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Promoting Sustainable Agriculture through Community-Based Liquid Organic Fertilizer Production from Household Organic Waste in Metut Village, North Kalimantan

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ABSTRACT

The accumulation of unmanaged household organic waste remains a persistent environmental challenge in rural areas, including Metut Village, Mentarang Hulu District, North Kalimantan, Indonesia, where organic waste is commonly burned or indiscriminately discarded. At the same time, local farmers continue to depend on relatively expensive chemical fertilizers. This community service program aimed to improve residents' knowledge and practical skills in converting household organic waste into liquid organic fertilizer (LOF) as an affordable and environmentally friendly alternative for sustainable agriculture. The program employed a combination of community education and hands-on training implemented through four stages: socialization and educational counseling, training and demonstration, supervised independent practice, and evaluation using pre-test and post-test assessments. A total of 28 participants, consisting of housewives, farmer group members, and village youth, were involved in the program. The results demonstrated a substantial increase in participants' knowledge, with average scores improving from 46.4 in the pre-test to 86.1 in the post-test. Participants successfully produced liquid organic fertilizer independently using kitchen waste fermented with a bioactivator for 14–21 days and subsequently applied the product to home garden crops. The program contributed to reducing household organic waste generation, lowering fertilizer expenditures, and promoting environmentally sustainable agricultural practices. These findings indicate that liquid organic fertilizer training is an effective approach for community empowerment and sustainable waste management in rural communities.

Keywords: community empowerment, household organic waste, liquid organic fertilizer, sustainable agriculture, waste valorization, rural community

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INTRODUCTION

Waste management is one of the most pressing environmental challenges in Indonesia. Organic waste, primarily originating from food residues and household activities, constitutes the largest proportion of municipal solid waste. However, a significant fraction of this waste is inadequately managed and ultimately disposed of in landfills or openly burned, resulting in environmental pollution, greenhouse gas emissions, and the loss of valuable nutrients that could otherwise be recycled into productive uses (Edy & Aji, 2026). Consequently, the development of simple, affordable, and sustainable waste management strategies is urgently needed to reduce environmental impact while promoting resource recovery. The conversion of household organic waste into fertilizer is one of the most practical and environmentally friendly approaches to address this issue (Naufa et al., 2023; Firdani et al., 2023. Organic waste can be transformed into various value-added products, including compost (Rini et al., 2021; Suttrisno et al., 2024), eco-enzymes (Seprianto et al., 2023), and liquid organic fertilizer (LOF), thereby reducing waste accumulation and supporting sustainable agricultural practices. Among these alternatives, liquid organic fertilizers are particularly attractive because they are easy to produce, require relatively simple technology, and can be manufactured using locally available materials. LOF is roduced through the fermentation of organic matter by beneficial microorganisms and contains essential macro- and micronutrients as well as microbial communities that contribute to soil fertility and plant growth (Dwisvimiar et al., 2023).

Previous community empowerment programs have demonstrated that training in the production of liquid organic fertilizer from household waste can significantly improve public knowledge and practical skills while encouraging community-based waste management and reducing dependence on external agricultural inputs (Bai et al., 2025; Abrori et al., 2022;Herniwanti et al., 2023). Such initiatives are consistent with the principles of appropriate technology and circular economy approaches which convert waste into useful products. Similar strategies have been successfully implemented through the utilization of coffee-processing waste for bio-pellet production (Hadiyane et al., 2021), corn product diversification (Rumidatul et al., 2025), and probiotic silage production from local forage resources (Hidayat et al., 2025). Despite these advances, communities in remote areas continue to face substantial challenges in managing organic household waste. This situation is evident in Metut Village, located in the Mentarang Hulu District, Malinau Regency, North Kalimantan Province. The village is situated in a remote inland region where most residents depend on farming and shifting cultivation for their livelihood. Consequently, considerable quantities of organic household waste, including vegetable residues, fruit peels, and kitchen waste, are generated daily. Due to the limited availability of waste collection services and transportation infrastructure, residents commonly dispose of waste by open burning or dumping it in yards and nearby waterways. These practices pose environmental risks and contribute to local ecosystem degradations.

