BIOFERTILISER FROM ANAEROBIC DIGESTATE DERIVED FROM RED MEAT PROCESSING INDUSTRY WASTEWATER SLUDGE AND BY-PRODUCTS

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KEYWORDS
Biofertiliser, Resource Recovery, Circular Economy, Digestate

EXECUTIVE SUMMARY

In response to environmental regulations, red meat processors are transitioning to modern wastewater treatment and resource recovery. Diverting organic by-products and wastewater sludge into anaerobic digesters produces biogas and nutrient-rich digestate, enhancing sustainability. However, managing liquid digestate is challenging, leading to an investigation into solid biofertiliser production for marketability and regulatory approval. Feasibility is assessed through mass balances, technology analysis, market research, digestate characterisation, cost benefit analysis and regulatory review. Biofertilisers can foster a circular economy, replacing fossil-fuel-derived fertilisers, reducing waste disposal and carbon footprints while creating jobs and generating income through biofertiliser sale, carbon credits and other products.

INTRODUCTION

In response to strict environmental regulations, the Australian red meat processing industry is transitioning from traditional pond wastewater treatment to modern systems. Additionally, a shift in industry mindset, by viewing by-products as valuable resources instead of waste, has unlocked an opportunity: resource recovery from red meat production solid by-products and wastewater sludge. By directing these resources into anaerobic digesters, high-energy biogas and nutrient-rich digestate are produced, enhancing industry sustainability. The Australian Meat Processor Corporation (AMPC) has funded this biofertiliser research project as part of the Bio-Resource Recovery Facility initiative, where putrescible by-products and sludges undergo anaerobic digestion to yield energy via methane production. The biofertiliser project focuses on the feasibility of converting digestate into solid biofertiliser pellets, creating a marketable product and reducing disposal costs and environmental impacts. This project aims to assess the feasibility of producing biofertiliser from anaerobic digestate at red meat processing facilities, paving the way for sustainability, efficiency, and environmental benefits.

Full project implementation could replace up to 3% of Australian fossil-fuel-based fertilisers, reduce waste disposal, and significantly reduce carbon footprints by offsetting synthetic fertiliser production and off-gassing, waste transport and landfill decomposition, and reducing fossil fuel use in meat production. The biofertiliser plant runs on renewable energy produced by the integrated facility's anaerobic digesters. Biofertiliser application enriches soil organic matter, improving carbon depletion, and can further foster a circular economy by nourishing co-digestible energy crops, completing the cycle. Project implementation provides social benefits like resource management, enabling facility expansion and live export reduction, creating industries and job growth, and reducing reliance on rock phosphate mining in developing nations. Financially, it lowers waste disposal costs, generates revenue from biofertiliser sales and carbon credits, and creates income from other integrated facility products, including non-potable water, biogas, energy, heat, and recovered CO2.

HIGHLIGHTS

- Biofertiliser facilities offer financial and ESG benefits
- Biofertiliser markets: municipal, NRM, landcare, mining, forestry, and commercial

- Nutrient-rich, lower pathogens & contaminants than biosolids, enabling many reuses
- Digestate conversion to biofertiliser cuts logistic costs, gains regulator support
- Absence of biofertiliser regulations; base new framework on biosolids guidelines

METHODOLOGY

A feasibility study was conducted on the production of biofertiliser from anaerobic digestate at red meat processing facilities. This included a mass balance study, technology analysis, market research, supply vs demand analysis, preliminary digestate characterisation, cost benefit analysis and regulatory review. Eleven strategically chosen red meat processing facilities across Australia were analysed for potential biofertiliser production and market insights. Literature on biofertiliser production from red meat processing by-products was reviewed, including technologies, costs, regulations, and market potential. To gauge market interest in biofertiliser, potential end-users and stakeholders in various sectors were surveyed. Digestate characterisation tests evaluated nutrient content, quality, contaminants, and pathogens, with an aim to ensure regulatory compliance and identify optimisation prospects. Testing included an example facility's anaerobic pond sludge, and various mixtures of lamb and beef offal, digester inoculum and grain dust (for co-digestion potential). A cost benefit analysis for producing biofertiliser was conducted, and a review of national and global biofertiliser regulations was undertaken. Different business models for funding and operating the biofertiliser facility were explored, considering advantages and associated risks. A multi-criteria assessment confirmed project viability.

