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Utilization of Catfish Pond Wastewater for Liquid Organic Fertilizer Production in Mangir Village, Banyuwangi Regency

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ABSTRACT

Catfish pond wastewater, rich in essential nutrients such as nitrogen, phosphorus, and potassium, holds significant potential as a primary raw material for liquid organic fertilizer. In Mangir Village, Banyuwangi, this waste is not utilized optimally and is often discharged directly into the environment, causing pollution. This community service activity aimed to empower the Mangir Village Farmers Group through participatory training on converting catfish pond wastewater into environmentally friendly, economically valuable liquid organic fertilizer. The methods implemented included a participatory approach through socialization, technical training in fermentation processes, practical mentoring, and assistance with marketing strategy. The results demonstrated a significant increase in farmers' knowledge and skills in processing waste into high-quality liquid fertilizer. Furthermore, there was a noticeable rise in the group's interest in adopting organic farming practices. This initiative successfully produced a marketable liquid organic fertiliser, contributing to sustainable waste management, reducing environmental pollution, and decreasing farmers' dependence on chemical fertilisers. The activity also introduced the community to the concept of a circular economy, turning waste into a valuable resource. This empowerment model can serve as a reference for other regions seeking to develop sustainable, economically productive agricultural practices.

Keywords: Catfish Pond Wastewater, Liquid Organic Fertiliser, Farmer Empowerment, Sustainable Agriculture, Circular Economy.

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INTRODUCTION

The global expansion of aquaculture is a critical response to increasing demands for animal protein, yet it often generates significant environmental externalities, particularly through nutrient-rich effluent discharge (Faisal & Raisa, 2022). This challenge is particularly acute in small-scale,

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intensive catfish (Clarias sp.) farming, a sector characterized by rapid growth and high operational intensity. In Indonesia, a leading producer, this practice is a vital source of livelihood for countless rural communities. However, the sustainability of these operations is threatened by the direct environmental impact of their waste and the associated economic pressures, creating a cycle that undermines long-term viability. This report details a community service initiative in Mangir Village, Banyuwangi Regency, designed to address these interconnected challenges by transforming waste liabilities into agricultural assets. The partner for this activity is the "Mina Lestari" catfish farmers' group in Mangir Village. This group operates a collective of ten intensive catfish ponds, with a total production capacity of approximately 5,000 fish per harvest cycle. A preliminary situational analysis, conducted through direct observation and structured interviews with group members, revealed a critical and unmitigated problem: the management of pond wastewater. To maintain water quality and prevent the buildup of toxic ammonia and nitrite, the group performs routine partial water exchanges. This practice generates substantial wastewater volumes, estimated at 20-30 cubic meters per pond per cycle.

Historically, this nutrient-rich effluent, laden with organic matter from unconsumed feed, fish metabolites, and faeces, has been discharged directly into an adjacent irrigation canal without treatment. The group members identified this canal as the most convenient and cost-free disposal route. However, this practice has led to tangible negative consequences. Downstream local agricultural stakeholders have reported increased algal growth in water channels, a classic symptom of eutrophication. Furthermore, the farmers' group itself expressed concern about the long-term sustainability of its practice, acknowledging its potential to conflict with neighbouring crop farmers and to contribute to local environmental degradation. This situation represents a classic linear economic model, in which resources (water and feed) are consumed, and a byproduct is disposed of, creating a negative externality. Simultaneously, the partner group faces significant economic pressures that compound the environmental issue. The rising cost of commercial fish feed constitutes their most considerable operational expense. The direct discharge of wastewater signifies a total loss of the residual nutrients, notably Nitrogen (N), Phosphorus (P), and Potassium (K), for which they have already paid through feed inputs. This represents a direct economic waste. Concurrently, the agricultural community within and around Mangir Village, including many families involved in fish farming, struggles with the volatility and high cost of synthetic fertilizers. Interviews with farmers revealed that access to affordable, reliable fertilizer is a significant constraint on their crop productivity, forcing them to reduce application rates or to seek inferior alternatives, ultimately depressing yields.

Therefore, the core problem for the "Mina Lestari" group is twofold: 1) An environmental problem of polluting wastewater discharge that threatens local water bodies and community relations, and 2) An economic problem characterized by the loss of valuable nutrients and high input costs for both aquaculture and agriculture. This analysis clearly demonstrates that the partner is trapped in an unsustainable model in which a cost centre (waste management) is separated from a potential value stream (nutrient recycling). In this context, our intervention was formulated. The circular bio-economy paradigm offers a viable solution, proposing that waste streams can be redesigned as inputs to other processes (Alfahnum et al., 2024). The high nutrient content of the catfish pond wastewater, which currently makes it a pollutant, is precisely what makes it a potential raw material for liquid organic fertilizer (LOF). By converting this effluent into LOF, the partner group can simultaneously resolve its waste problem and create a new, marketable product. This integrated approach directly addresses the identified needs: it mitigates environmental pollution, provides an affordable fertilizer for local agriculture, and creates a new income stream to enhance the economic resilience of the fish farmers. Consequently, this community service programme was not merely a theoretical exercise but a direct response to a validated and pressing need. The following report outlines the participatory methods employed to empower the "Mina Lestari" group with the knowledge and practical skills to implement this eco-innovation, thereby transitioning from a linear waste disposal model to a circular value-creating system.