Simultaneously, local farmers remain highly dependent on chemical fertilizers, which are relatively expensive and often difficult to obtain because of the village's remote location and limited distribution networks. The absence of adequate waste-processing facilities further exacerbates this problem, creating a dual challenge of increasing waste accumulation and limited access to affordable agricultural inputs in the region. Therefore, a practical and locally adaptable solution that simultaneously addresses waste management and agricultural productivity is urgently needed. Although training programs on organic waste utilization have been conducted in many regions of Indonesia, similar initiatives remain scarce in the remote areas of North Kalimantan, particularly in Metut Village. The geographical isolation, socio cultural characteristics, and resource limitations of the predominantly Dayak community necessitate a context-specific approach. The novelty of this community service program lies in the adaptation of liquid organic fertilizer production techniques to locally available materials and the specific conditions of rural Dayak communities in West Kalimantan. This approach is expected to enhance community acceptance, facilitate long-term adoption, and enable residents to independently continue practicing the program after it completion. Based on these considerations, this community service activity was conducted to enhance the knowledge and practical skills of Metut Village residents in converting household organic waste into a liquid organic fertilizer. The program aims to reduce organic waste generation, lower fertilizer expenditure, and promote sustainable agricultural practices in the community. Furthermore, the initiative contributes to the achievement of several Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land).

METHOD

This community service program was conducted from April to May 2026 in Metut Village, Mentarang Hulu District, Malinau Regency, North Kalimantan Province, Indonesia. The target participants consisted of 28 village residents selected purposively, including housewives, members of farmer groups, and youth organization (Karang Taruna) members. These groups were chosen because they are the primary generators of household organic waste and play a central role in agricultural activities win the village. The program was implemented over approximately two months, encompassing the preparation, implementation, and evaluation stages.

The program employed a combination of community education and practical training approaches that were implemented in a participatory manner. The first stage involved socialization and educational counseling, during which the community service team provided information regarding the environmental impacts of organic waste, the potential of organic waste as a raw material for fertilizer production, and the benefits of liquid organic fertilizer (LOF) for soil fertility and plant growth. A pre-test was administered before the educational session to assess the participants' baseline knowledge. The second stage consisted of training and demonstration

activities in which the team demonstrated the complete process of producing liquid organic fertilizer, including the sorting and chopping of organic waste, preparation of the bioactivator solution, mixing of materials, and fermentation in a closed container. The third stage involved independent practice and mentoring, where participants were divided into small groups and guided to independently produce liquid organic fertilizer under the supervision of the community service team. This stage was intended to strengthen the participants' practical skills and enhance their ability to replicate the process at the household level. The final stage was evaluation, which was conducted through pre- and post-test assessments to measure improvements in participants' knowledge. Additional evaluation methods included direct observation of the quality of the liquid organic fertilizer produced and semi-structured interviews to collect participants' feedback and assess the program's potential sustainability. The pre- and post-test instruments consisted of 20 multiple-choice questions covering the types and environmental impacts of organic waste, the concept and benefits of liquid organic fertilizer, the procedures for producing liquid organic fertilizer, and its application to agricultural crops.

The primary materials used in this program were household organic waste, including vegetable residues, fruit peels, and kitchen waste. The supporting materials included a bioactivator solution (EM4) or local microorganisms (MOL), brown sugar or molasses as an energy source for microbial activity, and clean water, preferably well or dechlorinated water. The equipment used included fermentation drums or sealed plastic buckets, knives or chopping tools, filters, measuring cups and funnels. During training,the participants used 5 kg of organic waste as the primary raw material and nutrient source, 100 mL of EM4 bioactivator or MOL to accelerate the fermentation process, 250 g of brown sugar or molasses as an energy source for microorganisms, and 5 L of clean water as the fermentation medium and solvent. The compositions of the materials used for liquid organic fertilizer production are presented in Table 1.

