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Multi-Stakeholder Collaboration in Liquid Organic Fertilizer Production Training for Community Empowerment in Sukakarya Village

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ABSTRACT

Program pengabdian masyarakat ini bertujuan untuk meningkatkan kapasitas masyarakat dalam mengelola limbah organik rumah tangga melalui pelatihan produksi pupuk organik cair (LOF) di Desa Sukakarya. Program ini dilaksanakan dengan kolaborasi multi-pemangku kepentingan yang melibatkan dosen universitas, mitra industri (Pertamina), dan kelompok tani perempuan setempat (KWT Melati). Kegiatan ini mengadopsi pendekatan partisipatif yang menggabungkan sesi pendidikan, pelatihan praktik, dan evaluasi melalui tes pra dan pasca. Limbah organik rumah tangga seperti sisa sayuran, kulit buah, dan sisa nasi diolah menggunakan metode fermentasi anaerobik sederhana dengan Mikroorganisme Efektif 4 (EM4) sebagai bioaktivator. Hasil menunjukkan peningkatan yang signifikan dalam pemahaman peserta tentang pengelolaan limbah, konsep ekonomi sirkular, dan prosedur produksi LOF. Selain itu, peserta menunjukkan peningkatan kesadaran lingkungan dan kesiapan untuk memproduksi LOF secara mandiri di tingkat rumah tangga. Meskipun program ini terbatas pada tahap produksi tanpa aplikasi lapangan, hasilnya menunjukkan potensi yang kuat untuk pengelolaan limbah berkelanjutan dan pemberdayaan masyarakat. Inisiatif ini menyoroti efektivitas pendidikan berbasis masyarakat yang didukung oleh kolaborasi multi-pemangku kepentingan sebagai model yang dapat direplikasi untuk program keberlanjutan lingkungan pedesaan.

This community service program aimed to enhance community capacity in managing household organic waste through training on liquid organic fertilizer (LOF) production in Sukakarya Village. The program was implemented using a multi-stakeholder collaboration involving university lecturers, an industrial partner (Pertamina), and the local women farmer group (KWT Melati). The activity adopted a participatory approach combining educational sessions, hands-on training, and evaluation through pre- and post-tests. Household organic waste such as vegetable residues, fruit peels, and leftover rice was processed using a simple anaerobic fermentation method with Effective Microorganisms 4 (EM4) as a bioactivator. The results showed a significant improvement in participants understanding of waste management, circular economy concepts, and LOF production procedures. In addition, participants demonstrated increased environmental awareness and readiness to independently produce LOF at the household level. Although the program was limited to the production stage without field application, the outcomes indicate strong potential for sustainable waste management and community empowerment. This initiative highlights the effectiveness of community-based education supported by multi-stakeholder collaboration as a replicable model for rural environmental sustainability programs.

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INTRODUCTION

The growing generation of household organic waste presents an urgent environmental challenge that requires collaborative solutions integrating scientific expertise, industrial support, and active community participation (Czekała et al., 2023). Composting and organic waste valorization have emerged as sustainable strategies for waste management, particularly with the advancement of microbial-based technologies that improve decomposition efficiency and fertilizer quality(Manea et al., 2024; Voss et al., 2024). In line with circular economy principles, the transformation of organic waste into agricultural inputs offers a pathway to reduce environmental burdens while enhancing local resource efficiency (Lizundia et al., 2022). uch approaches also contribute to the achievement of the United Nations Sustainable Development Goals (SDGs), especially those related to sustainable consumption, environmental protection, and community empowerment (Amran et al., 2021; Zhou et al., 2022)

Recent studies have demonstrated that organic waste can serve as a viable alternative to chemical fertilizers through the production of liquid organic fertilizer (LOF) (Widyabudiningsih et al., 2025). Household kitchen waste, including vegetable residues and fruit by-products, contains essential nutrients that support plant growth and soil fertility (Haryanta et al., 2023). he application of bioactivators such as Effective Microorganisms 4 (EM4) enhances the fermentation process and improves nutrient availability in LOF formulations (Pradiksa et al., 2022). Moreover, agricultural waste valorization provides both environmental and socioeconomic benefits, reinforcing circular economy practices at the grassroots level (Amran et al., 2021; Puglia et al., 2021). Nevertheless, proper processing techniques and quality control remain critical to prevent environmental risks, including potential soil contamination resulting from improper waste management (Puglia et al., 2021; Szulc et al., 2021).