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METHODS

The Community Service activity was conducted from May to August 2025, employing a participatory and methodical approach to ensure effective knowledge transfer and sustainable adoption of the technology. The implementation was structured into four distinct, interconnected stages: (1) Preliminary Socialization and Participatory Problem Identification, (2) Technical Training on Liquid Organic Fertiliser (LOF) Production, (3) Hands-on Practical Implementation and Marketing Guidance, and (4) Comprehensive Monitoring and Evaluation. The initial stage, Preliminary Socialisation and Participatory Problem Identification, spanned the first two months (May-June 2025). This critical phase was designed to build trust and ensure the intervention was tailored to the community's specific needs. It commenced with in-depth observations and semi-structured interviews conducted with key members of the Mangir Village Farmers Group. These discussions aimed to comprehensively understand the local agricultural and aquaculture practices, with a specific focus on identifying challenges related to waste management and the financial burden of chemical fertilizers. Particular emphasis was placed on collaboratively exploring current management practices for catfish pond wastewater, quantifying its volume, and mapping its disposal pathways to fully assess its environmental impact. This participatory diagnosis ensured that the proposed solution, converting waste into LOF, was directly relevant and addressed a genuinely felt need within the community.

Following the problem identification, the Technical Training on LOF Production was delivered. This structured training module was conducted collaboratively with the community partners. The curriculum was designed to be accessible and comprehensive, covering the scientific rationale and the step-by-step practical methodology for processing catfish pond wastewater. The core technical process involved teaching the participants the correct formula and procedure for fermentation. This included precisely mixing raw catfish pond wastewater with additives: molasses (or palm sugar) as a carbohydrate source to feed beneficial microorganisms, and a starter culture of Effective Microorganisms (EM4) to inoculate the solution and accelerate aerobic decomposition of organic matter. The participants were thoroughly instructed on the importance of using sealed, anaerobic containers for a fermentation period of 7 to 21 days, during which microbial activity would break down organic components and stabilize the nutrient content. The training also covered post-fermentation steps, including simple quality checks (e.g., pH and aroma) and the final packaging of the finished LOF product. The third stage, Hands-on Practical Implementation and Marketing Guidance, was crucial for translating theoretical knowledge into tangible skills. Participants were not merely passive listeners; they were actively involved in the entire production cycle under the service team's guidance. This hands-on session included collecting wastewater, calculating and mixing the raw materials, filling and sealing the fermentation drums, and finally bottling the matured fertilizer. To ensure the initiative's economic sustainability and empower the group to become self-reliant entrepreneurs, the service team embedded a practical business development component within the training. Before the technical production, dedicated sessions were conducted to equip participants with actionable marketing and business skills. This focused on transforming their perception of the fertilizer from a mere byproduct into a marketable commodity. The guidance was efficient, covering:

1. **Market Identification and Value Proposition:** Participants were guided to identify and segment their primary customer base, such as local vegetable growers, chilli farmers, and ornamental plant enthusiasts, and to articulate the unique selling points of their product (e.g., 'an affordable, locally-made organic fertilizer that improves soil health').
2. **Financial Literacy:** We facilitated hands-on exercises to calculate the cost of production per litre, determine the break-even point, and establish a competitive yet profitable pricing strategy.
3. **Sales and Distribution Channels:** The team explored feasible, low-cost marketing avenues, including direct promotion within their personal networks, consignment agreements with local agricultural supply shops (warung tani), and leveraging social media platforms like WhatsApp and Facebook for community-based marketing."

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The final stage, Monitoring and Evaluation, was conducted towards the end of the project period (August 2025). This phase aimed to assess the effectiveness of the intervention and the competency level of the farmers' group. The service team evaluated participants' understanding of the production process and their proficiency in the practical skills required, including fermentation management and product packaging. This evaluation was conducted through direct observation, participants' practical demonstrations, and focused group discussions to gather qualitative feedback on the challenges and successes encountered, thereby providing insights for future program refinement.

RESULTS AND DISCUSSION

The community service program was implemented in Mangir Village, Rogojampi District, Banyuwangi Regency, through a series of structured stages. The initial phase involved an extensive survey, conducted five times through discussions and interviews with the Mangir Village Farmers Group. This was crucial for identifying the core problem: the unmanaged discharge of catfish pond wastewater and its environmental consequences.

