



CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA



Entomal Biotech

- Kuala Lumpur, Malaysia
- Waste management; Food industry; Agribusiness
- www.entomal.com
- ★ Analysis period: 2019-2025

Bioconversion of Food Waste to Protein Using Black Soldier Fly (BSF) Technology

Business Spotlight

Entomal Biotech is a Malaysian company that processes food waste and agricultural byproducts into high-value resources. Using Black Soldier Flies (BSF), Entomal specialises in producing alternative protein and sustainable animal feed solutions. Entomal drives innovation in waste management and agriculture while bolstering food security.

Entomal revolutionises food waste management through the innovative Waste-to-Protein solution, using biotech breeding of BSF. This innovative approach converts organic waste into two valuable outputs of BSF larvae, processed into high-protein animal feed; and BSF frass, a nutrient-rich residue for use as organic fertiliser. By diverting food waste from landfills, Entomal offers a sustainable and cost-effective alternative that recovers proteins and nutrients and reduces Greenhouse Gas (GHG) emissions.

Entomal biotech's patented Entomal Mobile Bio-Conversion (EMBC) systems represent a leap forward in scalable, on-site waste management that adapts to diverse waste volumes and operational environments. The company's commitment to sustainability and innovation has earned it prestigious recognition, including the ASEAN Entrepreneurship Awards, Taiwan Innovation Excellence Awards (TIE), Petronas Future Tech 3.0 and several other honours for the company's market expansion across the region.



Keywords

Food waste, Insect farming, Animal feed, Organic fertiliser, Food security



Innovation

Product/service design, End of life management, Resource circularity, Resource substitution

Analysis of Entomal

Context and baseline

Malaysia is grappling with mounting volumes of food waste, estimated at approximately 16,700 metric tonnes daily in 2021. This increasing trend is the result of rapid urbanisation, population growth, and changing lifestyles and consumption patterns.1 Currently, the majority of the food waste ends up in landfills, contributing to the formation and release of methane emissions, a potent greenhouse gas (GHG), and placing pressure on limited landfill space. According to the Food Waste Index 2024 of the United Nations Environment Programme (UNEP), food loss and waste contribute globally to an estimated 8%-10% of global GHG emissions, underscoring its critical importance in mitigating climate change.² In Malaysia, the lack of segregation and reliance on landfilling not only pose environmental and climate risks, but also lead to economic strain from escalating waste management costs and diminishing landfill capacity. This situation calls for a transition away from traditional food waste disposal methods and adopting more sustainable, resource-efficient alternatives.

Entomal Biotech works to address the global issues of food waste, food security, landfill dependency, and GHG emissions through a sustainable, biotechnological solution. Food waste management is transformed to 'turn food waste into feed' via cutting-edge Waste-to-Protein technology using Black Soldier Flies (BSF). Food waste is thus diverted from landfills, ultimately reducing methane emissions, and food waste becomes a substitute for other sources of animal feed and fertiliser, conserving resources. Entomal is thus making food waste management both more resilient and more cost-effective.

Food waste is converted by Entomal into insect protein, which can then be used as a feed ingredient for livestock and aquaculture. By establishing decentralised food waste recovery facilities, the company is helping to solve local food waste and food security problems, while also providing a sustainable source of feed protein through a circular solution that creates a re-entry point for transformed protein into agri- and aquaculture, and back into the food chain.





Innovation

Entomal uses state-of-the-art entomological biotechnology, integrating insect biology knowledge with modern process innovations in order to tackle food waste and sustainably derive proteins and nutrients. At the heart of this company's technology is one of nature's most efficient recyclers, the BSF larvae (*Hermetia illucens*). These remarkable insects transform low-value organic waste into high-value products that can re-enter agri- and aquaculture food chains, thus putting the circular economy into practice.

