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Central Queensland Biofuel Opportunities Report: Lantana camara and Leucaena leucocephala as Strategic Feedstocks

Prepared for: Donna Kirkland MP
Prepared by: Capricorn Conservation Council (CCC)
Prepared by: Sophie George (BEnvS BSBio)

Acknowledgement of Country

We respectfully acknowledge the Darumbal People as the Traditional Custodians of the lands and waters of the Rockhampton Region. We recognise their enduring connection to Country, culture and knowledge systems and pay our respects to Elders past, present and emerging. We emphasise that all future biofuel development must be undertaken in genuine partnership with Traditional Custodians and guided by cultural authority.

1. Introduction

The global transition toward renewable energy systems presents both a challenge and an opportunity for regional economies to redefine their role within emerging low-carbon industries. In Queensland, and particularly within Central Queensland, this transition is uniquely positioned to leverage existing agricultural systems, industrial infrastructure and extensive areas of degraded and invasive species-dominated landscapes to support the development of a sustainable biofuel sector.

Central Queensland presents a compelling case for second-generation biofuel development due to its capacity to utilise non-food lignocellulosic biomass, thereby avoiding competition with food production while addressing land degradation and invasive species proliferation. Species such as *Lantana camara* and *Leucaena leucocephala* represent highly viable feedstocks within this context, offering both high biomass productivity and favourable biochemical properties for conversion into bioethanol, biodiesel, biogas and biochar (Jain, Kunwar and Mittal, 2025; Aleman-Ramirez et al., 2022).

This report provides a technical and policy-aligned analysis of these feedstocks, situating them within the Queensland Energy Roadmap 2025 and associated biofuel mandates, while ensuring alignment with the Capricorn Conservation Council Strategic Plan 2026–2028 and CCC's broader advocacy for environmentally sustainable, socially equitable and culturally informed development pathways (Queensland Treasury, 2025; Capricorn Conservation Council, 2025).

2. Policy Context and Strategic Alignment

The Queensland Energy Roadmap 2025 outlines a comprehensive framework for transitioning the State's energy system toward a low-emissions future, emphasising reliability, affordability and sustainability (Queensland Treasury, 2025). Within this framework, biofuels are identified as a critical component of energy diversification, particularly in regional areas where agricultural and industrial systems can support feedstock production

and processing.

The implementation of biofuel mandates under Queensland legislation establishes a regulated demand for ethanol and biodiesel, creating market certainty and incentivising industry development (Queensland Government, 2024a). These mandates are reinforced by sustainability criteria requiring measurable greenhouse gas reductions and responsible land-use practices, ensuring that biofuel production contributes positively to environmental outcomes (Queensland Government, 2024c).

Importantly, Queensland's biofuel strategy is closely linked to regional economic development objectives, including the establishment of bioenergy hubs, investment in renewable fuel infrastructure and support for industry partnerships. This presents a significant opportunity for Central Queensland to position itself as a key contributor to the State's bioenergy future.

This policy direction aligns directly with the Capricorn Conservation Council Strategic Plan 2026–2028, which prioritises biodiversity protection, Indigenous leadership, science-based advocacy and a just and ethical renewable energy transition (Capricorn Conservation Council, 2025). CCC's submissions to government processes further emphasise that energy transition must not replicate extractive economic models, but instead deliver community benefit, environmental protection and long-term sustainability.

3. Scientific and Technical Basis for Biofuel Feedstocks

3.1 Lignocellulosic Biofuel Systems in Central Queensland

Lignocellulosic biomass represents one of the most promising pathways for sustainable biofuel production due to its abundance, high carbohydrate content and ability to utilise non-food feedstocks (Rijal et al., 2016). The conversion of lignocellulosic biomass into biofuel involves pre-treatment processes to break down complex plant structures, followed by enzymatic hydrolysis and fermentation to produce ethanol or other fuels.

Research conducted in Central Queensland demonstrates the technical feasibility of these systems, with biomass such as *Agave tequilana* achieving high glucose recovery and ethanol conversion efficiencies under optimised conditions (Rijal et al., 2016). These findings are directly transferable to other lignocellulosic feedstocks, including Lantana and Leucaena, which exhibit similar structural and biochemical properties.

The relevance of this research to Central Queensland cannot be overstated, as it confirms that regional climatic and environmental conditions are suitable for the development of second-generation biofuel systems at scale.

3.2 Lantana camara as a Strategic Feedstock

Lantana camara is widely recognised as one of the most problematic invasive species globally, with significant impacts on biodiversity, agricultural productivity and ecosystem function (Jain, Kunwar and Mittal, 2025). Its ability to dominate landscapes, suppress native vegetation and alter soil processes has resulted in widespread ecological degradation across tropical and subtropical regions.

However, emerging research highlights the potential to transform Lantana from an ecological

liability into a valuable bioresource. The species' high holocellulose content of approximately 61.1% supports its use in bioethanol production, while its favourable calorific value and low ash content enable its utilisation in solid biofuels such as briquettes and pellets (Jain, Kunwar and Mittal, 2025). In addition, Lantana biomass can be converted into biogas and biochar, contributing to circular bioeconomy systems.

Beyond energy production, Lantana demonstrates significant potential for environmental remediation, including phytoremediation of contaminated soils and improvement of soil nutrient dynamics (Jain, Kunwar and Mittal, 2025). Studies indicate that Lantana can enhance soil nitrogen availability, microbial activity and overall soil fertility, contributing to improved ecosystem function under controlled conditions.

