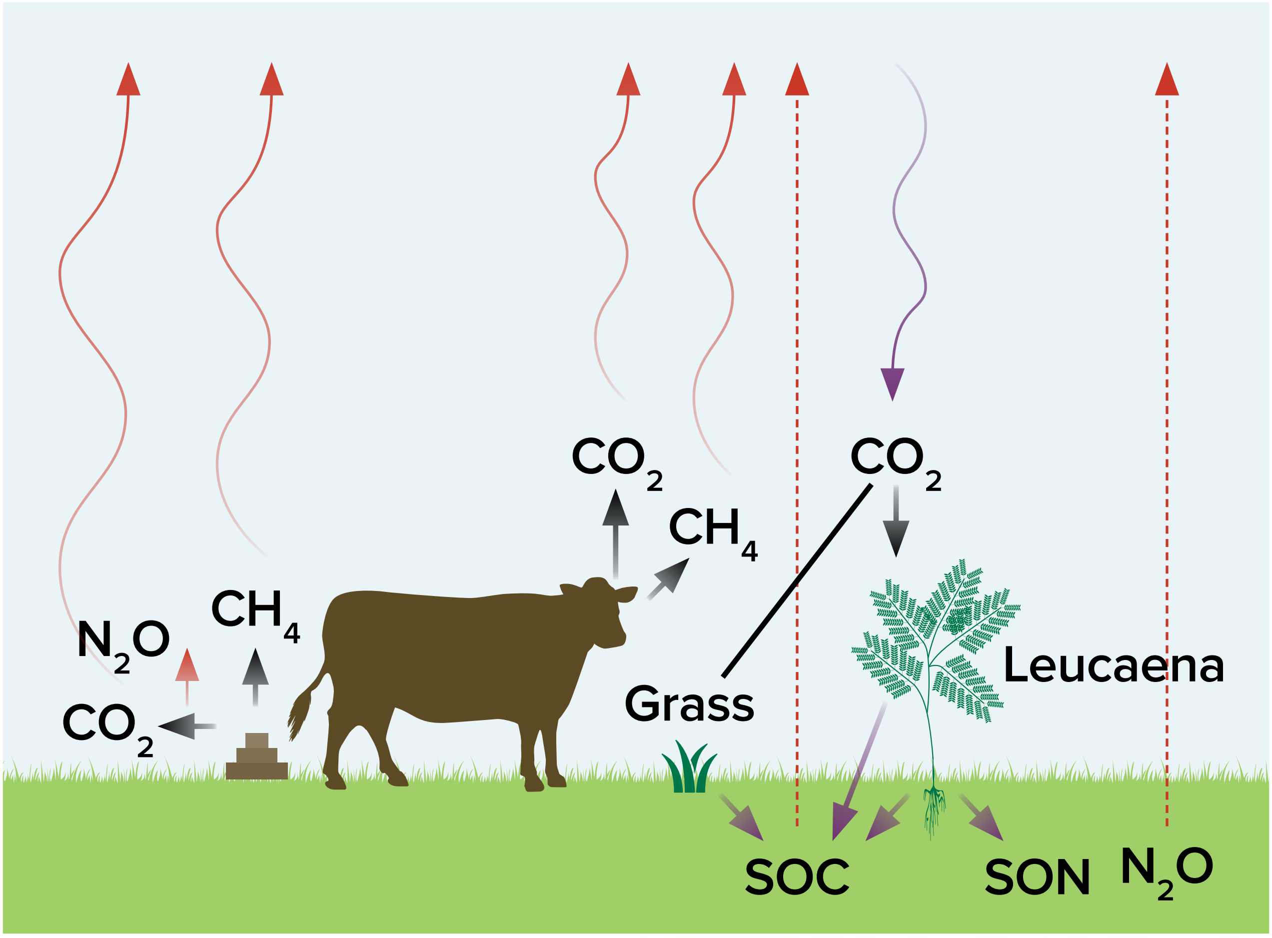
7. Leucaena and the grazing environment



Chapter 7. Leucaena and the grazing environment

7. Leucaena and the grazing environment

There are important environmental implications with planting and maintaining an improved grazing system based on leucaena. Such a long-term grazing system influences the physical, social and economic characteristics of the local environment, with both positive and negative impacts.

