CHAPTER 11 - OTHER USES OF EUCALYPTS
Foliage, Fodder, Honey, Bioenergy

Graham Milligan (NZFFA)
Ian Nicholas (Scion)
Lyre Iriate (University Católica de Ávila, Spain)

The rapid initial growth rate, crown structure, foliage and high wood density of eucalypts makes them ideal for a range of uses, some of which can be integrated with the production of sawn timber or pulpwood. These include:

- Foliage production
- Agroforestry
- Honey production
- Coppice production
- Carbon sequestration
- Land treatment of waste water and solid waste

Details on some of these uses are provided below.

Foliage for floral displays

The foliage of eucalypts and to a lesser extent, the seed capsules and bark, have been used in the floral art industry for many years. As with all art materials, preferences depend on the fashion of the day and vary from country to country. The most favoured species is *E. gunnii*.

Because there is a lot of variability in the growth form of foliage, selections for marketing have given rise to names such as:

"Blue Ice" – *E. gunnii*

"Little Boy Blue" – *E. gunnii*

"Baby Blue" – *E. pulverulenta*

"Kira Supreme" – *E. pulverulenta*

Overseas, supply of eucalypt foliage is a multi-million dollar business. Some producers offer foliage dyed to a colour of the purchaser's choice. Natural colour varies according to species (Table 23).

In New Zealand the floral art market has been dominated by "Baby Blue" for several years. Foliage sold for spectacular prices when it first became popular. Many growers entered the market which consequently became over-supplied.

Foliage of *E. pulverulenta* **"Baby Blue"**

Management of a foliage production unit

Procedures for foliage production vary with the size of the operation, but good practice has been found to include:

- cultivation of the soil before planting
- planting of small-grade trees (raised in Hillsons rootrainers or similar) in double

Table 23: Species of *Eucalyptus* used for floral display in New Zealand

Species	Natural foliage colour
E. gunnii	Blue (juvenile leaf)
E. crenulata	Blue/purple
E. rubida	Blue/purple (juvenile leaf)
E. parvula	Green
E. pulverulenta	Blue
E. polyanthomus	Green
E. risdonii	Blue
E. moorei	Green
E. nicholii	Green
E. cinerea (Silver Dollar)	Blue

- 1 x 1 m rows (alternate spacing)
- spacing of 3 metres between double rows to allow access during harvesting
- promotion of airflow around the trees to assist health.

If trees are planted in spring, cutting of foliage can commence the following autumn and continue during winter/early spring. During the active growth phase, transport of foliage can be difficult due to collapse of young leaf tissue. Fungus and insect attack may downgrade the product. This is not usually a problem in Otago and Southland, but in more humid northern regions a pesticide spraying programme may be required.

A eucalypt cutting bed can last for several years. Occasional mortality of individual trees may result from fungal infection of the stem.

Foliage for stock fodder

Sheep, cattle and deer readily eat the leaves of a number of eucalypt species. Eucalypts offer an advantage over willows and poplars because they are less vulnerable to seasonal moisture deficiency.

The following points have been noted in Southland:

- Leaves, bark and small twigs of *E. gunnii* are palatable and at times they are more attractive than grass.
- Any eucalypt that is palatable to rabbits, hares and possums will be readily eaten by livestock. Possums do not browse *E. glaucescens* or *E. neglecta* and sheep and cattle will rarely eat leaves of these species even if fodder is scarce.
- There is considerable scope for research into the establishment of eucalypt fodder banks, particularly the identification of suitable varieties and management techniques. The ability of eucalypts to withstand periodic drought, together with their rapidity of growth, suggests that they have real potential as an option for supplementary fodder.
- Note that the foliage of *E. cladocalyx* is palatable but can be toxic to stock when eaten in any quantity.

Honey production

Eucalypt flowers are attractive to honeybees and most species provide nectar. The quantity and quality varies, but species considered to be useful for honey production in New Zealand include *E. amygdalina*, *E. cladocalyx*, *E. globulus*, *E. gunnii*, *E. leucoxylon*, *E. macarthurii*, *E. melliodora*, *E. pulchella*, *E. sideroxylon* and *E. viminalis*. Of these, *E. melliodora* is most highly-regarded.

A species list summarising times of the year when pollen and nectar are produced, is shown in Table 24. This list was produced in South Africa and is unlikely to relate exactly with New Zealand conditions, although observations on the winter-flowering *E. leucoxylon* seem to agree with those in this country. Flowering time is known to vary among seedlots of the same species so these lists provide guidelines only.