OUTCOMES

The mass balance indicated there is potential for sustainable fertiliser production; if all 127+ AMPC member facilities adopt anaerobic digestion and biofertiliser plants, up to 3% of Australia's fertiliser demand can be met. The literature review showed that technology for digestate processing is available, with achievable capital and operating costs. Income from biofertiliser, biogas, heat, energy, high-quality water, and carbon credits drive a positive investment return, together with reduced waste disposal costs. Surveys revealed interest from Natural Resource Management, forestry, commercial sales, and mine rehabilitation sectors, with market demand exceeding potential production. Digestate tests resulted in positive nutrient ratios and content comparable to commercial soil conditioners, with potential for tailored nutrient enrichment. Digestate quality surpassed municipal biosolids, in terms of pathogens and contaminants, indicating versatile reuse options. In the absence of biofertiliser regulations, municipal biosolids guidelines can be used as a base on which to develop new regulations. A positive cost benefit analysis supports solid biofertiliser pellet production from liquid digestate.

CONCLUSION

The outcomes of the feasibility study showed that producing biofertiliser at red meat processors will create financial, environmental and social benefits, establish a circular economy and contribute to sustainable fertiliser production. Processing liquid digestate in a biofertiliser facility results in a product that is easier and cheaper to manage. Markets with the greatest demand for biofertiliser are municipal, Natural Resource Management, Landcare, and mining sectors. End-user surveys showed that the most interested potential biofertiliser users are in the forestry, commercial, Natural Resource Management, and mining sectors. The most suitable biofertiliser production method is to mechanically dewater the digestate and then thermally dry it into biofertiliser pellets. Digestate composition was found to be nutrient-rich and can be tailored to suit specific user requirements. Low pathogen and contaminant levels will allow a wide range of biofertiliser reuse opportunities. Biofertiliser regulations do not currently exist, however it is recommended to use municipal biosolids guidelines as a guide to create a new framework with regulators. The cost benefit analysis showed a positive return on investment. Several business models for funding and operating are available, and a positive multi criteria assessment shows the project should proceed with further stages. Biofertiliser production at red meat processors offers cost recovery, a shift towards sustainability and the establishment of a circular economy. This study guides integrated Bio-Resource Recovery Facility designs at red meat processors, demonstrating how industries can transform by-products to support a circular economy, recover valuable resources, and progress towards Net Zero targets by reducing carbon footprints. Embracing the use of biofertilisers not only nourishes soils and crops sustainably, but also closes the loop on waste streams, creating a regenerative circular economy for future generations.

