Eucalyptus species

1. Introduction and Main Uses

The genus Eucalyptus has provided foresters and farmers with a valuable resource of fast growing species able to grow under a wide range of conditions depending on the particular species being used. Eucalypts along with Acacia and pines have been the backbone of tropical plantation forestry and have demonstrated an ability to grow quickly on often difficult sites and under conditions that might differ from those identified in their natural habitat, As with all plantation trees, fitting the species to the site is important and with Eucalypts there is the added complication of ensuring that not only the right species is being used but also that a careful selection has been made of the provenance.[1] It is not adequate to think in terms of species only and this will be considered further under section 3 "Seed Sources".

There are over 600 species of Eucalypts, however this note will concentrate on those key species that are particular utilised for fuelwood production. *E.grandis* and *E. saligna* are widely used species and are associated more with the higher rainfall sites; *E. camaldulensis,* and *E. tereticornis* likewise have been planted throughout the tropics and are both tolerant of semi-arid conditions.

All Eucalypts are good for fuelwood and pole production. Their suitability for timber is somewhat mixed and depends on the species. One of the drawbacks of their rapid growth is the build up of stresses within the tree leading to distortion after the tree has been felled and sawn. However, with careful sawing some species of Eucalypts can be used as more than acceptable construction timber. *E. cloeziana* is for example a good potential timber species and highly favoured for transmission poles and *E.camaldulensis* produces a timber which is heavy and resistant to termites . Most (but not all) eucalypts demonstrate a good ability to coppice and can be grown under a wide range of planting conditions; but as a group they have acquired a bad reputation of being over-competitive with agricultural crops and to utilise large amounts of water when growing actively. Their consumption of water is probably no more than any other fast growing forest species, but if water is available they will use it and transpire freely. However they are best planted well away from food crops and those crops intolerant of competition for light and water. But where under-utilised land can be made available for the production of wood, then Eucalypts have an important role in farm forestry. Production rates from coppice can be extremely high and once established the crop is tolerant of poor growing conditions. However it should be noted that during establishment, it is critical that all weed competition is removed if high productivity and survival is to be obtained.

Most Eucalypts are susceptible to some degree to termite damage- both as a newly planted seedling and as timber or pole wood. In termite-prone areas, this has to be taken into account through appropriate chemical treatment of the planting stock and/or the wood.

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[1] Provenance relates to the specific area that the seed originated. There can be a wide range of growth characteristics of some Eucalypt species depending on the place of origin.

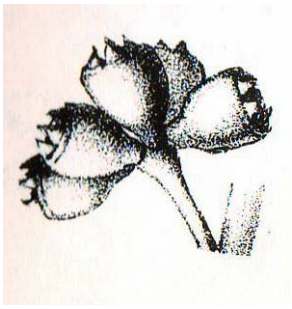
Eucalypts belong to the family Myrtaceae. The flowers tend to be groups into inflorescences (with the exception of *E.globulus* which has single flowers). The flowers form distinctive fruits with a ribbed receptacle often topped by the remains of valves from the upper part of the ovary. Bark varies from ribbed to the smooth and can be distinctly deciduous - peeling off to leaving new bark of a strongly contrasting colour as is the case for *E.camaldulensis* and *E.saligna*. In contrast, the bark may be persistent, and sometimes very hard as in the group of ironbark species, or it may be fibrous and deeply furrowed.

The leaves are also variable in both shape and colour, but generally narrow and long in relation to their breadth i.e. lanceolate. They are positioned alternatively on the branchlets. Many species demonstrate the production of juvenile foliage which is quite different and distinctive from the mature foliage. It is possible to see both types of foliage on a single tree at the same time, indeed *E.globulus* often demonstrates this property.