The environmental considerations associated with a perennial leucaena-grass pasture are:

Positive

Leucaena systems:

- are a long-term sustainable shrub-based pasture option
- are a significant drought mitigation strategy which can provide a bank of dry season biomass when managed appropriately
- improve ground cover which reduces the potential for runoff and erosion
- respond quickly following drought-breaking rainfall
- provide shade and shelter, and mitigate seasonal feed gaps, thereby improving animal welfare
- improve soil fertility through accretion of soil carbon and nitrogen
- improve pasture biodiversity, especially when combined with trees
- reduce methane emission intensities from beef production
- reduce dryland salinity and improve water quality
- can be managed proactively through adoption of The Leucaena Network Code of Practice

Negative

- There is an ongoing weed issue associated with non-cultivated leucaena.
- There is inconsistency between local and state government policy in the control of weed leucaena.

7.1 Sustainable production system, drought mitigation, animal welfare

Leucaena pastures are unique among animal production systems in the tropics and subtropics in that they offer graziers the opportunity to intensify production in a sustainable manner. Leucaena-grass pastures are persistent, productive and allow higher stocking rates than grass-only pastures when managed appropriately.

Beef production can be up to four times greater than from unimproved native pastures; this enables cattle to be moved off ecologically vulnerable native pastures and out of riparian zones.

This approach to grazing management prevents land degradation and contributes to conservation and biodiversity of dedicated sites whilst maintaining overall farm productivity and profitability.

The extensive root system of leucaena allows the plant to use water deeper in the soil profile and so produces high quality green leaf during dry periods in summer, autumn and early winter – or until frosted. Property owners using leucaena report improved and near consistent growth rates in animal production during dry times, with rapid leaf growth when rainfall breaks the drought.

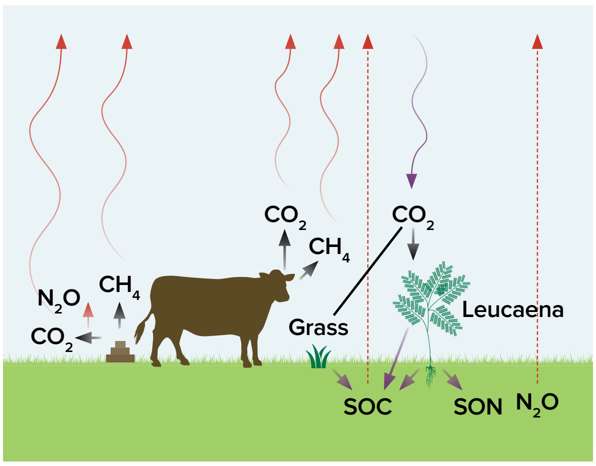
7.2 Greenhouse gases and soil carbon

As ruminants, cattle emit methane as part of the fermentation and digestion of a highly fibrous diet.

Direct livestock emissions account for around 10 per cent of Australia's greenhouse gas emissions (GHG). Ruminant livestock are responsible for approximately 65% of total emissions from the agriculture sector.

Methane and nitrous oxide are significant GHG with significantly greater global warming potential than carbon dioxide. Reducing enteric methane and nitrous oxide emissions from livestock will help reduce Australia's overall GHG emissions and mitigate future climate change.

Figure 7.1: Emissions and sequestration under a leucaena-grass grazing system



Adoption of a leucaena-based production systems by the Australian beef industry has multiple benefits. In addition to better productivity for livestock, leucaena contains secondary compounds that effectively lower enteric methane production by about 20% compared to a grass-only diet.

Measuring methane emitted from cattle fed leucaena-grass diets

These compounds include mimosine, flavanol glycosides and condensed tannins, and result in subtle, but significant, changes to the rumen microbial populations.