Following the problem identification, the program was executed through the following key stages:

1. Identification of Catfish Pond Wastewater Issues: Over 1 to 2 months, the team conducted observations and interviews to thoroughly understand the partners' challenges related to waste management and fertilizer use, confirming that direct wastewater discharge was the primary issue.
2. Technical Training on Liquid Fertiliser Production: A training session was held to transfer knowledge on processing catfish pond wastewater into liquid organic fertilizer. The training covered the use of additives (molasses/palm sugar, EM4), the fermentation process, and packaging.
3. Practical Session on Liquid Fertiliser Production and Marketing Guidance: This hands-on session ensured participants could independently execute the fermentation process, from mixing ingredients to storing and packaging the final product. Furthermore, the partners were educated on fundamental marketing management, including identifying target markets (e.g., local vegetable farmers) and developing simple online and offline marketing strategies.

Figure 1. Training Session on Liquid Fertiliser Production from Catfish Pond Wastewater
Source: Primary Documentation

4. Monitoring, Evaluation, and Equipment Grant: The service team evaluated the partners' capabilities in production and packaging. To ensure the sustainability of the initiative, a set of fermentation equipment was granted to the group (Figure 2).

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Figure 2. Grant of Fermentation Equipment for Catfish Pond Wastewater
Source: Primary Documentation

To measure the program's impact, a comparative analysis of the partner's condition was conducted, focusing on three key aspects, as summarised in Table 1.

Table 1. Comparative Analysis of Partner Conditions Before and After the Training Intervention

Aspect Evaluated	Condition Before Training	Condition After Training
Waste Utilization	Catfish pond wastewater was discharged directly into the environment, causing pollution.	Wastewater is now processed into liquid organic fertilizer, reducing pollution and creating a valuable resource.
Technical Processing Skills	Partners lacked the knowledge and skills to process the wastewater.	Partners have independently acquired the technical competency to produce liquid organic fertilizer through fermentation.
Fertiliser Production Practice	No practical experience in creating value-added products from waste.	Partners can actively produce, package, and manage the production of marketable liquid organic fertilizer.

Source: Primary data, processed by the authors.

The results demonstrate a significant transformation in the practices and capabilities of the Mangir Village Farmers Group. The comparative data in Table 1 clearly indicate that the intervention successfully addressed the identified problems, moving the partners from a linear waste-disposal model to a circular-economy framework. Before the training, the partners were trapped in a cycle where aquaculture waste was an environmental liability. The direct discharge of nutrient-rich wastewater was a source of pollution, and the economic value locked within this waste stream was entirely lost. The post-training condition reveals a fundamental shift. The partners now possess the technical skills to convert this waste into a valuable product, thereby closing the nutrient loop. This directly mitigates the environmental pollution they had previously contributed to, aligning with the findings of Pardiansyah et al. (2019) on the polluting potential of aquaculture effluent.

The acquisition of technical processing skills is the cornerstone of this transformation. The hands-on training empowered the partners, moving them from a state of dependency to one of self-reliance. This empowerment is critical to the initiative's long-term sustainability, as noted by Noer et al. (2025), who emphasize that knowledge transfer is vital to stimulating local economic innovation. The ability to independently manage the fermentation process ensures that liquid organic fertilizer

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production can continue beyond the service program. Furthermore, integrating marketing guidance was a crucial step toward economic viability. By educating partners on target markets and sales strategies, the program helped reframe the liquid organic fertilizer from a mere technical output into a potential source of income. This creates a direct economic incentive for the farmers to continue the practice, enhancing the resilience of their operations by diversifying income streams, as suggested by Sartika et al. (2024). The creation of a marketable product from a former waste stream is a textbook example of the circular bio-economy in action (Alfahnum et al., 2024). In conclusion, the program's success lies in its integrated approach. It did not merely provide a technical solution for waste management but also built local capacity and addressed the economic dimensions of the problem. The transformation observed in the Mangir Village Farmers Group from seeing wastewater as a problem to valuing it as a resource exemplifies the principles of a circular economy. This model not only improves local environmental conditions but also fosters sustainable rural development by creating new value chains from existing resources, making it a replicable example for other regions facing similar challenges.

CONCLUSION

This community service initiative successfully resolved the partner's core problems: environmental pollution from untreated wastewater and a lack of valuable byproducts. The outcome is that the Mangir Village Farmers Group can now independently process their catfish pond waste into liquid organic fertilizer, creating a new economic opportunity and mitigating their environmental impact. The main challenge overcome was the partners' initial lack of technical skills and their perception of wastewater as a useless pollutant. Future activities should focus on developing a sustainable business model and marketing strategy for the fertilizer to ensure long-term economic benefits. The authors would like to express their deepest gratitude to Banyuwangi State Polytechnic for funding this Community Service activity through its Centre for Research and Community Service (P3M). Appreciation is also extended to the Mangir Village Government and the Mangir Village Farmers Group for their active participation and full support throughout the activity. The authors also thank all parties who contributed to the completion of this activity and the writing of this article.

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