Closing the Loop:

Black Soldier Fly technology to convert agricultural waste

Australian Government

AUSTRALIAN Pork

FUTURE GREEN SOLUTIONS

FRDC

Australian eggs

Dairy Australia

AgriFutures® Australia

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

THE UNIVERSITY OF WESTERN AUSTRALIA

Queensland Government
Department of Agriculture and Fisheries

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Project overview and objectives

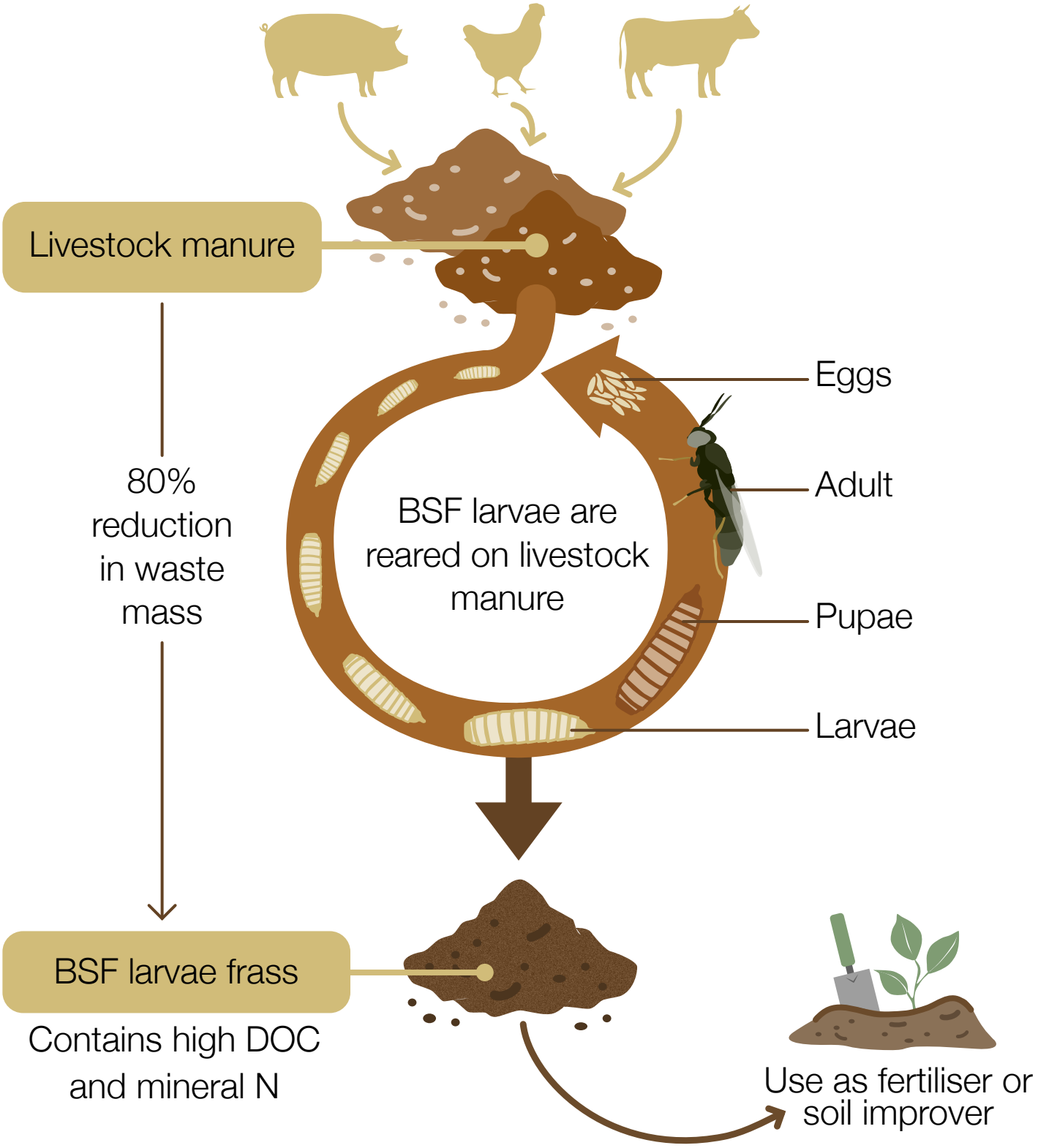
This project investigated Black Soldier Fly technology as a sustainable and profitable management solution for livestock wastes. The project explored how to convert low-value agricultural waste products into high quality, innovative fertilisers and soil improvers that are safe to handle, store, transport and apply. The project also aimed to overcome obstacles to technology adoption and support early adopters by engaging policymakers and farmers in research activities.