Generally the rumen microbiomes share similar bacterial taxa, but the diversity of methanogens in the rumen of cattle grazing leucaena is significantly different from those grazing grass-only pastures. Some bacterial populations decrease, while others increase in abundance, resulting in more microbial protein synthesis and a change in fermentation patterns. This change in fermentation to end-products such as propionate, butyrate and branched-chain fatty acids can be associated with the redirection of energy into animal productivity (growth) and an alternative hydrogen sink, redirecting available hydrogen away from methane production.

Growth rates of cattle grazing leucaena-rhodes grass pastures are substantially higher and enteric methane production commensurately lower than those of cattle grazing a rhodes grass-dominated tropical grass pasture, particularly when the leucaena is irrigated.

As a perennial legume, leucaena fixes nitrogen and increases the store of carbon in the soil. Leucaena has the potential to sequester about 780kg carbon/ha/year in the first five years of growth through accumulation in its woody stem and roots; a further 8–10t carbon/ha can be stored under leucaena-grass pastures in the top 15cm of soil. Compared with old cropping country, sequestration with leucaena pastures is much higher and equates to about 3.9t carbon/ha. This can be a valuable input to newly developed grazing systems where soil organic matter has been depleted by years of previous cultivation for cropping.

Where soils are low in phosphorus and sulphur, nitrogen fixation and carbon storage can be improved by applying fertilisers.

The Commonwealth Emissions Reduction Fund presents an emissions mitigation opportunity for leucaena growers. The fund will credit abatement resulting from innovations which reduce emissions intensity by adopting new practices on-farm.

Modelling of leucaena-based production systems can provide estimates of the impacts on farm profitability of improved live weight gain, increased soil carbon storage, methane emission reduction and higher urinary nitrogen concentration.

Soil sampling has shown significant increases in soil carbon in grazed leucaena-grass pastures

To compute GHG emissions on a whole-farm basis, herd numbers and age/class structures can be used in static GHG emissions calculators, such as the Beef-Greenhouse Accounting Framework.

7.3 Leucaena, soil fertility, dryland salinity, erosion and water quality

Much of the nitrogen fixed by leucaena is returned to the soil reversing the 'nitrogen rundown' that occurs in pure-grass swards. Soil carbon is enhanced by the decomposing woody branches and leaf and root litter from both leucaena and inter-row grass growth. Leucaena pastures can revitalise the fertility and structure of degraded soils; however, the period for establishment and grazing on these soils may need to be extended.

Leucaena hedgerows have a beneficial impact on the hydrology of catchments. Leucaena planted across the slope (along contours) with vigorous grass cover between rows encourages water infiltration, decreases run-off and so reduces sediment load in local waterways. In central Queensland, established leucaena pastures have reduced run-off, soil loss and sedimentation after high intensity rainfall.

Contoured hedgerows of leucaena have also reduced run-off and soil erosion in farming systems in Indonesia and the Philippines.

Contoured leucaena encourages water infiltration and decreases run-off.

Leucaena in catchments can mimic the water use of the original native woodland vegetation, thus preventing the development of dryland salinity by restricting deep drainage of excess rainfall. Whereas the roots of grass can extract water from the soil to a depth of 1.5–2m, leucaena roots can pull water from 3–5m, thus preventing rising water tables bringing salt to the soil surface.

Contoured leucaena on sloping land reduces erosion in Indonesia.

Most leucaena roots are in the same soil zone (0–150cm) as companion grasses; however leucaena's ability to extract water from below this zone provides superior drought tolerance. There is less risk of deep drainage under leucaena-grass pastures than under annual crops, such as sorghum or wheat, due to the perennial nature and deep root systems.

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, and so can lower water tables to combat dryland salinity.

This 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 220ha of the recharge area in 1980.

7.4 Environmental benefits reported in other countries

Leucaena contributes to sustainable cattle production in Latin America under intensive silvopastoral systems. These combine high-density cultivation of leucaena (4,000–40,000 plants/ha) with grasses and timber trees. The layers of vegetation enhance habitat complexity and biodiversity.