To ensure optimal efficiency and resource use, Entomal has developed specialised equipment and hardware that span the insect's entire lifecycle from

¹ Shukla, K et al (2024), Food waste management and sustainable waste to energy: Current efforts, anaerobic digestion, incinerator and hydrothermal carbonization with a focus in Malaysia, in Journal of Cleaner Production, https://www.sciencedirect.com/science/article/pii/S0959652624009053

² UNEP (2024), Food Waste Index 2024: Think, Eat and Save: progress to halve global food waste, United Nations Environment Programme, https://wedocs.unep.org/20.500.11822/45230

breeding and growing of BSF to the final processing to recover protein and nutrients. The company's proprietary innovations streamline and enhance the bioconversion process through:

- Al-powered LED lighting to stimulate Black Soldier Fly mating
- Indoor climate control systems for precision breeding
- Advanced larvae rearing tray systems for scalable production
- Robotic automation for seamless process integration and system design

In the wake of the COVID19 pandemic, Entomal shifted its focus to in-house design, research and development, resulting in the patented Entomal Mobile Bio Conversion (EMBC) system, a gamechanger in decentralised food waste management and resource recovery. These mobile units are designed for flexibility and have been successfully deployed in diverse settings such as hotels, schools, community sites, etc. EMBC is scalable to varying waste volumes and operational environments, reinforcing its versatility and wide applicability across Malaysia and elsewhere.

Entomal maximises the value of BSF larvae and their byproducts. Mature larvae are rich in protein, amino acids, and fatty acids, ideal for livestock feed, aquafeed, and even for select pharmaceutical and cosmetic applications. The nutrient-rich excreta of the larvae, known as frass, can be used like manure to increase soil fertility and boost crop yields, as it contains nutrients, organic matter and beneficial microbes. Entomal continues to explore diverse downstream applications for their insect protein, particularly as functional cat and livestock feed, offering a complete and balanced diet enriched with antimicrobial peptides to support gut health and immunity.

Entomal Biotech's BSF systems are engineered for efficient, sustainable, and community-driven operations, ensuring high-quality output and measurable environmental benefits. The key operational features include:

- Efficiency: each Entomal Mobile Bio-conversion unit can process at source up to 3 tonnes of food waste per month. The system converts waste into valuable resources within 7–10 days, achieving an average waste reduction rate of 70%–80%, depending on the waste type.
- Product quality: the BSF larvae produced by the company contain 40%-45% protein and 30%-35% lipids, making these components suitable for use in poultry raising, aquaculture, and

- pet feed. The composted frass produced is a nutrient-rich organic soil conditioner, improving soil fertility and reducing reliance on chemical fertilisers.
- Monitoring & data: each unit operation is supported by data tracking and performance monitoring and reporting, ensuring transparency, efficiency, and alignment with sustainability metrics.



Circular Economy impact

Entomal Biotech contributes to the circular economy by recovering nutrients and proteins from food waste, illustrating resource recovery, and the recovered nutrients in turn substitute for chemical fertilisers, providing a good example of resource substitution.

Resource circularity is achieved by using BSF larvae to convert food waste into valuable products, thus recycling proteins and nutrients independently back into agri- or aquaculture for food production. Unlike other insect protein producers, Entomal is purposebuilt to address the dual global challenge of pollution and GHG emissions from food waste and food security. The application of composted frass in agriculture furthermore contributes to resource substitution, by partially replacing chemical fertilisers. This dual-output system transforms waste into income-generating commodities for urban communities, while minimising landfill dependency and GHG emissions.

EMBC system are adaptable to diverse waste volumes, and a 7–10 days processing cycle ensures rapid waste conversion with minimal maintenance. Entomal systems had by October 2025 cumulatively transformed 55 metric tonnes of food waste and substituted approximately 11 tonnes of chemical fertilisers. Carbon footprint analyses show that 137 tonnes of CO₂e emissions were avoided. Entomal supports their clients with carbon reporting and sustainability compliance. To further accelerate market adoption, Entomal is in

the process of securing key certifications, including SIRIM's Carbon Footprint (CFP) analysis and Verra Carbon Standards.³ These accreditations validate carbon reduction impacts and meet Environment, Social, and Governance (ESG) targets through verifiable, circular waste solutions. The company is thus validating their circularity impact and ESG alignment with a verified carbon footprint reduction, plug-and-play scalability, and fast-turnaround equipment for food waste management.

