BSF Larvae-Based Food Waste Management: A Student-Led Innovation for Wonorejo Village in East Java

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ABSTRACT

This community service activity was carried out to address the issue of household organic waste accumulation in Wonorejo Village by introducing a sustainable and environmentally friendly solution: the cultivation of Black Soldier Fly (BSF) larvae, commonly known as maggots. The main objective was to educate and empower local residents, particularly women involved in kitchen waste management, through a socialization and training program that promotes maggot-based waste processing. The method of implementation involved direct presentations using PowerPoint slides, followed by discussions, a question-and-answer session, and the distribution of a structured questionnaire to evaluate participants' understanding and motivation. The results indicated a high level of cognitive comprehension among participants regarding the role of maggots in decomposing organic waste and mitigating its environmental impact. Participants also showed a strong sense of responsibility toward environmental protection and a willingness to share their new knowledge. However, motivation to begin maggot cultivation was only moderate, highlighting the need for further technical training and support. The activity demonstrated the potential for maggot farming to reduce food waste by up to 60%, lower methane emissions, and offer additional income opportunities. Nevertheless, cultural stigma and inconsistent waste segregation remain challenges. This initiative revealed that, with proper education and local engagement, sustainable waste management practices can be effectively introduced in rural communities.

Keywords: *community service, empowerment, maggot, BSF larvae, food waste*

INTRODUCTION

Wonorejo Village is the northernmost administrative area of Malang Regency, East Java. Strategically located as the main gateway to Malang from Surabaya, Wonorejo shares borders with Pasuruan Regency to the north. Despite its advantageous location, Wonorejo exhibits characteristics of a semi-rural community, with limited agricultural activity—comprising no irrigated paddy fields—and a predominant land use consisting of dry land (331.41 hectares), public facilities (51.33 hectares), and forested areas (179.28 hectares) (Gultom, 2023). Based on demographic data, Wonorejo has a relatively diverse employment profile, with a significant number of residents engaged as mobile traders (192 individuals), cooks (180), and private school teachers (49). However, a large portion of the population remains unemployed (139 individuals as of 2022), and a substantial number are school-aged children and youth (2,515 students), reflecting both a developmental challenge and an opportunity for community-based empowerment initiatives. The location of Wonorejo Village is illustrated in Figure 1.

One environmental issue that has emerged in Wonorejo is the management of organic solid waste, particularly food waste. While quantitative data on food waste volume remains unavailable, its accumulation poses ecological and health risks, including the proliferation of disease vectors and the emission of greenhouse gases such as methane. Currently, food waste disposal is largely unmanaged, with limited repurposing for animal feed and no structured treatment system in place. In response to this pressing issue, students from Mahapala UNNES (Universitas Negeri Semarang's nature enthusiast student organization) initiated a community service project on July 2, 2025. This initiative aimed to introduce maggot-based food waste management—specifically, the cultivation of Black Soldier Fly (BSF) larvae—as a sustainable and ecologically sound solution. Beyond its environmental benefits, maggot cultivation presents potential socio-economic advantages, offering

residents an opportunity to transform waste into value-added resources such as animal feed and organic compost.

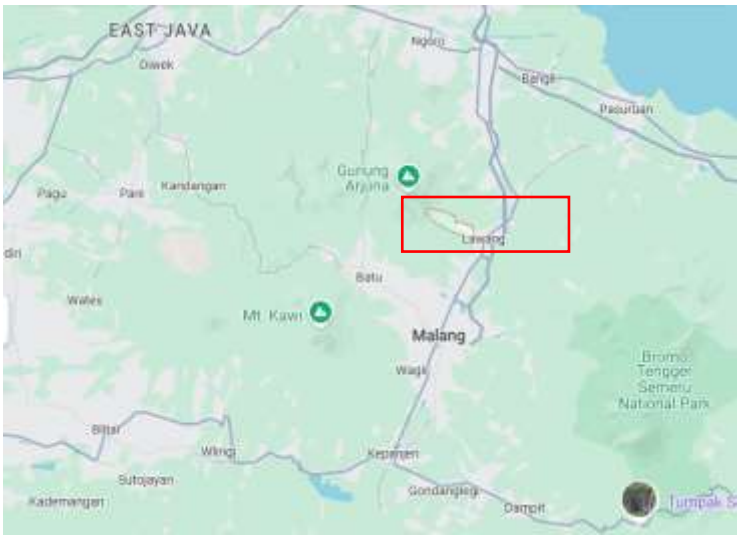

Figure 1. Wonorejo Village Location

The Black Soldier Fly (Hermetia illucens), commonly referred to as BSF, has emerged as a popular and sustainable choice within organic waste management systems due to its short life cycle, high feed conversion efficiency, and its remarkable ability to recover nutrients from a wide range of organic materials. BSF larvae can reduce kitchen organic waste biomass (SOD) by approximately 50–60%, transforming it into high-protein biomass. The nutritional profile of BSF larvae, which consists of around 28% protein, is comparable to the oil content found in nutrient-rich seeds such as flaxseed, linseed, and rapeseed, which typically contain around 40% protein (Matthäus et al., 2019).

