Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Fly Farm

Small commercial pilot scale evaluation and optimisation

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1.0 Abstract

This project evaluated the commercial feasibility of using insect bioconversion technology to process JBS Australia's low-value waste streams—primarily paunch and red offal—into high-value products such as protein meal, oil, and frass (biofertiliser).

Conducted in partnership with FlyFarm, the three-month pilot tested over 90 feedstock formulations, refined optimal recipes, and scaled operations from lab to near-industrial level using automated systems. Key results included an average feed conversion ratio (FCR) of 7.5 (best 5.3), 484 kg of protein meal (>55% protein), 99.1% pure BSF oil, and pathogen-free, nutrient-rich composted frass.

Market validation was obtained from aquafeed and pet food sectors, with pricing confirmed up to AUD $6,500/tonne for protein meal.

A detailed design and ROI analysis by Wiley revealed that new-build scenarios were not viable with standard BSF strains; however, modified strains or repurposed facilities may yield commercial potential.

The project confirmed technical feasibility and product marketability, but further work is needed on cost-effective capital deployment and genetically improved strains to achieve commercial viability.

2.0 Executive summary

Overview

This project aimed to explore the technical and commercial feasibility of converting JBS Australia's low-value red meat waste streams—primarily paunch and red offals—into high-value protein meal, oil, and biofertiliser through insect bioconversion using black soldier fly (BSF) larvae.

The main problem addressed was the limited utilisation of nutrient-rich abattoir waste, which currently incurs disposal costs and presents sustainability challenges. By evaluating a scalable BSF-based bioconversion process, the project sought to create a circular economy opportunity for the red meat industry.

The primary audience includes red meat processors, aquafeed and pet food manufacturers, and sustainability-focused agricultural sectors.

Results from this project will help levy payers and stakeholders assess whether an insect-based solution could improve waste valorisation, reduce environmental impact, and generate new revenue streams.

Objectives

- Evaluate the suitability of JBS waste streams for BSF bioconversion.
- Optimise feed formulations and production processes to maximise yield and quality.
- Produce commercially viable quantities of protein meal, oil, and frass for market testing.

- Engage with aquafeed and pet food markets to validate pricing and demand.
- All objectives were met, with promising technical performance and strong market validation, although commercial-scale viability requires further investigation.

Methodology

- FlyFarm operated a dedicated pilot plant for three months using 100% JBS-supplied waste inputs.
- More than 90 feedstock recipes were tested to optimise larval growth, feed conversion, and output product quality.
- Outputs were benchmarked through lab testing and market engagement, while Wiley was commissioned to deliver a capital build and ROI model for future expansion.
- Environmental and process controls (e.g., temperature, moisture, and humidity) were closely managed and adjusted during scale-up.

Results/key findings

The pilot successfully converted 18 tonnes of waste into 484 kg of BSF protein meal (>55% protein), 99.1% pure oil, and pathogen-free composted frass with balanced NPK values.

Feed conversion ratios ranged from 5.3 to 9.0. Product trials confirmed strong market interest: Biomar (aquafeed) and RPF (pet food) validated product specifications and pricing (up to AUD $6,500/tonne for protein meal).

Frass outperformed commercial fertilisers in germination tests, confirming its premium positioning in regenerative agriculture.

Benefits to industry

The project demonstrated that BSF-based waste valorisation is technically viable and capable of producing market-ready products from red meat by-products. This offers processors a potential solution to reduce waste disposal costs, enhance environmental sustainability, and unlock new, premium markets for protein and fertiliser.

The work supports broader industry goals around circularity and resource efficiency.

Future research/extension/adoption and recommendations

While the process and products have proven viable, financial modelling suggests that building a new facility is not yet cost-effective using natural BSF strains. Future work should focus on leveraging existing infrastructure or exploring genetically enhanced strains to improve ROI.

Further scale trials, especially for high-value outputs, and continued market development are recommended. JBS will continue investigations and provide updates to AMPC and the wider industry.