In Sukakarya Village, household organic waste generated from daily domestic activities remains largely unmanaged and is commonly disposed of without further processing. This condition not only contributes to environmental degradation but also reflects limited community access to practical knowledge and appropriate technologies for waste utilization. Addressing this gap requires a structured community service approach that combines academic guidance, industrial experience, and local community engagement.

Accordingly, this community service program was designed as a multi-stakeholder collaboration involving university lecturers, an industrial partner (Pertamina), and the local women farmer group (KWT Melati). The role of university lecturers includes transferring scientific knowledge, developing training modules, and providing technical assistance related to liquid organic fertilizer production. The involvement of the industrial partner contributes practical insights into sustainable practices, environmental responsibility, and resource efficiency, while also supporting program implementation. Meanwhile, KWT Melati acts as the primary community partner and beneficiary, actively participating in training activities and serving as a local agent for knowledge dissemination and practice sustainability.

The program adopts a participatory training method consisting of counseling sessions, hands-on demonstrations, and guided practice in producing liquid organic fertilizer from household organic waste (Abidin et al., 2024; Alsiken-Nanglegan, 2023). The expected outputs of this program include increased community knowledge and skills in organic waste processing, the production of liquid organic fertilizer that can be applied to local agricultural activities(Rakhmawati et al., 2023), and the availability of simple guidelines for LOF production at the household level(Thammayod et al., 2024). In the longer term, the anticipated outcomes encompass improved environmental awareness, reduced household waste volume, enhanced soil fertility, and strengthened economic potential through sustainable agricultural practices(Ramarao et al., 2024).

Through this integrated and collaborative approach, the program not only addresses local waste management challenges but also promotes community empowerment and self-reliance. The synergy between academia, industry, and community organizations demonstrated in this initiative is expected to serve as a replicable model for implementing sustainable, community-based waste management programs in other rural areas.

METHOD

This study employed a community service–based implementation method conducted in Sukakarya Village as part of a collaborative program involving university lecturers, an industrial partner

(Pertamina), and the local women farmer group (KWT Melati). The methodological framework was designed to facilitate community empowerment through participatory education and hands-on training in the production of liquid organic fertilizer (LOF) using household organic waste. The program was implemented through a structured sequence of stages, including preparation, socialization, training, and evaluation. Figure 1 illustrates the overall flow of the community service activities, from initial assessment to training implementation and outcome evaluation.

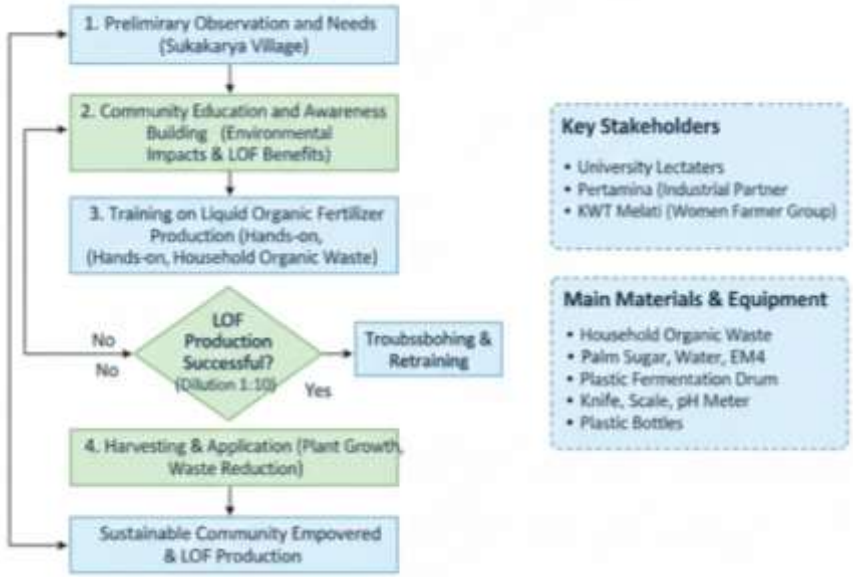

Figure 1. Flowchart of the Community Service Program on Liquid Organic Fertilizer Production in Sukakarya Village

Stages of Activity

The implementation of the community service program consisted of the following stages:

1. Preliminary Observation and Needs Assessment
   This initial stage involved field observations to identify the types and quantities of household organic waste generated by residents of Sukakarya Village. Informal interviews and discussions were conducted with community members and representatives of KWT Melati to assess existing waste management practices, levels of awareness, and local needs related to organic waste utilization and sustainable agriculture.
2. Community Education and Awareness Building
   Educational sessions were conducted to increase community understanding of the environmental impacts of unmanaged household organic waste and the potential benefits of converting such waste into liquid organic fertilizer. These sessions were facilitated by university lecturers with support from the industrial partner, using presentations, interactive discussions, and simple educational materials to ensure accessibility and comprehension.
3. Training on Liquid Organic Fertilizer Production
   Practical training activities focused on the step-by-step production of liquid organic fertilizer using household kitchen waste. Participants were directly involved in each stage of the process, allowing them to acquire hands-on skills using low-cost, locally available materials and simple technology. This approach was intended to ensure that the method could be easily replicated at the household or community level.

Materials and Equipment

Main Materials

1. Household organic waste (vegetable residues, rice leftovers, fruit peels) collected from residents of Sukakarya Village
2. Palm sugar (locally sourced, 100%)
3. Clean water
4. EM4 Agriculture (PT Songgolangit Persada, liquid form, pH 3.5)

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Main Equipment

1. Plastic fermentation drum (60 L capacity)
2. Knife
3. Digital scale
4. pH meter
5. Plastic bucket (20 L capacity)
6. Stainless steel funnel
7. Plastic bottles (PET, 1 L) for packaging

Equipment Setup

As shown in Figure 2, the equipment arrangement consisted of a closed plastic fermentation container to support anaerobic conditions, a pH meter to monitor fermentation progress, and auxiliary containers for material preparation and liquid transfer. This configuration was selected to ensure practicality, safety, and reproducibility of the liquid organic fertilizer production process at the community scale.

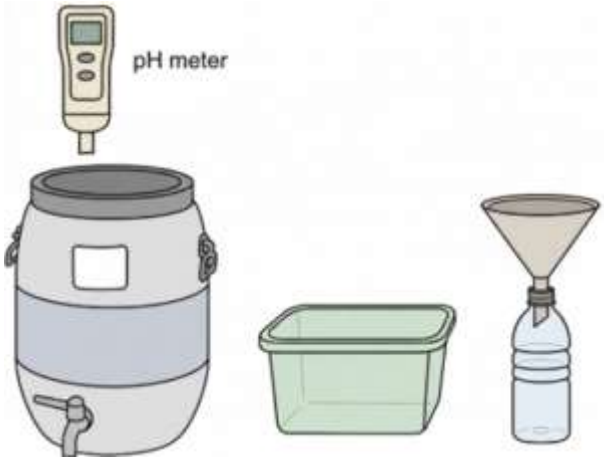

Figure 2. Main equipment used in the fermentation process of liquid organic fertilizer from household organic waste

Liquid Organic Fertilizer Production Procedure

The production of liquid organic fertilizer was carried out using an anaerobic fermentation method, following these steps:

1. Material Preparation: Household organic waste was collected, chopped into smaller pieces to accelerate decomposition, and placed into a sealed fermentation container.
2. Addition of Bioactivators: A solution containing EM4 and a carbohydrate source, such as dissolved palm sugar or rice washing water, was added to stimulate microbial activity during fermentation.
3. Fermentation Process: The mixture was stored in a shaded area for 10–14 days. Gentle stirring was performed every 2–3 days to maintain uniform fermentation conditions and support microbial growth.
4. Harvesting and Application: After fermentation, the liquid fraction was filtered to separate solid residues. The resulting liquid organic fertilizer was diluted with water at a ratio of 1:10 prior to application to ensure safe use on plants.

This methodological approach emphasizes participatory learning, technical feasibility, and sustainability, aligning the implementation process with the objectives of community empowerment, household waste reduction, and the promotion of environmentally friendly agricultural practices in Sukakarya Village.

RESULTS AND DISCUSSION

Relevance of Waste Management Education at the Community Level

One of the main challenges encountered in rural communities is the limited application of proper household organic waste management practices. Kitchen waste, including vegetable residues, fruit peels, and leftover rice, is commonly disposed of together with other domestic waste and transported directly to temporary or final disposal sites. Over time, this practice contributes to environmental pollution,

unpleasant odors, and the potential proliferation of disease vectors(Czekała et al., 2023). Similar conditions were observed in Sukakarya Village, where household organic waste had not been systematically separated or utilized prior to the implementation of this community service program.