Table 1. Composition of Materials Used for Liquid Organic Fertilizer Production

No.	Material	Quantity	Function
1	Organic waste (vegetable residues and fruit peels)	5 kg	Main raw material and nutrient source
2	EM4 bioactivator or local microorganisms (MOL)	100 mL	Accelerates the fermentation process
3	Brown sugar or molasses	250 g	Energy source for microorganisms
4	Clean water	5 L	Fermentation medium and solvent

Source: Community service activity data, 2026.

RESULTS AND DISCUSSION

The community service program conducted in Metut Village was successfully implemented and received a high level of enthusiasm from the participants. All stages of the program, including socialization, training, mentoring, and evaluation, were carried out according to the planned schedule with consistent attendance and active participation from the 28 participants. The strong engagement demonstrated by the participants reflected their interest in acquiring practical knowledge and skills related

to household organic waste management and sustainable agricultural practices in the study area.

During the initial socialization and educational counseling stage, the community service team delivered materials covering waste types, the environmental and health impacts of organic waste accumulation, and the basic concepts and benefits of liquid organic fertilizer (LOF). Through discussions,the participants became increasingly aware that their common practices of burning or indiscriminately disposing of household waste contributed to environmental degradation. Simultaneously, they recognized the ecological and economic potential of organic waste which had previously been regarded as worthless. The pre-test results revealed that the participants possessed limited prior knowledge regarding the conversion of organic waste into liquid organic fertilizer, with an average score of 46.4. These findings indicate the need educational interventions to improve community understanding of sustainable waste management practices.

Figure 1. Documentation of the socialization and educational counseling activities.

Training and practical sessions were conducted through direct demonstrations of liquid organic fertilizer production. Organic waste materials were first chopped into smaller pieces to accelerate their decomposition and were subsequently placed in fermentation containers. The waste was then mixed with a bioactivator solution consisting of EM4, brown sugar and water. The containers were tightly sealed to create anaerobic conditions and allowed to ferment for 14–21 da. During the fermentation period, the containers were occasionally stirred and opened briefly to release the accumulated gases. Following the demonstration, the participants practiced the procedure independently in small groups under the guidance of the community service team. The participants showed considerable enthusiasm throughout the activity, as evidenced by the numerous questions and discussions concerning alternative raw materials and appropriate methods for applying liquid organic fertilizer to crops.

After the fermentation period, the liquid organic fertilizer produced by the participants exhibited characteristics that indicated successful fermentation. The product had a dark brown color and a fermented aroma resembling that of traditional fermented foods, without any unpleasant odors. Prior to application, the fertilizer was diluted with water and subsequently applied to vegetable crops cultivated in the participants' home gardens. Participants reported that the production process was simple, inexpensive, and feasible to implement using materials readily available in their homes. These findings suggest that thise technology is suitable for adoption in rural communities with limited access to agricultural inputs and waste management facilities.

Figure 2. Documentation of the liquid organic fertilizer production practice.

The evaluation results demonstrated a substantial improvement in the participants' knowledge following the program. As shown in Table 2, the average post-test score increased to 86.1 compared with the average pre-test score of 46.4, representing an increase of 39.7 points. This improvement indicates that the participatory training approach, which integrated educational counseling, demonstrations, and hands-on practice, was highly effective in enhancing knowledge and practical skills related to organic waste utilization. In addition to the increase in knowledge, the participants successfully produced liquid organic fertilizer that was ready for field application and expressed their intention to continue using the technology in their household gardens and agricultural activities.

Table 2. Summary of Community Service Program Outcomes

No.	Indicator	Achievement
1	Number of participants	28 persons
2	Average pre-test score	46.4 ± 8.2
3	Average post-test score	86.1 ± 6.5
4	Knowledge improvement	39.7 points
5	Product generated	Liquid organic fertilizer ready for application
6	Follow-up action	Application of liquid organic fertilizer in home gardens

Source: Community service activity data, 2026.