2. Site Requirements

Because of the wide range of species/provenances of this group, suitable Eucalypts can be identified for most situations within the tropics. Looking at some of the site requirements for the key species: -

<u>*E.grandis/E.saligna*</u> – these species are very similar botanically and in performance and growing requirements and consequently are frequently mixed up. They are suited to sites above 900 m in altitude where there are no excessive periods of drought, however within Africa these species can tolerate a dry season of 6-7 months, providing rainfall in the rest of the year is reliable and in excess of 1,250 mm. They are not tolerant of shallow soils and require moderately fertile land if they are going to reach their optimum production levels. Both species coppice well and provide good poles and fuelwood; the wood can be sawn to provide acceptable construction timber if carefully seasoned and in Australia is regarded as acceptable for house building



Leaf and fruit of E.grandis

E.tereticornis – this species is more drought tolerant than *E.grandis* and can be used in semi-arid environments where rainfall is down to 600 mm; it will also tolerate a long dry

season. Unlike *E.grandis* and *E.saligna*, it is associated with lower altitudes and can be used from close to sea level up to 1,000 m. It is also tolerant of relatively poor sites In low rainfall areas (<600mm) it prefers alluvial flats subject to flooding. In areas of higher rainfall it grows on the lower slopes of hillsides and extends to mountain slopes and hillsides. Soils include rich alluvials, sandy or gravelly loams and seasonally waterlogged clays in forested wetlands. When planted as an exotic *E. tereticornis* appears to grow best on well-drained, fairly light-textured soils in areas receiving an annual rainfall of over 800 mm. *E. tereticornis* produces a hard heavy red timber with an S.G. of 0.8 -1.0 and is excellent at coppicing.

E. camaldulensis – has very similar properties to that associated with *E. tereticornis* and as with *E.grandis* and *E.saligna*, the two species are often mixed up.

E.camaldulensis under trial in Sri Lanka for biomass

In its native Australia it has one of the widest distributions of any eucalypt and therefore particular care is needed when selecting the provenance. It is associated with a rainfall range of 400 -1,500 mm and is a common choice for low-rainfall sites. The altitude range is also the same as with *E.tereticornis*.The wood has an SG or around 0.60 but older trees can have much higher densities. The wood is regarded as a very good fuel and makes particularly high quality charcoal. It is also aid to be resistant to termites. Eucalypts can hybridise between species and one particularly important hybrid has been a cross between *E.tereticornis* and *E.grandis* to provide a tree with the valuable combination of improved drought tolerance for *E.grandis* whilst retaining the greater productivity of this species over *E.tereticornis.*

The famous Mysore Gum, which has dominated Eucalyptus planting in India is a hybrid of *E.tereticornis* and represents a major proportion of the 1 million ha of Eucalypts that have been planted in the country.

E. citriodora – this species is known as the Lemon scented Gum, because of its particularly strong and distinctive sent that pervades the oil and leaves of this species. It is popular as a source of eucalyptus oil for both medicinal and perfume properties. It coppices only moderately well which makes it less suitable for intensive fuelwood production. It has a very extensive altitudinal range from sea level up to 2,000 m and is suitable for moderate rainfall regimes of 700-1,500 mm and will grow on a wide range of soils. In its native habitat is grows on gravelly soils, podzols and residual podzols of lateritic origin. Stands also occur on deep red loams, hard gravelly clay, and on soils derived from sandstone. The soils are usually well drained.

In the humid tropics, *E.deglupta, E.urophylla* and *E.brassiana* are widely used. *E.deglupta* is indigenous in areas outside Australia including the southern parts of the Philippines, Indonesia and Papua New Guinea. *E deglupta* is the dominant species used in the Philippines for pulpwood plantations.

3. Seed sources

As indicated in the introduction, the correct provenance selection is the key to the successful commercial planting of Eucalypts and there have been a series of international provenance trials for the more promising species. For *E. camaldulensis*, the Petford provenance (Queenland) has consistently proven itself to be a good choice in terms of both survival and growth. The Kennedy River provenance from Northern Queensland has similarly proven to be a good choice. Seed and advice can be obtained from national Forest Departments and from the Australian Tree Seed Centre linked to CSIRO. [Expand]

4. Nursery Practice

Eucalypt seed is small, generally more than 500,000 seeds make up one kg. The seed is usually relatively easy to germinate. It also stores well provided storage is within air-tight tins at an adequately cool temperature and in a fully dry state. Propagation of Eucalypts should always been carried out using seedling stock, vegetative propagation is possible using mist watering equipment and this is favoured by the large commercial companies wishing to maximise production with the use of clonal material. However this technology is not appropriate for the average farmer-forester. The seed requires no pre-treatment and can be either sown into a trays or seed beds for eventual pricking out after about 4 days after germination, once the cotyledons have been formed; or by direct sowing into tubes/pots. Because of the small size of the seed, a more controlled sowing can be obtained by mixing the seed with a suitable inert medium (i.e. dry sand) or by the use of a carefully calibrated shaker (based on the principle of a pepper/salt cellar).

