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Turning waste to value - Valorisation of biodegradable waste using Invertebrates

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Solid waste management is a service that is to be provided by municipalities, however many municipalities around the world struggle to provide their citizens with an adequate level of service. Globally, 70% of solid waste is landfilled or dumped and almost half of this waste (44%) is of biodegradable organic matter. When the organic matter decomposes anaerobically, greenhouse gases that contribute to climate change are released. In addition, the leachate contains heavy metals and plant nutrients that contribute to pollution and eutrophication, respectively, when reaching water bodies, and microbial pollutants that can cause disease transmission. One reason a large proportion of the biodegradable is landfilled or dumped is that these are the cheapest options. To treat biodegradable material requires both waste segregation at the source and a more complex treatment, while the revenue stream of the products generally is low.

One way to increase the interest to manage and treat the biodegradable fraction is to find ways to better utilise the resources captured in this fraction. Introducing treatments that generate products of higher value could make the treatment bear more of its own cost. One novel treatment for biodegradable waste valorisation is fly larvae treatment, in which organic waste is converted into larval biomass that can be used as animal feed and a treatment residue that can be used as an organic fertiliser. The produced animal feed can replace fish and soy meal in the feed production and thereby also lowers the environmental impact of feed production. The most commonly used fly in fly larvae treatment is the black solider fly (*Hermetia illucens* (L.), Diptera: Stratiomyidae) that originates from the Americas. This fly is of interest because the larvae are large and thus easy to separate from the treatment residue, and because the fly does not eat as adult and therefore is not a vector for disease transmission. The fly larvae treatment system we have developed at SLU comprise of two main components: 1)

decentralised waste treatment units, at which the conversion of waste into insect biomass takes place; and 2) a centralised rearing and refining facility, at which the young larvae required for the treatment are reared and the products from the decentralised waste treatment units are treated to guarantee high product quality. The treatment is done in small batch modules that each have the capacity to treat 15 kg in the two weeks process. These smaller modules can be aggregated to larger modules and by doing so the treatment capacity can be adapted to the waste volumes in a dynamic way. Treating the waste where it is generated reduce the need for transportation of the waste. We have found that the content of microbial and environmental pollutants decreases in the fly larvae treatment and that the greenhouse gas emissions from the treatment are low compared to other biological treatments. Most of our research has focused on food waste, and we have found that it is an optimal substrate for fly larvae treatment, yielding large quantities of fly larvae per treated volume waste. According to current European legislation, food waste is not allowed as fly larvae substrate, due to the content of meat. The research focus has thus shifted to plant-based waste sources, such as reclaimed bread and vegetable and fruit peels. These substrates are, however, not optimal for fly larvae treatment as the nutrients are not as easily available to the fly larvae as it is in mixed food waste. In order to achieve higher efficiency with these substrates, we have evaluated different pre-treatments and found that fungi pre-treatment is an efficient way of making complex bound substrates more available to the fly larvae. We have also found that the protein content of the larvae does not change much with the substrate the larvae are reared in, but the fat content and profile change a lot. The composition of the larvae is important to know in the refining of the larvae to either animal feed or to other technical uses, such as bioplastic (the protein fraction) and biofuel (the fat fraction).

Our current focus is on further system development, including better understanding of pre-treatments, deeper understanding on the substrate’s impact on larval composition, a better understanding of the environmental impact of the system, as well as continued system development for full-scale implementation. So far the research has resulted in one pilot plant running in Eskilstuna, Sweden that processes up to 150 tons per year and a plant in Heinan, China that is under construction that will be able to process 4-6,000 tons of food waste per year.