# Leucaena

## A guide to establishment and management

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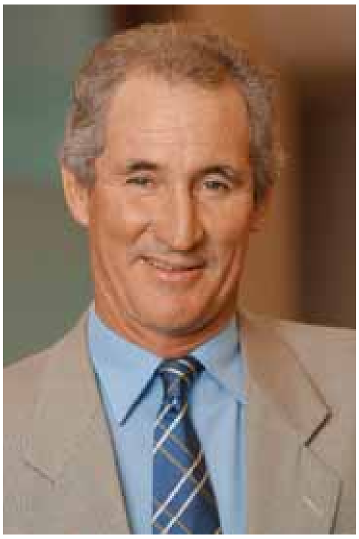
# Foreword

From very humble beginnings in 1955 when variety trials were first conducted at CSIRO Samford Research Station, the area of land in northern Australia under leucaena has grown to cover almost 150,000 hectares. Leucaena now provides a large part of the diet for well over 100,000 cattle. Increasing seed sales indicate that this area and its economic significance will continue to increase substantially in the future.

Great credit must go to the researchers at the University of Queensland. Dr Max Shelton and Dr Scott Dalzell and their team are world leaders in their field. The Leucaena Network, guided by Keith McLaughlin and assisted by pioneer farmers such as Peter Larsen, continues to promote the economic and environmental benefits of leucaena production.

Historically, the seasonal fluctuation in north Australian pasture quality has created the difficulty in meeting today's demanding market specifications. Leucaena, a drought-tolerant, long-lived, high-protein legume, offers a viable opportunity to overcome this problem. Established growers have demonstrated that leucaena adds enterprise profitability by allowing reduced age of turn-off, increased herd numbers and marketing flexibility.

As a result of industry interaction it became evident that a publication outlining the requirements to establish and maintain leucaena was vital. Meat & Livestock Australia (MLA) has met this requirement by funding this comprehensive publication. I encourage producers to digest the information contained in this book as it offers practical advice about the establishment of leucaena and its role in the highly variable beef production environment.



**Don Heatley**
**Chairman**
**Meat & Livestock Australia**

# Preface

The first historical records of the use of leucaena by man date back several millennia from excavations in Mexico. Its early use was as a food for humans; its first known use as forage for cattle has been more recent—Asian smallholders were feeding leucaena to cattle in Eastern Indonesia in the 1930s and in the Philippines in the 1970s.

Although research into leucaena's value as forage in Australia began in the 1950s, it was not until the 1990s that large-scale adoption started to gain momentum. Many factors contributed to this long lag between early research and the uptake of the technology by graziers.

During the 1980s and '90s, dedicated champions brought researchers and innovative graziers together to solve outstanding problems. The technology evolved and adoption increased markedly. Key technical discoveries included:

- Solving of the mimosine toxicity problem
- Better agronomic practices, especially weed control during establishment
- More appropriate plant and animal management
- Improved varieties, seed quality and treatment, especially scarification of seed

The formation of The Leucaena Network in 2000 marked a crucial point in the history of leucaena in Australia. The Network brought together many forward-thinking graziers with common interest who negotiated with Queensland Government agencies on policies for the responsible use of leucaena. It worked closely with research agencies, particularly the University of Queensland, to deliver new research and training initiatives such as the Leucaena for Profit and Sustainability (LPS) training courses.

With support from MLA, the Leucaena for Profit and Sustainability training course notes have now been upgraded into this book. University of Queensland researchers, with 20 years of experience, have teamed with successful leucaena graziers to ensure a balance of theory and practice.

The attractively presented information contained in this book will be invaluable to new and existing growers wishing to learn more about the best ways to establish and manage leucaena.

Max Shelton and Scott Dalzell
The University of Queensland, September 2006

# Acknowledgements

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Figures. We thank PROSEA for permission to use the line drawing of leucaena; DPI&F for permission to use and modify the figure of liveweight gains from pasture.

Data. Table 1.2 Adapted from Cheffins 1996; Table 1.3 from Esdale and Middleton 1997; Table 4.4 from B. Mullen using DPI&F data.

Appendices. NRM&W for permission to publish *Policy to Reduce the Weed Threat of Leucaena* (Appendix 3).

# Contents

## The benefits of leucaena

- ✓ **Better weight gains for longer.** Leucaena is the most productive and most sustainable tropical forage legume. No other forage plant can put the same weight on stock over so long a period of the year.
- ✓ **Top nutritional value.** Leucaena leaf is high in protein and is easily digested by ruminants; it rivals lucerne in feed value.
- ✓ **Highly palatable.** Cattle prefer leucaena to most other forages, making for high intake and subsequent weight gains.
- ✓ **No danger of bloat.** Leucaena does not cause bloat—unlike lucerne or clovers.
- ✓ **Flexible markets.** Excellent weight gains allow you to target the best markets at times when prices are highest.
- ✓ **Drought proofing.** Leucaena keeps producing high-quality green leaf through dry periods during summer, autumn and early winter.
- ✓ **Long life, lower cost.** Once leucaena is established, it can last for more than 30 years; no need for annual forage crops.
- ✓ **Improves soil fertility.** Nitrogen fixed by leucaena reverses 'nitrogen run-down' seen in pure-grass swards and improves grass quality and quantity.
- ✓ **Reduces soil erosion.** Leucaena and vigorous grass planted across the slope encourages water infiltration and reduces run-off.
- ✓ **Prevents rising water tables and salinity**. Leucaena's deep roots can extract water from the soil to a depth of 3–5 m thus preventing rising water tables that can bring salt to the soil surface.
- ✓ **Reduces greenhouse gasses.** Carbon is sequestered in the woody growth. Highly digestible leucaena diets can reduce cattle methane production by 20–40%.

## but ...

### Agronomic considerations

- ? **Only on good soils.** Leucaena grows best on deep fertile soils.
- ? **Costly to establish.** Leucaena seedlings do not compete well against grasses or weeds, which must be effectively controlled.
- ? **No frost tolerance.** Frost kills leaf and stems to ground level (although plants regrow from root crown).
- ? **Psyllid insects** can devestate new leaf, especially under coastal humid conditions.

### Management considerations

- ? **High palatability** means that leucaena needs suitable management to prevent overgrazing or wasteful utilisation.
- ? **Mimosine toxicity.** Leucaena can be toxic if the animals are not inoculated with special rumen bacteria.

### Environmental considerations

- ? **Heavy seed production** in ungrazed areas, such as roadsides, can allow leucaena to spread and become an environmental weed.

# 1. Why plant leucaena?

## 1.1 What is leucaena?

Leucaena (*Leucaena leucocephala*) is a deep-rooted perennial leguminous tree or shrub with foliage of very high nutritive value for ruminant production. It is palatable, nutritious, long-lived and drought-tolerant.

In northern Australia, leucaena is planted in hedgerows with grass sown in the inter-row to form a highly productive and sustainable grass–legume pasture system for cattle grazing. It is generally grown on deep, fertile soils in sub-humid environments where annual rainfall averages 600–800 mm. Being deep-rooted, leucaena is able to exploit soil moisture beyond the reach of grasses and so remain productive well into the dry season. Once established, leucaena-grass pastures can remain productive for over 40 years.

Prosea

*Leaves of leucaena, round flower heads and seed pods*

UQ

*An early stand of leucaena at Gayndah – planted in 1975 and grazed every year for over 30 years.*

### Brief history of leucaena

The native distribution of the genus *Leucaena* ranges from southern Texas in north America through Mexico and into Central and South America.

Species in the genus have been used as human food for several thousand years but less commonly for feeding livestock.

It is thought that around the 1600s Spanish colonists transported leucaena westwards to the Philippines and South-East Asia for use as a shade plant in tea and coffee plantations. As a multipurpose plant in the Philippines and Indonesia, the tree is used for timber, fuel wood, furniture and in agroforestry systems; as a shrub, it is used as a forage for feeding of ruminant livestock.

The history of leucaena in Australia is more recent. 'Wild' leucaena arrived on the coast of northern Queensland in the late 1800s, but it was not until the 1960s that the first forage variety was released by the CSIRO. Another decade passed before the first commercial stands were planted in the 1970s. In the mid-1980s, the leucaena psyllid insect devastated productive stands in humid coastal districts, and commercial planting slowed. But as graziers in the drier inland areas realised that the psyllid was only an intermittent problem, major plantings recommenced in the 1990s.

Some 400–500 graziers now grow an estimated 150,000 ha of leucaena pastures—with the area increasing rapidly.

## 1.2 Why plant leucaena?

Leucaena and grass pastures are the most productive, sustainable and profitable system of producing grassfed beef in northern Australia.

Tight market specifications for young, well-finished cattle demand that cattle grow quickly throughout their lives, despite a highly variable climate and severe dry seasons.

Access to major export markets such as Japan, Korea and the European Union requires animals to reach a target weight at a young age; specifications for feedlot entry depend on the market. Typical market specifications for grassfed animals in Australia (2006) are shown in table 1.1.

*Table 1.1 Market specifications for grassfed cattle*

| Market | Live wt (kg) | Dressed (kg) | Fat (mm) | Age (mon) | Teeth |
|---|---|---|---|---|---|
| Jap Ox | 518–800 | 280–440 | 7-22 | <42 | 0-4 |
| EU | 440-780 | 240-420 | 7-22 | <30 | 0-4 |
| Korean | 520–750 | 280–400 | 7-22 | <42 | 0-4 |
| Domestic | 250-550 | 130–300 | 4-15 | <16 | 0-2 |
| **Feedlot entry** | | | | | |
| Jap | 380-500 | | | | <2 |
| Domestic | 280-350 | | | <18 | 0 |

Steers need to gain about 200 kg each year to grade as Jap Ox, and it is not easy to achieve this reliably off tropical grass pasture.

### What's wrong with our grass pasture?

Steers on brigalow pastures of buffel grass, Rhodes grass and green panic gain only 140–190 kg liveweight a year.

Even on good soils, the protein content of the grass is generally too low to maximise beef production of the beef cattle eating it. Nitrogen needed for grass growth and quality becomes tied up in soil organic matter, especially after the pasture has been growing for a number of years.

Higher production is achieved when more nitrogen can be made available by disturbing the soil, for example when brigalow pastures are blade ploughed, or by adding a vigorous legume to the grass pasture.

### What are the benefits from leucaena?

Leucaena is one of the few tropical or subtropical legumes that will remain permanently productive on the heavier clay soils. It not only improves the growth rates of cattle at critical times of the year but will keep on doing so for decades.

Cattle on leucaena/grass pastures will gain 250–300 kg per year, and at a higher stocking rate; production per hectare can be nearly four times that from old buffel grass pasture (table 1.2).

*Table 1.2 Typical performance by steers grazing a range of pasture systems in tropical Queensland (modified after DPI&F)*

| Forage system | Average stocking rate (ha/steer) | Liveweight gain/year (kg/steer) | Liveweight gain/year (kg/ha) |
|---|---|---|---|
| Native pasture – central Qld | 10 | 100–140 | 25–35 |
| Buffel grass – run down | 3 | 140–150 | 45–50 |
| Buffel grass – good condition | 2 | 170–190 | 85–95 |
| Leucaena – buffel grass | 1.5 | 250–300 | 165–200 |

Leucaena-fed steers can reach 600 kg liveweight (optimum Jap Ox) at 24–30 months of age (2- or 4-tooth). This is 6–12 months earlier than those on straight buffel grass, significantly increasing the carcase value and rate of steer turnover. Table 1.3 illustrates the value of leucaena/grass pasture for finishing cattle.

*Table 1.3 Steer performance over 150 days*

| Feeding system | Steer liveweight gain (kg/day) |
|---|---|
| Buffel grass – 150 days | 0.86 |
| Leucaena–buffel – 150 days | 1.26 |
| Buffel 50 days, feedlot grain 100 days | 1.41 |

DPI&F

CHM

*Steers after gaining 1.26 kg/day over 150 days of summer (see table 1.3)*

*Table 1.4 Carcase grading for some drafts of steers fattened on leucaena–grass pastures*

| Property location | No. of steers | Av. dentition | Av. fat depth (mm) | Av. carcase weight (kg) | Slaughter date |
|---|---|---|---|---|---|
| Monto | 33 | 1.9 | 15.0 | 322.8 | Feb 06 |
| Wandoan | 10 | 1.6 | 14.9 | 329.9 | Jan 06 |
| Banana | 24 | 1.3 | 14.0 | 291.7 | Nov 05 |
| Wandoan | 42 | 2.3 | 16.0 | 367.1 | April 06 |

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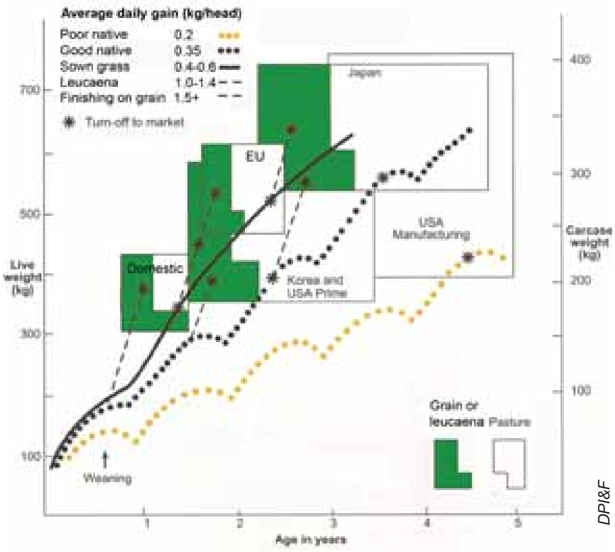
## 1.3 Choose your market

A significant benefit of the rapid liveweight gain of cattle grazing leucaena–grass pasture is increased flexibility in targeting domestic and export markets according to the best prices.

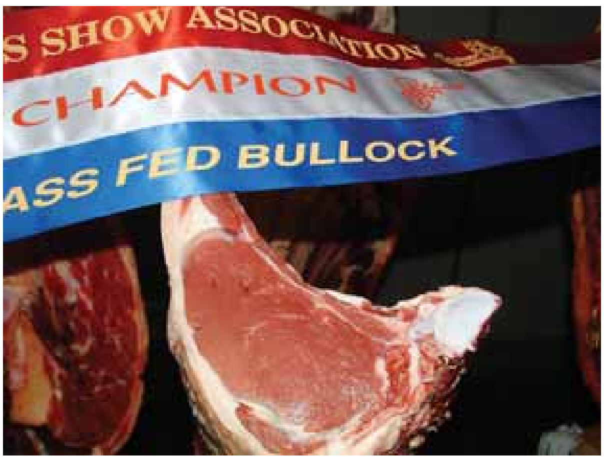
The criteria to access both export and domestic beef markets are becoming increasingly stringent. The adoption of product quality standards such as MSA (Meat Standards Australia) sets objective criteria with associated price incentives for graziers. High quality pasture systems such as leucaena make it easier to meet the high grades for individual cuts without resorting to grain finishing.

Leucaena pasture can also be used for improving breeder condition, conception and branding rates in breeding herds, for growing out stud bulls and for backgrounding weaners before placing them into feedlots.




DPI&F

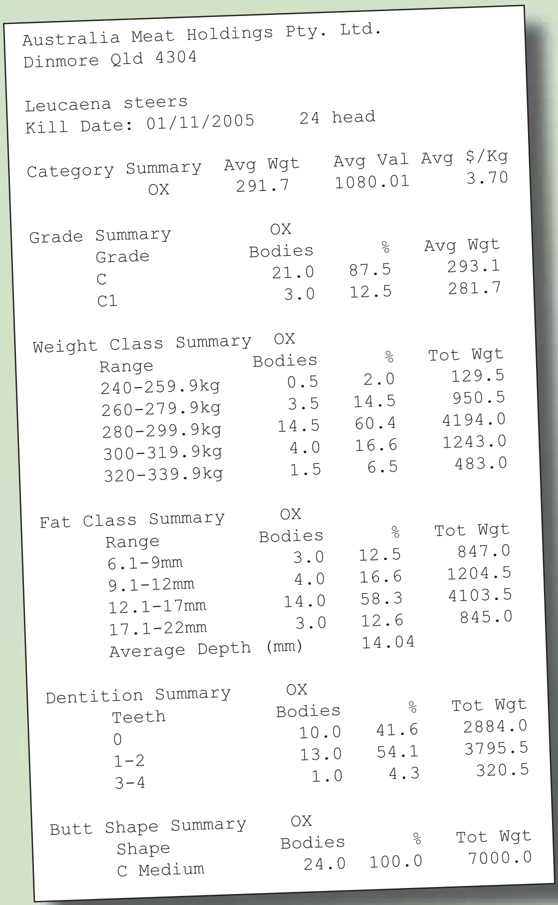
*Growth patterns of beef cattle on different pastures and the finishing options for various markets. (Modified with permission of Department of Primary Industries and Fisheries)*




DPI&F

*Steer fattened on leucaena wins carcase grading award*

### A kill sheet summary for leucaena-fed steers



Australia Meat Holdings Pty. Ltd.
Dinmore Qld 4304

Leucaena steers
Kill Date: 01/11/2005 24 head

| Category Summary | Avg Wgt | Avg Val | Avg $/Kg |
|---|---|---|---|
| OX | 291.7 | 1080.01 | 3.70 |

| Grade Summary Grade | OX Bodies | % | Avg Wgt |
|---|---|---|---|
| C | 21.0 | 87.5 | 293.1 |
| C1 | 3.0 | 12.5 | 281.7 |

| Weight Class Summary Range | OX Bodies | % | Tot Wgt |
|---|---|---|---|
| 240-259.9kg | 0.5 | 2.0 | 129.5 |
| 260-279.9kg | 3.5 | 14.5 | 950.5 |
| 280-299.9kg | 14.5 | 60.4 | 4194.0 |
| 300-319.9kg | 4.0 | 16.6 | 1243.0 |
| 320-339.9kg | 1.5 | 6.5 | 483.0 |

| Fat Class Summary Range | OX Bodies | % | Tot Wgt |
|---|---|---|---|
| 6.1-9mm | 3.0 | 12.5 | 847.0 |
| 9.1-12mm | 4.0 | 16.6 | 1204.5 |
| 12.1-17mm | 14.0 | 58.3 | 4103.5 |
| 17.1-22mm | 3.0 | 12.6 | 845.0 |
| Average Depth (mm) | | 14.04 | |

| Dentition Summary Teeth | OX Bodies | % | Tot Wgt |
|---|---|---|---|
| 0 | 10.0 | 41.6 | 2884.0 |
| 1-2 | 13.0 | 54.1 | 3795.5 |
| 3-4 | 1.0 | 4.3 | 320.5 |

| Butt Shape Summary Shape | OX Bodies | % | Tot Wgt |
|---|---|---|---|
| C Medium | 24.0 | 100.0 | 7000.0 |

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*Leucaena-fed steers on the hoof (above) and on the hook (right)*

DPI&F

## The benefits ...

Leucaena has nutritional, agronomic and environmental benefits over other tropical pasture legumes. These are:

- **Better weight gains for longer.** Leucaena is the most productive and most sustainable tropical forage legume available when grown under suitable conditions. No other forage plant can put the same weight on stock over so long a period of the year.
- **Top nutritional value.** Leucaena leaf is high in protein and is easily digested by ruminants; it rivals lucerne in feed value. Part of the protein is protected by tannins and passes through the rumen and is more efficiently digested in the intestines.
- **High palatability.** Cattle relish leucaena and eat it in preference to most other forages, making for high intake and weight gains. But it may need special management to prevent over- or wasteful utilisation.
- **No danger of bloat.** Unlike lucerne, clover or medics, leucaena does not cause bloat.
- **Flexible marketing.** Excellent weight gains over long periods allow graziers to target either domestic or export markets, and to market finished animals when prices are highest.
- **Drought proofing.** Leucaena's deep root system allows it to use water deeper in the soil profile than grasses. It keeps producing high quality green leaf through dry periods during summer, autumn and early winter—or until hit by frost.
- **Long life, lower cost.** Once leucaena is established, it can last for more than 30–40 years; there is no need to plant other legumes or expensive annual forage crops.
- **Improved soil fertility.** Much of the nitrogen fixed by leucaena is returned to the soil and used by the grass, reversing the 'nitrogen run-down' seen in pure-grass swards and improving grass quality and quantity.
- **Reduced soil erosion.** Leucaena planted across the slope with a vigorous grass encourages water infiltration and reduces run-off.
- **Reduced dryland salinity**. Leucaena is deep rooted. Whereas the roots of grass can extract water from the soil to a depth of 1.5–2 m, leucaena roots can pull water from 3–5 m, thus preventing rising water tables bringing salt to the soil surface.
- **Reduced greenhouse gases.** Carbon dioxide is locked up in the woody stems and roots of leucaena and in the increased growth of grass. Ruminants belch more methane when digesting poor quality fibre. The better digestibility associated with high-quality leaf of leucaena may reduce methane production by 20–40%.


*Green leucaena leaf keeps cattle gaining weight even when the grass has hayed off.*

## … but there are limitations

### Agronomic limitations

- **Only for better soils.** Leucaena does not grow productively on infertile or acid soils; it needs deep, fertile soils of neutral or slightly alkaline reaction with high levels of available phosphorus.
- **Susceptible to frost.** Frosted leaf drops, stems may be killed to ground level but will regrow from crown.
- **Slow and costly to establish.** Leucaena seedlings suffer strongly from weed competition and often from attack by insects, kangaroos, wallabies and hares.

### Management limitations

- **Psyllids.** Psyllid insects may attack leucaena, specially under humid coastal conditions.
- **Mimosine toxicity.** Leucaena is toxic unless animals are inoculated with special rumen bacteria.

### Environmental limitations

- **Heavy seed production.** Heavy seed production can allow leucaena to spread slowly in ungrazed environments such as roadsides, and so become a weed.

## The future

Leucaena/grass systems are being adopted rapidly. Some 13 million hectares of northern Australia could be suitable for growing leucaena, with 4–5 million hectares in the Fitzroy Catchment alone. While most of this land will never be planted to leucaena, the potential for increasing beef productivity is huge.

There continues to be concern about the potential of leucaena to become an environmental weed; to address this concern, factual information is being disseminated and a voluntary Code of Practice implemented for the responsible use of leucaena.

## The Leucaena Network

The Leucaena Network was formed in 2000 to promote the use of leucaena as a valuable forage plant and to counter the anti-leucaena movement within the environmental lobby. With assistance from the Department of Primary Industries and Fisheries and The University of Queensland, the Network has developed a Code of Practice to encourage responsible management of leucaena so as to maximise beef cattle production and minimise the weed risk to the environment.

The Code of Practice will help growers establish environmental credibility with the broader community. The Code of Practice is presented in Appendix 2.

