

Market potential for Black Soldier Fly fertiliser products

Fiona Dempster, Vandana Subroy, Tamara Harold,
and Marit E. Kragt

Centre for Agricultural Economics and Development, School of Agriculture and
Environment, The University of Western Australia

This report was commissioned by Australian Pork Limited on behalf of the Commonwealth Government of Australia for the Rural R&D for Profit project 18-04-007; Closing the loop: Black Soldier Fly technology to convert agricultural waste.

Citation: Dempster, F., Subroy, V., Harold, T. & Kragt, M. (2022). *Market potential for Black Soldier Fly fertiliser products*. The University of Western Australia.

We acknowledge the contribution of Yassine Filali Anssari, whose honours report provided guidance to the analysis, the Australian Government Department of Agriculture and Water Resources through Australian Pork Limited for providing funds to conduct the research as well as our industry partners and research collaborators from AgriFutures Australia, Dairy Australia, Future Green Solutions, Queensland Government Department of Agriculture and Fisheries, Australian Eggs, Australian Meat Processing Corporation, and other industry partners.

Market potential for Black Soldier Fly fertiliser products

Table of Contents

| | | |
|----|--|----|
| 1. | Introduction | 2 |
| 2. | Australian fertiliser market | 3 |
| | 2.1 Target markets and demand | 3 |
| | 2.2 Sustainability trends..... | 4 |
| 3 | Black Soldier Fly products | 5 |
| 4 | Australian organic fertiliser products | 7 |
| 5 | BSF market constraints | 8 |
| 6 | Summary and Conclusion | 9 |
| | References | 10 |
| | Appendix A..... | 12 |
| | Appendix B..... | 16 |

1. Introduction

The Black Soldier Fly, *Hermetia illucens*, is a non-pest insect that is useful for managing large concentrations of animal manure and other biosolids (Sheppard et al. 2002). Black Soldier Fly (BSF) larvae can bioconvert manures or food wastes into proteins and lipids that can be used as animal feed, fertilisers, or biopolymers (Lin and Li, 2021). The global market for BSF products is expected to reach \$3.4 billion by 2030, driven by increasing demand for animal feed, increasing global meat demand, a growing aquaculture industry, and growing government support for the use of insect meals (Meticulous Market Research, 2021).

The use of BSF technology to turn livestock wastes into useful end-products will support the transition to a more sustainable agricultural sector. Researchers, through the *Closing the loop: Black Soldier Fly technology to convert agricultural waste* project, are investigating the potential to create different types of fertiliser products from livestock waste (and other waste streams) through bioconversion by BSF larvae. To aid in the investigation, we need to understand the market potential for the BSF fertiliser products and identify what features of BSF fertilisers will distinguish them from other commercially available products.

This report explores the Australian fertiliser market, including trends and consumption, and reviews currently available commercial organic fertilisers and soil improvers that would be in direct competition to the BSF products. BSF frass can also be supplied wholesale as an input ingredient to other organic fertiliser manufacturers, but we don't include this market in the analysis.

There are several characteristics that could be analysed to provide useful market information. The scope of this analysis will compare the macronutrient (NPK) composition, available forms, price, carbon content, and any noteworthy marketing claims (such as sustainable packaging or health of waterways and soils).

2. Australian fertiliser market

The Australian fertiliser industry includes manufacturers, importers, agents of overseas suppliers, and distributors. Fertiliser products are sold either directly to consumers (via agents), or via wholesale through dealers.

Australia has an open and competitive domestic market for fertiliser products. The Australian fertiliser market has an average annual sale of 5.4 million tonnes between 2012 and 2017 (Fertiliser Australia, 2021). The industry's full economic effect on Australia's GDP is in excess of \$8 billion each year (APH, 2008). The market supports both organic fertilisers (manure, compost, or other animal and plant products) and synthetic fertilisers (chemical fertiliser or mined fertiliser).

Compared to the global fertilizer market, the Australian market makes up approximately 1% of global consumption. Australia imports less than 2% and exports less than 0.5% of fertiliser products on the world trade market (Fertiliser Australia, 2021).

2.1 Target markets and demand

The anticipated market for BSF fertilisers products are commercial growers, including broadacre farmers and horticulturalists. The home gardening sector could be another viable market but is not the focus of this report.

Agricultural industries are dependent on fertiliser for crop production with the grains sector driving the majority of Australia's fertiliser demand. The total gross value of crops was \$28 billion in 2019-2020 financial year (Australian Bureau of Statistics, 2021), which in turn creates a significant demand for fertiliser products.

In an average year, Australia uses approximately 1 million tons of nitrogen, almost 0.5 million tons of phosphorus, and close to 0.2 million tons of potassium through fertiliser application (Fertilizer Australia, 2021). Over the last few decades, the demand for nitrogen to create Urea or NPK fertiliser products has increased substantially, more so than demand for other nutrients (Figure 1).