Table 25 shows the flowering season for a number of eucalypt species in New South Wales, Australia. Again, variation can be expected for New Zealand conditions, and also among seedlots of the same species.

Table 24: Months during which nectar and/or pollen are produced by *Eucalyptus* species in South Africa. Cells shaded grey indicate peak activity.

Species	Nectar production	Pollen production	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Comment from SA
E. albens	●	●	●	●●	●●	●●	●●	●	●	●			●	●	fairly regular
E. amplifolia	●	●	●	●●					●	●	●	●●	●●	●●	fairly regular
E. elata (E. andreana)	●	●	●	●						●	●	●●	●●	●●	regular
E. blakelyi	●	●								●	●	●●	●●	●●	fairly regular
E. botryoides	●	●	●●	●●	●				●	●			●	●	irregular
E. bridgesiana	●	●	●●	●●	●								●	●●	regular
C. calophylla	●	●	●●	●●	●●	●	●							●	regular
E. camaldulensis	●	●	●●	●●	●●	●	●		●	●	●	●●	●●	●●	regular
E. cinerea	●	●	●						●	●	●●	●●	●●	●	regular
E. citriodora	●	●								●	●●	●●	●	●	fairly regular
E. cladocalyx	●		●●	●●	●●	●	●		●	●	●●	●●	●●	●●	regular
E. cornuta	●	●	●●	●●	●	●	●				●	●	●	●●	regular
E. deanei	●	●	●●	●●	●	●					●	●	●	●●	fairly regular
E. delegatensis	●	●	●●	●●	●									●	fairly regular
E. diversicolor	●		●	●	●●	●●	●●	●	●	●					regular
E. fastigata	●		●●	●●	●								●	●●	regular
C. ficifolia	●		●●	●●	●						●	●	●	●●	regular
E. fraxinoides	●	●	●●	●								●	●	●●	fairly regular
E. globulus	●	●	●			●	●	●	●	●●	●●	●●	●●	●	irregular
E. globoidea (eugenoides)	●	●	●●	●●	●●	●	●							●	fairly regular
E. gomphocephaia	●	●	●●	●●	●●	●●	●	●	●	●	●			●●	fairly regular
E. grandis	●	●	●●	●●	●●	●●	●	●	●	●	●	●	●●	●●	regular
C. gummifera (corymbosa)	●	●	●	●	●●	●●	●	●							regular
E. hemiphloia	●	●	●●	●●	●●	●	●					●	●	●●	regular
E. lehmannii	●	●	●	●	●	●				●	●	●●	●●	●	fairly regular
E. leucoxylon	●	●	●	●	●		●	●	●●	●●	●●	●●	●	●	fairly regular
E. linearis	●	●	●									●	●●	●●	regular
E. longifolia	●	●	●	●							●	●●	●●	●●	fairly regular
E. macarthurii	●	●	●								●	●●	●●	●●	regular
E. macrorhyncha	●	●	●	●●	●●	●								●	regular

Source: Loock 1970

Table 24: Months during which nectar and/or pollen are produced by *Eucalyptus* species in South Africa. Cells shaded grey indicate peak activity.

