Bio-based Fertiliser from Anaerobic Digestate Derived from Red Meat Processing Industry By-products

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Abstract: In response to environmental regulations, Australian 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 bio-based fertiliser production for marketability and regulatory approval. Feasibility is assessed through mass balances, technology analysis, market research, digestate characterisation, cost benefit analysis and regulatory review. Bio-based fertilisers 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.

Keywords: Biofertiliser; Resource Recovery; Red Meat Industry

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 (BRF) 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 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. Project implementation provides social benefits like resource management, enabling facility expansion and live export reduction, creating industries and job growth, and reduced rock phosphate mining. 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.

Material and Methods

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 (see the findings in Figure 1 and Figure 2).

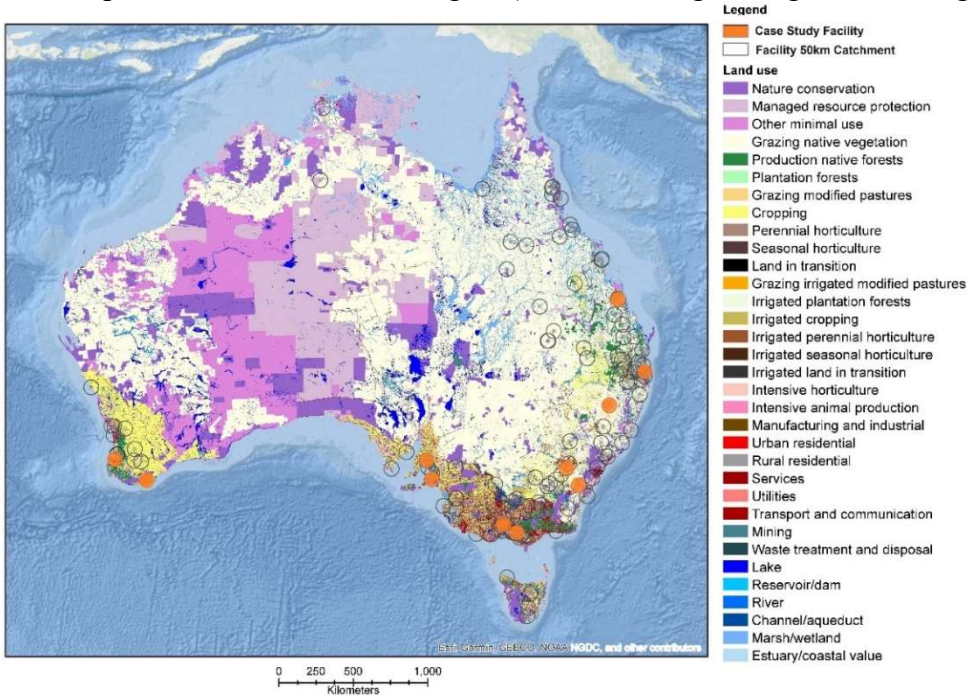