### Other Network activities

Other roles have now been adopted in response to opportunities and industry needs under the proactive Network policy.

Responsible development includes maximising the potential benefits of the leucaena/grass pasture system through research activities that address current production limitations and environmental issues. The Network conducts regular training courses for graziers and has sponsored University of Queensland research projects funded by Meat & Livestock Australia (MLA)—including the production of this guide.

## Pioneer of broadscale leucaena pastures — John O'Neill

If John Wildin is known as the first champion of leucaena among government agencies, then John O'Neill was among the first group of graziers to take the plunge and invest in broadscale leucaena planting for cattle fattening.

John and Del own 'Nyanda', 15,400 ha of country nestled against the Carnarvon Gorge 65 km south of Rolleston. Half of the property is mountainous and forested but around 2,600 ha have been cleared for grazing.

John first read about the advantages of leucaena in Queensland Country Life. At first he thought little of it, but went back to the article thinking that "If it is half as good as the article says, it must be good" and it might solve his need for high quality pastures for finishing his steers.

He planted his first 30 ha in 1980, followed this with another 25 ha in 1981 and continued to plant paddocks over the next 10 years. His most recent planting was 100 ha in January 2005 so he now has 600 ha of leucaena and little room for further expansion.

J O'Neill

*New leucaena stand 12 months after planting*

Over the years, John has settled into a pattern of grazing 650 to 700 Brahman x Droughtmaster breeders on native pastures and fattening his steers after weaning on leucaena interplanted with buffel and Callide Rhodes. He markets these as Jap Ox and averages 340–370 kg carcasses with 70% 2-teeth. The steers are given HPG but no other supplements.

John was one of the first recipients of the 'leucaena bug', a special rumen bacteria that cattle need to break down the toxic mimosine found in leucena foliage. CSIRO scientist Dr Raymond Jones, who discovered the rumen bug, demonstrated that leucaena toxicity could be prevented on-farm when he inoculated John's cattle in the mid-1980s. John has only re-inoculated only once—at the end of 2005.

He values his leucaena as it has been highly productive for its entire life (now 25 years), making it a highly profitable resource as the only major cost was at planting. His original paddock was particularly good last year. He has one paddock which has declined in vigour somewhat but this paddock is close to the home and gets continuously grazed with little chance for recovery. Recent tests by UQ showed that the protein content and mineral profile of the leucaena in the oldest paddock to be excellent.

J O'Neill

*Leucaena stands still highly productive 17 years later*

John said that it could be difficult to muster steers with his close-spaced rows (spear gates are a must) and that heavy frosts in the area defoliate or kill the stems leaving little feed during the cold winters. However, frost was a positive for height control as tall trees out of the reach of cattle regrew from ground level after a heavy frost. Psyllid insects have been a problem in wet years but these had not occurred over the past three summers.

# 2. Establishing leucaena

Leucaena is highly productive once established, and will keep providing high quality feed for decades. But establishment is not always easy, and poor establishment has long-term consequences.

IJP

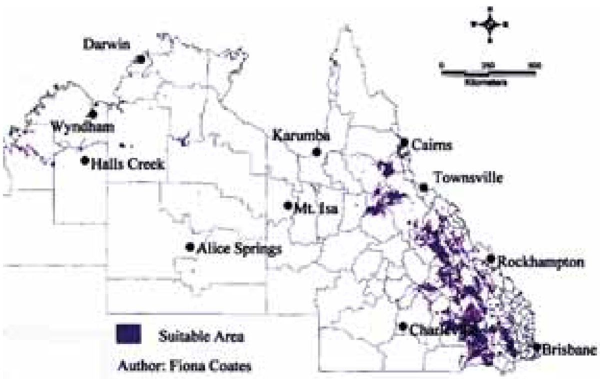
*A leucaena stand never recovers from poor establishment.*

## 2.1 Where does it grow best?

### Climate

While established leucaena can tolerate and produce leaf during dry spells and droughts, it performs best in areas that receive more than 600 mm annual rainfall. Leucaena thrives in 1,000+ mm rainfall environments in the humid tropics, but the psyllid insect causes serious damage under these more humid conditions. Most leucaena in Australia is planted in subhumid (600–800 mm rainfall) inland Queensland because psyllid numbers are lower and serious attacks less frequent. The map below shows where leucaena could be grown in northern Australia.

Leucaena is a tropical plant and is adapted to hot environments; 75% of growth occurs during

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*Areas suitable for growing leucaena in northern Australia based on soil type and rainfall (600–800 mm)*

the warmer summer months in subtropical Queensland. Growth slows when daily maximum temperatures fall below 25°C in autumn, and stops when minimum temperatures fall below 10°C.

Soil temperatures need to be above 18°C for leucaena seed to germinate rapidly. Frost can kill seedlings of all cultivars outright, while all established plants are susceptible to damage. Mild frosts (0 to –3°C) result in leaf drop and severe frosts (below –3°C) kill above-ground stems down to ground level. However, frosted plants grow vigorously from the root crown in spring with

IJP

*Leucaena on lower slope (foreground) is frosted while plants further up are still green.*

adequate soil moisture.

If part of a leucaena paddock is susceptible to frost, the whole paddock should be grazed heavily before the first frost. Cattle actively seek the lush, young regrowth on frosted leucaena, and plants in the frosted area can be severely weakened if cattle concentrate on the new growth before the plants have fully recovered. These areas may need to be fenced and managed separately.

### Climate

- Annual rainfall over 600 mm per year.
- Psyllids worse when rainfall over 800 mm per year.
- Over 75% of growth in summer months when maximum temperatures over 25°C.
- All varieties susceptible to frost, but mature plants not killed.
- Regular frosting with heavy grazing will weaken plants.


IJP


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UQ

*Aerial parts of all leucaena cultivars are killed by frost (above and opposite page). Seedlings are killed but mature plants grow vigorously from the base in spring with adequate moisture (left).*

## Soil type

Leucaena grows best on deep, fertile, well-drained neutral to alkaline soils; deep soils allow the plants to exploit subsoil nutrients and moisture below two metres. It needs moderately fertile soils of pH higher than 5.5 and with good levels of phosphorus, sulphur and calcium to maximise growth and nitrogen fixation. Leucaena cannot tolerate prolonged waterlogging, especially as a seedling.

Leucaena should be planted on the best soil types on the property. It is well suited to the scrub, brigalow and downs soils of central Queensland, the red volcanic soils of the Burnett, the basalt soils in North Queensland and any fertile alluvial soil, but it can be grown on deeper duplex and loamy soils.

Leucaena will not grow well on the shallow, infertile duplex soils typically under native pasture or on strongly acidic soils. Although nutrient deficiencies and low pH can be overcome by applying fertiliser or lime, shallow rooting depth and low soil moisture availability will limit growth on these soils.

### Soils for leucaena

- Best on deep, fertile, well-drained neutral to alkaline soils.
- Suited to brigalow and scrub soils, downs country of CQ, basalt soils of NQ, red volcanic soils of Burnett, deep, fertile alluvial soils.
- Deep roots can exploit moisture and nutrients in subsoil.
- Growth limited in shallow soils.
- pH above 5.5, P above 15 ppm, S above 5 ppm $SO_4$.
- No prolonged water-logging.

## 2.2 Paddock selection and planning

Graziers should consider a number of factors when selecting where to plant leucaena. Where possible:

- select deep, well-drained and fertile soils
- avoid cold hollows or flats that frost
- fence frost-prone areas within a paddock from frost-free areas and manage differently in spring
- on sloping land, place hedgerows on the contour or in straight rows across the general slope to minimise erosion
- straight rows are easier to muster as cattle can be seen up the rows
- plant a minimum of 40 ha (100 acres) to minimise the damage caused by hares, rabbits, kangaroos, wallabies, emus, ducks, locusts and other animals. Small 'trial' blocks of leucaena can be completely destroyed by predation.

The recommendations of the Code of Practice aim to minimise the risk of leucaena plantings becoming environmental weeds (see Appendix 2 for more detailed description).

Keep plantings away from watercourses such as creek banks and flood ways, boundary fences or other areas where livestock are excluded.

Surround the leucaena with 'buffers' of grass pastures to prevent seedlings from escaping.

## 2.3 Cultivar selection

Four commercial leucaena varieties have been released for forage production in Australia over the last 40 years, but only three remain on the market. The naturalised 'common' type found in many coastal areas of tropical Australia should not be used for forage production.

### 'Common' type

'Common' leucaena (species *Leucaena leucocephala* subspecies *leucocephala*) was introduced to Australia from Papua New Guinea and the Pacific Islands more than 100 years ago.

It has become naturalised in small disturbed areas along the coast from northern NSW to north-western Western Australia. 'Common' leucaena is not very productive, sets masses of seed and is susceptible to psyllid damage under the coastal climate.

S. Smith

*Leucaena grows and produces best on land that could be classed as cropping country—deep, fertile soils without waterlogging.*

'Common' leucaena is not recommended for commercial use for cattle production and, being classified as an environmental weed, should be eradicated.

## Commercial cultivars

All commercial leucaena cultivars are of species *Leucaena leucocephala* subspecies *glabrata*, and are more vigorous and productive.

**cv. Peru.** Argentinean botanists first collected seed of this variety from Peru. It was tested and released as a cultivar in Australia by the CSIRO in 1962, and is still commercially available. Peru's more shrubby growth with good basal branching produces high dry matter and protein yields, but it is highly susceptible to the psyllid insect.

**cv. Cunningham.** CSIRO researchers crossed cv. Peru with another variety from Guatemala, and released it as cv. Cunningham in 1976. Cunningham is a good grazing plant being multi-branched and bushy. It is taller than Peru, and produces more forage. It is susceptible to frost and psyllid damage. Cunningham is a prolific seed producer.

**cv. Tarramba.** Tarramba was bred by the University of Hawaii and was released in Australia under Plant Breeders' Rights by The University of Queensland, the University of Hawaii, the Queensland DPI&F and the CSIRO in 1994. Tarramba is more arboreal (tree-like) and needs more frequent height management than Peru or Cunningham, but is more vigorous, has better tolerance of cool conditions and keeps growing under psyllid attack. It is also a less prolific seed producer. More vigorous seedling growth gives rapid establishment and reduces risk of failure due to weed competition or insect attack. Frost susceptibility is similar to that of Cunningham and Peru.

## Which cultivar?

Consider the following factors when selecting which cultivar to plant:

### Your climate

Tarramba's cool tolerance can give an advantage in more southern areas making establishment (later summer/autumn plantings) more flexible and giving more rapid recovery in spring following frost damage in winter. Its more vigorous recovery after psyllid damage is an advantage in humid areas with more than 800 mm rainfall.

UQ

*Vigour, plant structure and height of cv. Cunningham (left), Tarramba (centre) and KX2 (right) in trials in Papua New Guinea.*

### Management requirements

Tarramba's vigorous and tree-like growth habit means that it can quickly grow beyond the reach of grazing cattle. Even when grown in double rows, Tarramba will need some form of height management at least once during its productive life depending on the environment and grazing management. This might occur by crash grazing with adult cattle, through frost damage or mechanical treatment, after which vigorous shoot growth will form a more bushy hedge.

| Attribute | Peru | Cunningham | Tarramba | KX2 hybrid |
|---|---|---|---|---|
| Species | *L. leucocephala ssp. glabrata* | *L. leucocephala ssp. glabrata* | *L. leucocephala ssp. glabrata* | *L. pallida x L. leucocephala ssp. glabrata* |
| Forage yield | moderate | high | high | very high |
| Forage quality | very high | very high | very high | high |
| Psyllid resistance | low | low | low/moderate | high |
| Growth after psyllid attack | slow | slow | moderate | rapid |
| Frost resistance | poor | poor | poor | poor |
| Growth after frost damage | slow | slow | moderate | rapid |
| Establishment | slow | slow | moderate | rapid |
| Form | branching | branching | arboreal | arboreal |
| Cutting management | rare | rare | occasional | frequent |

## Future leucaenas

### Psyllid-resistant hybrid

The University of Queensland is carrying out a breeding program to produce a psyllid-resistant hybrid leucaena for northern Australia.

The breeding program is based upon an inter-specific hybrid between *L. pallida* and *L. leucocephala*. It aims to produce a psyllid-resistant and vigorous plant, with greater cool tolerance (but not frost tolerance) than existing cultivars. As such, it will be well suited to all current leucaena growing areas and also to humid coastal areas (with their high psyllid pressure) and to cooler subtropical areas where it will grow better in autumn and spring with adequate moisture. The project is coordinated by The Leucaena Network and funded by Meat & Livestock Australia's (MLA) Northern Beef Program. The breeding program will not be completed until 2008, and seed is unlikely to be commercially available before 2010.

### *Leucaena collinsii*

*Leucaena collinsii* originates from Mexico and Guatemala, and is best suited to hot, wet, tropical environments. It is very resistant to psyllids, produces high quality forage and is a bushy, well-branched shrub. *Leucaena collinsii* may be developed as a cultivar for the wet tropics (with more than 1,500 mm rainfall), and for irrigation in coastal areas blighted by the psyllid. It may have a role in intensive beef production systems as an alternative to sugar cane production. Preliminary grazing trials in Papua New Guinea showed excellent liveweight gains in cattle.

### Sterile *L. leucocephala*

A potentially male-sterile line of cv. Peru is being investigated. If truly sterile, male-sterile lines of Peru, Cunningham and Tarramba could be developed which would set little seed, thereby significantly reducing the environmental weed risk of leucaena plantings. A sterile line might also produce more forage as energy is not diverted to seed production. This male-sterility technology could also be used to generate new hybrid leucaena varieties for forage and timber production.

## Seed price

The price of seed varies considerably between varieties. Tarramba seed is more expensive as the cultivar is a less prolific seeder, and is covered by Plant Breeder's Rights. Approximate seed prices in early 2006 were: Tarramba ($40/kg), Cunningham ($20–25/kg) and Peru ($15/kg).

Seed can be purchased from:

Heritage Seeds Pty Ltd (statewide)
for Cunningham and Peru.

Leucseeds Pty Ltd (Banana) for
Tarramba, Cunningham and Peru.

Queensland Agricultural Seeds Pty Ltd
(Toowoomba) for Cunningham.

Southedge Seeds Pty Ltd (Mareeba)
for Cunningham and Peru.

Direct from graziers/seed producers —
Cunningham and Peru but check seed quality.

## Seed quality

Your seed must be of high quality. Bruchid beetles can infest 90% of unprotected seed crops and destroy ripening leucaena seed before it is harvested. Seed crops should be treated in the paddock and fumigated post-harvest to be bruchid-free. It should also be free of weed seeds, have a recent harvest date and have been stored under dry, cool conditions. All seed sold should have a germination test.

### Seed quality

Look for:

- low bruchid damage (small holes in seed)
- low weed seed contamination
- recent harvest date and storage conditions
- need for further scarification
- high viability (germination test)

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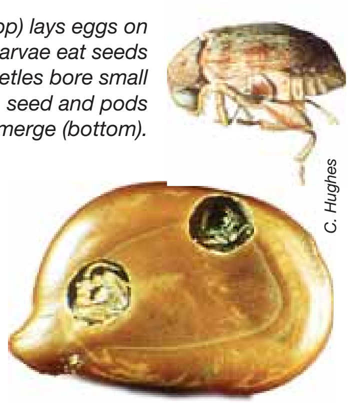
Leucaena seed pods (top) being harvested from a twin-row stand (bottom)

*Bruchid beetle (top) lays eggs on leucaena pods. Larvae eat seeds (middle). Adult beetles bore small round holes in seed and pods when they emerge (bottom).*



C. Hughes

UQ

## 2.4 Seed treatment

### Seed scarification

Seed of many legumes is often scarified to break dormancy and allow germination. Seed dormancy is a survival mechanism; it increases the chances of some seedlings surviving by preventing all seed from germinating at once. However, scarified seed germinates quickly and, under ideal planting conditions, is easier to manage than a patchy, staggered strike.

Leucaena's seed dormancy is due to its hard waterproof seed coat; this must be breached to allow water to reach the embryo and start the germination process. More than 90% of fresh leucaena seed may be dormant without scarification and can survive for more than 5 years in the soil.

#### Methods of scarifying seed

Several methods have been used to break the waterproof seed coat of leucaena.

The coat of leucaena seed has been ruptured by immersing seed in hot water (boiling for 5 seconds or 80°C for 4 minutes), but this method can be unreliable. Seed coat strength can depend on the age of the seed, the variety and the environmental conditions under which it was grown.

Mechanical scarification, in which the seed is physically damaged is the best way to overcome these problems. With proper calibration, mechanical scarification gives a more uniform strike, faster germination and emergence, and greater seedling vigour. Most seed producers now sell mechanically scarified seed, and some seed merchants will mechanically scarify home-grown seed for a small fee.

#### Handling scarified seed

Scarified seed does not retain its viability as long as unscarified seed because moisture from the atmosphere can enter; four months is the maximum when stored under humid conditions. Some seed producers store their scarified seed in an air conditioned environment of mild temperature (below 20°C) and low humidity (less than 30% relative humidity) and sell it in airtight drums. Normally, seed should be scarified immediately before planting.

Some growers have soaked scarified seed in water for a few hours just before planting to further speed up germination and emergence. This is not recommended as waterlogging will rot seed and the soft seed can easily be damaged (killed) during planting with mechanical seeders.

#### *Rhizobium* inoculation

The productivity of leucaena stands depends upon efficient nitrogen fixation. Most legumes form a symbiotic (mutually beneficial) relationship with *Rhizobium* bacteria—the plant provides the bacteria with energy and the bacteria fix atmospheric nitrogen (N) that the plant uses for protein production. These bacteria infect the root hairs and form small nodules.

Healthy leucaena pastures can fix 75–150 kg N/ha each year (equivalent to 160–325 kg urea/ha), and this is cycled to the companion grasses.

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*Grass without legume on left; grass with nitrogen fixed by leucaena on right.*

### Inoculation with *Rhizobium* bacteria

- Ensures the correct type of *Rhizobium* for leucaena.
- *Rhizobium* bacteria fix atmospheric N for plant to make protein.
- Leucaena must fix N to sustain long-term productivity of the pasture.
- Can fix over 75 kg N/ha/year, equivalent to more than 150 kg urea/ha/year.

As the bacteria use molybdenum (Mo) in the fixation process, and the plant uses phosphorus (P) to grow and sulphur (S) to make protein, leucaena needs these elements in adequate concentrations to ensure high levels of N fixation. Molybdenised superphosphate is an adequate source of Mo, P and S if your soil is deficient in these essential nutrients.

## Types of inoculum

Native *Rhizobium* usually present in the soil are unlikely to form effective nodules with leucaena, and will fix little, if any, nitrogen. Effective nodules have an orange-pink-red colour inside when cut whereas ineffective nodules are a pale pasty green, but it can be difficult to find nodules on leucaena roots in the field as they usually fall off as the root is being dug out.


UQ

*Pink nodules on roots of leucaena are healthy and actively fixing nitrogen.*

Leucaena has a specific *Rhizobium* requirement using strain CB3126 (also recommended for *Desmanthus*). The commercial Nodulaid 100® inoculum is made up of moist black peat and *Rhizobium* bacteria. Some brands contain pre-mixed adhesives such as Celstik®. Packets of inoculum should be stored in a domestic fridge; each packet has an expiry date as old packets lose viability.

Inoculum quality is controlled by the Australian Legume Inoculants Research Unit; inoculum is usually provided with the seed at purchase by the seed merchant or producer.

UQ

*Packet of commercial inoculant with* Rhizobium *strain specific to leucaena (and desmanthus).*

UQ

*Store inoculant in a fridge and check the expiry date.*

### Leucaena needs specific *Rhizobium*

- Nodules formed with native bacteria are ineffective.
- Special strains have been identified and cultured (CB3126).
- Commercially available from seed suppliers.
- Refrigerate and check use-by date.

## Applying the inoculum

Instructions are included with the inoculum packet. It can be applied in the following ways:

### Slurry inoculation of seed

Mix inoculum powder at the recommended rate of one 250 g packet of inoculum per 100 kg of seed in one litre of clean water until thoroughly dissolved.

### Don't kill the *Rhizobium*

*Rhizobium* are sensitive to:

- drying out
- heat
- sunlight
- fertilisers and agrochemicals

Inoculate seed immediately before planting.

Extra sticker, such as milk or 5 g methyl cellulose, can be added to hold the inoculum to the seed. Within 12 hours, the prepared slurry should be mixed through the scarified seed in a clean cement mixer. The wet seed should be dried in the mixer or in a cool shady place (not in the sun) and planted the same day if possible—but certainly within three days.

### Lime pelleting

Lime pelleting is rarely necessary in fertile alkaline soils, but can prevent direct contact between the bacteria and acidic fertilisers such as superphosphate. However, fertiliser is best applied through the fertiliser box on the drill, and banded just below and to the side of the seed.

To pellet 100 kg seed, dissolve 1.5% methyl cellulose powder solution in 1 L of water, mix in 250 g of peat inoculum and evenly coat the seed in a cement mixer. Add 12.5 kg of very fine lime (use microfine, omyacarb or plasterer's whiting—**not quicklime or builders lime**) and mix for 1-3 minutes.

The seed should be evenly covered in lime and the pellet should be hard enough to roll lightly between the fingers without disintegrating. To make a stronger outer coat, the pelleted seed can be sprayed with a 1:1 mixture of PVA wood glue and water while rolling in the drum. Dry as for slurry inoculation.

Sow pelleted seed within 24 hours, or store below 15°C for up to 7 days.

### Slurry inoculation to soil at planting

*Rhizobium* can be applied at planting by water injection to the soil directly around the seed by diluting the inoculum in large volumes of water.

### Post-planting inoculation

*Rhizobium* inoculum has been applied to established seedlings. The peat inoculum is mixed into water and then diluted, eg to 100 L, and applied in a jet below the soil or litter surface to the base of the plant. The spray rig must be clean as any pesticide residues may kill the bacteria, as will direct sunlight, high temperatures and drying out. This application is best in the late afternoon during or just before rain or irrigation to help the inoculum percolate down to the plant roots.

Another approach is to inject the diluted inoculum below and behind a scuffler tine immediately beside the seedlings during mechanical weed control early in establishment.

Post-planting inoculation is more risky and expensive than applying *Rhizobium* to seed at planting.

Seed should be treated with an insecticide that is not toxic to *Rhizobium*. Chlorpyrifos (eg Lorsban®), in powder form, provides effective control of insect pests and reduces the viability of *Rhizobium* only slightly (liquid-based formulations of Lorsban® using xylene are particularly toxic to *Rhizobium*). The use of new insecticides (eg Cosmos®) on inoculated seed needs further evaluation.