The effectiveness of insect farming, particularly for waste reduction, largely depends on factors such as the composition and consistency of the feed substrate, the selected insect species, maintenance parameters, and farming protocols (Ortiz et al., 2016). When utilizing food waste as feed, key considerations include the physical, chemical, and microbiological properties of the waste—such as moisture content, nutrient profile, microbial safety, and contamination from non-organic materials like plastic. For example, vegetative food waste, typically low in protein, can be suitable feed for BSF larvae and mealworms but may not sufficiently support the development of housefly larvae (Fowles & Nansen, 2020). Organic waste streams such as vegetable scraps, restaurant leftovers, and kitchen waste containing meat are particularly suitable for BSF and housefly larvae (Cheng et al., 2017). Notably, BSF larvae are capable of tolerating wet waste and elevated temperatures, enabling them to process diverse waste streams effectively. The valorization of food waste through fermentation followed by insect bioconversion—particularly using edible insects like BSF—has shown promising potential in both environmental and economic dimensions (Alattar et al., 2016).

In the context of Wonorejo Village, where food waste remains largely unmanaged and often ends up in landfills, the introduction of BSF cultivation presents a sustainable alternative. Given the village's lack of formal waste processing infrastructure and its significant household-generated organic waste, BSF farming could not only reduce environmental pollution but also generate high-value products such as animal feed and compost. Moreover, the approach is well-suited to the socio-economic profile of the village, which includes many unemployed residents and a large student population—offering opportunities for local skill-building, income generation, and community engagement in environmental stewardship.

This article explores the implementation of the maggot-based food waste management system in Wonorejo Village as a model of student-led innovation aligned with the Tri Dharma of Higher Education, particularly the pillar of community service. Through collaborative knowledge transfer and environmentally conscious practices, the initiative aspires to build local capacity, reduce

pollution, and foster sustainable livelihoods within the village.

METHOD

This community service activity was conducted by members of Mahasiswa Pecinta Alam Universitas Negeri Semarang (MAHAPALA UNNES) as part of the implementation of the Tri Dharma of Higher Education, specifically in the area of community engagement. The method used centered around a structured educational outreach aimed at promoting sustainable household-level food waste management through the cultivation of Black Soldier Fly (BSF) larvae, commonly referred to as maggot farming.

This activity took place on Wednesday, July 2, 2025, at the Village Hall of Wonorejo, Kecamatan Lawang, Kabupaten Malang. The primary objective was to disseminate knowledge regarding the maggot-based food waste management system, which has been successfully applied by the organization since 2022, especially to address the challenges posed by unmanaged Kitchen Organic Waste (*Sampah Olahan Dapur* or SOD).

The target audience for the activity was the village women's organization (PKK), selected due to their central role in managing household food preparation and kitchen waste. This demographic was considered strategically important for facilitating behavioral change at the household level. The socialization activity employed a direct instructional approach using PowerPoint slides as visual aids during the presentation. Participants were encouraged to engage in interactive discussion sessions and were provided opportunities to ask questions directly, fostering a deeper understanding of the presented content.

To assess the effectiveness of the socialization and measure participants' understanding of the subject matter, a structured questionnaire was distributed at the end of the session. The questionnaire contained both closed and open-ended questions related to the participants' comprehension of maggot cultivation, their perception of the session, and their interest in applying the practices discussed. The data collected from the questionnaires served as a basis for evaluating the success of the activity and provided qualitative and quantitative feedback for future improvements and potential replication in other communities.

This participatory method not only allowed for knowledge transfer but also aimed to empower local communities to implement environmentally friendly waste management practices that could mitigate the environmental impacts of unmanaged food waste, reduce household waste volume, and provide an alternative source of income through the sale of BSF larvae as animal feed or composting agents.

