheca	Coolibah (flooded box)	18-24	>300	1,5,7,8	Very adaptable
Eucalyptus muellerana	Yellow stringybark	20+	>600	5,7	Medium to heavy soils
Eucalyptus nicholii	Nichol's gum	30	>600	7	Most soils
Eucayptus nutans	Red flowered moort	3	>400	1	Sandy loams
Eucalyptus occidentalis	Flat topped or swamp yate	20-25	>350	1,2,4,5,6,7	Very adaptable
Eucalyptus oldfieldii	Oldfield's mallee	4	<500	1,4	Well drained soils, drought tender
Eucalyptus oleosa *(var. kochii)*	Watheroo mallee	10-13	>300	1,3,4,5,6,7	
Eucalyptus oleosa					

Table contd. . .

List of trees

Botanical name	Common name	Mature height (m)	Rainfall (mm)	Use	Comment
(var. oleosa)	Giant mallee	10-13	>300	1,3,4,5,6,7	
Eucalyptus ovata	Swamp gum	22		1	
Eucalyptus patens	W.A. blackbutt (Yarri)	45	>600	7	Moist subsoil
Eucalyptus platypus	Moort	3-8	>400	1,2,4,5,6,7	Very adaptable, prefers heavy soils
Eucalyptus platypus *(var. heterophylla)*	Coastal moort	3-8	<500	1,7,8	Heavy soils
Eucalyptus preissiana	Bell-fruited mallee	1.5-2	>500	1	Grows in poor soils, very adaptable
Eucalyptus pyriformis	Pear-fruited mallee	3-4	<500	1,4,5	Best on light soils
Eucalyptus redunca *(var. melanophloia)*	Black-barked marlock	10	>400	1,4,5,7	Adaptable dense mallee
Eucalyptus regnans	Mountain ash	60+			
Eucalyptus resinifera	Red mahogany	20+	>800	7	
Eucalyptus rhodantha	Rose mallee	1-2.5	<500	1	Straggling, of great beauty
Eucalyptus robusta	Swamp mahogany	15-25	>500	1,4,5,7	Best on wetter sites
Eucalyptus rudis	WA flooded or blue gum	10+	>500	1,4,5	Tolerates wet areas
Eucalyptus saligna	Sydney blum gum	20+	>600	1,5,7	Fertile loams and gravels
Eucalyptus salmonophloia	Salmon gum	12-25	>300	1,2,3,4,5,6	Adaptable and widespread
Eucalyptus salubris	Gimlet	13-20	>300	1,2,4,5,6	Heavier loams
Eucalyptus sargentii	Salt river gum	8-11	>350	1,2,6,7	Very salt tolerant
Eucalyptus sheathiana	Ribbon barked mallee	8	<500	1,4	Best on light soils, drought tolerant
Eucalyptus sieberi	Silvertop ash	20+		1	
Eucalyptus sideroxylon *(v. rosea)*	Red ironbark	20-30	>400	1,2,3,4,5	Very adaptable
Eucalyptus spathulata	Swamp mallet	5-8	>300	1,2,6,7	Very salt tolerant
Eucalyptus stoatei	Scarlet pear gum	6-8	>300	1	
Eucalyptus stricklandii	Yellow flowered blackbutt (Strickland gum)	7-8	<500	1,4,5,6	Light soils
Eucalyptus tereticornis	Forest red gum	40		1	
Eucalyptus tetragona	Tallerack or silver marlock	2-8	<500	1	Light soils
Eucalyptus todtiana	Coastal blackbutt	6	>400	1,4,5	Lighter soils
Eucalyptus torquata	Coral gum	6-8	>300	1,4,5,6	Well drained soils, ideal for coast
Eucalyptus transcontinentalis	Redwood	15-20	<500	1,4,5	Light soils
Eucalyptus viminalis	Manna ribbon gum	20+	>500	1,7	
Eucalyptus wandoo	Wandoo or white gum	15-20	>400	1,2,4,5	Very adaptable
Eucalyptus woodwardii	Lemon flowered gum	12-15	<500	1	
Eucalyptus woolsiana	Grey box	8-25	>400	1,5,8	Heavier soils
Fagus sylvatica	Common beech	30		1,8	Deciduous, alkaline soils,suckers
Ficus macrophylla	Moreton Bay fig	15+	>500	1,7	
Gleditsia triacanthos	Honey locust	20	>500	1,7	Suckers freely, has large thorns
Grevillea robusta	Silky oak	20	>100	1	Coastal
Hakea bucculenta	Red pokers	5	>200	1	
Hakea laurina	Pincushion hakea	5	>300	1,7	
Hakea multilineata		5	>200	1	Light soils, open position

Table contd. . .

