

Black Soldier Fly Technology: A Corner Stone for Decentralized Waste Management



Saleha Mahmood*

Government College University Lahore, Pakistan

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***Corresponding author:** Saleha Mahmood, Government College University, Katchery Road Lahore, Pakistan

Abstract

Organic waste is the major component of municipal solid waste produced in low- and middle-income countries. It is one of the most neglected and unaddressed real world issues that could be resolved through decentralized waste management models applied at the household and community level. In this regard, Black Soldier Fly (BSF) technology holds promising waste treatment and recycling potential. The technology is financially viable, technically feasible and institutionally implementable. Its economic benefits and potential revenue options is a deriving factor that could make it socially acceptable and encourage waste segregation at source which is a prerequisite to decentralized waste treatment systems and resource circularity. The perceived practicability of this model was scientifically tested in Pakistan at household level.

Keywords: Decentralized waste management; Black soldier fly; Circular economy; Household waste; Organic waste recycling; Sustainable futures; Waste segregation

Introduction

Economic development and busy life styles have changed values and deprioritized the concept of waste producers' responsibilities. In low- and middle-income countries people are not habitual of separating waste components i.e., 'waste segregation' at the source of generation and are less encouraged to do it anymore. Tackling the waste at or in the proximity of the source especially at household or community level is commonly known as decentralized waste management [1]. It is one of the most sustainable but overlooked solution by the authorities when waste collection and its transport takes up to 70% of the total waste management costs [2]. Waste segregation at or near the source is an integral part of any decentralized system and crucial to achieve the objectives of a sustainable circular economy [3]. In these settings, organic waste comprises the major proportion around 50-75% of municipal solid waste, where household food waste is the dominant contributor [4]. Due to its perceived lower economic value, this waste component is not considered worth of recycling like other potential recyclables that are already scavenged by the informal sector. Therefore, it is still an underutilized resource [1]. The organic waste ends up in our streets, roadsides and dumpsites resulting in human health problems, increased pollution burdens and huge waste management costs.

In this context, *Hermetia illucens*, Black Soldier Fly (BSF) organic waste treatment and bioconversion technology is very promising. BSF declared "ecological engineers" and "crown jewel" of the insects in the food and feed industry, are non-vector and non-pest organisms which hold amazing waste sanitizing properties [4-6]. Its larvae (BSFL) voraciously eat up a large variety of organic wastes and in just two weeks results in up to 80% waste reduction with a ~20% biomass conversion into protein rich larvae as animal feed and 15-20% into stable residue as a soil conditioner for plant growth [7,8]. During the process, methane and leachate is not produced and CO₂ gas emissions are negligible thus reducing the global warming potential [9].

The study conducted in Pakistan was inspired from a two-tier waste management model for low- and middle-income countries proposed by Diener in which a centralized BSFL rearing facility could provide young larvae to several decentralized waste treatment units. This was the first study that applied the concept of BSFL waste bins as a substitute to the traditional waste bins at household level and assessed their perceived practicability in terms of social acceptance, cost, waste treatment and bioconversion performance [1].

Conclusion

BSF technology could successfully be applied at decentralized household and community level for waste management and encourage people to re-think organic waste as a 'resource'. It has a huge potential for social acceptance. During the study, 50% of the contacted households showed positive response and agreed to separately collect and recycle their kitchen food waste by placing BSFL bins in their houses. Substituting conventional waste bins with the BSFL bins can act as an incentive for source segregation. This may increase recovery and economic value of all waste components. BSFL decentralized waste management model can help divert massive waste loads from disposal sites and can save up to 70% of the cost related to collection, transport and disposal incurred in the conventional system. The study led the successful implementation of Diener's two-tier waste management model and resulted in up to 90% waste reduction and significant bioconversions into animal feed and soil conditioner.

Feedback by households and the set of instructions produced may provide a starting point for replicating the decentralized BSFL organic waste recycling system. It also provides a learning opportunity for the industry, government and academia towards future interventions. The tested model was also replicated later as a pilot project for one year at community level, during which 250kg kitchen waste from a boarding school of 800 students, 150 households and 5 restaurants was treated daily and recycled into protein feed for poultry. Though extensive public awareness campaigns were conducted, it was only after three months when almost sorted organic waste could be received. BSF technology might be able to revolutionize the decentralized waste

management system when extended operational assistance and awareness sessions are held with the waste producers.

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