

A Circular Revolution: How the Black Soldier Fly is Transforming Organic Waste Management

“Imagine walking out of a grocery store with four bags of groceries, dropping one in the parking lot, and just not bothering to pick it up. That’s essentially what we’re doing,” says one food scientist at the National Resources Defense Council.

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INTRODUCTION

Up to 30% of all food produced globally is wasted annually, according to government data; this proportion is said to have increased by about 40% since 1970. The UN Food and Agriculture Organization (FAO) estimates that this lost food costs almost USD 1T (~ EUR 890b) annually and contributes to CO2 emissions by around 8%!

The global food waste market is set to grow from **USD 40.3B in 2022 to USD 64.3B by 2030** - burning, burying, or shipping waste elsewhere is becoming an untenable strategy in an increasingly crowded and sustainability-focused world.

Given the vast land, water, and resources being squandered, it's no wonder that innovative companies are using black soldier fly (BSF), *Hermetia illucens*, as an organic waste conversion solution. Using BSF to digest organic waste and then utilizing protein-rich larvae to produce high-value resources such as animal feed, soil enhancers, and biofuels could be a profitable path to offset food waste.

ORGANIC WASTE'S POTENTIAL

1. Waste Diversion

One of the most immediate benefits of integrating BSF larvae into waste management systems is the diversion of organic waste from landfills. Organic waste in landfills emits methane, a potent greenhouse gas, contributing to climate change. By diverting organic waste, waste management companies help reduce their carbon footprint and mitigate environmental damage.

Lost food costs USD 1T annually, contributing to CO2 emissions by ~8%

Global Food Waste Market

USD 40.3B in 2022 to USD 64.3B by 2030

2. Resource Recovery

BSF larvae consume organic waste and convert it into a valuable biomass rich in proteins and fats. This biomass can be processed and used as a protein source in animal feed, reducing the need for traditional feed ingredients like soy and fishmeal. This not only conserves resources but also promotes sustainable and responsible animal agriculture.