Although the leucaena is managed to generate livestock products, significant leaf material deposited as litter on the soil has positive effects on soil properties and on biodiversity.

The silvopastoral system with leucaena supports more species of birds, ants, dung beetles and woody plants than conventional grass monocultures. It contributes to landscape-scale habitat connectivity and provides environmental services. Although these systems have been successfully implemented in Colombia, Mexico and other countries, they are currently adopted in a small area relative to the total available land suitable.

7.5 Leucaena – an environmental weed

While leucaena is recognised as a commercially valuable plant, it is also considered an environmental weed. Weedy leucaena can form dense thickets in previously disturbed areas and so reduce biodiversity, especially if it is not proactively managed or grazed.

Leucaena probably reached northern Australia via Papua New Guinea in the late 1800s, and it was reported that a weedy type of leucaena (*L. leucocephala* ssp. *leucocephala*) had become naturalised in coastal north Queensland by 1920. 'Common' leucaena is a weed of disturbed land in coastal Queensland, around the Gulf of Carpentaria and the Northern Territory. It grows on the banks of waterways, but cannot tolerate waterlogging.

The area of 'common' leucaena in northern Australia is relatively small despite it being present in northern landscapes for over 100 years.

While there has been some escape of leucaena from cattle properties since commercial plantings in the early 1980s, leucaena seed has also been deliberately spread to stabilise earth works along roads and approaches to bridges. It also spreads through the movement of seed pods in flowing water and in contaminated soil via machinery.

However, leucaena has not been an explosive weed compared to the millions of hectares of weeds such as prickly acacia, rubber vine or lantana.

Leucaena that has escaped from the paddock onto the roadside

The invasive nature of leucaena is due to its large seed production potential and relatively long-lived seed banks allowing it to spread initially between rows, and even outside planted paddocks into disturbed locations such as roadsides and riparian zones. These characteristics pose management challenges to landholders and relevant jurisdictions who acknowledge the value of commercial varieties but also the need to manage weedy types off farm.

Nevertheless, producers can employ various methods to control overgrown leucaena. The treatment of leucaena varies between local government agencies ranging from no action to formally recognising it as an environmental weed and applying requirements to minimise its impact.

7.6 The Leucaena Network and Code of Practice

The Leucaena Network has developed a voluntary 'Code of Practice for the Sustainable Use of Leucaena-based Pasture in Queensland' (see Appendix for details).

Aims of best management Code of Practice

- avoid planting leucaena near potential risk zones
- minimise seed set in grazed stands
- diminish the risk of seed dispersal
- control escaped plants from grazed stands.

The Leucaena Network Code of Practice recommends maintaining a vigorous grass in the inter-row. This aims to prevent seedlings establishing and thickening.

7.7 Government policy

Leucaena has been included in formal weed prioritisation and/or risk assessment processes in Australia to determine appropriate strategies to minimise its potential or current impacts.

While not declared a weed at a national or state/territory level in Australia, leucaena has been declared by several local government authorities in Queensland.

The weed status of leucaena in Queensland has been reviewed by the Department of Natural Resources and Mines in 2003 (see Further reading Appendix).

Control of weed leucaena

A voluntary **Code of Practice for best management of leucaena-based Pasture in Queensland** is promoted by The Leucaena Network. It aims to avoid planting leucaena near potential weed risk zones, minimise seed set in grazed stands, diminish the risk of live seed dispersal, and control escaped plants from grazed stands.

Other control options include:

- Selection of herbicides and development of a sterile leucaena variety.
- Control of excess height and seed production by grazing cattle and by periodic slashing.
- Insect predators such as the leucaena psyllid, a flower-eating caterpillar, and the seed-eating bruchid beetle but these are only partially effective.

Landholders and relevant jurisdictions in charge of invasive species need to work together to minimise its spread as a weed and manage existing infestations.

Relevant states and territories provide information such as fact sheets on the potential weed impacts of leucaena as well as options to control infestations. In Queensland, the Biosecurity Act 2014 legislates that everyone has a general biosecurity obligation to take reasonable and practical steps to minimise the risks associated with invasive plants and animals under their control, including leucaena.