Business and market impact

Entomal Biotech operates under a service-based circular economy model and provides an end-to-end waste-to-value solution using their proprietary Entomal Mobile Bioconversion (EMBC) system, which utilises BSF technology to upcycle food and organic waste. The working model includes:

- System deployment: Supply and install the EMBC units at client sites or operate them through food waste collection network.
- Operational support: Provide training, technical assistance, and data reporting to ensure smooth daily operations, including waste segregation, larvae rearing, and post-treatment handling.
- Product value chain: Support clients in managing and commercialising the by-products, such as BSF larvae (insect protein) and organic soil conditioner (frass), either by purchasing them back or helping connect clients to downstream buyers in the feed and fertiliser markets.
- Consultation & EPCC projects: Entomal also offers consultancy and Engineering, Procurement, Construction & Commissioning (EPCC) services for palm oil mill owners and the food and beverage industry that generates by-products from their production lines. These projects are tailored to integrate BSF technology into their waste management systems, turning production residues into valuable, sustainable resources.

Equipment and operational partnership, along with consulting and project development expertise, are also provided by Entomal, ensuring that clients achieve positive environmental impact and maximum economic return through sustainable waste conversion. The company has successfully raised funds through equity crowdfunding, received strategic investment from Leave a Nest Capital (Japan), and secured multiple local and international grants and awards including support from Khazanah Nasional, Yayasan Hasanah, Cradle, Y Thinkcity,

SIDEC, state government initiatives, and several international sustainability funding programmes aimed at scaling up their impact across Malaysia and the ASEAN region. Some RM 8 million (approximately USD 1.9 million) in project value has been obtained by the company for the 2026 fiscal year.

Local communities, especially farmers and community groups, are also brought in to participate in Entomal systems' operations. These local operators receive a part-time allowance or salary for managing the EMBC units. Under the profit-sharing model, all end-products, including larvae and frass, can be sold to generate income and thus contribute to:

- · reducing farmers' feed costs
- providing extra income opportunities for community participants
- promoting local circular economy ecosystems through community-led waste management.

This inclusive approach ensures that Entomal's BSF systems deliver environmental benefits, economic empowerment, and community support at the grassroots level.

Business to Government (B2G) initiatives focused on food waste bioconversion are also currently being spearheaded by Entomal. One flagship project is a centralised waste bioconversion plant capable of processing 30 tonnes/day of food waste. The facility is scheduled to begin operations by the end of 2026 or Q1 2027, in collaboration with DBKL City Council and commercial malls and hotels. This initiative is further supported by Climate Impact Innovations.

With the support and investment from local publicly listed companies, family offices, and venture capital firms, Entomal and its partners will be positioned to lead Malaysia's transition towards a circular, low-carbon waste management ecosystem. It will set a benchmark for sustainable urban development, community engagement, and climate-positive innovation

Entomal Biotech is currently registered with the Bursa Carbon Exchange (BCX), Malaysia's national voluntary carbon market operated by Bursa Malaysia. Plans are under way for conducting a comprehensive carbon footprint assessment aligned with the internationally recognised verification standards, including Verra and the Gold Standards to quantify and validate the carbon reduction benefits of BSF-based bioconversion systems. Future plans are to generate verified carbon credits for trading on the BCX and global carbon markets.

³ SIRIM: https://www.sirim-qas.com.my/service/iso-14067-product-carbon-footprint-cfp/; Verified Carbon Standard (Verra): https://verra.org/programs/verified-carbon-standard/

Stakeholders

The mainstream adoption of waste-to-resource technologies is being pioneered by Entomal Biotech in order to reduce landfill dependency, strengthen food system resilience, and promote environmental health. The company is scaling circular solutions by forging strategic partnerships with stakeholders such as industry leaders, government bodies, and global organisations to accelerate the transition toward a circular economy.

In its early years, Entomal Biotech focused on advancing insect farming and sustainable protein production through rigorous research and development. Collaborations with esteemed academic institutions including the Universiti Malaysia Terengganu (UMT), Universiti Teknologi MARA (UiTM), Universiti Putra Malaysia (UPM), Taylor's University, Universiti Tun Hussein Onn Malaysia (UTHM), and the University of Saskatchewan in Canada, enabled extensive studies on insect breeding, feeding, and processing to optimise high-quality insect yields.

