

The Black Soldier Fly in Southeast Asia: From Food Waste to Bankable Opportunities



Innovative financial solutions for nature

December 2023

Food waste: Why should we care?

Natural resource imbalances^{1,2}

- Food waste accounts for almost **a quarter of freshwater resources, cropland area, and fertilizer use** globally
- **40% of food produced** is lost or wasted
- **11% of world population live in hunger, while another 26% are overweight**



Climate change^{3,4}



- Landfills release **methane (CH₄)**, a greenhouse gas (GHG) **28 times as potent** as carbon dioxide (CO₂)
- Methane is the **second most abundant** anthropogenic GHG after CO₂, accounting for **16% of global emissions**

- **Reducing methane emissions** is among the strongest levers we have in the fight against climate change

Food waste



1. Production

From primary food supply to processing

2. Consumption

From points of sale to end-consumption

Land degradation⁵



- Around **40% of all habitable land** is used to produce food, causing **80% of deforestation**
- **Soil degradation** has reduced the productivity of nearly **a quarter of land**
- This affects **3.2 billion people** and cost around **10% of global GDP** in lost ecosystem services

Biodiversity loss⁶

- Nearly **70% of our planet's wildlife** population has been lost since 1970
- This is in large part caused by **unsustainable forestry and overfishing**
- **Managing food waste** more effectively would go a long way towards creating **sustainable ecosystems**

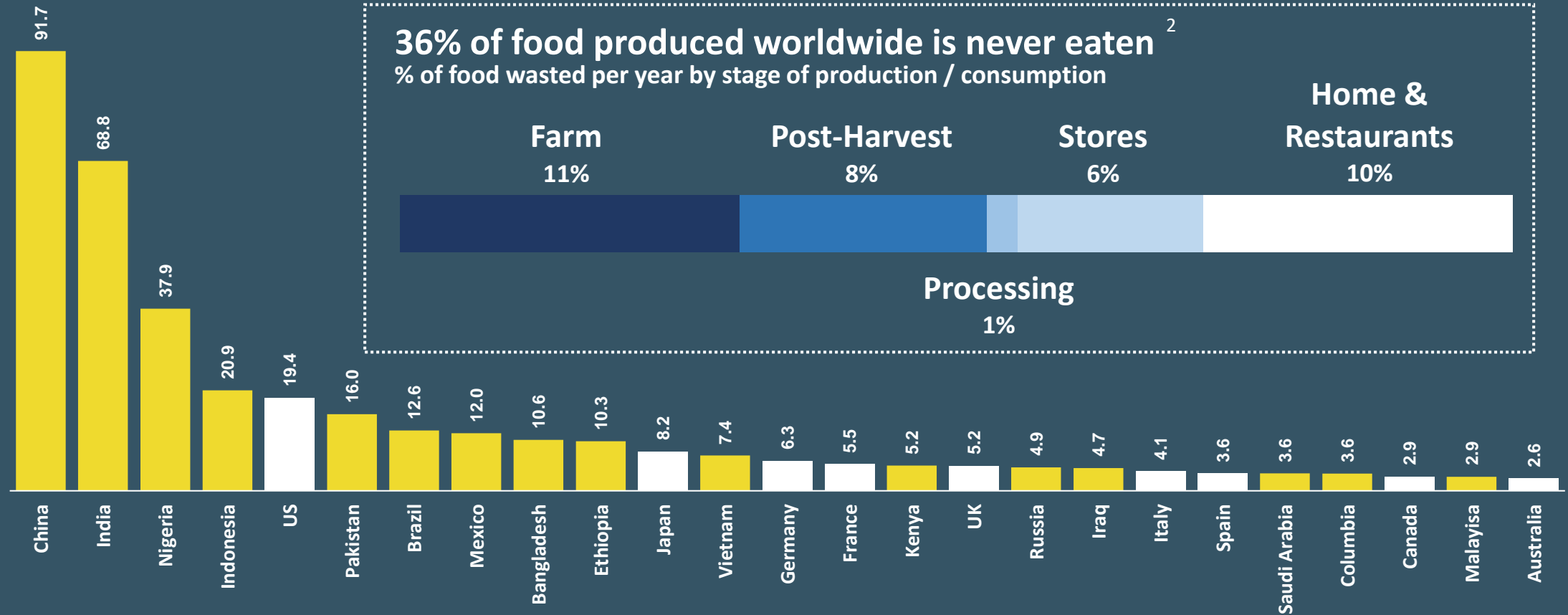


Sources: (1) US National Institute of Health; (2) WWF; (3) EPA; (4) UN Environment Programme; (5) WWF; (6) WWF; Seneca Impact Advisors