In Central Queensland, the widespread presence of Lantana across degraded landscapes presents a unique opportunity to integrate invasive species management with biofuel production. By harvesting and converting Lantana biomass into energy products, it is possible to simultaneously reduce ecological impacts and generate economic value. This approach aligns strongly with CCC's strategic priorities and broader sustainability objectives, providing a pathway for environmental restoration that is both practical and economically viable.

3.3 Leucaena leucocephala as a High-Yield Bioenergy Resource

Leucaena leucocephala is a highly productive, nitrogen-fixing species with substantial potential for bioenergy production due to its high biomass yield, favourable chemical composition and adaptability to degraded environments (Aleman-Ramirez et al., 2022). Its high cellulose content supports efficient ethanol production, while its seeds and residual biomass enable biodiesel, biochar and activated carbon production within integrated biorefinery systems.

The species has been widely promoted within Central Queensland due to its capacity to improve soil fertility, increase pasture productivity and enhance carbon outcomes (Christensen, 2023). However, its invasive characteristics present significant risks when not carefully managed, particularly in landscapes where containment and monitoring frameworks are insufficient.

The expansion of Leucaena across Central Queensland has been actively driven through structured extension programs delivered by Fitzroy Basin Association in partnership with The Leucaena Network (Christensen, 2023). These programs have systematically encouraged large-scale adoption, reaching over 1,400 landholders and facilitating widespread establishment of Leucaena-based systems across the catchment (Christensen, 2023). This promotion has prioritised productivity and economic outcomes, often resulting in monoculture-style plantings at scale.

While these programs have delivered measurable agricultural benefits, they have also contributed to significant unintended ecological consequences. The extensive promotion and establishment of Leucaena has facilitated its spread beyond managed systems into surrounding ecosystems, including riparian zones and sensitive environments across the region. This reflects a failure to adequately integrate environmental risk assessment and long-term governance into program design and implementation.

The scale of adoption and subsequent spread indicates that the invasive potential of

Leucaena was not sufficiently mitigated, despite its well-documented characteristics. This highlights a broader systemic issue within regional natural resource management, where program delivery has prioritised short-term productivity gains over long-term ecological sustainability.

As a result, while Leucaena remains a valuable bioenergy feedstock, its continued use must be carefully managed within a more robust governance framework that includes containment, monitoring and diversified land-use strategies. Without this, further expansion risks exacerbating ecological degradation and undermining broader sustainability objectives.

4. Biorefinery Systems and Regional Industry Opportunity

The development of a biofuel industry in Central Queensland must be underpinned by integrated biorefinery systems capable of converting biomass into multiple high-value products. This approach maximises resource efficiency and economic viability while supporting circular economy principles (Aleman-Ramirez et al., 2022).

Central Queensland is uniquely positioned to support this model due to its existing industrial infrastructure, including sugar mills, agricultural processing facilities and fuel distribution networks. The conversion of existing infrastructure into biofuel production facilities presents a cost-effective pathway for industry development, reducing capital requirements while accelerating implementation.

The Queensland Government's investment in bioenergy hubs and renewable fuel infrastructure further supports this opportunity, providing a policy and funding framework for regional industry development (Queensland Government, 2024b). This creates a clear pathway for Central Queensland to emerge as a leader in sustainable biofuel production.

5. Land Use, Environmental Protection and Bioregional Planning

The sustainable development of biofuel systems requires careful land-use planning to ensure that environmental impacts are minimised and biodiversity is protected. Consistent with Queensland's bioregional planning framework, biofuel production should prioritise already cleared land, degraded landscapes and weed-infested areas (Queensland Government, 2024c).

The utilisation of Lantana directly contributes to ecosystem restoration by reducing invasive species coverage, while controlled Leucaena systems can support soil improvement when appropriately managed (Jain, Kunwar and Mittal, 2025; Christensen, 2023). However, the risks associated with poorly managed Leucaena expansion highlight the importance of integrating environmental safeguards into all biofuel development pathways.

6. Social, Economic and Cultural Outcomes

The development of a biofuel industry in Central Queensland presents significant opportunities for regional employment, economic diversification and community development. Workforce programs, including Skilling for Work, provide pathways for employment in land rehabilitation, biomass harvesting and environmental management, supporting both economic and ecological outcomes.

Importantly, biofuel development must be undertaken in partnership with Traditional

Custodians, ensuring that cultural values, knowledge systems and governance structures are embedded within project design and implementation (Capricorn Conservation Council, 2025).

7. Author Capability Statement

The author is an environmental scientist, biologist, educator and regional community leader with extensive experience in biodiversity conservation, environmental policy advocacy and Indigenous partnerships across Central Queensland. As Coordinator of Capricorn Conservation Council and a Lecturer at CQUniversity, the author brings a combination of scientific expertise, regional knowledge and practical implementation experience to the development of sustainable biofuel systems .

8. Conclusion

Central Queensland presents a unique and compelling opportunity to develop a sustainable biofuel industry that integrates environmental restoration, renewable energy production and regional economic development. The utilisation of Lantana camara and Leucaena leucocephala as feedstocks provides a pathway to achieve these outcomes, provided that development is guided by robust governance, scientific evidence and cultural authority.

Respectfully,

S George

Sophie George (BEnvSc BScBio)

Coordinator (Executive Officer)

Capricorn Conservation Council

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