RESULTS AND DISCUSSION

Outputs and Models Introduced to the Community

The primary output of this community engagement activity was the introduction of a maggot-based food waste management system through the cultivation of Black Soldier Fly (BSF) larvae. This model functions as both a service (environmental education and skill transfer) and a new socio-cultural approach to managing household waste in rural communities. It offers a practical, low-cost, and sustainable method for addressing the accumulation of organic waste, especially kitchen leftovers (SOD), which are prevalent in Wonorejo Village.

The main dimensions of the model introduced include: (1) training in the step-by-step cultivation of BSF larvae using food waste as feed; (2) Educational outreach and knowledge dissemination through socialization activities directed at PKK (women's household associations); and (3) Socio-Cultural Engineering: Encouraging behavioral shifts in waste handling practices within households, promoting environmental stewardship, and recognizing waste as a resource. In terms of equipment, the community was introduced to simple maggot cultivation units, which consist of plastic bins or containers with breathable lids, layered substrates for larvae growth, and drainage mechanisms. These low-tech setups are appropriate for small-scale, household-level implementation, aligning with the economic and infrastructural conditions of the village. The activity illustration can be seen in Figure 2.

Figure 2. The Member of PKK learn about BSF larvae

The Impact of The Maggot-Based Waste Management Socialization

To assess the impact of the maggot-based waste management socialization initiative in Wonorejo Village, a structured post-activity questionnaire was administered to participants, primarily consisting of local women involved in household kitchen waste management. This evaluation aimed to measure not only the level of cognitive understanding regarding the role of Black Soldier Fly (BSF) larvae in organic waste decomposition but also to gauge the motivational factors influencing participants' readiness to adopt and advocate for sustainable practices. The questionnaire served as a critical tool in determining the effectiveness of knowledge transfer during the outreach session, as well as identifying potential areas for improvement or future intervention. The data tabulation of the questionnaire can be analyzed from Table 1.

Table 1. Understanding and Motivation Regarding Maggot (BSF Larvae)

Category	Item	Mean Score	Category
Understanding About Maggot	Q1: I know what a maggot (BSF larva) is.	3.91	High
	Q2: I know that maggots can help decompose organic waste.	4.29	High
	Q3: Maggots can reduce the negative impact of waste on the environment.	4.46	High
Motivation About Maggot	P1: I am interested in trying maggot cultivation.	3.31	Medium
	P2: I feel responsible for protecting the environment from waste.	4.20	High
	P3: I feel motivated if there is environmental training or education.	3.97	High
	P4: I am willing to share knowledge about maggots with others.	3.94	High

Source: primary data (2025)

Based on the results of the post-activity questionnaire, the level of understanding among participants regarding maggot (Black Soldier Fly larvae) and its role in food waste management was notably high. Participants demonstrated a strong grasp of the basic concept of what maggots are, with a mean score of 3.91 for the statement “I know what a maggot (BSF larva) is.” Even more impressive was their awareness of the ecological function of maggots: the statement “I know that maggots can help decompose organic waste” received a high mean score of 4.29, and the statement “Maggots can reduce the negative impact of waste on the environment” earned the highest average rating of 4.46. These findings suggest that the knowledge transfer during the socialization session was highly effective in increasing cognitive understanding of maggot-based waste processing among the

participants. These finding is in line with previous studies concerning about knowledge transfer activity effectivity (Lan et al., 2022; Liu et al., 2024; Ting, 2023).

In terms of motivation, participants generally exhibited a positive attitude toward maggot cultivation and environmental action. Most motivational indicators fell into the high category. The strongest motivational response came from the statement "I feel responsible for protecting the environment from waste," which received a score of 4.20, indicating a deep sense of environmental responsibility among attendees. Similarly, high scores were noted for willingness to participate in environmental education ("I feel motivated if there is environmental training or education," 3.97) and a readiness to share knowledge ("I am willing to share knowledge about maggots with others," 3.94). These findings indicate that the socialization effort has not only raised awareness but also fostered community engagement and the potential for knowledge diffusion within the village (Ohmer et al., 2022; Rudito et al., 2022; Sunarti et al., 2023).

However, the score for the item "I am interested in trying maggot cultivation" was slightly lower at 3.31, placing it in the medium category. This suggests that while participants are intellectually and emotionally engaged, there may still be some hesitation when it comes to directly implementing maggot cultivation themselves (Galán-Díaz et al., 2024; Handayani et al., 2021). Such hesitation could stem from unfamiliarity with the technical process, perceived effort required, or concerns related to hygiene and social acceptance within the household (Raman et al., 2022; Sumardiono et al., 2024).

