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Empowering Communities by Sustainably Utilizing Tourism Waste Through Maggot-Based Feed Innovation for Biofloc Farming

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ABSTRACT

This community engagement program was conducted to address organic waste accumulation in the Gentala Arasy tourism area of Jambi City, which contributes to environmental pollution and affects public health. In collaboration with Bank Sampah Omah Sinau, the initiative focused on converting sugarcane pulp and corn cobs into fish feed for local biofloc-based catfish farming. The program adopted a participatory model consisting of awareness campaigns for local vendors, technical training in waste processing, modification of waste shredders to electric motor systems, cultivation of black soldier fly (BSF) larvae, and the production of pellet feed using organic waste materials. The modified equipment significantly reduced noise and air pollution while improving processing efficiency. Community members were actively involved in all stages, with evaluation results indicating that 70% of participants had developed the skills to independently produce pellet feed. The program also included workshops on financial literacy and small-scale business planning to support long-term sustainability. Despite challenges such as inconsistent waste supply and the absence of a structured distribution system, the initiative successfully enhanced the community's capacity in sustainable aquaculture practices. This model highlights the potential of integrating appropriate technology and waste management for community empowerment and circular economic development.

Keywords: Alternative Feed; Aquaculture; Community Empowerment; Maggot; Waste Management

INTRODUCTION

The tourism area surrounding Gentala Arasy Bridge, commonly known as Ancol Jambi, is one of the most popular destinations in Jambi City. The vibrant trading activities, such as vendors selling grilled corn and sugarcane juice, generate organic waste, including sugarcane pulp and corn cobs, which are often discarded improperly. After trading hours conclude, this waste is frequently scattered across the tourism site and is only cleaned each morning by sanitation workers, who subsequently transport it to Temporary Disposal Sites (TPS). This situation is not solely the responsibility of the Sanitation Department; it is also a pressing concern for the local administrative authorities at both the sub-district and district levels in East Jambi. Moreover, the habit of visitors and traders discarding waste directly into the Batanghari River further exacerbates the issue, resulting in environmental pollution, the deterioration of the area's aesthetics, unpleasant odors, the spread of diseases, and an increased risk of flooding due to waste accumulation.

This phenomenon reflects the suboptimal management of organic waste within the tourism area. Inadequate organic waste

management can lead to environmental pollution, eutrophication, the deterioration of urban aesthetics, greenhouse gas emissions, and adverse impacts on human health (Sharma et al., 2019). Additionally, mismanagement of organic waste not only poses environmental risks but also represents a missed economic opportunity, considering the availability of various waste processing technologies capable of producing value-added products (Sampat et al., 2019).

This situation reveals a significant gap between the potential for organic waste utilization and the implementation of sustainable management systems in tourism areas. Therefore, an alternative approach is urgently needed—one that not only alleviates environmental burdens but also provides economic benefits to the surrounding community.

This community service initiative was designed as an integrated effort to address both environmental challenges in the tourism area and the need for alternative feed in catfish (Clarias sp.) aquaculture. The proposed scheme, based on community empowerment, was carried out by a team from Batanghari University in collaboration with the Omah Sinau Waste Bank, a POSYANTEK (Integrated Technology Service Post) located in RT 24, Tanjung Sari Sub-district, East Jambi District. This partner institution operates a waste bank and simultaneously cultivates catfish using a biofloc system across four independently managed ponds.

In aquaculture, the management of production ponds is a constant challenge, particularly concerning the accumulation of nitrogen compounds, which can severely impact aquatic animal physiology and result in significant production losses. Ammonia (NH_3), nitrite (NO_2), and nitrate (NO_3) exhibit toxicity at varying levels under different environmental conditions; in this context, biofloc technology offers an effective alternative by converting nitrogenous compounds into non-toxic forms (Robles-Porchas et al., 2020). Biofloc systems provide an environmentally efficient fish farming method by utilizing microbial communities within a closed system to enhance feed digestibility (Bossier & Ekasari, 2017). Furthermore, this technology promotes an integrated and sustainable food production system, capable of producing higher yields with less land and fewer inputs. Nevertheless, the partner organization continues to face the significant challenge of high feed costs.

Based on the study by Wibowo, Nataliningsih, and Permana (2022), a single biofloc pond requires approximately 4.4 kilograms of feed per day, a demand that the partner struggles to meet due to the continuously rising cost of feed and the fluctuating, often declining, price of catfish in the market. This economic pressure, where high production costs are not matched by sufficient income, is a common issue among fish farming communities, as also experienced by the aquaculture group in Lopak Alai Village (Mufidah et al., 2021). This situation underlines the urgent need for more affordable and sustainable alternative feed sources. In this context, organic waste from the tourism area, such as sugarcane pulp and corn cobs, offers potential to be processed into alternative fish feed through the cultivation of maggots (Black Soldier Fly larvae), known for their high protein content.

