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Empowering Fish Farmers through Tubifex sp. Cultivation Using Fermented Organic Waste to Improve Feed Self-Sufficiency and Reduce Costs

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ABSTRACT

Background: The availability of high-quality natural feed is a crucial factor in the success of fish farming. Tubifex sp. is a natural feed with high protein content, yet its availability in the wild is often inconsistent and highly dependent on environmental conditions. The Mina Barokah Fish Farmers Group in Samarinda has long relied on wild-caught Tubifex sp., which is subject to fluctuations and requires significant time and cost for collection.

Purpose of the Study: This community service program aimed to provide knowledge and practical skills in cultivating Tubifex sp. using fermented organic waste, enabling the group to produce natural feed independently and sustainably.

Methods: The program involved 13 members and was carried out through presentations, discussions, hands-on training, continuous field mentoring, and evaluation using pre-tests and post-tests.

Results: The average knowledge score increased from 55% in the pre-test to 85% in the post-test. In addition, three cultivation units were successfully established, and the first harvest reached 300-500 grams per unit per week. The program strengthened natural feed self-sufficiency, promoted the utilization of local organic waste, reduced feed procurement costs by up to 40%, and encouraged environmentally friendly aquaculture practices. Overall, this initiative contributed to improving both the economic resilience and technical capacity of the fish farmers.

Keywords

Fish farming; Natural feed;
Organic waste; Tubifex sp.; Feed
self-sufficiency

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Introduction

Natural feed plays a crucial role in the fish seed production phase, as it determines survival rate, growth, and overall seed health. During the early life stages, fish larvae require feed that matches their mouth opening size, is easily digestible, and is rich in essential nutrients (Andriani et al., 2022). Tubifex sp. is one of the most widely used natural feeds in hatchery practices due to its high protein content (54–57%), complete essential amino acid composition, and high digestibility (Febrianti et al., 2020; Khotimah et al., 2023). However, the availability of Tubifex sp. in nature is highly dependent on aquatic environmental conditions and is seasonal, often leading to supply uncertainty, additional costs, and inconsistent quality.

The Mina Barokah Fish Farming Group is a community actively engaged in freshwater aquaculture, particularly catfish, tilapia, and gourami. Their activities cover the stages from hatchery to nursery, located at Talang Sari Street RT.02, Tanah Merah Village, North Samarinda District, Samarinda City. The group is supported by adequate facilities and infrastructure, including approximately 1,200 m² of land with 18 active concrete ponds, as well as sufficient water sources from irrigation and groundwater. It consists of 13 active members who possess basic experience in small-scale aquaculture and demonstrate openness to technological innovation. In addition, there is abundant access to organic waste from nearby markets and households.

However, the utilization of local organic waste and market waste as a medium for cultivating natural feed has not been optimized. The Mina Barokah group still relies on wild-caught Tubifex sp. to meet hatchery feed requirements, resulting in dependence on natural supply. This condition highlights a gap between the availability of local resources and the need for sustainable natural feed.

One potential solution is the cultivation of Tubifex sp. using organic waste, particularly tofu by-products, which are abundantly available in the surrounding area. The utilization of organic waste not only ensures an independent and sustainable supply of natural feed but also supports cost efficiency and environmentally friendly waste management in line with circular economy principles. Therefore, this community service activity focuses on training in Tubifex sp. cultivation based on fermented organic waste at the Mina Barokah Fish Farming Group. Through this initiative, it is expected that the group can enhance its independence in natural feed production, reduce reliance on wild supply, and strengthen the sustainability of its aquaculture practices.

Baseline knowledge assessment before the program showed that participants had an average initial knowledge score of 55%, indicating the need for structured training and practical mentoring in organic waste-based Tubifex sp. cultivation.

Method

The activity was conducted from July to September 2025 at the Mina Barokah Fish Farming Group (Pokdakan) site in Samarinda.

The implementation of the program employed four methods:

Presentation and Discussion: This session provided an overview of the benefits of Tubifex sp., cultivation techniques based on organic waste, and media quality management.

