

Household Organic Waste Utilization for *Hermetia illucens* Larvae Cultivation in a Circular Economy

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Abstract. Waste management has become a major environmental issue in Semarang City due to population growth and rapid urban development, including in Sendangguwo Village, Tembalang District. The increasing volume of household organic waste requires sustainable management strategies to reduce waste accumulation and support environmental conservation. This community service program aimed to implement a circular economy approach through the establishment of an Organic Waste Bank and the cultivation of *Hermetia illucens* larvae as a form of organic waste utilization with economic value. The program was carried out in three stages: (1) socialization and education on household organic waste management through the Organic Waste Bank, (2) practical training on *Hermetia illucens* larvae cultivation, and (3) evaluation of program implementation. Training and mentoring methods were employed, involving the service team and partners from PT BERRSIH as resource persons and facilitators. The results showed that the program successfully established an Organic Waste Bank in Sendangguwo Village and improved community knowledge and skills in managing organic waste and cultivating larvae. The cultivated larvae can be utilized as an alternative feed source for poultry and fish, providing additional economic benefits to the community. In conclusion, the integration of an Organic Waste Bank with *Hermetia illucens* larvae cultivation effectively supports circular economy practices by reducing household organic waste and creating value-added products. This program contributes to environmental sustainability, community empowerment, and the development of innovative waste management practices for society.

Keywords: organic waste; hermetia illucens; waste bank

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INTRODUCTION

Waste is defined as any residual material or substance resulting from human activities that is no longer used and is therefore discarded. Public perception of waste often associates it with something dirty and no longer useful, leading to the assumption that it must be destroyed or disposed of (Mulasari, 2012). All human activities inevitably generate waste. Therefore, waste management is not only the responsibility of local governments but also of the entire community to prevent negative environmental impacts (Hardiatmi, 2011).

The increase in population and human activities is a major factor contributing to the rise in daily waste generation. Tembalang District consists of 12

villages with a population of approximately 189,169 people, all of which are included in the waste management services of Semarang City. Based on data from 2020, the level of waste management services in Tembalang District remains relatively low at 27%. This indicates that more than 73% of waste is not properly managed and is likely disposed of into the environment (Badan Pusat Statistik Kota Semarang, 2019). One area within Tembalang District, namely RT 03 RW 03 of Sendangguwo Village, has significant potential for developing waste management through Organic Waste Bank programs and *Hermetia illucens* larvae cultivation. This is due to its proximity to the East Flood Canal river and the persistent habit among some residents of disposing

of waste into the river. According to the official website of Sendangguwo Village, 28.19% of residents are unemployed.

Waste-related problems can be categorized into three aspects: downstream, process, and upstream. On the downstream side, the issue is the increasing volume of waste being disposed of. In the process aspect, the limitation lies in human resources available for waste management, both from the community and the government. Meanwhile, the upstream issue involves the suboptimal systems applied in final waste processing (Sahil et al., 2016). Many people consider burning waste as part of waste management; however, this practice can cause air pollution and negatively impact public health. Such behavior may be influenced by the level of knowledge and maturity within the community (Mulasari, 2012). Providing training on Organic Waste Banks and larvae cultivation not only helps change the habit of disposing of waste into rivers but also creates employment opportunities for local residents.

Organic waste management aimed at reducing the volume of waste sent to temporary disposal sites can be carried out by utilizing *Hermetia illucens* larvae. Maggots are insect larvae that live on organic waste; the term “maggot” became widely recognized around 2005 through the bioconversion team of IRD-France and the Research Institute for Freshwater Ornamental Fish Culture (LRBIHAT) (Izzatusholekha et al., 2022). According to the Indonesian Agency for Agricultural Research and Development (2019), *H. illucens* larvae are capable of reducing organic waste, such as food scraps, by up to 56% by converting it into their biomass. At least three products can be generated through the utilization of *H. illucens* larvae: the larvae themselves as an alternative protein source for livestock, liquid organic waste residue, and solid organic residue from larvae activity, both of which can be used as organic fertilizer or fish feed (Suciati and Faruq, 2017; Johan et al., 2022).