Species	Nectar production	Pollen production	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Comment from SA
C. maculata	●	●	●	●●	●●	●●	●●	●	●				●	●	regular
E. maidenii	●	●	●●	●	●							●	●	●●	irregular
E. melliodora	●		●●	●	●				●	●	●	●●	●●	●●	regular
E. microcorys	●	●	●●	●	●					●	●	●●	●●	●●	regular
E. microtheca	●	●	●●	●●	●										fairly regular
E. muelleriana	●	●	●	●●	●●	●								●	regular
E. obliqua	●	●	●●	●●	●●	●	●						●	●	regular
E. occidentalis	●		●	●	●	●●	●●	●							irregular
E. paniculata	●	●	●●	●	●	●	●	●	●	●	●	●●	●●	●●	regular
E. pauciflora (coriacea)	●	●	●								●	●●	●●	●●	regular
E. pilularis	●	●	●●	●●	●	●	●			●	●	●●	●●	●●	regular
E. polyanthemos	●						●	●	●	●	●●	●●	●●	●	regular
E. propinqua	●	●	●●	●●	●●	●	●				●	●	●	●●	fairly regular
E. punctata	●	●	●●	●●	●	●				●	●	●	●	●●	regular
E. racemosa (crebra)	●								●	●	●●	●●	●●	●	fairly regular
E. radiata	●		●●	●●	●	●	●					●	●	●●	regular
E. regnans	●	●	●●	●●	●●	●							●	●	regular
E. resinifera	●	●	●●	●●	●	●	●	●	●	●	●	●	●●	●●	fairly regular
E. robusta	●	●	●●	●●	●●	●	●	●						●	regular
E. rubida	●	●	●●	●	●						●	●●	●●	●●	regular
E. salmonophloia	●	●									●	●●	●●	●	fairly regular
E. salubris	●		●●	●	●							●	●	●●	irregular
E. siderophloia	●	●	●	●	●●	●●	●●							●	fairly regular
E. sideroxylon	●		●●	●	●	●	●	●	●	●	●●	●●	●●	●●	regular
E. sieberiana (sieberi)	●	●										●	●●	●●	fairly regular
E. smithii	●	●	●●	●	●	●	●					●	●●	●●	regular
E. stuartiana	●	●	●●	●●	●●	●●	●				●	●	●	●	fairly regular
E. tereticornis	●		●	●	●				●	●●	●●	●●	●	●	regular
E. triantha (acmenioides	●	●	●									●	●●	●●	fairly regular
E. viminalis	●	●	●●	●							●	●	●●	●●	fairly regular

Source: Loock 1970

Table 25: Flowering seasons of *Eucalyptus* species in New South Wales, Australia

Autumn	Spring	Winter	Summer
C. gummifera	*E. agglomerata*	*E. albens*	*E. amplifolia*
C. maculata	*E. blakelyi*	*E. citriodora*	*E. botryoides*
E. bridgesiana	*E. dealbata*	*E. creba*	*E. camaldulensis*
E. longifolia	*E. globoidea*	*E. sideroxylon*	*E. cladocalyx*
E. macrohyncha	*E. globulus*		*E. fastigata*
E. microcarpa	*E. melanophloia*		*E. fibrosa*
E. stellulata	*E. populnea*		*E. intertexta*
E. viminalis	*E. tereticornis*		*E. melliodora*
			E. microtheca
			E. muelleriana
			E. paniculata
			E. pauciflora
			E. pilularis
			E. piperita
			E. propinqua
			E. punctata
			E. saligna
			E. nitens (not on original list)

Agroforestry

Eucalypts are suitable for agroforestry because they have a crown that makes less shade than some other species, especially most softwoods. Analysis of shade under pruned and thinned *E. nitens* managed for agroforestry is not far from unshaded pasture.

Eucalypts in a pruned shelter also make ideal tall shelter trees, although in some locations the competition for soil moisture is considered a disadvantage.

Biomass for bioenergy

Eucalypts are known for their rapid initial growth rate. Their wood has a higher density than pines, other softwood species and some hardwoods. These attributes have stimulated interest in biomass production since the 1980s.

Table 26: Results from eucalypt biomass studies.

Species	MAI (t/ha/yr oven-dry)	Age (yr)	Stocking (stems/ha)	Volume (m^3/ha)	MAI (m^3/ha/yr)	Source reference†
E. saligna	21	2.6	5000	-	-	(1)
E. saligna	15	3.2	6013	-	-	(1)
E. saligna	16	8	829	-	-	(1)
E. saligna	17	9	1064 (1111**)	214	24	(2)
E. saligna	18	9	1383 (1457)	238	26	(2)
E. saligna	20	9	1807 (1924)	264	29	(2)
E. saligna	21	9	2366 (2551)	292	32	(2)
E. saligna	23	9	3088 (3380)	321	36	(2)
E. saligna	24	9	3990 (4444)	345	38	(2)
E. saligna	24	9	5127 (5827)	362	40	(2)
E. saligna	20	9	6206 (7694)	325	36	(2)
E. fastigata	15	4	7250	-	-	(1)
E. regnans	15	4	2050	103	26	(1)
E. regnans	27	7	1850	371	53	(1)
E. regnans	30	10	1075	537	54	(1)
E. regnans	21	13	1300	542	42	(1)
E. regnans	26	17	1250	854	50	(1)
E. nitens	20	4	6470	-	-	(1)
E. nitens	15	5	1675	-	-	(1)
E. nitens	14	6*	1317 (4873)	-	-	(1)
E. maidenii	28	4	3030	117	30	(3)

* - Coppice
** - Initial planting density
† - References: (1) Shula *et al.* 1989
(2) McKenzie & Hay 1996
(3) I. Nicholas (unpublished data)

In the 1990s Forest Research scientists conducted biomass studies in existing *E. nitens* and *E. saligna* stands, that is, stands that had been designed for maximum stem growth rather than for maximum biomass production. Later studies provided information directly related to bioenergy production.