It's not just the wealthiest countries that are wasting food

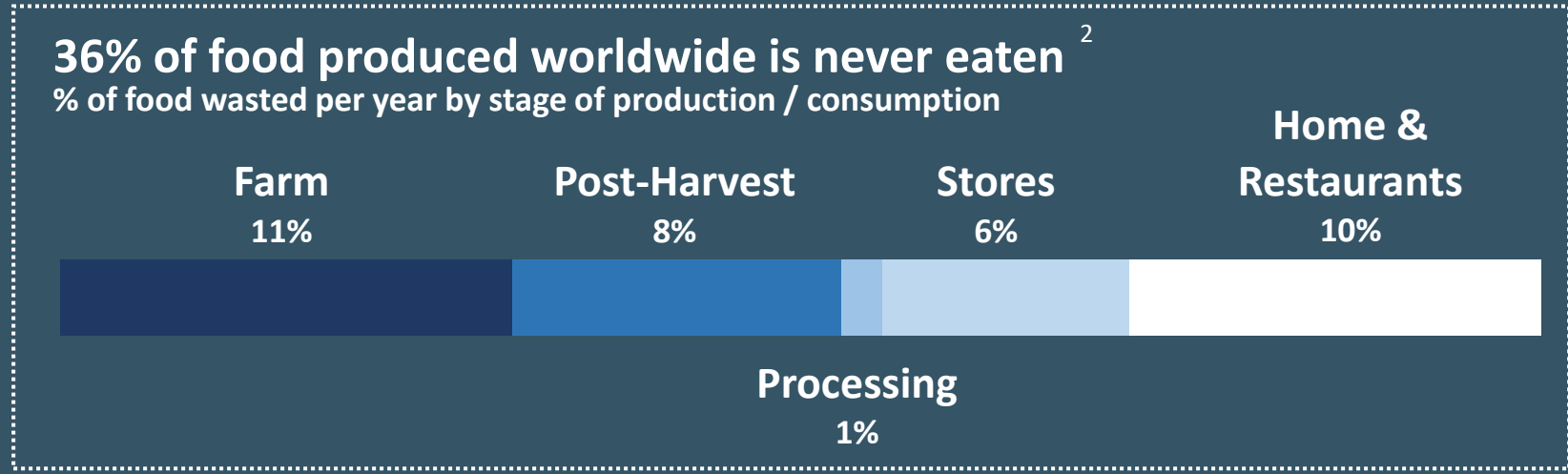
Annual household food waste ¹

million mt per year



36% of food produced worldwide is never eaten ²

% of food wasted per year by stage of production / consumption

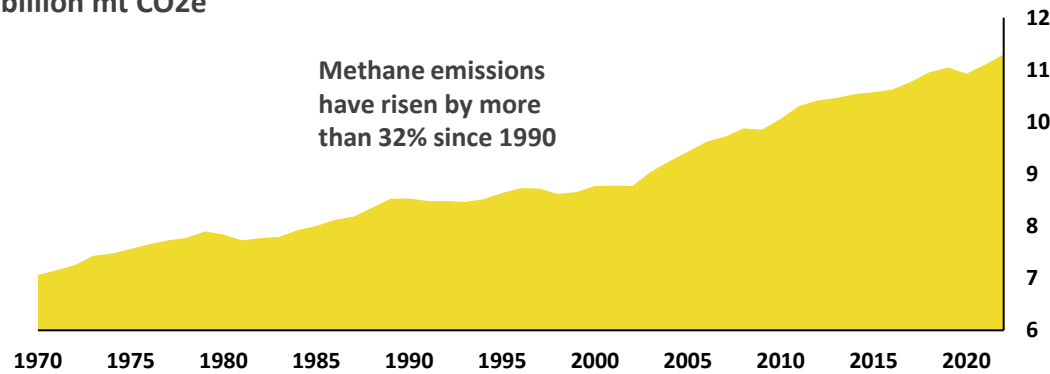


Sources: ¹ Statista (as of 2020), ² Earth.org; Seneca Impact Advisors

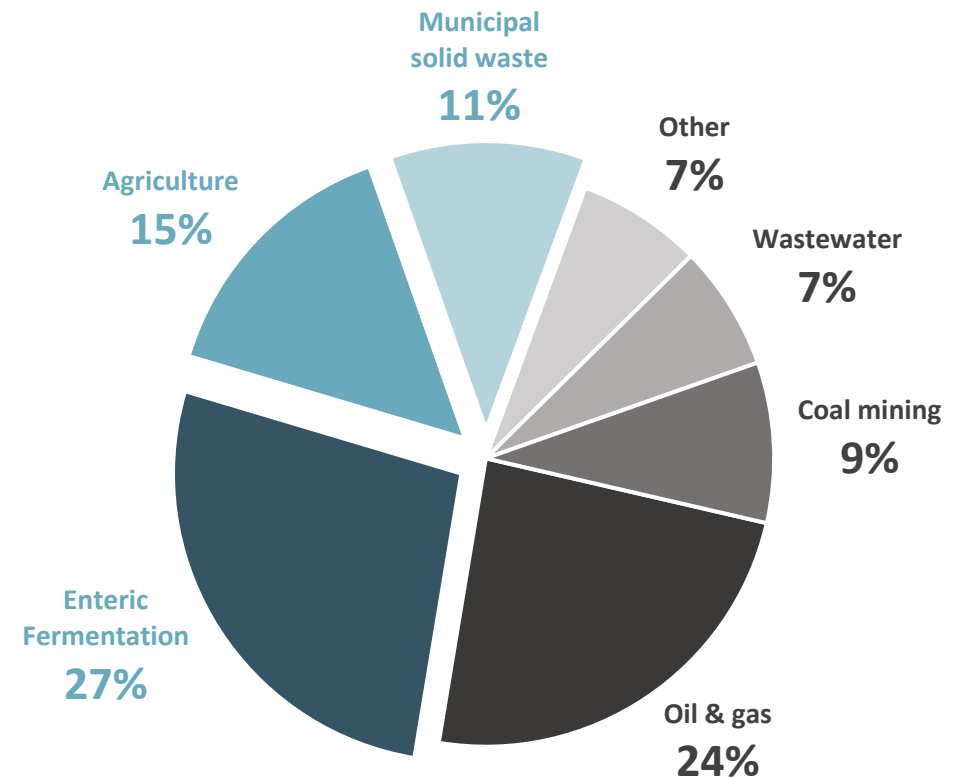
