Black Soldier Fly
A Circular Economy Solution for Scotland

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This document highlights the economic potential for Black Soldier Fly (BSF) farming in Scotland and presents findings from a Scotland-specific Life Cycle Analysis (LCA) study, which found BSF farming in Scotland using pre-consumer food waste feedstock could provide a low-carbon, high-value alternative to conventional food waste treatment and protein production processes.

Introduction

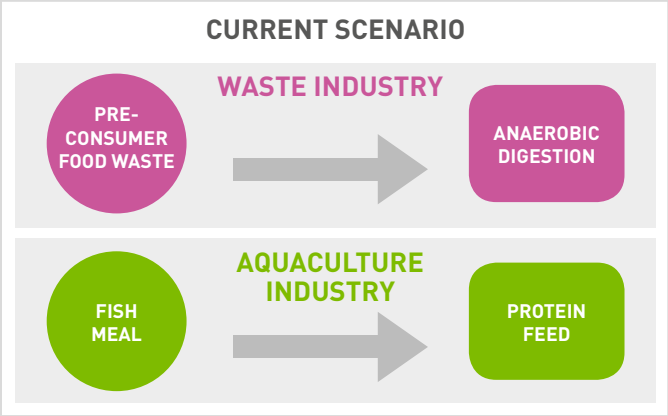
In July 2017, the EU passed legislation allowing use of insect meal for feed in aquaculture. This follows similar legislative changes in Canada and the US, where insect meal, primarily derived from Black Soldier Fly (BSF) larvae, is now displacing fish meal in the salmon farming industry.

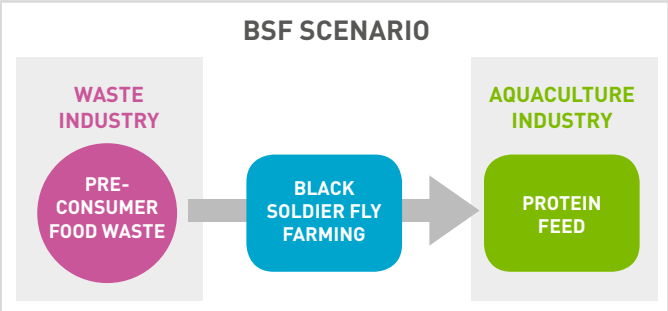
BSF: A Circular Economy Solution

BSF larvae are voracious consumers of organic material. Extensive testing has shown BSF do not carry human[1] or livestock diseases[2], nor are they an invasive species risk in northern climates[3], requiring tropical conditions to survive. BSF farming can rapidly convert large quantities of pre-consumer food waste/by-products into high quality protein, while insect frass (manure) can be used as a soil enhancer similar to compost. This presents two potential opportunities for Scotland:

Protein Supply for Aquaculture:
Scotland's salmon farming sector is the third largest in the world, and the country's second largest food exporter after whisky[4]. The sector pays the highest feed costs among the top 4 salmon farming nations[5], consuming an estimated 238kt of feed annually, of which an estimated 160kt is sourced from wild caught fish[6]. Domestic BSF farming could reduce the industry's reliance on feed from wild ocean fish stocks. Tests have shown insect meal can replace 50% or more of fish meal in farmed fish diets[7], and studies have found favourable attitudes towards use of insect meal on the part of both fish farmers and consumers[8].

Organic Waste Treatment:
Scotland produces an estimated 0.74 Mt[9] of non-household food waste each year. According to Scotland's Carbon Metric, the best-case waste management option currently available for this material in Scotland is Anaerobic Digestion (AD). Alternative BSF treatment could generate greater economic value and jobs for Scotland.





The Scottish Advantage

Scotland is ideally-positioned to be a leading BSF producer in Europe thanks to the:

- **High Demand** for protein-rich aquaculture feed.
- **Large Supply** of suitable organic feed stock, including pre-consumer food waste from agriculture, food and drink, and grocery retail sectors.
- **Academic Expertise** in salmon farming, BSF rearing and animal feed[10].
- **Availability and supportive policy for use of low-grade waste heat** to maintain BSF farming conditions.

