

Economic Evaluation of Leucaena at Pinnarendi Station

In 2016 a project led by the Department of Agriculture and Fisheries was initiated to compare the growth of cattle grazing on Wondergraze leucaena and the newly released Redlands cultivar, which is resistant to the leucaena psyllid insect. The project also aimed to assess the viability of adopting leucaena on arable red earth soils, which have low native fertility but cover a large area of similar cleared land types in northern Queensland. This trial was conducted at Pinnarendi Station near Mount Garnet, with co-funding from Meat and Livestock

Australia through the Redlands for Regions project. This case study analyses data collected during the project to assess the profitability of two scenarios transitioning from a rundown stylo-buffel grass pasture to either

1. A renewed stylo-buffel pasture improved through regular fertilisation and wet season spelling or,
2. Establishing leucaena into the rundown pasture, also with regular fertilisation and spelling.

Were the Changes Profitable?

A 30-year discounted cash flow (DCF) investment analysis was conducted to assess the financial impact of transitioning to either scenario. The findings indicate both scenarios significantly enhance profitability compared to the rundown buffel-stylo paddock. The leucaena scenario, with higher initial costs and longer payback, yields a higher net present value (NPV) and annualised returns. The renewed pasture scenario, with lower initial costs and quicker payback, offers a higher internal rate of return (IRR), appealing to those seeking faster returns.

Table 1: Investment analysis results

	Leucaena	Renewed Pasture
Set up costs (nominal value)	\$307,706	\$129,333
Net Present Value (NPV)	\$728,625	\$285,046
Annualised NPV (per year)	\$47,398	\$18,543
Internal Rate of Return (%)	17.4	33.5
Payback period (years)	11	5
Breakeven initial cost outlay	\$1,036,331	\$414,379
Peak deficit with interest	-\$334,154	-\$91,956

Establishing leucaena on a 500-hectare rundown pasture

- Tripled carrying capacity
- 16% improvement in emissions intensity
- 86% improvement in annual LWG

Fertilising and spelling a 500-hectare rundown stylo-buffel pasture

- 1.5 x increased carrying capacity
- 5% improvement in emissions intensity
- 79% improvement in annual LWG



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Advantages of leucaena and stylo pastures

Sown leucaena pastures offer several advantages to beef enterprises, including higher stocking rates, increased liveweight gains, enhanced nutrition and soil health, and reduced emissions intensity compared to undeveloped pastures.¹ Leucaena, the most productive forage in central Queensland, shows potential for northern expansion, especially the new psyllid-tolerant 'Redlands' variety suitable for higher rainfall areas.²

Establishment Process

The analysis examines yearling steers entering the paddock at 235kg, that are then sold after 12 months as feed-on steers. Leucaena development required fallowing the paddock prior to sowing after turning off the last cohort of steers grazed on the rundown pasture, this marked the beginning of year 1 of development. Table 2 shows the grazing timeline for each scenario during implementation along with stocking rates and grazing periods in the initial 6 years.

Table 2: Grazing timeline with stocking rates and periods of grazing.

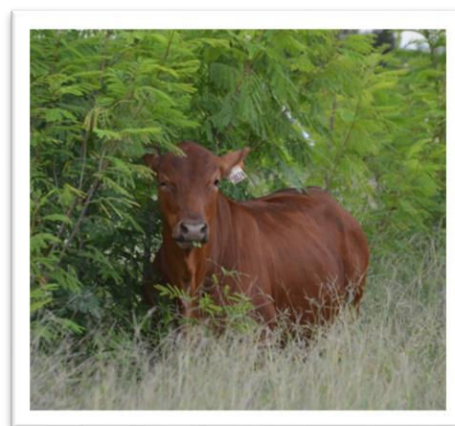
Year	Leucaena into existing pasture	Renewed pasture
1	No grazing – fallow paddock then plant leucaena	75% stocking 9 months
2	No grazing – (leucaena establishment phase)	Full stocking 12 months
3	Full stocking for 6 months	Full stocking 12 months
4	Full stocking for 9 months	Full stocking 9 months
5	Full stocking for 12 months	Full stocking 12 months
6	Full stocking* for 12 months (Then repeat year 4-6 to year 30)	Full stocking* 12 months (then repeat year 4-6 to year 30)

* Conservative stocking incorporates wet season spelling every third year

Initial costs

Table 3 details the costs involved in preparing the soil, planting, and weed control for the leucaena scenario as well as fertilising in both the leucaena and renewed pasture scenario. Input prices were sourced from local suppliers and operations were costed based off the producer's machinery costs, work rates and fuel use. Labour was costed at \$35/hour and diesel at \$1/litre (ex GST and rebate). Machinery costs included labour, fuel, oil, repairs, and maintenance if machinery was already owned. Depreciation, interest, travel, insurance, and storage costs plus profit were also included if the machinery was purchased to establish or manage the sown pastures, reflecting contractor rates.