List of trees

Botanical name	Common name	Mature height (m)	Rainfall (mm)	Use	Comment
Hakea salicifolia	Willow hakea	3-4		1	
Hakea sauveolens	Sweet hakea	3		1	
Ilex aquilifolium	Holly	15		1	
Jacaranda mimosifolia	Jacaranda	8-12	>500	1,8	
Kunzea baxteri	Baxter's kunzea	2-3		1	Frost tender, light soils
Lagunaria patersonii	Norfolk Island hibiscus	10+	>500	1,4	Hairs in fruit cause itching
Leptospermum laevigatum	Victorian ti-tree	5-10	<500	1,7	Lower level of windbreak, can become a pest in coastal regions
Ligustrum spp.	Privet species	1-12		1	
Liriodendron tulpifera	Tulip tree				
Lophostemon confertus	Brush or Queensland box	10		1,8	
Melaleuca armillaris	Bracelet honey myrtle	3-5	<500	1,7	Lower level of shelter belt
Melaleuca cuticularis	Salt water paperbark	5		1	Waterlogged, semi-saline light soils
Melaleuca hamulosa		5	>300	1	Heavier soils
Melaleuca lanceolata	Moonah/Rottnest Island ti tree	4-6	>300	1,6	Very hardy, very salt tolerant
Melaleuca leucadendron	Long-leaved paperbark	22	650	7	Adaptable
Melaleuca nesophila	Western tea myrtle	3		1,7	
Melaleuca rhaphiophylla	Swamp paperbark	6		1	Good moist soil plant
Melaleuca thyoides				1,6	Salt and waterlogging tolerant
Melaleuca uncinata	Broom honey myrtle	3		1,4,7	Used for brush fences, moist soils
Melia azderach	Cape lilac / white cedar	15-45	>500	1,8	Fruit toxic to pigs and poultry
Myoporum insulare	Boobialla	4	>500	7	Tolerates drought
Olea europaea	Olive	5-8	>400	1,7,8	Fruit crop edible after treatment
Photinia glabra	Chinese hawthorn	3		1	Drought tender
Pinus brutia	Calabrian pine	20	>400	8	Coastal
Pinus canariensis	Canary Island pine	20+	>400	5,7,8	Slow growth, long lived
Pinus halepensis	Aleppo pine	12-24	>450	5,7,8	Very adaptable
Pinus pinaster	Maritime pine	15-30	>500	5,7	Sandy soils
Pinus pinea	Stone pine	15-18	>450	1,8	Will grow in drier areas
Pinus radiata	Monterey pine	to 40	>600	5,7	Fast growth
Pittosporum eugenioides	Tarata	6	>300	1	
Pittosporum phyllyraeoides	Weeping pittosporum	3-8	>400	1	Seed is easy to germinate
Platanus occidentalis	Plane tree (American sycamore)		20	>600	1 Deciduous
Populus alba	White poplar	30		1,7	Deciduous, open position
Populus nigra (italica)	Lombardy poplar	30	>600	1,7	Moist areas
Prunus laurocerasus	Cherry laurel	7		1	Drought and frost tender
Prunus lusitanica	Portugal laurel	6		1	Light to medium soils

Table contd. . .

List of trees

Botanical name	Common name	Mature height (m)	Rainfall (mm)	Use	Comment
Quercus canariensis	Algerian oak	25		1	Medium to heavy soils
Quercus cerris	Turkey oak	35		1	Deciduous
Quercus ilex	Holm oak	25		1	Drought and frost tender
Quercus robur	English oak	30		1	Deciduous, well drained alkaline soils
Salix babylonica	Weeping willow	10	>600	1,8	Needs lots of water, can cause dam and drain problems
Santalum spicatum	Sandalwood	8		1,3,5	Parasitic plant, slow grower
Schinus molle	Pepper tree	14	>200	8	Most soils, drier areas
Tamarix aphylla	Athel tree/tamarisk	10	>150	1,7,8	Good arid area tree
Tamarix articulata	Evergreen tamarisk	8-12	>300	1,7	
Tamarix gallica	Spring flowering tamarisk	6		1	Deciduous
Ulmus procera	English elm	30		1	Deciduous
Virgilia capensis	Virgilia	20	>750	1	Can be short lived

Key to uses

1 = Ornamental, 2 = Tannin production, 3 = Oils or perfumes, 4 = Honey or pollen, 5 = Timber or firewood, 6 = Salt tolerant
7 = Windbreak, 8 = Shade

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