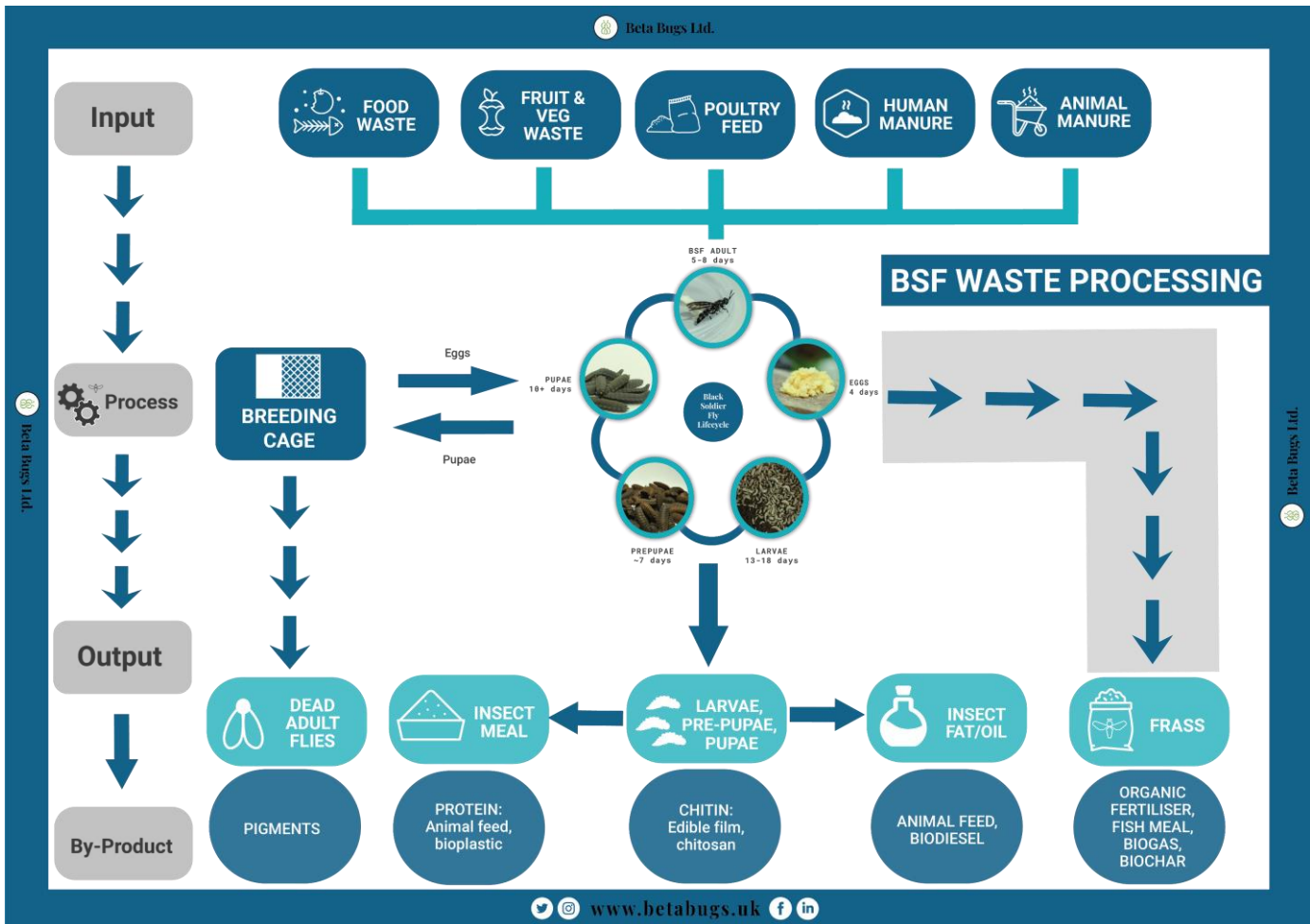
3. Soil Enhancement

The nutrient-rich frass (a mixture of BSFL excretion, uneaten substrates, and shed exoskeletons) produced by BSF larvae can be used to enhance soil quality. It is an excellent organic fertilizer that improves soil structure and promotes plant growth. Waste management companies can market this product to agricultural and horticultural sectors, contributing to soil health and reducing the need for chemical fertilizers.

4. Biofuel Production

Another exciting prospect is the potential use of BSF larvae for biofuel production. The oils extracted from the larvae can be converted into biodiesel or other biofuels, offering a renewable and environmentally friendly alternative to fossil fuels.

Diagram 1 - Flow Diagram Outlining BSF Process



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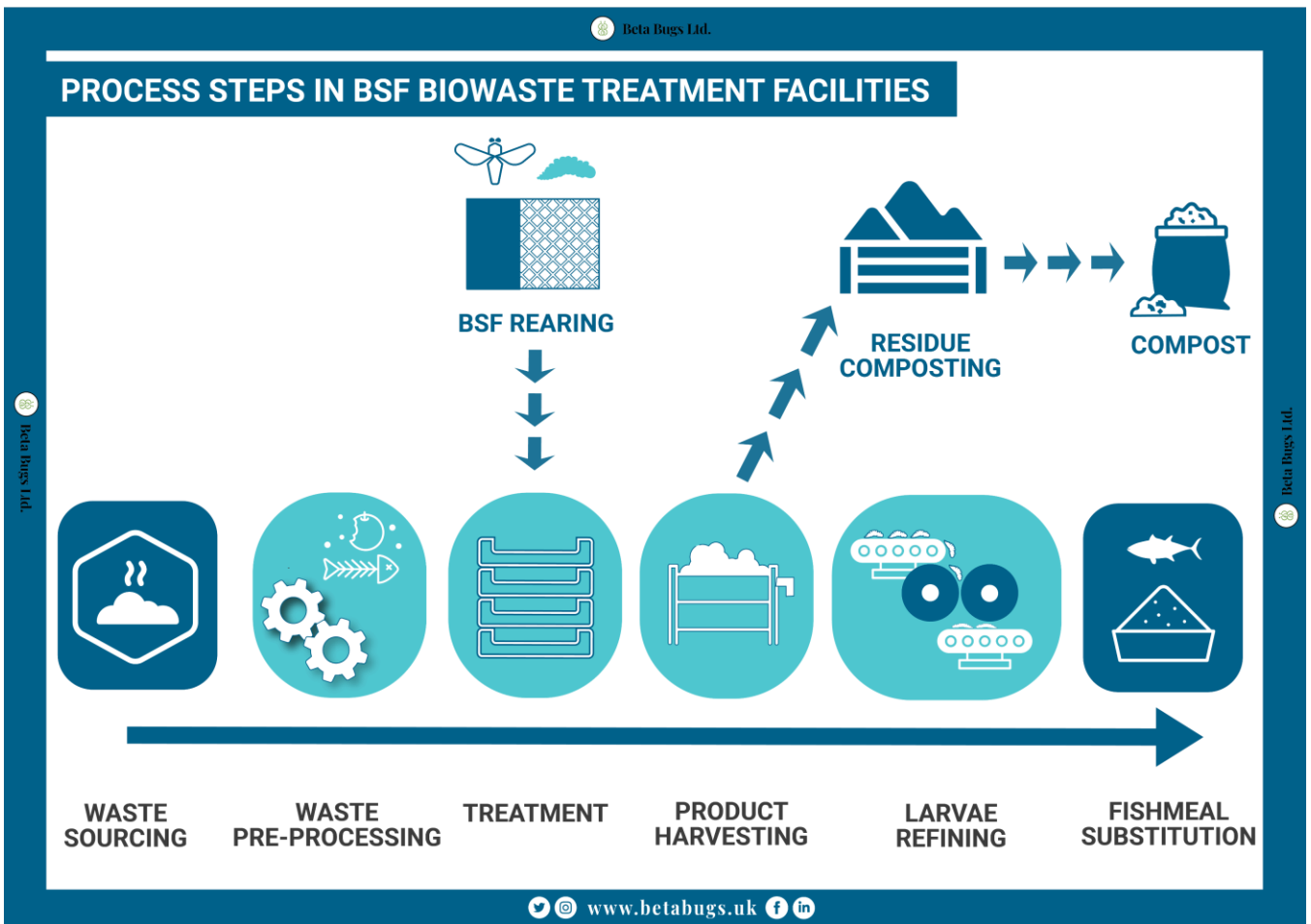
A SUSTAINABLE ALLY IN FIGHTING WASTE