In Western Australia, leucaena has been classified as a high environmental weed risk for the Pilbara and Kimberley regions where it is not recommended for use on pastoral leases, but can be grown on freehold land (though this represents less than 2% of the area).

The recent investment in Australia by industry and government to develop sterile leucaena varieties is a positive and proactive initiative. Jurisdictions which currently ban or discourage the growing of leucaena may consider allowing the introduction of sterile varieties in certain situations. This would lead to an expansion of the leucaena industry not only in Australia, but also potentially in other countries where weed concerns are preventing it from being grown or promoted for commercial purposes.

7.8 Control of unwanted plants

Mechanical control

Dense stands of leucaena can be controlled using bulldozers with stick-rake or blade-plough attachments, or with forestry mulching machinery. However, ground disturbance is often followed by extensive seedling emergence.

Cutter bars that sever the root system below ground (at 30cm) will kill most plants but, if cut at ground level, most will re-shoot.

Some graziers blade plough between the hedgerows to control unwanted leucaena seedlings and to invigorate grass growth.

Herbicides

Effective herbicides for control of leucaena are currently under investigation. As with other woody weeds, highest mortality is achieved by controlling younger plants.

Application

Basal bark treatment is effective on larger plants. The stems are sprayed to a height of around 30–40cm from ground-level with herbicides mixed with diesel or oil-based products. Triclopyr/picloram (Access™) based product mixed with diesel is registered for both basal bark and cut stump applications on leucaena in Queensland.

Cutting plants at ground level and spraying the cut stem immediately afterwards is effective but expensive and impractical for large areas unless machinery such as a mulcher is used. The herbicide must be applied immediately after slashing.

Screening tests show that foliar applications of glyphosate, clopyralid and triclopyr/picloram-based products can kill leucaena but with variable results especially with larger plants. However, there are no current label registrations for any herbicides to be applied using foliar application in Australia. Permits have been approved for control of leucaena seedlings on mine rehabilitation sites using a foliar application of triclopyr/picloram (150/50g a.i./100L water).

In Australia, collaborative research between industry, producers, government and Dow AgroSciences (now DowDuPont) provide some promising results:

- Basal bark techniques (both the traditional and newer thin-line method which involves spraying a more concentrated mix to the bottom 5cm of stem) using triclopyr/picloram (Access™) consistently gave the best results.
- Cut stump applications of aminopyralid/metsulfuron-methyl (Stinger™) mixed with water and an aminopyralid/picloram gel (Vigilant™ II) provided greater than 80 and 60% efficacy, respectively.
- Ground applications of picloram granules (Tordon™ Granules) also show promise, with limited impact on surrounding grasses and legumes.

- Ineffective treatments included cut stump applications using glyphosate (Glyphosate 360®) and metsulfuron-methyl (Brush-Off®), gas gun applications using metsulfuron-methyl (Brush-Off®) and aminopyralid/metsulfuron-methyl (Stinger™) and ground applications of tebuthiuron (Graslan®) and hexazinone (Velpar® L).

Fire is not a control option for leucaena and often results in large-scale seedling regrowth unless combined with follow-up control.

Biological control

A seed-consuming bruchid beetle (*Acanthoscelides macrophthalmus*) has become established in many countries including Australia but its effectiveness is variable.

The sap-sucking psyllid (*Heteropsylla cubana*), accidentally introduced into many countries, has negative impacts on the productivity of leucaena, but has not reduced its weediness.

Grazing management plays an important role. As leucaena seedlings are not competitive, maintaining a strong grass pasture within the leucaena paddock and in surrounding buffer areas will greatly reduce spread into new areas.

Use of time-controlled grazing (short-duration high-density grazing) is effective for controlling height and reducing the amount of seed that can be dispersed. Periodic slashing of tall leucaena in paddocks will also reduce seed production.

In countries such as Indonesia and Thailand, intensive harvesting of naturalised (weed) leucaena for fuelwood and fodder has minimising the impacts and spread of leucaena.