3.0 Introduction

The red meat processing industry generates substantial volumes of low-value waste by-products—such as paunch and red offals—which are costly to dispose of and underutilised as potential resources. This project addresses a key industry challenge: how to convert these waste streams into valuable, marketable products using innovative, sustainable technologies. There is currently a knowledge gap regarding the technical and commercial feasibility of insect bioconversion—specifically using black soldier fly (BSF) larvae—to process these materials at scale.

The central question this research explores is: Can insect bioconversion technology effectively and economically transform red meat waste streams into high-value outputs such as protein meal, oil, and fertiliser? This question is vital in the context of rising sustainability expectations, pressure to improve resource efficiency, and growing market demand for alternative proteins and bio-based products.

The primary target audience for this research includes red meat processors, sustainability managers, and commercial decision-makers seeking to reduce waste management costs while unlocking new revenue streams. It is also relevant to stakeholders in aquafeed, pet food, and fertiliser markets interested in sustainable, high-quality inputs.

The results of this pilot study will inform investment decisions for the potential full-scale deployment of BSF bioconversion within JBS Australia and the broader meat industry. Findings will support industry stakeholders and levy payers in understanding the economic, technical, and environmental value of adopting insect-based circular economy solutions.

4.0 Project objectives

The objectives of the FlyFarm Small Commercial Pilot Scale Evaluation and Optimisation project were to:

- Operate a pilot-scale insect bioconversion facility for three months, dedicated exclusively to processing JBS Australia's low-value waste streams (primarily paunch and red offals).
- Identify the optimal feedstock recipes and processing parameters to maximise black soldier fly (BSF) larval growth, feed conversion efficiency, and product yield.

- Produce sufficient volumes of insect-derived protein meal, oil, and frass (biofertiliser) to allow downstream markets to evaluate product quality, demand, and pricing.
- Conduct a cost-benefit analysis and develop indicative business models to assess the commercial viability of scaling the process at JBS facilities.
- Engage with potential aquafeed, pet food, and fertiliser markets to validate end-product specifications and commercial opportunities.

These objectives aimed to demonstrate both the technical feasibility and market potential of BSF bioconversion as a sustainable solution for red meat industry waste.

5.0 Methodology

The methodology for the FlyFarm Small Commercial Pilot Scale Evaluation and Optimisation project involved the following key steps:

- Pilot Plant Operation: FlyFarm dedicated its pilot-scale facility for a three-month period to exclusively process JBS-supplied low-value waste streams (primarily paunch and red offals), with trial activities spanning over seven months in total.
- Feedstock and Recipe Trials: Over 90 feedstock formulations were tested to identify optimal blends that maximised black soldier fly (BSF) larval growth, feed conversion efficiency (FCR), and product yield. Ingredients included shredded paunch, spleens, carbohydrate supplements (e.g., maize meal, mill run), and small-scale additions of tallow.
- Process Optimisation and Scale-Up: The process was scaled from lab trials to near-industrial levels using FlyFarm's FF2 automated system. This included refining environmental controls (e.g., humidity and temperature), larval seeding rates, tray loading densities, and feeding cycles to improve production efficiency.
- Product Handling and Composting: Post-harvest processing of larvae involved microwave drying and oil pressing to produce protein meal and oil. Frass was composted using indoor/outdoor methods, moisture adjustment, and aeration techniques to ensure pathogen reduction and nutrient optimisation.
- Market Engagement and Validation: Samples of BSF-derived products were provided to potential buyers (e.g., Biomar for aquafeed, RPF for pet food) for testing, feedback, and pricing discussions. Market signals were used to assess commercial viability.
- Economic Modelling: Wiley was engaged to develop a high-level capital design and ROI model (+/-30%) based on a potential full-scale deployment at JBS's Dinmore site, considering both new-build and existing building scenarios.

This structured approach allowed the project to systematically evaluate technical performance, product marketability, and financial feasibility.