Direct contact with fertiliser will also kill the bacteria. Fertiliser must be placed well below and to the side of the inoculated seed or lime pelleting used to protect the inoculum if seed is placed in contact with fertiliser.

### Applying *Rhizobium* inoculant

1. Applying at planting

- slurry inoculation – quick and easy
- lime pelleting – more complicated
- water injection – mix inoculum into water

2. Applying after planting

- spray into soil with adequate water at base of seedlings/shrubs
- less efficient use of inoculum

## 2.5 Land preparation

Leucaena seedlings have slow shoot growth, initially putting most energy into root development. This slow growth makes them particularly susceptible to competition for water and nutrients from other plants and to insect and wildlife predation.

**Leucaena seedlings are susceptible to weed and grass competition.**

Successful land preparation must:

- maximise soil moisture
- physically prepare a seed bed
- minimise weed competition

### Storing moisture

The paddock should be fallowed, using repeated cultivation or herbicide application to kill weeds and store soil moisture. Establishment is most reliable with a full profile of soil moisture as seedlings can access this moisture as their root systems develop, reducing their dependence on follow-up rain. Many growers aim to store at least 1 m of soil moisture (equivalent to 250 mm rainfall) before planting.

But fallowing can lead to ‘long fallow disorder’, which causes phosphorus deficiency in the leucaena seedlings. Clean fallowing for longer than 12 months can reduce populations of VAM fungi, which the leucaena seedlings need to improve uptake of phosphorus. This condition can seriously slow leucaena establishment with the weakened seedlings more susceptible to weed competition. As leucaena is very sensitive to phosphorus deficiency, starter phosphorus fertiliser at planting can help to compensate for the low VAM activity.

Once the pasture is established, organic matter cycling in the soil sustains a healthy population of VAM fungi.

**Land preparation**

- Fallowing is essential to accumulate a full profile of soil moisture.
- Long fallows may deplete beneficial soil VAM fungi – starter P fertiliser may be needed.
- Deep rip (50+ cm ) along rows if needed.
- Prepare a fine uniform seed bed:
  – good soil–seed contact for germination
  – fine tilth required for herbicides.


*Check soil moisture with a probe before planning to plant.*

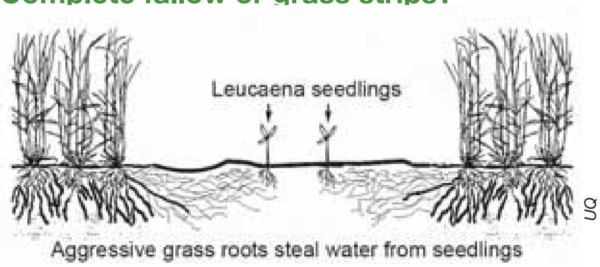
### Fine seedbeds

A relatively uniform, fine seedbed will provide the good contact between soil and seed needed for successful germination, and will improve the efficiency of soil-applied pre-emergent herbicides such as Spinnaker®.

Planting into old grass pasture will require a significant effort to break up clods and grass sods while old cropping land may need deep ripping to break up compacted layers in the subsoil and so increase the rooting depth of leucaena.

### Competition from grass and weeds

#### Complete fallow or grass strips?




*Leucaena can sometimes be established into cultivated strips but the grass will grow back quickly.*

A complete fallow (cultivated or sprayed out) gives the most reliable establishment. Sometimes retaining narrow grass strips in the inter-row can be justified to prevent soil erosion and ensure that the grass re-establishes between the leucaena rows. For example, it is difficult to establish grass into the downs soils of central Queensland, and the narrow strips act as seeding nurseries. However, leaving grass strips may reduce the total soil moisture available to leucaena by 70–80% compared to a complete fallow.

## Clean cultivation

- no weed competition
- chemical weed control
- cultivation weed control
- leucaena grows unchecked

E. Young

E. Young

## Grass strips

- lower cost of soil preparation
- less chance of erosion
- maintain grass on downs soil

*But*

- grass competes with leucaena for limited water
- grass can greatly slow time to full establishment of leucaena

CSIRO

*Bare strips must be at least 2–3 m wide and cultivated regularly to prevent grass roots encroaching on the leucaena, especially with competitive species such as buffel grass.*

DPI&F

*(Left) Leucaena rows can be planted into cultivated strips in sprayed-out native pasture.*

**Note:**
**The cultivated strips in these examples are too narrow!**

Cultivated strips on either side of the leucaena rows must be at least 2 m wide, and kept bare until the leucaena is more than 1.5 m tall to stop the grass spreading and competing with leucaena seedlings for moisture. This may take more than six months. Strips of tough grasses such as buffel can be sprayed periodically with glyphosate to reduce water use without killing the grass completely. Spray must not drift onto the glyphosate-sensitive leucaena.

#### Zero till

The major advantage of a fully cultivated seedbed is that it kills established and emerging weeds while creating a fine tilth for good soil–seed contact. The downside is that significant soil water is lost at each cultivation. Zero till (ZT) farming will preserve this scarce water and reduce erosion losses.

Leucaena can be planted ZT into wheat stubble in late summer. The stubble captures early to mid-summer rainfall to recharge the soil profile, prevents soil erosion and suppresses weeds. Late planting avoids heatwave conditions. Planting leucaena ZT uses similar techniques to planting sorghum ZT.

Complete weed control during establishment is vital and can be maintained by application of the residual herbicide Spinnaker®—with or without other knock-down herbicides. When herbicide is applied over the leucaena row at planting or in a later pre-emergent operation, the sprayed strips should be at least 4 m wide (see Section 2.7).

## 2.6 Planting

### Planters

A good leucaena planter needs an accurate seed metering system, good depth control and dual press wheels.

Planters can be single or twin row. The planter may need a coulter in front to cut or displace stubble, followed by a tine or disc opener mounted on a parallelogram. This allows the seed to be accurately placed into moist soil at the minimum depth that ensures the seed remains wet for seven days. Twin press wheels are used to press both sides (not above) of the seed for good soil–seed contact. *Rhizobium* inoculant can be applied by water injection at planting.

A fertiliser box with its own delivery tube and tine may be needed for some soils.

One seed should be dropped every 5–10 cm. Planting too deep stops the fragile emerging seedlings from reaching the surface. Shallow plantings often result in poor and erratic germination as partially germinated seed will die in dry soil.

The soil on either side of the seed row should be compacted with side press wheels as single press wheels over the seed tend to cause crusting and sealing of the surface. The ridge formed by twin press wheels should be smoothed off (often by a wire brush or chain) to maintain accurate planting depth. A range of dedicated leucaena planters is available from machinery companies while other growers have modified existing machinery (see next page).

### Row spacing

The recommended row spacings for dryland planting in the subhumid zone are twin rows (usually 50–100 cm apart) at 6–8 m centres or single rows 5 m apart.

The advantages of twin rows are:

- a more even plant stand as gaps in one row are compensated by plants in the adjacent row
- competition between the rows limits the height of the leucaena and improves the accessibility of forage to cattle.

Row spacings have ranged from 3 m to 10 m depending on typical local rainfall and on the planters and weed control equipment available.

Narrow row spacing (3 m or less), and associated shading and high grazing pressure, make it difficult to maintain a strong grass sward, and is no longer recommended. Wider rows, moderate stocking rates and rotational grazing aid the persistence of native bluegrasses in central Queensland. However, with wide row spacings, competitive grasses such as buffel may use most of the rainfall.

*IJP*

*UQ*

*IJP*

*UQ*

*IJP*

*A. Richardson*

*Some leucaena seed planters are manufactured specifically, others farm-made. Note the parallelogram frames for even planting depth, precision feed, various configurations of twin press-wheels and soil-smoothing devices.*

### Planting time

The most critical time for leucaena establishment is at planting and the few weeks after emergence. November to January is the preferred period for planting in subtropical Queensland. There is no risk of a late frost, and rainfall is more reliable in the early growing season, as is the chance of follow-up rain in February and March. Soil temperatures should exceed 18°C but young seedlings can be burnt if they emerge in extremely hot conditions (January and February) in lighter textured soils. March planting is feasible in frost-free locations.

## Essential planting conditions

- Soil has full profile of moisture (at least 1 m).
- Soil temperatures above 18°C with no chance of frost.
- Avoid mid-summer planting (with heatwaves) on sandy soils.
- Best times are Nov–Jan (dryland) and March (irrigation).

## Planting check list

The chances of successful establishment are maximised by:

### Seed

- Having seed ready, scarified, inoculated, and treated with insecticide.

### Planting

- Planting into a full profile of soil moisture after rain or irrigation
- Planting at least 2 kg seed/ha or 1 seed every 5–10 cm in the row in twin rows 6 m apart.
- Keeping a uniform planting depth at 3–5 cm for dryland plantings. Place seed just deep enough to ensure the soil will still be wet one week after planting.

### Fertiliser

Fertiliser is seldom used on good soils but if soil phosphorus levels are low, apply a small amount of 'starter' fertiliser, such as single superphosphate, starter Z or MAP, to promote rapid establishment. Aim to apply about 40 kg of P/ha to a 2 m strip across the leucaena rows. Band the fertiliser 5–7 cm below and beside the seed row.

### Weed control

- Control weeds chemically or mechanically until the young plants are at least 1.5 m high (see Section 2.7).
- Have weed control machinery and chemical supplies ready before planting takes place, and attack weeds while they are still less than 1 cm high.
- Breaking crusted soil with Yetter wheels allows seedlings to emerge and knocks out weeds. Losses of leucaena seedlings are minimal.

## If crusting is a problem –

Leucaena seedlings cannot break through the soil crust.

Break crust with light cultivation such as Yetter wheels.

UQ

*Yetter wheels over the rows break any surface crust and knock out weeds without greatly disturbing leucaena seedlings.*

## Planting leucaena

- double or single hedge-rows
- row spacing: dryland at least 6 m, irrigation at least 5 m
- seeding rate at least 2 kg/ha
  (20 seeds/m row to give 3-10 shrubs/m)
- planting depth 3-5 cm
  (need wet soil for 7 days)
- dual press-wheels
- control crusting with Yetter wheels.

## 2.7 Soil insect control

Insect pests above and below the soil surface can devastate populations of emerging leucaena seedlings.

Most above-ground insect pests can be controlled with chlorpyrifos (Lorsban®) applied in baits to the soil surface along the leucaena row. Beetle baits with a vegetable oil attractant should be applied at the rate of 2.5 kg/ha with a fertiliser spreader as soon as the first leucaena seedlings emerge and for the next 1-3 weeks until the shoot produces new 'fern' leaves. During this time, baits need to be replaced after heavy rain.

*Beetle bait recipe*

| Ingredient | Amount |
|---|---|
| Cracked grain (sorghum or barley) | 2.5 kg |
| Vegetable oil | 125 mL |
| Lorsban® (500 g/L emulsifiable concentrate (EC) liquid formulation) | 100 mL |

Subsoil insecticide treatment is also needed to protect emerging seedlings from below-ground insects such as earwigs and false wireworm larvae. An in-furrow spray with Lorsban® EC has been proposed to control insect larvae but may kill the *Rhizobium* bacteria; it is safer to treat the seed with Lorsban® dry powder formulation while inoculating.

Systemic insecticides such as Cosmos®, in which the active ingredient is absorbed into the emerging leucaena seedling, have been tested to treat the seed directly before planting. These insecticides are registered for use on commonly grown crops but not on leucaena seed; it is not known whether they will damage the *Rhizobium*.

Scarab and false wireworm beetles live in plant debris that accumulates on headlands and contour banks, emerging in the late afternoon to feed on leucaena. Removing plant debris well before planting will reduce beetle populations.

### Control insect pests

Insect control is vital for first three weeks

**Below-ground pests** – earwigs, false wireworm larvae

- Treat seed with Lorsban® dry powder

**Above-ground pests** – scarabs, earwigs, crickets, false wireworm beetles and wingless cockroaches

- Use beetle bait (Lorsban® EC)

Remove plant debris from paddock before planting.

## 2.8 Weed control

Leucaena seedlings cannot tolerate competition. All weeds must be controlled in the row and for 2 m on either side of the row. Kill weeds as soon as they germinate (under 1 cm high) and maintain complete control for 6–12 months. Leucaena growers should have their weed control strategy ready and prepared before planting.

### Mechanical options

Weeds in leucaena can be controlled using mechanical cultivators.

DPI&F

*False wireworm beetles (top left) and scarab beetles (right) eat young leucaena seedlings at ground level while false wireworm larvae (top left) eat the germinating shoots below ground.*

CHM

*All weeds must be controlled within the rows and for at least 2 metres on either side.*

Over-the-row mechanical options include a variety of hillers, scufflers and rolling cultivators (such as Yetter wheels). Inter-row cultivation using tined or off-set disc implements effectively controls grass and weeds. Leucaena seedlings respond to scuffling, which breaks their lateral (side) roots, by developing a deeper tap root that allows them to exploit subsoil moisture throughout their life.

S. Smith

*Above and below. Mechanical weed control with Yetter wheels over the rows and scufflers between.*

S. Smith

## Chemical options

Several combinations of herbicides can be used to control weeds in establishing leucaena. At present, only two selective herbicides (Spinnaker® and Fusilade Forte®) are officially registered for use on leucaena. Some chemical control options that have been successful *in trial plantings* include:

- spraying Spinnaker® over the entire area or in a band along the planting rows at planting
- spraying weed seedlings with glyphosate ***before*** leucaena emerges
- band spraying grass weeds within-row with Verdict® or Fusilade Forte®. Adding Basagran® (active ingredient bentazone) to Fusilade Forte® controlled both grass and broad-leaf weeds.

Glyphosate spray and drift will kill young leucaena seedlings. Plants over 1 m tall are less affected but can still be badly damaged. Any inter-row spraying with glyphosate is hazardous. If attempted, use an efficient shielded spray rig, coarse spray nozzles to reduce fine droplets, high water rates (at least 100 L/ha) at low pressure, slow vehicle speed and still weather conditions to minimise potential spray drift.

***Caution: Glyphosate spray or drift will kill young leucaena seedlings.***

### Spinnaker® 700 WDG

Spinnaker® 700 WDG controls most broadleaf and some grass weeds at germination and seedling stage. Spinnaker® can be applied at planting, or after planting but before emergence of leucaena. It is slightly phytotoxic on young leucaena, especially if applied with an oil, and should be used with care after leucaena seedlings have emerged.

Spinnaker® acts by providing a thin ‘blanket’ of residual herbicide on or very near the soil surface, and can prevent grasses from establishing for up to 15 months. If this protective blanket is disturbed, weed control will fail at the point of disturbance. Excessive trash on the soil surface can tieup the herbicide resulting in poor weed control.

After application, Spinnaker® needs at least 25 mm of rain on clay soils to activate it and incorporate it to a depth of 5 cm. The entire area can be sprayed, or preferably apply a band along the planting rows at planting. The addition of an oil (eg Synertrol® at 250 mL/100 L) improves the kill of emerged weeds and improves residual control; it should be used only in pre-emergent applications.

Spinnaker® was developed specifically for use on legume crops and so will not control leguminous weeds such as maloga bean, chain pea or sesbania (horse bean), which can be serious weed pests in young leucaena.

Remember the potential 15-month residual action of Spinnaker® when planning to plant improved grasses in the inter-row.

## 2.9 Companion grasses

Grasses play an important role in the sustainability of leucaena pasture systems. Leucaena is a highly efficient legume, fixing large amounts of nitrogen through the *Rhizobium* in its root nodules. Some nitrogen ends up as protein in the grazing animal's body but most returns to the soil, either through leaf-fall or animal excreta. Nitrogen-hungry grasses use the extra nitrogen to produce good quality feed (and fibre).

Without a grass to use up the nitrogen, unproductive weeds often invade the inter-row or masses of leucaena seedlings may germinate. In lighter textured soils, excess nitrogen can be leached down and result in soil acidification.

CHM

*Without a vigorous grass, masses of leucaena seedlings or nitrogen-loving weeds establish.*

A vigorous grass sward protects the ground and increases rainfall infiltration. In clean-cultivated plantings, grass is normally sown in the year after the leucaena is planted. However, in the recent dry years, it has often been difficult to get good establishment because the soil moisture has been exhausted.

UQ

*It can be difficult to establish grasses in clay soils especially in dry years when soil moisture has been exhausted.*

### Which grass?

Choose the grasses best adapted to your soils and rainfall.

**For the heavy clay downs soils** of central Queensland, the best-adapted grasses are:

Bambatsi (*Panicum coloratum* var. *makarikariense*) — can be difficult to establish and is slow to develop in its first year. But once established it is tolerant of drought and will grow in the cooler months.

Purple pigeon grass (*Setaria incrassata*) — easy to establish, but unpalatable and not recommended.

Floren bluegrass (*Dichanthium aristatum*) — well adapted to heavy clay soils, but unproven with leucaena and seed is expensive.

Queensland bluegrasses (*Dichanthium sericeum*) — well adapted and native to the downs soils. Retaining strips of bluegrass will help later spread. It is palatable but not deep-rooted. Plants are easily uprooted and do not tolerate heavy grazing.

**For the lighter, self-mulching brigalow clay soils**:

Buffel grass (*Cenchrus ciliaris*) — the main species planted with leucaena. It spreads rapidly, is drought tolerant and can handle heavy grazing pressure. But it is extremely competitive for moisture and may limit the productivity of established leucaena in dry years. Weakening the buffel grass immediately alongside the leucaena rows by cultivation or herbicide application may increase the yield of leucaena.

UQ

*Buffel is drought-tolerant and can withstand heavy grazing, but competes with leucaena for shallower soil moisture.*

**For the fertile and friable scrub soils**, there are many well adapted grass species such as:

Green panic and Gatton panic (*Panicum maximum*) — very palatable and suited to many soils. Panic pastures improve as nitrogen levels build up in the soil under leucaena. They are tolerant of shading and will grow in the leucaena hedgerows.


UQ

*Green panic responds strongly to the nitrogen fixed by leucaena.*

Rhodes grass (*Chloris gayana*) — cv. Callide is a late-flowering tall type that needs high fertility to persist; cv. Finecut is a shorter type with fine leaf and stems and will grow with less nitrogen input. Rhodes grasses are subtropical species and can provide some growth in cooler conditions.

Rhodes grass and the panics are less competitive than buffel for moisture and so may promote leucaena productivity.

**On the higher rainfall (800+ mm) coast or under irrigation,** several suitable grass species can tolerate high stocking rates in frost-free environments:

Signal grass (*Brachiaria decumbens*) cv. Basilisk — a creeping species for frost-free areas with more than 1,000 mm rainfall.

Humidicola (*Brachiaria humidicola)* cv. Tully — a very aggressive creeping grass, especially for wet soil conditions. Hard leaf is not so palatable as pangola. Good for irrigation in the wet tropics.

Pangola grass (*Digitaria eriantha*) — very productive and palatable creeping grass, can withstand heavy grazing but has to be planted from runners. Can be susceptible to virus attack in the wet tropics.

Digit grass (*Digitaria milanjiana*) cv. Jarra — well adapted to the lighter soils (sands to loams) in the high rainfall areas. Taller than pangola but can be planted from seed; resistant to pangola virus.

Rhodes grass cvv Callide, Samford, Finecut — perform well under irrigation in more subtropical areas but can be damaged by very high stocking rates.

Creeping bluegrass (*Bothriochloa insculpta*) cv. Bisset — creeping grass for clay soils of medium fertility. Fluffy seed and slow to establish.

## Establishing grass

Grass seeds need a fine seedbed to establish, and the ground in the inter-row may need extra scuffling with bare cultivation or zero till. Seed of some grasses can be spread through a fertiliser spreader but fluffy seeds such as buffel and bluegrass may need special treatment. Seed may be left on the surface to be washed in by rainfall or may be lightly covered with soil but most grasses should not be buried more than 1 cm deep.


E. Young

*Planting grass seed with a rolling drum seeder and rubber-tyred roller.*

## Winter-active legumes

Winter-active legumes such as clovers (*Trifolium* spp.), medics (*Medicago* spp.) and vetches (*Vicia* spp.) can be planted with grasses in the inter-row in subtropical regions that receive some winter rainfall. They will provide high quality feed when the leucaena has been frosted or when the leucaena and warm-season grasses are not growing because of low temperatures. These species can persist through reserves of hard seed in the soil. Vigorous growth of clovers and medics can cause bloat in cattle—unlike bloat-free leucaena. Lucerne will compete with leucaena for sub-soil moisture.

## Opportunity cropping

Crops and forages can be planted in the inter-row once the leucaena is fully established. Winter forages such as oats and rye grass can be cropped annually. This is especially attractive to irrigators seeking to improve the return on the heavy capital investment. Row spacing should reflect the cropping machinery.

Without the extra water from irrigation, any crop is going to use water that would be available to grow leucaena.

### No-grass (leucaena-only) pastures

Continued cultivation of the inter-row to keep out grasses and weeds may maximise water use efficiency and growth of the leucaena (especially for irrigators), with cattle getting access to grass in adjacent paddocks.

But reduced ground cover can increase soil erosion on sloping land, weeds can invade or leucaena seedlings establish if cultivation is not effective. There is risk of soil acidification on lighter soils and cattle eating high leucaena diets can waste protein.

Leucaena-only is not recommended in the 'Code

## 2.10 Early grazing management

Young leucaena plants must be allowed to grow vigorously and unchecked; vigorous early growth leads to strong mature shrubs.

Grazing too early:

- weakens developing seedlings
- prolongs time to full establishment
- slows recovery after grazing
- can reduce productivity for the entire life of the leucaena pasture.

Grazing too heavily leaves the plant frame small.

Once leucaena starts to flower and produce pods, leucaena stem growth and leaf production is markedly reduced as the plants put greater energy into seed production. This can happen at any time, especially with Cunningham and Peru, and will peak as the days shorten coming into winter.

### Early grazing rules

- Do not graze until plants are more than 1.5-2 m tall (6-12 months).
- Then graze lightly to stimulate branching, especially in Tarramba.
- Plant grass and leave to recover.
- Start normal grazing when plants are 3–4 m tall (15–24 months).

Light grazing when flowering is first seen will allow the plant to keep producing leaf, promote basal branching and stem thickening and reduce the environmental weed potential from excessive seeding.

IJP

*Light grazing encourages new shoots and more bushy growth (above), but plants should be allowed to reach a height of 1.5 m before grazing (below) — and this may take more than a year with poor weed control.*

CHM

### The 'show pony' effect

Leucaena often looks its best in the first two years after establishment, especially on old cultivation; after this, growth can slow. This initial period of rapid growth—the 'show pony' effect—is because the deep roots of leucaena can tap unused water and nutrients in the subsoil layers (1.5 to 5 m) below the normal rooting zone of crops and pastures. The leucaena growth slows once these resources are exhausted; light rainfall stays in the upper layers where there is strong competition from the shallow-rooted grasses.