Odjo et al. (2019) emphasize that maggots are a highly nutritious animal protein source that can be integrated into feed for fish and monogastric livestock. Developing maggot production techniques emerges as a promising solution to help farmers overcome the challenges of feed availability. Given that catfish are carnivorous and highly adaptable to a variety of natural and formulated food sources, maggots present an ideal alternative to commercial fish feed (Jayadi et al., 2024).

However, the partner institution continues to encounter operational difficulties in processing organic waste due to frequent breakdowns of their diesel-powered waste shredder, which requires high maintenance costs and contributes to both air and noise pollution

(Priono et al., 2019). To overcome this issue, the community service team, together with Electrical Engineering students from Batanghari University, took the initiative to modify the waste shredder by incorporating electric motor technology. This modification aims to lower operational costs, reduce pollution, and facilitate the production of pelletized alternative feed from organic waste.

This innovation introduces a significant novelty by converting waste from tourism activities into fish feed through the application of appropriate and sustainable technology. Waste that once polluted the tourist environment can now be repurposed as a productive resource for alternative feed production, thereby closing the waste cycle. Furthermore, the program seeks to strengthen the institutional capacity of the partner organization, particularly in the areas of financial management and marketing. Currently, the partner lacks a robust financial recording system, relying predominantly on intuition for business planning rather than empirical data. Their limited understanding of market dynamics renders them vulnerable to price fluctuations and exploitation by middlemen (Zahari & Lastari, 2021).

Therefore, this community service program offers an integrated approach: technology modification, environmental education, feed innovation, and training in financial management and marketing. It is hoped that these efforts will not only help restore the environmental quality of the tourist area but also bolster the economic resilience of the partner institution and the surrounding fish farming community. The Omah Sinau Waste Bank could serve as a model of integrative management for waste processing, feed production, and community economic empowerment around tourism areas. A fundamental shift in paradigm and behavior regarding waste and local resource management is crucial to achieving a better quality of environment and life.

METHODS

This community engagement program was carried out at Omah Sinau, an Integrated Technology Service Post (POSYANTEK) that also functions as a waste bank and a small community library. It is located on Prabu Siliwangi Street, RT 24, Tanjung Sari Sub-district, East Jambi District, Jambi City. The partner organization consists of 37 active managers and members who are involved in educational activities and integrated waste management efforts.

Figure 1. Mini Library Room and Member Meeting Area

The approach employed was a participatory community empowerment model. The activities engaged lecturers and students from various study programs at Batanghari University, including Electrical Engineering, Economic Management, and Aquaculture. The methods applied in this program included: Community awareness campaigns, technical training and mentoring, application of appropriate technology, problem-solving workshops, and activity evaluations.

1. Program Stages and Implementation Timeline

This community service program was implemented from May to October 2024, with the following detailed stages:

a. Initial Awareness and Education Campaigns (May–June 2024)

Awareness campaigns were conducted among sugarcane juice and corn vendors operating in the Gentala Arasy tourism area. The objective was to raise awareness of the importance of organic waste management. Vendors were instructed to separate sugarcane pulp and corn cobs to prevent indiscriminate disposal and

encourage their utilization as raw materials for fish feed production.

b. Technical Training and Mentoring (June–August 2024)

The community and partner members received training on waste management, organic waste shredding, and fish pellet production processes. Regular mentoring sessions were provided by lecturers and students to strengthen technical capacities.

c. Shredder Machine Modification (July–August 2024)

The partners' existing diesel-powered waste shredder was modified to utilize an electric motor, aiming to reduce air and noise pollution while lowering operational costs. To enhance energy efficiency, a solar panel system was also installed as an auxiliary power source.

The redesigned shredder adopted a system that efficiently cut organic waste into smaller pieces, powered by an electric motor. Compared to diesel engines, electric motors offer lower environmental pollution levels (Nugraha et al., 2020). Selecting the right drive components was essential to maintain optimal machine performance and efficiency (Subhidin, 2022).

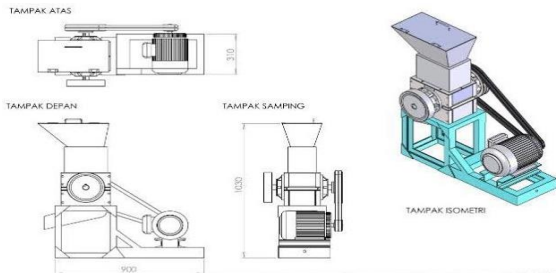

Figure 2. Design of Waste Shredder Modification Using an Electric Motor

d. Pellet Feed Production (August–September 2024)

The shredded waste was processed as raw material for fish pellet production. This activity was part of the innovation effort to convert organic waste into economically valuable products for the community and the partner institution.

e. Workshops and Evaluation (September–October 2024)

Workshops were organized to identify solutions for challenges in catfish farming and to evaluate the outcomes of the project. Evaluations focused on behavioral changes, skill improvements, and the impact of applied technology on partner productivity.