The climate impacts are dire

Food production and organic waste's methane emissions

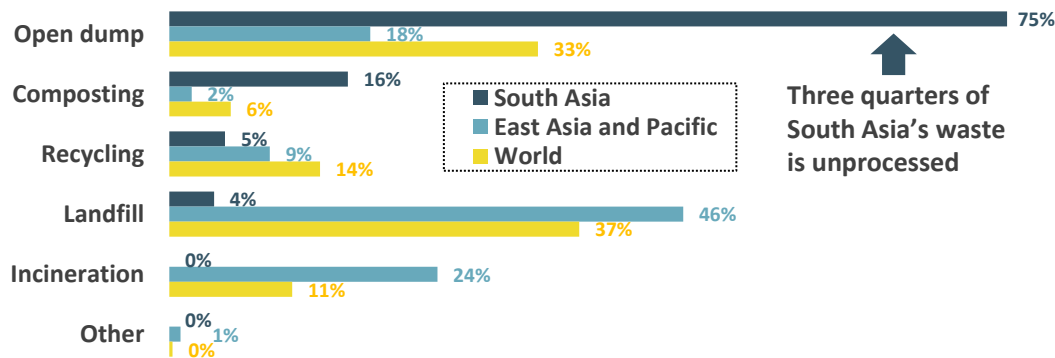
Global annual methane emissions¹
billion mt CO₂e



Estimated global anthropogenic methane emissions by source³



Waste treatment and disposal methods²



Sources: (1) Statista; (2) World Bank (2018); (3) Global Methane Initiative (2020); Seneca Impact Advisors