The leucaena may not grow especially well again until heavy rainfall replenishes the moisture in the deeper soil layers.

# 3. Managing the leucaena plant

## 3.1 Mineral nutrition

If cattle are to achieve their maximum weight gains from leucaena, the plants must also be growing to their full potential. Most leucaena is planted on good soil without fertiliser and it is generally assumed that thereafter it will look after itself. This section illustrates plant nutrition problems and recommends ways to fix them to ensure continuing high levels of production.

### Plant nutrition

Plants need major nutrients and trace elements.

All plant nutrients come from the soil (although legumes can fix their own nitrogen).

Plant growth is limited by the nutrient that is most deficient.

Leucaena growth is suppressed before deficiency symptoms appear—hidden hunger.

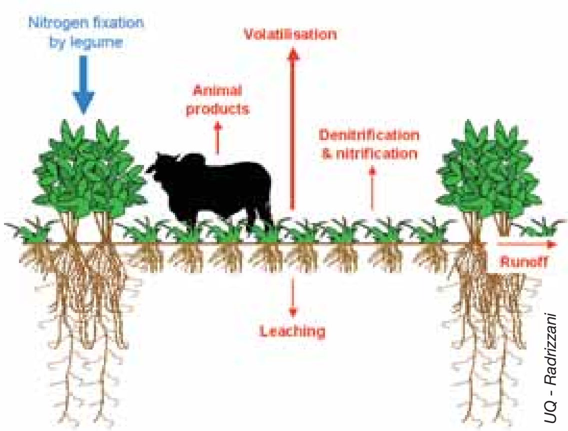
Test soil before planting and apply fertiliser.

Test plant tissue of established leucaena.

### Nitrogen

Actively growing leucaena leaf is highly nutritious and should contain 3.5–5.0% nitrogen (N)—equivalent to 21–31% crude protein.

High N concentrations in the leucaena foliage will be achieved only when the right *Rhizobium* bacteria on the leucaena roots are actively fixing




*Positive (blue) and negative (red) influences on nitrogen reserves in soil with active N fixation by leucaena.*

### Nitrogen

Young leaf should contain 3.5–5.0% N —equivalent to 21–31% crude protein.

Leaf N levels below 3.5% normally indicate ineffective N fixation.

All soils are low in N.

High N concentrations in leaf depend on *Rhizobium* bacteria actively fixing N.

atmospheric N, and this requires adequate supply of key nutrients—phosphorus, sulphur, calcium and molybdenum.

Only about 10% of the N eaten by cattle is retained in their bodies, the rest being returned to the pasture through urine and faeces. Some of this N on the ground will be lost through volatilisation, leaching and immobilisation in grass litter, but most becomes the main source of nitrogen for grass growth.

### Phosphorus

Phosphorus (P) is deficient in most Australian soils, and this has led to the widespread use of phosphate fertilisers for pasture improvement as legumes need P for protein production. However, most soils in which leucaena is grown have moderate P levels (more than 15–20 ppm), high enough for active early growth of leucaena. Some soils may need starter P at establishment, especially after a long fallow.

Leucaena pastures growing in soils marginal in P may become deficient after several years of intensive grazing.

### Phosphorus

The best leucaena soils have adequate P.

Starter P may be needed after a long fallow.

Leucaena in marginal P soils may become deficient after a few years.

Superphosphate supplies P and S in equal amounts.

## Sulphur

Sulphur (S) is vital in protein synthesis, and leucaena has a high S requirement. Along with P, S is one of the most commonly limiting nutrients of leucaena pastures in Queensland. Sulphur deficiency in plants is often linked with N deficiency.

Deficiencies are most likely to occur on basaltic soils, free-draining soils under moderate to high rainfall and where vegetation has been burned regularly.

Soils that experience pasture 'run-down' are likely to experience S deficiency because much of the S will be locked up in soil organic matter. Leucaena pastures may exhibit a similar decline in yield over time with effects becoming more obvious five years or more after establishment (see *Troubleshooting nutrient deficiencies*).

> **Sulphur**
>
> Sulphur is an essential part of protein.
>
> Sulphur deficiency can halve yields of forage.
>
> Soil S levels vary with depth and may be low deeper in the profile.
>
> Sulphur deficiency is common on soils that experience pasture run-down.

## Potassium, calcium and magnesium

Potassium (K), calcium (Ca) and magnesium (Mg) are generally in sufficient concentrations in clay and clay loam soils suitable for growing leucaena. Generally, leaf tissue Ca concentrations should be 2–2.5 times higher than Mg concentrations. High leaf concentrations of Ca can result from restricted growth due to other nutrient imbalances or physical limitations to growth.

## Micronutrients

Micronutrients are trace minerals that plants need in very small amounts. They can sometimes be limiting in the strongly alkaline soils suitable for growing leucaena.

Molybdenum (Mo) plays a special role in *Rhizobium* symbiosis and Mo deficiency may resemble N deficiency. Zinc (Zn) can be deficient on cracking clay soils. Local advice should be sought for an economic approach to overcoming deficiencies.

## Nutrient rundown in leucaena pastures

Plant nutrients can become deficient if the leucaena pastures have been intensively grazed for some years. Many leucaena plantings are now over 10–15 years old and some graziers are reporting a decline in the vigour of their aging leucaena, particularly on soils of marginal fertility—such as forest or poorer brigalow soils. Analyses of leaf samples are indicating likely P, S, K and Zn deficiencies. Graziers should have leaf analyses done on older stands. Rundown in nutrients such as P and S with time also reduces N fixation by *Rhizobium* bacteria and can result in lower N (protein) content (figure 3.1).

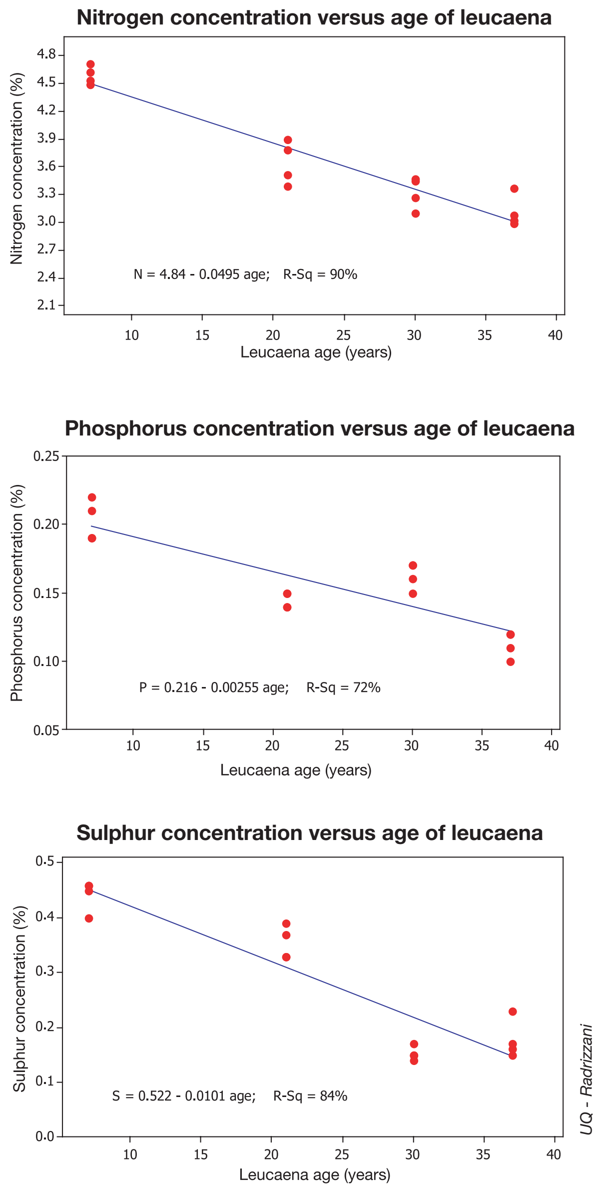



*Figure 3.1 Rundown in N (top), P (middle) and S (bottom) content of leaf tissue with increasing age of leucaena stand.*

## Troubleshooting nutrient deficiencies

Nutrient deficiencies were first suspected at the DPI&F Brian Pastures Research Station near Gayndah in the mid-1980s, but took time to confirm because soil analyses showed both P and S to be adequate at the soil surface.

However, analyses of young leaf in 2006 indicate deficiencies of P, K and S, with marginal levels of zinc and copper, in aging stands of leucaena.

*After decades of production, the leucaena at Brian Pastures Research Station was no longer vigorous.*

*Pale yellow new leaves suggest sulphur deficiency.*

Another example of diagnosis and correction of a nutrient deficiency can be given for 'Meadowbank Station' on the McBride Plateau in north Queensland. The leucaena there was growing poorly despite good soil moisture and adequate temperatures, and new foliage was pale yellow. Psyllid damage was also regularly severe. At first, poor *Rhizobium* inoculation was suspected because leaf N concentrations were low at 1.9–2.5% dry matter, but further application of inoculant had no effect.

*Pale foliage of sulphur-deficient leucaena on basalt soil on the McBride Plateau*

A complete leaf tissue nutrient analysis showed that leaf S concentration was very low. Application of sulphate of ammonia (Gran-Am®) improved growth but only for a short time. When 25 kg/ha elemental S was applied the improvement was dramatic, growth doubled and the more healthy plants were better able to tolerate psyllid insects.

## 3.2 Height management

To optimise beef production and minimise environmental concerns, leucaena hedgerows should be maintained with a dense leaf canopy within browse height. It should be prevented from seeding as excessive flowering and seed production reduce forage production.

UQ

*For good productivity, leucaena should not be allowed to grow above browse height.*

Light early grazing when leucaena exceeds 1.5 m in height (usually 9–12 months after planting) will encourage prolific branching and maximise leaf production later. Grazing pressure in subsequent years can generally be managed to maintain the hedgerows at a desirable height of 2–3 m while frost damage will control plant height in frost-prone areas.

L. Sollenberger

*Grazing pressure should be managed to keep plants between 2 and 3 metres tall.*

But some leucaena will always grow beyond browse height and will need to be cut back. A leucaena canopy above browse height may shade grasses excessively, especially in narrow row spacings, and weaken the sward.

### Controlling height of leucaena

The height of leucaena hedgerows can be controlled by:

- Planting in twin rows to reduce size of individual plants.
- Increasing the number and size of grazing animals. Large animals such as bulls can break down stems 4–5 m high after fattening steers have eaten all leaf within reach. Lactating cows, with their high nutritional need, pull down high stems to reach leaf at the tips.

UQ

*Large animals, especially lactating cows, will push down stems 4 metres tall.*

- Slashing when too many plants are beyond reach of stock or after seed harvesting. Large trees have to be cut back with a heavy duty slasher. Rough slashing which lacerates and splits stems will promote more budding and regrowth branches than a clean cut.

IJP

P. Larsen

*Slasher based on a heavy-duty Tritter (top) lacerates and splits stems, which regrow well from multiple bud sites (bottom).*

Leucaena stems after slashing (above) and subsequent regrowth (below)

## How high and when to cut

Regrowth of leucaena after cutting depends on:

- photosynthetic capacity of residual leaf
- availability of active buds
- mobilisation of carbohydrates and nutrients from remaining stems and roots
- and most importantly, soil moisture availability.

Cutting heights of 1 m or more maintain high numbers of active buds and adequate reserves of carbohydrates.

Leucaena should be cut only when there is adequate soil moisture for rapid regrowth. Trees may die if cut when the soil is waterlogged or be severely weakened if cut during drought.

### Height management

- Use large animals to break down tall stems.
- Slash if too many tall stems for cattle.
- Slash at height of more than 1 metre.
- Only cut when soil moisture is adequate for rapid regrowth.

The height of these hedgerows of leucaena cv. Peru is maintained by grazing.

# 3.3 Psyllid insects

## Damage by psyllids

The leucaena psyllid (*Heteropsylla cubana*) damages plants when both nymphs and adults feed by sucking sap from the developing shoots and young foliage. Heavy infestations defoliate the plant and stop growth. Older leaves are not directly damaged to any great extent, but can be smothered in sooty mould.

DPI&F

UQ

*Psyllids suck the sap from new shoots and leaves. Severe damage can lose several months growth. In humid coastal regions, up to 80% of production can be lost.*

Where psyllids have been active, there may be no new leaves for up to 30 cm from the stem tip, representing a loss of several weeks or even months of growth.

Quantification of the damage caused by the psyllid is difficult. When psyllids are not controlled, leucaena production in subhumid inland areas can be reduced by 20–50% and up to 50–80% in humid coastal environments.

## Options for combating psyllid

### Avoid psyllids

In Australia, most leucaena has been planted in subhumid (600–800 mm annual rainfall) areas where the frequency and severity of psyllid attack is less.

### Do nothing

Given time, environmental conditions change and the psyllids disappear. Drought and frosts lead to leaf drop and reduction in psyllid populations. Very heavy rain (or overhead irrigation) and hot, dry winds will also reduce psyllid populations. However, graziers must be prepared to lose leucaena forage production during these periods of attack.

### Spraying insecticide

The psyllid is readily killed by low doses of several insecticides. Dimethoate, a systemic insecticide, is registered for use on leucaena, and provides effective control for up to 3–4 weeks. Graziers must strictly observe the correct withholding period before grazing to ensure pesticide residues are not present in the foliage eaten by stock. Insecticide use is warranted to protect establishing leucaena and high-value seed crops.

CHM

*Leucaena trees on left are badly affected by psyllids; trees on right were sprayed with dimethoate insecticide.*

## Psyllid populations

Nymphs and adults feed on growing points.

Breed prolifically with life cycle of 10–16 days.

Populations build-up rapidly, but can be reduced by:

- heavy rainfall (overhead irrigation)
- low humidity
- hot dry winds
- frost.

## The psyllid insect

The leucaena psyllid (*Heteropsylla cubana*) is a small yellow-green insect 1–2 mm long. It is native to Central America and the Caribbean where it has presumably co-existed with leucaena for thousands of years.

C. Sorensson

Although it has been reported to occur on a few other leguminous shrubs and trees, these are not damaged to any great extent, and it is probable that the psyllid can only complete its life cycle on plants in the genus *Leucaena.*

The psyllid first became a problem on experimental plantings in Florida in 1983. From there, it spread rapidly throughout the tropics and subtropics and is now present in all areas where leucaena is grown. In Australia, following the first recording at Bowen in north Queensland in April 1986, the insects spread 800 km to Gympie within 3 months, and by mid-October reached Brisbane.

The extremely rapid rate of spread suggests that air currents (including high-level winds and cyclone activity) are largely responsible for their dispersal. It is not uncommon to find psyllids on isolated stands of leucaena.

### Life cycle

Female psyllids lay up to 400 eggs on very young shoots where they are lodged between the folds of the developing leaflets. The eggs are oval, 0.3 mm long and 0.1 mm wide; newly laid eggs are white, but turn orange or reddish brown after a day or two. Eggs hatch in 2–4 days, and through five nymphal stages, become adults 10–16 days later, depending on climatic conditions. The nymphs rapidly become mobile and congregate in large numbers on the growing points of young shoots. Populations can build up extremely rapidly, producing many generations in a year.

In the field, psyllid populations normally fluctuate widely over time. Peak numbers of nymphs tend to occur soon after rain but are affected by moisture and plant nutrient status, leucaena stand density, humidity and exposure to wind. Management that maximises forage production (ie abundant young leafy growth) greatly increases psyllid numbers.

In Queensland psyllid numbers are highest during the wet season whereas in South-east Asia they are most abundant during the early dry season at the end of the monsoon. The build-up of psyllid populations is reduced by periods of sustained intense rain (or irrigation) or one or two days of hot, dry (35+°C) temperatures. Frost will kill psyllids (but also the leucaena).

### Grazing management

Some cattlemen graze their leucaena heavily as soon as the psyllid populations build up in an attempt to remove their feed source and break the population cycle. However, psyllids will generally remain in high numbers as the plants regrow.

### Biological control

In any environment, there will be some predators that feed on one or more stages of the life cycle of the psyllid; it has been controlled effectively in its native habitat by natural predators. The larvae of the common ladybird beetles are good predators but do not seem to be able to keep psyllid populations under control in commercial leucaena pastures.

IJP

*Ladybird beetles attack psyllids but cannot breed fast enough to keep up with an explosion in the psyllid population.*

Other useful predators include *Curinus coeruleus* (a beetle that attacks psyllid larvae) and *Psyllaephagus yaseeni* (a wasp that attacks the eggs of the psyllid), but these have not yet been released in Australia.

The introduction of biological control agents to Australia is a complex procedure because of their possible interactions with other species. For example, one Australian biological control program is seeking to control the tropical weed *Mimosa pigra* through the introduction of a host-specific psyllid of the genus *Heteropsylla.* Introducing the *Psyllaephagus* wasp to control the leucaena psyllid could negate this program.

### Selection and breeding resistant varieties

There are three possible approaches:

- Use of moderately psyllid-tolerant varieties of *L. leucocephala.* Tolerance of psyllids exists with varieties such as K584 and Tarramba showing some ability to grow slowly under psyllid pressure. These cultivars appear to have long-lived leaves and the capacity to produce many new branches when growing tips are damaged.
- Using other psyllid-resistant *Leucaena* species. Of the available species, *L. diversifolia* and *L. pallida* are the most promising. There is considerable variation within these species, and not all lines have the same degree of resistance. However, these species do not appear to be high-quality animal feed. *L. collinsii* is both highly resistant and has good nutitrional value. It shows potential as a forage for wet tropical areas.
- Breeding interspecific *Leucaena* hybrids. Many species of the genus *Leucaena* are resistant to psyllids, and some can be hybridised with *L. leucocephala*. Meat & Livestock Australia (MLA) is currently supporting the development of an interspecific hybrid between *L. pallida* and *L. leucocephala* due for release in 2010.

## Psyllid resistance

Little variation in resistance within commercial cultivars — all are susceptible.

More vigorous Tarramba recovers faster.

Good resistance within other species eg *L. collinsii* for wet tropics

Psyllid-resistant hybrids are being developed – due for release in 2010.

UQ - G. Kirchhof

*Psyllids ravaging the shoots of* Leucaena leucocephala *(above) but not those of the adjacent plants of* L. pallida *(right).*
*MLA is currently supporting the breeding and selection of a hybrid between these two species that will be palatable and productive to cattle but not to the psyllid insect.*

UQ - G. Kirchhof

## 3.4 Irrigating leucaena

The use of irrigation can have a large impact on the productivity of leucaena systems. Higher productivity allows increased stocking rates, and improved reliability allows more accurate budgeting of costs and returns.

The main information on irrigating leucaena comes from the Ord River Irrigation Area in WA, where leucaena has been grown experimentally over the past 30 years, and commercially for 20 years. The system in the Ord is based on flood irrigation of leucaena grown in bays on raised beds (much of this leucaena has now been ploughed out in favour of crops such as sugar cane).

A number of graziers have established irrigated systems in Queensland, predominantly using centre-pivot and flood irrigation.

Some of the technologies discussed earlier for dry-land leucaena do not necessarily apply to irrigated leucaena; different establishment and management issues may be appropriate but knowledge is far from complete.

UQ

*Irrigated leucaena/grass pastures in the Ord River floodplain. Rows were originally planted at 1.8-2.7 m apart. Although spacing was later increased to 3.6 m, rows were still found to be too close together.*

### Establishing irrigated leucaena

Planning an irrigated leucaena pasture system is critical. The layout of paddocks must consider efficient water delivery and animal management; cattle may need access to adjacent 'dry' pastures when paddocks are waterlogged and to provide extra grass forage to complement the high leucaena production.

In northern Queensland, planting in the dry season (frost and temperature permitting) will enable stricter control of the amount of water applied and avoid waterlogging problems that may occur when heavy rain follows irrigation. On loamy soils, planting in cool seasons prevents the seedlings getting burnt by high soil surface temperatures in summer.

In the Ord, leucaena was originally planted in rows that were too close together (1.8–3.6 m). Narrow row spacings (even at 3.6 m) prevented the establishment of a productive inter-row grass necessary to provide fibre to the diets of cattle, and to use the recycled nitrogen to prevent soil acidity. A strong grass sward also reduces the incidence of cattle bogging in wet conditions. In Queensland, row spacings over 5 m, similar to dryland leucaena, have been used to promote stronger grass growth.

Higher seeding rates of leucaena (up to 4 kg/ha) are used to achieve dense plant populations within spaced double leucaena rows. Final stands with plants spaced approximately 15 cm apart produce many fine stems and a high proportion of leaf. Seed

CSIRO

*Overhead irrigation increases the reliability of establishment and of productivity, but increases capital and recurrent costs.*

can be planted at a shallower depth as irrigation is used to keep the surface soil moist.

Soil insect and weed management are still of prime importance during establishment. Effective weed control improves water use efficiency. The same weed control chemicals are used as for rain-grown leucaena although the effectiveness of pre-emergent herbicides may be reduced if overhead irrigation leaches the active ingredients from the soil profile. The same mechanical methods of weed control can also be used.

Inter-row grass species such as pangola or Tully humidicola have been used in the Ord whereas bambatsi, Callide and Finecut Rhodes, and Gatton panic have been used successfully in Queensland. The selected species must be able to tolerate heavy grazing and soil compaction under high stocking rates. Grass establishment practices are similar to those for dryland leucaena.

Due to the high levels of plant growth and the removal of large amounts of soil nutrients in animal liveweight, soil fertility (P, S, K, Zn or Mo) should be monitored every 2 years. Regular application of fertilisers should be economically viable with the high level of productivity. In the Ord, 200 kg/ha DAP (36 kg/ha N and 40 kg/ha P) was applied as a starter fertiliser at planting. Growers tried to keep available soil phosphorus levels at 20 ppm (naturally 8–22 ppm) by applying 200 kg/ha triple superphosphate (39 kg/ha P) with added zinc and sulphur every second year.

## Water management

The Ord system had abundant quantities of cheap water available. In the past, 80–100 mm irrigation were provided each fortnight, giving an annual irrigation usage of 25–30 ML/ha. Combined with the annual rainfall of 660 mm, this was equivalent to 3,660 mm per year and was higher than the annual evaporation (2,900 mm/year). This was not efficient use of water, and the saturated soil profile limited root development of the leucaena to a depth of only 60 cm.

Irrigation management in Queensland needs good economic returns per megalitre of water through strategic water application. Irrigators use about 4 ML/ha/year over 4–5 applications. Spray systems give better and more even water application than flood irrigation and reduce the need for land levelling. Both pivots and guns are used to deliver water and even hand sets have been used during establishment.