2. Tools and Techniques Used

a. Modified waste shredder equipped with an electric motor
b. Solar panels for supporting energy efficiency
c. Fish pellet molding equipment
d. Participatory evaluation forms (both quantitative and qualitative)

3. Role of the Partner Organization

The Omah Sinau partner organization served as the host site, activity facilitator, and end-user of the implemented technologies. They were responsible for coordinating the collection of waste from vendors at the tourism site and managing the produced feed for catfish cultivation. This role is expected to strengthen the program's sustainability and enhance the partner's long-term self-reliance.

RESULTS AND DISCUSSIONS

As part of the program's goals, community activities focused on raising environmental awareness and promoting sustainable waste management. One of the main activities is outlined in the following section.

1. Environmental Awareness and Education Campaigns

An environmental awareness campaign was conducted on July 17, 2024, in the Gentala Arasy tourism area, involving 50 participants, including the East Jambi Sub-district Head, community leaders, and vendors of sugarcane juice and grilled corn. The event focused on educating participants about the importance of organic waste separation, maintaining the cleanliness of tourist sites, and utilizing organic waste as raw material for fish feed.

Figure 3. Waste Utilization Awareness Campaign with Waste Bank Participation

As shown in Figure 3, the campaign ran successfully and reached the targeted number of participants. The Waste Bank Omah Sinau played an active role in delivering educational material, with community leaders and vendors demonstrating strong participation. As emphasized by Pratama et al. (2021), community empowerment initiatives are most effective when they involve local organizations, leaders, and government agencies and engage the broader community actively.

2. Maggot Cultivation for Feed Ingredients

To reduce fish feed costs, the partner organization developed a maggot farming facility using shredded organic waste as the growing medium. After 21 days of cultivation, maggots were harvested, with some directly used as feed and the rest dried for pellet production. According to Jovantheo et al. (2022), BSF (Black Soldier Fly) larvae offer high nutritional value, containing approximately 42–45% protein, 31–35% fat, and 20% ash. Yunianta et al. (2023) further stated that BSF maggots could provide up to 52% crude protein, making them an excellent source for catfish feed. Proper feeding management, based on fish body size, is essential to maximize feed efficiency, promote fish growth, reduce operational costs, and maintain water quality. Setiawan et al. (2021) found that using maggot-based feed at a 75% substitution rate significantly improved absolute weight gain, gut structure, and muscle organ development in catfish.

Figure 4. Maggot Breeding Cage

Figure 5. Harvest-Ready Maggots

Figure 4 shows the maggot rearing cages constructed by the partner organization, while Figure 5 illustrates the harvested maggots ready for use. Harvested maggots were weighed to determine the appropriate composition for pellet formulation.

3. Organic Waste-Based Fish Feed Production

The raw materials for pellet production included corn cobs, sugarcane pulp, tofu dregs, maggots, cow manure, tapioca flour, vitamins, and minerals. Tofu dregs were sourced from a local tofu factory and processed together with other organic ingredients.

Figure 6. Waste Shredder Machine Modified with an Electric Motor

The shredding process was carried out using a machine modified with an electric motor, replacing the previous diesel engine. As illustrated in Figure 6, the modified shredder

was designed to reduce air and noise pollution, important considerations given its proximity to the community library. Maciejewska et al. (2019) highlighted that internal combustion engines, such as diesel engines, emit greenhouse gases and other pollutants, while electric motors offer a more environmentally friendly alternative.

Figure 7. Drying Process of Shredded Organic Waste

Figure 8. Ground Raw Material Result

The shredded materials were then sun-dried for three days (Figure 7), ground into fine powder (Figure 8), mixed, and formed into pellet feed.

Table 1. Composition and Formula of the Manufactured Fish Feed

No	Proximate Composition (%)	Feed Material Content					References
		Protein	Carbohydrate	Fat	Ash	Moisture	
1	Corn Cob	3,4	17,4	13,3	30	14	(Widaningsih et al., 2018)
2	Sugarcane Bagasse	1,9	47,5	0,6	2,6	10,6	(Rafles et al., 2017)
3	Tofu Waste	15,8	27,4	2,6	2,8	11,4	(Fillaili & Ningtyias, 2020)
4	Tapioca Flour	0,8	85,3	0,7	0,1	13	(Herawati, 2019)
5	Cow Manure	14,9	62,2	-	13,0	10	(Syarizal, 2024)
6	Maggot	47,1	7,5	25,3	6,25	10,79	(Makinde, 2015)

Source: Processed Data

According to Table 1, maggot meal contributed the highest protein content (47.1%), followed by tofu dregs with 15.8%. This highlights the potential of local organic waste to serve as a valuable, high-protein feed resource, supporting the findings of Handayani et al. (2021) that organic waste, when properly processed, can generate significant economic value for use as animal feed or fertilizer.