The black soldier fly (BSF) as a bioconversion solution

BSFs' unique characteristics make them a highly efficient organic waste *upcycling* solution ^{1, 2}

The species

The black soldier fly, *Hermetia illucens*, is a common species of the *Stratiomyidae* family

The species is native to the Neotropical realm, which includes southern North America, Central America, South America, and the Caribbean islands

But in recent decades, BSFs have become virtually cosmopolitan, adaptable to a wide range of climate and environmental conditions

The advantages

- BSFs produce less stench in compost systems
- Adult BSFs don't have to consume food at all
- As such, they are not a pest to humans and are not attracted to human habitation or foods
- With little expendable energy, they do not spread as easily as other fly species
- BSF larvae can significantly reduce E. coli and reclaim would-be pollutants
- They can reduce the volume of compost by around 50%

Adult BSFs measure about 16 mm long, with a predominantly black body and metallic reflections from blue to green on the thorax and sometimes with a reddish end of the abdomen



An adult female lays between 500 and 900 eggs at a time

Larvae are 1 mm long and can reach 25 mm in length and 0.10 to 0.22 g in weight by the end of the larval stage

The larval stage lasts from 13 to 18 days, while the pupal stage lasts from 7 to 10 days. Adult BSFs can typically survive for only about 5 to 8 days

The scientific evidence

A change in our collective knowledge of BSFs occurred in the 1980's, when the species was recognized initially for their role in forensic entomology and later for their use for organic waste treatment, and providing an alternative source of crop fertilizer and animal feed

Since then, there has been a proliferation of BSFs' use by farmers, and feed and fertilizer manufacturers