In Queensland, furrows for flood irrigation vary in length from 850 to 2,000 m, with a maximum of 1,000 m now recommended. Furrows can be damaged by cattle tracks that divert water and cause uneven watering. Grass in the furrows also slows the flow of water.

*Water furrows can be damaged by cattle tracks and water flow slowed by heavy grass growth.*

Leucaena is sensitive to waterlogging and will often die where surface water fails to drain rapidly. Flood-irrigated paddocks need laser-levelling and may require more than one levelling operation as settling commonly occurs where fill is deposited. Planting an annual crop between the first and second levelling operations will give best results. Length of irrigation run must match soil type so that blocks can be wet up over a 12–24 hour period. Tail drains and furrows should be regularly maintained to distribute water evenly and to remove excess water rapidly out of the paddock.

In the Ord, irrigation is applied in bays 40–50 m wide or in furrows between raised beds. Bays have the advantage of being simple and rapid to irrigate using check gates, but are also more prone to poor surface drainage. Raised beds should be at least 20–30 cm in height and the bed structure maintained as the soil settles through irrigation and trampling by cattle. Low beds can slump to such an extent that the integrity of the furrows is lost, making siphon irrigation difficult.

## Height management in the Ord

Height control of vigorous leucaena may need to be more regular in irrigated pastures unless rotational grazing systems using high stocking rates for short periods can keep leucaena within grazing height.

Leucaena in the Ord is normally slashed every 18–24 months to a height of 50–70 cm to keep foliage within the reach of yearling cattle. This cutting has been done with a conventional rotary slasher, a large-diameter circular saw or a gang of saws. As slashers smash and split the leucaena stems severely, saws are preferred (unlike for dryland leucaena in Queensland).

Smashing the stem of plants growing on wet soil has resulted in root rots leading to plant death. 'Leucaena dieback' caused by a crown rot (*Pirex subvinosus*) became common in stands of irrigated leucaena in the Ord in the late 1990s, and spread from localised infection points at the rate of about 1 m a year.

UQ

*'Leucaena dieback' on wet heavy soils*

Management factors that proved partially successful in containing the spread of *Pirex* included:

- Limiting heavy grazing during the wet season and immediately after irrigation.
- Avoiding over-watering.
- Limiting the duration of waterlogging following irrigation through accurate levelling, installing effective tail drains, and managing slope and length of run to match soil type and pump capacity.
- Minimising damage to crown and stem during slashing by using a cutting implement that gives a clean cut rather than shattering the stem. Not slashing when the ground is saturated as waterlogging promotes the disease.

*Pirex* may not become a management issue for irrigated leucaena in Queensland as the levels of water use will be much lower than in the Ord.

IJP

*Leucaena slashed too low with a conventional rotary slasher when waterlogged may result in 'leucaena dieback'.*

UQ

*Low slashing in wet soils encourages the* Pirex *fungal disease and 'leucaena dieback'.*

## Grazing management

In the Ord, stocking rates of 6.5 head/ha are common with annual liveweight gains of 1,500 kg/ha, or 200–240 kg/head. The best weight gains result when leucaena forage allowance averages 2.0 kg/head/day over the grazing period. Stock are rotationally grazed, with grazing periods ranging from 2–10 days. Rotational grazing is important to maintain the vigour and productivity of the grass.

In Queensland, recommended stocking rates are lower at 4 head/ha because less water is used and the leucaena currently under irrigation has not yet matured. It might be important to provide additional sources of roughage and energy (grain, hay, silage or adjacent grass pasture) to cattle grazing irrigated leucaena to balance the cattle diet and make most efficient use of the leucaena protein source.

E. Young

*Establishing leucaena under the 80 ha-centre pivot of David McCullagh in central Queensland*

## Irrigating leucaena

Significantly increased productivity.

Stocking rates = 3–6 hd/ha year round depending on amount of water applied.

Liveweight gain of more than 1000 kg/ha/yr.

Efficient water use at low rates of application 4–5 ML/ha/yr.

UQ

*Fat cattle on irrigated leucaena*

# A producer's experience

## Establishing irrigated leucaena in the Burdekin

Don and Laurel Heatley have about 240 ha of leucaena under flood irrigation from the Burdekin River on 'Byrne Valley', 44 km west of Home Hill.

Don says, "There are some things you do because you know they will work but, when you start, you are not sure exactly how you will make it all happen. We have made a lot of mistakes but have learned from the experience".

After an irrigation lease to rice growers ceased in 1990, the Heatleys converted eight rice bays (each 400 m wide by 4 km long) to Callide Rhodes grass but found it hard to manage. In 2000, they started removing the rice bays and developing hilled beds for leucaena irrigated from underground mains.

Despite many problems during the 2002–2003 drought, Don maintained 1,000 weaners that would otherwise have had to be sold, and now plans to finish 500 steers on leucaena in addition to the normal property turn-off. The results convinced him that his irrigated leucaena development was not only viable but could be expanded.

As a first-time leucaena grower, Don wrestled with questions about furrow length, seeding rates, planting depth, row spacings, bed height, ripping beds, when to plant, heat-treated versus scarified seed, suitable companion grasses, grass invasion of rows, soil tests and type of equipment required. In addition to soil sinkage and waterlogging on laser-levelled bays, he also experienced uneven flow through fluming, erosion at some fluming outlets, and slow flow through the inter-rows.

Perseverance has overcome most problems. Don now finds that farming/irrigation is a one-man job, and he is steadily decreasing water usage as his experience grows. He is experimenting with special techniques such as 'surge irrigation' on flood-irrigated clay soils and the use of soluble fertiliser versus mechanical application.

*Costs for establishing 80 ha of leucaena in 2002-03*

| Item | Cost ($) |
|---|---|
| Ground preparation:<br>1 discing, bedding plus fertilising,<br>2 scarifications (238 hours @ av. $8.50) | 2023 |
| Seed (260 kg @ average $15/kg) | 3900 |
| Fertiliser (MAP @ $540/t) | 5400 |
| Total for 80 ha | 11323 |
| Cost per hectare | 141.53 |
| Cost per acre | 56.60 |

UQ

*Don Heatley describes how he has overcome his problems with growing leucaena.*

Lessons Don learned along the way include:

- always have water for cattle outside leucaena paddocks
- avoid planting in the wet season
- rip ground under beds before planting
- keep grass competition away from young leucaena.

Don plans to develop another 800 ha under centre pivot irrigation if Queensland tree clearing legislation permits. He is currently investigating a 1,400 m diameter centre pivot to irrigate leucaena on river loam soil.

T. Larsen

*Irrigated leucaena along the Burdekin River*

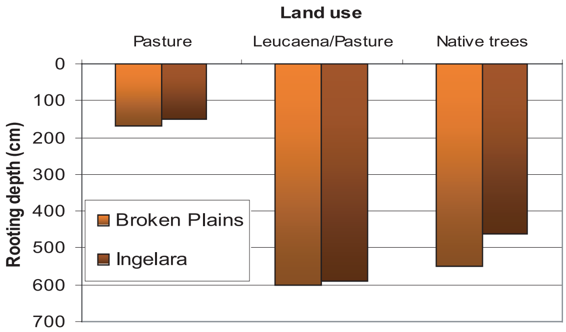
# 4. Grazing management

## 4.1 Leucaena growth and carrying capacity

### Water use and forage growth

The aim is to grow as much leucaena/grass pasture as possible from the area planted by making the best use of the limited rainfall. Rainfall Use Efficiency (RUE) indicates the amount of leucaena forage that can be grown per mm of rainfall, and it varies with environment and management regime.

Although leucaena is able to use water from deep in the soil profile (figure 4.1), most of its roots are in the same 1.5 m rooting zone as the inter-row grass; thus leucaena growth can be limited by competition for water from the associated grass.




UQ - Poole, Sheehan and Rowlings

*Figure 4.1 Rooting depth of pasture grasses, leucaena and native trees on two properties in central Queensland*

At Redland Bay near Brisbane, the RUE of leucaena grown without grass was high at 4–16 kg DM/ha/mm of rainfall whereas the RUE of leucaena growing with intensively competitive buffel grass near Rolleston in central Queensland was only 2.2 kg DM/ha/mm of rainfall (table 4.1). Buffel's dense root system captured 85% of the rainfall, suggesting that reducing the dominance of buffel grass could increase the amount of leucaena grown.

UQ

*Grass competes for water, reducing the RUE of leucaena—but grass is essential for a sustainable grazing system.*

Options to reduce the competition between grass and leucaena could involve:

- planting leucaena rows closer together at 5–6 m spacings
- spraying or ploughing out strips of grass adjacent to the leucaena rows.

However, grass is needed to provide fibre to animal diets, to prevent leucaena seedlings establishing between the rows, and to 'soak up' the excess nitrogen fixed by the legume.

*Table 4.1. Effects of grass competition and plant density on the RUE (kg edible dry matter/ha/mm rainfall) of leucaena stands.*

| Management effect | Leucaena stand | RUE |
|---|---|---|
| Competition effect (Central Queensland) | Leucaena–buffel grass | 2.2 |
| Density effect (Redland Bay, Qld) | High density leucaena<br>Low density leucaena | 16<br>4 |

UQ - Budisantoso

### High protein feed during droughts

Broadscale plantings of leucaena in Queensland have proven to be an extremely effective drought and dry season mitigation measure. Graziers with substantial areas of leucaena have been able to survive recent severe droughts with their cattle in much better condition than those of graziers with no leucaena. The 5–6 m deep roots of leucaena allow it to produce some high quality leaf during dry periods and this enables stock to digest poor quality grass roughage.

### How much leucaena?

Questions that need to be considered when asking how much leucaena is needed include:

- What area should be planted?
- What proportion of grass and leucaena in the paddock and how much in the diets of cattle is ideal?
- Cattle relish leucaena and a large herd can eat all the leaf quickly. Is this wasting leucaena?
- When there is little grass available, can cattle graze leucaena only?
- Why do cattle sometimes spend more time in the adjoining grass paddock than in the leucaena?

When young cattle have access to abundant grass and leucaena, the proportion of leucaena in their diet is closely related to the time that they spend grazing it (Figure 4.2).

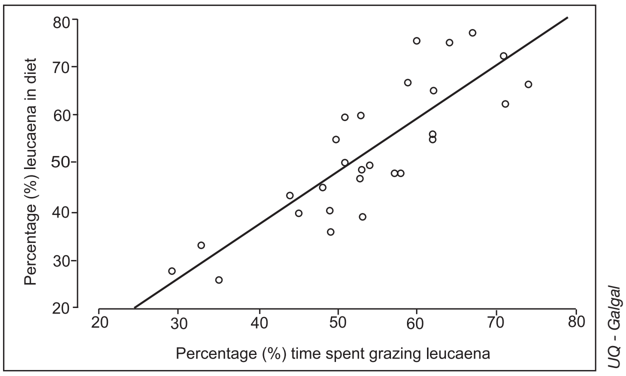



*Figure 4.2 Relationship between time spent grazing leucaena and % leucaena in diet*

Liveweight gain is closely related to the amount of leucaena in the diet. A steer must consume a diet containing 35–40% leucaena (4 kg/day for a 450 kg steer) to gain more than 1 kg/day (figure 4.3).

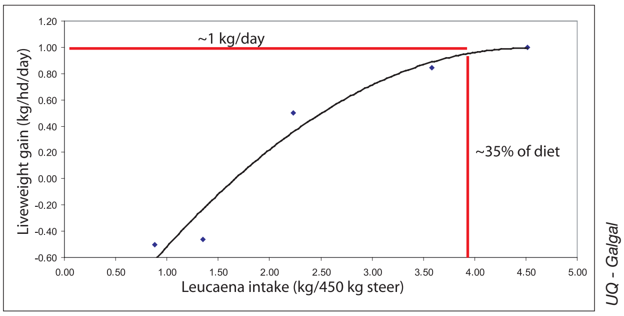



*Figure 4.3 Relationship of liveweight gain with intake of leucaena*

Many graziers report that grazing behaviour varies for other reasons. Sometimes cattle leave lush leucaena to seek young green grass in an adjacent paddock.

A steer needs to eat 35–40% of leucaena in its diet to gain 1 kg/head/day.

The number of cattle that can be finished from a paddock of leucaena can be calculated. Table 4.2 assumes different growth rates (based on different leucaena RUE) and calculates the amount of leucaena grown and eaten by steers of 450 kg liveweight, and the number of grazing days available per hectare—assuming 35% leucaena in the diet.

A RUE of 2 kg/ha/mm will give about 1,200 kg of edible leucaena per hectare—sufficient for 203 days grazing or a whole year stocking rate of 0.6 hd/ha. This might be typical for a heavy clay soil where leucaena is grown with strong buffel grass.

A RUE of 4 kg/ha/mm would generate 2,400 kg of edible leucaena per hectare—sufficient for 508 days grazing or a whole year stocking rate of 1.6 hd/ha. This might typify areas with a deep alluvial soil and growing with a less competitive grass such as green panic or Rhodes grass.

Another way of estimating carrying capacity is to use the RCS (Resource Consulting Services) concept of grazing days per 100 mm rainfall; some graziers have estimated their carrying capacity on leucaena at around 75 grazing days per 100 mm rainfall. In a 600 mm rainfall zone, this equates to 450 grazing days (1.2 head/ha year round), which is similar to the calculation below using a RUE of 4 kg/ha/mm.

Irrigation will increase productivity and carrying capacity according to the amount of water applied.

*Table 4.2 Calculation of carrying capacity of 450 kg steers on leucaena/grass pasture, based on Rainfall Use Efficiency (RUE) and assuming 35% leucaena in diet.*

| | Leucaena–buffel | Leucaena–green panic | Irrigated leucaena 4 ML = 400 mm |
|---|---|---|---|
| RUE (kg/ha/mm) | 2 | 4 | 4 |
| Rainfall (mm) | 600 | 600 | 600+400 |
| Total leucaena grown (kg/ha) | 1200 | 2400 | 4000 |
| Residual after grazing plus losses | 400 | 400 | 400 |
| Total available for grazing | 800 | 2000 | 3600 |
| % leucaena in diet | 35 | 35 | 35 |
| Days grazing available/ha | 203 | 508 | 923 |
| Stocking rate for year (hd/ha) | 0.6 | 1.4 | 2.5 |
| Area (ha) needed to fatten 50 steers for 50 days | 37 | 15 | 8 |

## 4.2 Grazing leucaena

### Regrowth after grazing

Regrowth after heavy grazing and rain can be described as having three distinct phases.

- Phase one lasts about 4 weeks during which regrowth is slow due to low leaf area.
- Phase two is a 4–10 week period of maximum growth of leaf and young green stem; there is little growth of wood.
- Phase three occurs when leaf yield increases slightly but woody biomass increases dramatically as the trees grow taller.

Maximum edible forage (leaf and small stem) occurs when edible forage makes up 50–60% of total regrowth biomass. Longer intervals give a lower proportion of leaf and higher wood yields.

Grazing management should aim to leave 10% leaf, and then to allow sufficient time to maximise the yield of edible forage. In the example given in figure 4.4, this is achieved 8–12 weeks (50–80 days) after regrowth starts—assuming adequate soil moisture and temperature—and this would be a good time to put the cattle back in.

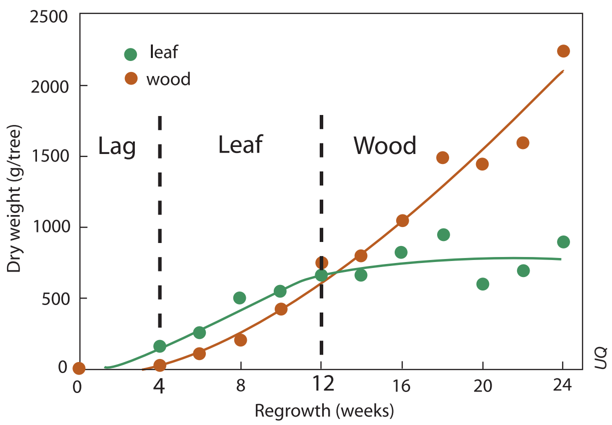



*Figure 4.4 Leaf and stem regrowth of leucaena after cutting*

### Regrowth after grazing

Three distinct phases – lag, leaf and wood:

- Forage growth is slow during lag phase.
- Max growth occurs when 50-60% is edible.
- Regrowth period of 8-12 weeks optimal – depends on temperature and soil moisture.
- Too much wood is wasteful and needs physical control.

## Grazing systems

### Continuous grazing

Some graziers leave their cattle in their leucaena continuously; all gates are open and cattle are free to choose where and when they graze. This system requires large areas of leucaena and low stocking rates; it is low maintenance but does not maximise productivity if the area of leucaena is limited.

### Rotational grazing

Most leucaena is grazed on a seasonal or rotational basis.

In seasonal grazing, the leucaena is locked up to accumulate leaf for cattle in critical seasons such as autumn and early winter when grass quality is dropping quickly and steers need to be finished. This system is useful where the area of leucaena is insufficient for a more continuous forage supply.

In rotational grazing, cattle are moved around blocks of leucaena allowing time (at least 60 days after severe defoliation) for paddocks to fully recover before the next grazing.

Rotational grazing aims to keep cattle grazing prime leucaena pasture year-round. To achieve this, graziers need to monitor pasture yield and composition to calculate animal feed days, rotation times and stocking rates.

Irrigated leucaena pastures are well suited to rotational grazing as pasture yield can be guaranteed by the timely application of water, simplifying feed budgeting and stocking rate management.

### Continuous grazing

- needs large areas of leucaena
- simple management

### Seasonal grazing

- makes most of smaller areas of leucaena
- use leucaena to fill autumn/winter protein feed gap
- target specific animals

### Rotational grazing

- rests leucaena and grass periodically
- maintains grass yield and vigour
- better control of leucaena utilisation by animals

## Cell grazing

In cell grazing (short duration grazing), a large number of cattle rotationally graze small paddocks (cells) for a short time, followed by long periods of rest. The cattle quickly eat most of the available fodder and then are moved on; the cell is then rested for 60–90 days to recover.

Some graziers report increased productivity from this system. They claim benefits to be:

- intense grazing pressure helps manage the height of leucaena and prevents it growing out of the reach of cattle
- more even grazing pressure giving better utilisation of pasture resources
- better redistribution of nutrients from dung and urine across the paddock
- high animal traffic accelerates nutrient cycling and improves water infiltration improving pasture productivity.

However, the disadvantages are:

- setting up a cell grazing system requires substantial infrastructure development and investment in electric fencing, speargates for mustering and watering points
- cell grazing is labour intensive as pasture condition and utilisation need to be monitored regularly and cattle shifted frequently (even daily).

CHM

*With water points outside the block of leucaena, cattle can be mustered easily with the use of speargates. Back rubbers at the gate may be used to control buffalo fly.*

### Cell grazing

- intense and even grazing pressure
- better control of leucaena height
- rapid cycling of nutrients to grass
- easier to ration leucaena

But

- less diet selection
- more costly to set up
- more management required

Leucaena/grass pastures are well suited to cell grazing because:

- once established, the leucaena is remarkably tolerant of heavy grazing—although the grass must not be over-grazed under high stocking rates
- leucaena-grass pastures are often uniform and therefore easy to assess for pasture yield and feed budgeting
- the high productivity (and economic viability) of the leucaena system means that only relatively small areas need be developed for cell grazing.

UQ

*Steers off leucaena, which is well suited to cell grazing management.*

UQ

*Steers can graze a leucaena paddock continuously if there is enough legume.*

## Producers' experiences

### Irrigated leucaena produced 1,500 kg/ha/yr

Graziers in the Ord have adopted intensive, short-term rotational grazing systems for more effective use and control of the leucaena growing rapidly with flood irrigation.

On one property:

- cattle are rotated through cells every 2 days followed by 30 days rest and regrowth
- high stocking rates of 5–8 live export steers (170 kg LW/hd) produced 1,400–1,700 kg LWG/ha/year.
- despite the intensive grazing, the leucaena still has to be slashed every two years.


UQ

*Steers grazing irrigated leucaena pastures in the Ord under an intensive, short-rotation grazing system*

### Weight gains of 357 kg/year off leucaena

Robert and Maree Ryan run a steer-fattening enterprise on 2,000 ha of fertile grey brigalow soil near Taroom. They established their first 35 ha of Tarramba leucaena in November 2000.

Robert has now set a record for liveweight gain from an area of 150 ha leucaena/Gayndah buffel pasture planted in January 2002. He grazed a total of 150 steers (at 1 steer/ha) and followed the weights of one mob of 71 animals that had been dosed with Synovex S®.

In 374 days between February 2004 and February 2005, the 71 steers gained 357 kg for the year or 0.98 kg/day. This 12-month period included a hard winter during which steers gained only 0.52 kg/day for 160 days from 20 July to 27 December 2004. The best period was 37 days to 10 March 2004 when steers gained 1.72 kg/day.

Robert's kill sheets tell the leucaena story. Carcase weights of 43 steers slaughtered in May 2006 averaged 367 kg, with 16 mm fat at 2.3 teeth. In comparison, a similar group of 28 Santa x Hereford steers on straight buffel grass averaged 372 kg carcase weight with 18 mm of fat, but took longer to turn-off with an average of 3.5 teeth.

The Ryans planted another 40 ha of Tarramba leucaena in December 2005, and have grazed this lightly with 30 steers since April 2006.

### Rotationally-grazed beef factory

Tom and Ruth Wagner of Banana in central Queensland have split about 1,300 ha of leucaena/buffel grass pasture into 16 paddocks of 80 ha. Eight hundred steers of 450 kg are rotated around this system with a week in each cell. Finished animals are turned off as Jap Ox after 32 weeks.

The pastures are then spelled during spring and early summer. One result is a very uniform stand of leucaena and buffel.


UQ

*Steers finished as Jap Ox after 32 weeks on leucaena*

# 4.3 Making the best use of leucaena

## Leucaena as a protein supplement

The main value of leucaena is as a much needed protein supplement to cattle grazing tropical grass pastures. Rapidly growing cattle need about 13% crude protein in their diets to produce good weight gains; they cannot get this from grass alone (figure 4.5).

When cattle are introduced to leucaena paddocks, their intake of protein immediately increases according to the proportion of leucaena in their diet—which will depend on the amount available, seasonal factors and animal behavior (table 4.3).

Leucaena is extremely palatable and cattle keep eating it while it is available. Thus, with year-round access, they tend to eat excessive amounts of leucaena protein early in the growing season leaving insufficient leucaena forage for when the grass hays off in autumn. Case studies have shown that for 65% of the time, animals grazing leucaena had more protein in their diet than they needed for high weight gains (figure 4.6).

This over-consumption of leucaena in summer and accompanying protein deficit in autumn can lead to a decline in animal performance (figure 4.7). Regulating leucaena intake by restricting access early in the growing season or by a cell grazing system with some grass-only paddocks might improve production efficiency.