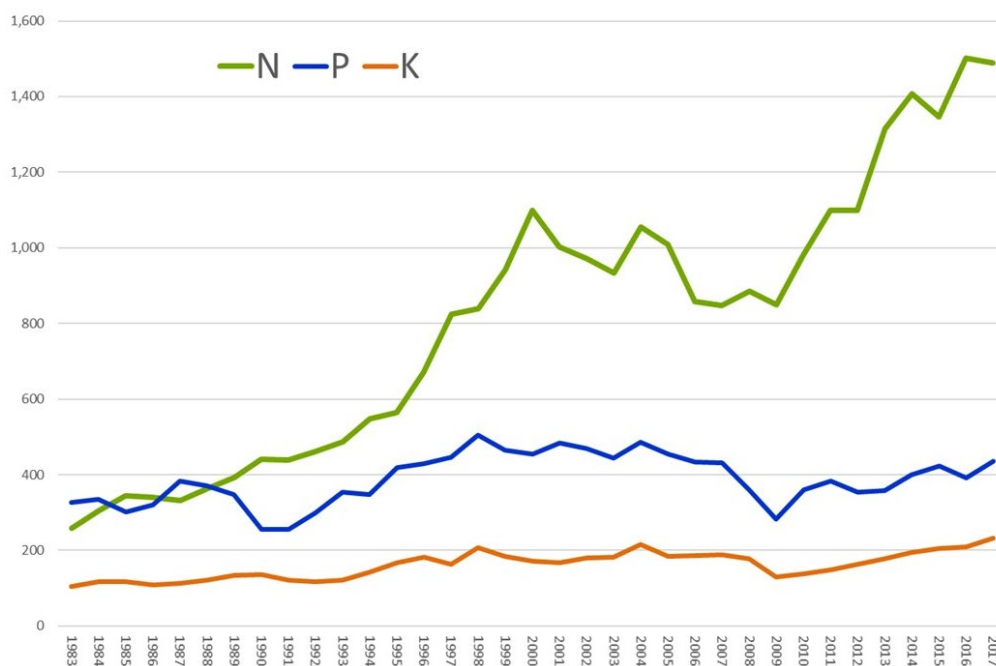


Figure 1. Australian agriculture demand for nutrients (in '000s t) between 1983 to 2017 (Source: Fertiliser Australia, 2021).

In 2012, Australia’s agriculture sector applied nitrogen-based fertilisers to 32.3 million hectares of land, with ammonium phosphates application covering the largest area, followed by urea application. Nearly 40% of the area that nitrogen-based fertilisers were applied to was in Western Australia (Australian Bureau of Statistics).

The willingness of consumers to pay for food that has been grown using organic farming approaches is much higher than in previous decades due to the perceived health and environmental benefits of organic farming methods (Drugova et al. 2019). With a growing demand for organically certified food, demand for organic fertilisers are expected to increase as well.

2.2 Sustainability trends

Fertiliser application in the agricultural sector can contribute to elevated levels of nitrogen and phosphorus in waterways if farming methods do not manage the risks of erosion, runoff, and leaching. Nitrogen can also contribute to greenhouse gas emissions through the release of nitrous oxide.

The world is trending towards making the fertiliser supply chain and its use more sustainable. Sustainability is at the heart of the International Fertiliser Association (IFA)’s vision; *“Productive and sustainable agriculture systems contribute to a world free of hunger and malnutrition”* (IFA’s Global Sustainability Report, 2019). IFA released their first Global Sustainability Report that outlines the size of the global fertiliser industry and demonstrates how the industry plays an important role in contributing towards the United Nations’

Sustainable Development Goals. IFA are working in partnerships to develop a Global Technology Roadmap for the Nitrogen Fertilizer Sector looking at technologies and strategies necessary for the industry to pursue a pathway towards a more sustainable sector and a lower carbon footprint (IFA's Global Sustainability Report, 2019). The Fertiliser Institute (TFI)'s Sustainability Report 2020 found that minimizing greenhouse gas emissions is a priority for companies in the fertilizer industry, and there is an trend for fertilizer manufacturers to use low-impact energy sources, such as solar or steam from waste heat (The Fertiliser Institute 2021).

In Australia, fertiliser regulations are delegated to State Governments. While State Government regulations all aim to manage description and safety of fertilizers, policy details vary by State. Several states have guidelines and calculators in place to support best-practice nutrient management that achieves more sustainable production.¹

The key representative body of the fertiliser industry, Fertilizer Australia, is committed to responsible and sustainable production and use of fertilisers (Fertiliser Australia, 2020). Through its Fertcare program, Fertilizer Australia promotes good farming practices and aims to train and equip people all along the fertilizer supply chain in minimising environment and food safety risks, such as avoiding denitrification and reducing greenhouse gas emissions (Fertiliser Australia, 2021).