Waste management is essentially one form of circular economy implementation, which is an economic model aimed at minimizing waste and maximizing the use of available resources. The application of a circular economy aligns with the Sustainable Development Goals (SDGs), particularly in achieving an integrated waste management system from upstream to downstream.

The objective of this community service activity is to reduce waste accumulation, particularly organic waste, and to create economically valuable business opportunities through the sale of *Hermetia illucens* larvae as feed for poultry and fish. This

approach establishes a sustainable cycle of waste management, waste utilization for larvae cultivation, and the use of larvae as feed. This waste management cycle represents a practical design for implementing a circular economy through this community service program.

Waste management is a form of circular economy implementation, which aims to minimize waste and maximize resource utilization. This concept supports the Sustainable Development Goals (SDGs), particularly in creating an integrated waste management system. This community service program aims to reduce organic waste accumulation and create economic opportunities through the cultivation and sale of *Hermetia illucens* larvae as poultry and fish feed. This creates a sustainable cycle of waste management and resource utilization. Scientifically, the program contributes to the application of bioconversion technology and sustainable waste management models. Socially, it increases environmental awareness, improves community skills, and creates additional income opportunities, especially for unemployed residents in Sendangguwo Village.

METHODS

This community service program was conducted in RT 03 RW 03, Sendangguwo Village, Semarang, to address household organic waste problems through the establishment of an Organic Waste Bank and the cultivation of *Hermetia illucens* larvae. The program was implemented systematically in three main stages: preparation, implementation, and evaluation. The preparation phase included administrative coordination and licensing with local authorities and program partners, such as the Village Head and neighborhood leaders (RT/RW), to ensure institutional support for the program. Preliminary field observations and interviews with residents and local government representatives were also carried out to identify existing waste management practices and specific challenges related to household organic waste. In addition, educational materials, training modules, and cultivation tools were prepared to support the implementation of the activities. Preliminary observation and needs assessment are important steps in designing effective community-based programs (Amirullah et al., 2023).

The implementation stage focused on education, practical training, and mentoring to improve community knowledge and skills. Socialization and educational sessions were conducted to introduce

household waste segregation and organic waste management through the Organic Waste Bank. Such educational approaches have been shown to increase community awareness and participation in waste management initiatives (Satori et al., 2023). Furthermore, hands-on training on *Hermetia illucens* larvae cultivation was provided, including preparation of the cultivation media and the use of household organic waste as feed substrate. Practical training and technology dissemination are effective strategies for empowering communities in sustainable waste management practices (Aisyah & Rizki, 2022). Throughout this stage, mentoring and assistance were provided by the community service team in collaboration with PT BERRSIH to ensure that participants could independently apply the knowledge and skills gained during the program.

The evaluation stage was conducted to assess the effectiveness and sustainability of the implemented activities. Monitoring was carried out to evaluate participant involvement and measure improvements in community knowledge and practical skills related to waste management and larvae cultivation. The strengths and limitations of the program were identified to provide recommendations for future improvement and to ensure the long-term sustainability of community-based organic waste management initiatives. Program evaluation is a critical component for continuous improvement and sustainability of community empowerment programs (Amirullah et al., 2023).

More specifically, the alternative solutions to address waste-related challenges in RT 03 RW 03, Sendangguwo Village, were implemented through the following steps:

- 1) Administrative coordination and licensing with program partners and local authorities, including the Village Head and neighborhood leaders (RT/RW);
- 2) Preliminary field observations to identify community-specific issues, conducted through interviews with residents and local government representatives. These interviews explored existing waste management practices, particularly those related to household organic waste;
- 3) Provision of educational and socialization materials on waste management, including household-level waste segregation, *Hermetia illucens* larvae cultivation as a method for treating organic waste, and the establishment of an Organic Waste Bank as a sustainable system supporting ongoing waste processing;
- 4) Implementation of training and technology

dissemination activities, focusing on practical skills in larvae cultivation and the utilization of household organic waste as feed substrate. Institutional strengthening efforts were also carried out to ensure the long-term sustainability of the Organic Waste Bank;

- 5) Mentoring and assistance to support the application of larvae cultivation techniques, organic waste processing using larvae, and product management practices based on the knowledge and skills acquired during the training sessions.