*Table 4.3 Percentage leucaena in diet of cattle grazing leucaena and grass on six properties in central Queensland from December to May 2005*

| Property | Average leucaena in diet (%) | Range (%) |
|---|---|---|
| A | 75 | 60–98 |
| B | 53 | 24–74 |
| C | 51 | 32–92 |
| D | 50 | 30–79 |
| E | 44 | 13–67 |
| F | 15 | 5–48 |

UQ - Streeter

### Protein content of grass plunges in autumn

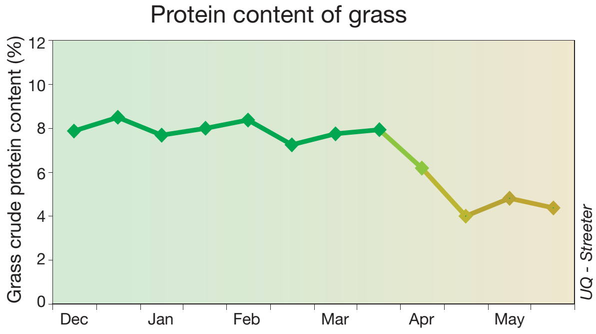



*Figure 4.5 Change in grass protein from December to May*

### Eating too much leucaena can be wasteful

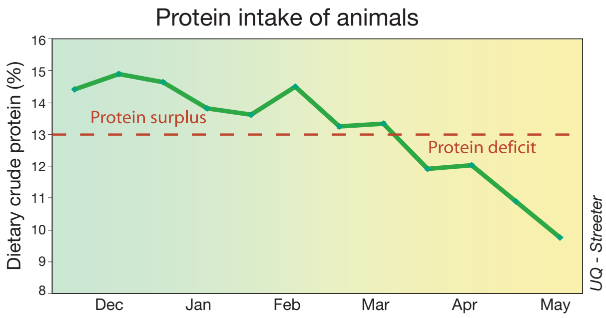



*Figure 4.6 Cattle grazing abundant leucaena in summer may be wasting protein needed in autumn.*

### Weight gains drop when leucaena runs out

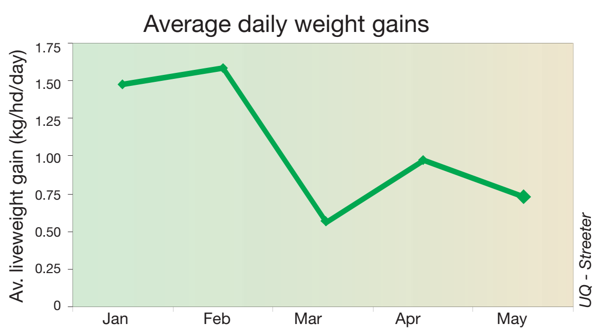



*Figure 4.7 Daily weight gains of cattle are related to the proportion of leucaena in the diet.*

Management options to even out protein intake include:

- restricting access to leucaena to ration intake
- rotational grazing with three days on leucaena and four days on grass only
- cell grazing with only half the cells having leucaena/grass and the remainder grass only.

## Rationing leucaena intake

Rationing leucaena early in season will:

- extend the period of finishing with a daily gain of 1 kg/day
- maximise weight gain/ha from the leucaena
- enable flexibility in marketing cattle (timing sale and targeting markets).

## Strategic use of leucaena

Several strategies have been used to make best use of leucaena systems. These strategies use leucaena:

- as a supplement to improve the protein content of the diet at a specific time of year, usually from autumn through to spring
- to finish steers to market specifications
- to background weaners going into a feedlot or onto a live cattle export ship
- to 'spike feed' breeders, usually heifers, before calving
- for growing and conditioning bulls for sale, as an alternative to finishing on grain.

In most strategies, it is assumed that there is insufficient leucaena to feed the entire herd year-round, and maximum benefit has to be obtained from the limited resource.

In all cases, cattle must be protected against mimosine or DHP toxicity (see Section 4.4).

### Finishing steers on leucaena

Leucaena is now commonly used to finish cattle for local and export markets. Early work at DPI&F Brian Pastures Research Station showed that leucaena could be used to finish steers in autumn or spring. Leucaena paddocks were spelled through summer to accumulate 1,500–1,800 kg/ha of edible leaf. In autumn, steers weighing 480 kg and stocked at 1.5 steers/ha gained about 1 kg/day for 80 days—by which time they had eaten nearly all the available forage (see table 4.4). The weight gains started to slow as less and less leucaena herbage was available.

Better results were achieved when finishing steers with adequate leucaena herbage available throughout the entire grazing period. At Clermont, two drafts of steers averaged 1.5–1.6 kg/head/day over a 52-day period (see table 4.4).

Under a leader-follower system, younger more efficient 'leaders' eat the best quality and most accessible forage, with the more mature 'followers' eating the remaining forage. This gives efficient use of forage and effectively manages plant height.

*Table 4.4 Mean liveweight gains of steers finished on leucaena at Brian Pastures (BP) during spring and autumn fattening periods from 1986 to 1991, and for drafts of home-bred (Home) and purchased (Gulf) steers at Clermont in 2004.*

| Paddock | | No. of cattle | Initial weight (kg) | Grazing duration (days) | Av. daily gain (kg/head) |
|---|---|---|---|---|---|
| BP (clay loam) | Spring | 47 | 501 | 81 | 1.0 |
| | Autumn | 20 | 472 | 75 | 1.0 |
| BP (deep clay) | Spring | 30 | 524 | 87 | 0.7 |
| | Autumn | 41 | 468 | 94 | 1.0 |
| Clermont (Home) | Summer | 60 | 542 | 52 | 1.6 |
| (Gulf) | Summer | 44 | 530 | 52 | 1.5 |

DPI&F; B. Mullen

## Backgrounding weaners

There is increasing interest in using leucaena to background weaners going into feedlots.

Young cattle are fed leucaena for 50 to 100 days to prevent poor post-weaning performance and to improve weight gains before going onto grain.

In the Ord, the leucaena system is used primarily to prepare young cattle for live export markets into South-East Asia. Weaners of 170 kg liveweight graze leucaena for a 300-day period to reach 360 kg.

## Spike feeding heifers

Short-term supplementary feeding (spike feeding) of cows and heifers during late pregnancy can reduce the interval from calving to cycling. Supplementation after calving increases milk yield and hence weaner weights but has less effect on fertility. Leuceana can be a good resource for spike feeding.

Spike feeding should extend for at least 50 days and should start about six weeks before the main calving season begins (September/October in much of northern Australia). Heifers late in their first pregnancy are the best targets for spike feeding.

## Energy supplementation

Weight gains of cattle grazing leucaena may be able to be improved by feeding an energy supplement.

Energy supplements may improve protein utilisation and total metabolisable energy intake of leucaena diets. If protein intake is excessive and energy deficient, the rumen bacteria break down the protein (inefficiently) to get their source of energy, and excess ammonia is lost through the animal's urine.

If insufficient total forage is available to finish a mob of forward stores but there is plenty of leucaena, the value of the leucaena may be extended by feeding an energy supplement such as grain, molasses, silage or hay. Direct substitution should reduce the intake of leucaena.

This increased efficiency has not yet been conclusively proven in the paddock. In the Ord, steers increased weight gains from 0.73 to 1 kg/hd/day when fed 1 kg maize/day during the dry season, but at Meadowbank Station in north Queensland, no response was found to feeding a wet season supplement of 2.5–3.3 kg molasses/day plus urea and cotton seed meal.

## Finishing stud bulls

Young stud and herd bulls have been finished on leucaena as an alternative to grain finishing. Tests have shown semen quality to be high, and the bulls have performed well in the paddock after sale.

UQ

*Brahman cattle on leucaena and Gatton panic pasture in the Chaco region of Paraguay*

## 4.4 Leucaena toxicity and the leucaena bug

Leucaena/grass pastures are extremely productive, long-lived and drought tolerant. Cattle can gain over 1 kg/day for long periods, putting on more than 300 kg a year. The leaves and small green stems of leucaena are very palatable, highly digestible (60% digestibility) and contain high concentrations (20-30%) of crude protein—some of which is by-pass protein.

**But …** the leaves, green pods and seeds contain a toxic amino acid (protein-like compound) called mimosine. Mimosine is found in all commercial varieties of leucaena at 4–12% of dry weight.

Mimosine stops cell division and thus is severely toxic and can often be fatal. However, mimosine toxicity *per se* is rare because plant enzymes and bacteria in the rumen of cattle usually rapidly break down mimosine to another product known as DHP.

This is not a detoxification process because DHP is also toxic; it stops the thyroid gland from functioning normally. The effects of DHP tend to be cumulative and toxicity builds up in animals over time and so is seen in stock that have been eating large amounts of leucaena over a long period. Although rarely fatal, it can significantly limit animal production.

Leucaena toxicity can be managed easily by introducing into the animal's rumen a bacterium that degrades the DHP.

UQ

*Severe DHP toxicity – note symptoms of poor growth, loss of hair from switch of tail and excessive salivation.*

### Leucaena toxicity

Leucaena toxicity can describe three basic conditions in unprotected cattle:

#### 1. Mimosine toxicity (rare)

- occurs rarely and only under a special set of circumstances
- kills quickly (within 3–10 days of consuming large quantities of lush leucaena)
- symptoms include loss of appetite, sudden hair loss, sores and ulcers on the tongue and in the mouth and throat, and badly damaged liver and kidney tissue

#### 2. Severe (visible) DHP toxicity (occasional)

- more likely than mimosine toxicity
- rarely fatal
- occurs with a diet of more than 30% leucaena for long periods of time
- symptoms can take several months to appear
- symptoms include lethargy, depressed appetite and growth, hair loss from pizzle and switch in tail, sores on skin, excessive salivation, goitres, cataracts, low blood thyroxine levels, poor breeder fertility including abortion, and cows giving birth to weak, goitrous calves.

#### 3. Mild (hidden) DHP toxicity (more common)

- animals appear healthy and do not exhibit symptoms
- may be affecting about 30-50% of Queensland cattle herds grazing leucaena—even herds previously inoculated
- occurs when animals consume low (less than 30%) leucaena diets or high leucaena diets for short periods of time (less than 3–4 months)
- suppresses appetite and reduces feed intake
- can retard growth and weight gain by up to 50%.

## Mimosine

Mimosine is a non-protein amino acid that:

- is present in all commercial cultivars
- impedes cell division
- is acutely toxic
- can cause rapid and violent death, but is normally broken down to less toxic DHP.

## When can leucaena toxicity occur?

Young, lush vigorous summer growth contains very high mimosine concentrations. Toxicity can occur when cattle consume large amounts of this lush leucaena. They are at greatest risk of mimosine toxicity when the normal processes of mimosine degradation to DHP are overwhelmed, which happens when:

- they eat 100% new leucaena growth at the break of a drought before the grass starts growing
- unaccustomed hungry cattle are given unlimited access to lush leucaena.

Mimosine toxicity is rare but devastating when it occurs. Mimosine toxicity is easily identified and remedied by immediately removing the animal from the leucaena.

## Preventing mimosine poisoning

Do not let hungry cattle gorge on lush leucaena:

- introduce hungry cattle slowly
- make sure there is ample roughage for cattle to eat
- give the rumen bacteria time to adapt to high leucaena diets.

UQ

*Moderate DHP toxicity – plenty of leucaena and grass but poor growth of animals and hair loss at switch*

DHP (the breakdown product of mimosine) toxicity is more common. Severe DHP toxicity can be readily overcome by inoculating cattle with the special rumen bacterium; animals then recover quickly, increase forage intake and gain weight rapidly.

Mild DHP toxicity may not be recognised and thus remain untreated.

## Economic impact of leucaena toxicity

Although rare overall, deaths from mimosine toxicity can be very costly for the individual grazier.

The economic impact of DHP toxicity is large. The reduction in appetite has an immediate impact on weight gain and thus profitability.

Mild (hidden) DHP toxicity can have an even larger economic impact because graziers are not aware that it is limiting animal production. Potential weight gain can be reduced by 30–50% without animals showing the distinctive symptoms of DHP toxicity. Weight gains of 0.5–0.8 kg/day appear satisfactory but could be 1.0–1.5 kg/day.

UQ

UQ

*When these bare stalks (left) recover with a flush of leucaena leaf but no grass as the drought breaks (right), beware of mimosine toxicity.*

# The leucaena 'bug'

## Before the bug

Before the 1980s, cattle in Australia eating more than 30% leucaena would show symptoms of severe DHP toxicity. In summer months in the subtropics and year-round in the wet (or irrigated) tropics, they had poor weight gains or even lost weight.

On his travels to Hawaii, Dr Raymond Jones of the CSIRO found goats being fed leucaena that showed no such symptoms. He went on to isolate, from the goat rumen, a bacterium that could degrade both mimosine and DHP to harmless by-products. This bacterium was named *Synergistes jonesii* in Dr Jones' honour.

Mixed cultures of the bug were successfully introduced to cattle in Australia from Hawaii under quarantine, and were shown to confer complete protection to animals eating diets of 100% leucaena. It appeared to be easily transferred from animal to animal and spread rapidly within experimental herds, although the mechanisms of transfer have not been identified.

## How the bug works

**Mimosine in forage**

(plant enzymes and many rumen bacteria)

⇩

**3,4-DHP in rumen digesta**

(*S. jonesii* only)

⇩

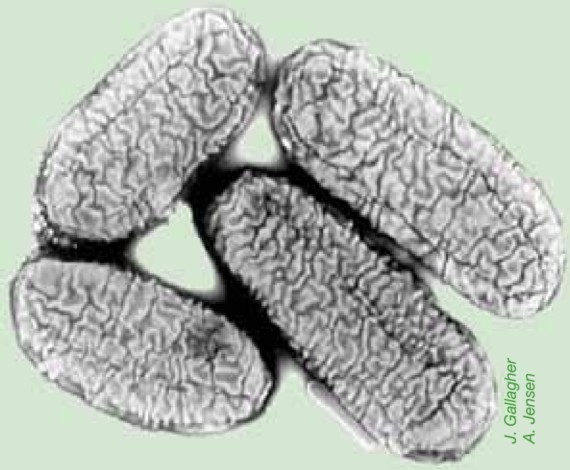
**2,3-DHP in rumen digesta**

(*S. jonesii* and some other rumen bacteria)

⇩

**Harmless by-products – including nitrogen**

Plant enzymes begin rapidly converting mimosine to 3,4-DHP as soon as leucaena is eaten and chewed, degrading as much as 40% of mimosine. When the chewed leucaena reaches the rumen,




*The leucaena bugs —* Synergistes jonesii *bacteria*

the remaining mimosine is rapidly degraded by a host of rumen bacteria, including *Synergistes jonesii*. Only *S. jonesii* can detoxify 3,4-DHP to the 2,3-DHP form, which is slightly less toxic. 2,3-DHP can be broken down further by *S. jonesii* and some other rumen bacteria which incorporate the nitrogen that was tied up in the amino acids into their own bodies.

## Since the bug

Animal growth rates from leucaena pasture have increased by 30–100% since the bug was introduced. Previously, intake of leucaena was limited to about 30% of the diet and this restricted full utilisation.

## How to obtain the bug

The leucaena bug was originally cultured in fistulated cattle grazing leucaena. Rumen fluid was extracted from these donor animals, transported under oxygen-free conditions and transferred to recipient cattle. Today, the bug is cultured artificially in a fermentation vat at the DPI&F Animal Research Laboratory at Yeerongpilly, Brisbane. The mixed culture bacterial inoculum is stored at –20°C and distributed frozen on wet ice in 500 mL bottles through DPI&F Brian Pastures Research Station, Gayndah.


*The original trial introducing the leucaena bug. This steer was suffering from severe DHP toxicity. Note the poor growth and loss of hair from switch and pizzle.*


*The same animal after 4 months grazing 100% leucaena and inoculation with* Synergistes jonesii

## Getting the bug into your cattle

The bug can be administered by direct injection into the rumen but the current recommendation is an oral dose using a standard drenching gun.

The inoculum must be handled carefully to ensure the bacteria survive; it should be thawed immediately before drenching, and exposure to air (oxygen) minimised.

The DPI&F suggests that 10% of animals in the herd be inoculated with 100 mL of culture (5 head/bottle). Cattle should be grazing leucaena for at least seven days before inoculation to ensure the rumen contains adequate DHP for the bug to become rapidly established. If this is not possible, cattle should be put onto leucaena immediately after inoculation—which may result in a slower build up and spread of the bacteria. It may take 5–6 weeks before the bug protects the entire mob.


*Drenching with leucaena bug culture: 10% of animals should be inoculated with 100 ml of culture each.*

### Introducing and keeping the bug

For effective introduction and retention of the bug in your herd, remember:

- the leucaena bug is anaerobic, living only in an oxygen-free environment and dying if exposed to air or water
- the bug must have a regular source of leucaena to survive long term.

## Other ways of acquiring the bug

Other methods of spreading the bug have been tried:

✓ Animals that have been directly inoculated with the bug are mixed with your own herd for at least 8 weeks. A ratio of about 10% protected animals will speed up spread.

? Transfer of trough water or manure from properties with inoculated cattle into stock drinking water does not work. Oxygen dissolved in water is likely to kill any leucaena bugs present. As a result, these methods are not recommended.

## Maintaining the bug in your herd

The leucaena bug can survive in low numbers in the rumen of protected cattle for several months since they were last fed leucaena. However, it is recommended that you either:

- retain a few 'carrier' animals on leucaena year-round to maintain the bug in your herd or

- inoculate new cattle if restocking after drought.

After a prolonged spell off leucaena (especially after a drought):

- Cattle should be reintroduced to leucaena slowly to give the depleted bacterial population of the rumen (both *S. jonesii* and other bacteria that can convert mimosine to DHP) time to build up.
- Make sure there is ample roughage (grass or hay) available in the paddock to minimise the risk of cattle eating too much leucaena too quickly.
- Prevent unprotected cattle gorging themselves on leucaena until the bug spreads from inoculated animals throughout the whole herd.

## Bug management for different production systems

Our lack of knowledge about the ecology of *S. jonesii* is limiting our ability to give better advice on management strategies. In this section, we provide some suggestions.

### Short-term backgrounding or finishing

As the aim when backgrounding is to maximise animal performance over a short period of 50–100 days, cattle must be effectively inoculated quickly. If it takes 5–6 weeks (35–42 days) for the bug to spread from 10% of each herd to the whole mob, most animals would experience sub-optimal performance. It may be necessary to inoculate a larger proportion (say 20–30%) of animals to get the protection needed in time. More research is needed to quantify the rate of spread of *S. jonesii* in cattle herds.

Retention of the bug can be a problem on properties where entire mobs of cattle are brought in and old mobs are trucked out. Some carrier animals from each mob or permanent carriers should be kept unless animals from each new mob are inoculated.

### Seasonal grazing

Cattle protected in autumn should keep their protection until spring despite a 3–5 month spell off leucaena.

### Feeding breeding heifers, cows and bulls

Pregnant cows, especially heifers, must be protected as severe DHP toxicity can cause abortions and increase calf mortality. Heifers should be inoculated (either directly or by animal-to-animal transfer) while exposed to small amounts of leucaena. For example, they could become accustomed to leucaena in a leader-follower rotational grazing system by following a mob of finishing steers when little leucaena leaf would be left. Once protected, heifers could safely eat diets containing high proportions of leucaena.

All stud and herd bulls fed on leucaena should be directly inoculated.

### The use of energy supplements

The effect of feeding energy supplements on the leucaena bug is not known. For example, feeding grain acidifies the rumen and changes the rumen microbial population. It is not known how sensitive *S. jonesii* is to low pH.

## Other sources of the bug

In Australia, the bug is now produced in a fermentation vat in the lab and the steers dosed orally. But rumen fluid can also be taken from a fistulated animal eating leucaena (left) and injected direct into the rumen of a new animal using a rumen injector (right).

UQ

T. Hall

# 5. Leucaena costs and returns

Leucaena growing is a long-term land use. Any investment in leucaena typically involves a high initial outlay of funds to develop the pasture, a period of lower returns as the pasture is establishing followed by a long period of production and relatively stable returns.

The value of a leucaena investment to a business depends upon:

- the costs of establishing the pasture
- how successfully it establishes
- the length of productive life of the leucaena
- the alternative land use that may have been implemented if leucaena was not planted.

Land suitable for successful leucaena pastures will have alternative uses, and establishing the leucaena pasture may not necessarily be the most profitable option.

The value of a leucaena investment to a business is usually analysed using relatively complex techniques that take these factors into account. This section will not deal with this more complex investment analysis but highlights some of the important factors that contribute to making leucaena a successful investment.

## 5.1 Costs of establishment

Establishing a leucaena/grass pasture is expensive and it is important to use correct techniques. The combination of the costs of establishment, low animal production during the establishment phase and the income foregone from the activity that the leucaena is replacing can be important to the cash flow of the farm business.

Clearing or blade ploughing paddocks, fencing and water reticulation may also add to establishment costs.

The cost of establishment will vary with the method of ground preparation, seeding rates and cost, and method of pre- and post-plant weed control.

Total planting costs are around $450/ha at contract rates (table 5.1), but $250 to $350/ha when graziers use their own equipment and time.

## 5.2 Returns

### Returns during establishment

The length of the establishment phase for leucaena depends firstly on how quickly a viable stand of leucaena plants can be achieved, and secondly on how successfully a grass pasture is established between the rows of leucaena. Generally we budget on a light grazing of the leucaena pasture in the 12-month period after the leucaena is planted.

The next summer is generally the time for establishing the grass. Thus we generally also budget on a lighter utilisation of the leucaena pasture during the second year with stocking rates varying between one 300 kg steer per one hectare and one steer per two hectares.

Variable seasonal conditions during the 12 months after leucaena planting could impact considerably on the estimated gross margin for the establishment year shown in table 5.2. Dry years would reduce both weight gain and length of period of grazing; in wetter years the weight gain should be maintained but the grazing period could be longer. In a drought year, a nil result could be expected.

The gross margins calculated in table 5.2 treat the leucaena pasture as a separate enterprise that buys and sells steers onto and off the pasture. Cattle enterprises that do not incur these transaction costs could increase their gross margin to reflect the reduction in costs.

### Returns after establishment

Returns from leucaena pastures over the longer term depend upon the buying and selling price of the cattle grazing the pasture, the weight gained while they are grazing the pasture and the length of time during each year that the leucaena can be grazed.

The second gross margin in table 5.2 provides a simplified example for a leucaena pasture that is continuously grazed for nine months each year on average.