“Adoption of BSF technology and its products has potential to increase productivity and profitability via reduced input costs and generation of alternative revenue streams to a wide range of agricultural enterprises.”

Image credit: Ooid Scientific

What is BSF technology?

The Black Soldier Fly (BSF) (Hermetia illucens) is a non-biting, non-invasive and non-pest fly species which naturally consumes organic wastes (see **factsheet**). The adult flies themselves do not eat, but the BSF larvae can consume animal manures and other organic wastes such as abattoir and food waste. BSF farming produces 200kg of larval waste for every tonne of animal manures or other organic waste processed. This larval waste is known as frass and includes the larvae's excrement (castings), their exoskeletons, and the remains of their food source. Frass can be high in mineral nitrogen and organic carbon and has potential to be used as an effective soil improver or fertiliser. The insect meal also has potential for use as a fertiliser either singly or in combination with mineral fertilisers to ensure a high quality, tailored product.



Why use BSF technology to manage manures?

Livestock industries in Australia produce significant amounts of manure and other organic waste products that must be managed in a sustainable manner from an environmental and economic perspective. Manure management on Australian farms is a significant cost (estimated AUD $100–200 million annually), impacting productivity, profitability and sustainability of businesses.

Manures can be used as fertilisers to supplement or (in part) replace mineral fertilisers, in turn benefitting the productivity and profitability of Australian agricultural production systems. In particular, waste-derived fertiliser can play a key role in enhancing the circularity of Australia's agriculture. However, major constraints and barriers to solid manure use exist (e.g. cost of transport and management of the materials). Poor management of manures can also cause significant environmental impacts such as pest outbreaks (e.g. stable fly), nutrient leaching and run-off into waterways, greenhouse gas emissions, and odour.

By using BSF technology, manures and other agricultural waste products can be turned into highly valuable products that are then recycled back into production on the farm. BSF larvae reproduce rapidly, have high feed conversion efficiency, and can be reared on a range of waste streams, including animal, slaughterhouse and cropping wastes. Once fully commercialized, BSF technology could process hundreds of tonnes of waste per day. This 'closed loop approach' to waste management has potential to increase productivity and profitability, reduce waste, labour and transport costs, improve environmental impacts, and contribute to enhancing the sustainability, of agriculture in Australia.

Research Approach

This project evaluated the performance of BSF products (insect extracts and frass) that were produced from a variety of agricultural wastes including pork, poultry broilers and layers, and dairy and meat processing wastes.

A combination of laboratory bench top investigations, glasshouse trials, and extensive field studies were completed to assess the effectiveness and safety of these products as soil fertilisers and soil conditioners. Modifications of the products via granulation, pelletisation, coatings and encapsulation technologies were also assessed for their ability to improve safety, application, and storage. The economic, environment, and agronomic values of each of the products were determined, as well as greenhouse gas (GHG) emissions, odour, and leaching potential. Economic feasibility and potential adoption of BSF technology was assessed via interviews and surveys with industry experts, government regulatory bodies, and primary producers across Australia.

Image credit: Ooid Scientific

Benefits to industry

This project has identified the following benefits of using BSF technology to process agricultural wastes.