RESULTS AND DISCUSSION

The initial stage of this community service program was conducted through an introductory session and socialization of the planned activities, aimed at encouraging active participation from residents throughout the program. This session was integrated into the community's routine monthly meeting, held on the third Sunday afternoon at a resident's house. The activities conducted at this stage are presented in Figure 1.



Figure 1 Socialization Activities of the Community Service Program During the Regular Meeting of RT 3 RW 3, Sendangguwo Village, Semarang

The initial stage of the program involved a coordination and socialization session with the residents of RT 03 RW 03, Sendangguwo Village. During this session, the objectives of the program were explained by the head of the community service team, followed by discussions regarding the activity plan and implementation schedule. Based on the discussion results, the agreed activities included: (a) waste management training, (b) *Hermetia illucens* larvae cultivation training, and (c) the establishment of an Organic Waste Bank management structure. At the end of the session, a questionnaire was distributed to assess participants' understanding of waste-related issues and current waste management practices. Similar socialization

and discussion-based approaches have been shown to increase community awareness and participation in community empowerment programs (Pinandita et al., 2023).

The questionnaire results showed that most residents were already familiar with the concept of a Waste Bank, and a similar program had previously been implemented in the area. However, the existing Waste Bank only focused on inorganic waste such as plastics and cardboard, while organic waste management remained underdeveloped. In addition, the management system operated at the village level, making it less effective in addressing neighborhood-specific issues. As a result, some residents still disposed of waste into nearby rivers. The questionnaire also revealed that residents had limited knowledge of *Hermetia illucens* larvae cultivation, despite its high potential as a bioconversion agent for household organic waste. Nevertheless, participants showed strong interest in learning and applying this method. This finding is consistent with the study by Indriyanti et al. (2023), which reported that community assistance in maggot cultivation improved public knowledge and encouraged waste segregation practices.

The first core activity of the implementation stage was waste management training. This activity began with a socialization session on household waste management, covering both organic and inorganic waste. The session was delivered by Dr. Sri Sumiyati, M.Si., coordinator of the Waste Bank in Gedawang Village, Banyumanik, Semarang, and was attended by approximately 30 participants, most of whom were housewives. The training emphasized that effective household waste management begins with individual awareness and motivation, which can then influence other family members to practice proper waste segregation. Educational and practical training methods are effective in increasing community understanding and skills in waste management practices (Suminar et al., 2022; Pinandita et al., 2023).

During the training, participants were introduced to waste segregation into three categories: organic waste, inorganic waste, and hazardous waste (B3). Once sorted, appropriate treatment methods can be applied. Organic waste can be processed through *Hermetia illucens* larvae cultivation, while inorganic waste can be collected and sold through the local Waste Bank. The use of *H. illucens* larvae as a bioconversion agent has been widely recognized as an effective method for reducing household organic waste while producing economically valuable biomass as animal feed (Indriyanti et al., 2023).

The results of the training showed increased community awareness and understanding of proper waste management practices. Participants actively engaged in discussions and hands-on activities, indicating strong enthusiasm for adopting the Organic Waste Bank and larvae cultivation program. The successful implementation of a Waste Bank requires collaboration among households, local government, and other stakeholders to ensure long-term sustainability. Documentation of the socialization and waste management training activities is presented in Figure 2.



Figure 2 Waste Management Training Activities Conducted by the Resource Person with Residents of RT 3 RW 3, Sendangguwo Village, Semarang

The second core stage of the program involved training on the cultivation of *Hermetia illucens* larvae. In this activity, the community service team collaborated with a partner from PT BERRSIH. The training was attended by youths from RT 03 RW 03, Sendangguwo Village, Semarang. This session provided participants with fundamental knowledge of *Hermetia illucens* larvae and the technical procedures required for their cultivation.