If termite attack is of concern in the field, then a degree of protection can be provided by mixing in a suitable slow-release insecticide (i.e. Suscon) into the soil mixture in accordance to the instructions provided by the manufacturer. Later, care will need to be exercised not to disturb the soil around the roots at planting, in order to provide sufficient protection to enable the seedling to become established.

Germinating seedlings require dense shade to ensure that the top layers of the soil mix never dries out. For direct sown pots this can be easily achieved by placing a sheet of hessian over the tubes and watering through the covering. As germination progresses the shade can be gradually raised to gradually increase light penetration. After pricking out and or singling of the tubes, the height of the shade can be increased further and later removed to ensure that the seedlings start to become hardened for eventual planting out. If the soil mix was somewhat inert in terms of fertility, then a liquid fertiliser can be used to ensure that growth meets the intended planting out time which ought to be linked to the start of the reliable rains. Over use of a fertiliser will however make the seedling too soft and susceptible to die back after planting. Eucalypts grow quickly in the nursery can should reach an acceptable size within 2.5- 4.0 months depending on the temperature. Excessive growth can be controlled by regular root pruning together with controlled watering. If stock is clearly going to be too large, then it should be cut back using garden shears or a sharp knife at about 10 cm preferably 2-3 weeks before the seedlings are due to leave the nursery.

5. Site Preparation

The site should be cleared and prepared well in advance of the likely planting date. It should be prepared to agricultural standards with all competing weeds removed. Eucalypts are very intolerant of weed competition and all weed growth including grasses must be removed and controlled until canopy closure. If possible, the site should be ploughed and harrowed where there is the opportunity of having recourse to the use of agricultural machinery. Following the onset of the rains and the wetting of the upper 30 cm of soil, planting can commence. If tubed stock is being used, the plastic sleeves should be carefully split using a sharp knife. However, if termites are a serious threat, it might be worth retaining the tube in position to give further protection. If the seedlings have been established using a enclosed polytube then it will be essential to partly split the pot to avoid root deformity.

In terms of planting design, it is recommended that for energy plantations, where Eucalypts are being planted as a pure crop that spacing should be within the range of 2 x 2 metre to 1 x 1 metres (2,500 -10,000 sph). Following planting, the crop should be rigorously weeded until the crop is fully established. Replacement of failed seedlings should be planted as soon as possible before the end of the rains; otherwise replacement will need to be delayed until the next planting season.

6. Management Practice

Biomass Production

Eucalypts are generally responsive to coppicing, though there is a range in this ability throughout the genus. Certainly for *E.grandis/E.saligna*, *E.tereticornis* and *E.camaldulensis* this would be the preferred management technique for biomass production. Those Eucalypts reported to be poor at coppicing include: *E. astringens*, *E. botryoides, E. cloeziana, E. pilularis* and *E. regnans.*

The crop is coppiced at intervals of less than 4 years depending on the size of material required and it should be possible to obtain at least 5 crops before replacement of the stools would be required. The frequency of coppicing is related to both to the size of produce required and the original espacement. For short rotation coppice (SRC) crops grown at 1 x 1 m, it would be expected that a coppicing regime of 2-3 years would be required. The more traditional approach to fuelwood production would be to establish the crop at around 2.5-3.0 metre espacement and to operate on a 4-8 year rotation aiming to produce fuelwood of dimensions closer to 20 cm diameter and requiring extensive crossing cutting and splitting before use. The choice of size of material and hence the management regime would therefore be dictated by the kiln unit being used. There is very little difference between the Eucalypts as far as their heating quality is concerned and calorific value is within the range of 4,700 -4,800 calories/kg. Similarly good quality charcoal can be made at an average yield of 9.3 m3 of wood per ton of charcoal[2]