A wide range of stand ages and species have been assessed for biomass productivity in New Zealand and information is summarised in Table 26. Nearly all of the investigations listed were carried out at different sites, in stands with different spacing and under different management regimes. The studies have tended to reflect forestry species favoured at the time rather than those with specific potential for bioenergy production.

Sampling from a Nelder spacing trial has provided an excellent analysis of the effect of spacing on productivity of *E. saligna* at age 9 years. Massey University has established a series of long-term bioenergy trials, including a coppicing study superimposed on a Nelder trial with *E. saligna* and a trial incorporating repeated harvesting of a range of species. At Lincoln University, biomass evaluations have been conducted on *E. ovata* and *E. nitens* grown in Nelder trials. Research investigating land treatment with waste water and waste solids has also produced information about eucalypt biomass production potential.

Data from a trial in the central North Island show that total stem production by 7-year-old *E. nitens*, across a stocking range of 2,400-1,100 stems/ha, can range between 297 and 194 m^3/ha. With mean annual increment of 42-28 m^3/ha/yr it is easy to see why *E. nitens* is currently the main candidate species for production of both short-fibre pulp and bioenergy in New Zealand, but only where it is correctly sited.

Biomass studies incorporating time or spacing variations have been established for *E. saligna* and *E. regnans*. The *E. regnans* studies were carried out in stands thinned for pulp production and results do not represent maximum productivity for bioenergy purposes (Table 26).

Coppicing

Eucalypts are known for the development of epicormic shoots following severe damage to the stem e.g. by fire. Shoots developing from a stump when the stem has been cut close to the ground are known as “coppice shoots”. The ability of a stump to coppice varies with species, tree vigour, tree size and age, also with season of cutting and certain environmental factors.

Coppice shoot development varies not only between species, but between provenances within species. It is poor or non-existent during winter. *E. delegatensis* rarely coppices and *E. nitens* is a weak coppicer, only coppicing when young. Coppicing for *E. nitens* varies between seed sources.

Active lignotubers (bulbous masses formed in leaf axils, from which new shoots may develop) are not found in *E. nitens*, *E. fraxinoides*, *E. fastigata* or *E. oreades*. These species have a low coppicing potential.

Lignotubers and epicormic buds develop in *E. macarthurii*, *E. elata*, *E. saligna* and *E. nobilis*, and these species have good coppicing ability.

Tree reproduction through coppicing can be used for regeneration of a cutover stand. Silvicultural systems based on short-term coppicing rotations can be designed for production of fuelwood, posts, small poles and pulpwood. The rotations are repeated three or four times before parent stumps are replaced with new nursery stock.

No exhaustive testing of all eucalypt species has been carried out, but observations in four countries (summarised in Table 27) have yielded the following information:

In Australia it is reported that regular use is made of coppice stems from advance growth of *E. fastigata*, *E. grandis* and *E. camaldulensis*. Species that rarely coppice are *E. nitens* and *E. astringens*. The best-known non-coppicing species are *E. regnans*, *E. delegatensis* and *E. fraxinoides*.

In India it is reported that commonly-grown species are *E. globulus*, *E. tereticornis* (hybrid), *E. grandis* and *E. camaldulensis*, all of which have good coppicing ability when young. This may vary between sites. Plantations are usually managed under a simple coppice system for a maximum of four rotations. Stumps and roots are then dug out and the area is replanted.

In South Africa it has been found that differences in terms of eucalypt coppicing have been noted between sites. Twenty species were planted at two sites receiving higher than average rainfall during the periods before and after felling. Coppicing ability of *E. nobilis*, *E. glaucescens*, *E. fastigata*, *E. deanei* and *E. nitens* (Tallaganda provenance) was poor at one site. For most species the distribution of coppice shoots around the stump differed with location, exceptions being species with low coppicing potential (*E. deanei*, *E. oreades* and *E. fraxinoides*). *E. fraxinoides*, *E. oreades* and *E.nitens* (the Ebor provenance, (now called *E. denticulata*) failed to coppice adequately at either site. *E. regnans* and *E. delegatensis* were excluded from the assessment due to poor tree survival prior to felling.

