

BioPro (Bio-waste Processing)

Abstract

Assisting North Macedonia in achieving better waste treatment by handling bio-waste using BSF in mobile containers. Treating bio-waste using BSF has many benefits, specifically for North Macedonia, which will be discussed in this paper.

Who Are We

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What is 'BSFL'

BSFL (Black Soldier Fly Larvae) are a type of fly larvae that are able to consume large amounts of organic waste. After growing for two weeks, the larvae reach approximately 8,000x their original size. They then consist primarily of protein and fats, and are considered high-grade animal feed. In addition, their excrements are considered high-grade plant fertilizer. These 3 byproducts make BSFL an optimal bio-waste processor - they turn organic waste, an economic liability, into an economic opportunity.

The Project

Our idea is to place BSF based bio-waste processing containers near sources of sorted organic waste (e.g. farms, supermarkets, restaurants, markets and more) across North Macedonia. The BSF treatment will be handled in those containers by trained employees. The grown larvae are sold off as animal feed, and their excrements as high-grade fertilizer. Having bio-waste processing containers near large sorted sources of waste, instead of one big treatment facility has many advantages: it eliminates the need to sort already mixed waste to organic and non-organic, it lowers the initial costs of the project and most importantly, it allows for scaling of the project in the future.

Each container has a number of gastronomes in it. Over the course of two weeks, the young Larvae digest the organic waste. All they need in this phase is a moist and warm environment that can be maintained easily inside the container (60% - 70% moisture, 28-30° C). When the larvae are in their peak size, they can be separated from the remains using a simple machine, and the resulting products are sold off as stated before.

North Macedonia as the optimal place for our project

Handling large amounts of organic waste with BSF lowers the need to treat it in various other polluting ways. This has many benefits, which include:

- Macedonia has a large air pollution problem¹. BSF offers a bio-waste management solution without the major air pollution risks of traditional composting: BSF emits about half as much CO₂ per ton of bio-waste treated². Furthermore, the emitted CO₂ is captured in the closed container.
- Macedonia spends about one eighth as much as the average European country on environmental issues³. BSF bio-waste treatment is much more profitable than traditional treatment (i.e. composting), and is thus a much more realistic option for North Macedonian authorities.
- Macedonia currently treats organic waste (25% of all Macedonian waste⁴) in 54 landfills around the country, of which only one meets the criteria of modern environmental standards. As a result, North

¹ <https://naturvernforbundet.no/international/environmental-issues-in-macedonia/category939.html>

² <https://www.unescap.org/sites/default/files/Session4%20-%20imanol1.pdf>

³ https://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_protection_expenditure_accounts; <https://balkangreenenergynews.com/north-macedonia-spends-eur-182-million-on-environmental-protection-in-2018/>

⁴ https://limpezapublica.com.br/textos/handbook_biowastemanagement_macedonia_-_ks.pdf (pg. 36, fig 3.3.2)

Macedonia improperly treats about 99.5% of its organic waste⁵. Fixing this mistreatment of organic waste is not only a huge opportunity for environmental and economic profits, but is also required if North Macedonia wants to meet the EU's regulations.

Having an alternative protein and fat source for animals greatly reduces the need for agriculture targeted towards animal feed. This specifically helps Northern Macedonia because of the following reasons:

- Macedonia has a big water pollution problem⁶, which is created partly due to mismanagement of agricultural waste-water. Furthermore, food waste constitutes 21% of fresh water wastage worldwide. Thus, implementation of BSF bio-waste treatment in North Macedonia will result in less waste of water.
- About 40% of Macedonia's land is devoted to agriculture⁷, including agriculture used to feed livestock. Having an alternative source for livestock feed lowers the need to maintain those agricultural lands and frees them for other uses.
- Most of the Northern Macedonian job market is based around unsustainable jobs, that are destined to disappear in the future. Integrating sustainable technology in Northern Macedonia insures the creation of long-term job markets and economic stability - especially considering the fact that BSF treatment can be taught to the layman in a short amount of time (i.e. in a week long seminar).

Our Partners

- FreezeM - an Israeli startup that specializes in breeding and growing BSF, and cooling and freezing BSF eggs for distribution. They will be our larvae supplier (this BSF distribution method greatly reduces operation costs).
- Dan Oryan - the ambassador of Israel to the Republic of North Macedonia.
- Greenagro - the leading Macedonian animal food company. Hopefully, they will be our main consumers.

The SDGs our project fulfills

2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture:

Firstly, the BSF are an alternative source of food for livestock, which means that less potential human food is wasted on feeding livestock. Secondly, the BSF fertilizer contains chitin, which enhances natural defensive mechanisms in plants and lowers the chance of wilting due to pests.