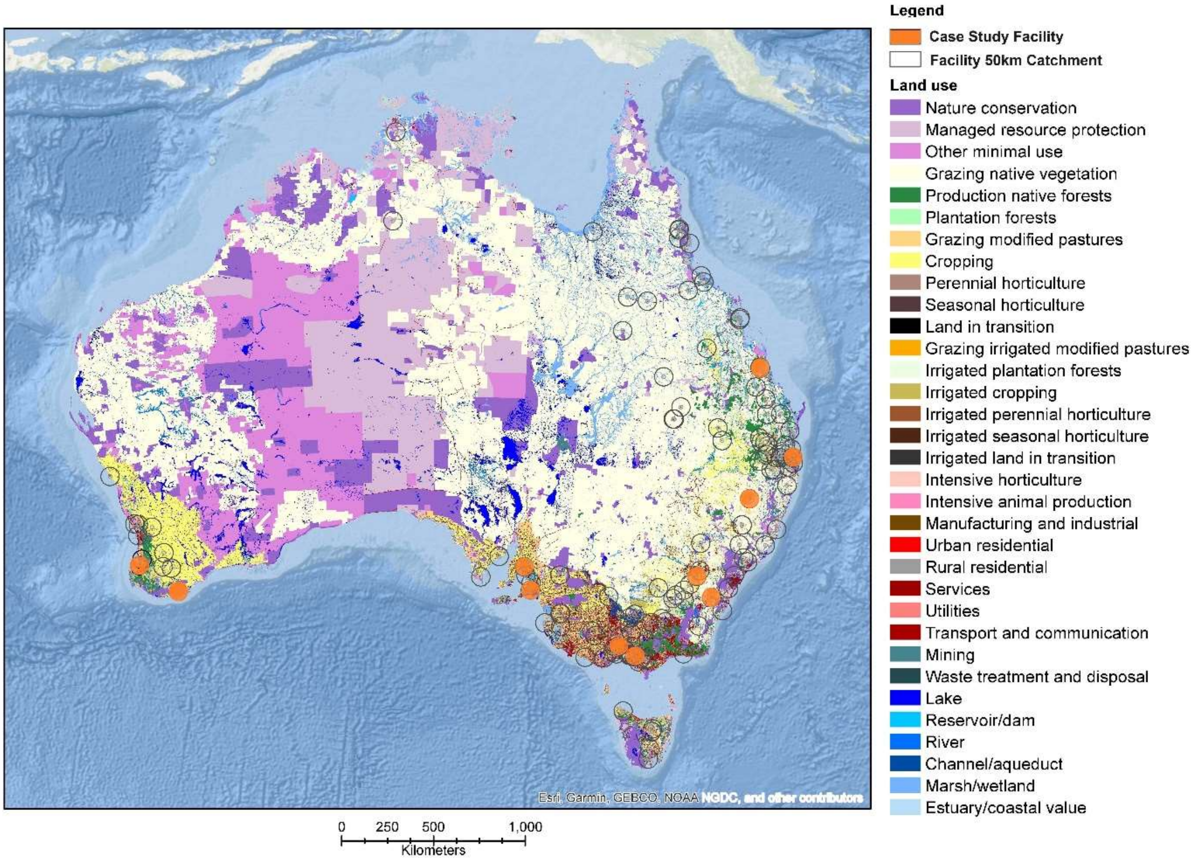


Figure 1: Eleven AMPC Member Case Study Facilities for Detailed Analysis

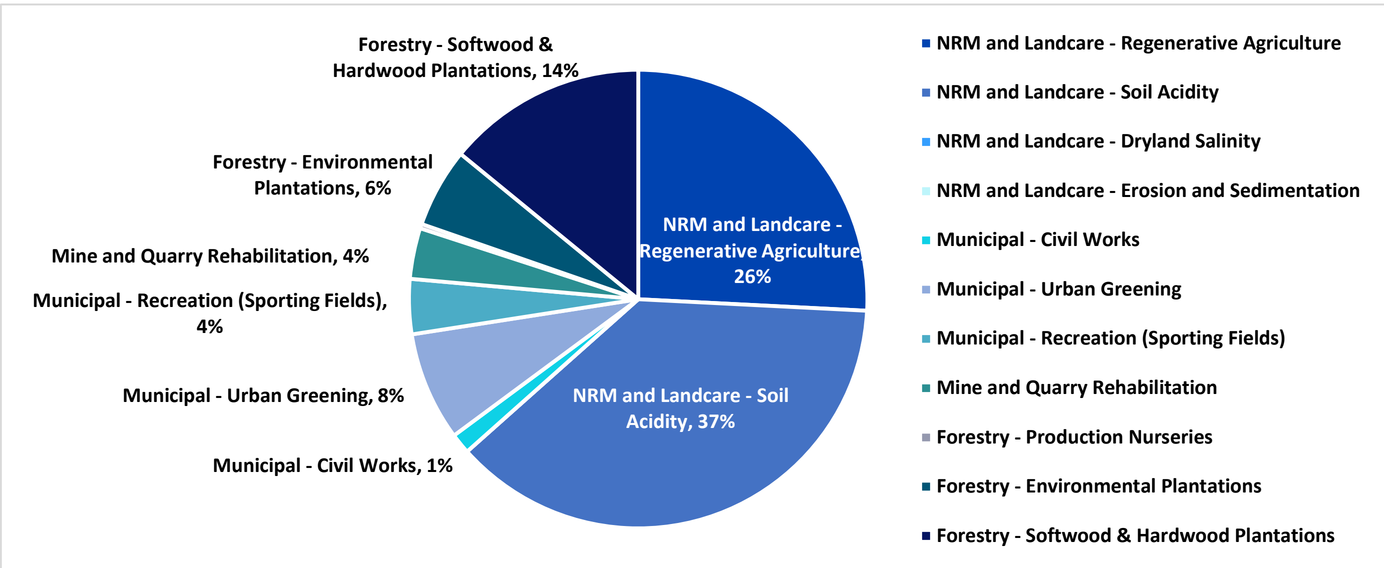