Seed origin influenced early growth as well as coppicing performance. The comparison of volume and coppicing potential of the two *E. nitens* provenances showed a difference in performance between seedlots.

Coppicing potential of species that coppiced well was similar at both sites. A site-related difference was noted for *E. andrewsii*, *E. campanulata*, *E. nobilis*, *E. fastigata*, *E. deanei*, *E. nitens* (Ebor), *E. oreades* and *E. fraxinoides*. In the case of *E. deanei*, *E. nitens* (Ebor), *E. oreades* and *E. fraxinoides*, better coppice development was noted where the original trees had grown well.

A study in New Zealand comparing the coppicing ability of twelve species belonging to the sub-genus *Symphyomyrtus* and seven species of the sub-genus *Monocalyptus* was carried out at Aokautere, near Palmerston North. Regrowth and yield were monitored through five 3-year rotations. A brief summary of results is included in Table 27.

Table 27: Reported coppicing ability of *Eucalyptus* species

Species	Coppicing ability			Source reference*
	Good	Medium	Poor	
E. amplifolia	X		X	(7)
E. amygdalina		X		(4)
E. andrewsii	X		X	(3)
E. astringens				(1)
E. badjensis	X			(3)
E. benthamii	X	X	X	(3)
E. botryoides		X		(4)
E. botryoides x *saligna*				(4)
E. brookerana	X			(4)
E. camaldulensis	X		X	(1,2)
E. coccifera			X	(4)
E. cordata				(4)
E. cypellocarpa	X			(3)
E. dalrympleana	X	X		(5)
E. deanei	X		X	(3)
E. debeuzevillei			X	(6)
E. delegatensis				(1,6)
E. denticulata	X			(5)
E. dunnii	X			(3)
E. elata	X	X		(3,4)
E. fastigata	X		X	(1,3)
E. fraxinoides			X(3)	(1,3,6)
E. glaucescens	X(5)			(3,5)
E. globulus	X			(2)
E. grandis	X		X	(1,2)
E. leucoxylon			X	(4)
E. macarthurii	X		X	(3)
E. niphophila		X	X	(6)

Table 27 cont: Reported coppicing ability of *Eucalyptus* species

Species	Coppicing ability			Source reference*
	Good	Medium	Poor	
E. nitens			X	(1,3, 4,6)
E. nitida		X		(4)
E. nobilis		X	X	(3)
E. obliqua		X	X	(4)
E. oreades		X	X	(3)
E. ovata	X		X	(4)
E. pauciflora			X	(6)
E. pseudoglobulus	X		X	(10)
E. pulchella			X	(4)
E. quadrangulata	X		X	(3)
E. regnans			X	(1)
E. robusta	X			(8)
E. rodwayii	X			(4)
E. saligna	X			(3)
E. sieberi	X			(9)
E. smithii	X			(3)
E. subcrenulata	X			(5)
E. tereticornis	X			(2)
E. urningera	X			(4)
E. viminalis			X	(4)

* Source references

(1) Jacobs 1955

(2) Tewari 1992

(3) Little & Gardner 2003

(4) Sims *et al.*.1999

(5) www.primabio.co.uk/bm_sppbiomasspotential.htm

(6) www.eucalyptus.co.uk

(7) www.edis.ifas.ufl.edu/FR013

(8) www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_2/eucalyptus/robusta.htm

(9) Forrester *et al*. 2002

(10) Sims 2001

Key Points

- Eucalypt sawlogs are relatively easy to saw if the right techniques are employed.
- Eucalypt logs can provide a reasonable percentage of clear length timber.
- Sawing conversions can range from 50-60%.
- New techniques for successful sawing of small diameter logs are being validated.
- Eucalypts produce acceptable appearance and engineering veneer products.

Suggested reading:

Gaunt *et al.* 2002

Haslett 1988 a & b 1990

Kininmonth *et al.* 1974

McConnochie & Low 2007

McKenzie, Ball & Roper 2000

McKenzie *et al.* 2003a & b

McKimm *et al.* 1988

Roper & Hay 2000