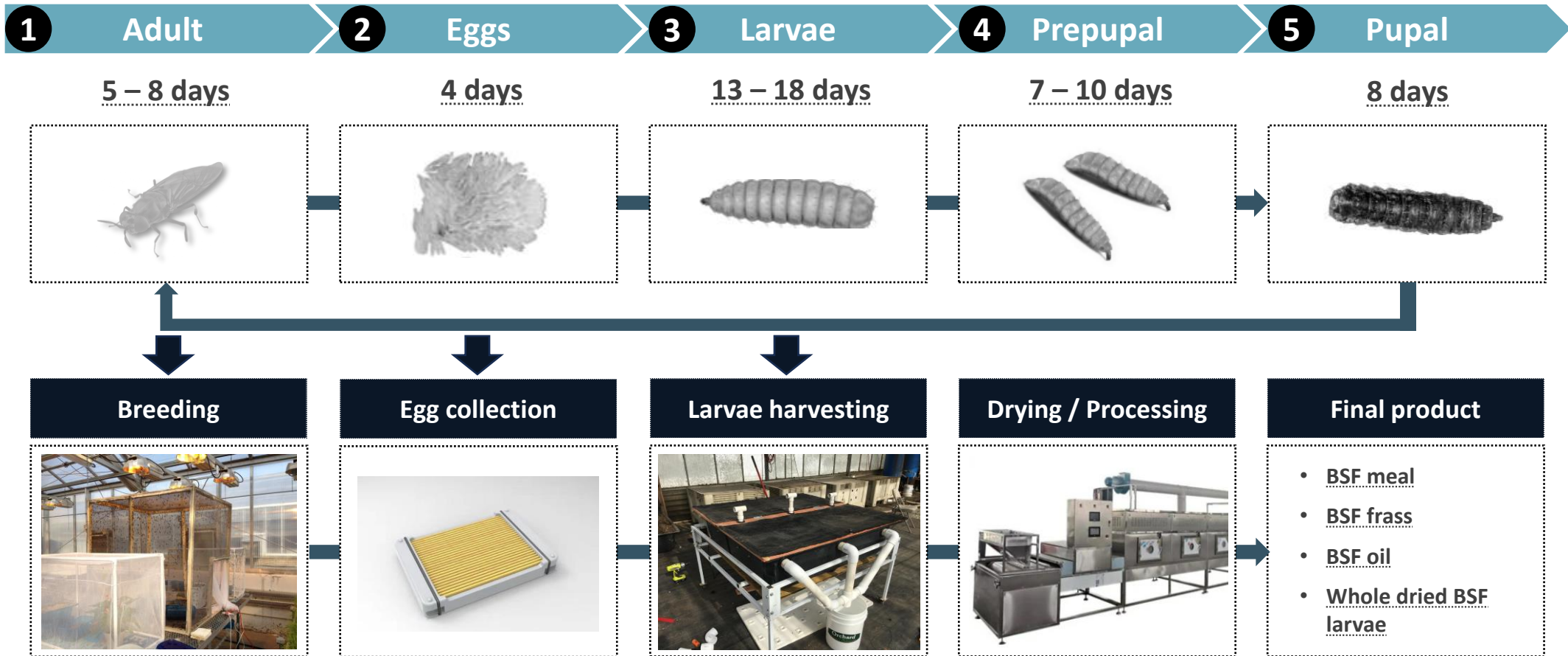
BSF larvae / frass use cases

- Animal feed
- Fertilizers
- Cosmetics / personal care products
- Chitin, for used in shipping as an agent against biofouling, in water purification, and as a soil amendment
- Bioremediation to remove pollutants or contaminants
- Human / pet food

Sources: (1) [Journal of Insects as Food and Feed](#); (2) [Scholarly Community Encyclopedia](#); Seneca Impact Advisors

BSFs' short bioconversion process

The 7-week life cycle of a *typical* black soldier fly ^{1,2}



Sources: (1) [Scholarly Community Encyclopedia](#); (2) [Symton BSF](#); Seneca Impact Advisors

The commercial market for BSF products

Potentially a \$1.5 billion global market by 2030 ^{1, 2}

By product type

- 1 BSF meal
- 2 BSF frass
- 3 BSF oil
- 4 Whole dried larvae

BSF products typically belong to one of these four formats

By commercial application

- 1 Animal feed
- 2 Fertilizer
- 3 Cosmetics / Personal care
- 4 Other

Animal feed and fertilizer are the two main commercial applications at present

By downstream user

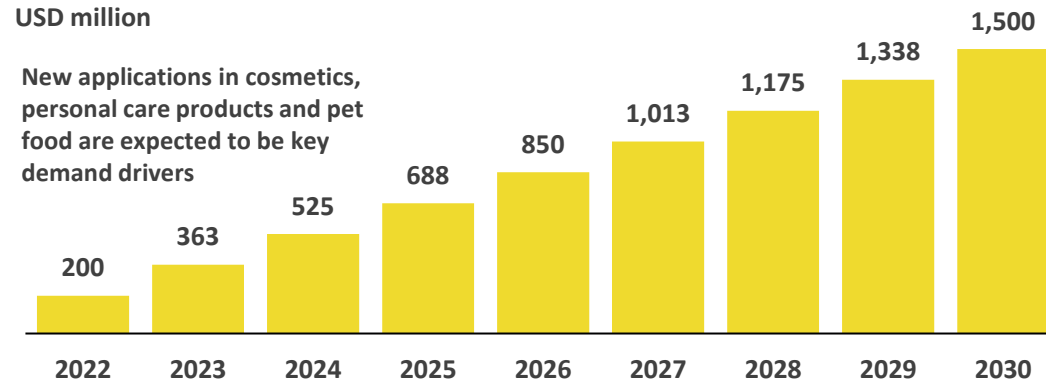
- 1 Feed manufacturers
- 2 Fertilizer manufacturers
- 3 Farmers
- 4 Consumer goods companies

Some feed and fertilizer manufacturers have their own BSF production operations

Market potential estimates

USD million

New applications in cosmetics, personal care products and pet food are expected to be key demand drivers



Major BSF product suppliers

- Bioflytech (Spain)
- Enterra Feed (Canada)
- Entobel (Singapore)
- Entofood (Malaysia)
- Entomo Farms (France)
- EnviroFlight (US)
- F4F (Chile)
- Hexafly (Ireland)
- InnovaFeed (France)
- nextProtein (France)
- Nutrition Technologies (Malaysia)
- Protenga (Singapore)
- Protix (Netherlands)
- Sfly (France)