Field Practice: Participants conducted hands-on practice in Tubifex sp. cultivation, beginning with the construction of a worm “apartment” rack system as the culture container. The next step involved preparing a mud-based culture medium fermented with the addition of 10% organic material. Fermented tofu waste, the most abundant organic waste in the surrounding area, was used as the primary feed source for the worms. After the medium was prepared, Tubifex sp. seeds were evenly distributed into each culture unit. Participants also installed a water flow system

with an optimal discharge rate of 2 liters per minute to maintain media quality and oxygen supply. The final stage involved daily maintenance, including regular feeding, monitoring water flow, and removing excess sediment.

Assistance: The team provided direct guidance throughout the maintenance process.

Evaluation: Pre-tests and post-tests were conducted to measure knowledge improvement, along with monitoring of harvest outcomes.

Table 1: Activity Stages.

Meeting	Activity	Objective
Meeting 1	1) Participants' initial knowledge pre-test	1) Assess participants' initial understanding
	2) Program introduction	2) Provide an overview of the program
	3) Introduction of the implementing team	3) Introduce the mentoring team
	4) Introduction to equipment and culture media	4) Explain the importance of Tubifex sp. as natural feed
	5) Explanation of the nutritional value of Tubifex sp. and its role as natural feed	5) Raise awareness of organic waste management
	6) Introduction to the concept of utilizing organic waste	
Meeting 2	1) Demonstration of constructing culture racks ("apartment system")	1) Train farmer groups to prepare aquaculture facilities
	2) Guidance on preparing mud media through organic waste fermentation	2) Teach proper preparation of culture media
Meeting 3	1) Demonstration of tofu waste fermentation process	1) Provide knowledge about tofu waste fermentation
	2) Explanation of the benefits of fermentation	2) Guide participants in producing organic waste-based feed for Tubifex sp.
	3) Practical session on preparing feed for Tubifex sp.	
Meeting 4	1) Seeding/stocking Tubifex sp. into the culture media	1) Train participants in seeding and managing the culture media
	2) Installation of a water flow system with an appropriate flow rate	2) Teach water flow regulation and colony maintenance
	3) Practice of daily maintenance routines	
Meeting 5	1) Monitoring the growth and development of the colony	1) Ensure participants' ability to monitor the growth of Tubifex sp.
	2) Practice of harvesting techniques	2) Train partial harvesting techniques and problem-solving skills
	3) Discussion of challenges encountered during maintenance	
Meeting 6	1) Participants' final knowledge post-test	1) Measure the improvement in participants' knowledge
	2) Review of participants' understanding	2) Evaluate productivity and economic benefits
	3) Calculation of production efficiency and cost savings	
Meeting 7	1) Presentation of results (harvest achievements, culture units constructed)	1) Present the program outcomes
	2) Reflection and feedback session	2) Receive feedback from participants
	3) Closing and expression of gratitude	3) Strengthen program sustainability

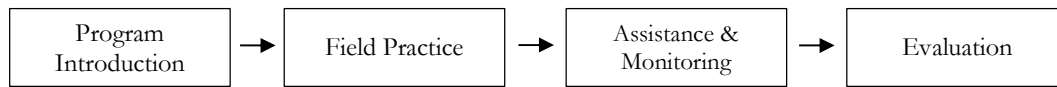


Figure 1. Method flowchart of the community service program

Results

The training activity was attended by 13 members of the Mina Barokah Fish Farming Group, consisting of hatchery-scale farmers cultivating catfish, pangasius, gourami, and ornamental fish. The results are presented according to the main implementation outputs: participant attendance, introduction phase, practical stage, and evaluation stage.

Table 2: Participant attendance during program implementation.

Meeting	Number of Participants	Attendance Rate (%)	Main Activity
Meeting 1	13 of 13	100.0	Program introduction and pre-test
Meeting 2	12 of 13	92.3	Rack construction and media preparation
Meeting 3	13 of 13	100.0	Tofu waste fermentation practice
Meeting 4	12 of 13	92.3	Stocking and water-flow installation
Meeting 5	11 of 13	84.6	Monitoring and harvesting practice
Meeting 6	12 of 13	92.3	Post-test and cost-efficiency calculation
Meeting 7	13 of 13	100.0	Presentation of outcomes and reflection

Overall, participant attendance ranged from 84.6% to 100.0%, with an average attendance rate of 94.5%, indicating strong commitment to the program activities.