6.0 Results

The pilot project demonstrated that black soldier fly (BSF) bioconversion is a technically viable method for transforming red meat processing waste—primarily paunch and red offals—into valuable commercial products. Key outcomes included:

- **Feedstock Conversion & Yield**:
    - 18 tonnes of JBS waste were processed over the trial period.
    - Achieved an average Feed Conversion Ratio (FCR) of 7.5, with the best result at 5.3.
    - Peak larvae yield reached 553 kg/week.
- **Product Outputs**:
    - **Protein Meal**: 484 kg of BSF protein meal was produced with a consistent protein content of >55%.
    - **BSF Oil**: Achieved 99.1% purity, rich in lauric acid (22%), suitable for pet food and aquafeed.
    - **Frass (Biofertiliser)**: Composted to pathogen-free status with balanced NPK ratios; some batches demonstrated superior performance to commercial fertilisers.
- **Market Validation**:
    - **Biomar** (aquafeed) expressed interest in the protein meal and indicated a demand of up to 15,000 tonnes/year, subject to consistency and certification compliance.
    - **RPF** (pet food) accepted the product at AUD $6,500/tonne, conditional on reliable supply and nutritional consistency.
    - BSF oil attracted interest in both aquafeed and pet sectors, with indicative prices between AUD $1,500–4,000/tonne depending on application and volume.
- **Process Optimisation**:
    - More than 90 feedstock recipes were trialled to balance nutrient profiles and processing efficiency.
    - Environmental controls were refined to manage temperature, humidity, and microbial activity.
    - Composting protocols for frass were improved to enhance nutrient content and soil application value.
- **Commercial Feasibility**:

- Wiley's modelling indicated that a new-build facility based on natural BSF strains was not financially viable.
- However, repurposing existing buildings or leveraging genetically improved BSF strains could improve ROI, though these strains are still under development.

Overall, the pilot confirmed strong technical outcomes and promising commercial interest, with financial viability dependent on future facility design and strain selection.

7.0 Discussion

The FlyFarm pilot project demonstrated clear technical viability in using black soldier fly (BSF) larvae to convert JBS Australia's low-value waste streams into high-value products, including protein meal, insect oil, and frass-based fertiliser. The process was successfully scaled from lab to near-industrial conditions using FlyFarm's automated systems, achieving consistent product yields and quality. The optimisation of feed formulations—particularly those using shredded paunch and red offals—enabled strong larval performance and efficient conversion rates, with an average FCR of 7.5 and peak protein levels above 55%.

Product quality was validated through engagement with leading aquafeed and pet food manufacturers. Both Biomar and RPF expressed interest in larger-scale uptake, subject to volume consistency and compliance with nutritional and certification standards. Additionally, the frass product showed strong potential as a premium biofertiliser, outperforming some commercial options in nutrient profile and germination performance.

Despite these successes, economic modelling highlighted challenges in achieving a viable return on investment under a new-build scenario using natural BSF strains. Capital cost estimates suggest that leveraging existing infrastructure or adopting enhanced BSF strains—still under development—may be necessary to reach commercial feasibility. Further validation at scale, as well as ongoing genetic and infrastructure optimisation, will be critical next steps for successful industry adoption.

In summary, the pilot achieved its technical and market-facing objectives, laying the groundwork for further investment consideration. However, commercial success will hinge on future cost reductions and improvements in biological performance.

8.0 Conclusions

The FlyFarm pilot project has successfully demonstrated the technical feasibility of using black soldier fly (BSF) bioconversion to transform JBS Australia's low-value waste streams—such as paunch and red offals—into high-quality, market-validated products. The project achieved strong biological performance, with consistent yields of protein meal, insect oil, and biofertiliser, and engaged potential end users in the

aquafeed, pet food, and regenerative agriculture sectors. These outcomes confirm that insect-based processing can offer a sustainable and value-adding solution for the red meat industry.

However, while the technical results and market feedback were promising, economic modelling suggests that a greenfield facility based on natural BSF strains is not currently viable in Australia. Alternative approaches, including the use of existing infrastructure or genetically enhanced strains, may bring the business case into a commercially acceptable range. These findings highlight the need for continued innovation in system design, strain selection, and cost optimisation to support broader industry adoption.

Overall, the project has generated valuable data, validated market interest, and clarified the critical success factors required for scale-up. It provides a strong foundation for future research, development, and potential investment in sustainable insect bioconversion within the Australian red meat sector.