Taken together, these insights point to an opportunity for follow-up initiatives that focus on practical training, demonstration of maggot cultivation systems, and mentorship. The high level of understanding and motivation, especially in terms of willingness to share and promote environmental stewardship, positions the community of Wonorejo as a promising partner for long-term sustainable waste management practices rooted in local empowerment and education.

Assessing the Strengths and Challenges of Maggot Cultivation as a Community-Based Waste Solution

The introduction of Black Soldier Fly (BSF) maggot cultivation in Wonorejo Village has shown considerable promise as a practical and sustainable solution for managing organic waste. One of the most significant strengths of this approach lies in its environmental impact. BSF larvae are capable of reducing the volume of food waste by 50–60%, a figure that aligns closely with the needs of Wonorejo, where unprocessed kitchen waste has long posed environmental and health risks. By diverting this waste from landfills, maggot farming contributes to odor reduction, minimizes the presence of disease-carrying pests, and mitigates the release of methane—a potent greenhouse gas—thereby addressing multiple environmental concerns at once.

Beyond environmental benefits, BSF cultivation also carries economic potential. The protein-rich larvae can be harvested and used as an alternative to conventional animal feed, particularly for poultry and fish. Moreover, they can be sold to generate supplementary household income, offering a compelling incentive for residents to adopt the practice. The method itself is also highly accessible; it requires minimal financial investment, utilizes locally available materials, and does not demand sophisticated infrastructure or technology—making it particularly suitable for a rural context such as Wonorejo.

Despite these strengths, the implementation of maggot cultivation does not come without its challenges. Before the socialization and training session, awareness of BSF larvae and their utility was very limited among the village community. This lack of prior knowledge contributed to initial hesitation, with some participants expressing doubt or reluctance about engaging in insect-based solutions. Cultural perceptions also played a role; for many, the idea of rearing maggots—even for environmental or economic benefit—was unfamiliar and somewhat off-putting due to negative associations with waste and decay. Overcoming this cultural barrier will require sustained education and community engagement.

Another notable concern is the need for consistent waste quality control. Effective maggot cultivation depends on proper waste segregation, with non-organic materials such as plastic or metal

needing to be excluded from the composting process. Without clear protocols and continued reinforcement, ensuring the purity of the waste stream may prove difficult, potentially hindering the success of the cultivation efforts.

CONCLUSION

The community engagement initiative conducted by MAHAPALA UNNES in Wonorejo Village successfully introduced a maggot-based organic waste management model utilizing Black Soldier Fly (BSF) larvae. This program served not only as a technical solution to household waste challenges but also as a form of environmental education and socio-cultural engineering. The intervention demonstrated strong outcomes in terms of raising awareness, building motivation, and introducing a feasible, low-cost technology appropriate for rural households. Findings from the post-activity questionnaire revealed a high level of participant understanding of maggot roles in decomposing organic waste, as well as positive motivational attitudes, particularly regarding environmental responsibility and willingness to share knowledge. These outcomes suggest that the socialization activities were effective in achieving cognitive and affective learning objectives. Furthermore, the potential of BSF cultivation to reduce food waste volumes by 50–60% and serve as an alternative income source positions it as a sustainable and scalable solution within similar rural contexts.

Despite these promising results, the initiative also faced several limitations. The most prominent challenge was participants' initial hesitation in applying maggot farming practices themselves, as reflected in the lower score related to practical adoption. This reluctance may be attributed to unfamiliarity with the process, concerns about hygiene, or cultural resistance toward maggot cultivation. Additionally, successful implementation of the model depends heavily on consistent waste sorting practices—something that may require sustained oversight and behavioral reinforcement. To address the limitations identified and enhance the long-term impact of the program, future efforts should focus on expanding community capacity and deepening engagement. One effective step would be to conduct hands-on training workshops that allow participants to directly practice BSF cultivation techniques, helping to build their confidence and familiarity with the process. In addition, fostering a peer mentoring system among early adopters can create a supportive environment for grassroots knowledge sharing and sustained motivation. To ensure the information is accessible to all, especially in rural contexts, the development of user-friendly guidebooks or illustrated instructions tailored to local literacy levels is essential.

Further integration of the program into local environmental policies or school curricula can institutionalize the initiative and nurture environmental awareness from an early age. Finally, conducting long-term monitoring of behavioral changes and the outcomes of waste management practices will provide valuable feedback for continuous improvement and ensure the program's sustainability. Overall, the experience in Wonorejo illustrates that when education, simple technology, and community involvement are combined effectively, they can foster environmentally responsible behaviors and empower local residents to play an active role in sustainable development.

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