3 Black Soldier Fly products

Black Soldier Flies (BSF) are non-invasive, non-biting, non-pest fly species that support several potentially profitable sustainable products. The BSF larvae can be reared on a range of food, animal, cropping, or abattoir wastes. The larvae have a high waste degradation efficiency, depending on the type and composition of the waste substrate (Gärttling and Schulz 2022, Sheppard et al. 2002 and Zhang et al. 2021). The BSF larvae have the potential to contribute to a circular economy system by improving waste management on farms or at centralised facilities. BSF larvae themselves are fat and protein-rich and could serve as animal feed for aquaculture or other industries.

A summary of selected studies on frass products reared on various source substrates is provided in Table 1.

¹ See, for example, <https://agriculture.vic.gov.au/climate-and-weather/understanding-carbon-and-emissions/nitrogen-fertilisers-improving-efficiency-and-saving-money> or <https://www.dpi.nsw.gov.au/agriculture/soils/guides/soil-nutrients-and-fertilisers/bfdc>

Table 1. Frass product analysis from the scientific literature and commercially available products.

| Study / Company | Frass substrate | Frass NPK (W/W%) |
|-----------------------------|---|--------------------|
| Gärttling and Schulz (2019) | Not known | 3.4 – 2.9 – 3.5 |
| Gärttling and Schulz (2022) | Numerous | 1–1–1 ¹ |
| Beesigamukama et al. (2020) | Brewery spent grains | 2.1 – 1.16 – 0.17 |
| Klammsteiner et al. (2020) | Chicken feed | 2.59 – ns – ns |
| | Grass cuttings | 2.44 – ns – ns |
| | Fruit and vegetables | 1.83 – ns– ns |
| Bardee (nd) | Food waste | 3.5 – 1.9 – 2.1 |
| Entofood | Agricultural feedstuff | 3 – 2.5 – 0.5 |
| EnviroFlight® | Dried Distillers Grains with Solubles, brewer’s grains, cookie meal, and pre-consumer processing organics | 3 – 2 – 1 |
| Innovafeed | GMO-free vegetable substrate | 3 – 4 – 3 |
| Nutrition Technologies | Agro-industrial by-products | 3 – 2.8 – 1.6 |
| The Critter Depot | Almond hulls and grains | 5 – 3 – 2 |

¹Averaged ratio for multiple studies. Note: ns = not stated.

The focus of this report is the BSF frass and larvae manufactured into organic fertilisers or soil improvers. BSF products can exist in a variety of forms, including granular, pelletised, encapsulated, and liquid, for deep placement or surface placement. There are several large BSF technology companies around the world that produce BSF fertilisers. Some of the claims made by these companies are summarised below.

The US company EnviroFlight® produces a frass-based fertiliser called EnviroFrass. The larvae have been reared on human and animal waste streams. The company guarantees a NPK content of 3%, 2%, and 1% respectively and markets the product for “*anyone looking for a natural, chemical free fertilizer*” (<http://www.enviroflight.net>). Another US based company The Critter Depot sells its frass product as “Black Soldier Fly poop”, marketing it as an “extremely potent 100% natural fertilizer” having an NPK ratio of 5:3:2 (<https://www.thecritterdepot.com/products/black-soldier-fly-larvae-frass>). The company also emphasises the natural presence of chitin in BSF frass and its importance in suppressing plant diseases by inducing an immune response in plants. The Paris-based company InnoVaFeed markets its organic fertilizer as prepared from a GMO-free vegetable substrate with the resulting product being rich in organic matter (>75%), and having a balanced NPK profile (3-4-3), that can be used in organic farming (<http://www.innovafeed.com>). Entofood fertilizer produced by the Malaysian company Entofood also emphasises the organic carbon content of its product (22%), which has an NPK composition of 3–2.5–0.5

(<https://www.entofood.com/>). The Singaporean company Nutrition Technologies® produces a BSF Frass fertiliser product marketed under the label *Hi Frass*® (<https://www.nutrition-technologies.com/hi-frass>). Like other companies, they market their product having an NPK content of 3–2.8–1.6 as being loaded with beneficial microorganisms, which improve soil fertility and structure, and also emphasise the enhancement in plants' defence mechanisms owing to chitin in their product.

A Canadian company Enterra™ (<https://enterrafrass.com/>), an Indian start-up Elies Biotech® Private Limited (<https://eliesbiotech.co.in/>), and two US based companies Symton® (<https://symtonbsf.com/>) and Arbico Organics (<https://www.arbico-organics.com/>) also sell Black Soldier Fly Frass products marketed as EnterraFrass™, Microrapid™, Symton® Sassy Frass, and Black Soldier Fly Larvae Frass, respectively. These products are advertised as natural, organic fertilisers. However, their websites do not state the substrate the frass was reared on or list the product's nutrient analysis. The Symton® site simply states that BSF larvae are fed a “custom blend of an all-natural, vegetarian diet”.