Control of isolated or small patches of weed leucaena before they get the opportunity to spread and establish large and persistent seed banks is the best preventative strategy.

Mulcher used to control leucaena plant height and hence reduce seed production

7.9 Weed status in some other countries

While the native distribution of leucaena is mainly restricted to Mexico and Central America, a combination of deliberate and non-deliberate dispersal has led to it becoming a widely naturalised species around the world.

Leucaena is a widespread weed in all tropical Pacific islands, and indeed can be found in more than 125 countries.

Hawaii

Leucaena was introduced to Hawaii after European settlement and was spread widely through use for fuelwood and cattle fodder.

It has become naturalised and has spread into previously disturbed and drier habitats. Although it is much less common in intact native dry forests, its resilience to wild fires and grazing could threaten the integrity of remnant native dryland forest.

The succession in areas dominated by leucaena has not been well-studied but non-native, rather than native species, are more likely to replace it.

Because of its widespread distribution, especially on steep slopes, leucaena is a low priority for eradication or control.

Leucaena is widespread on steep slopes in Hawaii.

Eastern Indonesia

Leucaena has been present in Eastern Indonesia for well over seventy years and is regarded by communities as a highly beneficial plant with a multitude of uses.

These include livestock forage, firewood, building timber, as a vegetable for human consumption and has several medicinal uses.

While leucaena has a moderate risk of becoming weedy under an Australian weed risk assessment, local communities and authorities regard it as a resource and an economically valuable plant rather than as a pest.

They report that wider adoption of leucaena by local communities would discourage timber and forage cutting in conservation areas and reduce the pressure on existing forest resources.

Leucaena being harvested for cattle fattening in Eastern Indonesia

In Eastern Indonesia, where leucaena is regularly cut and harvested, it is unlikely to become weedy. Even in disturbed areas it is harvested regularly by locals and new seedlings are grazed by wandering livestock.

7.10 Soil acidification

Rates and sources of soil acidification under temperate legume pastures in southern Australia are well documented, but less is known about the soil acidification potential of tropical legume pastures.

Acidification occurs under pastures usually occurs as a result of:

- the accumulation and cycling of organic matter in the topsoil (0–15cm) and the release of carbonic and carboxylic acids
- legume roots extracting calcium, magnesium and potassium from lower in the soil profile for use in biological nitrogen fixation and excreting hydrogen into the rhizosphere
- the removal from the paddock of soil nutrients in livestock product or manure/urine
- leaching of excess nitrogen in nitrate or ammonia from the soil profile.

The high rates of nitrogen fixation and longevity of leucaena pastures have led to speculation that soil acidification could occur.

However, soil type (and buffering capacity) and environment also have a significant influence. Most acidification in the tropics occurs on light textured soil with neutral to slightly acid pH and in monsoon environments with relatively low grass production. These conditions are basically the opposite to those under which leucaena is planted in Australia – medium-heavy textured soils, neutral to alkaline soils with high buffering capacity, moderate rainfall and good grass growth.

Globally, leucaena is often found in high pH calcareous limestone-derived soils where acidification would not be a problem.

Little change in pH after nearly 40 years

The pH of a soil has not changed under a leucaena-green panic pasture grazed for more than 37 years.

Specifications at this site:

- Gayndah, subtropics, 730mm annual rainfall
- calcareous basaltic Vertosol soil with 60% clay content
- pH 1:5 soil:water 7–9.5
- CEC 65 meq/100g soil.

As this calcareous clay soil is similar to the alkaline, highly buffered cracking clay soils in which most leucaena is planted in Queensland, soil acidification is not likely to threaten the long-term sustainability of leucaena pastures.

However, leucaena established on lighter, poorly buffered soils of lower initial pH, particularly in high rainfall areas or under irrigation, may require applications of lime to prevent soil acidification suppressing leucaena growth and damaging soil chemical properties.

Globally, leucaena is often found in high pH calcareous limestone-derived soils where acidification will not be a problem.