Figure 2: Proportional Land Uses Near AMPC Member Facilities Suitable for Biofertiliser Application

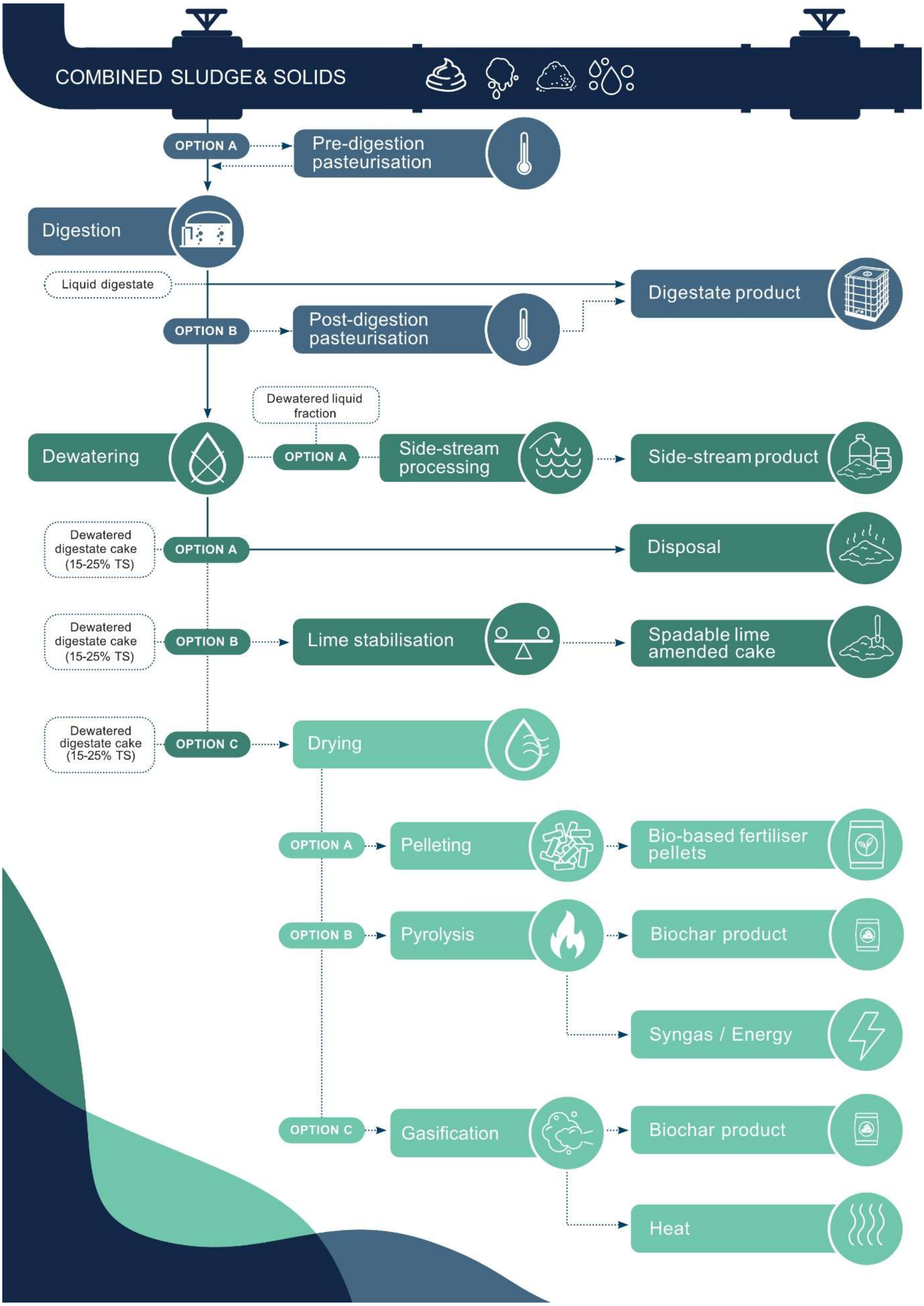
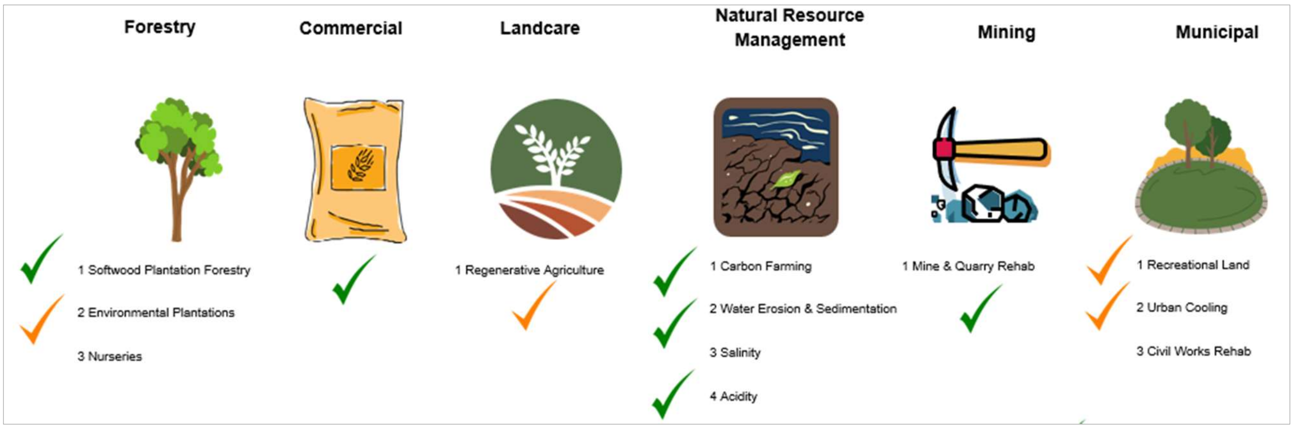