The waste management education conducted as part of this program played a crucial role in enhancing community awareness regarding the environmental impacts of unmanaged organic waste and its potential transformation into value-added products. Through structured educational sessions facilitated by university lecturers and supported by the industrial partner, participants—primarily members of KWT Melati—were introduced to basic principles of waste segregation, the identification of biodegradable waste, and the environmental risks associated with improper disposal practices. This educational approach aligns with the concepts of zero waste and circular economy, which emphasize waste reduction at the source and the reuse of organic materials within a closed-loop system (Lizundia et al., 2022).

As illustrated in Figure 3, the education and training activities actively involved community members in participatory discussions and practical demonstrations related to household organic waste management and liquid organic fertilizer (LOF) production. The engagement of participants during these sessions reflects a positive learning environment and indicates increased interest and motivation to adopt more sustainable waste handling behaviors. Beyond knowledge transfer, the activity functioned as a behavioral intervention, encouraging participants to reconsider household waste as a valuable resource rather than as a disposal problem.

The results of this educational intervention demonstrate that targeted waste management education, supported by multi-stakeholder collaboration, can effectively improve community understanding and readiness to implement sustainable practices. This finding underscores the importance of integrating educational components into community-based environmental programs as a foundation for long-term behavioral change and community empowerment.

Figure 3. Community Education on Waste Management at Sukakarya Village

The education session also functioned as a catalyst for behavioral change. Participants demonstrated a gradual shift from indiscriminate waste disposal practices toward more responsible behaviors, including the segregation, collection, and independent processing of household organic waste. This finding supports (Manea et al., 2024)who emphasize that waste management technologies

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yield more effective outcomes when combined with structured social engagement and educational interventions.

The effectiveness of the educational activities was further validated through pre-test and post-test evaluations administered during the program. The assessment results indicate a clear and consistent improvement in participants understanding of organic waste management and circular economy concepts. As shown in Figure 4, the comparison between pre-test and post-test scores across ten assessment items reveals a substantial increase in participant performance following the education and training sessions. The horizontal axis (Items 1–10) represents individual assessment questions covering both conceptual knowledge and procedural understanding, while the vertical axis reflects participant scores expressed as percentages.

Before the intervention, pre-test scores generally ranged between 40% and 65%, indicating limited initial comprehension, particularly in procedural aspects of liquid organic fertilizer (LOF) production. After the educational intervention, post-test scores increased significantly, reaching approximately 80% to 95% across all items. The most pronounced improvements were observed in Items 3, 5, and 6, which relate to core procedures of LOF preparation and fermentation, where post-test scores increased by more than 30 percentage points compared to pre-test results. In addition, Items 9 and 10, which assess knowledge of LOF application and dilution techniques, showed high post-test achievement levels, approaching 90–95%, indicating strong mastery of practical application concepts.

Overall, the pattern displayed in Figure 4 confirms that the training program successfully enhanced both theoretical understanding and practical competencies among participants. These findings highlight the critical role of structured, community-based education supported by multi-stakeholder collaboration in fostering sustainable waste management practices and strengthening community capacity.