Australian companies that produce Black Soldier Fly include FlyFarm, Bardee, Future Green Solutions, and GoTerra. FlyFarm and Bardee both advertise BSF frass as organic fertiliser products on their websites.

4 Australian organic fertiliser products

There are several Australian brands providing commercial organic fertiliser products that could be in direct competition with a BSF product. These companies provide products of different nutrient quality to use on crops at various growth stages. For example, the [Katek poultry manure product](#) claims to help plants be more resistant to pests and diseases.

Organic products have varying percentages of macro and micro nutrients and carbon content. As these characteristics contribute to nutrient retention and turnover, soil structure, moisture retention and availability, degradation of pollutants, and carbon sequestration, our study will primarily focus on these.

In this market analysis, we will firstly consider the presence of the three primary macronutrients in each of the fertiliser products: Nitrogen (N), Phosphorous (P) and Potassium (K). We will then consider the presence of trace elements and carbon content, the price, and the sustainability claims, and the available forms. This analysis aims to provide a better understanding of where the competitive advantages are for BSF products, thereby providing direction on how to position BSF fertiliser or soil improver products on the market.

We conducted an online search of commercially available organic fertiliser and soil improver products and their relevant characteristics and claims. At the time of writing, there are a limited range of products produced in Australia from insect frass or other insects such as meal worm. Some companies that sell insect frass (for different purposes and markets)

include Bardee, FlyFarm, Future Green Solutions, GoTerra, Green Man Char, Easy Organics, and Organic gardening solutions.

Appendix A lists the characteristics of organic fertilisers on the market in competition with BSF products, including NPK, trace elements, carbon content, prices, and claims. Note that the macronutrient (NPK) analysis is generally presented on a w/w% basis. This means that a fertiliser with NPK ratio of 5:4:2 has 5% by weight of Nitrogen (N), 4% by weight of Phosphorous (P), and 2% by weight of Potassium (K). The following key observations are made about the competitor's products:

- There is a wide range of NPK analysis and trace elements in the organic fertilisers available in the market (Appendix A), ranging from low 1s to 12 or 14 N
- The prices for commercial organic products vary from less than \$150/tonne for a granular product, and up to \$10,000/L for some premium liquid fertilisers. The price depends on a product's ingredients and production method, its macronutrient and micronutrient content, and trace element analysis.
- The carbon content for the manure based fertilisers are up to 34%.

The fertiliser products being developed in the project *Closing the loop: Black Soldier Fly technology to convert agricultural waste* vary in their NPK and carbon content, depending on the substrate on which BSF larvae have been reared. Some results of recent trials are provided in Appendix B.

The key observations on the BSF products include:

- The NPK ratios of BSF frass fertilisers depend on what the substrate on which the Black Soldier Fly larvae are reared
- The NPK ratio of initial trials of BSF frass being reared on wastes from eggs and poultry is low compared to manure products.
- Black Soldier Fly frass has a higher carbon (>35%) and Potassium content, and comparable Nitrogen and trace elements compared to insect frass competitor products.
- The BSF frass could benefit if organic waste is included in the starting feed substrate as it may help improve the NPK content in the final product.

5 BSF market constraints

The establishment of BSF products into the Australian domestic market and potentially global trade requires management of a series of risks associated with the BSF production process as well as those typically associated with organic fertilisers (Fertiliser Australia, 2021).

- The manufacturing process needs a consistent production of insect biomass and relies on a multi-stakeholder cooperation to provide consistent quantity and quality of waste stream.

- Handling protocols will need to be developed to ensure no contamination occurs during transport and storage.
- Regulations need to be developed for the description, labelling, and use of BSF fertilisers
- There is no clarity on the classification of the BSF products: outputs may be considered a waste or a product, and that product may be subject to fertiliser or compost standards.
- Consumer demand will need to be established, including consumer preferences for different characteristics of potential BSF fertiliser products and their willingness-to-pay for different products.

6 Summary and Conclusion

The review of the market and available products and feedback from the research team provides information for a SWOT analysis in Figure 3.