Then Entomal collaborated with waste collection partners and clients to follow the company's standard operating procedures (SOPs) for food waste segregation, collection, and handling before waste supply to the company's processing facility or farm. The SOPs ensure that only organic and biodegradable waste is collected (free from plastic, metal, or chemical contaminants); pretreated or stored under safe and hygienic conditions to prevent odour and pathogen growth; with all logistics processes fully traced, making it possible to monitor the volumes, types, and sources of all incoming waste. Through this structured approach, Entomal Biotech is now able to ensure consistent feedstock quality, improve processing efficiency, and support collaborative partnerships with waste collectors, food service operators, and corporate sustainability programmes.

Beyond waste treatment, Entomal Biotech has developed multiple BSF-based product lines to strengthen the circular bioeconomy, creating sustainable value chains across the pet food, livestock, and aquaculture sectors. Four major BSF-based value chains with market demand have been developed.

1. Food waste ▶ BSF protein ▶ Pet food (Tera Diet)

Tera Diet Cat Food, Premium cat food infused with BSF insect protein, currently recorded as one of the best-selling local brands and and offered by major retailers and on-line marketers in Malaysia. This product demonstrates strong consumer acceptance of insect-based protein as a sustainable and nutritious ingredient.

2. Food waste ► BSF protein ► Livestock/Chicken feed

♣ Chicken Feed Formula, developed in collaboration with MARDI Corporation, a government agency under the Ministry of Agriculture and Food Security (MAFS). The formulation utilises BSF protein to enhance poultry growth and feed efficiency. A Memorandum of Understanding (MoU) has been signed to advance commercialisation nationwide.

3. Food waste ► BSF protein ► Aquaculture feed (Fish & shrimp feed with UMT)

Tiger Grouper Fish & Shrimp Feed, created in partnership with the Universiti Malaysia Terengganu (UMT), which specialises in marine fish research. The feed formulation has undergone successful trials and is now ready for large-scale commercialisation in the aquaculture sector.

4. Food waste ➤ BSF frass ➤ Organic fertiliser & soil conditioner

Frass Compost (organic soil conditioner), is widely used by local farmers and landscapers. Trials have shown that frass application improves soil fertility, increases crop yield, and enhances plant resilience compared to conventional compost.

Through these integrated value chains, Entomal Biotech demonstrates how waste can be transformed into high-value nutritional and agricultural resources, supporting Malaysia's circular economy, food security, and low-carbon goals. Entomal Biotech also partnered with international technology providers in insect protein production, which has resulted in the enhancement of the company's processes and the acceleration of innovation. These efforts have translated into successful implementations across Malaysia and abroad, including projects with Indonesia, South Korea, Singapore, Brazil and China. The company offers specialised consultancy and engineering services to help other enterprises adopt insect protein technologies. Through ongoing collaboration with academic and industrial partners, the company continues to develop cutting-edge products and processes that meet evolving market needs.



Implementation

Malaysia faces an impending waste crisis with landfill capacity projected to run out by 2050.⁴ Limited land availability and the rising costs of landfill operations have intensified both environmental and fiscal pressures on the government. Compounding the issue is Malaysia's comparatively low recycling rate and persistent challenges in waste management infrastructure, technology, and skilled labour.

Entomal Biotech is stepping up with scalable, circular solutions. By offering advanced ento-biotechnology systems, the company empowers other enterprises and organisations to install, upgrade, or adapt waste processing systems, and thus boost their operational efficiency while reducing environmental impact. Entomal's innovations not only tackle the waste management sector but also contribute to building a more resilient and secure food system.