Sources: (1) nForming Solutions; (2) SkyQuest Technology; Seneca Impact Advisors

BSFs' commercial value

BSF products' value goes beyond their sustainability impacts ^{1, 2, 3, 4}

Animal feed

BSF larvae are rich in nutrients such as fat, protein and high-quality amino acids and minerals, making them suitable as a feed for chicken, pigs, fish, prawn and many pet species

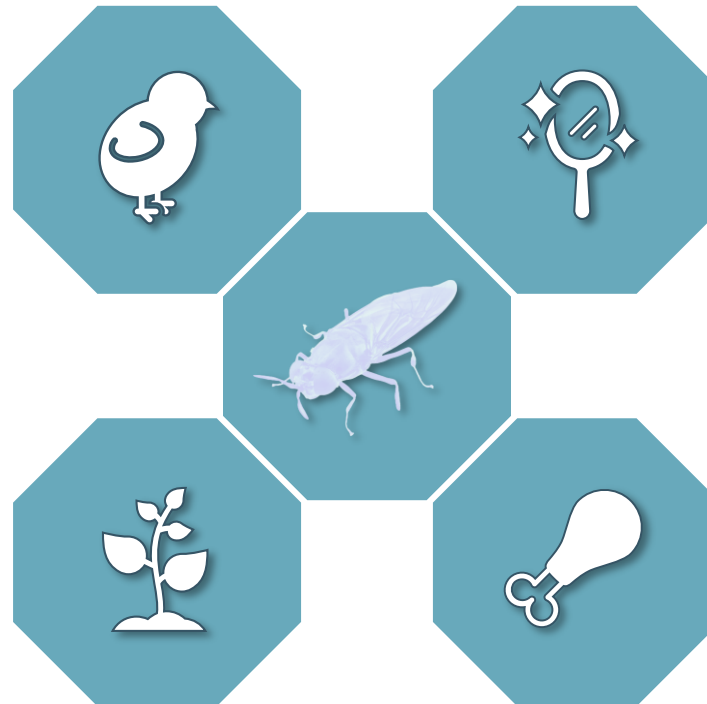
While BSF larvae cannot completely replace other feed sources for poultry and hogs, their relatively stable cost makes them a viable supplement to existing alternatives

Fertilizer

BSF larvae frass is an organic fertilizer that has been shown to contain more nutrients than red worm castings

It has 10x the nitrogen, 4x the phosphorus and more than 2x the potassium of typical homemade compost

It also contains chitin, which would dramatically increase plants' defenses against insects



Cosmetics / Personal care

BSF larvae oil is an antimicrobial, antibacterial and antiviral compound naturally rich in essential omega fatty acids, including omega 3, 6 and 9

It also contains lauric acid, which can be used for acne treatment, as well as antioxidants and phospholipid conducive to skin rejuvenation

Other

BSF larvae have been shown to be an effective bioremediation agent for the disposal of hazardous waste, such as antibiotic bacteria residue produced by pharmaceutical companies

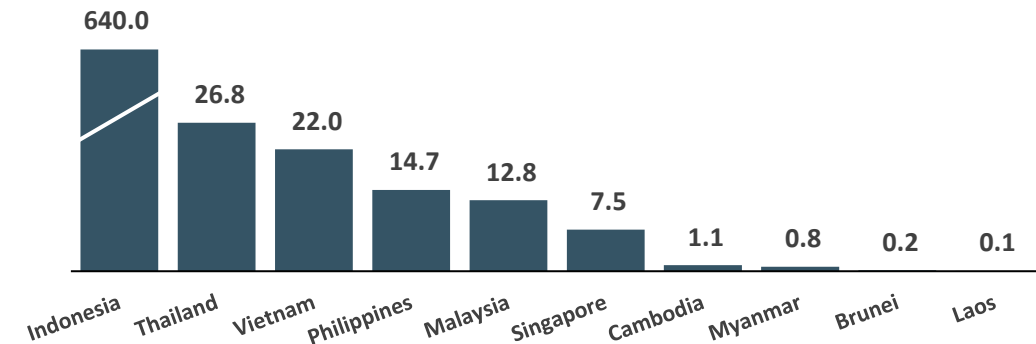
BSF larvae are richer in zinc and iron than lean meat and their calcium content is as high as that of milk. These properties may make them a commercially viable human dietary supplement in the future

