# 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 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.

**Establishing leucaena on a 500 ha rundown pasture**

- **Tripled carrying capacity**
- **16% improvement in emissions intensity**
- **80% improvement in annual liveweight gain**

**Fertilising and spelling a 500-ha rundown stylo-buffel pasture**

- **1.5 x increased carrying capacity**
- **5% improvement in emissions intensity**
- **80% improvement in annual liveweight gain**

## 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 |

## 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 10 months | Full Stocking 12 months |
| 4 | Full stocking for full 12 months | Full Stocking 9 months |
| 5 | Full stocking for 9 months | Full Stocking 12 months |
| 6 | Full stocking* for full 12 months<br>(Then repeat year 5-6 to year 30) | Full Stocking* 12 months<br>(then repeat year 3-6 to year 30) |

* Full stocking incorporates wet season spelling 25% each year and 50% 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 on 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 10 m. Assuming no establishment failure, the total cost to establish leucaena across the 500-ha paddock was $269,464, or approximately $538/ha. Leucaena was developed over 4 years at 125 ha each year to better ensure manageable areas for reliable establishment. Native pasture was grazed on remaining paddocks until all paddocks were converted.

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[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)<br>*Subtotal = $73,860* | 1. Fertilise whole area 200 kg/ha single superphosphate<br>**Total Cost = $95,433** |
| 2. Plant leucaena ($70,626), spray with imazethapyr (e.g. Spinnaker) ($2,222) and fertilise leucaena rows with Super at 200kg/ha ($31,591).<br>*Subtotal = $104,239* | |
| 3. Tyne Cultivation ($29,441). 200 kg/ha single Superphosphate application to interrow ($101,092). Aerial Spraying Albatross* ($9,663)<br>*Subtotal = $119,696* | |
| **Total cost = $313,207** | |

*Costed one in four years, reflecting incursion risk

Leucaena seed was planted at 1.5 kg/ha using a leucaena planter with seed costed 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) | **Additional costs over 30 years = $733,776*** |
| Fencing maintenance costs, 2% per year. ($360) | |
| $10 per head for dry season supplementation ($1,062) | |
| **Additional costs over 30 years = $803,515*** | |

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 and Stylo) | Leucaena |
|---|---|---|---|
| Dry matter produced (kg/ha) | 2200 | 3,650 | 6,000 |
| Pasture utilisation rate (%) | 51 | 52 | 55 |
| Dry matter digestibility (%) | 49.5 | 55 | 55 |
| Steer liveweight gains (kg/yr) | 120 | 214 | 223 |
| Dry matter intake (kg/hd/day) | 8 | 10.6 | 9.8 |
| Dry matter eaten (kg/hd/yr) | 2,909 | 3,865 | 3,588 |
| Dry matter available (kg/ha) | 740 | 1643 | 3240 |
| Carrying capacity (ha/hd) | 3.9 | 2.35 | 1.1 |
| Steer mortality rates (% losses/yr) | 2 | 1 | 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).

| Diet | 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 | 0.16 |
| 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 | 0.37 |
| 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 | 0.55 |

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

| Scenario | Native pasture | Leucaena and stylo-grass | Stylo-grass |
|---|---|---|---|
| Total steers carried (hd/yr) | 127 | 212 | 452 |
| Mortalities (hd/yr) | 3 | 4 | 5 |
| Steer sale weights (kg) | 355 | 449 | 458 |
| Weaner purchases, freight and 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 8% of their weight during transport to sale. Both treatment scenarios had greater productivity, annual variable costs (weaner purchase and pasture costs) and net sales at paddock level, resulting in an $48,356 greater gross margin for the renewed pasture and a $123,626 greater gross margin for leucaena, relative to the native pasture.

## What About Risk?

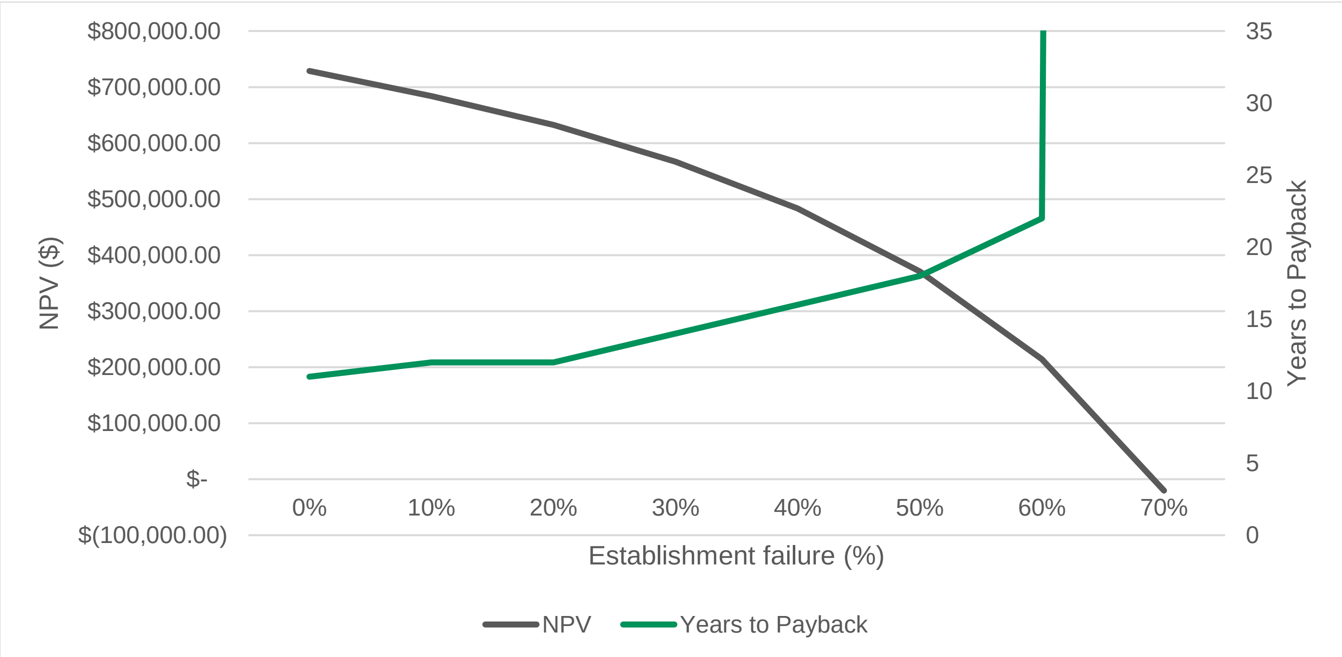
The processes described above should result in a low risk of establishment failure. However, to mitigate the risk of establishment failure during the sowing of leucaena and stylo, it's essential to consider several key factors, such as:

- Climatic suitability and the prognosis for suitable rainfall before and after sowing (SOI)
- Suitability of the site (soil fertility, depth, 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 Net Present Value (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 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 pastures[4]. 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-ha paddock using the Meat and Livestock Australia (MLA) carbon calculator. The results for the full 30 years of analysis are presented in Table 8[5].

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

| | Emissions Intensity | Cattle Carried(steady-state) |
|---|---|---|
| Rundown pasture | 13.9 kg $co_2e$ / kg LW | 127 hd/yr |
| Fertilised rundown pasture | 13.2 kg $co_2e$ / kg LW | 212 hd/yr |
| Leucaena-grass | 11.6 kg $co_2e$ / kg LW | 452 hd/yr |

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 consumed[6]. However, the increase in the number of cattle carried (and beef produced) 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.