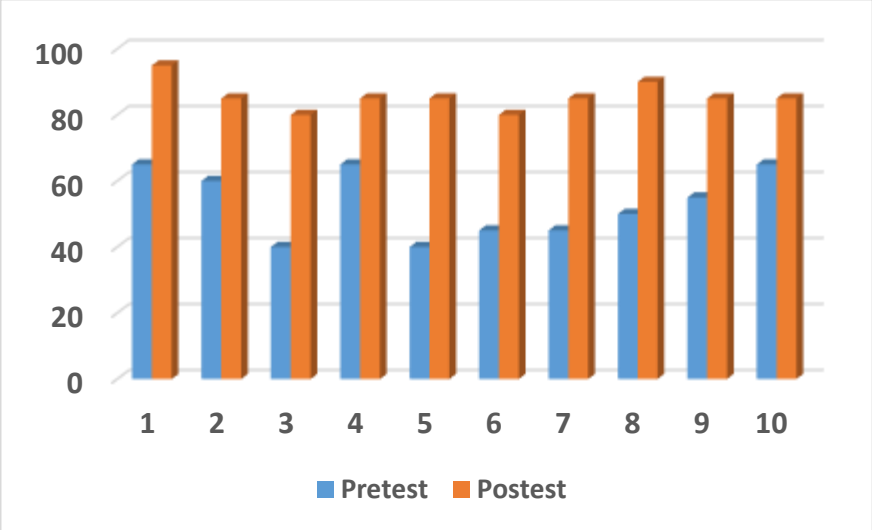

Figure 4. Comparison of Pre-Test and Post-Test Results of Participants

Innovation in Liquid Organic Fertilizer (LOF) Production

The practical session on liquid organic fertilizer (LOF) production was conducted in Sukakarya Village as part of a collaborative community service program involving university lecturers, an industrial partner (Pertamina), and members of KWT Melati. The activity focused on hands-on training using household organic waste generated by local residents, including vegetable residues, fruit peels, and leftover rice. Animal-based materials were deliberately excluded to minimize odor generation and to ensure that the production process remained simple, hygienic, and suitable for household-scale implementation.

As illustrated in Figure 5, the LOF production process employed an anaerobic fermentation method using Effective Microorganisms 4 (EM4) as a bioactivator and molasses or palm sugar solution as a carbon source for microbial metabolism. This method was selected due to its practicality, low cost, and ease of replication at the community level. The use of microbial bioactivators has been reported to accelerate organic matter degradation and enhance nutrient availability in liquid organic fertilizers(Haryanta et al., 2023; Pradiksa et al., 2022). During the training, participants were actively

involved in each stage of the process, including waste preparation, mixing of materials, fermentation setup, and monitoring of fermentation conditions.

Figure 5. Process of Making Liquid Organic Fertilizer (POC)

The resulting liquid organic fertilizer produced during the training exhibited a dark brown color and a homogeneous liquid texture after filtration, accompanied by a mildly fermented odor without any offensive smell. These characteristics indicate that the fermentation process proceeded effectively and that organic matter decomposition occurred as expected. At the time of reporting, the LOF produced had not yet been applied to crops, as the activity was intentionally limited to the production and fermentation stages. The absence of an application phase reflects the program's focus on capacity building and skill acquisition rather than immediate agronomic evaluation.

Nevertheless, participants demonstrated a clear understanding of the recommended application methods, dilution ratios, and safety considerations for future use of LOF on agricultural and horticultural crops. This knowledge transfer is essential for ensuring that the fertilizer can be applied correctly and safely once the fermentation process is fully completed.

Strengthening Local Community Capacity and Empowerment

Beyond the technical aspect of LOF production, the activity significantly contributed to strengthening local community capacity and environmental awareness. Participants gained practical skills in transforming household organic waste—previously regarded as useless or problematic—into a valuable agricultural input. This finding illustrates that environmental problem-solving can be initiated at the household and community levels using simple and accessible technologies.

From an empowerment perspective, the program introduced participants to the concept of waste valorization, encouraging them to view organic waste as a potential economic resource. Several members of KWT Melati expressed interest in continuing LOF production independently and exploring opportunities for small-scale packaging and commercialization. This aligns with the waste valorization framework proposed by Amran et al. (2021), which emphasizes converting waste into value-added products while maintaining environmental sustainability.

In addition, the program strengthened collaboration among community members, facilitators, and supporting stakeholders. Discussions during the training highlighted the potential for developing a community-based system for household waste segregation and collection, which could support continuous LOF production in the future. If implemented consistently, such a system may serve as a replicable model for sustainable waste management in other villages within Musi Rawas Regency.

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Despite the positive outcomes, several challenges were identified during the activity. Some participants initially perceived household organic waste as dirty or unsuitable for reuse, requiring additional motivation and explanation. Minor technical issues also arose, such as loosely sealed fermentation containers and inaccuracies in molasses ratios, due to participants limited prior experience with fermentation processes. These challenges indicate the importance of follow-up activities, continued mentoring, and periodic monitoring to ensure consistency, product quality, and long-term sustainability of community-based LOF production initiatives.

CONCLUSION

This community service program demonstrates that collaborative training on liquid organic fertilizer (LOF) production using household organic waste effectively enhanced participants knowledge, practical skills, and environmental awareness. Through the involvement of university lecturers, an industrial partner (Pertamina), and KWT Melati, the program successfully transferred simple and low-cost LOF production techniques based on anaerobic fermentation. The training resulted in improved understanding of waste management and circular economy concepts, encouraged a positive shift in community attitudes toward organic waste utilization, and strengthened local capacity for sustainable practices. Although the activity was limited to the production stage without field application, the outcomes indicate strong potential for future implementation, scaling, and community-based entrepreneurship through continued mentoring and follow-up programs.

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