Sources: (1) [Insects Journal](#); (2) [The Critter Depot](#); (3) [Chiang Mai University](#); (3) [Frontiers in Microbiology](#); (4) [Nutrition Insight](#); Seneca Impact Advisors

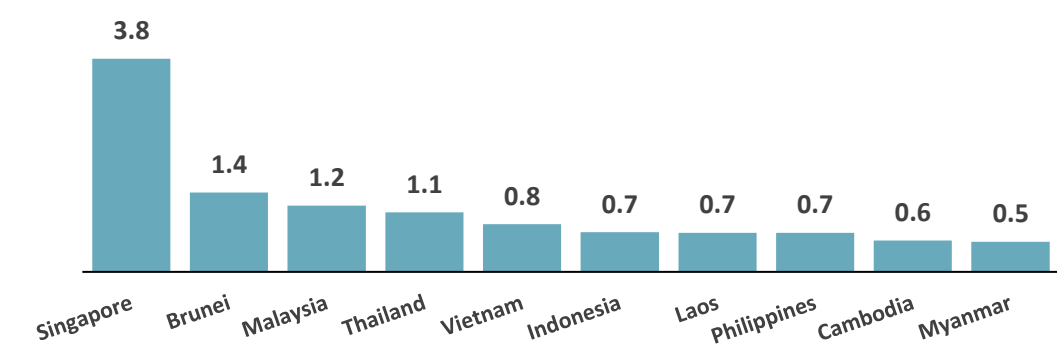
BSF application potential in Southeast Asia (1/2)

There is an abundance of unused resources and sizable agricultural markets for BSF products ^{1,2}

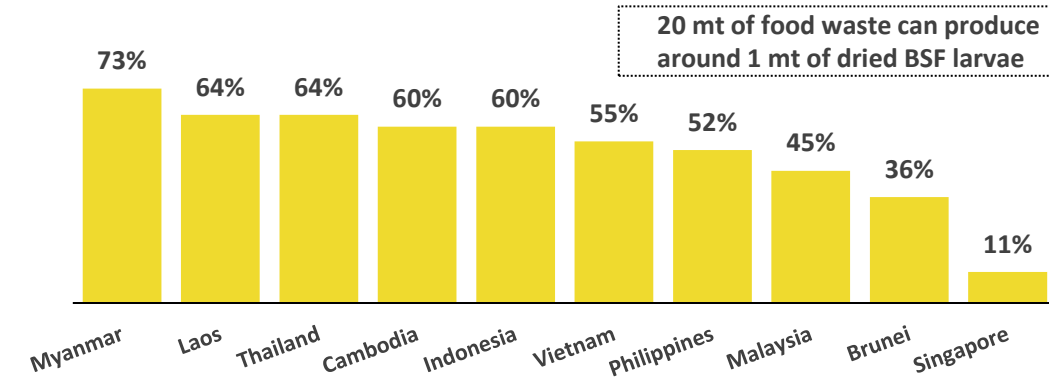
Annual municipal solid waste generation
million mt



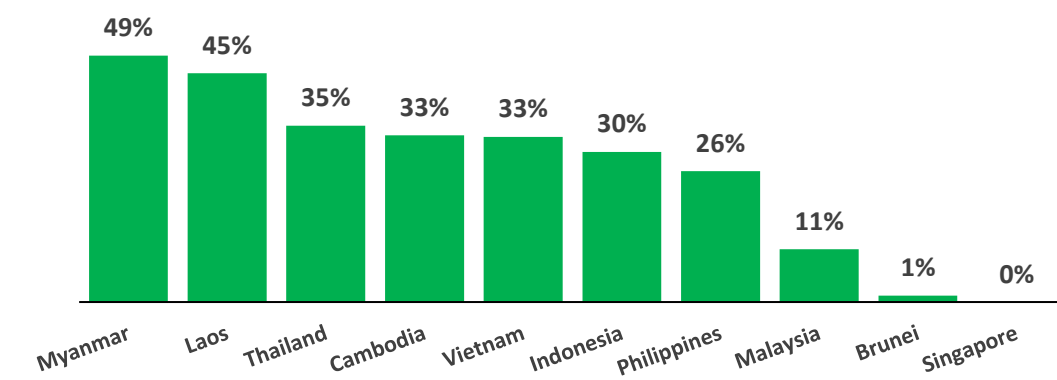
Daily municipal solid waste generation per capita
kg / capita / day