The pellet molding process is depicted in Figure 9, and the final fish feed product created by Omah Sinau is shown in Figure 10.

Figure 9. Fish Pellet Molding Process

Figure 10. Fish Feed Pellets Produced by Omah Sinau

Laboratory analysis confirmed that the pellets contained between 30% and 36% protein (Anam et al., 2019), meeting the nutritional standards required for optimal catfish growth.

4. Evaluation and Partner Capacity Building

After completing the training sessions, the partner organization demonstrated improved technical competencies. Monitoring data revealed that 70% of members were able to independently produce fish pellets, as reflected in Figure 11, which shows participants' understanding of pellet-making techniques.

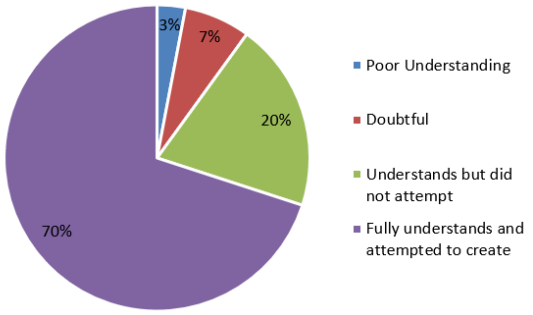

Figure 11. Partners' Understanding of Fish Pellet Production

The evaluation process used a combination of knowledge-based tests, observational skill assessments, and participatory monitoring sheets. This method aligns with Alastalo (2020), who emphasized that combining theoretical knowledge tests with skill observations provides a comprehensive assessment of competencies, ensuring both understanding and application.

Thus, the educational interventions, technical mentoring, and the introduction of appropriate technology successfully enhanced the capabilities and independence of the partner community.

The findings indicate that combining educational approaches with appropriate technology can significantly impact organic waste management practices. Environmental education increased public awareness and created new economic opportunities through waste valorization.

Maggot cultivation emerged as a sustainable and cost-effective alternative feed source. Odjo et al. (2019) stressed the importance of maggots as a protein-rich supplement for fish and livestock diets. Jayadi et al. (2024) also highlighted the adaptability of catfish to various feed sources, including maggots.

Utilizing sugarcane pulp, corn cobs, and tofu dregs provided a practical solution by leveraging local resources. As noted by Fauzi et al. (2012), sugarcane pulp contains over 70% polysaccharides, while tofu dregs offer a high protein content (Fillaili & Ningtyias, 2020). Laboratory analysis confirmed that the fish pellets produced were nutritionally adequate (Anam et al., 2019).

The use of an electric motor-powered shredder aligned with environmentally sustainable practices, reducing both noise and air pollution compared to diesel-powered machines (Nugraha et al., 2020; Subhidin, 2022).

Economically, the adoption of self-made feed production reduced operational costs and improved profitability for the community partner. The program also strengthened organizational capacity in production management and business planning.

Nonetheless, certain limitations were identified: the availability of waste depended on seasonal vendor activity, the modified machines require further testing for long-term durability, and the distribution network for the produced pellets is still underdeveloped.

To address these challenges, future initiatives should prioritize:

1. Developing SOPs for household-scale maggot farming and pellet production,
2. Providing additional training in financial management and marketing strategies,
3. Building stronger distribution networks through local cooperatives,
4. Strengthening partnerships with universities for internships and technology development programs.

These steps aim to reinforce the foundation for the program's long-term sustainability, in line with Ceptureanu et al. (2018), who emphasized that sustaining community-based programs is critical to maintaining their positive impacts and community trust.

CONCLUSION

This community engagement program successfully demonstrated that the sustainable utilization of tourism waste through appropriate technology and community empowerment can effectively address environmental challenges while creating economic opportunities. The modification of waste shredders with electric motors reduced pollution and operational costs, while the production of maggot-based fish feed provided a cost-effective alternative for catfish farming, with 70% of participants able to independently produce pellets. However, limitations were observed, including seasonal fluctuations in waste availability, the need for long-term testing of the modified shredder's durability, and the underdeveloped distribution network for the produced feed. Future studies should focus on developing standardized protocols for small-scale maggot and pellet production, exploring the durability and scalability of the technological innovations, enhancing financial and marketing training, and building cooperative-based distribution models to ensure the long-term sustainability and broader replicability of the initiative.

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