9.0 Recommendations

Based on the outcomes of the FlyFarm pilot project, the following recommendations are proposed for industry stakeholders, future research partners, and potential adopters:

1. **Leverage Existing Infrastructure**
   Investigate opportunities to retrofit or repurpose existing facilities to reduce capital expenditure and improve the return on investment. This approach may enable earlier commercial deployment compared to new-build scenarios.

2. **Continue Strain Development**
   Support ongoing development and testing of genetically enhanced or optimised BSF strains (e.g. monoclonal antibody G strains) that can improve feed conversion efficiency, growth rates, and overall yield—particularly with high-fibre red meat inputs like paunch.

3. **Conduct Extended Scale-Up Trials**
   Undertake further trials at increased scale and over longer durations to confirm consistent production, refine operational parameters, and validate cost assumptions under more realistic commercial conditions.

4. **Strengthen Market Engagement**
   Continue building relationships with key aquafeed, pet food, and fertiliser buyers to secure offtake agreements and understand evolving product specifications, certification requirements, and traceability expectations.

5. **Assess Product Diversification**
   Explore higher-value product variants and formulations (e.g. functional protein blends, oil derivatives, frass-based specialty fertilisers) to expand potential markets and improve revenue per tonne of input material.

6. **Evaluate International Options**
   Consider assessing the economic viability of deploying this technology in alternative geographies (e.g. North or Central America), where feedstock profiles, operating costs, and

regulatory conditions may better support profitable operations.

7. **Maintain Stakeholder Communication**
   JBS should continue to update AMPC and broader industry stakeholders on progress, challenges, and lessons learned as further investigations and commercial evaluations are conducted.

These recommendations aim to guide the pathway from successful pilot outcomes toward scalable, cost-effective industry adoption of BSF bioconversion in red meat processing.

10.0 Project outputs

The *FlyFarm Small Commercial Pilot Scale Evaluation and Optimisation* project delivered the following key outputs:

1. **Technical Validation of Bioconversion Process**
   - Operated a pilot-scale BSF bioconversion facility for three months, processing 18 tonnes of JBS paunch and red offal waste.
   - Achieved consistent yields of insect-derived products with high quality and commercial potential.

2. **Optimised Feedstock Recipes and Process Parameters**
   - Developed and trialled over 90 feed formulations.
   - Identified optimal feed blend (e.g. 80% shredded paunch, 10% red offal, 10% carbohydrate) and refined environmental and processing conditions for scalability.

3. **Product Outputs**
   - **Protein Meal**: 484 kg of high-protein meal (>55%), suitable for aquafeed and pet food.
   - **BSF Oil**: 99.1% fat content, rich in lauric acid, suitable for feed and pet food applications.
   - **Frass (Biofertiliser)**: Composted, pathogen-free fertiliser with balanced NPK ratios and strong germination performance.

4. **Market Engagement and Validation**
   - Secured feedback from major potential customers:
     - **Biomar** (aquafeed): Expressed interest and estimated demand of up to 15,000 tonnes/year.
     - **RPF** (pet food): Accepted the product at AUD $6,500/tonne, subject to supply reliability.
   - Confirmed market potential across aquafeed, pet food, and regenerative agriculture sectors.

5. **Capital and Business Model Development**
   - Commissioned Wiley to deliver a detailed (+/-30%) capital cost estimate and ROI model for a potential full-scale facility at JBS Dinmore.

- Determined that new-build using natural BSF strains is not viable; alternative pathways (e.g. existing buildings or GM strains) are being explored.

6. **Reporting and Recommendations**
   - Delivered a comprehensive final report detailing feedstock trials, product analysis, process optimisation, market engagement, and commercial modelling.
   - Developed actionable recommendations for future research, infrastructure planning, and industry adoption.

These outputs collectively demonstrate the technical feasibility and market interest necessary to progress toward commercial adoption, while also highlighting areas where further work is needed to achieve cost-effective scalability.

11.0 Bibliography

None

12.0 Appendices

12.1 Appendix 1 – Wileys Document Titled: 20250624 26746 Pre-engineering Report Rev 02 - AMPC Versio

12.2 Appendix 2 – FlyFarm Document Titled: JBS FlyFarm BSF Bioconversion Opportunity June 2025