Food / organic waste as a % of municipal solid waste



Share of employment by the agriculture sector



Sources: (1) UN Environmental Programme (2017); (2) ASEAN Stats; Seneca Impact Advisors

BSF application potential in Southeast Asia (2/2)


Municipal solid waste treatment – BSF would provide a sustainable alternative

	Source Segregation	Urban Collection Rate	Treatment / Disposal				
			Composting	Sanitary Landfill	Open Dump	Open Burning	Open Burning
Brunei	< 50%	90%		✓	✓		
Cambodia	< 50%	80%	✓	✓	✓	✗	
Indonesia	< 50%	56 – 75%	✓	✓	✓	✗	✓
Laos	< 50%	40 – 70%	✓	✓	✓	✗	
Malaysia	< 50%	> 70%		✓	✓		✓
Myanmar	50%	na		✓	✓		✓
Philippines	50 – 70%	40 – 90%	✓	✓	✓		
Singapore	70%	> 90%		✓	✓		✓
Thailand	< 50%	> 80%	✓	✓	✓		✓
Vietnam	< 50%	80 – 82%	✓		✓		

Sources: (1) [UN Environmental Programme \(2017\)](#); Seneca Impact Advisors


How much would it cost to set up BSF production facilities?

Typical greenfield project parameters in Southeast Asia



Black soldier flies

ASEAN Countries



Snapshot

Project owner	Entrepreneur with experience in the local animal feed and fertilizer markets
Objective	Introduce BSF products to the domestic market on a commercial scale
Value chain	Production / Distribution
Public-sector partners	Local agriculture department / trade organizations
Potential Funders	Foundations / multilaterals / HNWIs / family offices / impact investors / development banks

Financial factors

Funding need	\$250,000 - \$500,000
Funding structure	Grants and/or private-sector debt and/or equity
Use of proceeds	Equipment (50%), Facilities (25%), Working capital (25%)
Breakeven	2 - 3 years
IRR	15 - 20%

Background

- Access to food waste from wholesale produce markets and the hospitality industry is a critical factor for the project to scale up
- The typical project operator would have extensive relationships with animal feed and fertilizer producers, farming cooperatives and individual farmers who make up the target market for the end BSF products
- While production costs may not be a competitive advantage in the project's startup phase, pricing may be significantly more stable than imported alternatives, leading to a more reliable source of supply for customers
- Longer term, there may be opportunities to export more value-added products in the form of BSF oil for use in cosmetics products

Sustainability factors

Organic waste upcycled	10,000 mt / year in the initial stage
Methane reduction	650 mt / year in the initial stage
Employment	> 50 local workers

About Seneca Impact Advisors

Seneca Impact Advisors is a specialist advisory firm based in Hong Kong with extensive experience and networks in the Asia-Pacific region. It specialises in developing innovative financial solutions for scalable and commercially viable nature and climate positive projects. Seneca's aim is to mobilise private-sector capital to protect and restore nature.

Seneca was formed to bridge the financing gap between traditional conservation and private investment capital seeking returns. There is a growing amount of capital with a willingness to invest in nature-based projects with highly impactful and measurable outcomes. However, there have been few scalable and commercially viable projects to attract investment capital. By working with leading NGOs, governments, ODA agencies, environmentally passionate entrepreneurs, and ESG-concerned corporates, the team at Seneca has been successfully originating

and developing projects to meet the demand from funders. With enhanced public awareness about the climate crisis, biodiversity loss and resource depletion there is a significant amount of capital seeking nature and climate positive investments.

Structuring bankable projects requires knowledge of both conservation and investments. The team at Seneca combines its passion for the natural world with financial and technical expertise to help build commercially viable projects which contribute positively to the environment and society.



AGRICULTURE



FOOD



FORESTRY



FRESHWATER



COASTAL ECOSYSTEMS

Contact us

Seneca Impact Advisors Limited

21st Floor, CMA Building
64 Connaught Road Central
Central, Hong Kong

+852 3895 0965
info@senecaimpact.earth
www.senecaimpact.earth