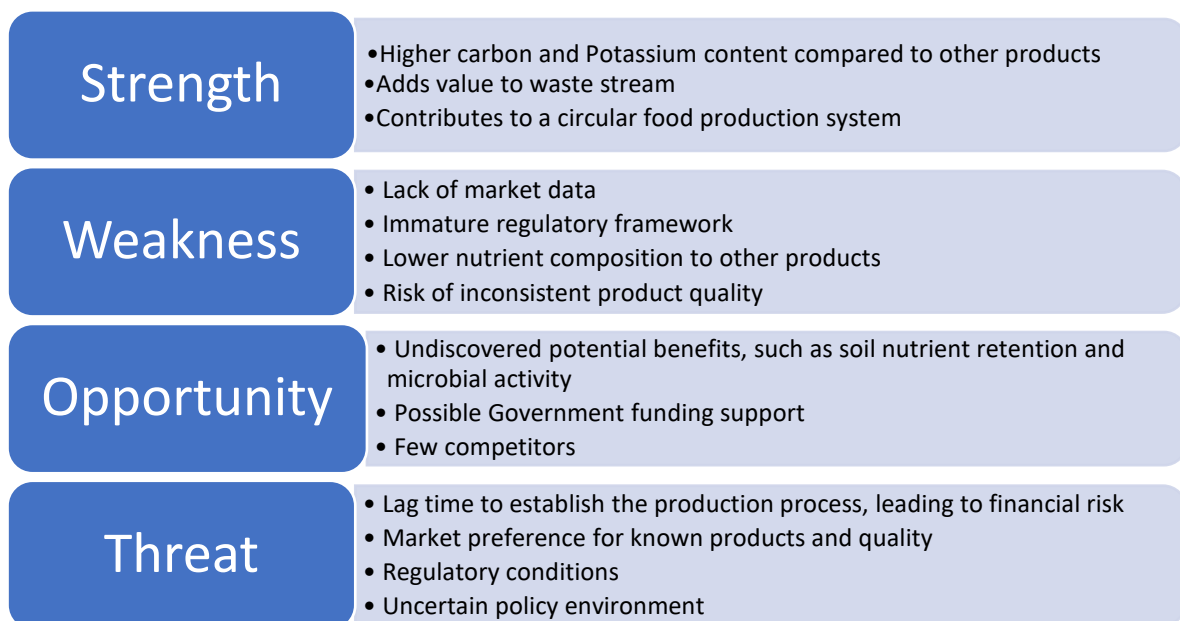


Figure 3. SWOT analysis of BSF fertiliser product.

The information and results presented in this report (Appendix A) reveal:

- A limited range of products produced from insect frass or by-products, such as meal worm exist but are of low volume.
- We found several producers of BSF frass and BSF larval-rearing by-products around the world ranging in scale from small to large.
- We are aware of just one large-scale producer in Australia— Bardee, located in Victoria who sell BSF frass produced from food waste as SuperFly® Organic Fertiliser in either pelletised or fine granular forms. They also sell other frass-by products such as SuperFly® Chitin Concentrate and Bardee Insect Meal. Their products are certified

organic. Bardee also supply their frass to other companies such as Earth Systems who create biochar-blended frass fertiliser products marketed under the label of Green Man Char.

- Black Soldier Fly frass has a higher carbon and Potassium content, and comparable Nitrogen and trace elements compared to competitor products.
- Common other potential benefits listed in competitor products are improved soil health, increased water holding capacity, and reduced incidence of pests and diseases in plants owing to the chitin content in BSF frass.
- Further analysis of the BSF organic fertiliser products should quantify these other potential benefits, as these may be inherently linked to the market value of the product.

References

Australian Parliament House (2008). *Interim report: Pricing and supply arrangements in the Australian and global fertiliser market (Chapter 2)*. Prepared by Committee on Agricultural and Related Industries, Australian Parliament House. Department of the Senate, Parliament House, Canberra.

Australian Broadcast Corporations (2021). *Strike Energy plans urea fertiliser plant*. ABC Rural, 12 January, 2021.

Australian Bureau of Statistics (Reference period: 2019-20 financial year). *Value of Agricultural Commodities Produced, Australia*. ABS Website, accessed December 2021.

Australian Bureau of Statistics (Reference period: 2011-12 financial year). *Land Management Practices Survey -fertiliser statistics*. ABS Website, accessed December 2021.

Bardee (nd) *Superfly. Probiotic Superfood for Plants*. Downloaded from https://global-uploads.webflow.com/62109cd5d08d230c379e06f7/627e358d8a6b6451df52c14e_Superfly%20-%20Probiotic%20Superfood%20for%20Gardens.pdf

Beesigamukama, D., Mochoge, B., Korir, N.K., Fiaboe, K.K.M., Nakimbugwe, D., Khamis, F.M., Subramanian, S., Dubois, T., Musyoka, M.W., Ekesi, S., Kelemu, S., & Tanga, C.M. (2020). Exploring Black Soldier Fly Frass as Novel Fertilizer for Improved Growth, Yield, and Nitrogen Use Efficiency of Maize Under Field Conditions. *Frontiers in Plant Science* 11.

Cameron, A and Xia, C (2021). *Agricultural overview: December quarter 2021*. Australian Bureau of Agricultural and Resource Economics and Sciences, No. 200, December 2021.

Davenport, N. (2019). *NPK value of everything organic!* Nutrient Company, blog post 10th January 2019. Available at <https://thenutrientcompany.com/blogs/horticulture/npk-value-of-everything-organic-database>

Drugova, T., Pozo, V.F., Curtis, K.R. & Fortenbery, T.R. (2019). *Organic Wheat Prices and Premium Uncertainty: Can Cross Hedging and Forecasting Play a Role?* Journal of Agricultural and Resource Economics 44(3): 551–570.