Introduction Phase

Participants receive theoretical material on the role of *Tubifex* sp. as a natural feed, its nutritional value, and its advantages in enhancing fish seed growth. The presentation also covers the principles of organic waste-based aquaculture and the environmental benefits of this system.

The first topic introduces silk worms (*Tubifex* sp.), including their habitat, feeding habits, and reproduction. The material then continues with cultivation techniques of *Tubifex* sp., starting from the preparation of tools and materials, construction of the “apartment system” racks, fermentation processes, and maintenance practices.

The second topic discusses the potential of organic waste available in Samarinda, which is easily obtained and can be utilized as supplementary feed to support the growth of *Tubifex* sp.. In this session, members of the fish farmer group (Pokdakan) together with the Community Service Team from Mulawarman University determine the types of organic waste to be applied in the practical cultivation of *Tubifex* sp..



Figure 2. Introduction Phase of Tubifex sp. Cultivation as Natural Fish Feed

Practical Stage

Construction of Tubifex Worm Rack System: Each rack unit consisted of stacked plastic containers measuring $60 \times 40 \times 20$ cm, arranged vertically to optimize space efficiency and facilitate harvesting. The structure was built using lightweight steel with overall dimensions of 2×1.7 meters and covered with a transparent fiber roof. The construction process actively involved the participation of members of the Mina Barokah Fish Farming Group.



Figure 3. Practical Stage: Construction of the Tubifex sp. Rack System

Preparation of Fermented Mud Media: The mud was collected from settled ponds and then mixed with organic materials (rice bran and vegetables) at 10% of the total media volume. The mixture was fermented for 5–7 days until it developed a characteristic fermented odor, indicating optimal microbial activity.



Figure 4. Practical Stage: Preparation of Fermented Mud Media

Preparation of Fermented Tofu Waste as Feed for *Tubifex* sp.: Fresh tofu waste was fermented using liquid probiotics for three days to reduce fat content and break down proteins into more easily digestible forms for *Tubifex* sp. According to [Daeli et al. \(2025\)](#), anaerobically fermented tofu waste produces feed with high protein content and essential nutrients, making it a potential sustainable raw material for *Tubifex* sp. cultivation.



*Figure 5. Practical Stage: Preparation of Fermented Tofu Waste as Feed for *Tubifex* sp.*

Stocking of *Tubifex* sp. Seeds: *Tubifex* sp. seeds obtained from previous cultivation were evenly distributed into each culture container.



*Figure 6. Practical Stage: Stocking of *Tubifex* sp. Seeds*

Water Flow Installation: PVC pipes were installed to distribute water at a controlled flow rate of 2 liters per minute. This flow rate was sufficient to maintain media quality without disturbing the structure of the worm colonies.



Figure 7. Practical Stage: Water Flow Installation

Maintenance: Fermented tofu waste feed was provided every two days, accompanied by regular monitoring of water flow and removal of excess sediment to prevent media decomposition.

Evaluation Stage

Monitoring was conducted every 2–3 days to observe worm colony density, media quality, and feeding response. Knowledge evaluation was carried out through pre-tests and post-tests.

The average pre-test score of participants was 55%, indicating that their initial understanding was still limited to conventional *Tubifex* sp. cultivation and wild harvesting practices. After the training, the average post-test score increased to 85%, with most participants able to explain the cultivation stages and perform the practices independently. The practical output of the program was the establishment of three *Tubifex* sp. cultivation units. Partial harvesting began on day 14, with yields ranging from 300 to 500 grams per unit per week. The use of fermented tofu waste and the rack-based cultivation system also reduced natural feed procurement costs by up to 40% compared with the previous reliance on wild-caught *Tubifex* sp.

Discussion

The community service activity conducted at the Mina Barokah Fish Farming Group demonstrated that *Tubifex* sp. cultivation based on fermented organic waste is a simple yet effective technology to support the sustainability of fish hatchery operations. Evaluation results showed a significant increase in participants' knowledge, with the average score improving from 55% (pre-test) to 85% (post-test). Partial harvesting could be performed on day 14, yielding an average of 300–500 grams per unit per week. The rack system facilitated harvesting, fermented tofu waste accelerated colony growth, and a stable water flow rate of 2 liters per minute maintained media quality. This production system provided a tangible economic benefit by reducing natural feed costs by up to 40% compared to previous methods that relied on wild collection. These findings are consistent with [Rahmawati et al. \(2023\)](#), who reported that the use of fermented organic media can enhance the availability of natural feed while reducing dependence on wild sources. The rack system innovation also proved efficient in space utilization, simplified maintenance, and reduced mechanical disturbances to worm colonies. This highlights the importance of adaptive and space-efficient culture system design for sustainable natural feed production, in line with [Shobibah et al. \(2018\)](#), who emphasized that proper culture system design can improve spatial efficiency and productivity at small scales.