The findings of this program are consistent with previous community empowerment initiatives demonstrating that training on the conversion of organic waste into liquid organic fertilizer can effectively improve community knowledge and self-reliance. Bai et al. (2025) reported significant improvements in participants' understanding and technical skills following household waste-based liquid organic fertilizer training, similar to the outcomes observed in Metut Village. Comparable results were also reported by Abrori et al. (2022) and Herniwanti et al. (2023), who emphasized that the combination of theoretical instruction and practical experience is essential for successful technology transfer within communities. Similar approaches have been employed in community programs focused on compost production (Rini et al., 2021; Suttrisno et al., 2024) and eco-enzyme production (Seprianto et al., 2023), both of which relheavily on participatory demonstrations and hands-on learning.

The success of this activity further supports the concept that waste materials can be transformed into valuable resources through the application of simple appropriate technologies. This waste valorization principle has been demonstrated in various community development contexts, including the conversion of coffee-processing waste into bio-pellets as an alternative fuel source for energy-independent villages (Hadiyane et al., 2021), diversification of corn products into cornstarch to increase agricultural value addition (Rumidatul et al., 2025), and production of probiotic silage from local forage resources as a low-cost livestock feed alternative (Hidayat et al., 2025). Similar to these initiatives, the conversion of household organic waste into liquid organic fertilizer in Metut Village transformed materials previously considered waste into economically and environmentally beneficial resources.

Beyond improving knowledge and skills, the program generated measurable environmental benefits through the reduction of household organic waste disposal in the area. Based on participant reports, each household reduced the amount of organic waste burned or discarded by an average of 2.5 kg. With 28 participants, the total reduction reached approximately 70 kg of organic waste per week, equivalent to 280 kg per month. When projected over a one-year period, the initiative has the potential to divert approximately 3.36 to of organic waste from the local environment. This reduction contributes not only to cleaner surroundings but also to lower greenhouse gas emissions associated with open burning and the uncontrolled decomposition of organic waste.

From an economic perspective, the program also provided tangible benefits by reducing participants' dependence on chemical fertilizers and increasing their income. According to participant feedback, farmers were able to save approximately IDR 50,000–75,000 per month on fertilizer expenditures because part of their crop nutrient requirements could be supplied through the self-produced liquid organic fertilizer. The utilization of locally available materials and the simplicity of the production process enhance the feasibility of their long-term adoption. The availability of organic waste as a raw material and the high level of community participation are important supporting factors for sustainability. Nevertheless, maintaining consistent

implementation and providing follow-up mentoring remain critical challenges to ensure that the practice becomes an established collective habit within the village and continues to contribute to sustainable agriculture and environmental management in the long term.

CONCLUSION

The community service program on the conversion of household organic waste into liquid organic fertilizer in Metut Village, Mentarang Hulu District, Malinau Regency, North Kalimantan, was successfully implemented and achieved its intended objectives. The program significantly improved participants' knowledge, as evidenced by the increase in average test scores from 46.4 in the pre-test to 86.1 in the post-test. Furthermore, the participants acquired the practical skills necessary to independently produce liquid organic fertilizer from household kitchen waste through a bioactivator-assisted fermentation process. The program contributed to the reduction of household organic waste generation, decreased expenditure on chemical fertilizers, and provided an environmentally friendly fertilizer alternative to support sustainable agricultural practices. To ensure the initiative's long-term sustainability and broader impact, continued mentoring and the development of village-level waste management institutions are recommended. Future programs should also include laboratory analyses of the nutrient content of the liquid organic fertilizer to establish quality standards and facilitate its wider application in the community.

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Ethical Compliance

All procedures conducted during this community service program involving human participants in Metut Village complied with the standard institutional ethical guidelines. Participation was entirely voluntary, and the principles of informed consent were upheld by ensuring that all participants received adequate information regarding the activities and provided their consent. The program was implemented with due consideration for the participants' comfort, safety, privacy, and well-being throughout all stages of the activity.

Data Access Statement

The data supporting the findings of this community service program, including the questionnaire instruments, are available from the corresponding author upon reasonable requests. The pre- and post-test data collected during the program are not publicly available due to participant privacy and confidentiality considerations.

Conflict of Interest Declaration

The authors declare that they have no affiliations or involvement with any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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