The cultivation process consists of several developmental stages that must be well understood, including:

- 1) Egg hatching stage, which represents the initial phase of cultivation. *Hermetia illucens* eggs are placed in a hatching container with organic feed prepared beneath it to support newly hatched larvae. The eggs typically hatch within 3–4 days;
- 2) Larval stage, which begins immediately after hatching. The larvae fall onto the prepared organic substrate and actively consume organic waste for approximately 18–21 days, contributing significantly to waste reduction

- through bioconversion;
- 3) Prepupal stage, characterized by a color change from pale yellowish-white to dark brown or black. At this stage, the larvae cease feeding and prepare for metamorphosis;
 - 4) Pupal stage, during which the larvae undergo hardening and transformation for a period ranging from 7 days to one month before emerging as adult flies. During this stage, the pupae should be transferred to a suitable breeding enclosure;
 - 5) Adult stage, in which the Black Soldier Fly has a lifespan of approximately 7–14 days. During this period, mating and oviposition occur, thereby sustaining the cultivation cycle.
 - 6) This training enabled participants to understand the complete life cycle of *Hermetia illucens* and its application as an effective method for organic waste management, while also providing potential economic benefits for the community.



Figure 3 *Hermetia illucens* Larvae Cultivation Training Activity

The third activity involved the establishment of the Organic Waste Bank management, which was conducted concurrently with the routine monthly meeting of RT 03 RW 03 in Sendangguwo Village, Semarang. The Waste Bank was organized at the RW level; therefore, its management structure consisted of representatives from each RT within RW 3. The meeting was attended by delegates from all RTs in the area.

During this session, the importance of strong commitment from both program initiators and community members was emphasized. Effective waste management not only contributes to environmental cleanliness and sustainability but also offers economic benefits, particularly through the cultivation of *Hermetia illucens* larvae.

The implementation of *Hermetia illucens* larvae cultivation has shown positive results, with active participation from local residents. The harvested larvae have been marketed online in 330 mL bottles at a price of IDR 10,000. Furthermore, the larvae products were analyzed for protein content in both dried and fresh forms. Additional protein analysis was also conducted on eggs produced by chickens fed with larvae-based feed and compared with eggs from chickens fed with conventional commercial feed (Table 1).

Table 1 Protein Content Analysis of *Hermetia illucens* Larvae and Chicken Eggs

No.	Sample	Protein Content (%)
1	Dried <i>Hermetia illucens</i> Larvae	39.118
2	Fresh <i>Hermetia illucens</i> Larvae	10.531
3	Egg from Chicken Fed with Commercial Feed	9.760
4	Egg from Chicken Fed with Larvae-Based Feed	10.384

The implementation of this program provides important contributions both scientifically and socially. From a scientific perspective, this activity demonstrates the practical application of bioconversion technology using *Hermetia illucens* larvae for household organic waste treatment. The results support previous findings that maggot cultivation can effectively reduce organic waste while producing high-protein biomass for animal feed (Indriyanti et al., 2023). In addition, this program contributes to the development of a community-based waste management model integrated with circular economy principles, which can be replicated in other areas facing similar waste-related challenges.

From a social perspective, the program increases community awareness and knowledge regarding proper waste segregation and sustainable waste management practices. The establishment of an Organic Waste Bank and larvae cultivation activities also create potential economic opportunities for residents through the sale of larvae as poultry and fish feed. Furthermore, the program encourages behavioral changes, particularly in reducing the habit of disposing of waste into nearby rivers, thereby contributing to environmental sustainability and improving community welfare.

CONCLUSION

The community service program successfully achieved its objectives of improving community knowledge and skills in household waste management through waste sorting training, *Hermetia illucens* larvae cultivation, and the establishment of an Organic Waste Bank. The program increased public awareness of proper waste management and showed that organic waste can be converted into economically valuable products, supporting circular economy implementation. For future action, continuous mentoring, regular socialization, and advanced training are needed to maintain community participation and ensure program sustainability. Expanding the Organic Waste Bank and developing the commercialization of larvae-based products may further increase environmental and economic benefits.

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