Figure 3: Liquid Anaerobic Digestate Processing Options to Produce Biofertiliser



Legend:

✓ High potential demand

✓ Growing sectoral demand

Figure 4: End-User Survey Results for Sectoral Biofertiliser Demand Potential

Table 1: Indicative Red Meat Processor Digestate Contaminant and Pathogen Characteristics vs. Municipal Biosolids Classifications

Parameters	UOM	Red Meat Processor Digestate	Biosolids Grade P1/T1/A and C1/A*	Biosolids Grade P2/T2/B and C2/B*
Total solids	%w/w	26%	>15%TS	>15%TS
As	mg/kg	<1	20	60
Cd	mg/kg	<0.3	2	20
Cr	mg/kg	36	100-400 (for Cr III)	500- 3000 (for Cr III)
Cu	mg/kg	160	100-200	2500
Pb	mg/kg	13	150 - 300	420
Ni	mg/kg	15	60	270
Se	mg/kg	7**	3	50
Zn	mg/kg	960	200 - 250	2500
Hg	mg/kg	<0.05	1	15
E. coli	MPN/g	<100	<100	<1000
Faecal Coliforms	MPN/g	240,000	<1,000	<2,000,000

*Municipal Biosolids Guidelines were reviewed across Australia, with comparative classification limits consolidated in this table.