Fertiliser Australia (2021). *The Australian Fertilizer Industry Review 2021*. Fertiliser Australia. Available at <https://fertilizer.org.au/Publications/Sustainability-Report>.

- Fertiliser Australia (2020). *Australian Fertilizer Industry Sustainability and Stewardship report 2020*. Fertiliser Australia. Available at <https://fertilizer.org.au/Publications/Sustainability-Report>
- Gärttling, D., Schulz, H., 2022. Compilation of Black Soldier Fly Frass Analyses. *Journal of Soil Science and Plant Nutrition* 22, 937-943.
- Gärttling, D. & Schulz, H. (2019). *Compilation of black soldier fly frass analyses*, p. 126. In: O Schlüter, A., Fröhling, J., Durek, S., Bußler, T. & Piofczyk (eds.), Proceedings, INSECTA 2019 International Conference, 5 - 6 September 2019, Potsdam, Germany.
- Grain Producers Australia (2021). *Farmers need access to Australian made fertiliser*. Grain Producers Australia News. Available at <https://www.grainproducers.com.au/post/farmers-need-access-to-australian-made-fertiliser>
- Klammsteiner, T., Turan, V., Fernández-Delgado Juárez, M., Oberegger, S. & Insam, H. (2020). Suitability of Black Soldier Fly Frass as Soil Amendment and Implication for Organic Waste Hygienization. *Agronomy* 10, 1578.
- Lin, F.Y. & Li, A. (2021). *A primer on the Black Soldier Fly Market in Asia*, Mana Impact, 12th May 2021. Available at: <https://www.manaimpact.com/post/a-primer-on-the-black-soldier-fly-market-in-asia> Accessed 8/2/22.
- Linehan, V., Thorpe, S., Andrews, N., Kim, Y. & Beaini, F. (2012). *Food demand to 2050: Opportunities for Australian agriculture*, 42nd ABARES Outlook Conference, 6 – 7th March, 2012, Canberra, Australia.
- Meticulous Market Research (2021). *Black Soldier Fly Market by Product (Protein Meals, Biofertilizers {Frass}, Chitin/ Chitosan, Others {Cocoons, Pupa}), Application (Animal Feed, Agriculture, Pet Food, Pharmaceutical, Cosmetic, Biofuel), and Geography- Global Forecast to 2030*, Meticulous Market Research, 158 pages.
- Researcher Nester (2021). *Organic Fertilizers Market: Global Demand Analysis & Opportunity Outlook 2024*. Available at: <https://www.researchnester.com/reports/organic-fertilizers-market/446>
- Sheppard, D.C., Tomberlin, J.K., Joyce, J.A., Kiser, B.C., & Sumner, S.M. (2002). Rearing Methods for the Black Soldier Fly (Diptera: Stratiomyidae), *Journal of Medical Entomology* 39(4), 695–698.
- The Fertiliser Institute (2021). *Sustainability Report 2020*. The Fertiliser Institute, 2021. Available at: <https://www.tfi.org/sustainability>
- The International Fertilizer Association (2020). *GLOBAL SUSTAINABILITY REPORT 2019*. International Fertilizer Association, March 2020.
- United Nation's Food and Agriculture Organisation (2009). *How to Feed the World in 2050*. Expert paper series.
- United Nations (2019). *2019 Revision of World Population Prospects*.
- Zhang, J., Zhang, J., Li, J., Tomerlin, J.K., Xiao, X., ur Rehman, K., Cai, M., Zheng, L. & Yu, Z. (2021). Black soldier fly: A new vista for livestock and poultry manure management. *Journal of Integrative Agriculture* 20, 1167-1179.

Appendix A

Analysis of a list of characteristics of organic fertilisers on the market in competition with BSF products, including NKP, trace elements, carbon content, prices, and claims.