The company's patented EMBC units are gaining traction across diverse environments. The first unit was launched at Taylor's University in July 2023, followed by a deployment at Sunway Lagoon in December. Throughout 2024 to 2025, installations expanded to Le Meridien Petaling Jaya Hotel, Sunway Lagoon Park, the MBSA Recycling Centre, SJK(C) Lick Hung Primary School, Oasis International School, IJM Land developments, PPB Group, DBKL's food court at Jalan Raja Laut Aziz. These showcase the EMBC system's adaptability across hospitality, education, municipal, and commercial settings. Looking ahead to 2026, several deployments are already in the pipeline, along with further innovations to the business model to suit market demand and customer needs while supporting government policies and ESG initiatives.

Entomal's innovation and market traction have been recognised with prestigious awards and certifications, listed here.

- MySTI Myhijau Mark Certification by Ministry of Science, Technology, and Innovation (MOSTI), affirming research and development excellence and commercialisation potential
- ASEAN Entrepreneurship Award (Japan, 2024) and Taiwan Innovation Excellence Award (2023) for net-zero solutions
- Recognised by Petronas Future Tech 3.0, Slingshot 2023, and Malaysia's Tech to Watch 2024

- RM 1.75 million (USD 400,000) via equity crowdfunding raised on Mystartr; a Malaysia Madani grant of RM 200,000 (USD 47k) for sustainability innovation secured
- Winner of Panasonic Deep Tech Innovation Challenge and Future FoodTech Festival for breakthrough Innovation in food security and nutrition

Other honours with multiple accelerator programmes include the Digital Village Accelerator programme (DiVA), Seleangor Accelerator Programme by Selangor Information Technology and Digital Economy Corporation (SIDEC), BioEconomy Prestige Accelerator Programme, MRANTI Global Accelerator Programme, Korea-ASEAN Business Model Competition and WITSA World Cup Global Silver Medallist.





⁴ https://www.trade.gov/market-intelligence/malaysia-waste-management#:~:text=Malaysia%20disposes%20of%20more%20than,while%20producing%20new%20renewable%20energy.

Takeaways

Entomal Biotech has become a national and regional inspiration in sustainable biotechnology by combining technical depth and entomological knowledge with market agility, and by aligning with environment, social and governance priorities in the hospitality, retail and waste management sectors. The company's ability to scale across industrial, municipal, and community markets positions it as a strategic partner for governments, corporations, and investors seeking high-impact, future-ready solutions.

And in addition to being a front-runner in insectbased protein production, Entomal is expanding its business to become a one-stop-shop provider of food-waste management and resource-recovery solutions. Sustained investment in research and development has led to breakthrough products addressing food waste and food security challenges in Malaysia and beyond. Their mobile bioconversion systems offer scalable solutions for cities, industries, and communities seeking efficient waste management for urban sustainability. And last but not least, Entomal achieved the vision outlined in the 2024 Circular Economy Blueprint for Waste Management in Malaysia.













Acknowledgements

This business case study was prepared for the ASEAN Circular Economy Business Alliance (ACEBA) within the framework of the Technical Advisory project: Mobilising Business Action for Circular Economy in the ASEAN countries under the EU SWITCH-Asia Policy Support Component for the sole purpose of documenting and analysing business experiences with circular economy. ACEBA is an ASEAN-centric and business-led initiative that fosters business leadership and action on circular economy in Southeast Asia. ACEBA is an initiative of ARAIBA Sdn Bhd, a not-for-profit business organization that promotes responsible and inclusive business, in collaboration with national business membership organizations and with technical advisory of the EU SWITCH-Asia Policy Support Component.

The business case was produced by Sri Shalini Sathyanarayanan (circular economy expert) and reviewed by Rene Van Berkel and Thomas Thomas (regional experts and ACEBA co-convenors) on the basis of information provided and validated by Entomal Biotech, Malaysia.

Disclaimer

The content of this publication is the joint responsibility of Entomal Biotech, Malaysia and the expert team. This publication does not constitute an endorsement of Entomal Biotech, Malaysia by the European Union nor any of the partners of the SWITCH-Asia Policy Support Component, nor necessarily reflect their views.



www.aceba.co



info@aceba.co



www.switch-asia.eu



EU SWITCH-Asia Programme @EUSWITCHAsia



SWITCH-Asia @SWITCHAsia



SWITCH-Asia Official @switch-asia-official