*Table 5.1 Development cost calculator for establishing leucaena and grass into old cultivation land at contract rates (UQ & The Leucaena Network)*

| | Cost/ unit | Number of operations | % paddock treated | Mechanical weed control only | Mechanical weed control pre-planting & pre-emergent herbicides at planting | Mechanical weed control pre-planting & spray herbicides post-planting |
|---|---|---|---|---|---|---|
| **Pre-planting costs** | | | | | | |
| Roundup® | $5/L | 2 L/ha | 100% | $0 | $0 | $0 |
| Primary cultivation | $50/ha | 1 operation | 100% | $50 | $50 | $50 |
| Secondary cultivation | $15/ha | 2 operations | 100% | $30 | $30 | $30 |
| Scuffling | $15/ha | 2 operations | 100% | $30 | $30 | $30 |
| Spray rig costs | $6/ha | 1 spray | 100% | $0 | $0 | $0 |
| **Planting costs** | | | | | | |
| Planting costs (contract rate) | $40/ha | 1 planting | | $40 | $40 | $40 |
| Leucaena seed (cv. Tarramba) | $40/kg | 2.5 kg/ha | | $100 | $100 | $100 |
| Seed dressing (Cosmos®) | $8/2.5 kg seed | 1 application | | $8 | $8 | $8 |
| Beetle bait | $11/ha | 1 application | 100% | $11 | $11 | $11 |
| Starter fertiliser (MAP) | $550/ton | 2.5 kg/100 m row | 33% | $69 | $69 | $69 |
| Spinnaker® | $335/kg | 0.14 kg/ha | 100% | $0 | $47 | $0 |
| Spray rig costs | $6/ha | 1 spray | 100% | $0 | $6 | $0 |
| **Post-planting costs** | | | | | | |
| Grass weed control (Fusilade Forte®) | $52/L | 2 L/ha | 25% | $0 | $0 | $26 |
| Broadleaf weed control (Basagran®) | $35/L | 2 L/ha | 25% | $0 | $0 | $18 |
| Grass seed | $20/kg | 2 kg/ha | 100% | $40 | $40 | $40 |
| Planting costs (contract rate) | $8/ha | 1 planting | 100% | $8 | $8 | $8 |
| Scuffling | $15/ha | 2 operations | 100% | $30 | $0 | $0 |
| Yetter wheels | $8/ha | 1 operation | | $8 | $8 | $8 |
| Spray rig costs (mixed chemicals) | $6/ha | 1 spray | 100% | $0 | $0 | $6 |
| **Total direct development costs/ha** | | | | **$424** | **$447** | **$444** |
| **Total direct development costs/acre** | | | | **$172** | **$181** | **$180** |

*Note – these costs are indicative and were accurate at the time of publication. The table should be used by graziers so that they know what activities are involved in planting leucaena and can calculate their own costs.*

*Table 5.2 Potential gross margins for 200 ha leucaena in the establishment year and once established*

| | Establishment year per ha* | Established leucaena per ha* |
|---|---|---|
| Area planted (200 ha); stocking rate 1 steer/ha* | | |
| **Costs** | | |
| 300 kg steer @ $1.85/kg | $555 | $555 |
| Freight to property | $15 | $15 |
| Interest on steer (7.5% p.a.) | $10.25 | $30.80 |
| Animal health | $5 | $5 |
| Total costs | $585.25 | $605.80 |
| | | |
| **Production** | | |
| 1.0 kg/day for 90 days | 90 | |
| 1.0 kg/day for 270 days | | 270 |
| Final weight (kg) | 390 | 570 |
| | | |
| **Income** | | |
| Steer selling price $1.75/kg | $682.50 | $997.50 |
| less: Livestock levy $5/hd | $5 | $5 |
| Freight to yards $20/hd | $20 | $20 |
| **Gross income** | **$657.50** | **$972.50** |
| **Total costs** | **$585.25** | **$605.80** |
| **Gross margin** | **$72** | **$367** |

**At this stocking rate of 1 steer/ha, results per head are the same as results per hectare.*

The gross margin figure for an established leucaena pasture is less variable than the gross margin for the establishment phase but can still be significantly impacted by variable seasons and prices. An allowance should also be made in the farm budgeting process for some maintenance costs for the leucaena pasture. These costs vary considerably between leucaena pastures and include such things as height management, fertiliser inputs, weed control and repairs on fixtures associated with the leucaena pasture. Some allowance for the costs of labour associated with the management of the livestock in the leucaena pasture system will also have to be made where they are incurred.

## 5.3 Leucaena versus alternative land use

Is converting from a buffel grass pasture to a leucaena pasture the best investment?

What are the returns on an investment from converting, for example, 500 ha of buffel grass pasture to leucaena/buffel pasture at a rate of 100 ha/year.

The main benefits expected from the development are in increasing the carrying capacity of the paddock from about 167 head (3 ha/head) to about 250 head (1.5 ha/head) and in increasing the annual liveweight gain/head from 150 kg to 300 kg. Annual liveweight gain/ha would then increase from 50 kg to 200 kg.

No additional fencing or watering costs are included in the analysis.

The productivity of the leucaena pastures is assumed to decline by 5% per year after 25 years of production.

A simple livestock trading model was used to estimate the profitability of the pasture in each year of the investment, with steers being purchased at 350 kg liveweight and sold after 300 days. Transaction costs are incurred by the leucaena enterprise.

The scenario assumes that the enterprise runs for 30 years and is then sold. Our analysis indicates that the leucaena development could return about 30% on the funds invested if the pasture is successfully established and maintains its productivity.

However, part of the calculated return is due to the increase in land value—which is in proportion to its additional carrying capacity or may even attract a premium.

The initial investment in developing the leucaena is repaid in about the seventh year of operations, but a long productive life of leucaena is essential to achieving high returns.

There are many potential options for leucaena development. Under central Queensland conditions, most options analysed for the development of dryland leucaena have shown reasonable returns. However, before converting fertile cultivation land to leucaena, a comparative cashflow analysis should be calculated. Even if less profitable, these analyses do not account for lifestyle factors that may attract owners from mechanised cropping to cattle grazing.

*The significant capital investment in overhead irrigation equipment must be considered in the economic analysis of irrigating leaucaena.*

## 5.4 Economics of irrigated leucaena

Widespread dryland plantings of leucaena have shown it to be a productive and profitable investment in central Queensland.

### Uncertainty

Some landholders have access to irrigation water and are applying it to leucaena to improve establishment and production and to reduce the uncertainty of animal output.

There is some level of uncertainty in the profitability of irrigated leucaena because it is a relatively new but very intensive production system—especially if using overhead irrigation.

To be profitable the investment must be able to cover all costs and provide a return on the capital invested.

The value of irrigated leucaena as an investment is very sensitive to:

- development costs
- production off the pasture over time
- trading margins on livestock
- value per kg of weight gain
- returns from any alternative production system or investment.

To accurately assess the economics of irrigated leucaena, the developer needs good data on:

- development costs for pumps, furrow irrigation, ring tanks or spray systems
- water requirements, availability and pricing
- pasture production during the year
- animal growth rates and stocking rates.

This data is being generated through the efforts and records of some innovative graziers but is not yet good enough for any broader recommendations. All prospective irrigators need to critically assess their unique circumstances.

# A producer's experience

## Leucaena Gross Margins

Scott and Judy Smith run over a thousand head of cattle on their property 'Glenlivet' near Thangool. The 2,700 ha property comprises 1,850 ha forest country and 810 ha scrub.

In March 2001, they planted 40 ha of leucaena at a cost of just over $210/ha.

Planting costs for 40 ha

| | |
|---|---|
| Ploughing | $4,400 |
| Herbicide | $1,500 |
| Seed 100 kg@$11 | $1,100 |
| Buffel seed | $1,500 |
| Total cost | $8,500 |
| Cost per ha | $212 |

Scott and Judy run the 40 ha of leucaena as a 2-paddock rotation. The leucaena now feeds a draft of about 32 steers for about 90 days with three drafts per year as each is sold and then replaced. The steers average 580 kg and gain about 110 kg liveweight at 1.2 kg/day.

In 2003-04, Glenlivet received only 540 mm of rainfall but Scott and Judy still put a total of 100 steers through the 40 ha over the 12 months.

Scott and Judy estimate that the leucaena has increased the carrying capacity of that 40 hectares five-fold.


S. Smith

*Leucaena planted on Glenlivet*


UQ

*Leucaena and grass pasture on Glenlivet*

*Economic returns from grazing leucaena at Glenlivet*

| | per draft |
|---|---|
| No. of days on leucaena | 92 |
| Stocking rate (head/ha) | 0.8 |
| LWG (kg/head/day) | 1.2 |
| Average steer weight in (kg) | 530 |
| Average steer weight out (kg) | 640 |
| Average weight gain (kg) | 110 |
| Price ($/kg) | 1.62 |
| Variable cost ($/ha) | 688.60 |
| Interest ($/hd@5%) | 8.63 |
| Total variable cost ($/ha) | 697.20 |
| Gross income ($/ha) | 809.45 |
| Gross margin ($/ha) | 112 |
| GM ($/ha) – 3 drafts/year | 336 |


S. Smith

*Cattle on leucaena gained good weight even during the dry conditions.*

# 6. Leucaena and the environment

It is important to understand the environmental implications of planting a stand of leucaena and grass pasture. The environmental issues to be considered are:

- leucaena—the environmental weed issue
- The Code of Practice
- Government policy
- controlling unwanted leucaena
- leucaena and salinity control
- leucaena and water quality
- leucaena and greenhouse gases

## 6.1 As an environmental weed

A weed is a plant in the wrong place; an environmental weed is a plant that invades a native habitat and reduces biodiversity.

Leucaena does occur as a weed in northern Australia. It can be found in previously disturbed sites, especially along creeks and ungrazed areas in coastal Queensland, around the Gulf of Carpentaria and the Northern Territory, where profuse seeding and long-lived soil seed leads to continuing germination of new plants. Leucaena grows on the banks of waterways rather than in the water as it is not tolerant of waterlogging.

However, while leucaena clearly does have weed status in some regions, the following points are relevant:

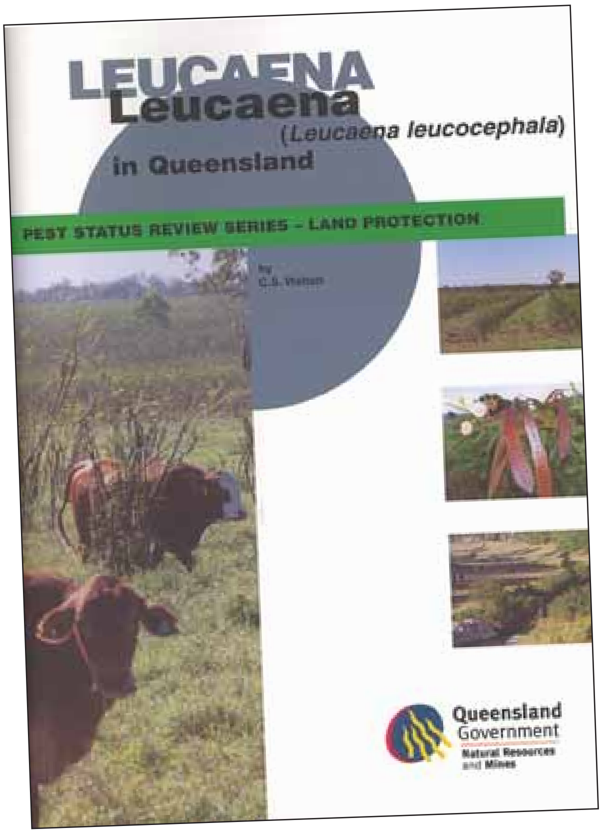
- Leucaena is no newcomer to northern Australia. Leucaena probably reached northern Australia via Papua New Guinea in the late 1800s. C.T. White, the Queensland Government Botanist of the 1920s and 1930s, reported in the 1937 Annual Report of the Department of Agriculture and Stock that a weedy type of leucaena (*L. leucocephala* ssp. *leucocephala*) had become naturalised in coastal north Queensland by 1920.
- The area of weed leucaena in northern Australia is relatively small despite it being present in northern Australia for over 100 years. Spread of leucaena seed has occurred by deliberate planting as an ornamental, water movement, in contaminated soil (eg via machinery and earth works), and in the dung of grazing animals. Estimates from shire surveys in 2000 indicated that there are between 1,500 and 9,100 ha of weed leucaena in Queensland. Thus leucaena has not been an explosive weed and the area is small compared to the millions of hectares of weeds such as prickly acacia, rubber vine or lantana.

UQ

*Leucaena can be classed as an environmental weed when thickets reduce biodiversity.*

- A recent survey has shown that there has been little escape of leucaena from central Queensland cattle properties since commercial plantings of leucaena commenced in the early 1980s. This is due to the control of seedlings and seed production by grazing cattle.
- Leucaena in Australia has some efficient insect predators such as the leucaena psyllid, a flower-eating caterpillar, and the seed-eating bruchid beetle.

To promote the responsible use of leucaena and allay the fears of environmentalists, The Leucaena Network has developed a Code of Practice.




*The weed status of leucaena in Queensland has been reviewed in this publication by the Department of Natural Resources and Mines 2003 (ISBN 0 7345 2452 8).*

## 6.2 The Code of Practice

The Leucaena Network has developed a voluntary 'Code of Practice for the Sustainable Use of Leucaena-based Pasture in Queensland'. Key tenets of the Code of Practice are:

- Leucaena should only be planted for use as forage for livestock.
- Only commercial cultivars of *L. leucocephala* ssp. *glabrata* should be planted and the weedy subspecies should be eradicated.
- Graziers should plan carefully where leucaena is planted, ensuring there is well-grassed and regularly grazed pasture between leucaena paddocks and boundary fences and watercourses. A buffer of at least 10 m should be maintained between hedgerows and boundary fencing.
- Graziers should manage grazing pressure or mechanically cut leucaena to ensure plants are kept within reach of cattle. Grazing cattle consume flowers or green pods and prevent seed production.
- Maintain a vigorous grass component in the inter-row, to prevent seedling recruitment and to provide cover to prevent soil erosion. An absence of grass can result in soil acidification over time (20 years) on lighter soils.

UQ

*Maintain vigorous grass in the interrow to prevent seedlings developing into a thicket.*

- Control unwanted seedlings that volunteer elsewhere on your property or that escape onto roadsides or neighbouring properties. Escaped leucaena is the responsibility of the grazier who owns the 'source' paddock.
- Report leucaena weed infestations to local government authorities.

CHM

*The ungrazed leucaena on the right has escaped from the paddock onto the roadside.*

Do not plant leucaena within 10 m of a boundary fence.

The owner of the source should treat any escapees with herbicide before they seed.

Full details of the Code of Practice can be found in Appendix 2.

## Government Policy

In November 2004, the DPI&F, NR&M and Environmental Protection Agency agreed on a Queensland State Government 'Policy to Reduce the Weed Threat of Leucaena' (see Appendix 3). The Leucaena Network lobbied this committee to ensure a reasonable outcome was achieved for graziers. In effect, the policy recognizes the value of leucaena as a pasture plant for the northern Australian beef industry but also its environmental weed potential. The policy has endorsed The Leucaena Network's Code of Practice; however, some of their recommendations are more stringent. This policy and voluntary compliance with the Code of Practice will be reviewed every three years. In 2007, The Leucaena Network will have to renegotiate the terms of the policy with the government departments. The policy also endorses the future development of sterile or less seedy leucaena hybrids that will further reduce the environmental weed potential of leucaena.

Local governments also have an important role to play in regulating the use of leucaena. They can declare leucaena a weed and restrict its use under local law provisions, and planting leucaena has been banned in some shires, for example Longreach. Shire councils are the bodies responsible for controlling weeds on Crown land. The Leucaena Network has unsuccessfully tried to get a uniform policy regarding the weed status of leucaena from the Local Government Association of Queensland. It has been working successfully with individual shire councils to eradicate localised weed leucaena infestations.

# 6.3 Control of unwanted plants

The common weedy leucaena should be killed wherever it occurs. Plants of the forage types should also be killed when they escape the paddock boundary and appear outside the fence along the roadside because they are highly visible and recognisable.

## Chemical control

For a woody plant, leucaena is not difficult to control with tree-killing herbicide in the appropriate formulation and applied in the appropriate manner; however, only one herbicide is currently registered for the control of leucaena in pastures and non-crop areas. Access® herbicide (containing the active ingredients triclopyr and picloram) is registered for basal bark and cut stump application in a 60:1 dilution with diesel oil (table 6.1). Basal bark application kills trees with stems less than 5 cm in diameter.

*Table 6.1 Herbicides registered in Queensland for the control of leucaena*

| Method | Herbicide | Rate |
|---|---|---|
| Basal bark | triclopyr (240 g/L) + picloram (120 g/L) e.g. Access® | 1 L per 60 L diesel (for plants with stem diameter <5 cm) |
| Cut and paint | triclopyr (240 g/L) + picloram (120 g/L) | 1 L per 60 L diesel |

Although the plant is easy to kill, the difficulty lies in permanent eradication of a species that can drop large amounts of hard seed that can stay viable in the soil for 5–10 years. Regardless of which method is used, regular follow-up treatments of thickets will be needed to kill seedlings as they emerge and before they mature and set seed.

Seedlings and lush regrowth from cut stumps can be killed by foliar applications of glyphosate but this also kills any surrounding grass leaving a bare patch for recolonisation by more leucaena seedlings.

## Mechanical control

Leucaena is difficult to kill by physically damaging the trees with fire or machine as it regrows vigorously from the roots and crown. Cutting plants at ground level allows them to coppice from the crown. Established leucaena plants must be ripped out by cutting off the roots below ground level using, for example, a blade plough. Regular treatment of seedlings growing from the hard seed in the soil could be necessary without the competition from a vigorous pasture and grazing animals.

# 6.4 Leucaena, salinity and water quality

Leucaena hedgerows have been shown to have beneficial impact on the hydrology of catchments. Contoured hedgerows of leucaena have reduced run-off and soil erosion in India, Africa and the Philippines. This effect has also been observed in central Queensland where established leucaena pastures reduce run-off and sedimentation after high intensity rainfall.

Another value of leucaena in catchments is its ability to mimic the water use of the original native woodland vegetation, thus preventing the development of dryland salinity by restricting deep drainage of excess rainfall.

In central Queensland, leucaena in established leucaena/grass hedgerows has root systems similar to native tree root systems in terms of rooting depth and water use (figure 6.1), and can lower water tables to combat dryland salinity.

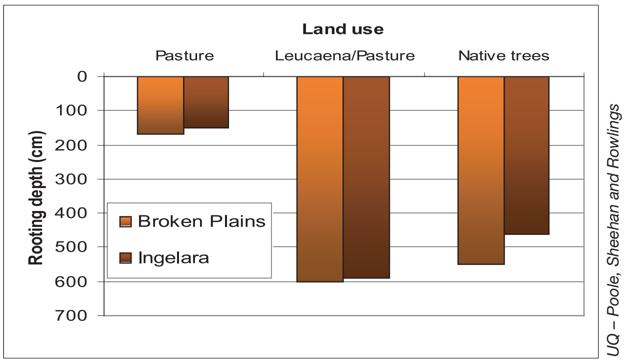



*Figure 6.1 Rooting depth of native trees, leucaena and grass pasture in central Queensland*

Leucaena systems extract water from deeper in the profile and have greater water use than annual crops (figure 6.2).

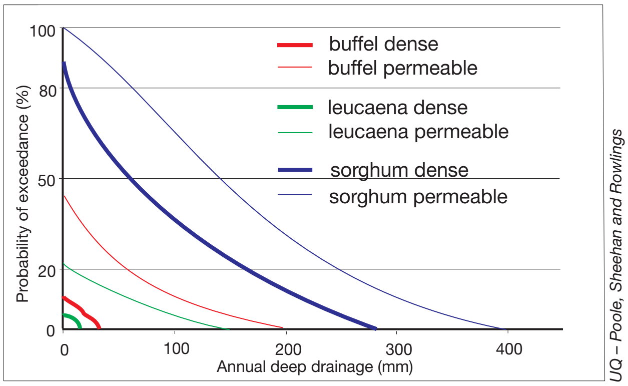



*Figure 6.2 Probability of deep drainage under buffel grass pasture, leucaena–buffel grass pasture and sorghum on dense and permeable soils (simulated with 100 years of rainfall).*

The soil under leucaena and under buffel grass had much lower risks of deep drainage (5% and 10% respectively) than the soil under sorghum (65% probability) with its short growing period.

This potential has been observed on a beef cattle property where localised salinity broke out at the base of a slope after the 1974 wet season. The saline seepage disappeared within two years of leucaena being planted over 220 ha of the recharge area in 1980.

## 6.5 Leucaena and greenhouse gases

Much carbon dioxide has been released over the decades through tree clearing and burning. Planting the long-lived small woody tree leucaena serves as a carbon sink, partly substituting for the loss of the original brigalow vegetation. Leucaena pastures sequester about 500 kg carbon/ha/year in the first four years. In addition, planting a tree in an ecosystem that previously supported woody brigalow scrub ensures that ecosystem processes are maintained.

Cattle emit methane from the rumen as part of the inefficient fermentation and digestion of fibrous grass. The improved quality of the ruminants' diet when cattle eat leucaena reduces methane emissions.

## 6.6 Other benefits

Leucaena pastures can also enhance the environment by revitalising the fertility of degraded soils by contributing biologically fixed nitrogen. The fine root system of the strong grass growth improves soil structure in the inter-row.

Leucaena pastures offer graziers the opportunity to intensify production in an environmentally sustainable manner. Leucaena/grass pastures are persistent and productive at higher stocking rates. Beef production is 4–6 times higher than from the best native pastures. This enables cattle to be moved off ecologically vulnerable native pastures and vulnerable riparian zones, preventing land degradation and contributing to conservation and biodiversity, whilst maintaining overall farm productivity and profitability.

The drought tolerance of deep-rooted leucaena can protect property owners against the worst effects of drought, provided stocking rates are moderate.

# THE LEUCAENA NETWORK

*"Promoting the responsible development of leucaena in sustainable and productive grazing and agroforestry systems to build stronger rural communities."*

The Leucaena Network was formed in Biloela in July 2000, primarily to counter the anti-leucaena movement within the environmental lobby. With assistance from the Department of Primary Industries and Fisheries and the University of Queensland, The Leucaena Network developed a Code of Practice which is designed to ensure the responsible management of leucaena to maximise beef cattle production and minimise the weed risk to the environment.

Our charter is to "promote the responsible development of leucaena in sustainable and productive grazing and agroforestry systems to build stronger rural communities".

Other advocacy roles have been adopted in response to obvious opportunities and industry needs (eg tree clearing issues and the National Action Plan for Salinity and Water Quality). Our policy is to be proactive rather than reactive.