| Company | Product name | NPKS analysis (w/w%) ^a | Carbon (%) | Trace elements (w/w%) | Price (Bunnings) ^b | Price (company) ^b | Other claims |
|-----------|-----------------------------------|-----------------------------------|---------------|---|-------------------------------|------------------------------|--|
| Carbon Ag | WA broadacre blend | 2.3 – 1.4 – 1.1 – 1.2 | 27% | Ca = 7.1, Mg = 0.6, Na = 0.5. Plus: Fe, Mn, B, Zn, Cu. | Not available | Not available | Improved moisture and nutrient retention, plus availability; Rapid plant growth and resilience; Increased natural suppression of pests and disease |
| | Loose compost products #1 | 2.54 – 1.27 – 0.65 | 24.2% | Ca = 2.62, Mg = 0.65, Na = 0.61. | Not available | Not available | Process waste by-products Soil health |
| | Loose compost products #3 | 2.97 – 2.1 – 1.32 | 33.7% | Ca = 1.02, Mg = 0.68, Na = 1.54. | Not available | Not available | Water holding capacity |
| | Loose organic compost #1 | 1.24 – 0.29 – 0.597 | 23.4% | Ca = 2.29, Mg = 0.31, Na = 0.41. | Not available | Not available | |
| | Chicken Manure #1 | 4.65 – 1.51 – 1.38 | 28.4% | Ca = 4.95, Mg = 0.53, Na = 0.26, Zn = 0.0379, Cu = 0.0027. | Not available | Not available | |
| | Chicken Manure #2 | 4.86 – 1.34 – 0.83 – 0.175 | 29.9% | Ca = 3.59, Mg = 0.333, Na = 0.26, Zn = 0.0313, Cu = 0.0023. | Not available | Not available | |
| | C33 compost derived carbon pellet | 2.7 – 0.9 – 1.2 – 3.3 | 33% | Co = 1, Zn = 4.8, Mn = 2.9, Ma = 0.6, Ca = 3.8. | Not available | Not available | Contains 45% organic matter, Nutrient cycling, Water-holding capacity, Soil stability and biological activity. |
| Bailey's | Blood and Bone mix | 8 – 1 – 2 – 7 | Not available | Ca = 4, Fe = 0.2. | Not available | 20kg = \$23.40 (\$1,170/t) | Accreditation from Fertiliser Australia |
| | Energy Turf | 13 – 0.6 – 8 – 11 | Not available | Ca = 2.5, Mg = 0.6, Fe = 1, Mn = 0.8. | Not available | 20kg = \$33.65 (\$1,683/t) | Accreditation from Greenlife industry |

| | | | | | | | |
|----------|---|-----------------------|---------------|--|---------------------------|----------------------------|--------------------------------------|
| | Energy Complete (granulated organic fertiliser containing Blood & Bone, Zeolite, Humates) | 12 – 4 – 12 – 7 | Not available | Ca = 1.8, Mg = 4, Fe = 0.25, Mn = 0.15, Cu = 0.05, B = 0.03, Mo = 0.015. | Not available | 20kg = \$34 (\$1,700/t) | ISO 9001 Quality endorsed company |
| | Energy Maxx (granulated organic fertiliser containing Blood & Bone, Zeolite, Humates) | 7 – 7 – 13 – 7 | Not available | Ca = 3, Mg = 0.4, Fe = 0.12, Mn = 0.15, Cu = 0.05. | Not available | 20kg = \$37.05 (\$1,853/t) | |
| | Energy (Chicken Manure) | 4.9 – 0.9 – 1.7 – 0.5 | Not available | Fe = 0.18, Mn = 0.03, Cu = 0.01, B = 0.02. | Not available | 33kg = \$23.87 (\$723/t) | |
| | GT N Trace | 20 – 0 – 0 – 1.9 | Not available | Mg = 1.2, Fe = 0.06, Mn = 0.15, Cu = 0.02, Zn = 0.19, B = 0.12. | Not available | 1,000ltr = \$1,630 | |
| Rich Gro | All Purpose Mushroom Compost | Not available | Not available | Not available | 11.6kg = \$5.13 (\$442/t) | 1,000 ltr = \$309 | Committed to a zero carbon footprint |
| | All Purpose Organic Compost | Not available | Not available | Not available | 14kg = \$3.95 (\$282/t) | | |
| | Organic Chicken manure (Certified Organic product) | Not available | Not available | Not available | 25kg = \$6.16 (\$246/t) | | |
| | Organic Cow manure (Certified | Not available | Not available | Not available | 25kg = \$6.95 (\$278/t) | | |

| | | | | | | | |
|-------------------|---|------------------------|---------------|--|------------------------------|------------------------------|--|
| | Organic product) | | | | | | |
| | Organic Sheep manure | Not available | Not available | Not available | 25kg = \$6.95 (\$278/t) | | |
| | Blood and Bone based Premium Fertiliser | 8 – 1 – 1 – 5 | Not available | Not available | 15kg = \$26.48 (\$1,765/t) | | |
| | Organics Phosphorous Root Health Booster (Made of Guano. Certified organic product) | 0 – 12 – 0 | Not available | Not available | Not available | \$685 / tonne | |
| Charlie Carp | All Purpose Fertiliser Pellets | 6 – 1 – 3 | Not available | Not available | 5kg = \$22.98 (\$4,596/t) | 5kg = \$22.98 (\$4,596/t) | Certified Organic by NASAA, 100% European Carp All vitamins, minerals and vital trace elements, Slow-release, Environmental benefits to waterways. |
| Yates | Blood and Bone Based Fertiliser | 8 – 1.6 – 1.5 – 1.3 | Not available | Ca = 3.4, Mg = 0.7. | 10kg = \$24.39 / (\$2,439/t) | 10kg = \$24.39 (\$2,439/t) | |
| | Professional Blood and Bone (Plus Potash) | 7.7 – 5 – 1.2 – 1.6 | Not available | Ca = 10. | Not given | Not given | |
| | Dynamic Lifter Soil Improver & Plant Fertiliser | 3.7 – 2 – 1.8 – 0 | Not available | Plus: S, Fe, Mg, Mn, Zn | 12.5kg = \$28.40 (\$2,272/t) | 12.5kg = \$28.40 (\$2,272/t) | |
| Katek fertilisers | Organic Gold (Poultry manure compost blend full of live beneficial microbes) | 3.5 – 1.55 – 1.6 – 0.4 | Not available | Ca = 1.8, Mg = 0.5, Fe = 0.16, Mn = 0.04, Cu = 0.009, Zn = 0.04, B = 0.003, Mo = 0.0008. | Not available | \$130-140/t (<\$150/t) | Soil microbes and trace minerals Resistant to pests and disease |