Figure 1: AMPC Member Facilities for Analysis

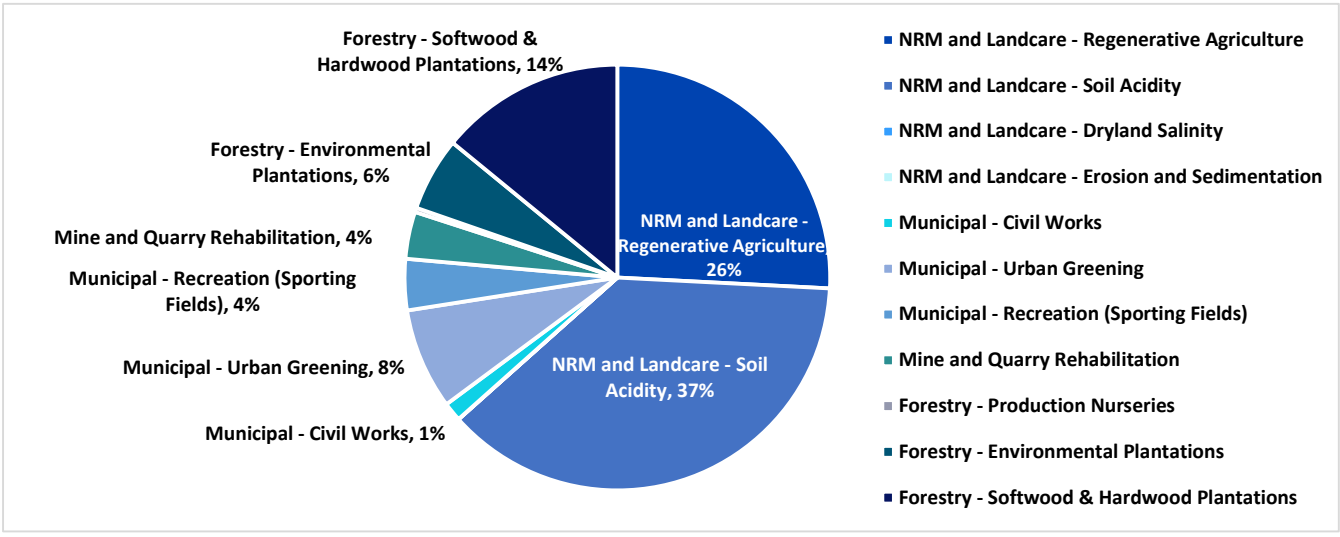

Figure 2: Land Uses Near AMPC Member Facilities for Biofertiliser Application

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. Refer to Figure 3 for the high-level, summarised survey results.

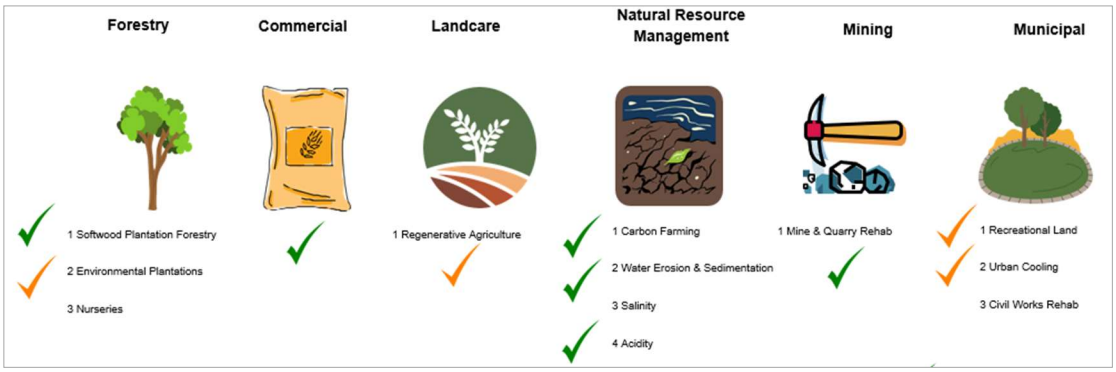

Figure 3: End-User Survey Results for Biofertiliser Demand

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.

Results and Conclusions

The mass balance indicates potential for sustainable fertiliser production, meeting up to 3% of Australia's demand if all AMPC member facilities adopt anaerobic digestion and biofertiliser plants. Preliminary digestate analysis show nutrient-rich content comparable to commercial soil conditioners, surpassing municipal biosolids in quality (Table 1) and with potential to tailor composition to suit specific end user requirements. Municipal Biosolids Guidelines were reviewed across Australia with comparative classification limits consolidated in Table 1.

Table 1: Red Meat Processor Digestate 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

Technology for digestate processing (Figure 4) is available at reasonable costs.