By turning organic residues into valuable bio-economy feedstock, an insect farming sector in Scotland could support the Scottish Government's circular economy policy objectives. To date, there are no commercial insect farming operations in Scotland however, numerous parties have expressed an interest in establishing a presence in the country.

[1] Wang and Shelomi (2017). [2] Lee et al. (2017). [3] Spranghers et al. (2017). [4] Glencross (2016). [5] Marine Harvest. (2017). 2017 Salmon Industry Handbook. [6] ZWS. (2015). [7] Some fish meal is required for its Omega 3. Makkar et al. (2014). [8] SRUC (2016). [9] ZWS (2016). [10] Institute of Aquaculture, Scottish Association for Marine Sciences, Stirling University, SRUC.

Scotland's Market Potential

Based on the market value of key process outputs, and assuming a gate fee comparable to AD, BSF treatment of pre-consumer food waste could generate £113 per tonne input.

Table 1. Value generated per tonne food waste input

	Gate Fee	Fat/Oil	Protein	Frass	Total
BSF	£29	£26	£56	£1	**£113**

There is an abundance of pre-consumer food residue and waste in Scotland which may be suitable for use in BSF farming. For example, a 2017 study found Scotland generates nearly 500kt of unused or landfilled agricultural feedstock every year. If just 10% of this material was used in BSF farming, this could generate an estimated £5.4m in additional economic value and provide over 2.7kt of feed ingredients for Scotland's salmon farming sector per annum[11]. The more labour intensive BSF farming process would also result in net job growth, though exact figures are unknown.

The Carbon Impacts of BSF Farming

A lifecycle assessment (LCA) was conducted by University of Edinburgh MSc student Anton Riera to understand the carbon impacts of treating pre-consumer food waste via BSF farming instead of AD. The study used Scotland-specific data and, consistent with the Carbon Metric approach, included both direct and avoided carbon impacts.

Direct vs Avoided Impacts

- **Direct impacts are the direct result of the process undertaken (e.g. transport emissions, energy use etc.).**
- **Avoided impacts are emissions which are prevented as a result of the process undertaken (e.g. avoided energy, fertiliser production, fish meal and fish oil production.**

Results

The study found that while both BSF and AD treatment of food waste result in a net carbon savings, BSF generates ~10% additional carbon benefit[12].

Table 2. Impacts per tonne food waste input (tCO2e)

	Direct	Avoided			
BSF	**Process**	**Fat/Oil**	**Protein**	**Frass**	**Total**
	0.106	-0.059	-0.098	-0.025	**-0.076**
AD	**Process**	**Electricity**	**Digestate**	**Liquor**	**Total**
	0.082	-0.127	-0.012	-0.013	**-0.069**

Sensitivity Analysis

Two further scenarios were modelled to ascertain their potential impact on the LCA findings:

1. **Use of Waste Heat**
   BSF farming requires constant temperatures of around 30°C. If this heat requirment can be met using existing low-grade waste heat, the net carbon savings of the BSF farming could double to -153.4 kgCO2e/tonne input.
2. **Grid Decarbonisation**
   As Scotland's electricity grid decarbonises, the carbon benefits of BSF will increase, while those from AD could diminish due to reduced displacement benefits from electricity generation. If Scotland achieves its objective of 50gCO2e/kWh by 2030, the carbon savings from BSF food waste treatment increase to -129.3 kgCO2e/tonne input.

Conclusion

- In July 2017, the EU passed legislation allowing insect meal to be used in aquaculture feed.
- BSF in particular, can convert large quantities of pre-consumer food waste into high value feed ingredients, plus byproducts.
- Scotland has the right economic conditions and resources to become a leader in BSF farming.
- BSF treatment of pre-consumer food waste could generate additional income for Scotland.
- A Scotland-specific LCA study found BSF treatment generates net emissions savings. These are likely to increase in future with continued electricity grid decarbonisation.

For more information about insect farming, see the EU White Paper **Insect Protein – Feed for the Future**.

[11] ZWS (2017). [12]Gas to grid and heat sales could improve carbon benefits of AD.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