| | | | | | | | |
|----------------------------------|---|--|---------------------------|---|-------------------|---|---|
| | Super Booster | 3.5 – 1.55 – 1.6 – 0.4 | Not available | Ca = 1.8, Mg = 0.5, Fe = 0.16, Mn = 0.04, Cu = 0.009, Zn = 0.04, B = 0.003, Mo = 0.0008. | Not available | \$300-350/t | |
| Bardee | Superfly®Organic fertiliser | 3.5–1.9–2.1–0.4 | 41.5% | Ca = 8.6, Mg = 0.7, Fe = 0.2, Mn = 0.04, Cu = 0.0045, Zn = 0.031, B = 0.0014, Mo = 0.00018, Si= 0.084, Co = 0.00014 | Not stocked here. | 8 kg = \$40 | Certified organic product line. Alive with 240 million beneficial microorganisms per gram, contains 10% chitin and nutritionally beneficial minerals for increased bio-diversity and healthy, well-structured soil. |
| Earth Systems/ Green Man Char | Biochar + Frass (80% biochar and 20% frass) | Frass component: 3.5 – 1.4 – 1.8 – 0.5 | Biochar component: 80-91% | Frass component: Ca = 10.8, Mg = 1.1, Na = 0.4, Si = 0.3252, Fe = 0.2643, Al = 0.0741, B = 0.0023, Cu = 0.0042, Mn = 0.0407, Zn = 0.0446, Mo = 0.0002, Co = 0.0001, Se = 0.0001 | Not stocked here. | Indicatively: 40ltr Biochar+Frass \$90.00 (Approx. 20 kg) | Local sourced biomass, rich in plant nutrients with up to two-hundred times more beneficial microbes than compost, Enhanced plant growth, Water holding capacity, Soil health, Reduced fertiliser use, Carbon sequestration, Resistance to pests and disease, Independently tested. |
| | Frass (80% frass and a 20% mix of biochar and wood vinegar) | Frass component: 3.5 – 1.4 – 1.8 – 0.5 | Biochar component: 20% | Frass component: Ca = 10.8, Mg = 1.1, Na = 0.4, Si = 0.3252, Fe = 0.2643, Al = 0.0741, B = 0.0023, Cu = 0.0042, Mn = 0.0407, Zn = 0.0446, Mo = 0.0002, Co = 0.0001, Se = 0.0001 | Not stocked here. | \$2,200/t (pers. comm) | Supercharged nutrient dense frass fertiliser blend, containing 200x more beneficial microbes than typical compost or worm castings, produced using 100% sustainably sourced biomass from local Australian suppliers Carbon-negative product. |
| Easy As Organics | Insect Frass | 3.5 - 1.39 - 1.75 | 33.4% | Ca = 10.5, Mg = 1. | Not available | 5kg = \$80 | Powerful bio fertiliser and inoculant, rich in beneficial microbes at 240 million CFU/g (200x that of compost). Slow release nitrogen for longer season crops. |
| Organic gardening solutions | Insect Frass | Not available | Not available | Not available | Not available | 100g = \$40 | Soil health, pest and disease with unparalleled results. |

^a The sulphur content is listed only if it has been specified on the company's website; ^b All prices in 2021/2022 Australian dollars.

Appendix B

Waste streams, form, NPK ratio, carbon content, trace elements and other beneficial characteristics from the BSF product analysis.

| Waste stream | Form | NPKS analysis (W/W%) N-P-K | Carbon % | Trace elements (W/W%) | Other observations |
|-----------------------|-------|-------------------------------|----------|---|--------------------|
| Vegetable | Frass | 3.9 – 0.61 – 0.5 | 44.63 | Ca = 0.17 Mg = 0.20 Na = 0.78 S = 0.45 | n/a |
| Industry (manure) mix | Frass | 2.28 - 1.03 – 3.08 | 35.77 | Ca = 5.10 Mg = 0.69 Na = 0.95 S = 0.68 | n/a |