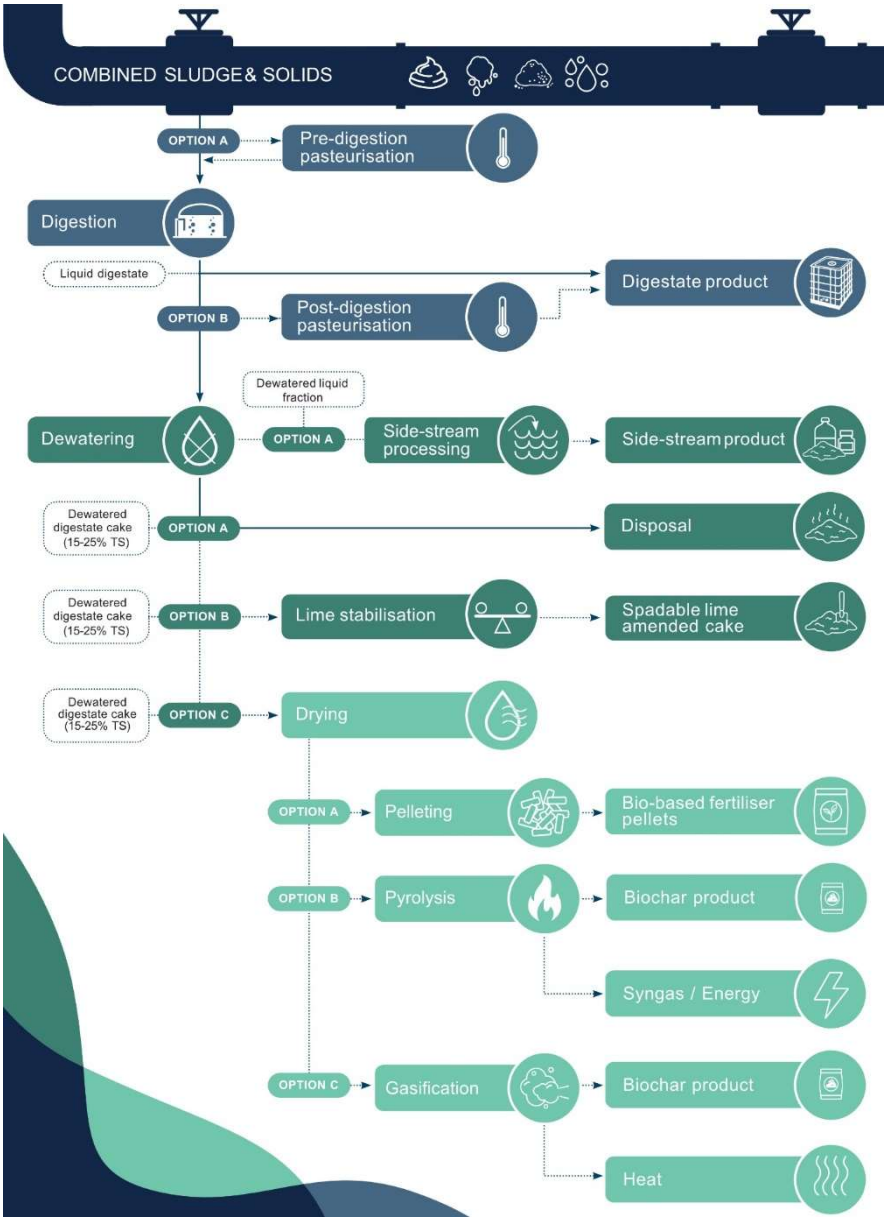

Figure 4: Processing Options to Produce Biofertiliser from Anaerobic Digestate

Reduced waste disposal costs and income streams from biofertiliser, biogas, heat, energy, water, and carbon credits drive positive returns. Surveys showed a market demand exceeding potential production, and interest in forestry, commercial, Natural Resource Management and mining sectors. Feasibility outcomes for producing biofertiliser pellets from digestate, reveal financial, environmental, and social benefits and a positive cost benefit analysis. Processing liquid digestate into biofertiliser pellets is easier and cheaper to manage. Markets with high fertiliser demand include municipal, Natural Resource Management, Landcare, and mining sectors. Mechanical dewatering, thermal drying and pelleting are the recommended biofertiliser production methods. Low pathogen levels allow versatile reuse opportunities. In the absence of biofertiliser regulations, municipal biosolids guidelines can be used as a base to develop a new framework with regulators. The study advocates for biofertiliser production at red meat processors, promoting a circular economy and contributing to Net Zero targets, transforming by-products into valuable resources for sustainable agriculture and waste reduction.