Leucaena was planted in rows every ten metres. Assuming no establishment failure, the total cost to establish leucaena across the 500-ha paddock was \$313,207, or approximately \$626/ha. Leucaena was developed over 4 years at 125 hectares each year to better ensure manageable areas for reliable establishment. Native pasture was grazed on remaining paddocks until all paddocks were converted.



Pic 1: Steer shaded by leucaena at Pinnarendi Station

¹ Shelton, M., Dalzell, S., Tomkins, N., & Buck, S. R. (2021). Leucaena-The productive and sustainable forage legume.

² M.K Bowen, F. Chudleigh, J.W Rolfe and B.H English (2019) Northern Gulf Beef Production Systems. DCAP. 58-84.

Table 3: Operations and cost outlays to prepare the soil, plant and fertilise pasture and control weeds (500 ha costs.)

Leucaena Planting Operations	Renewed Pasture
1. Offset disc whole area (\$20,551), Dozing (\$34,875), one tyne cultivation (\$14,721) and apply glyphosate (e.g. Ultramax 570) (\$3,713) <i>Subtotal = \$73,860</i>	1. Fertilise whole area 200 kg/ha single superphosphate <i>Subtotal = \$95,433</i>
2. Plant leucaena (\$70,626), spray with imazethapyr (e.g. Spinnaker) (\$2,222) and fertilise leucaena rows with Super at 200kg/ha (\$31,591). <i>Subtotal = \$104,239</i>	
3. Tyne Cultivation (\$29,441). 200 kg/ha single Superphosphate application to interrow (\$101,092). Aerial Spraying Albatross* (\$9,663) <i>Subtotal = \$119,696</i>	
Total Cost = \$313,207	Total Cost = \$95,433

*Costed one in four years, reflecting incursion risk

Leucaena seed was planted at 1.5 kg/ha using a leucaena planter with seed priced at \$80/kg. Additionally, both scenarios required 4.5 km fencing (\$18,000) and three additional water points (\$15,900) which enabled annual wet season spelling and rotational grazing to ensure ongoing pasture productivity.

Ongoing Annual Costs

Table 4 shows the ongoing costs involved for both scenarios, including regular applications of fertilisers, mechanical pruning of leucaena to maintain accessibility for cattle, and other maintenance activities essential for sustaining pasture productivity and animal performance.

Table 4: Ongoing annual costs *(nominal values – not discounted to present value).

Leucaena strips (Grass Base)	Renewed Pasture (Buffel Stylo Mix)
Fertilise whole paddock with single superphosphate at 150 kg/ha once every 3rd year starting in Year 5. (\$73,683)	Fertilise whole paddock with single superphosphate at 150 kg/ha once every 3rd year starting in Year 5. (\$73,683)
Prune 125 ha of Leucaena every year from year 5 (\$9,499)	Fencing maintenance costs, 2% per year. (\$360)
Leucaena rumen inoculant (\$815)	Dry Season Supplement (\$2,125/yr).
Leucaena control, 16 hours labour per year. (\$560)	
Fencing maintenance costs, 2% per year. (\$360)	
\$10 per head for dry season supplementation (\$1,062)	
Additional costs over 30 years = \$803,515*	Additional costs over 30 years = \$733,776*



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Did forage and cattle production increase?

Table 5 outlines the key pasture production figures for each scenario. The underlying forage and grazing parameters used for each pasture were informed by Queensland government project data and local specialists. The renewed pasture scenario increased the sustainable stocking rate 1.6-fold, the leucaena scenario resulted in a 3.5-fold increase. Annual steer liveweight gains over the 12 months averaged 120 kg/hd on native pasture, 214 kg/hd on the renewed pasture and 223 kg/hd on leucaena.

Table 5: Key production figures *(established pasture).