Coppicing is normally carried out at around 20 cm above ground level with a sloping cut, to ensure that rainwater does not cause rot. Following the development of successful coppice shoots, reduction of the number of shoots might be necessary. For pole production this would be down to 1-3 shoots, for biomass production, the upper limit is more flexible. After the shoots reach a utilisable size they are normally removed in a single operation, throughout the crop. In Sri Lanka, a biomass production regime of continuous cropping has been tried, whereby shoots are removed a they reach a utilisable size, which is a little over 2 cm diameter. This regime is popular with *Gliricidia* but it is probably less suitable for Eucalypts. However, it is a modified regime that might be worth consideration.

Pole and Timber Production.

Eucalypts – particularly *E.grandis/E.saligna* and *E. cloeziana* made excellent poles (however they require chemical preservation treatment for most uses) and for the production of low-medium grade timber. It would be relatively easy to manage an area of Eucalypts for a range of uses – both as a pole crop and for biomass production. This could be done through the division of the forest area into specific production zones, using close-planted SRC for biomass and a separate area of wider planted (3 x 3 metre) for pole/timber production. Another alternative would be to manage the crop on the basis of coppice with standards. In this management system, better formed individuals (spaced

[2] Refer Eucalypts for Planting, FAO.

roughly at 5 x 5 – 8 x 8 metres) would be allowed to grow on until they reach the desirable size, whilst the bulk of the crop would continue to be managed on a frequent cutting SRC system. After felling the standards, there regeneration would be encouraged through coppicing supported by vigorous singling to concentrate growth onto a single stem.

7. Productivity

Eucalypts can be highly productive providing care has been taken to match the species/provenance to the site and site preparation and establishment operations have been completed to an acceptable standard. Production rates in excess of 40 m^3/ha/an are not unusual and for SRC, production can exceed 50 m^3 or even 60 m^3/ha/an on the better sites not subjected to long periods of drought. For planning purposes however, production figures closer to 15-20 m^3/ha/an would be more realistic for most instances and on poorer sites where rainfall and soils are more questionable and management is not as tight as it should be, then 10-12m^3/ha/an would provide a more conservative guide.

8. Income Generation

Estimates have been made for the cost of production and the potential income generation from the growing of Eucalypts in Sri Lanka. The following table (Table 1) gives costings in Sri Lankan Rupees for a large scale commercial project, based on a 6 year SRC rotation and a modest productivity of 15 m3/ha/an. Division of all figures by a factor of 100 will give the costs in US$/ha.

Costs per ha:		Year 00	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Year 07
Survey, boundary demarcation & mapping		1,700	0	0	0	0	0	0	0
Land clearing:		3,000	0	0	0	0	0	0	0
Ground preparation:		6,372	0	0	0	0	0	0	1000
Planting and beating up:		2,571	0	0	0	0	0	0	1000
Seedling (incl. 25% suppl)		4,125	0	0	0	0	0	0	0
Weeding:		7,480	7,480	3,740	0	0	0	0	3740
Fertilising		2,979	0	0	0	0	0	0	2979
Singling Coppice		0	0	0	0	0	0	0	0
Pest and disease control		5,503	1,552	1,818	0	0	0	0	5503
General Plantation Maint.		3,250	1,000	1,000	1,000	1,000	1,000	1,000	3,250
Brashing/Pruning		0	0	0	0	0	0	0	0
Marking for thinning		0	0	0	0	0	0	0	0
Fire protection:		1,200	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Total establish. costs:		**38,180**	**11,032**	**7,558**	**2,000**	**2,000**	**2,000**	**2,000**	**18,472**
Overhead:		5,727	1,655	1,134	300	300	300	300	2,771
Road costs:		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Total Costs:		***46,907***	***15,687***	***11,692***	***5,300***	***5,300***	***5,300***	***5,300***	***24,243***

On this basis, it can be seen that over the first 3 years of establishment total costs are of the order of $740/ha per ha. At an average fuelwood price of $10.50/solid m3 ($7/stacked m3) and productivity of 15 m3/ha/an the IRR was calculated to be 12%. This was based on a rotation of 6 years with three coppice crops after the initial seedling crop, i.e. a total of 25 years.