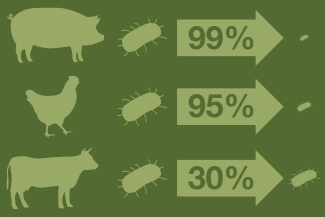
Compared to raw livestock manures, BSF technologies that treat agricultural waste were found to;

Reduce waste volume by up to 80% over a 19-day period.

Reduce transportation, application and handling cost.

Produce a more stable product with limited odour.

Reduction of greenhouse gas emissions. 31% reduction for CO_2 and 53% reduction for N_2O.



Reduce prevalence of some bacterial pathogens. 99, 95 and 30% reduction in faecal coliform counts for piggery, chicken and dairy manure, respectively.

Between 90 - 100% reduction in stable fly emergence. Stable fly are a declared pest species associated with poor manure management.

Manure-derived insect extracts are a good source of N and P and resulting fertiliser formulation can outperform commercial synthetic fertiliser (such as urea and DAP).

Manure-derived BSF frass can be used as an effective soil improver that can increase organic C and mineral N retention in soils, raise soil pH (liming effect), improve soil function, structure, stability and resilience to soil constraints (acidic soils, drought), increase the occurrence of plant growth-promoting rhizobacteria and enhance plant growth in a series of pot trials.

Post-modification of frass (such as coating with fatty acids or addition of inhibitors) can be used to further optimise frass into novel slow-release fertiliser products and reduce GHG emissions.

Adoption of technology and regulatory considerations

State regulators and farmers that were engaged throughout the project were generally very supportive of new innovations and interested in learning more about the potential for BSF technology as a waste management option.

This research project identified no major behavioural barriers to adopting BSF technology or BSF-derived products on farms. Australian farmers (including livestock producers, dairy farmers, and grain and horticulture growers) had positive opinions towards BSF technology and products, and were interested in using the technology or products on their farms.

Based on generalised processing and product information, no regulatory barriers exist to the reuse and adoption of manure derived frass as a fertiliser or soil conditioner in Australia. However, each state differed in their response to the potential classification of BSF manure derived products.

A technical report and **factsheet** were produced for stakeholders and government regulatory bodies on the classification and regulation requirements of manure-derived BSF products so that BSF products can meet the requirements to avoid classification as waste by-product. Open communication and transparency need to be provided to the regulators and decision makers to facilitate and expedite the adoption of BSF products in Australia.

Image credit: Daniel Kidd

The way forward

This research project has identified several key areas where future R&D efforts should be focused to further optimise and progress wider adoption of BSF technology for animal waste management:

- Test the scalability of BSF technology on farm. Pork production or poultry processing are reasonable sectors to target first. A commercialisation partner and a major primary industry partner would be required.
- Full economic evaluation of BSF technology to ensure it is viable for waste treatment of manure.
- Complete life cycle analysis to determine if BSF technology could be included as GHG abatement technology.
- Further R&D into optimisation of manure processing by BSF larvae, including consistency and safety of products, as well as post-processing of frass to decrease potential leaching of nutrients and improve characteristics for transport and storage.
- Further R&D into the benefits of manure derived frass for use in agriculture/ horticulture/turf industry.
- Further R&D into biosecurity, social license and regulatory stakeholder engagement to address barriers to adoption.
- Explore other benefits of BSF derived by-products, such as extraction of high-cost oils, vitamins, chitin and micronutrients, production of bioenergy and biofuel oils.


Image credit: Andrew Guzzomi


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Image credit: Matthew Redding


Image credit: Daniel Kidd

Funders & collaborators

This research was jointly funded by Australian Pork Limited, Future Green Solutions, The University of Western Australia, Agrifutures, Dairy Australia Limited, Australian Meat and Processing Corporation, Eggs Australia, and the Department of Agriculture, Fisheries and Forestry (Commonwealth).

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Publications

A set of published academic papers, technical reports, fact sheets, conference posters and media articles are available on the project **website**

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