Scenario	Rundown Pasture (Base)	Renewed Pasture (Buffel & Stylo)	Leucaena
Dry matter produced (kg/ha)	2,200	3,650	6,000
Pasture utilisation rate (%)	34	45	54
Dry matter Digestibility (%)	51	52	55
Steer liveweight gains (kg/yr)	120	214	223
Dry matter intake (kg/steer/day)	8	10.6	9.8
Dry matter eaten (kg/steer/yr)	2,909	3,865	3,588
Dry matter available (kg/ha)	740	1,643	3,240
Carrying capacity (ha/steer)	3.9	2.35	1.1
Steer mortality rates (% losses/yr)	2	2	1

Table 6 shows the average liveweight gains from when steers entered the paddock in May at approximately 235 kg to turnoff 12 months later – once each pasture was fully established. This table shows that the greatest improvement in pasture production occurs during the dry season, from May to October, enhancing business resilience and providing greater selling flexibility.

Table 6: Average liveweight gains over 12 months (kg/day).

Scenario	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Ave
Rundown Pasture	0.16	0.02	0.16	-0.03	-0.03	0.06	0.80	0.90	0.66	0.56	0.46	0.26	0.33
Renewed Pasture	0.37	0.3	0.22	0.2	0.24	0.42	0.71	1.1	1.23	1.1	0.7	0.5	0.59
Leucaena	0.55	0.24	0.10	0.15	0.35	0.45	0.85	1.12	1.14	1.02	0.75	0.65	0.61



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Table 7: Average production, sales, costs and gross margins.

Scenario	Native pasture	Stylo-grass	Leucaena & stylo-grass
Total steers carried (head/yr)	127	212	452
Mortalities (head/yr)	3	4	5
Steer sale weights (kg) – after weight loss to sale	330	418	426
Weaner purchases, freight & husbandry costs (\$/yr)	\$103,685	\$173,201	\$368,072
Increase in pasture costs (\$/yr)	\$0	\$25,303	\$28,697
Net cattle sales (\$/yr)	\$111,192	\$234,561	\$513,461
Gross margin (\$/yr)	\$3,014	\$51,370	\$126,640

* Net cattle sales = sales revenue less commission, levies, yard fees and freight.

Table 7 outlines the production and sales figures along with variable costs and gross margins for each scenario. All scenarios employed sustainable stocking strategies to graze the 500-ha paddock over 12 months. Cattle prices are 7-year averages recorded at North Queensland saleyards (2016-23). Weaner steers were purchased at \$3.39/kg (liveweight), while re-stocker steers were sold at \$2.93/kg (400-500 kg). Steers lost 7% of their weight during transport to sale. Both scenarios increased productivity, annual variable costs (weaner purchase and pasture costs) and net sales at paddock level, resulting in a \$51,370 improvement in gross margin for the renewed pasture and a \$126,640 improvement for leucaena.



Pic 2: Successful establishment of leucaena at Pinnarendi Station

What About Risk?

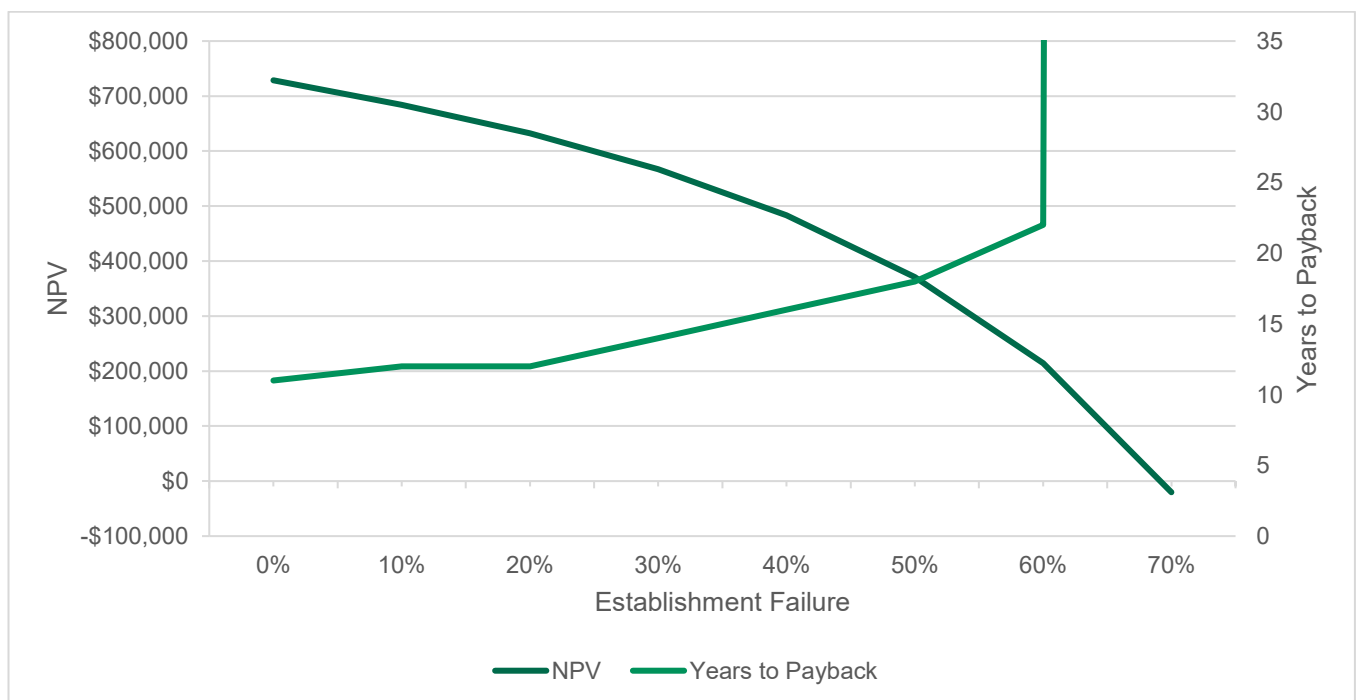
The processes described above should result in a low risk of establishment failure. However, to mitigate the risk of establishment failure during the sowing of leucaena and stylo, it is essential to consider several key factors, such as:

- Climatic suitability and the prognosis for suitable rainfall before and after sowing (SOI)
- Suitability of the site (soil fertility, depth and pH and whether cleared)
- Pests and diseases
- Weed competition

Figure 1 illustrates the financial consequences of establishment failures in sown pasture strategies, under the assumption that unsuccessful pastures are replanted in subsequent years until successful establishment is achieved. The graph demonstrates that the absence of establishment failure results in the highest profitability. Moreover, profitability decreases progressively with increasing rates of establishment failure, attributed to the escalating costs of soil preparation, replanting, and fertilisation required after repeated failures.

Specifically, the profitability of the sowing leucaena becomes negative if more than 70% of the area fails to establish during each replanting attempt. Adhering to established best practices can significantly reduce the risk of establishment failure. For detailed guidance on successfully establishing leucaena, please visit [How to Reliably Establish Leucaena](#).

Figure 1: Risk analysis: Effect of establishment failure on NPV



Environmental considerations including net carbon emissions

Legumes such as leucaena and stylo offer significant production advantages when grown in suitable environments. They enable more intensive production potentially contributing to an overall reduction in land usage, facilitating rehabilitation and conservation efforts in other areas of properties. Through a symbiotic relationship with nitrogen-fixing bacteria, legumes enhance soil vitality, fostering resilient and productive pastures⁴. The extensive root structures of leucaena and stylos can also stabilise soil, reducing erosion, and enhancing water infiltration. In doing so, they contribute to the preservation of water quality, an issue of particular importance in reef catchments.

The Australian Red Meat Industry has pledged to achieve carbon neutrality by 2030, making the impact of management practices on net carbon production increasingly important for producers. The successful introduction of climate-active carbon-neutral beef labelling highlights a growing consumer preference for sustainability in some markets, offering opportunities for premium pricing and green financing.

We assessed the carbon consequences of sowing stylo and leucaena on our 500-hectare paddock using the MLA (Meat & Livestock Australia) carbon calculator. The results for the full 30 years of analysis are presented in Table 8⁵.

Table 8: The estimated carbon emissions intensity of the three assessed scenarios based on the MLA carbon calculator (2024).

Scenario	Emissions Intensity (kg CO ₂ e / kg LW)	Cattle Carried (steady-state) Head / year
Rundown Pasture	13.9	127
Fertilised Rundown Pasture	13.2	212
Leucaena-Grass	11.6	452

The results indicate that these paddocks have become more efficient on an emissions intensity basis, as younger cattle reach target weight sooner. In the case of the leucaena-grass pasture, there were additional emissions intensity reductions due to leucaena's anti-methanogenic properties which reduce emissions for each kilogram of feed consumed⁶. However, the increase in the number of cattle carried (and beef produced) has increased aggregate emissions.

⁴ Shelton, M., & Dalzell, S. (2007). Production, economic and environmental benefits of leucaena pastures. *Tropical grasslands*, 41(3), 174.

⁵ Carbon calculator (2023) MLA. Available at: <https://carbon-calculator.mla.com.au/> (Accessed: 2023).

⁶ Alcock. Et al. (2015, March 30). Improving greenhouse gas emissions intensities of subtropical and tropical beef farming systems using Leucaena. *Agricultural Systems*.