The use of fermented tofu waste as the primary feed source yielded positive results. Its high plant-based protein content, combined with microbial degradation during fermentation, enhanced the availability of essential nutrients for *Tubifex* sp. growth. [Wulandari et al. \(2020\)](#) demonstrated that fermented tofu waste improves feed digestibility and essential amino acid content, making it suitable for both worm and fish feed applications. This is supported by [Galuh et al. \(2024\)](#), who stated that organic waste fermentation plays a dual role in improving feed quality while reducing environmental pollution. Similarly, [Xu et al. \(2019\)](#) reported that fermentation of agro-industrial waste increases nutritional value and enriches probiotic content, making it a viable alternative feed source.

Another critical technical factor is the stability of water flow (2 liters per minute), which maintains oxygen-rich conditions while preventing ammonia accumulation. This is essential, as *Tubifex* sp. is highly sensitive to water quality and prone to population decline under unstable environmental conditions ([Sucipto et al., 2023](#)). Proper water flow management is therefore a key determinant of success in intensive *Tubifex* sp. cultivation. [Smutná et al. \(2008\)](#) also emphasized that stable water quality, particularly dissolved oxygen levels, is crucial for maintaining the productivity of benthic organisms such as *Tubifex*.

Beyond technical and economic benefits, this activity also generated positive social impacts by enhancing the technical skills of Mina Barokah group members in natural feed cultivation. Participants are now capable not only of producing *Tubifex* sp. for internal use but also of

marketing surplus production to other farmers. According to Kurniawan (2019), feed cost efficiency is a key factor determining the sustainability of small-scale aquaculture, indicating that this technology has the potential to improve the competitiveness of local farming groups. This aligns with Halawa et al. (2025), who highlighted that feed cost efficiency and local feed independence are strategic factors in supporting the economic sustainability of aquaculture communities.

However, several challenges remain, particularly in maintaining the stability of the fermentation process to prevent media decomposition and ensuring participants' consistency in regulating water flow according to standard requirements. These constraints should be addressed through continued technical assistance and the development of simple, practical standard operating procedures (SOPs) that are easily understood by group members.

Overall, the training activity on *Tubifex* sp. cultivation strengthens evidence that organic waste-based fermentation systems offer an innovative solution with multiple benefits: (1) providing a sustainable natural feed source, (2) reducing production costs, (3) minimizing environmental pollution, and (4) empowering local aquaculture groups through improved technical capacity.

Conclusion

The community service activity conducted at the Mina Barokah Fish Farming Group successfully improved the knowledge and technical capacity of its members in *Tubifex* sp. cultivation based on fermented organic waste. Evaluation results indicated a significant increase in participants' understanding, from an average of 55% to 85% after the training. The rack system and the use of fermented tofu waste proved effective, enabling partial harvesting from day 14 with production yields of 300–500 grams per unit per week. This technology contributed to reducing natural feed costs by up to 40%, minimizing environmental pollution, and enhancing the group's economic potential through the sale of surplus production. Overall, *Tubifex* sp. cultivation based on fermented organic waste represents an innovative and sustainable solution to support small-scale fish hatchery operations.

To ensure the sustainability of these outcomes, continuous technical assistance is necessary so that group members can consistently manage the fermentation process and regulate water flow. In addition, the development of simple and practical standard operating procedures (SOPs) is essential to minimize technical errors and maintain production quality. Future efforts may include scaling up the operation by increasing the number of rack units to enhance production capacity, allowing not only for internal supply but also for broader market opportunities. Further studies are also recommended to evaluate the nutritional quality of *Tubifex* sp. produced through fermented organic waste systems, enabling a more comprehensive comparison with wild-caught *Tubifex* sp.

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Conflicts of Interest

The authors declare no conflict of interest.

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