The Executive and Management are elected at the Annual General Meeting; specialists are invited by the Executive to attend and contribute to meetings held every two months. The Executive Officer has received an honorarium payment from MLA, but all other operational expenses are paid from income derived from membership fees and industry support.

## Responsible development of leucaena

As mentioned, there is great concern in sections of the community about the spread of weedy leucaena in coastal peri-urban environments. The Network encourages the eradication of these highly visible infestations.

The Leucaena Network became involved in the weed debate not because we accept responsibility for these feral stands, as they did not originate from grazier plantings, but because we want to protect the reputation of commercial leucaena. Without addressing this issue, the weed stigma hinders the promotion of leucaena as a valuable forage plant.

The more graziers can demonstrate 'responsible development and utilisation' of leucaena by adhering to the Code of Practice, the more the leucaena industry will be able to establish its environmental credibility with the broader community.

## Other Network activities and projects

Responsible development also includes maximising the potential benefits of the leucaena/grass pasture system through research activities to address current production limitations and environmental issues. The Network has currently sponsored three MLA-funded projects with the University of Queensland with a value of over $700,000. The first project is to breed a new hybrid variety of leucaena that will be resistant to the psyllid insect pest. The second project is to investigate the causes and extent of leucaena toxicity in Queensland, and the third is the production of this graziers guide on establishment and management of leucaena.

The Network is currently promoting research projects to:

1. understand the rumen ecology of the leucaena bug (*S. jonesii*) to prevent leucaena toxicity
2. investigate and correct nutrient rundown in leucaena pastures to enhance the long-term productivity and sustainability of the system
3. quantify the impact of leucaena/grass pastures on dryland salinity, soil erosion and water quality
4. develop sterile *Leucaena* varieties for timber, biomass (fuel wood for renewable energy) and grazing in high rainfall coastal environments.

## Promotional activities

The Network has used a wide range of methods to promote the adoption and research and development of leucaena/grass pastures in Queensland.

Submissions and other promotional correspondence have been made to:

- the Productivity Commission
- House of Representatives Standing Committee on Science and Innovation
- Conservation Council
- Local Government Associations and Pest Management Committees
- Landcare
- Agforce.

In addition, we have had good exposure in the press. Field days and seminars are a major facet of our operation, as is the series of *Leucaena for Profit and Sustainability* courses. The University of Queensland, the Rural Press and the DPIF have all contributed. The Network has also worked with organisations such as the Tropical Grassland Society, along with consulting and agribusiness companies. The Network produces several newsletters and hosts its Annual General Meeting and Conference each year.

## Membership

We recommend that you join The Leucaena Network as our continued effectiveness, both financial and political, depends upon an enlarged membership base. Currently the Network has 120 members from a potential membership base of more than 500 (made up of current leucaena growers and other relevant agribusiness partners). Further promotion of The Leucaena Network and the valuable work it is doing on behalf of the grazing industry is required to boost grass roots support.

Those involved in or interested in the potential for leucaena are invited to join "The Leucaena Network" to keep abreast of new findings about its establishment and management and attend a *Leucaena for Profit and Sustainability* training course.

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*Training activities in the 'Leucaena for Profit and Sustainability' courses involve talks, exercises and field studies.*

Contact:
The Executive Officer
Phone: 07 4939 5711
Fax: 07 4939 8122
email: keithmcl@bigpond.net.au

# The Leucaena Network Code of Practice

A Code of Practice for the Sustainable Use of Leucaena/grass Pasture Systems in Queensland

## Preamble

Leucaena (*Leucaena leucocephala* subspecies *glabrata*), when planted with grass, provides the most productive, profitable and sustainable grazing system available in northern Australia. Leucaena has been grown commercially in Queensland since the early 1970s; it has been widely adopted by the beef industry and its use is increasing. Queensland's Environment Protection Agency, Department of Natural Resources Mines and Water, Department of Primary Industries and Fisheries and the grazing industry have accepted that leucaena is a valuable forage plant. Natural resource management agencies have officially sanctioned its planting for grazing.

## Attributes of leucaena/grass pastures

### Animal nutrition

- Extremely high nutritive value (similar to lucerne), suitable for ruminant animals only.
- Excellent palatability and digestibility, with high protein content (>20% crude protein).
- No bloat problems and efficient protein utilisation by animals (by-pass protein).

### Agronomic

- Highly productive pasture system for northern Australia, with long-term sustainability.
- Deep rooted, providing drought reserve forage.
- Low maintenance and long productive life (more than 40 years).

### Beef production

- High liveweight gains of growing cattle (250-300 kg/head/year).
- Reduced age of turn-off—superior meat quality.
- Flexibility to satisfy all domestic and export market specifications.
- Overcomes winter/dry season shortfall in feed quality and helps to target best market prices.
- High-quality nutrition for breeders – increased branding rates and weaner performance.

### Environmental

- Leucaena is a perennial, deep-rooted leguminous tree and maintains soil nutrient status and hydrological balances similar to the brigalow ecosystem it has replaced.
- Fixes nitrogen and restores soil fertility in run-down pasture and cropping country.
- Low risk of soil acidification on fertile clay soils.
- Prevents soil erosion when combined with a vigorous grass.
- Deep root system prevents deep drainage of water in catchment recharge areas thus ameliorating dryland salinity.
- Accumulates carbon in its woody stems and roots.
- Lowers methane emissions from cattle through more efficient digestion.

### Weed potential

The most significant weed trait of leucaena is its potential to produce hard seed. Any ripe seed that escapes flower-eating caterpillars and bruchid beetles can remain viable for several years. If leucaena escapes to ungrazed areas, over time it can form dense thickets.

The major weed threat comes from ungrazed 'common' weedy leucaena (*L. leucocephala* subspecies *leucocephala*). This has been naturalised in coastal and urban areas for more than 100 years—long before the release of commercial cultivars for grazing. However, it must be noted that commercial leucaena cultivars have similar weed potential. When planted as ungrazed ornamentals in urban areas, plants can contribute to the weed threat. Commercial leucaena pastures must not be allowed to contribute to the weed problem.

## Purpose of the Code

The Code aims to promote the responsible, sustainable and productive development of leucaena/grass pastures. The Code should be adopted by all graziers and natural resource management agencies.

### Features of the Code

The Code targets those features of leucaena that predispose it to weediness, and advocates management to limit their impact.

### Aims of the Code

- Restrict leucaena planting near potential weed risk zones.
- Minimise seed production in grazed stands.
- Diminish the risks of live seed dispersal.
- Control escaped plants from grazed stands.

### Tenets of the Code

1. Plant leucaena only if you intend to graze it and are prepared to manage it.
2. Do not plant leucaena near creeks or major watercourses.
3. Maintain a dense grass buffer between leucaena plantings and creeks or boundary fences.
4. Control escaped leucaena seedlings and plants:
   - on creek banks and other adjoining areas where cattle do not normally have access
   - on public roadsides (after first obtaining a permit from Main Roads or Shire Council).
5. Fully fence leucaena paddocks to avoid the risk of stock spreading ripe seed.
6. Keep leucaena at least 10 m away from external fence lines.
7. Replant poorly established leucaena (this cannot be remedied by encouraging ripe seed drop).
8. Graze or cut leucaena to keep it within reach of animals and so minimise seed set.
9. Graze leucaena strategically to minimise flowering and seed set.
10. Establish vigorous grass in the inter-rows to:
    - provide competition to minimise establishment of leucaena seedlings
    - use the excess fixed nitrogen the system produces
    - provide ground cover and prevent soil erosion.
11. Do not plant leucaena in pure stands with no grass as:
    - the system is more prone to soil erosion
    - it may acidify light soils over time.
12. Be familiar with any local law that may have been established, and assist your local government agency to identify any escaped or feral leucaena so that action can be taken to control it.
13. Give a copy of this Code to all who should have an interest in the responsible establish-ment and management of leucaena.

THE LEUCAENA NETWORK

*"Promoting the responsible development of leucaena in sustainable and productive grazing and agroforestry systems to build stronger rural communities."*

# Policy to Reduce the Weed Threat of Leucaena

## (LPG/2005/1910 – November 2004)

## Position Statement

Leucaena is recognised as valuable forage when managed properly, but it constitutes a threat to the natural environment if not contained in those areas in which it has been planted, or controlled in those areas that it has invaded.

Leucaena should only be planted in situations where containment is feasible.

The planting of leucaena for any purpose other than as highly managed and well contained forage is not supported by Government agencies, and should be discouraged.

## 1. Purpose of the policy

This policy addresses the need for land use management recommendations over the location, design and management of plantings of the shrub legume leucaena to reduce the weed risk. The policy has been developed by Government agencies with responsibilities for natural resource management following consultation with industry, local governments and community groups.

## 2. Background information on leucaena

2.1. *Leucaena leucocephala* originates from Central America and the Yucatan Peninsula of Mexico.

2.2. There are two main subspecies of *Leucaena leucocephala* ssp. *leucocephala* and ssp. *glabrata*. The other subspecies, *ixtahuacana*, is of no economic consequence at this stage.

2.3. Subspecies *leucocephala* is shrubby, low growing and much branched. It sets copious amounts of seed, and is often weedy. Originally referred to as the “Hawaiian type”, it is now preferably referred to as “Common”. This subspecies is naturalised in many of the islands of the Pacific and in South East Asia. The Spanish carried leucaena from Mexico to the Philippines between 1565 and about 1800, probably as forage for livestock. From there leucaena was taken to other parts of the Pacific for use as fuel wood, and for shade protection of crops such as coffee, cocoa, pepper and vanilla. During the nineteenth century, it was taken to Hawaii, Fiji, northern Australia, India, East and West Africa, and islands of the Caribbean. It was naturalised in northern Australia by 1920.

2.4. All cultivated varieties in Queensland belong to ssp. *glabrata*. Systematic evaluation for forage potential of this species commenced in Australia in 1955, initial work being carried out by CSIRO at Samford. Cultivars Peru and El Salvador were endorsed for release by the Queensland Herbage Plant Liaison Committee in 1962, cv. Cunningham, an intra-subspecific hybrid was released in 1976, and cv. Tarramba in 1994.

2.5. *L. leucocephala* has been planted for road embankment stabilisation and in gardens. These plantings have contributed to the spread of the species.

2.6. It is recognised that leucaena forage is extremely palatable, with a nutritive value similar to that of lucerne. Growth rates of cattle grazing leucaena are greater than those from other tropical forages. Once established, it provides the basis for a low maintenance system of producing high quality finished beef off pasture, making it a valuable tool in helping producers meet domestic and export market specifications without the use of less cost-effective cropping or feed lotting.

2.7. The Global Invasive Species Database lists *Leucaena leucocephala* among "One Hundred of the World's Worst Invasive Alien Species", although in Queensland weedy infestations are currently limited to relatively small areas across the state. Leucaena is potentially a serious environmental weed of riparian areas of coastal Queensland and is also becoming recognised as an important weed in non-coastal areas. Much of the current weediness concern may be attributable to naturalised *Leucaena leucocephala* ssp. *leucocephala*, which has been present in Queensland for more than 100 years. However, the cultivated varieties of *Leucaena leucocephala* ssp. *glabrata*, first introduced in the 1950s, also have potential to become weeds. This subspecies being present in some infestations, especially inland and in southeast Queensland.

2.8. Inadvertent spread of leucaena beyond the planted area can be avoided through appropriate site selection, careful grazing management of the stand, and vigilance on the part of the landholder or those responsible for initial establishment.

2.9. Potentially, browsing by cattle and attack by several insect predators [the leucaena psyllid (*Heteropsylla cubana*), a flower caterpillar (*Ithome lassula*), and the seed eating bruchid beetle (*Acanthoscelides macrophthalmus*)] can reduce seeding and the spread of weedy infestations. Insect predators are known to reduce, but not eliminate weediness potential. Management of leucaena stands should aim to minimise seed set and movement of seed from the stand. Alternatively, spread by seed could be eliminated by the development of sterile inter-specific hybrids.

2.10. Chemical means of control are available.

2.11. A consortium of leucaena growers has established the 'Leucaena Network' to highlight the benefits of the species and promote its responsible management through a Code of Practice.

2.12. The species is currently being promoted as a method of mitigating dryland salinity because it is a deep-rooted perennial.

## 3. Controls on Leucaena

3.1. There are no statewide controls on the planting and management of leucaena. *Leucaena leucocephala* is not a declared species under the *Land Protection (Pests and Stock Route Management) Act 2002*, although several Local Governments have declared the species under the local law provisions of the *Local Government Act 1993.*

3.2. Potentially, Local Governments could define establishment of leucaena plantations as amaterial change of use under the *Integrated Planning Act 1997*.

3.3. The '*Code of Practice for the Sustainable Use of Leucaena-based Pasture in Queensland*' developed and promoted by the Leucaena Network provides a farmer-initiated framework for the management and containment of leucaena. This code includes many of the issues contained in this policy.

## 4. Future advice

This policy addresses only general issues and principles. These will be expanded as necessary in supporting guidelines prepared in consultation with industry and community stakeholders.

Compliance with voluntary codes and this policy will be reviewed within three years of the finalisation of the document.

## Policy Principles

1. The precautionary principle of Ecologically Sustainable Development should be observed in the planting and management of *Leucaena leucocephala* to reduce the weed risk.

2. That *L. leucocephala* ssp. *leucocephala* should not be planted.

3. That planting of *L. leucocephala* ssp. *glabrata* should only occur under intensive management for fodder production.

4. Due to the potential impact of *L. leucocephala* ssp. *glabrata* on the environment, the following areas should be kept clear of the species:

- flood zones of creeks, waterways and other drainage lines or a minimum of 200 m from these waterways so that seeds will not be carried into the watercourse, and
- at least 20 m from any boundary fence line.

5. It is the landholder's responsibility to ensure that leucaena is not transported beyond the sown area, e.g. through the management of stock movement.

6. Responsibility for the control of 'escaped' or 'unused' *Leucaena leucocephala* ssp. *glabrata* lies with the person or agency owning the source stand.

7. All Queensland Government extension material relevant to leucaena will highlight the ecological risks, as well as the production and other benefits, associated with managing leucaena and the recommended control and mitigation techniques.

8. The development of sterile commercial cultivars will be encouraged, including material for timber plantations.

## Adoption of the policy

The Queensland Interagency Pest Management Committee endorsed the policy in April 2004. The Directors General of the Department of Natural Resources and Mines, Environment Protection Agency and the Department of Primary Industries and Fisheries approved the policy in November 2004.

## Availability of the policy

To receive a copy of the policy call, 07 3405 5541 or facsimile 07 350 5551 or write to the address below:

Land Protection

Department of Natural Resources and Mines

GPO Box 2454, Brisbane Qld 4001

An electronic copy of the policy is available from the Department's Internet web site at:

*http://www.nrm.qld.gov.au/pests/index.html*

Leucaena Policy – November 2004

# Further reading

## Books


Gutteridge, RC and Shelton, HM (1994). *Forage Tree Legumes in Tropical Agriculture*. CAB International, Wallingford, UK, 389 p.

Hughes, CE (1998). *Leucaena – A Genetic Resources Handbook.* Tropical Forestry Papers 37, Oxford Forestry Institute, UK, 274 p.

Hughes, CE (1998). *Monograph of Leucaena* (Leguminosae – Mimosoideae). Systematic Botany Monographs Volume 55, The American Society of Plant Taxonomists, 244 p.

Shelton, HM (2005). Forage tree legume perspectives. In Reynolds, S.G and Frame, J. (eds) *Grasslands: Developments, Opportunities, Perspectives*. FAO Rome, Science Publishers, Inc Plymouth UK, pp 81-108.

Shelton, HM, Gutteridge, RC, Mullen, BF and Bray, RA (1998). *Leucaena – Adaptation, Quality and Farming Systems*. ACIAR Proceedings No. 86. The Australian Centre for International Agricultural Research, Canberra, 358 p.

Shelton, HM, Piggin, CM and Brewbaker, JL (1994). *Leucaena – Opportunities and Limitations*. ACIAR Proceedings No. 57. The Australian Centre for International Agricultural Research, Canberra, 241 p.

Walton, CS (2003). *Leucaena (*Leucaena leucocephala*) in Queensland*. Pest Status Review Series – Land Protection. Queensland Department of Natural Resources and Mines, Brisbane, 51 p.


## Internet resources and fact sheets

***Tropical Forages****: Selection of Forages for the Tropics* – http://www.tropicalforages.info/index.htm


Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M. and Schultze-Kraft, R. 2005. Tropical Forages: an interactive selection tool., [CD-ROM], CSIRO, DPI&F(Qld), CIAT and ILRI, Brisbane, Australia. ISBN 0 643 09231 5.


For fact sheets on:

- *Leucaena diversifolia*
- *Leucaena leucocephala*
- *Leucaena pallida*
- *Leucaena* spp. artificial hybrids
- *Leucaena trichandra*

and companion grasses:

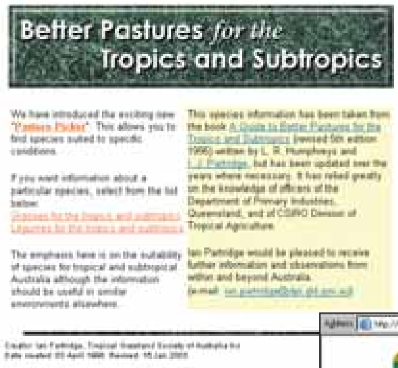
- *Bothriochloa insculpta* (creeping bluegrass)
- *Brachiaria decumbens* (signal grass)
- *Brachiaria humidicola* (Tully humidicola)
- *Cenchrus ciliaris* (buffel grass)
- *Chloris gayana* (Rhodes grass)
- *Dichanthium aristatum* (Floren bluegrass)
- *Dichanthium sericeum* (Queensland bluegrass)
- *Digitaria eriantha* (pangola)
- *Digitaria milanjiana* (Jarra digit grass)
- *Panicum coloratum* (Bambatsi)
- *Panicum maximum* (Gatton and green panic)
- *Setaria incrassata* (purple pigeon)



*(Right) Sample screens from Tropical Forages web site*

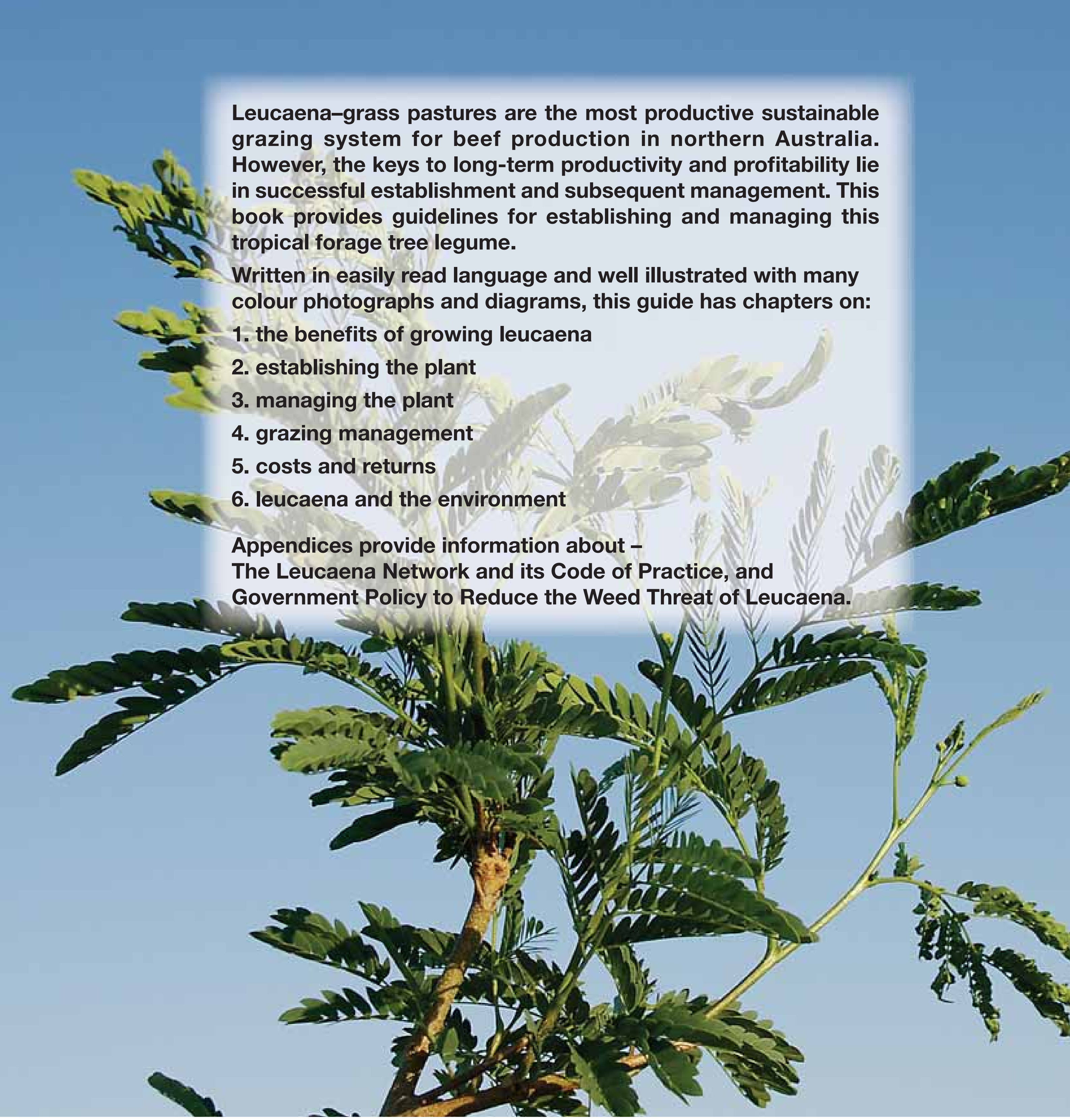
***Pasture Picker***: *Better Pastures for the Tropics and Subtropics in northern Australia* developed by the Tropical Grassland Society of Australia Inc.

http://www.tropicalgrasslands.asn.au/pastures






*Sample screens from Pasture Picker selection tool and typical fact sheet*



**Leucaena–grass pastures are the most productive sustainable grazing system for beef production in northern Australia. However, the keys to long-term productivity and profitability lie in successful establishment and subsequent management. This book provides guidelines for establishing and managing this tropical forage tree legume.**

**Written in easily read language and well illustrated with many colour photographs and diagrams, this guide has chapters on:**

1. **the benefits of growing leucaena**
2. **establishing the plant**
3. **managing the plant**
4. **grazing management**
5. **costs and returns**
6. **leucaena and the environment**

**Appendices provide information about –**
**The Leucaena Network and its Code of Practice, and**
**Government Policy to Reduce the Weed Threat of Leucaena.**

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