In 2021, the global BSF market’s estimated worth was pegged at USD 180M but is expected to surge to USD 2.3B by 2030. Large-scale facilities, designed to treat up to 200 tons of organic material daily, have been built or planned in the Netherlands, Canada, South Africa, China, and the USA.

Industrial-scale BSF production typically follows several typical steps that standardize the process:

1. Waste pre-processing, which sorts indigestible materials out.
2. BSFL (black soldier fly larvae) rearing and biowaste treatment.
3. The separation of BSFL from the process residue, and
4. Larvae and residue refinement into marketable products.

Diagram 2 – Process Steps in BSF Biowaste Treatment Facility



Low-Value Organic Waste

BSFL's conversion of low-value organic waste to high-value products has fewer adverse environmental impacts, such as less greenhouse gas emissions and a smaller ecological footprint for producing protein feed and other nutrient supplements. BSFLs are also safe for animal consumption because they are pest-free and do not accumulate mycotoxins or pesticides in their bodies.

Consistency of Organic Sources

But the economic feasibility of these emerging BSF facilities will depend on the right “brew” of factors. The type and consistency of organic sources, providing nutrient dense substrate, the efficient conversion of waste to biomass must be considered in scaling profitably. It's the reason why industrial waste processors are well suited to the space.

Production of Secondary Waste

Even when black soldier flies are bred on a large scale, secondary waste is produced, leaving large numbers of dead fly biomass. But this biomass can be an important renewable source of pigments such as melanin and ommochrome. These multifunctional uses create an attractive circular economy for everything BSF consumes and produces, upcycling what companies had once paid to throw away.

DEAD FLY BIOMASS IS VALUABLE

Industrial waste processors have a few key advantages when scaling BSF production:

- Balance sheet. With established businesses and cash flow, they can pursue scale investments, integrating a BSF facility with existing waste processing technologies, enhancing margins, and satisfying environmentally focused investors.
- Feedstock and customers. Existing food waste streams can provide a consistent feedstock for producing insect protein, and infrastructure for handling and delivery is already in place.
- Mindset and track record. Food waste processors regularly handle enormous amounts of waste and understand the regulatory and operational challenges and opportunities it presents.

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FOOD COMPANIES GET IN ON THE ACTION

Agriculture and protein companies also see the potential of upcycling their waste streams. The organic waste that comes out of the food production cycle is significant, and food companies are all looking for ways to bolster their sustainability credentials and improve their margins, which is why BSF provides such an intriguing opportunity.

For example, the recently announced investment and partnership between Tyson, a major protein company in the US and Protix, a leading BSF company based in the Netherlands. A more compelling industrial circle is difficult to imagine.

Tyson and Protix will jointly develop a BSF facility where Tyson can “offload” the organic waste from its vast food production network, which includes chicken, beef, and pork. It can then “offtake” BSF protein to supply its farming operations or specialty animal or pet ingredients business.

These are solid synergies for both companies. Tyson reduces cost and environmental impact while boosting its standing with ESG-minded investors. At the same time, Protix receives a constant feedstock for its voracious flies and a protein producer with an insatiable appetite for insect protein.



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WHO IS LEADING THE CHARGE?

Veolia

French multinational Veolia is considered the largest water, waste, and energy management company in the world, based on annual revenues of ~ USD 46B. It has a BSF farm in Malaysia annually produces 3k tons of insect-based products, Entomeal™ and Entolipid™, through a bioconversion process. Just this Fall, the company was granted permission to import its insect meal/oils into Europe for pet, aquaculture, and livestock feed use.

Veolia has also partnered with MUTETEC, which has developed a technical farming method for BSF that can be applied on a large scale. Separately, Veolia is running a six-month BSF pilot program in New Zealand and exploring the potential for BSF production in the UK.