In addition, organic agricultural waste goes back into the system cycle (as food for the BSF), therefore promoting a more circular waste treatment method.

6 - Ensure availability and sustainable management of water and sanitation for all: Water conservation by reducing traditional agriculture for animal feed and waste treatment.

8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all:

The BSF treatment is a sustainable job that doesn't require former education. The more containers there are, the more new jobs are created. Furthermore, the BSF technology field is in its early stages, thus implementation of our project opens up R&D for new sustainable markets.

11 - Make cities and human settlements inclusive, safe, resilient and sustainable: Reducing the linear manner of organic waste treatment in modern municipalities.

12 - Ensure sustainable consumption and production patterns: The BSF are an everlasting sustainable resource which can be used in agricultural production instead of temporary natural sources. Our solution closes the agricultural circle by using the bio-waste generated in the cycle as one of the

⁵https://www.researchgate.net/publication/299355819_THE_POTENTIALS_FOR_BIO_WASTE_MANAGEMENT_IN_MACEDONIA, <http://www.stat.gov.mk/Publikacii/ZivotnaSredina2019.pdf> (pg. 57)

⁶ <https://naturvernforbundet.no/international/environmental-issues-in-macedonia/category939.html>

⁷ <http://www.stat.gov.mk/Publikacii/ZivotnaSredina2019.pdf> (pg. 31, fig 3.1.2)

sources that fuel it. This means that this system has almost no waste and doesn't need to constantly buy more unsustainable products from external sources.

13 - Take urgent action to combat climate change and its impacts: in contrast to landfills, which is the main waste treatment option in North Macedonia today, BSF treatment eliminates the need to pollute the ground or burn waste. In addition to this, BSF emits about half as much gasses as regular compost, and this amount of gas can be filtered inside the container, which almost zeros the emission of greenhouse gasses from our solution.

15- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss: BSFL act as an alternative food source for livestock, reducing the need for agricultural grounds dedicated to growing animal feed. Our solution minimizes the mileage footprint of food and frees up land for other uses thus reducing deforestation.

The Operation Plan

A fully equipped pilot container costs around 17K\$ (Including the Shipping container, Separation machine, Food Grinder, Carts, Gastronormes, hygrometer, humidifier, heater and other instruments and the worker's salary for the period until the return of investment).

Each container can process around 45kg of organic waste per day in a process that takes 2 weeks.

8.5 tons of organic waste need to be processed to return the cost of a container. This means that the investment will be returned after 200 days and we'll start gaining profit.

850g of BSFL are needed to consume 8.5 tons of organic waste, and they cost 850\$. The profit comes from the protein powder, fats and fertilizer, that are worth around 1400\$, 1000\$ and 15,500\$ respectively. By our estimations, a trained worker can take care of 5 containers. The cost of these 5 containers plus the worker's salary is 90,000\$. This model is scalable, and can be multiplied indefinitely.

Overall, we can offer disposal of organic waste at the cost of 60\$ per ton, with an overall profit of 500\$ over the course of 200 days. For comparison, traditional waste-disposal services operate at around 75\$ per ton of evacuated waste.

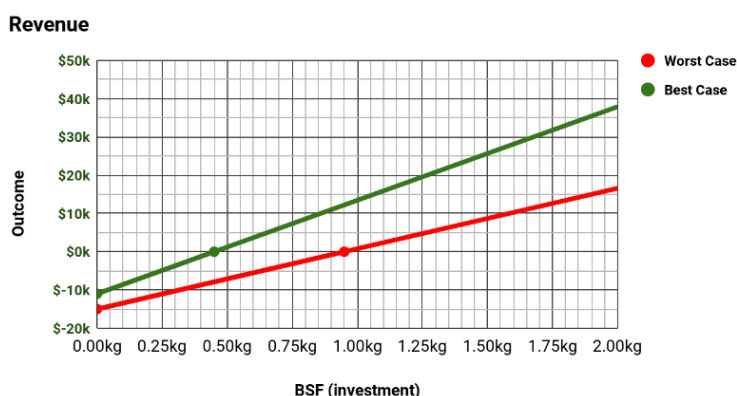


Figure 1: Revenue as a function of the weight of BSF put into the system. The dots represent the ROI point.

The Community

The container pilot project will drive a Macedonian-Israeli research and development partnership, with the potential of scaling into a regional and international project.

The work in the pilot containers is simple, and can be taught in a 1-2 week seminar in Israel or in North Macedonia, strengthening an international bond between communities and countries. This seminar can be an important learning experience - about not only the operation of the BSF containers, but also about sustainability and the importance of a circular economy. Moreover, promotion of these values will encourage trainees to later on spread sustainability in their communities, thus introducing those ideas to even more people. Overall, apart from being a physical solution, this is an educational one - bringing sustainable messages to the community in a natural way.