Kochi Corporation

India's Kochi Corporation will trial the use of BSF at its Brahmapuram solid waste plant, which handles approximately 100M tons of waste daily. This came on the heels of a significant fire at the plant, which saw toxic fumes sicken many people and livestock, leading Kochi to take a proactive, sustainable approach to waste management.

APPROXIMATELY

100M TONS OF WASTE DAILY

Tyson

The US-based Tyson is the world's second-largest processor and marketer of chicken, beef, and pork. It is one of the largest exporters of US beef and operates well-known food brands, including Jimmy Dean, Hillshire Farm, Ball Park, Wright Brand, Aidells, and State Fair. The protein producer made a minority investment into Protix, a leader in BSF production. Protix owns a 14,000 MT (Metric Tons) facility that can breed, rear, and process BSF in the Netherlands.

Cargill

One of America's largest private companies by revenue, Cargill had revenues of USD 165B in 2022. The company is a diversified agriculture and commodities business trading, purchasing, and distributing grain and other agricultural commodities ranging from palm oil and energy-to-steel. The business raises livestock and produces feed ingredients such as starch and glucose syrup, vegetable oils and fats for application in ultra-processed foods and industrial use, and aquafeed for fish farming. In 2022, Cargill entered a 10-year global partnership with Innovafeed, a French BSF producer. The wide-ranging agreement has Innovafeed formulating and scaling precision insect ingredients for Cargill's global animal feed business. According to their announcement, Innovafeed's insect meal in aquafeed saves up to 16,000 tons of CO2 for every 10,000 tons of insect protein.

ADM

The Archer-Daniels-Midland Company, known as ADM, is an American multinational food processing and commodities trading corporation headquartered in Chicago, Illinois. The company operates more than 270 plants and 420 crop procurement facilities worldwide, where cereal grains and oilseeds are processed into products used in food, beverage, nutraceutical, industrial, and animal feed markets worldwide

**MORE THAN 270 PLANTS
WORLDWIDE**



**MORE THAN 420 CROP
PROCUREMENT FACILITIES**



ADM has also partnered with Innovafeed to construct a BSF facility co-located with one of their corn processing sites in Decatur, Illinois. The BSF will feed on corn byproducts, and the plant will utilize waste heat, water recycling, and other utilities from the ADM industrial site. ADM's waste energy is expected to supply some 60 percent of the new plant's energy requirement.

The facility is expected to open in late 2024. At full capacity, it will produce an annual volume of 60,000 MT of protein meal (a brown powder that looks like cocoa), 20,000 MT of oil (a source of essential fatty acids and energy), and 400,000 MT of fertilizer.

PRODUCTION RATE OF ANNUAL VOLUME

60,000 MT OF PROTEIN MEAL

20,000 MT OF OIL

400,000 MT OF FERTILIZER

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CHALLENGES AND CONSIDERATIONS

While the entry of waste management, food, and agriculture companies into the black soldier fly market holds great promise, there are several challenges and considerations to address:

CLIMATE CONSIDERATIONS: While BSF larvae can survive in a wide range of environments, they are optimally produced in elevated temperatures and humidity levels, making Southeast Asia an optimal location for production. Naturally, this could inhibit companies in colder, less humid climates from investing in BSF production on a large scale.

REGULATORY FRAMEWORK: The regulation of insect-based waste management and production processes for food and animal feed is still evolving in many regions. Interested companies need to work closely with regulators to ensure compliance with existing laws and develop clear guidelines for the industry.

SCALABILITY: To fully harness the potential of the black soldier fly market, entrant companies must invest in scaling up production. This entails building large-scale BSF facilities, which can be capital-intensive.

PUBLIC PERCEPTION: Convincing the public, especially in the West, to accept insect-based products for human consumption will be challenging, but its use in animal feed and fertilizers will prove easier. Education and awareness campaigns are crucial to address this issue.

Conclusion

These significant new entrants into the BSF market are a positive step toward more sustainable and eco-friendly waste management practices and mark a maturing sector. BSF's ability to convert organic waste into valuable resources aligns with the principles of the circular economy, benefiting the environment, reducing waste, and conserving resources. It also creates new revenue streams for mature companies and margin-enhancing opportunities across their value chains. As the industry scales, perhaps we'll finally be doing something about that last "grocery bag".



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APPENDIX

- <https://www.businessinsider.com/households-waste-a-ridiculous-amount-of-food-2016-2>
- <https://www.epa.gov/international-cooperation/international-efforts-wasted-food-recovery#:~:text=The%20UN%20Food%20and%20Agriculture,in%20nine%20people%20remain%20undernourished.>
- <https://www.acumenresearchandconsulting.com/food-waste-management-market>
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